RUTGERS JERSEY ROOTS, GLOBAL REACH

Atlantic Crossing

14 dec

December 4: The Recovery

Posted by: Scott in: Atlantic Crossing

We arrived at the Investigador in the morning, about 9:30 am. We drove up from Baiona to Vigo in the rain, but it really doesn't matter if we get wet. All planning is based on the wave forecast. We need low waves to put the Zodiac in the water, and the small Zodiac is the safest way to approach The Scarlet Knight for recovery. The wave heights had peaked at 7 m, and they were forecast to come down. Nilsen was checking the different forecast products from the COOLroom, and emailed us that wave heights of 22 feet were being reported. It was the last environmental guidance we would receive from the COOLroom before heading out, and I would think of that email over and over again throughout the next day.

The Spanish Research Vessel Investigador was built for work. The Investigador has a vast aft deck, cranes on both sides, a large A-frame off the stern, a small Zodiac on the starboard, and numerous cabins for a large scientific crew. It's perfect for us. On the other hand, the Investigador was not built for speed. A typical operating speed is about 8 knots. We are also heading directly into the wind & waves, and that will certainly slow our progress. We have about an 18 hour steam directly into hard weather to get to Scarlet, so we are bracing for an uncomfortable ride. The crew is strapping down all the crates and toolkits on the deck. We leave Vigo at noon on Thursday, December 3. Lunch is served as we make our way west along the bay towards the sea. We pass Baiona off to our port side, and see it from the same point of view as the crew of La Pinta some 516 years ago.

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As we head out towards the Bay entrance, we get our first feel of the waves that will dominate every aspect of our lives for the next 2 days. We leave the protection of land, and we get to feel the downward side of that 7 m storm. We are seeing the occasional 20 foot wave but they are not the most prevalent – a good sign. We head to our bunks. There is little we can do while steaming into this sea, it's too rough to work on deck. The COOLroom has reduced The Scarlet Knight's surfacing interval to 2 hours. All that is required from us is to call in on the Iridium phone to get the updated position and pass it on to the Captain.

No one gets much sleep during this transit. You lay in your bunk but the waves slam you against the side wall, waking you. Every couple hours for the rest of the day and into the night it's the same routine – make your way up to the bridge, call the COOLroom for Scarlet's updated position, and write it on a piece of paper for the Captain. Most everyone skips dinner. The good thing we notice is that we are getting slammed into the side of our bunks less and less. More people are able to sleep. At 4 am I give the updated position to the Captain, and notice I am the only one from the scientific crew on the bridge or in the galley. By now I am getting used to the waves, and am hungry again. I think back to the cream filled croissants they serve for breakfast at the hotel, settle for a sandwich, and head down to my bunk. The next thing I know its Josh in my room, saying is time for the 6 am position check, and we have slowed the ship because we are close. Do I want to go recover a glider?

I head up to the bridge. The stillness of the past night is replaced by a hive of activity, with everyone working by the dim task lights illuminating only their own workspace. We scan the horizon around us. No lights from vessels. Clouds cover the moon. No sign of the sun. It is totally dark. Conversations are hushed. They give me the headset to talk to the COOLroom. John Kerfoot is on the other side. Its 6 am onboard the Investigador, and 12 midnight in the COOLroom. John tells me the COOLroom is packed and I am on the speakerphone. The room is full of our students, other scientists, and media. Once our voices from the ship are heard in the COOLroom, the webcams then broadcast both video and sound over the internet. Tina is there via an Instant Message video link to Antarctica, watching the procedure with a room full of colleagues at Palmer Station. I hear her voice from Antarctica and say we miss her on board the Investigador. Our students from the Azores and Canaries, our sponsors in DC, and my daughter in her dorm room in Vermont are among those watching over the web. But the conversation right now is between me and John Kerfoot. We are a few miles east of 12 W longitude, and Scarlet is a few miles west of 12 W. There are no ship lights on the horizon. Juan, the First Officer, shows me there are no ships on the radar for either the 6 mile or the 12 mile setting. The Investigador and Scarlet are alone at sea.

John in the COOLroom switches Scarlet to 15 minute missions, and the Investigador begins the approach. The Investigador crosses 12 W and continues to within 1 nautical mile of Scarlet. Its still pitch dark. We can't even see the waves, but we know they are much smaller simply because we are no longer getting hurled into the walls. All eyes are on the red lights of the Freewave modem. When the red light turns green, we have a line of sight radio modem connection directly to Scarlet, and three way communications between the crew on the Investigador, the crew in the COOLroom, and the glider at sea is established. The lights flicker between green and red, and the first glider speak from Scarlet is picked up on Chip's computer. We are still over a mile away, but Clayton and Chip installed the Freewave antenna high on the Investigadors mast. The antenna height increased our range, and we were seeing that impact. Soon we are within 1 mile and we have a solid green light and a strong signal between us and Scarlet. Three way typed messages are being sent between the Investagador, the COOLroom, and Scarlet. Someone jokes that it's probably the most expensive text messages they have ever sent.

The COOLroom tells us sunrise is still a couple hours away. We check the weather forecast. We have a narrow window of time. The 7 m waves from the storm have

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M	T	W	T	F	S	S
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25	26	27	28	29	30	31

« Dec

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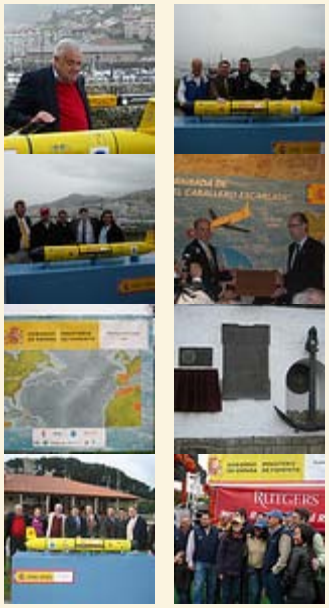


subsided and were now down to less than 3 m. The window could be as long as 6 hours before the next storm comes in and generates waves forecast to reach 8 m. At least the narrow window extends into daylight hours. We all agree that since the forecast weather window extends into daylight hours, a night recovery is too risky. We decide to maintain our position 1 mile to the west of Scarlet. After all this time at sea, there was no reason to risk a nighttime approach. The Captain says we should use this opportunity to serve breakfast, and that our cook has prepared bacon and eggs. The crew on the ship heads down to the galley. The COOLroom sent a few people out to get food at WaWa. My daughter in Vermont heard me say I was heading down to the galley for bacon and eggs and went to bed. We were 221 days since the launch of The Scarlet Knight off the coast of Tuckerton, New Jersey. The Investigador and Scarlet were now within 1 nautical mile of each other off the coast of Baiona in Galicia, Spain. We were at the exact place in time and space where we said we would be months earlier. We had rock solid communications with Scarlet, and she was telling us exactly where she was at that she was fine. I remember those early morning hours and that breakfast as being relatively relaxing for me. We were about to recover a glider after it completed its mission, something we had done well over 200 times, and I was confident in our abilities. The others around me in the galley say that they would not have used the word relaxed to describe my mood at that point.

Over breakfast we set the crews for the Zodiac. There would be three trips. The first Zodiac run will make a visual inspection of the glider as soon as there was enough light to see. The primary purpose was to ensure that it was safe for the divers to go into the water. We wanted to make sure there were no lines or anything else attached that the divers could get entangled in. We also wanted to make sure that the glider looked to be in good condition for recovery, that we would need no special tools. We would bring cameras, but the light was expected to still be too faint for quality photographs. If the glider looked to be in trouble, we would tie a line and a float to it, and use that for recovery from the Investigador if necessary. This Zodiac crew would make the first contact with Scarlet since the Azores. We gave that honor to Antonio Ramos from Universidad de Las Palmas de Gran Canaries and Enrique Fanjul from Puertos del Estando. I will be the third passenger on the Zodiac, and Juan, the Investigador's First Officer, will be the driver. After first contact, Antonio, Enrique and I would return to the Investigador. We would be replaced in the Zodiac by the two Rutgers divers Chip Haldeman and Dan Crowell, along with Clayton Jones from Teledyne Webb Research. Juan would drive them out to the Zodiac, and the two divers would go into the water for a complete video survey of Scarlet. The decision to not dive Scarlet for the video survey was made. Too many things could go wrong, and too much time with the glider and divers in the water. Scarlet will stay at the surface, and the divers will go in with snorkel gear, greatly simplifying the operation. The Zodiac would return to the Investigador with Clayton to pick up Dena Seidel and myself for the recovery. Juan would drive and Dena would film while Clayton and I pulled Scarlet on board and placed her in her cart. Juan would then return Dena, Clayton and me to the Investigador, and then recover the divers. Scarlet would remain in the Zodiac as it was hoisted aboard by the crane. During this process, Josh would give the play-by-play account over the Iridium phone to the COOLroom. Romeo would film from the Investigador.

Sunrise came about 8:30 am on the Investigador. It's hard to know exactly since the weather was cloudy. But that is about when the black night turn to gray and we could final see. Seas were just under 3 m. We began the approach. The Captain headed the Investigador east towards Scarlet. All available hands were on the deck in front of the bridge. Clayton climbed up into the crow's nest. Enrique, Antonio and I had already dressed for first contact. We were wearing our orange mustang suits and red Rutgers caps. We would be highly visible against the gray background of the sea. The approach was purposely slow, since we can either communicate with Scarlet or get a GPS position, but you can't do both. Space is a premium on gliders and satellite communications and satellite GPS both use the same antenna. Our plan was to go to the most recently reported position, break off communications so Scarlet could acquire a GPS fix, and then have her call back with the new position. When we arrived at the most recent position we had, Chip set Scarlet to call us back with a new position. When the new position arrived on the Investigador, we saw she had drifted to the south with the currents. The Captain turned to starboard along a southeast course. A few minutes later, Antonio called the first sighting.

"Over there! Over there! There she is!" Antonio was pointing just off our starboard side. The Captain turned the Investigador in the direction Antonio was pointing and we were on it in seconds. All aboard had a visual on Scarlet.

The recovery clock had started. We had a visual, we had to complete an underwater video survey of Scarlet to document her undisturbed condition, and get her safe on board the Investigador before the waves changed. We called time to go, and the first contact crew headed to the stern of the vessel. The crew craned the Zodiac over the side and Juan dropped down into it, started the engine and droving it around to the aft of the ship. The ships crew removed the safety line underneath the A-frame, clearing the path from the Investigador to the Zodiac. The waves moved the Zodiac up almost to the deck of the ship to maybe 6 feet below the deck. Boarding the Zodiac required you to time your jump to a rising wave crest. It was better to collide with a Zodiac coming at you then to fall 6 or more feet into Zodiac moving away from you. The crew called out the timing of the jump in Spanish. I didn't matter what they said, the instructions were understood by all. Antonio jumped first, followed by Enrique on the next wave, and me on the next. We arranged ourselves as best we could in the cramped Zodiac in seas that looked much higher from a 3 m Zodiac than the 47 m Investigador. Enrique took a position in the back with Juan, I in the middle, and Antonio in front. Juan gunned the engine and we were off in the waves for first contact with Scarlet.

As we approached, we could see the expected rings of barnacles on Scarlet that marked the seams between the major sections. Something we had seen before in the Azores. We saw that the top was coated with brown algae. Something new. Juan slowed the engine and started a quick loop around Scarlet. We could see that barnacles had also grown on the wings, another new development. Juan was a sailing champion in Spain, and was a master at handling the Zodiac in the rough seas. He completed the first lap in what seemed like no time. Scarlet was free of any lines or debris. We headed in for first contact, bow first. Antonio reached over the side, and touched Scarlet's tail fin, giving her what seemed like a gentle push. She responded as expected, submerging a bit and returning to the surface. Juan pulled the Zodiac alongside Scarlet. We could clearly see she was safe for the divers and ready for recover. I touched her on the pick point, and gave her a good push away from the boat and down into the water. Again the response was as expected, a submergence and a quick resurfacing. No need for a safety line. On her own, she was ready for the divers and for recovery.

Juan returned us to the stern of the Investigador. Getting back on the ship was an even greater challenge than entering the Zodiac. Again, you had to time your jump to the rising crest of a wave, but instead of jumping down into a Zodiac, you had to jump up onto the ship. Antonio tossed the Zodiac's bow line to the ships crew, and they pulled us in. Antonio was the first to jump. The Zodiac rose on a wave crest, and he was hauled aboard the Investigador. My turn. The Zodiac rose on the wave crest and I started my jump. I remember what looked like the big hands of several crew members coming at me, grabbing my mustang suit by the shoulders and hauling me in. I was back on board the Investigador due much more to the crew's ability to pluck me out of a bouncing Zodiac than for me to jump on my own. Enrique was the next to experience the weightless feeling of returning to the Investigador, and we were all three on board.

The deck was all emotions all at once. We had made first contact with the glider that flew across the Atlantic. Everyone was hugging and cheering. Josh called out the play-by-play to the COOLroom. Enrique was called aside by the Captain. The winds were picking up from the northeast, and so were the seas. In the short time of our first contact Zodiac trip, the weather had changed, and new concerns were changing the schedule. Our few hour window of time had expired. What was expected to be an unconstrained video survey of Scarlet had to be completed right now or be cancelled. And our divers were not yet fully dressed.

The jubilation of seconds ago turned to business. Everyone on board was a professional,

the best in the business, and we had a task with a limited time line to complete. Diver safety was paramount. They needed time to prepare themselves, and their equipment. Clayton worked with the crew to prepare the orange marker buoy with a line attached that the divers would use as a safety line. Clayton entered the Zodiac as we did and was handed the camera equipment. The divers, now ready, went to the aft deck and entered the water from the Investigador, swimming over to the Zodiac and boarding from the water. Jaun headed the Zodiac over to the glider and the divers were in the water, a transition that again seemed to occur in seconds. The Captain was relaying his concern for the divers in the growing waves to Enrique, and Enrique was relaying it to me. They wanted the divers out of the water as soon as possible. We called the Zodiac on the radio. The Captain talked to Juan, and then to Clayton. Clayton talked to the divers. Clayton then assured the Captain that the divers felt sufficiently safe to continue the video operation. They had been in similar seas, and were comfortable in the water. The Captain agreed that if the divers felt safe, Juan was approved to complete the next step of the recovery.

Juan left the divers with Scarlet and the large orange safety buoy, and returned with Clayton to the Zodiac. It was Dena's turn to jump. Her camera equipment was lowered over the side, along with Scarlet's cart. I made the jump, bringing the Zodiac crew back up to 4. Seas were picking up. As Juan pulled the Zodiac away from the Investigador, a large wave moved the Investigador high above us. As the wave fell away, I saw the bottom of the Investigador. I had never seen the bottom of a ship from that angle before, and noted that the seas had definitely increased since our first Zodiac run. Juan headed us over to Scarlet. Our job was to get Scarlet on the Zodiac and in the cart as soon as possible. Any precise biological sampling would be reserved for another glider on another day. As we approached, diver Chip was holding Scarlet by the nose, and diver Dan was filming. Dena was filming from the back of the Zodiac. I was again in the middle of the Zodiac, and Clayton in the bow. Juan pulled the Zodiac alongside Scarlet, placing her directly in between me and Clayton. From the water, Chip pointed Scarlet's tailfin at us in the Zodiac, and pushed. I grabbed the tailfin in my left hand and pulled her half way on board, in between me and Clayton, passing the tail fin to Clayton. Clayton grabbed the fin with both hands, and with Chip pushing from the water, completed the lift. Scarlet was on board the Zodiac.

Josh announced this on the iridium phone link to the COOLroom. But we still had work to do on the Zodiac. Scarlet was now sitting across the Zodiac resting on the two pontoons. We had to turn her 90 degrees and place her in the bottom of the Zodiac and on her cart where she could be strapped in. Space was already tight for 4 people, and we were now 4 people plus one 7-foot long robot. Do we take off the wings? No. There was no time. They want us back on the ship now. If we break a wing, we break a wing. Clayton and I rotate Scarlet and place her in the cart. Clayton attaches the strap, and she is locked in the cart. We leave the divers with their safety buoy and line, and Juan heads us back to the ship.

We repeat the boarding process. Wait for a rising wave crest, jump, and be plucked out of the air by the big hands of the crew. Clayton hauled me back on the Zodiac when the first wave did not rise as far as I hoped. The second wave was taller, and I was delivered into the hands of the ships crew and onto the deck of the Investigador. Dena was next, followed by the camera equipment and Clayton. Juan took the Zodiac back to the divers and their safety buoy, and returned them to the ship. The divers went from the Zodiac, jumping into the water and the boarding ladders on the stern of the ship. Chip and Dan were both able to climb aboard. The full scientific crew was back on board and safe. Still in the water was Juan with the Zodiac and Scarlet.

Juan circled the Zodiac around to the starboard side of the vessel where a new crane would lift the Zodiac out of the water and over the uncluttered rail onto the open aft deck. The port side crane had too many obstructions to miss in wavy seas. I also noticed Juan made the circle much wider than he did with me on the recovery. He also must have seen the bottom of the Investigador, and felt as I did, that it was a good place to avoid in these

conditions. Juan pulled the Zodiac up to the side of the Investigador and tossed the bow and stern lines to the ships crew. He started rigging the normal lifting sling, but it was too short with Scarlet inside. It was touching Scarlet's sides, and if we lifted with it, the force could break something on her. The crew on the Investigador found another web sling that could be used. Juan attached the longer sling to the Zodiac and tied a loop in the web as a pick point. The cable from the crane was lowered, and clipped to the pick. The glider was lashed to the bottom to the Zodiac. We were ready for the lift, except for getting Juan out of the Zodiac. Juan would not have the easy jump to the flat aft deck that we made. He would have to scale the side wall of the ship. The crew leaned over the rail and reached down to meet him. They made it look easy. The wave crest rose up, Juan jumped and a swarm of hands hauled him over the rail and onto the aft deck. Now all crew members where safe on board, and the Zodiac carrying Scarlet was read for the lift.

The lift began with a gasp of concern. The web slings are set up to lift an empty Zodiac with the heavy engine in the back. The weight in this Zodiac was shifted, with Scarlet moved more to the front. As the Zodiac came out of the water, its nose went down. We were easily at a 45 degree nose down angle instead of the level lift we all had envisioned. But Juan had done his job and Scarlet did not slip an inch. The Zodiac came over the rail and was now hanging over the deck. The crew grabbed an old tire to set underneath the back of the Zodiac to keep the engine from slamming onto the deck. She was lowered into her makeshift cradle and the lift line went slack. I heard Josh call over the Iridium phone to the COOLroom, "I think it is now safe to say, The Bear is in the Igloo! I repeat, The Bear is in the Igloo!" The coded message used in any glider recovery means the operation is over and the glider, along with everyone else on the boat, are safe on the deck of the recovery vessel. Josh heard simultaneous cheers from the deck of the Investigador off Spain, the COOLroom at Rutgers in New Jersey, and from the scientific crew at Palmer Station in Antarctica. The COOLroom noted the time, 1 hour and 6 minutes from first sighting to having Scarlet on deck. Tina at Palmer was given the honor of hitting send on the text message email sent out to the glider-ops list, "RU27: The Bear is in the Igloo!" With that, Scarlet was back. Scarlet was with her people. Scarlet was home.

3 Comments

08 dec

Latest News from Spain

Posted by: heifetz in: Atlantic Crossing

Ken Branson keeps us posted on events in Spain on his blog:

http://www.scarletknightinspain.blogspot.com/

check also the latest pictures posted on our Flickr page:

http://www.flickr.com/photos/rutgers_cool/sets/72157622810667977/

1 Comment

03 dec Web Cam Address

Posted by: Scott in: Atlantic Crossing

http://rucool.marine.rutgers.edu/

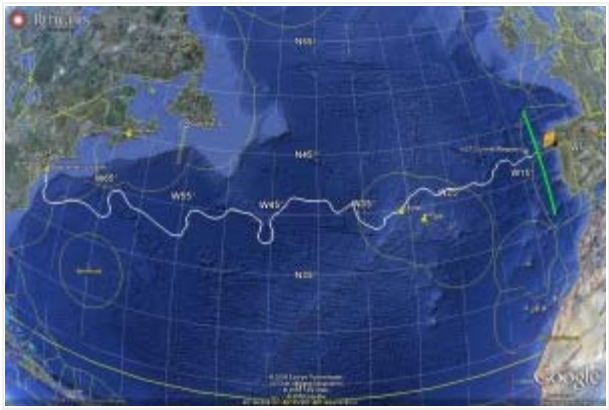
On left, click on COOL Room Web Cam to follow along thursday night and into Friday morning.

7 Comments

02 dec The Night Before

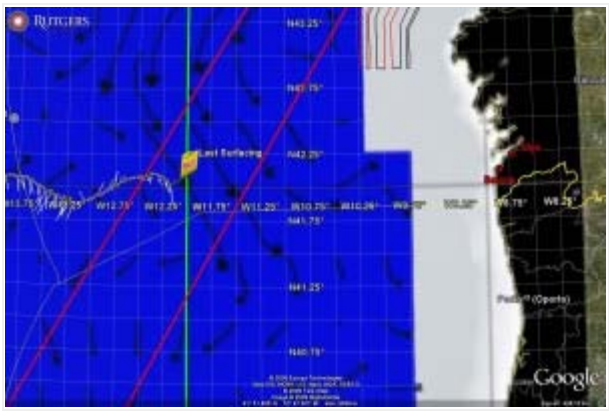
Posted by: Scott in: Atlantic Crossing

The Scarlet Knight has now flown 7379 km in the 219 days since it was deployed offshore New Jersey on April 27. It is now located just offshore 12 W, the safety (green) line we drew that kept us offshore of the heavy shipping traffic.



The recovery crew is in Baiona, Spain. The recovery vessel, the Investigador, is ready in Vigo. The vessel is loaded with recovery equipment, the freewave antenna is mounted on the top mast, and three external Iridium antennas are mounted on the port side. Freewave is how we will talk to Scarlet when we are within line of sight. Iridium is how we will talk to the COOLroom at Rutgers in New Brunswick, NJ.

Here is where we are heading. Just offshore of the 12 W (green) line. Currents are to the southwest, about 12 cm/sec. We are flying into the current to station keep, maintaining our position as best we can until we arrive on the Investigador. The waves are forecast to peak early thursday morning. We'll head out on the decreasing side of the storm, timed to get us offshore by 12 W near first light on Friday morning. If waves are near the forecast 3 m level, we hope to be able to lower the zodiac into the water for the recovery.



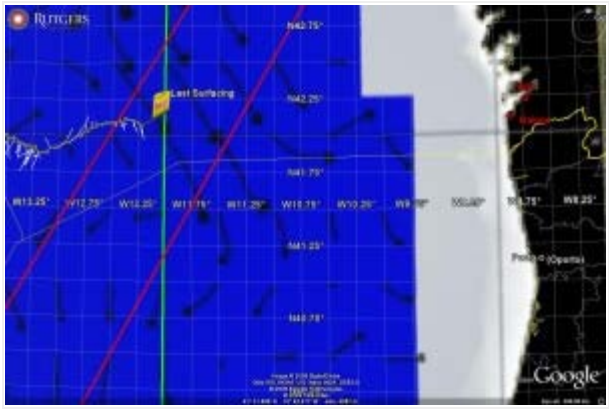
And here is our target. RU27. The Scarlet Knight. Its the night before we sail. We have prepared everything we can. We have met the amazingly capable crew on the Investigador and worked alongside our Spanish counterparts for the full day. Now we try to sleep.

2 Comments

02 dec An eye on the weather

Posted by: Scott in: Atlantic Crossing

Recovery team is fully assembled in Baiona. We met last night, looked at the weather. As expected, the choices are between bad and awful. We hope to leave during the awful weather tonight to arrive during the bad weather tomorrow. We meet with the ships Captain in 1 hour, go over procedures, start setting up equipment while still at the dock, and take another look at the weather reports. Scarlet is placed exactly where we want her, a few miles offshore of the 12 W (green) line in the plot below. This is about as close as we dare approach at this time. Someday we will learn more about operating gliders in these waters, but until then, we will stay clear of the swift currents to the south and the heavy vessel traffic.



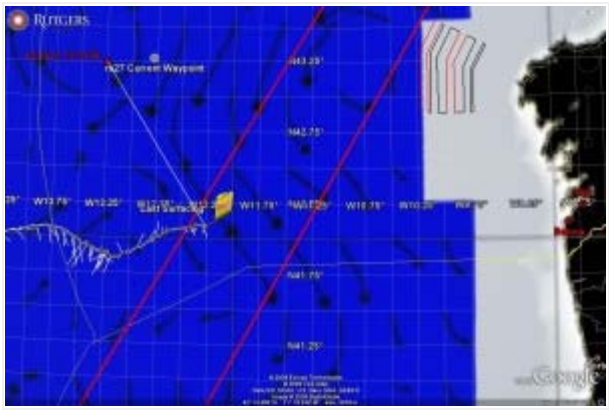
2 Comments

01 dec Welcome to Madrid

Posted by: Scott in: Atlantic Crossing

It was a busy weekend split between Thanksgiving celebrations and preparation for the trip to Spain for the recovery of The Scarlet Knight. So blogging fell by the wayside. Now we are at the Madrid airport, waiting for the plane to Vigo. Time to check in on Scarlet after the 3 am EST surfacing. We see she continues to make progress to the east, the desired direction, and continues to fight the currents trying to push her south. We'll continue this procedure for the next few surfacings until we meet up with Enrique from Puertos Del Estada in Vigo tonight. Many

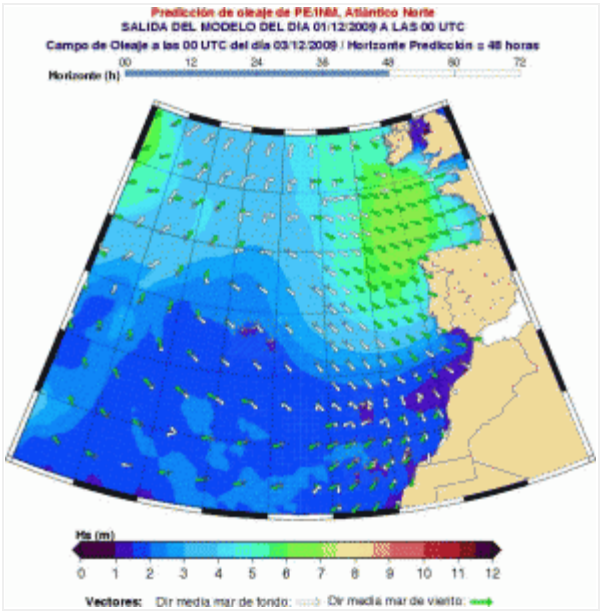
decisions on the boat departure time and how we fly the glider for the remaining few days will be made over tonight's dinner.



The weather watch has begun. We've been using this web page today at the airport.

http://www.puertos.es/en/oceanografia_y_meteorologia/predicciones/prediccion_de_oleaje_PdE/Mapas_de_Viento_y_Oleaje.html

Looks like the worst waves over the next few days are early morning on Dec 3, running about 6-7 m in the region around the glider.

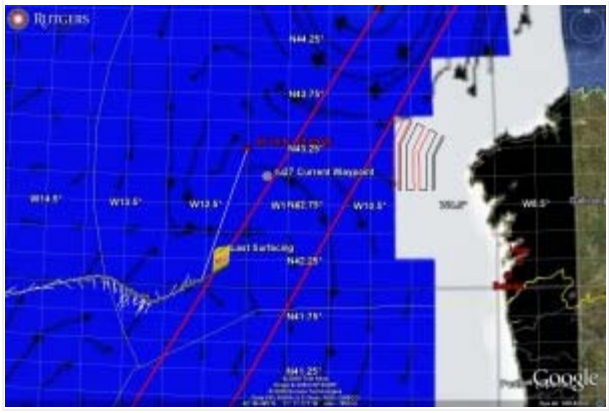


0 Comments

27 nov | Compensating for Biology

Posted by: Scott in: Atlantic Crossing

Its Thanksgiving here in the U.S., so most of us on this side of the Atlantic where home. But something offshore Spain was hard at work. We weren't spinning, but something pulled us to the right so that the fin was hard over, trying to keep us on course. Whatever it was, it stopped at 11 am this morning, so its still a bit of a mystery. We'll continue to watch this, and look for a pattern. We've seen day-night patterns in behavior, and new moon, full moon behaviors.



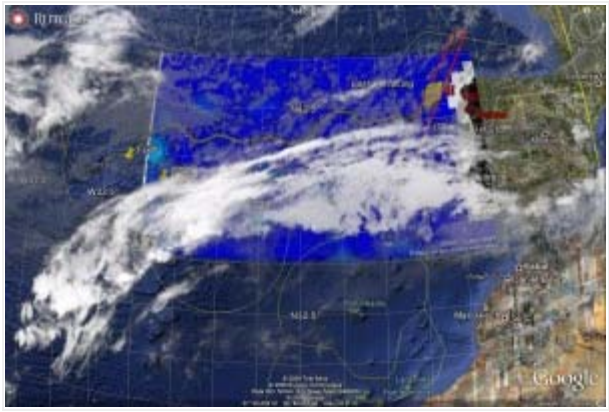
Right now our plan is to head northeast, so we'll compensate by steering a bit to the left.

1 Comment

26 nov | Pinzon's plan - heading downstream.

Posted by: Scott in: Atlantic Crossing

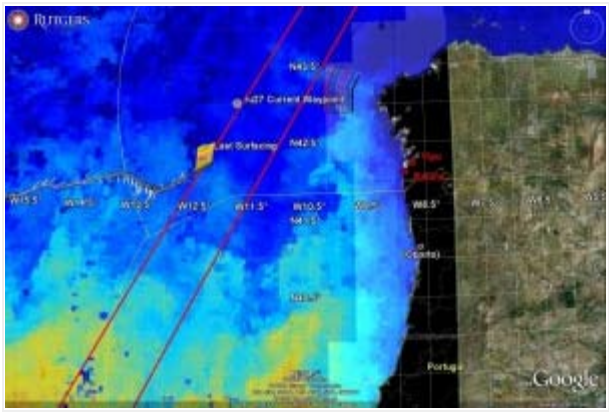
Cloud band has moved south, just below Scarlet's track.



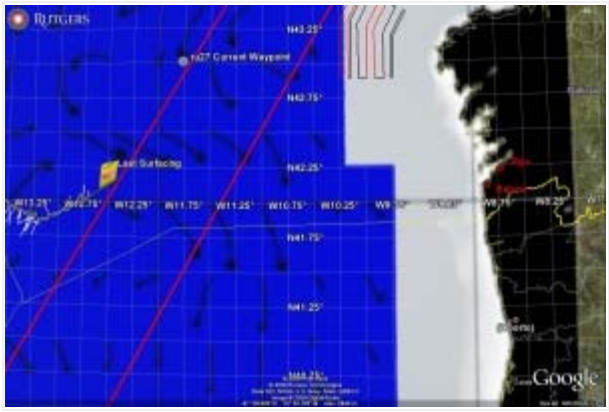
Here is our worst case vessel traffic image. There is the intense north-south routes along 10 W, plus another couple of traffic routes running from Northeast to southwest marked by the two red lines.

SST shows we are in some relatively warmer water, and to our east, we see

southward flowing colder water.



And zooming all the way in, but keeping the red traffic lines up are are heading northeast along one of the lines. Currents have been favorable this week, alternating between NE and very small. This has been making everyone happy on both sides of the Atlantic. We are making some distance, getting ourselves closer to shore for next week's trip to Spain.

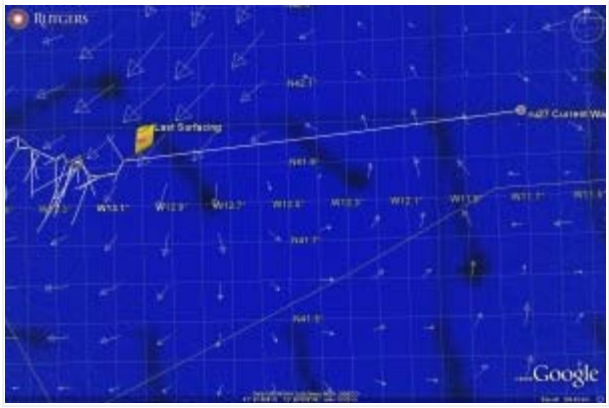


0 Comments

23 nov Uncertain Seas

Posted by: Scott in: Atlantic Crossing

Our last course change over the weekend was to turn Scarlet towards shore in Baiona and Vigo. Current speeds had dropped, and we saw our chance the head towards shore and try to get out of this southwest current that has been holding us back. Currents reported by Scarlet this morning have now switched, and we see the first northerly flow in over a week. Our waypoint is northeast, currents are northwest, we are good. A positive development after a week of difficult navigation. One very interesting development, in fact the first map I have seen like this along the entire trip, the overlay of the different current guidance products shows we have all compass points covered. The satellite altimeters (black arrows) say the currents are to the SE. The HYCOM model (white arrows) say the currents are to the SW. The glider (white lines along the track) says the currents are to the NW. And we are flying Scarlet to the NE. Today we continue to examine why our uncertainties in the state of the ocean are so high in this location.



0 Comments

21 nov

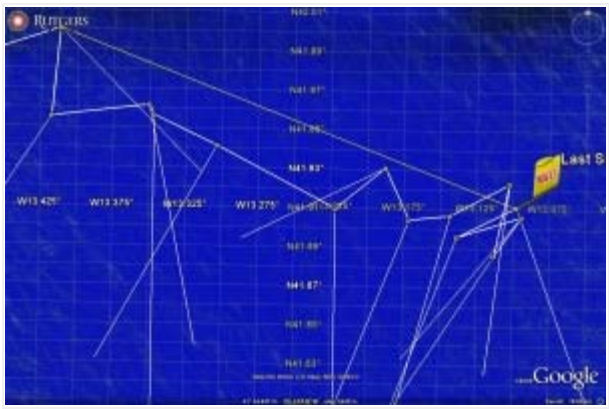
Small Steps Along a Historic Route

Posted by: Scott in: Atlantic Crossing

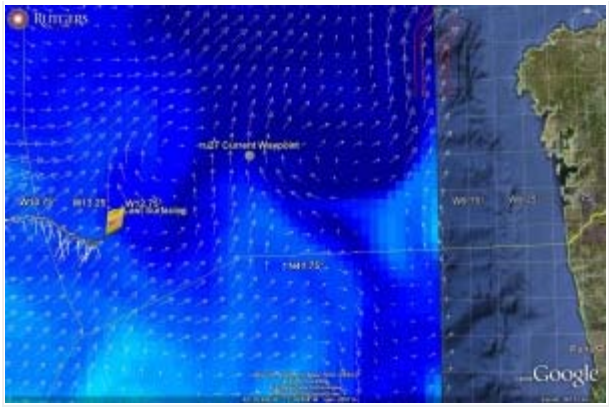
Tina changed Scarlet's waypoint from Antarctica last night and turned her to the Northeast. I know, nothing particularly newsworthy about a scientist in Antarctica flying an underwater glider off the coast of Spain, except for yesterday's visitors to the glider lab at Palmer Station. Below is a picture of NASA Astronaut Neil Armstrong and his wife Carol (front row) sitting with RU06 (second row) and Rutgers scientists Brian, Tina and Alex (third row) in the Antarctic snow just outside the Rutgers glider lab. The gray boxes are the glider shipping containers for the Antarctic fleet. For the folks at Puertos in Spain, we just sent two of those same crates to Vigo filled with equipment a couple days ago.

Another remarkable thing about last night's waypoint change was that it was based on ocean forecasts. Antonio has a new glider pathfinder system he calls Pinzon, in honor of Martin Alonso Pinzon, the Captain of the Pinta. Antonio noted that Scarlet was in a similar situation as Pinzon and Columbus back in February of 1493. Their story as Antonio told me is that the Nina and the Pinta had just suffered through a great storm where the Pinta was severely damaged, and were left struggling with strong westerly currents. Columbus chose the southern route with the Nina towards Portugal, but Pinzon, in the damaged Pinta, was dragged by the westerly currents, and could not keep up. Pinzon decided to steer his vessel north rather than head try to fight the currents, and when the wind switched to the Southeast, he turned the Pinta towards Baiona.

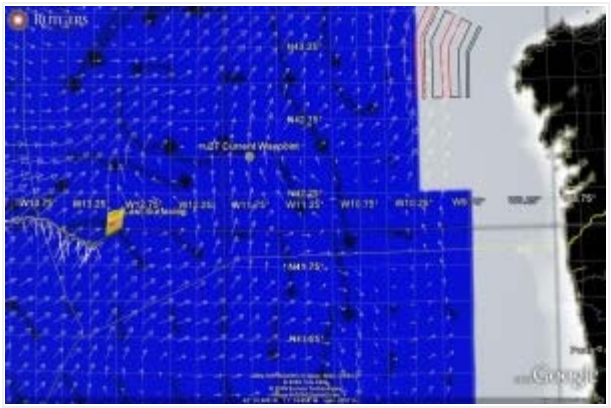
For the last 4 days, Scarlet has been experiencing stong currents to the west and southwest, greatly slowing our progress. We have been steering her generally to the north, zig zagging with the currents, fighting for every kilometer in the east direction while trying not to loose ground to the currents pushing us south. We have only traveled 29 kilometers over the last 4 days fighting these currents. But yesterday, we have forecasts from both sided of the Atlantic saying the currents would change today. Antonio's pathfinding program reads the forecast data files and plots a best course, suggesting Scarlet follow Pinzon's route, steering north till the wind shifts and then heading east. Based on the forecast for today, Tina turned Scarlet last night. The 3 am surfacing has currents to the southeast, the first easterly currents we have seen in 4 days. We hope this trend continues.



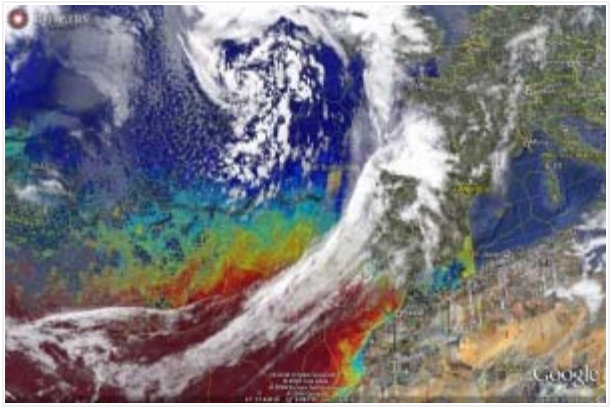
Checking the Navy HYCOM forecast, we see the currents are heading northeast over much of the region. We turned Scarlet to fly directly downwind with these currents. Our hope is to move us closer to shore for the pick up in early December.



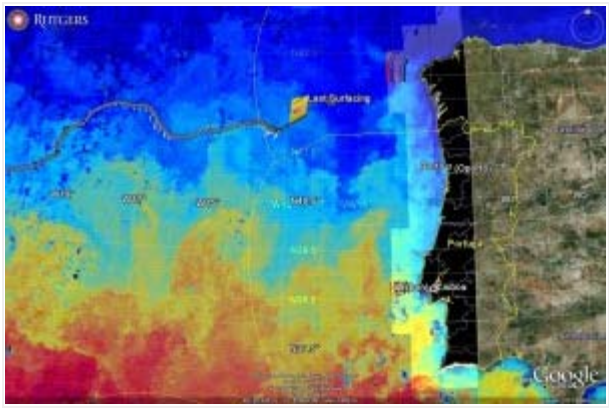
Comparing the HYCOM currents with the geostrophic currents observered by the altimeter, there is not a lot of agreement. But there is a reason for this. The geostrophic currents is the component of the current forced by the highs and lows of sea surface height. These currents change very slowing. HYCOM includes all the influences on the currents, including the winds and tides. There is going to be a lot more variability in the HYCOM model than the geostrophic currents, and as we get closer and closet to shore, that variability will begin to dominate. Antonio suggests it is time to start reducing the time between surfacings now that we are in the Spanish waters where the variability will increase. When people are back in the COOLroom on Monday, we'll start the process of reducing the time we spend underwater, first from 8 hours down to 6 hours. As we get even closer, we'll consider the next step down from 6 hours to 3 hours. These steps are standard procedures for bringing a glider home.



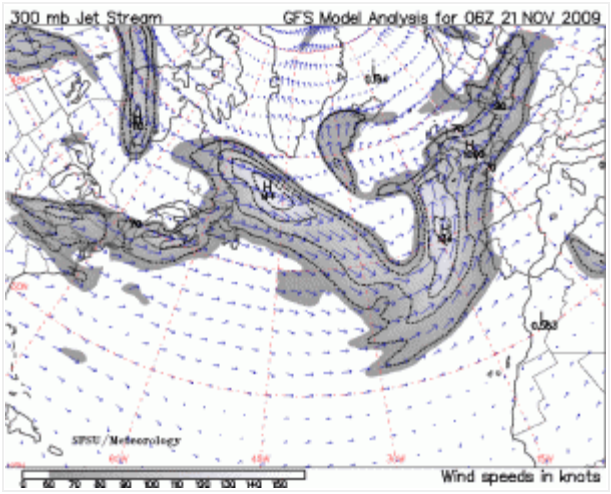
One good thing about the recent stormy weather is that the clouds are moving past us. The clouds are now over the Spanish mainland, with a clear patch opening up over Scarlet.



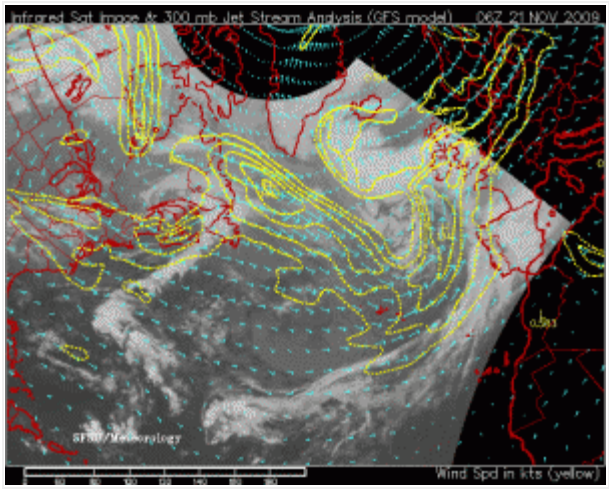
Zooming into a SST only image, we see Scarlet in a relatively warm patch if we focus on a west to east transect along 42 N. Further to our east is a patch of cooler water moving south, and beyond that is a patch of warmer water moving north. If we follow these currents around the loop, the northward moving leg flows right along 10 W with all the shipping traffic. This is something we need to avoid, and another reason for choosing the northern route as did Pinzon.



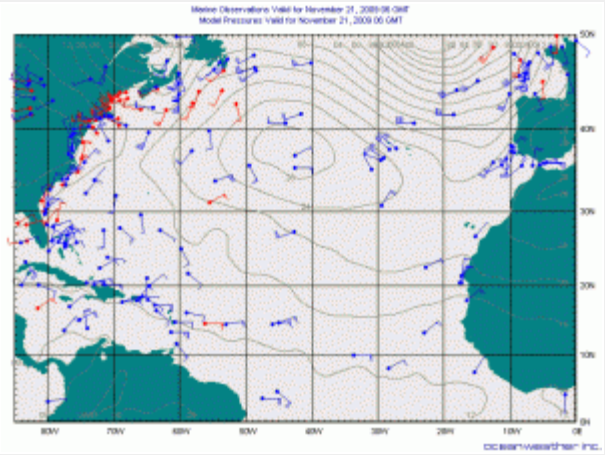
Looking further up into the atmoshphere, we have the map of the Jet Stream showing the sharp turn to the left it makes as it approaches Spain.



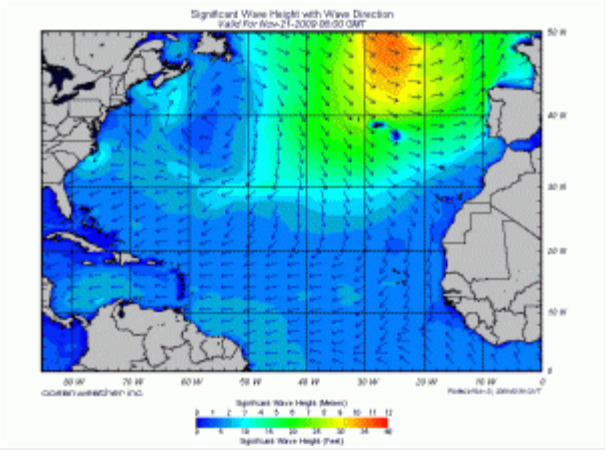
Overlaying the jet stream map on the satellite images of the clouds, the jet stream is bring clear air from south of Greenland over Scarlet and cloudy air from the tropics over Spain.



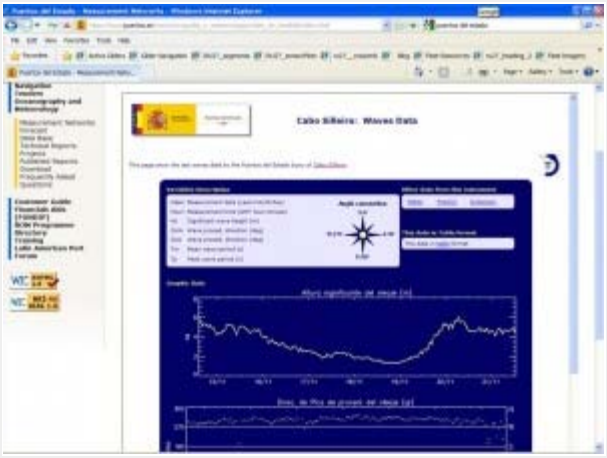
The surface weather chart from Oceanweather has stong winds along this path running across the Atlantic from Canada to Spain.



The result is big waves. At least the 30-35 foot (orange-red) waves are north of us. We are in the green zone, around 20 feet.



Checking the Puertos wave buoy, they are getting 5 m waves closer to shore. We'll hope for a window with 2 m waves in early December.



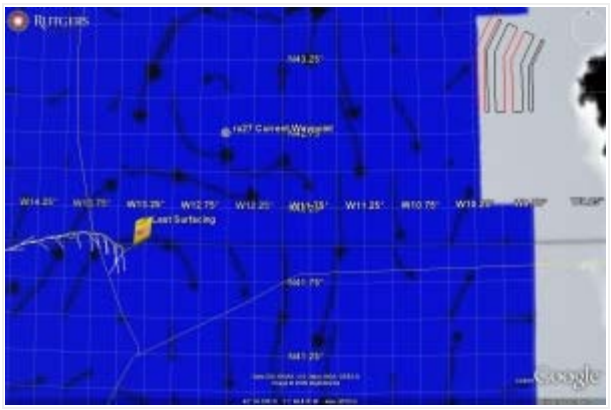
0 Comments

16 nov

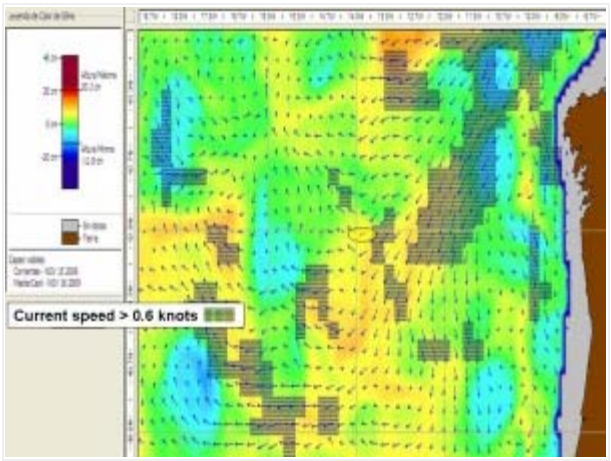
A New Roadmap from Spain

Posted by: Scott in: Atlantic Crossing

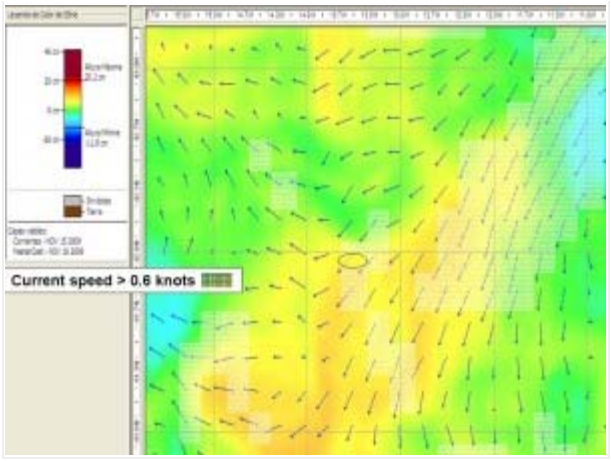
Ever since Scarlet entered Spanish waters, she has been fighting with a strong current to the south. Our usual geostrophic current maps derived from the satellite altimeter have not been of any help. The currents calculated from space are not agreeing with what Scarlet sees on the ground. Especially worrisome this morning was the strong current to the southwest running at 22 cm/sec. This is something we cannot fly against, so we have to turn sideways to it, and find more favorable currents. But which way to turn? Should we run perpedicular to this flow to the SE and try to get closer to shore? Or should we try to the NW? Guidance from our usual source, the geostrophic currents, can't be trusted.



That means we must turn to the models, where all the forcing is included. Just minutes ago Antonio sent me this result from the model runs he is looking at. We find Scarlet is on the western edge of a strong jet up to 0.6 knots in speed that is heading to the southwest. The current is too broad to cross without being swept back out to sea. Our best alternative is to favor the NW route, even though it seems like we are turning back away from Spain.



Below we zoom into the location of Scarlet at the edge of the jet. We'll start this turn by heading more to the north at the 11 am surfacing.



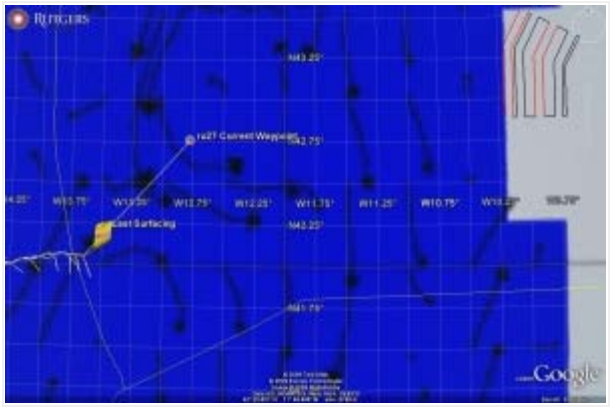
0 Comments

14 nov

EEZ+6

Posted by: Scott in: Atlantic Crossing

Scarlet completed the 11 am surfacing, took Antonio's waypoint from Tina in Antarctica, and headed off to the northeast. She is now 6 kilometers inside the Spanish Exclusive Economic Zone, otherwise known as the EEZ. Currents are still strong but the direction continues to rotate counterclockwise - a good sign. We hope this trend continues. In the image below, the thin yellow arc now to our west is the offshore side of the Spanish EEZ. The thin yellow line to our south is the border between the Spanish EEZ and the Portuguese EEZ. The thin rectangles in the upper right hand corner are the shipping lanes. Our mission now is to position Scarlet in a safe place for recovery. The U.S. recovery team leaves New Jersey on Monday, November 30, and meets our Spanish counterparts in Vigo on December 1.



Antonio in the Canaries has won the competition for the first reported communication with Scarlet inside Spanish waters. But the science team at Palmer Station in Antarctica wins the competition for the first reported celebration in honor of the crossing. After Tina transferred Antonio's waypoint to Scarlet and sent her on her way, she led the science team in a traditional Polar Plunge into the near zero degree centigrade waters of the Antarctic Ocean. I know the water is near zero degrees because I checked the temperature being reported by RU25.

Scientist #1 (Tina) into the water:

Scientist #2:

And Scientist #3:

After the plunge, the traditional warm up in the hot tub. Hats off to the Palmer Science Team for their game winning entry.

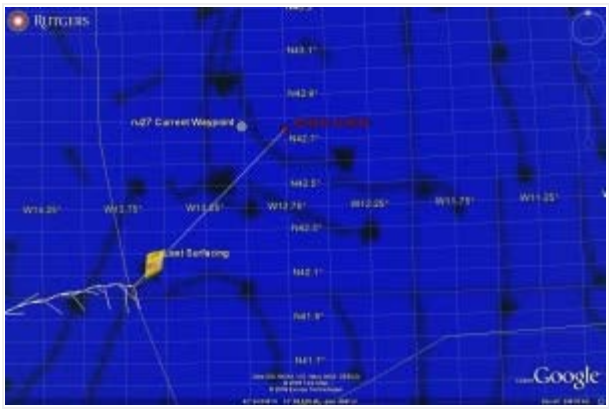
2 Comments

14 nov

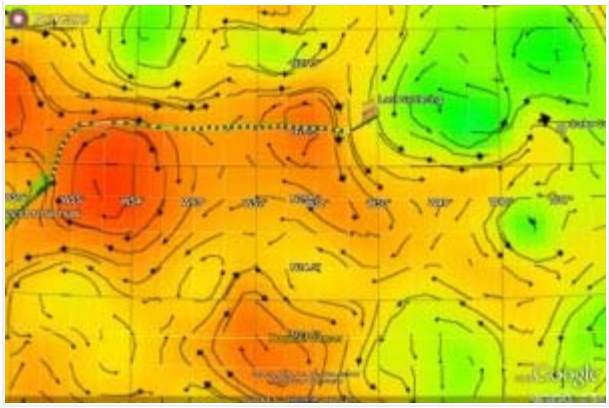
Honour All

Posted by: Scott in: Atlantic Crossing

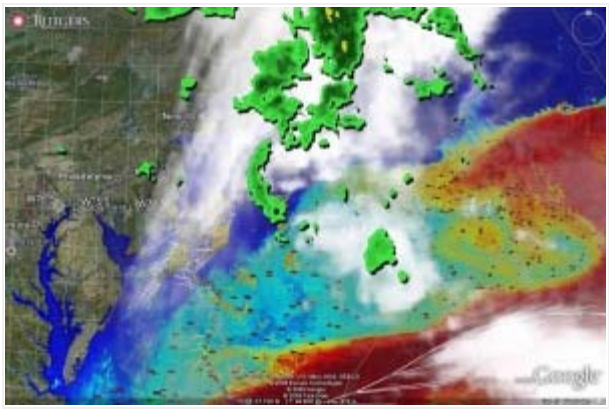
That's how Antonio ended his morning email today. He was the first to see Scarlet cross over the line. Now he has the honor of making Scarlet's first waypoint change in Spanish waters. As we get closer and closer to Spain, we will rely more and more on local knowledge. Antonio has asked us to maintain a course to the northeast to compensate for the currents to the southeast. Because ocean current speeds are nearly matched to Scarlet's own speed through the water, this will result in an eastward path over the ground for Scarlet. Antonio and I continue watching the forecasts and altimetry products for guidance on current patterns. The geostrophic currents from the satellite altimeter data we normally use tell us the current should have already turned to the northeast. Clearly this is not the case. This morning, Antonio sees that the products on his side have placed that northeast current some nautical miles still to our east. We'll head towards that current with Antonio's waypoint for the 11 am surfacing. Tina made the change to Scarlet's course from Palmer Station in Antarctica.



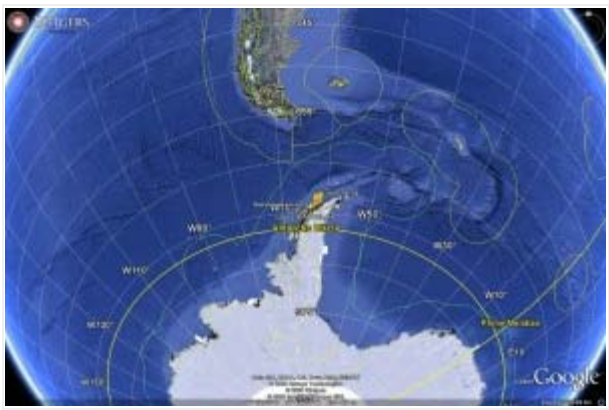
Checking the rest of the fleet, Teledyne's Drake continues on its climate change mission, maintaining the 26.5 N section. The agreement between the geostrophic surface currents from the altimeter and the depth average currents from Drake continues to amaze us. The satellites say Drake just entered a southward flowing current, and thats what Drake is reporting.



Back to the Middle Atlantic Bight, the coastal glider fleet (Rutgers & U. Delaware) is emerging from the trailing edge of Tropical Storm Ida. The front between clear weather and clouds is passing right over New Jersey. The rain has stopped, and people are out assessing the storm damage. Follow the Middle Atlantic Bight Blog at http://www.i-cool.org/?cat=5 for most recent updates.



Moving way south to the Antarctic continent, Tina and Alex deployed RU25 this week from Palmer Station. Follow along on the Antarctic blog at http://www.i-cool.org/?cat=21



5 Comments

14 nov

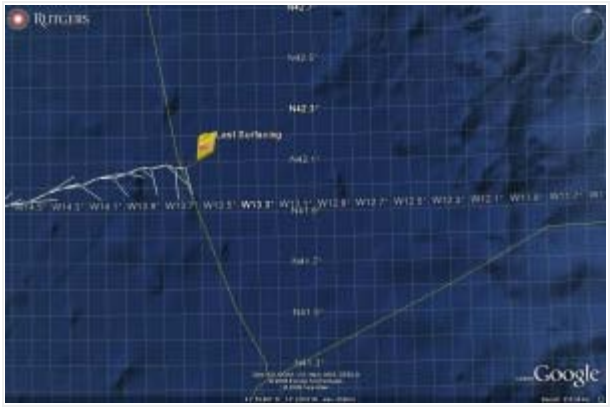
Spain!

Posted by: Scott in: Atlantic Crossing

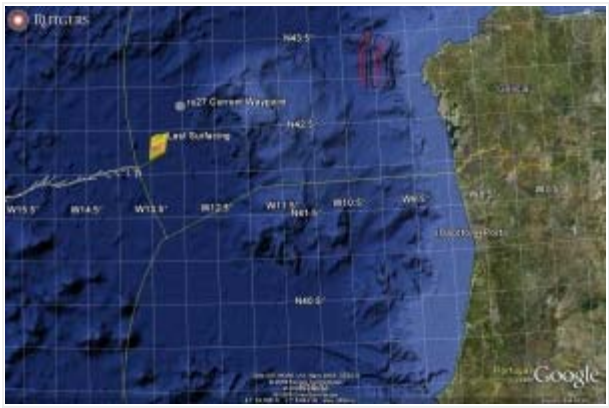
Today we begin a new era of global ocean exploration. The Scarlet Knight has

crossed the Altantic.

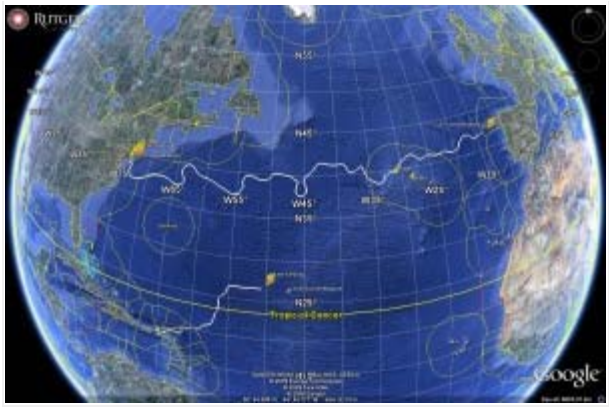
Scarlet surfaced inside Spanish waters on Saturday, November 14, 2009 at 8:17 GMT (3:17 am EST).



To our friends in Spain and Portugal, we look forward to seeing you in December for the recovery.



To our families back home, 201 days ago on April 27, we launched Scarlet and dedicated this mission to you. Thanks for understanding.



To our many partners on both sides of the Atlantic that made this possible, this has been a team effort that began over a decade ago. It is success story shared by all.

Thanks to all,

The R.U. COOL Team

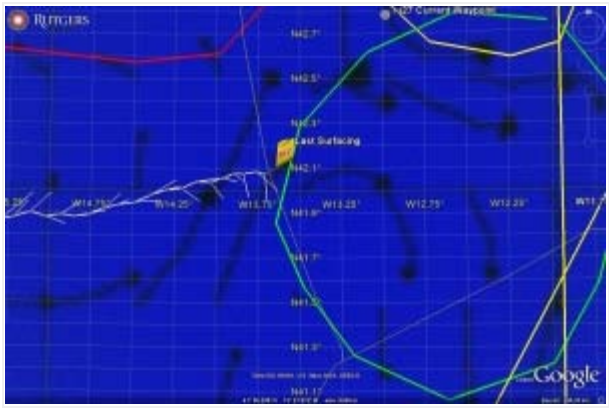
4 Comments

13 nov

2 Kilometers To Go

Posted by: Scott in: Atlantic Crossing

As we discussed in the last blog, our time for crossing into Spanish waters would depend on the currents. If the currents turned to the east, we would make it across at tonights 7 pm surfacing. If the currents turned to the south, we would have to wait for tomorrow morning. Currents turned to the south, and remain strong at 15 cm/sec. We were 6 kilometers from the line. We only flew 4 kilometers. That leaves us 2 kilometers shy of the Spanish Exclusive Economic Zone (thin yellow arc). We have flown 7279 kilometers in 200 days. We have one more 8-hour segment to go. What will 3 am bring us?



1 Comment

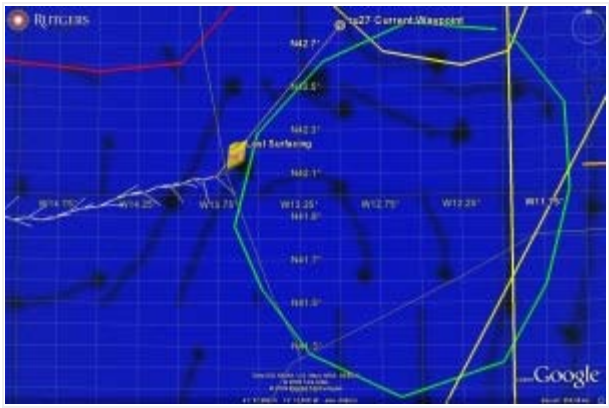
13 nov

200 Days at Sea. 6 Kilometers to go.

Posted by: Scott in: Atlantic Crossing

At 11 am this morning local time, Scarlet surfaced and reported currents to the SE at 15 cm/sec. So the current speed is still high, but they have rotated around counterclockwise, starting at South and switching to southeast. If this rotation

trend continues, it will align the currents more with the geostrophic currents, and it will push us closer to the Spanish EEZ. Our glider heading was maintained at NE.



Looking at the big clock, today is our 200th day at sea. We have flown 7,275 kilometers. For flight distance remaining, we have measured it several times, and have discovered that precise distance measurement is not a strength of google earth. Our best estimate is that we are just under 6 km from the edge of the Spanish Exculsive Economic Zone marked by the thin yellow arcs. Our last segment covered a distance of 6.5 km. We expect to be very close to Spanish waters at the 7 pm surfacing. If the current rotates more towards the east, we cross. If the current rotates more to the south, we'll be a few kilometers shy, and the crossing will occur at the 3 am surfacing. Either way, I bet we are watching.

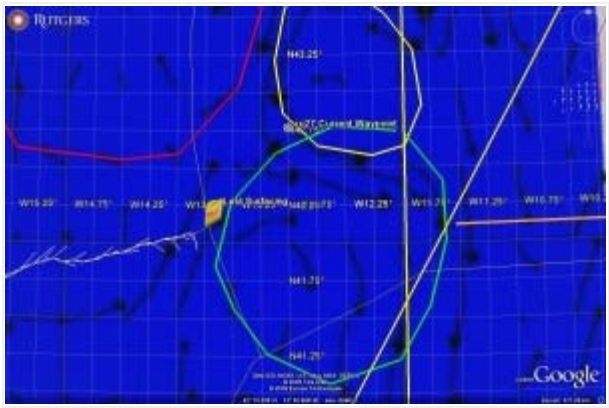
2 Comments

13 nov

12 kilometers and an unexpected current

Posted by: Scott in: Atlantic Crossing

Just a short blog - wanted to get this over to Antonio in the Canaries right away. Looks like we all will be pouring over our guidance maps today. Scarlet just reported a strong current 0f 13 cm/sec to the Southeast, almost exactly opposite to what we see in the geostrophic currents from the satellite altimeter. Strong winds? Inertial waves? Looks like Antonio and I will be generating a little email traffic in preparation for the 11 am surfacing. This new current slowed progress to the east a bit. We only covered about 4 kilometers, bringing us to within 12 kilometers of the Spanish EEZ as of 3 am (eastern standard time) today.



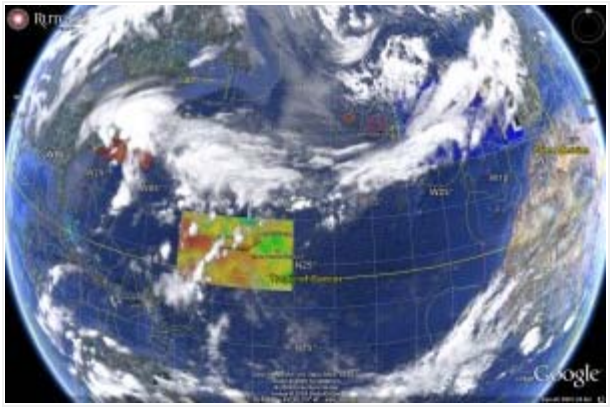
0 Comments

12 nov

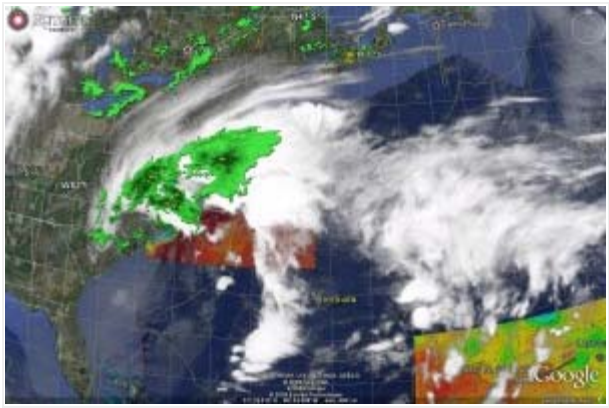
16 Kilometers & The Coolest 20 Years

Posted by: Scott in: Atlantic Crossing

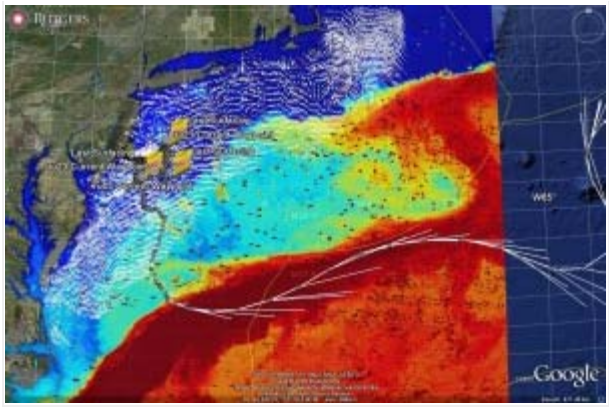
Gliders on both sides of the Atlantic are getting hammered by storms tonight. But thats ok. They are underwater gliders. They can handle it. They are what we'll use to explore some of the most extreme environments on the planet.



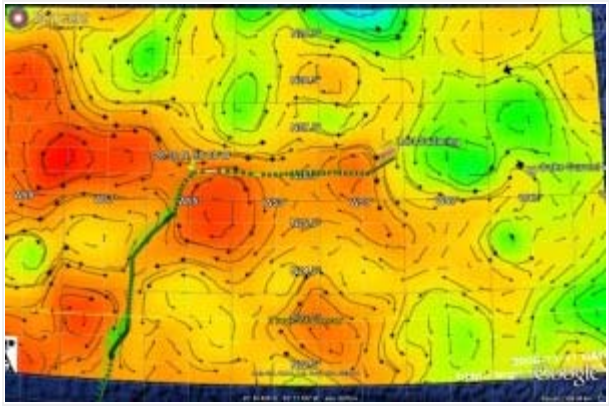
Zooming into the East Coast of the U.S., we get ready to close out the intense Mid Atlantic fall sampling season with the remnants of Hurricane Ida. White is clouds, green is rain. An amazing storm. Flooding along much of the east coast today on TV.



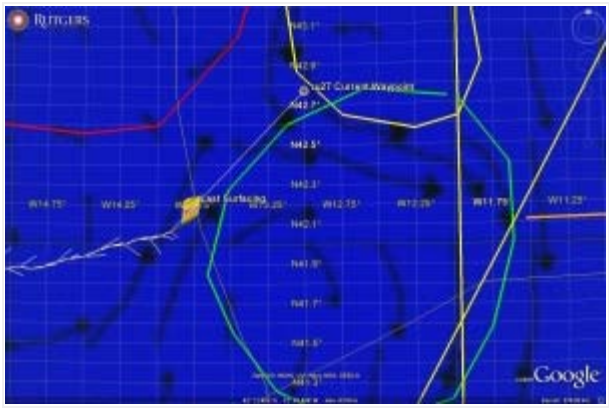
Look below the clouds and see one of the most amazing sights on the planet. A full scale regional coastal observatory running full bore through the storm. Satellites grabbed the initial sea surface tmeperature condition pre-storm. The full CODAR network was ready for this one, and the undergrads put it into google earth for the old guys like me to use. The gliders had an amazaing fall. First the 4-glider joint IOOS, Navy, ONR, NSF survey timed to the NOAA fisheries survey for the NOAA Fate program. Then the NSF OOI CI IO OSSI (I love that acronym). I lost track of how many AUVs and gliders were in the water, all being directed by the CyberInfrastructure software pulling data from the MARCOOS forecast models. Followed by this week's combined NSF OOI and DHS Center of Excellence field test. We had more satellites looking at the Mid Atlantic through that high pressure at the beginning of the week than every before. Now we end with a severe storm with the hottest set of optics gliders ever deployed. The grad students were drooling over the storm sediment transport data this morning, pulling off page after page of their next thesis chapter. On monday we'll start assembling it for the optics folks meeting down at Stennis right after Thanksgiving - Steve & Joan should get a kick out of it. Its been 20 years to go from vision to implementation. An amazing journey.



Speaking of 20 years, its been 20 years since Hank Stommel's article on the Slocum mission appeared in Oceanography. Now Drake is holding the line on climate change. Doug Webb has brought these gliders from vision to fruition in that time, and we hope he is also looking back at the last 20 years as an amazing journey.

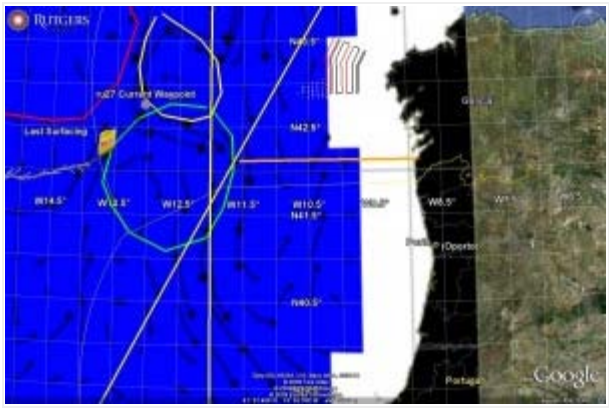


Speaking of amazing journeys, Scarlet is now just over 16 kilometers from the Spanish EEZ. Currents have dropped down to about 6 cm/sec, so we only made about 6 kilometers distance during the last 8 hour segment. We'll continue heading northeast. It could be a very different blog this time tomorrow night.



Zooming out we see Galicia. We are trying to ride the currents to the east a bit towards shore, then think about turning north into the yellow circle to avoid the most intense vessel traffic. It looks like there was some interest from the local newspapers today.

http://www.lavozdegalicia.es/vigo/2009/11/12/0003_8101106.htm



Another sign we must be getting close. Instead of a map, tonight Antonio sent us a picture for good luck. It is “The Guardian of the Bight”. In the center is Breogan, the first Celtic Galegian King, a sailor and adventurer. To the left is The Hercules Tower, built by the Romans in the 2nd century as a light house that is still in use today. As Antonio said, to the right is the sea, and The Scarlet Knight.

Below is the Investigador, the buoy tender used by Puertos del Estado. She is 47 m long. Crane, A-frame and Zodiac. All things that make a glider recovery team happy.

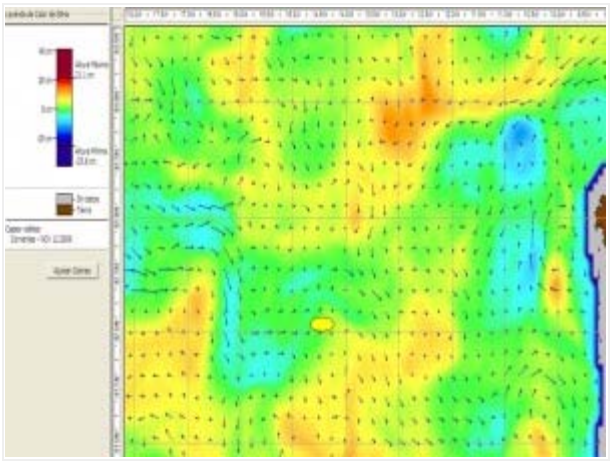
0 Comments

12 nov

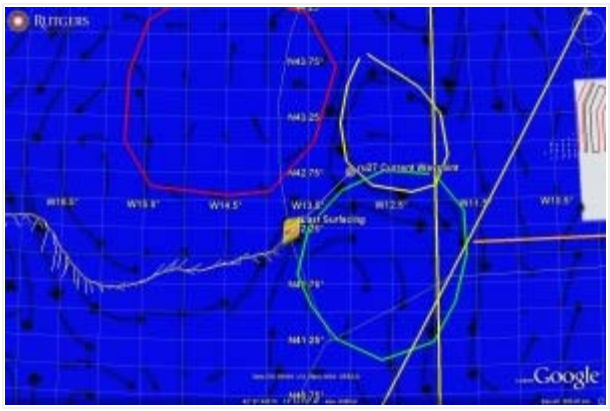
23 kilometers

Posted by: Scott in: Atlantic Crossing

Antonio sent in a series of images this morning based on the model currents. In those images we see that current flowing south along 13 W as the main feature in front of us.



Guidance from U. Colorado from the satellite altimeters similarly has that current flowing to the south along 13 W. Altimetry also says there is a strong current to the east just inside that green zone on the chart below. We want to head towards the northern edge of that eastward current. That approach would allow us to jump into the counterclockwise rotating eddy marked by the yellow circle. As planned, we moved the waypoint 15 minutes to the north. This moved our heading from 60 degrees to 45 degrees. We are heading NE as planned. Scarlet just surfaced right at the western edge of a jet to the northeast that we see in the altimetry. In fact, she is directly beneath one of the arrows on the map. We hope to follow this current into the Spanish EEZ. We are about 23 kilometers directly offshore of the Spanish EEZ. The distance along our heading of 45 degrees is 27 km. Scarlet just flew about 6.5 km during the last 8 hour segment. If this continues we should be within a couple kilometers of the Spanish EEZ tomorrow at the 11 am surfacing. That makes the most likely crossing point the 7 pm surfacing (U.S. east coast time) on Friday. Looks like my students will need to show up for class tomorrow at 11 am. We'll continue to refine the estimate every 8 hours with each surfacing.



0 Comments

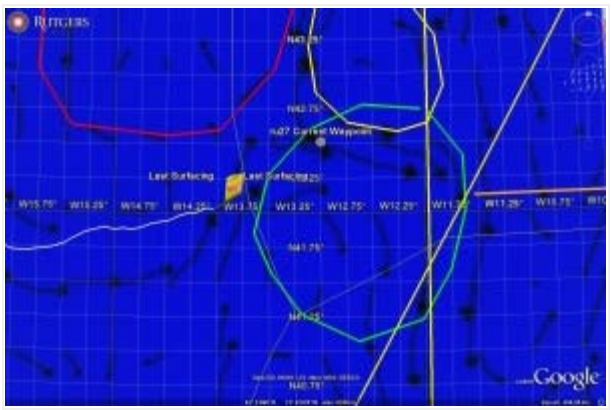
12 nov

29 Kilometers

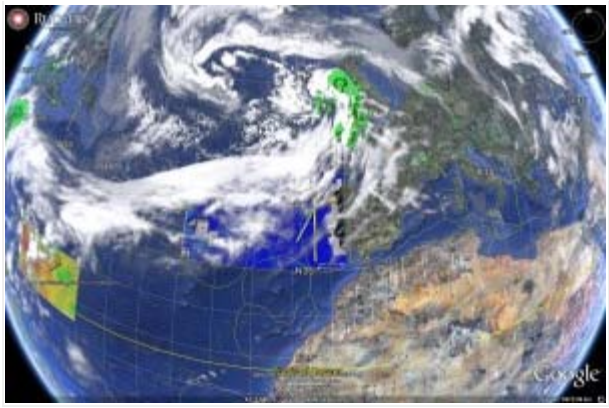
Posted by: Scott in: Atlantic Crossing

Our friends at Puertos del Estado http://www.puertos.es/es/index.html are doing an amazing job preparing for Scarlet's arrival in Spain. Our partners there, and the many critical oceanographic measurements they maintain and make available on their website, made Spain the natural choice for landfall on this trans-Atlantic mission.

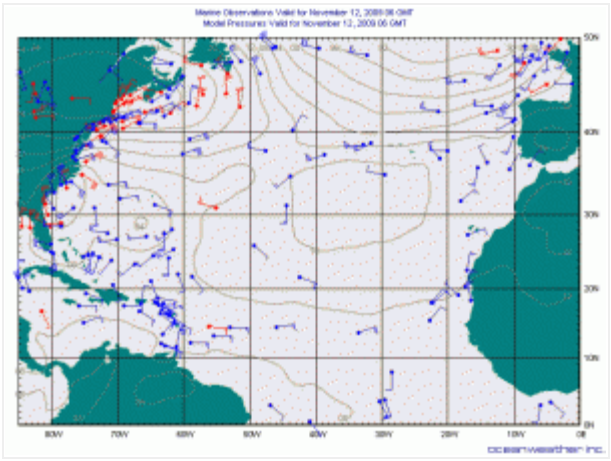
Checking in on Scarlet first, we see she is now 29 km offshore of the Spanish EEZ. The morning currents are to the southeast. The wobble we see between northeast and southeast currents is characteristic of an easterly current with inertial waves superimposed. Inertial waves usually are an indication of an abrupt change in the windfield, often due to a storm. The inertial waves spin in a horizontal circle and often persist well after the storm has passed.



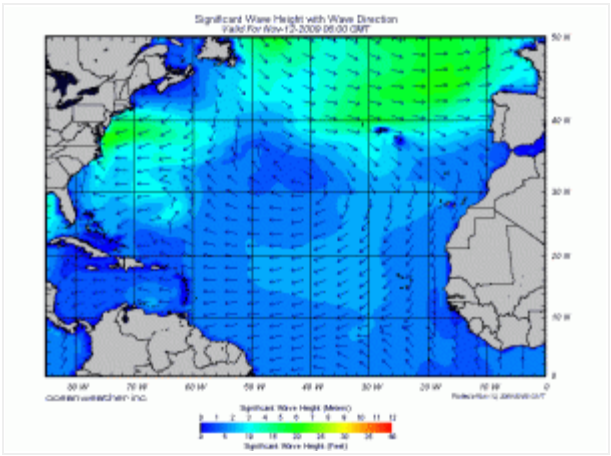
Checking the google earth clouds (white) and weather radar (green), we see a storm slamming into the U.K., and a line of clouds that trails off across the northwest tip of Spain.



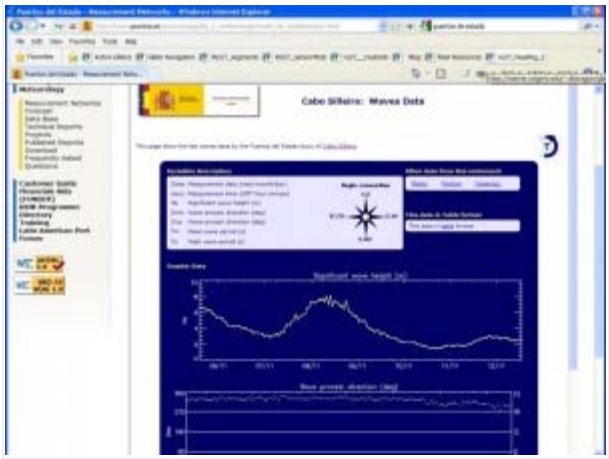
Checking the ship observations and surface pressure field, strong winds are heading at the northwest tip of Spain.



Checking the wave forecast, we see the strongest waves are offshore and to the northwest of Spain.



Checking into the Puertos website, we see the wave heights are still low for Spain, running 2-3 m, well below the 8 m high waves we experienced over the weekend. Amazing how your perspective changes. We are looking at 2-3 m waves and thinking the weather is good. Puertos has warned us to expect severe weather. We hear that out on the recovery vessel, the weather will either be bad or awful. Its the first time we are hoping for bad weather.



2 Comments

11 nov

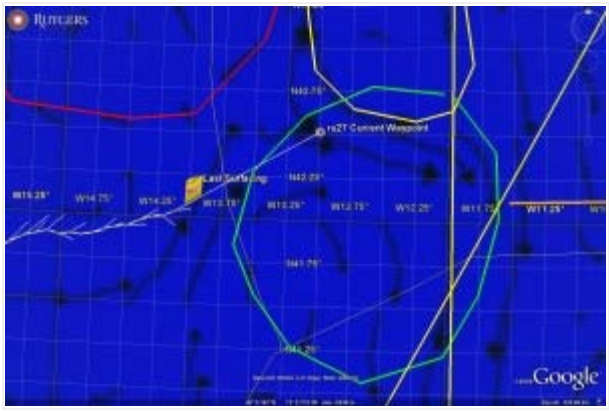
35 kilometers

Posted by: Scott in: Atlantic Crossing

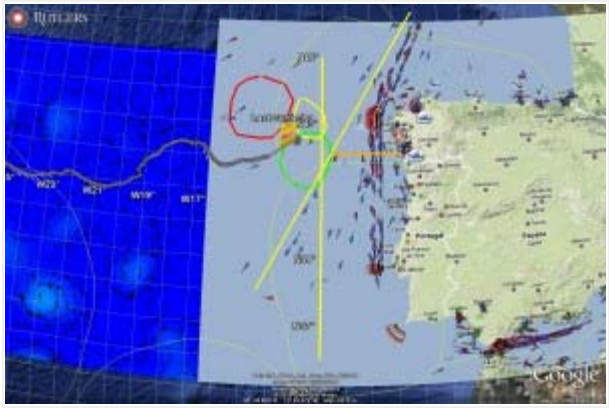
Reported currents at the 7 pm surfacing were nearly due east, running 12 cm/sec. Scarlet is doing a bit over 15 cm/sec relative to the water. A good speed at this stage. We'll hold the waypoint for this 7 pm to 3 am segment, and again for the 3 am to 11 am segment. Then we'll shift the waypoint north 15 minutes and run parallel to the northeast velocity vectors in the satellite altimetry.

Distance to the Spanish EEZ is 35 km. Scarlet flew a total distance of 22 km in the last 24 hours. Clicking off the segments, the friday 11 am surfacing will be one to watch. We'll see if we can set up for the live broadcast from the COOLroom. http://rucool.marine.rutgers.edu/index.php/COOL-Room-Web-Cam/COOL-Room-Web-Cam.html

I'll have to figure out what to do with by 10:55 to 12:15 class. Either the glider surfacing or the class has to be moved. More on that decision tomorrow.



One thing we are watching more closely is the vessel traffic. We are entering the most dangerous waters of the entire journey. Students have been monitoring vessel traffic off of Spain for at least the last month. Below is one of the worst traffic cases. It looks like there is no place that is totally safe, and there are some yellow lines we are very worried about crossing. We will need to minimize our surface time. Changes for every surfacing will need to be planned in advance. We won't want to keep this glider at the surface while we make up our minds on what to do next.



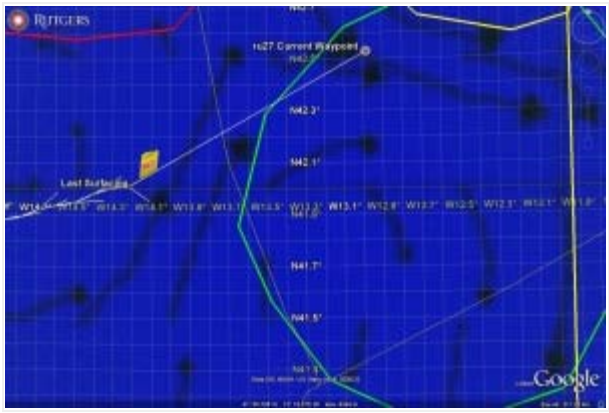
0 Comments

11 nov

44 kilometers

Posted by: Scott in: Atlantic Crossing

Results from Scarlet's 11 am surfacing are shown below. The reported ocean current is a bit of a surprise, 12 cm/s to the SE. Its certainly not on our satellite map. Satellites say the currents should be to the NE. We'll check what products we have from Spain. We are continuing to fly NE. Same objective cross into Spanish waters (thin yellow arc) follow currents to NE and into the yellow eddy discussed in the morning blog. 44 kilometers to the Spanish EEZ.



0 Comments

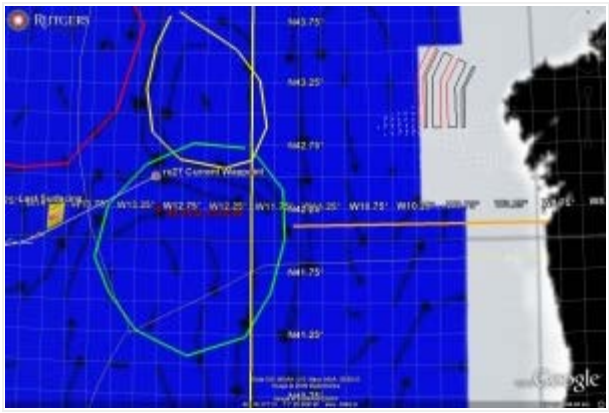
11 nov

Morning Update - 50 kilometers

Posted by: Scott in: Atlantic Crossing

Tail current has decreased to 8 cm/sec. Scarlet's speed relative to the water is holding steady at 17 cm/sec. Still moving along the line to the northeast, targeting the outer edge of the green circle. If we try to stay in the green circle, we could get advected south to Lisbon. So we'll continue moving around the outer edge of the green and into the yellow circle as best we can. West of the yellow circle is the eddy of unknown sign, the area of high uncertainty identified in red. East of the yellow circle is another racetrack shaped eddy that circulates through the ship lanes. One ship every 12 minutes in the main line. As of this morning, the yellow area is our target.

Distance to the Spanish EEZ is down to 50 km.



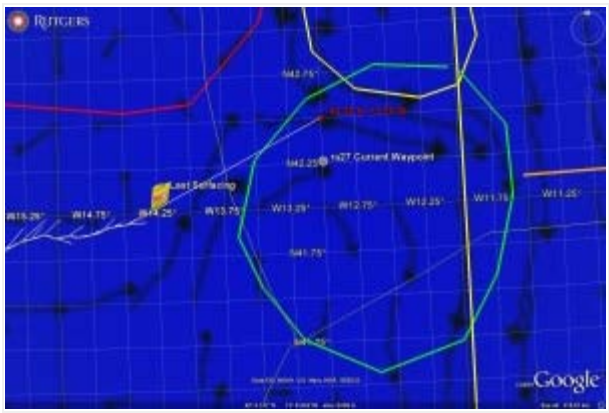
0 Comments

10 nov

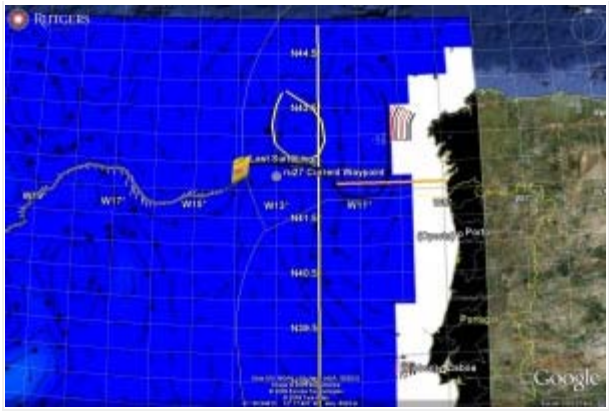
58 Kilometers

Posted by: Scott in: Atlantic Crossing

Scarlet has found a nice tail current of about 15 cm/sec. Her own speed was clocked at 17 cm/sec relative to the water. Nearly 9 km made good over the last 8 hour segment. Total distance to the EEZ is down to 58 km. We moved the waypoint north again. We want to ride the outer edge of that loop around the green circle.



Zooming out to the full region, we are trying to find a safe place to put Scarlet once we get inside the Spanish EEZ. The currents in the green circle above are no longer an eddy. The image below shows the eddy that once was there has evolved into a jet headed straight to Lisbon. Now we instead have two eddies a bit farther north, with the offshore eddy circled in yellow. If you follow the currents in towards the inshore eddy, your path will look something like the black line.



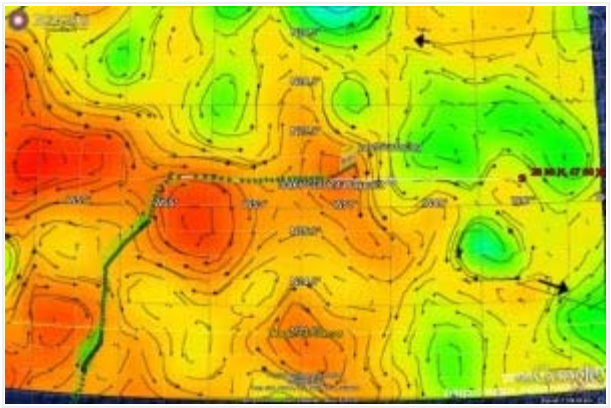
If you now superimpose a snapshot of the vessel traffic off Spain & Portugal, we see the black line crosses through a highly trafficed region. The safer eddy is the one in the yellow circle. Looks like we will try to follow the current in then stop inside the yellow eddy.

0 Comments

10 nov 75 kilometers to Spanish waters.

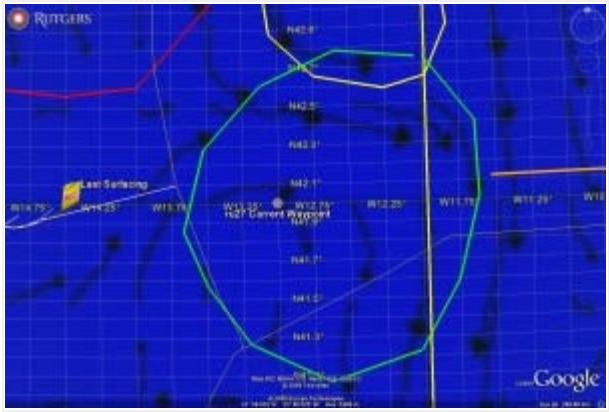
Posted by: Scott in: Atlantic Crossing

Drake continues to make steady progress to the east, holding the line perfectly. A truly amazing test. We'll soon move the waypoint out farther to the east and keep going.

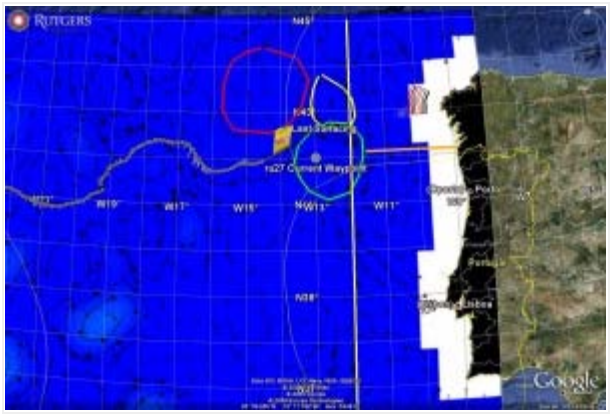


Zooming into Scarlet, we see she is 75 kilometers (thin white line) from the Spanish EEZ (the thin yellow arc). The pitch adjustment made yesterday looks like it

increased Scarlets forward speed to 16 cm/sec. Thats nearly 14 km/day on her own. Satellite altimetry says currents are also to the east.



Planning for where we send Scarlet once she enters the Spanish EEZ has become the topic of discussion. The eddy that was in the green zone has evolved into a loop in a strong jet that heads south to Lisbon - our Plan B for recovery. The yellow zone shows an eddy that has developed inside the Spanish EEZ and is offshore of 12 W (think yellow north-south line). Thats one place we can park. Another option is to try to ride around the outer edge of the loop in the green zone, jump out and head in along the orange line. The worry there is the increase in ship traffic.



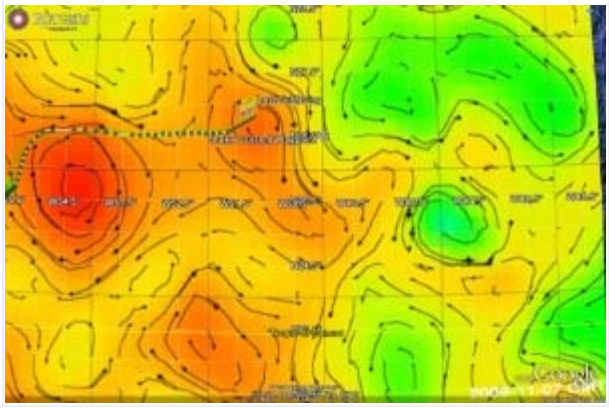
0 Comments

09 nov

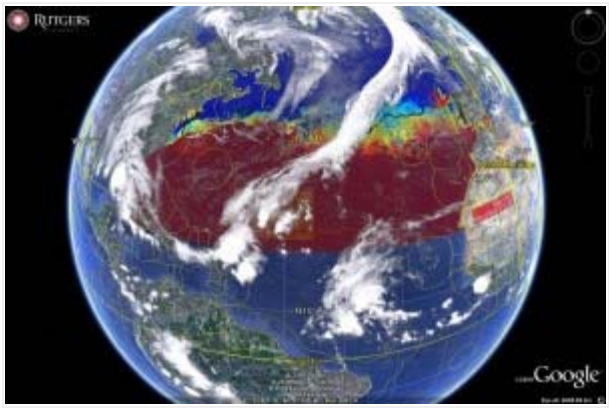
98 Kilometers to the Spanish EEZ

Posted by: Scott in: Atlantic Crossing

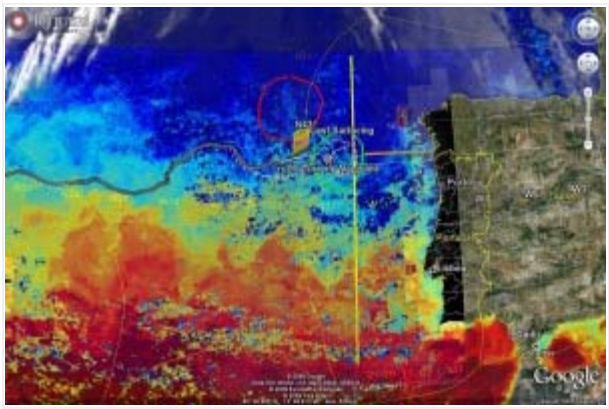
Drake remains steady on the 26.5 N line over the weekend. Depth average current is up to 8 cm/sec. We continue to find the deep gliders to be easier to fly from point to point. Currents are smaller over their range of operation. We are much closer to being a ship than a drifter. The shallow gliders are more like half ship, half drifter.



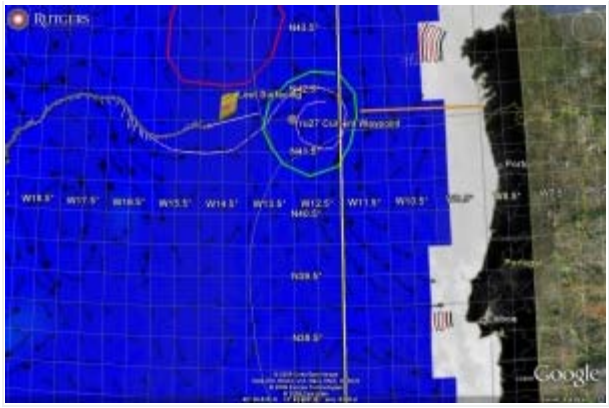
The Jet Stream continues to meander across the basin, leaving clear skies over the Middle Atlantic Bight and over Spain, but with Drake in clouds. Very different from last week.



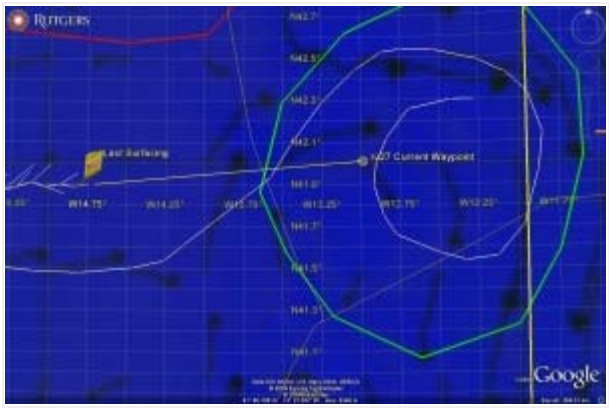
The Satellite sea surface temperature maps are starting to come in. There is about a day delay. The clear areas to our west are showing up now. Maybe later today or tomorrow we'll have SST back.



Satellite altimetry shows that persistent current running just along 12 W to Lisbon. That is our escape route if things go bad. Get into that current, minimize surfacings to avoid ships, and recover from Lisbon if we have to. The targeted eddy inside the Spanish EEZ shown in green appears to look more like a loop in this jet rather than an eddy. That will complicate the recovery process. Still, its good to be thinking about a recovery process rather than the alternative.



The north-south component of the ocean current reported by Scarlet has been fluctuating rapidly, sometimes to the north, sometimes to the south. It is too rapid for us to follow with an 8 hour update cycle. However, the east-west component of the current is steady to the east. So we'll take advantage of that and just fly east. We can let the wobbly north-south component change sign as it decides, while we use Scarlet's velocity to increase the eastward component. The distance to the Spanish EEZ is down to 98 km. Distance travelled along the path length from New Jersey is 7120 km. Distance made good on the last 8 hour segment was just about 7 km.



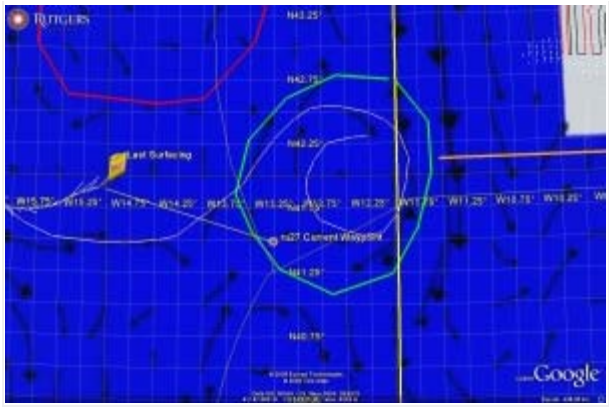
Today at the 11 am surfacing, we'll check out how Scarlet is flying, and likely make our final pitch adjustment to increase her forward speed.

0 Comments

08 nov A steady hand on the rudder

Posted by: Scott in: Atlantic Crossing

Scarlet's task for the rest of the weekend is to maintain a steady course along an ENE line towards the Spanish EEZ (thin white line). The currents have been relatively steady to the NE, so Scarlet has kept her heading to the SE. The target angle separation between the water velocity and Scarlet's glider velocity relative to the water is 60 degrees. Separation angle on the last segment was 58 degrees - pretty close. We'll maintain this configuration of crabbing a bit into the wind until the ocean currents change, or we reach the EEZ. I suspect the currents will change first. We'll have updated altimetery maps for the 11 am surfacing. Right now, we keep the waypoint the same. Distance to the Spanish EEZ is 117 km.



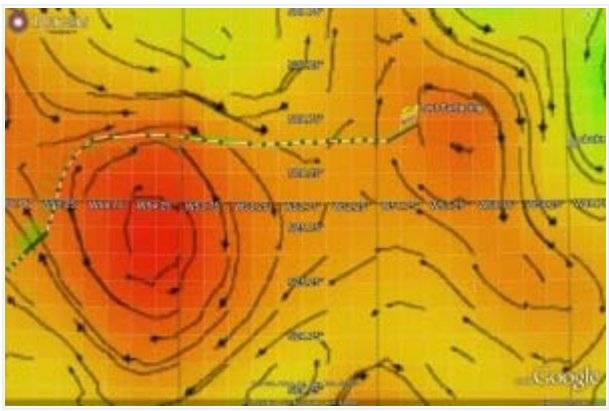
Looking ahead, the monday 11 am surfacing turns out to be an important one. Our distance made good was on the last 8 hour segment was 8 km. Sometime early monday we will cross the line that is 100 km from the Spanish EEZ. This is the point we are saving for Scarlet's final pitch adjustment to maintain her speed. It will be that last 100 km sprint across the EEZ and into the recovery eddy. Once in the EEZ, the flight path turns to center seeking on the eddy. We want to get into the eddy and stay there. The currents just east of 12 W are strong and will advect us south out of the area.

0 Comments

07 nov Winds and Waves on the Eastern North Atlantic

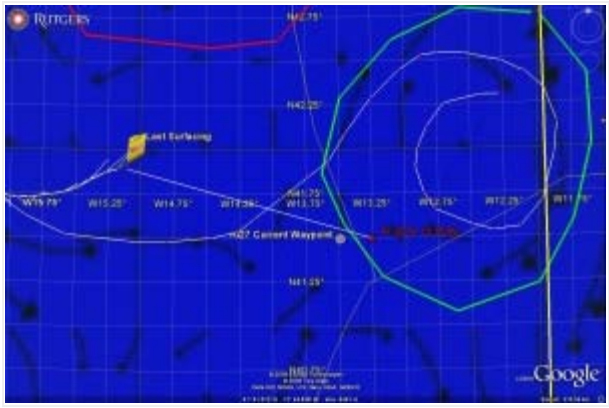
Posted by: Scott in: Atlantic Crossing

Drake is heading into the strongest northward currents along the western side of the clockwise rotating eddy centered near 51 W. He is having no trouble maintaining the sampling line, running straight along 26.5 N. In the image below, we have increased the scale of the current vectors by a factor of 3 - instead of the white vectors representing the equivalent drift over 1 day, the green vectors represent the equivalent drift over 3 days. Even though the currents reported by Drake are the average currents over the upper 1200 m of the ocean, the directions are in excellent agreement with the geostrophic surface currents calculated from the sea surface height measured bythe satellite altimeters as shown on the map. The current magnitude observed by Drake is a steady 4 cm/sec.

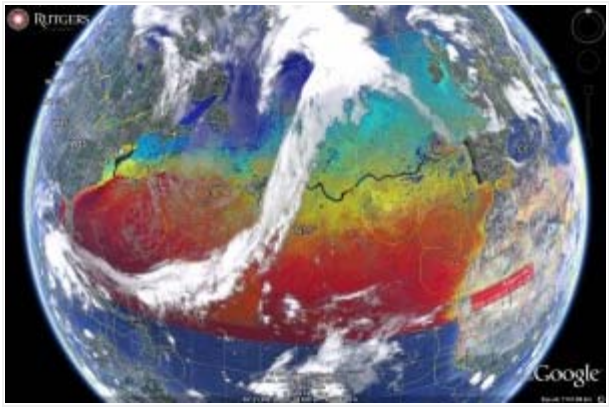


On the other side of the Atlantic, Scarlet is reporting stronger currents than expected from the sea surface height maps. Scarlet's currents are averaged over the top 150 m. Today the peak reached 23 cm/sec. Here we are showing the white arrows which are equivalent to 1 day of drift. The strong currents to the northeast are moving us along a more northerly path than expected. To compensate, we'll point Scarlet to the southeast. The angle between the current vector and Scarlet's own velocity relative to the water is about 60 degrees. We'll

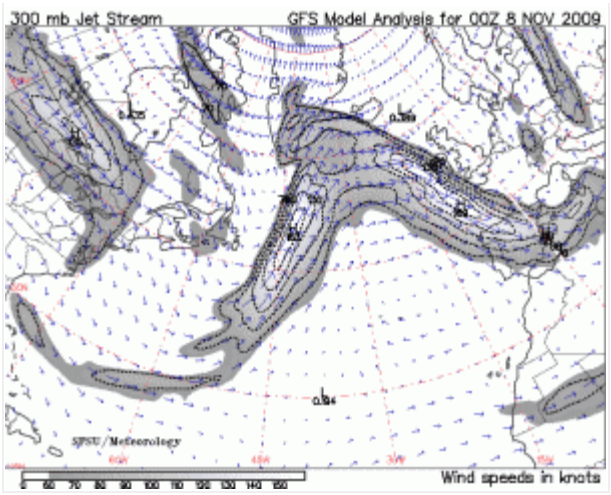
keep that angle about 60 for the night and early morning. If currents rotate more to the north, we'll increase the angle to around 90. If they rotate towards the east, we'll decrease it. We are trying to maintain the track between the thin white path line that spirals into the green circle and the region of high uncertainty indicated by the red circle to our north. Distance to the Spanish EEZ is down to 127 km.



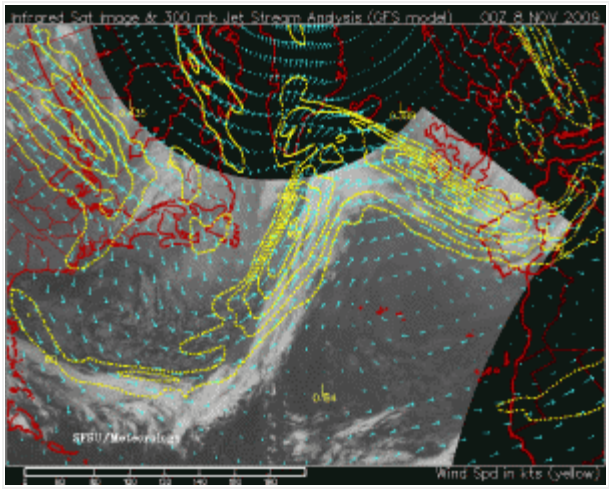
So why are the surface currents derived from the satellite altimetric measurements of sea surface height in better agreement with the deep currents reported by Drake and the shallow currents reported by Scarlet? Are the differences just random errors in the altimeter data? One thing to check is for unresolved eddies in the sea surface height field. For those we look at satellite sea surface temperature maps. But when you pop up the SST for Scarlet, you get patchy data. Overly the clouds and you see why. That straight band of clouds running east-west across the Atlantic is not a stable configuration for the atmospheric Jet Streams. Straight jets like to develop waves that grow rapidly in amplitude.



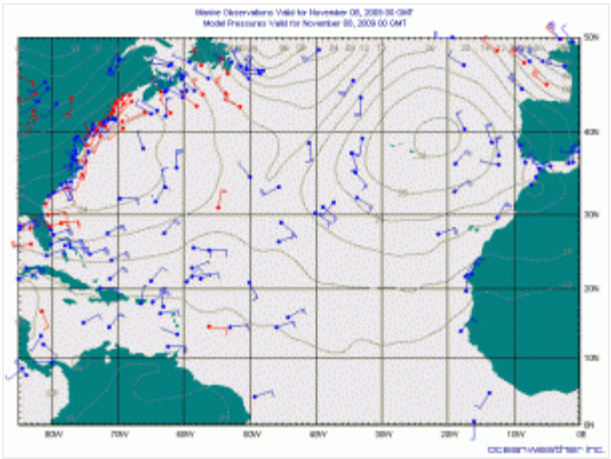
If we check out the Jet Stream forecast, we see the sine wave that now runs across the full Atlantic basin is indeed associated with the Jet Stream. It llooks like those upper level winds are heading right at Spain. Nice if you are an airplane heading that way. Not so good if you are a ship.



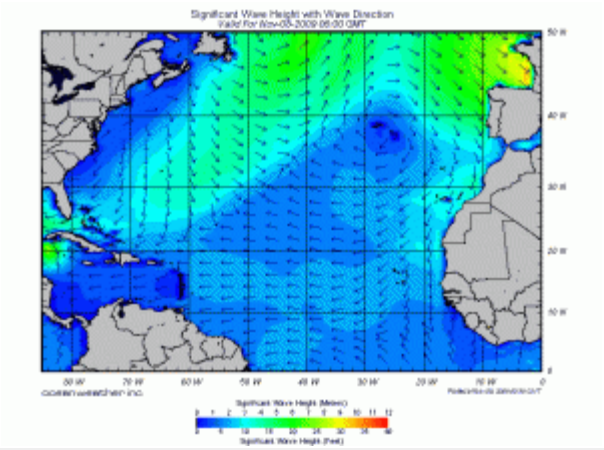
Jet Stream forecasters also overlay the cloud images on their forecasts for you so you can see the relation directly, saving you the trouble of importing the image into the universal Google Earth.



How do the lower level winds look in response? Are these causing the observed differences between Scarlet's depth averaged currents and the satellite altimeter's horizontally averaged surface currents? We can check out the surface winds from ship reports at Oceanweather. Strong surface winds from the northeast today. Ekman theory says we should be piling up water between the Azores and Spain right now, so thats not it.



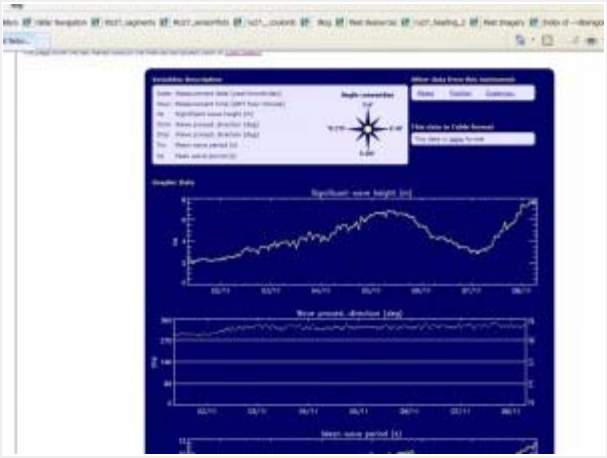
Strong surface winds also mean strong surface waves. Again heading to Oceanweather, we see forecast waves off the Spanish coast are running over 5 meters (15 feet).



So lets check the wave buoys at Puertos del Estado.

http://www.puertos.es/en/oceanografia_y_meteorologia/redes_de_medida/index.html

The Cabo Silleiro buoy is closest. Waves heights are approaching 8 m. Periods are long, as expected with that nice long fetch, but 8 m is still pretty big waves. As winter approaches, these big waves become more and more common off Spain. So we race the winter.

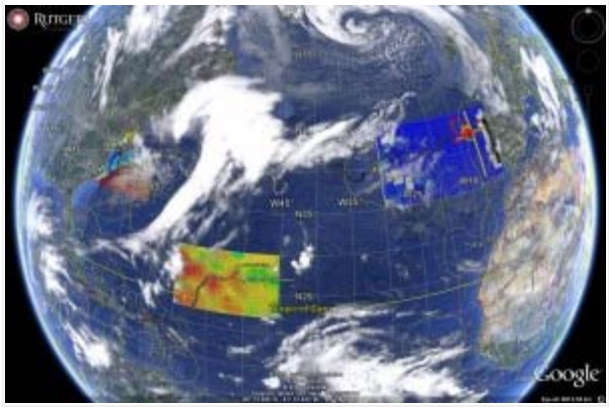


0 Comments

06 nov | 7 Gliders get ready for the weekend

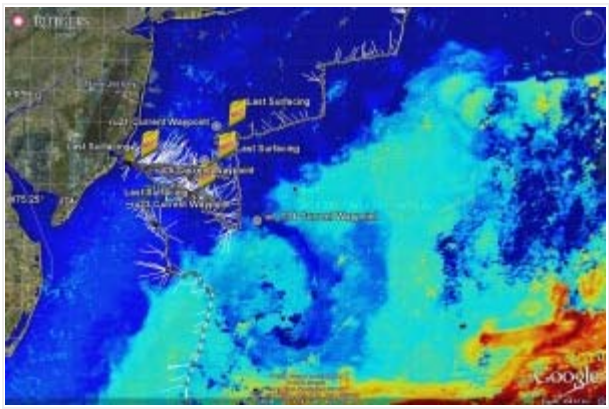
Posted by: Scott in: Atlantic Crossing

The deployed fleet has grown to 7 gliders. There are 5 in the Middle Atlantic Bight on a coordinated model-directed coastal mission, plus Drake & Scarlet on Trans-Atlantic missions. All three regions look relatively cloud free today.

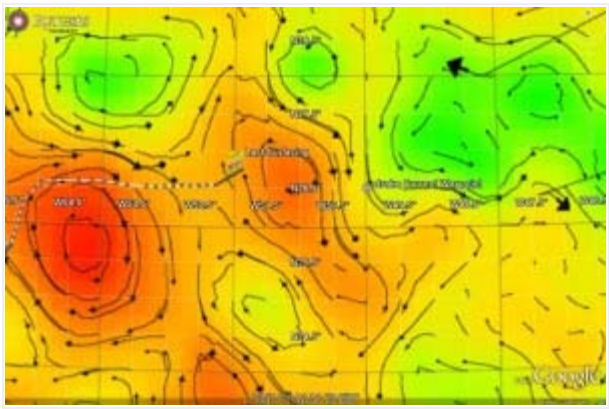


The Mid Atlantic is a glider party, Jersey style. Somewhere in all that traffic is the new UDel glider, the Blue Hen. Check out the Middle Atlantic Bight blog for an update from Oscar.

http://www.i-cool.org/?cat=5

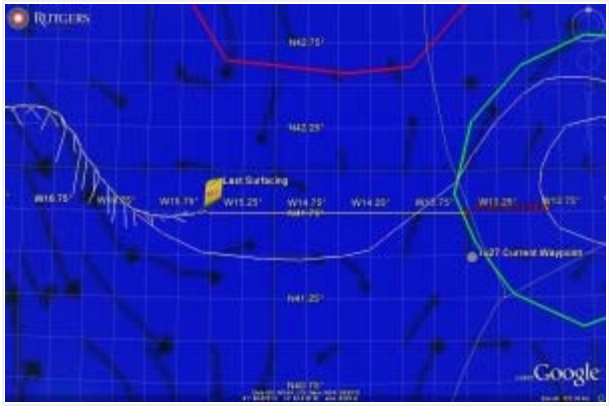


Drake is doing fine heading east along the 26.5 N line. I like how it used the eddy between 53W-55W to make the turn into the eastward line. Its amazing how the surface currents from the altimeter line up with the depth averaged currents from a glider undulating between the surface and 1200 m. Drake is just now starting to encounter the northward currents from the clockwise eddy centered near 51 W. Drake has an excellent weekend ahead of him. Can't wait to see how he does.



It looks like Scarlet has made it past that small current to the NE that threatened to whip her around in a tight circle back to the west. Last night shifted the waypoint just a bit to the south to help ensure that this would be the morning

outcome. Today at the 11 am surfacing we'll go back to an easterly course. Currents where within only a few degrees of Scarlet's course last night, so we got a good read on her speed. Scarlet's current speed relative to the water is 16 cm/sec, or just under 14 km/day. Last week's estimates where about 15 km/day. So she is slowing down. We have 1 more pitch adjustment left. After that, we start flying too steep for the attitude sensor. Plan for the weekend is to continue flying east to about 14.5 W. At that point we start the turn to the northeast towards the green circle of the pick up zone. This morning's distance to the Spanish EEZ is 170 km.

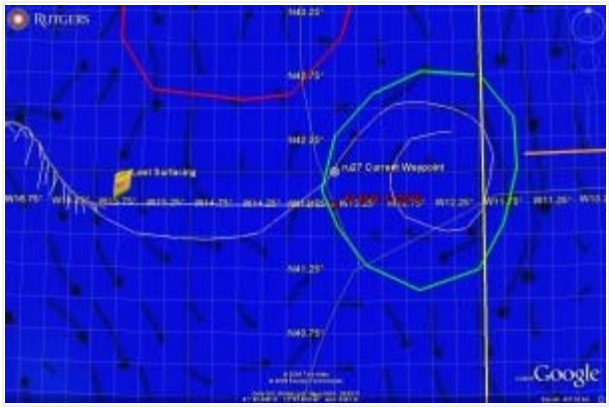


0 Comments

05 nov — Waypoint change to east

Posted by: Scott in: Atlantic Crossing

Scarlet's reported ocean currents are much lower the last three surfacings, down to 5 cm/sec. If this holds, it means we successfully made it out of the swift currents to the south by flying perpendicular to the current. It also means we can fly the direction we want. Following the white pathline into Spanish waters calls for an easterly course at this time. We'll make the change at the 11 am surfacing.

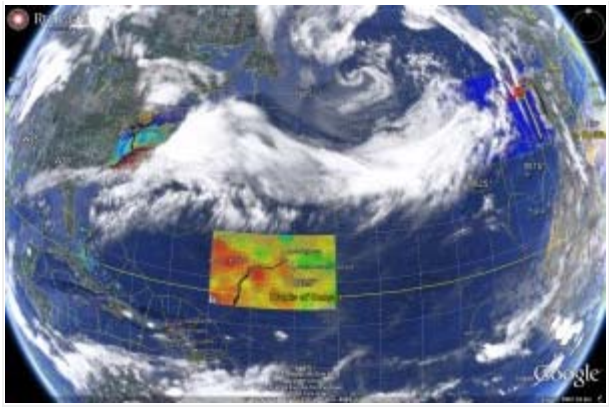


0 Comments

04 nov — Scarlet's 7,000th Kilometer.

Posted by: Scott in: Atlantic Crossing

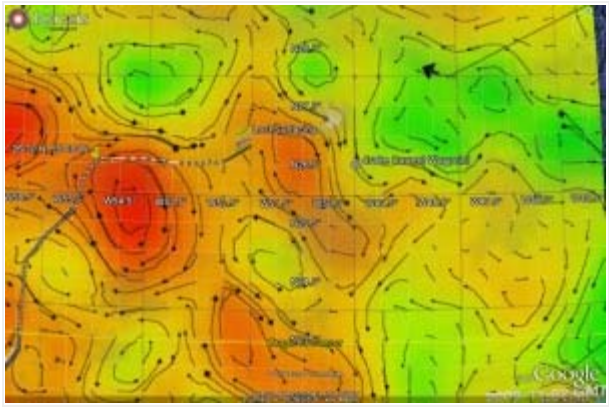
Three glider experiments looking through three breaks in the clouds.



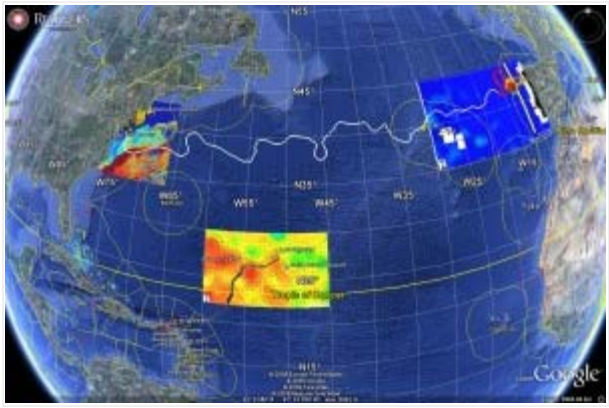
Oscar is posting updates on the NSF experiment on the Middle Atlantic Bight Blog.

http://www.i-cool.org/?cat=5

Here we'll focus on the two Trans-Atlantic gliders. Teledyne Webb's deep thermal glider Drake is approaching its first test along the 26.5 N line. There is a clockwise rotating eddy centered on the line at 51 W. How Drake crosses right through the middle of this feature will be interesting to watch in the current vectors, how its track is deflected, and in the resulting temperature structure and heat flux. Once past this eddy, Drake looks to have a tail current along 26.5 N all the way to the edge of this plot at 45 W.



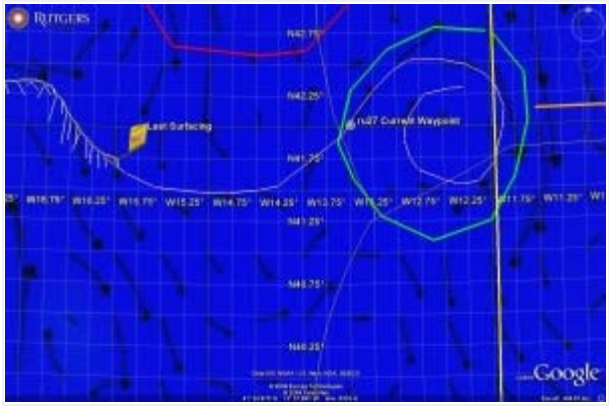
Scarlet crossed the 7000 km mark today, with it's current path length reading at 7022 km.



The approaches to Spain and Portugal are shown here. The red circle is the area of uncertainty discovered this past weekend - the area we are working to avoid. The green circle is our target region for the end of November. The eastern side of the

circle is 120 nautical miles from Vigo (orange line), and the western side is at the edge of the Spanish Exclusive Economic Zone, 200 nautical miles offshore. Inshore of the vertical yellow line, a strong current heads south along much of the peninsula towards Lisbon. This alongshore current is likely to be faster than Scarlet can fly. We'll try to stay just offshore of these as we wait for pickup in early December.

Zooming into Scarlet's local area, she is now just less than 200 km from Spanish waters. We hope to follow the looping white line into the green circle, then spin around the eddy towards its shoreward side. Once in this region, there are several options depending on timing. We can either continue to spin in the eddy or head into the strong alongshore current to move along the coast. Whichever is preferred for pickup.

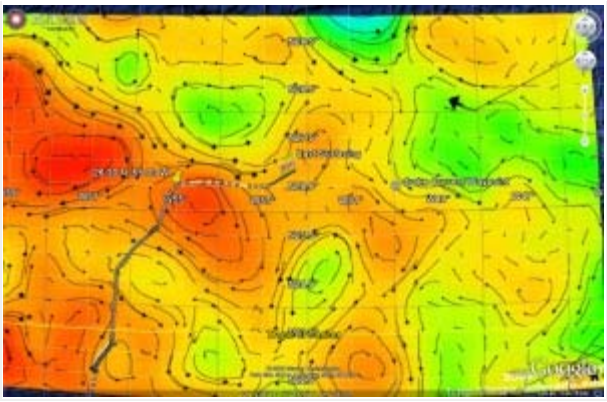


0 Comments

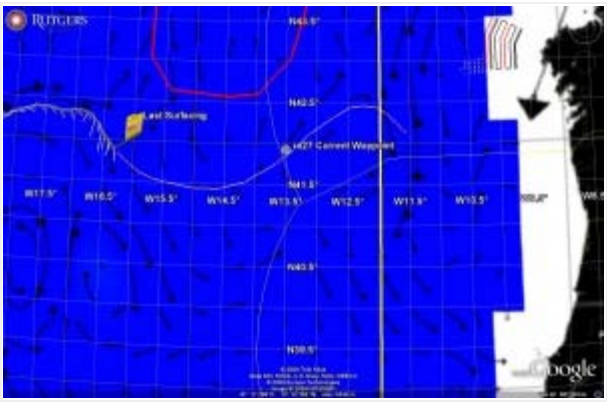
03 nov Drake's first challenge along the MOC line

Posted by: Scott in: Atlantic Crossing

Drake encounters his first challenge along the 26.5 N line. He is about to cross the southern edge of a clockwise rotating eddy. The surface currents will be against him. But Drake is a deep glider, diving to 1200 m. We'll see how we do over the next few days.



Scarlet continues to keep her nose pointed east as we move south with the currents. The combination is a southeast track. The objective is to use all of Scarlet's speed to fly perpendicular to all the current arrows, trying to move along the thin white line that takes it through currents to the east and then currents to the northeast. The distance along the wavey white pathline to the Spainish EEZ (thin yellow arc) is 250 km. The white line is extended into Spanish waters another 200 km, so that its total length is 450 km. If we did 15 km/day, thats 30 days. We likely will not keep this speed for the full 30 days. The think yellow stright line marks 12 W. This is the western boundary of the strong alongshore current that runs south, and the outer boundary of the vessel traffic we see in the AIS. Crossing that boundary will like put is in a current that is faster than the glider, and we would be advected south along the coast towards Lisbon as we waited for pick up.

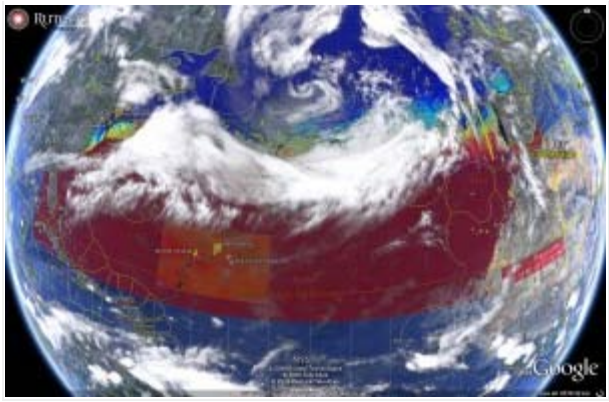


0 Comments

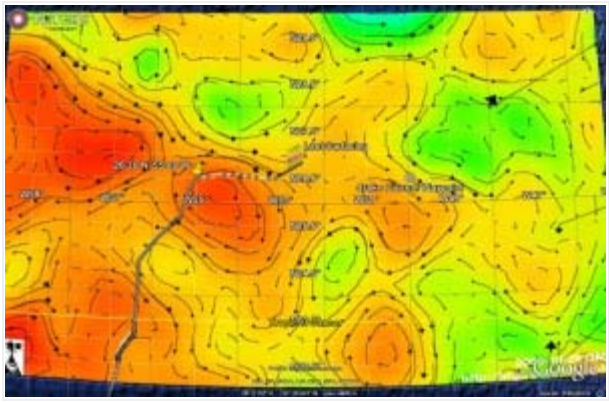
02 nov — Still trying to break free

Posted by: Scott in: Atlantic Crossing

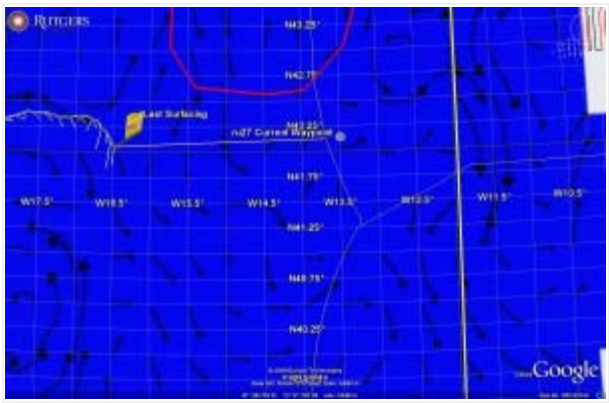
That long Trans-Atlantic band of clouds persists, with the New Jersey shelf emerging on the western side. Looks like high pressure and clear weather behind it, meaning clear skies for the NSF experiment that starts this morning. Glad we have an ocean all those satellites can look at instead of cloud tops.



Activities later in the day will focus on the Jersey shelf. We'll set the Trans-Atlantic fleet here for the day. Drake remains a rock star - heading east on the 26.5 N line. And the waypoint was moved farther downstream to the east as we head across. Next job this week for Drake is to slide the altimetry geostrophic current map a bit to the east so that Drake has about 1/3 of the map behind it and 2/3 of the map in front of it.

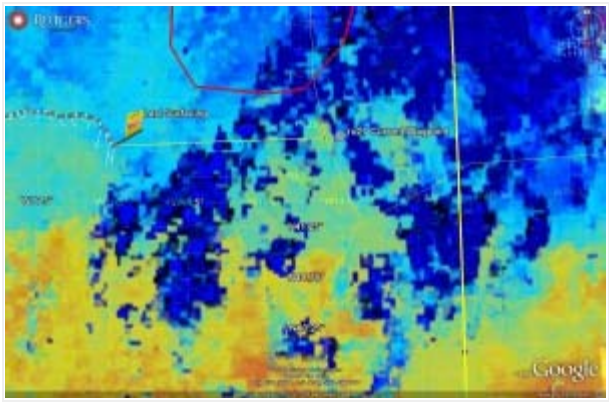


Scarlet reported even stronger currents overnight. Up to 34 cm/sec. We are not out of this feature (eddy?, jet?) yet. One good thing is that we are following it closely, continuing to update Scarlet's flight direction to be 90 degrees to the currents, and keep her nose pointed east. The other good thing on the ocean side is that the current direction did not change between 7 pm last night and 3 am this morning, but the currents decreased to 22 cm/sec. This could be a sign that we have crossed through the maximum velocity core, and we are moving through a shear zone with lower and lower current speeds.



The third good thing is that in spite of the clouds, there was a small break yesterday that resulted in a partial Sea surface temperature shot. Maybe today

we'll see some ocean color that will reveal the nature of this feature.

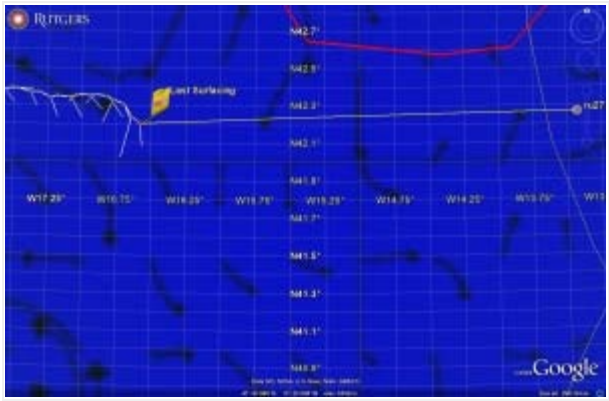


0 Comments

01 nov Some mighty fine piloting

Posted by: Scott in: Atlantic Crossing

Scarlet's noon surfacing returned much more favorable currents. Down to 15 cm/sec, mostly south and a very little bit east. With Scarlet pointed due east, and running 15 cm/sec relative to the water, our resultant direction over the ground was more like southeast. And we used all of Scarlet's velocity to move us from a strong unfavorable current to a weaker and more favorable place. We'll continue on this path for another segment or two. Pretty nice piloting on a weekend.



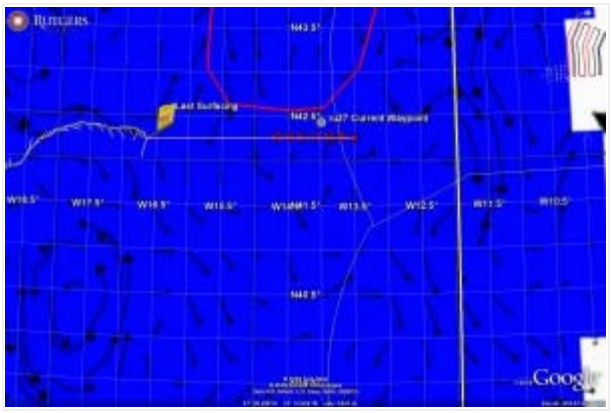
0 Comments

01 nov More surprises from the eastern North Atlantic

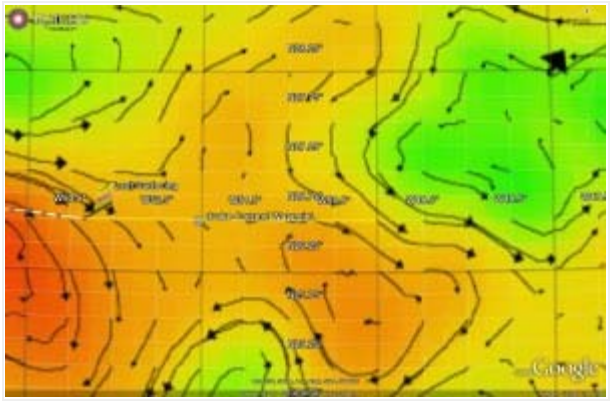
Posted by: Scott in: Atlantic Crossing

Scarlet sent us home some surprising news that currents had increased to 28 cm/sec to the SSW. We have not seen currents this strong for weeks. Yesterday's guidance from the altimeter had us in a region with virtually no currents. Today's altimetry is different again, currents to southeast are back, but not in the form of an eddy. Some of what we are seeing is the actual evolution of the ocean eddy field. Some of it is caused by the sampling pattern of the altimeter. Sometimes you have to wait several days for a satellite to pass near you to update your estimated current fields. Regardless of why (actual evolution or undersampling) the roadmap is changing every couple days. Antonio's waypoint change to straight east yesterday turned out to be a very good decision. With this morning's reported current stronger than Scarlet's own velocity, the best we can do

is fly perpendicular to this current until we break free. Thats exactly what Scarlet did last night, and its what we'll continue to do today. Distance to the Spanish EEZ is down to about 240 kilometers.



Drake's reported currents also increased overnight. He is riding a tail-current, making 30 km in the last 13 hour segment. Time to shift his waypoint further east.



0 Comments

31 oct

OOI's Ocean Observing Simulation Experiment begins

Posted by: Oscar in: Atlantic Crossing, Espresso & Biospace, Middle Atlantic Bight, NORUS

The Ocean Observing Initiative (OOI) has begun construction. For information of the OOI go tohttp://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/

The OOI has a large effort to build a mature cyberinfrastructure to support OOI and all ocean infrastructure. As part of that 6 effort and growing out of over a decade planning we begin. First things first, we toast with a Halloween pint, the three who got us here, John Delaney, John Orcutt, and Robert Weller. For this effort we are a small piece of the OOI, and we represent a small part of the OOI cyberinfrastructure team. We are teaming up with infrastructure being funded by the NOAA IOOS MarCOOS and the ONR ESPreSSO programs. For the next two weeks, we will be testing all the Planning and Prosecution software during an Observing System Simulation Experiment (OSSE). The OSSE software team is large but anchored by scientists/engineers from Rutgers, Scripps, Cal-IT, MIT, USGS, and NASA's Jet Propulsion Lab.

We will be testing several distinct software programs (to be highlight in several blogs to follow in the next few days) trying to coordinate real assets in the field

during windy rough November weather in the angry seas on the Mid-Atlantic Bight. During this week we highlight in a series of blogs the range of technologies we will be deploying. The observation assets that we will use are satellites including AVHRR, MODIS, GOES 11+12, FY1D, OCM, TMI+AMSRE, and AASTR. These images will be complemented with a full nested CODAR array. The in situ robotic systems will consist of a fleet of Teledyne Webb Slocum gliders complemented with a fleet of propellered REMUS and Iver AUV systems. These field assets are complemented with NOAA NODC moorings. For models, we are utilizing numerical models from U Mass Dartmouth (Avijit Gangopadhyay), Stevens Institute (Alan Blumberg), University of North Carolina (outer boundary condition, Ruoying He), Massachusetts Institute of Technology (Pierre Lermusiaux), Rutgers (John Wilkin), Jet Propulsion Lab (Yi Chao). These ocean models are complemented by the atmospheric NAM model. The model and observation data can be accessed through the our ocean data portal constructed by the Jet Propulsion Lab.

To follow along, go to: http://ourocean.jpl.nasa.gov/CI

A social network site will be unveiled on Monday to collate all efforts To people who use the ocean in the Mid-Atlantic, please send us your comments. Join the network at: http://cyber.marine.rutgers.edu/
Note this site will be cleaned but please come join the network to give us your feedback. We need your eyes and brains. Our goal is to collect all the goods, bads, and ALL suggestions to make the infrastructure good for those use the ocean. The next blog will talk about the status of the mid-Atlantic Ocean today.

Oscar & Scott (aka Scotscar)

0 Comments

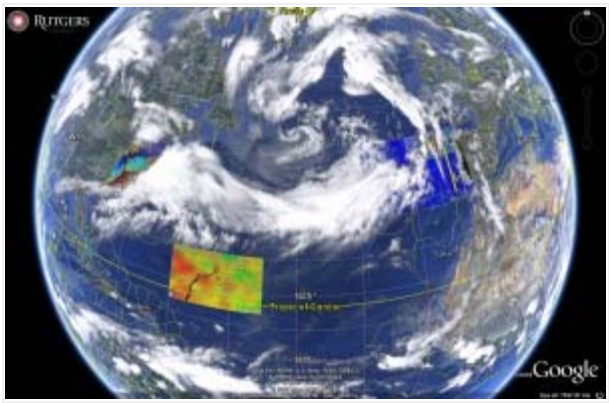
31 oct

Antonio Earns a Gold Star

Posted by: Scott in: Atlantic Crossing, Uncategorized

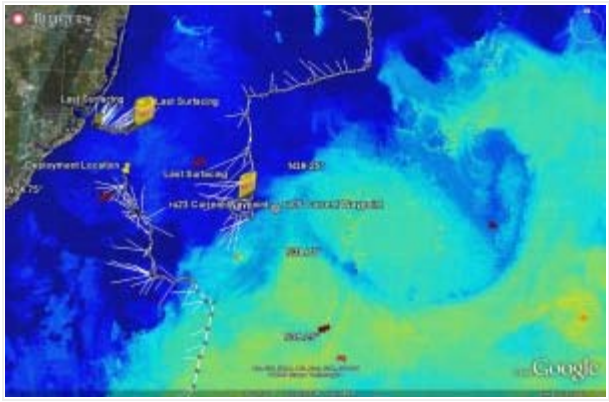
Sitting here at my dining room table on a Saturday morning, I look out at 2 worlds. Out the window is the center of Hopewell, the same streets walked by Charles Lindbergh. Staring at my wireless laptop screen, the internet takes me into the COOLroom, and the COOLroom takes me out to sea.

Checking on the North Atlantic Fleet, a band of clouds stretches all the way across the middle of the basin, separating the northern stormy weather from the clear skies of the south. Scarlet is working on our second attempt at a summer Atlantic crossing along the northern route, nearing the Spanish coast and racing the coming of winter. Meanwhile, Drake is enjoying the sunny weather of the tropics on our first attempt at a winter Atlantic crossing on the southern route. Peering out through the clouds on the left is the fleet currently deployed in the Mid Atlantic Bight. Lets check in on them first.



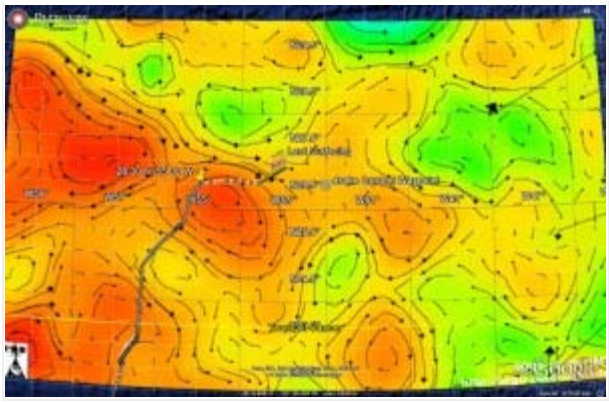
Zooming into the Middle Atlantic Bight of North America, and into the New Jersey

coast, we have a Sea Surface temperature image showing us a series of eddies in the Slope Sea, interacting with the shelf water at shelf break. RU15 has reached the outer edge of the Tuckerton Endurance line and is on its way in along a well trod path. I remember back in 2003 when we ran the Endurance line for the first time for Steve Ackleson at ONR. Yes, we were very worried we could loose the vehicle, but we also knew we had to establish the first glider Endurance line to demonstrate their value. Now, in the robot world, the Tuckerton Endurance line is nearly as good as the safety of home. Its one of the most trafficed glider lines in the world. While RU15 is heading in, three gliders from the NSF experiment, RU05, RU21 and RU23, are flying out in formation to meet it. It is definitely the hottest collection of ocean optics ever deployed on a fleet of autonomous underwater vehicles. One hope is to draw these gliders close for an intercomparison test over the weekend.

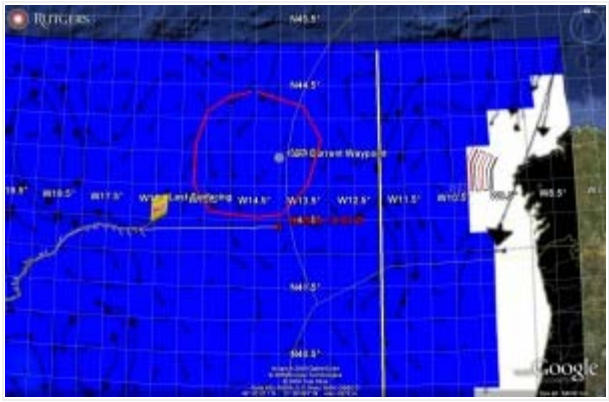


The NSF experiment starts on monday, and the gliders are likely to be sent out in different directions. The website to follow along is http://ourocean.jpl.nasa.gov/CI/. We just submitted the Year 4 renewal for the Mid Atlantic Regional Coastal Ocean Observing System (MARCOOS) proposal on friday, so all 38 MARCOOS Partners are turning away from text editing and heading out to sea with us on this joint experiment. Wendell Brown is coming down from the observatory lab at UMass to sit in the COOLroom next week to be the voice of IOOS on the video feed. Typically we broadcast voice with the video only at noon to the 4H groups concentrated in the center of our country (the 6 million in the middle), but we are looking at 10 am for live broadcasts this week to fit with our usual MARCOOS conference call time. To this we add the DHS Center of Excellence for Port Security. While NSF and IOOS focus on the environmental side, DHS will focus a security experiment in the exact same location at the exact same time. The DHS folks need to understand what is going on in the environment to improve Maritime Domain Awareness, and the NSF/IOOS folks need to know more about the what the people are doing if we are to properly study and monitor urbanized environments.

Now back to the tropics. The deep thermal glider Drake continues to amaze us with its ability to track a line in the open ocean. We are resetting the web page this weekend to prepare the displays to be of better use to both us and the scientists working out of the U. Southampton (UK), U. Miami (U.S.) and Max Planck (Germany) on Rapid Climate Change. The Southhampton program is on Meridional Overturning Circulation, or MOC. Their wesbsite is http://www.noc.soton.ac.uk/rapidmoc/ . In this case the undergraduate students in our Atlantic Crossing class are way out in front of the professors. The students have already contacted many of the scientists on the website and are talking about exchanges of data that will help Drake fly. Just as scientists and students in Spain and Portugal have been critical partners in our efforts to fly Scarlet across the Atlantic along the northern route, we are hoping the U.S. students make friends with the British students, combining their expertise to get Drake across along the southern route. We find the U.S. students are diving into this without waiting for their distracted professors to catch up.

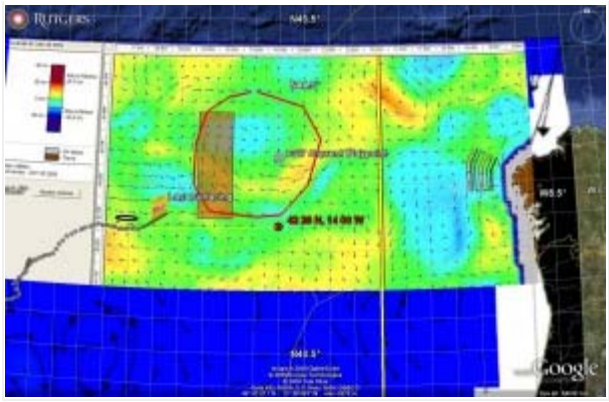


Finally, across the Atlantic to Scarlet and Antonio's story. In the last blog we were all amazed by the rapid change in the guidance provided by the satellite altimeter. The geostrophic currents in the image totally changed character in the space of a day. The route east located to our south was gone, replaced by a series of eddies that drew us to a more northern route. The new eddy is circled below in red.

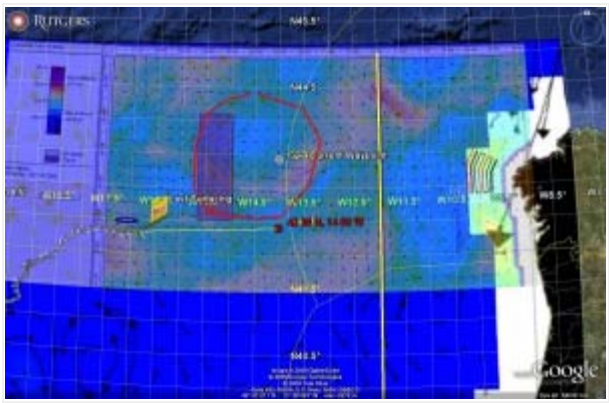


Saturday mornings are a great time for me to head out to sea in the observatory. I'm away from the office, my wife is at work, and our kids are sleeping in. Its a tradition I started with Hans Graber from U.Miami during the ONR Shallow Water 2006 Experiment. On Saturday mornings we would both head out to sea together, Hans from his observatory in Miami and me from mine at Rutgers. We'd meet on the NJ shelf and discuss the data we were both looking at, and what to do next with our ships, aircraft and gliders.

This morning when I logged in, I found an email from Antonio in the Canaries noting "THE LAST OBSTACLE". The time for interaction is short during the week, essentially non-existent. When you physically go to sea, everyone knows you will be intensely focused, and they leave you alone. But when you go to sea virtually, they see your body is still in the room, and expectations are different. Antonio was clearly trying to get my attention, and finally, on Saturday morning, I had the time to listen. Antonio was heading to the beach for some surfing. The storm we are watching in google earth was stirring up 7 foot waves in the Canaries. But before heading down the beach, Antonio logged into his observotry, and checked on the datasets he was watching. His data said the eddy was spinning in the exact opposite direction. He sent me the image this morning and we put it into google earth. Antonio noted that the guidance from our usual altimeter product would lead us right into the strongest currents to the west, suggesting we go around this region to the south by staying on a straight east course.



Adjusting the transparency of Antonio's map, and overlaying it on our standard geostrophic currents, we can see the area of disagreement. If we were on a data assimilation mission, this is the region of greatest uncertainty, since we are not even sure which direction this eddy is spinning. It is the exact region we would point the glider. It would have a simple mission. Determine the sign of the spin - amazingly basic information - but one of these global datasets is wrong, and that error will have a significant impact on the forecast is the wrong choice is made for assimilation. But Scarlet's mission now is a race with the clock, we need to beat the winter, meaning we need to avoid the regions of highest uncertainty. We made the decision to change the waypoint to straight east. But on this Saturday morning, all the glider pilots were watching the NSF fleet. They where changing the depths of the excursions and keeping the fleet together. Significant email traffic on this so I did not want to distract them from their main focus. We would need someone else to fly Scarlet. Tina - remember Tina? Azores rescue? - was following along over the internet in Antarctica. She's been down there for a few weeks prepping the Antarctic glider fleet for deployment on a NSF mission. Tina logged in from Antarctica, took control of Scarlet, and redirected her on a route to the east just as Antonio suggested. We hope Antonio enjoys the surf. He earned his gold star for the day.



Thinking back to Hank Stommel's 1989 fictional account of the The Slocum Mission http://www.tos.org/oceanography/issues/issue_archive/issue_pdfs/2_1/2.1_stommel.pdf , a futuristic look at the oceanography, I am even more convinced the future is now. For today's quote from Hank, we'll use, "There is nothing like the need to make decisions to lay bare areas of ignorance that are papered over in textbooks". Today we found a sign error in one of the world's textbooks, and we are not even sure which one is right.

Next week we take another step forward in the tranformation with the start of the NSF OSSE on the Mid Atlantic continental shelf. I wonder what we'll discover on monday.

0 Comments

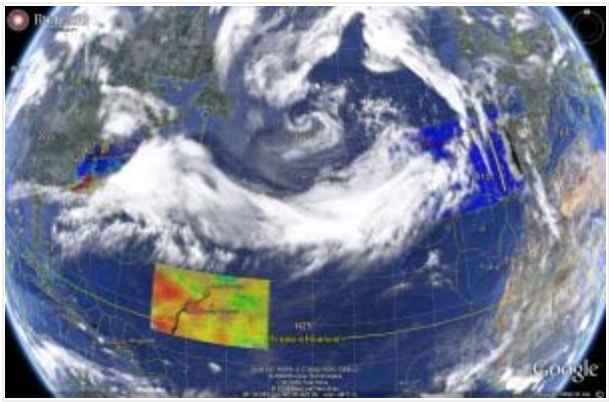
29 oct

An Anniversary is Noted

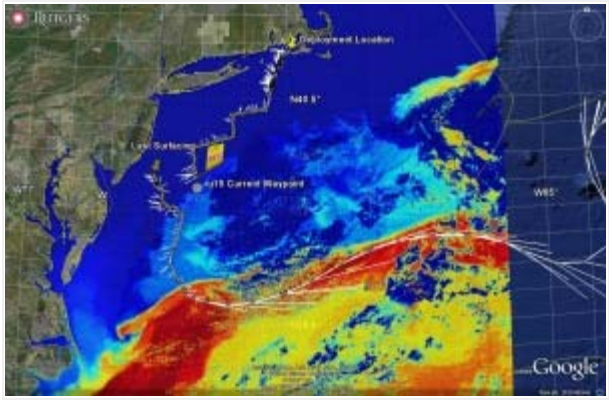
Posted by: Scott in: Atlantic Crossing

On October 29, 1992, Mike Crowley powered up Rutgers' new SeaSpace Satellite Data Acquisition System and tracked an overpass of one of the NOAA sea surface temperature sensing satellites. It was our first use of the Coastal Ocean Observation Lab's control center, what has come to be known as the COOLroom. Today Mike reminded me it was not much of a room back then. It still had no ceiling, some internal walls where still missing, and we had to wear hard hats to work on the computer. But on this day 17 years ago, the Coastal Ocean Observation Lab began sensing the ocean off the U.S. East Coast and has never stopped since.

Checking in on the Atlantic fleet, a band of clouds stretches straight across the Atlantic from the U.S. nearly to Spain. We'll need to check how this weather is affecting currents on the European side later on friday. I keep seeing emails from Antonio specifically on the currents, so I know he is keeping a watchful eye on us. Its good we have a distributed team.

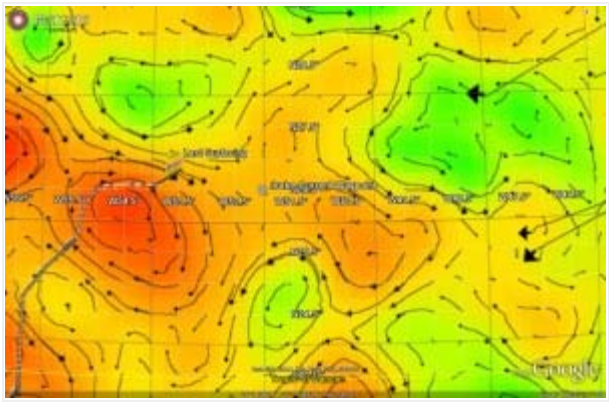


First closer to home, RU15 is about to hit its final offshore waypoint. Its on a dual use mission. It has the hottest optics package we ever deployed for the ONR mission, and its following the route to collect temperature data for the NOAA IOOS and NOAA Fisheries missions. It should hit its waypoint at the end of the Tuckerton Endurance line today, then head in for recovery. On Friday we also deploy 3 gliders for the NSF OOI. Glider party in the Mid-Atlantic.

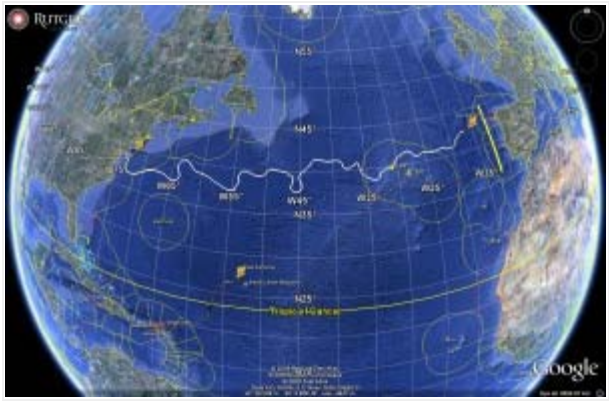


Moving south to Teledyne Webb's thermal glider Drake, we have hit the target latitude of 26.5 N and are heading east. We are running Drake along this line to determine how gliders can best contribute to the programs to monitor the north-south exchange of heat in the North Atlantic. The circulation is called the Meridional Overturning Circulation, abbreviated as MOC. The rapid climate change scenarios are often related to changes in the MOC. Drake is holding the line quite well so

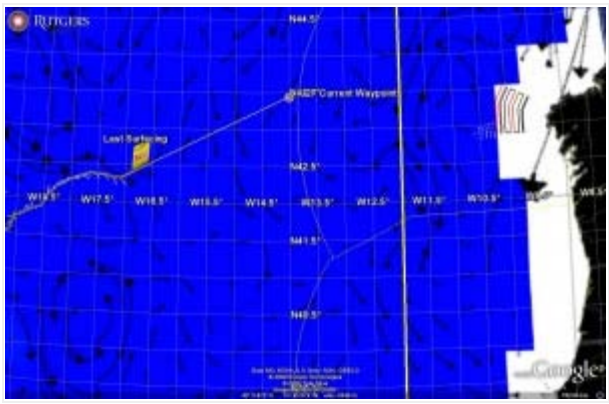
far. For those of us that grew up in the shallow glider world, it is truly amazing to see how well a deep glider can hold a line in the open ocean.



On to the glamour shot for Scarlet. At 8 pm on Oct 29, Scarlet surfaced and reported she had flown a total path length of 6,900.43 km. We'll round down to 6900.

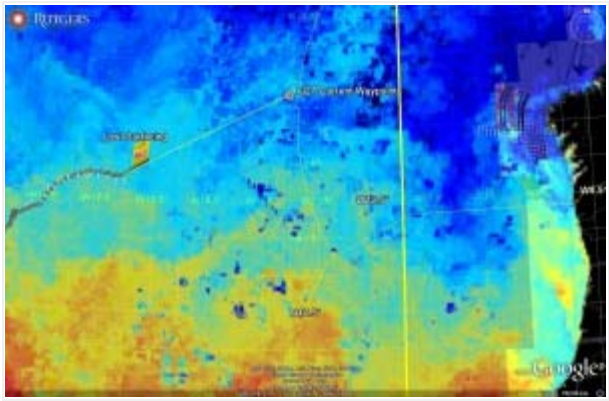


Zooming into Scarlet's present location, the altimetry map below shows the path planning shocker from the noon surfacing. The geostrophic currents on the map have totally changed in character. The jet to the southeast is gone, and the eastward currents we hoped to ride along 42 N are down to zero. Instead of the stronger currents being to our south, the stronger currents are now to our north. Luckily, Scarlet was on an eastward heading, so the distance to either route is the same. With this new information, we turned Scarlet northeast into the region with larger currents. According to this sea-map, the currents should be first to the northeast, and then to the southeast.

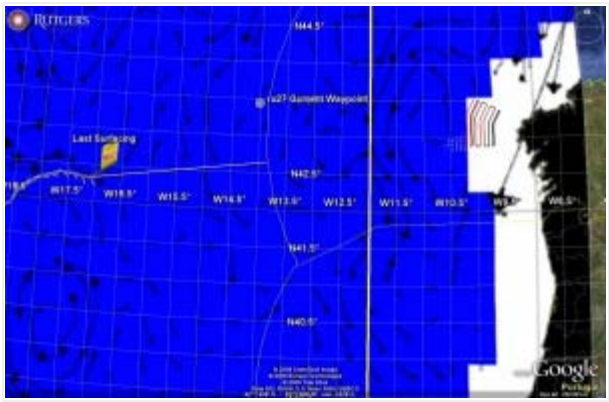


The satelite Sea Surface Temperature map below is in general agreement with the altimetery. Where the currents are northeast, we see warmer water heading

north. Where the currents are southeast, we see colder water heading south.



Lastly the recovery planning plot. Our first task is to get into Spanish waters by crossing the 200 nautical mile limit (thin yellow arcs) that marks the outer edge of the Exclusive Economic Zone (EEZ). As of 8 pm tonight, Scarlet is 269 km from the outer edge of the Spanish EEZ. Once we cross this line, our job is to position ourselves in Spanish waters at a location that is most favorable for recovery.



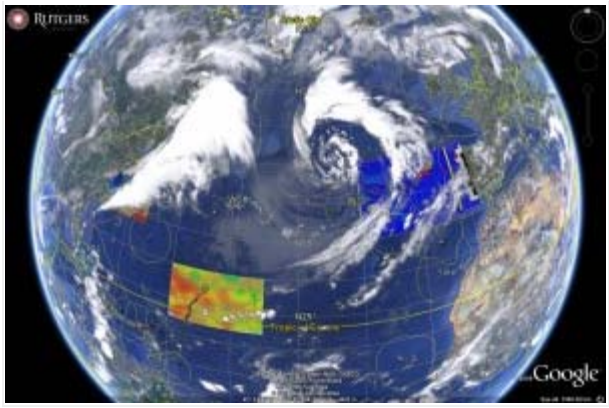
0 Comments

25 oct

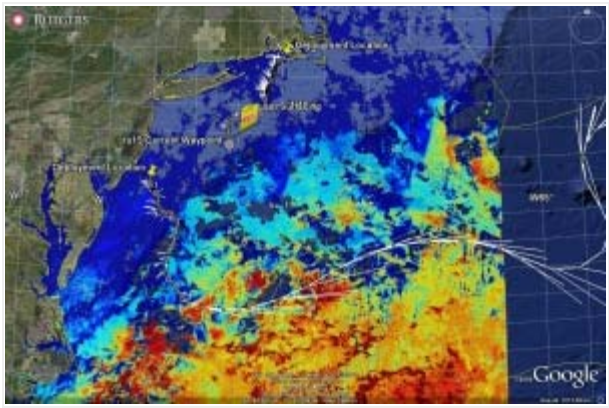
Atlantic Fleet Update

Posted by: Scott in: Atlantic Crossing

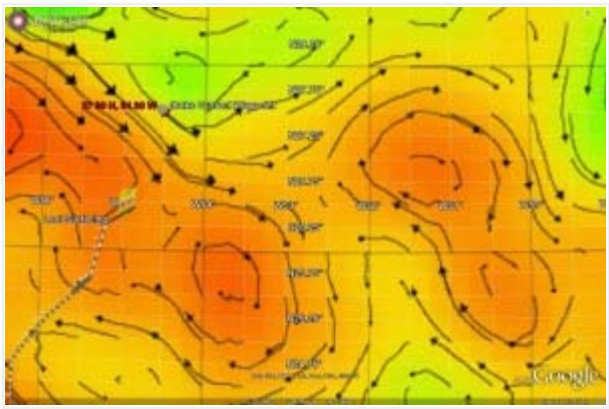
The IOOS glider and the Navy Glider where both recovered from the Mid Atlantic Bight testbed this last week. Both provide subsurface temperatures to compareto fisheries surveys, both provided assimilation data for our three regional dynamical forecast models, and both provided test data from the new Seabird glider CTD. The storm front with sever rains that we just experienced yesterday is moving offshore, and the tight storm over the western North Atlantic is heading towards Europe.



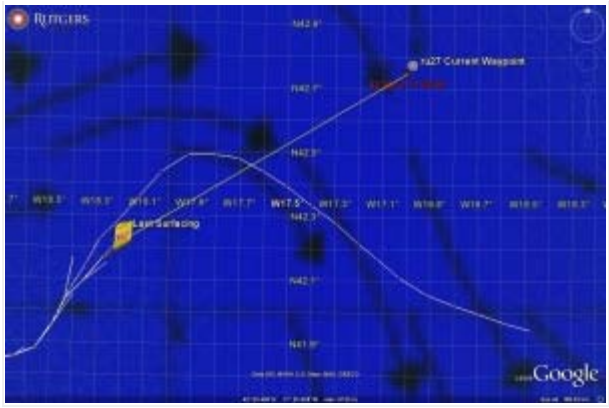
RU15 remains in the water on the Middle Atlantic Bight Shelf, completing and ONR optics and data assimilation mission just before the start of the NSF Ocean Observing Initiative Experiment.



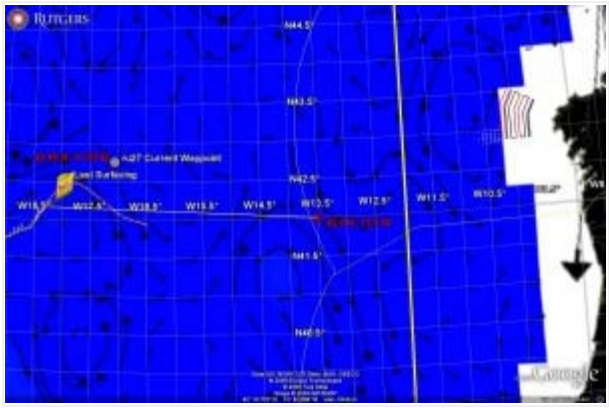
Drake is heading northeast and is only 1/4 of a degree south of 26.5 N. Once we hit this latitude, somewhere around 55W, we'll turn east.



Scarlet has found some favorable currents within a few degrees of our steering direction. Her navigation calculations indicate that the current is flowing at 16 cm/sec, and she is flying at 20 cm/sec, both in the same direction, clicking off 10 km in the last 8 hour segment. We'll continue this downstream direction at noon today.



Zooming out on the atlimeter's surface current map, it is 390 km to the red target star, and 370 km to the edge of Spain's Exclusive Economic Zone (thin yellow arc).



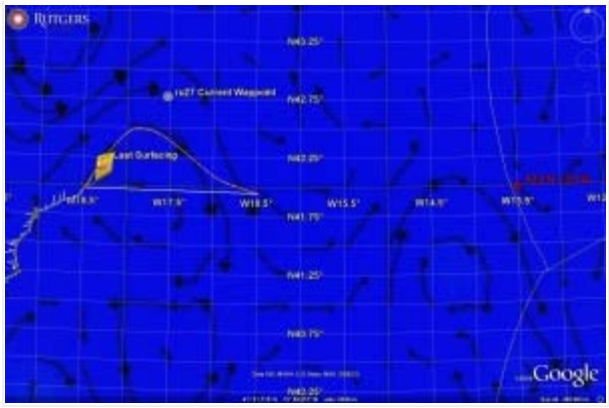
0 Comments

24 oct

Path-planning saves time

Posted by: Scott in: Atlantic Crossing

Head and tail current situations are great times to assess your glider speed relative to the water. At the 4 am surfacing, the currrent direction and Scarlet's flight path were both within 2 degrees of each other. We made nearly 10 km in the 8 hour segment, with a breakdown that looks like 2/3 Scarlet (6 km/8 hours) and 1/3 ocean (4 km/8 hours). If that holds for a full day, Scarlet is making 18 km/day by herself and 30 km/day if you add in the boost from the ocean currents. If we stay at this radius in the eddy, and continue to use its clockwise swirl velocity, we can cover the 210 km loop to 16.5 W in about 7 days at 30 km/day. If we try to go straight across the eddy using only Scarlet's own speed, the shorter distance is 165 km, but it now takes 9 days at 18 km/day. Going around the longer loop to the north to take advatage of the eddy swirl velocity saves us 2 days.

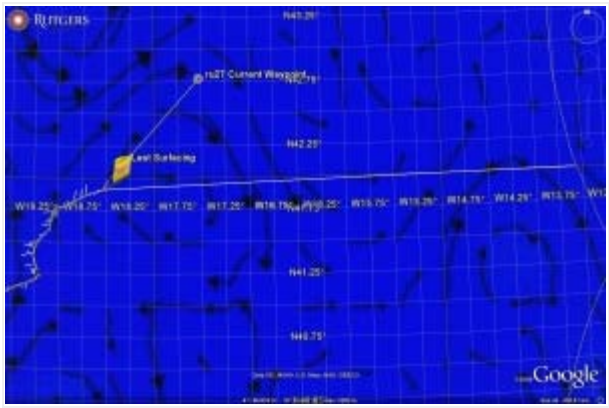


0 Comments

23 oct | Running downstream

Posted by: Scott in: Atlantic Crossing

After running east with our head down to escape The Wall, we just turned Scarlet northeast at the 8 pm surfacing. We have northeast currents along a northeast course. We'll run downstream until at least noon tomorrow. To properly exit on the eastern side, we need to ride one of the outer rings of this eddy. The straight east course was running us a little too close to the center. The worry is trying to fly due east out of the center - if you don't make it out in time, you risk spinning around for another lap. The Wall already caused a delay, we don't need another.

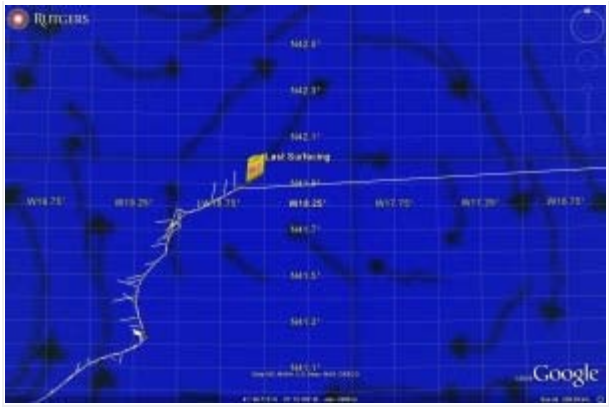


0 Comments

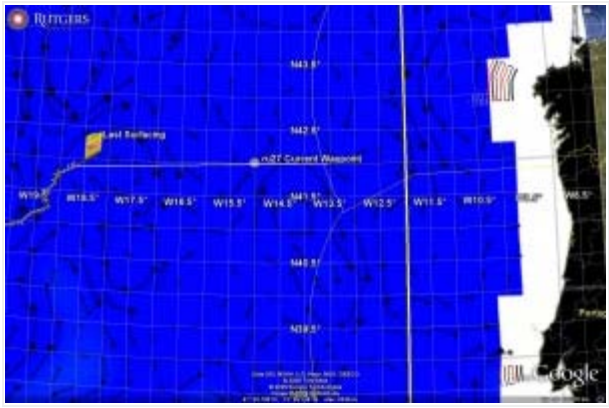
23 oct | Back in the Race

Posted by: Scott in: Atlantic Crossing

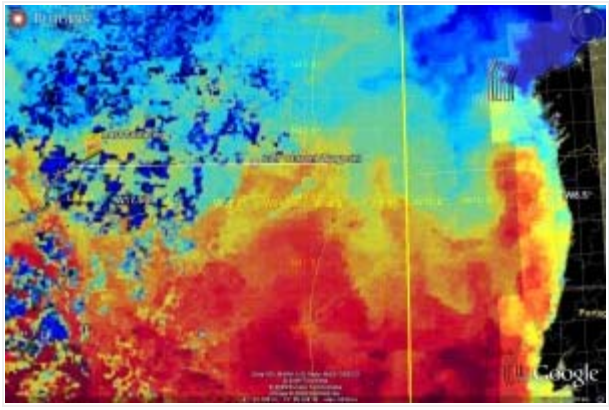
Scarlet has broken free of The Wall and is now has a series of four 8-hour segments with currents to the north, in excellent agreement with the geostrophic currents derived from the satellite altimeters. The Wall explored by Scarlet is still not resolved in the altimetric data, which for us defines the scales of resolution we can expect for the rest of this trip. We'll now use Scarlets velocity to head east, and use the clockwise swirl velocity of the eddy to spin us up to the north, over to the east, and back down to the south.



Looking downstream in the altimeter data, we are about 430 km to our next target point of 42.0 N, 13.5 W, a point that is 5 to 10 km inside the Spanish Exclusive Economic Zone, depending on how you measure it. We'll follow the wavey line of eastward currents in, so our path will be a little longer, but we'll get the boost from the currents. Assuming we make about 15 km/day from here on out, its about a month to get there.

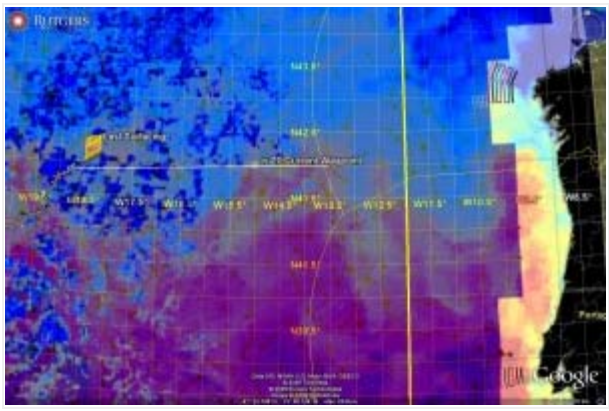


If we look at the satellite Sea Surface Temperature map for the same region, we see a similar wavy pattern in the temperature front between the warmer oranges and yellows, and the cooler greens and blues.

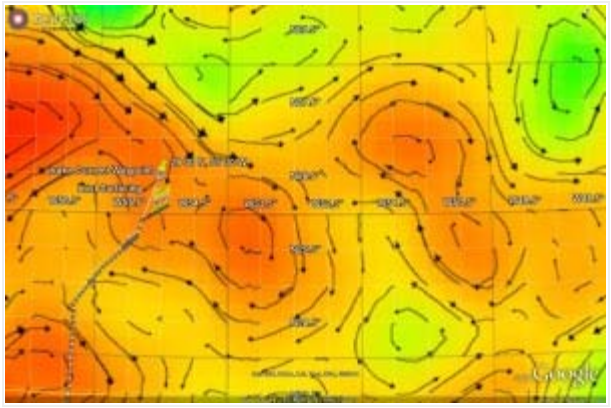


Overlaying the two satellite products, we see good agreement between the two products derived from different satellites. Its always good when views of the ocean from different satellites agree. The cold water flowing south from the Spanish EEZ

into the Portuguese EEZ is especially prominent. We anticipate that the agreement between these two satellites is going to work in our favor for path planning over the next month.



Moving over to Drake, progress continues to northeast. We are 75 km from the waypoint, a distance that will be covered in about 4 days. We'll adjust the waypoints to turn east once we hit 26.5 N.



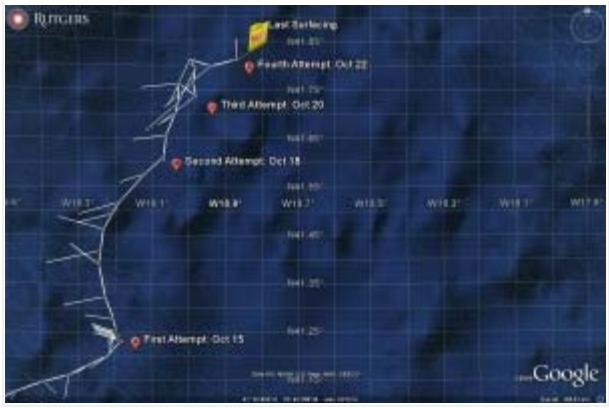
1 Comment

22 oct

Persistence Pays Off - Scaling "The Wall"

Posted by: Scott in: Atlantic Crossing

A week ago starting on October 14, Scarlet came upon a counter-current on her trip east. The westward flowing currents we not present in the large-scale geostrophic currents derived from the satellite altimeter maps of Sea Surface Height, and the area was covered with peristent clouds, blocking the view of the statellite infrared imagers that give us Sea Surface Temperature. There was a small scale feature out there, and our satellites couldn't see it. All we had for guidance was the data Scarlet was collecting herself. Over the next week we would use Scarlet as the explorer, and learn that this small scale feature was actually about 80 km long. It also would be given a name by people working in the lab. It came to be known as The Wall.



It took 4 attempts for Scarlet to cross The Wall. The first was on October 15 when she encountered strong currents to the west that slowed her progress towards Spain to a crawl. We did have guidance from the satellite altimeters that this westward flowing current extended a couple hundred kilometers to the east, so there was no way to burst through. We had to go around. Going around to the south meant warmer water that promotes biological growth and increasing our distance from our targeted pick up point. So Scarlet turned north, flying perpendicular to the westward current in a sweeping arc for a second attempt 3 days later on October 18. This route showed promise, with a report of nearly zero currents at one point. We expected this would be the front we were looking for, something that identified the strong sheer zone we expected to find between strong westward flowing currents and strong northward flowing currents. But 8 hours later, these hopes were dashed with a report that the westward currents were back, and even stronger. We went back to flying north, and letting the currents advect us west. Two days later, on October 20, the first clear satellite image came in, it was digitally enhanced, and we got our first look at The Wall from space. It was a clockwise rotating eddy that was not being resolved by the satellite altimeters. We saw the eastern edge of the eddy was only a few 10's of kilometers away, so we again turned Scarlet east for our third attempt. Again, we encountered strong currents that stopped us dead. We were pretty dissapointed by this news, but we have also been in these situations before. We turned Scarlet north again, persisting in our efforts to explore The Wall and find a way through. Then earlier yesterday we began to detect a change in the currents. We saw the current directions switch from flowing mostly to the southeast to almost due south. That meant we were approaching the outer edge of the eddy on its western side. With our hope renewed, and for a fourth time, we turned Scarlet east starting yesterday at noon. This time we would be heading for a distant waypoint so that Scarlet would use all of her energy to just fly east towards what we hoped was the eastern edge of The Wall. Then, this morning, at the 4 am surfacing, Scarlet reported a nearly 180 degree shift in the current direction. Currents were now flowing nearly straight north, and are back in agreement with the larger-scale altimetry maps. After a week of exploring, we had found the eastern edge of The Wall and crossed through it. Surprizingly the sheer zone between the two water masses on either side is only a few kilometers wide. Probably the location of a big biological party.

Thanks to all our partners on both sides of the Atlantic that provided guidance data during this most difficult week since the Azores. Today we begin the recalculations of arrival times.

0 Comments

17 oct

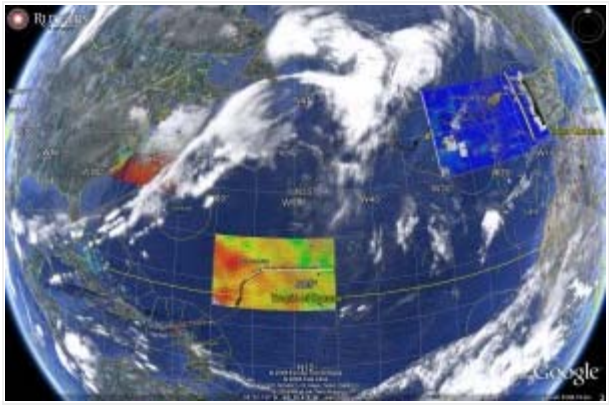
Fleet Update on a Stormy Saturday

Posted by: Scott in: Atlantic Crossing

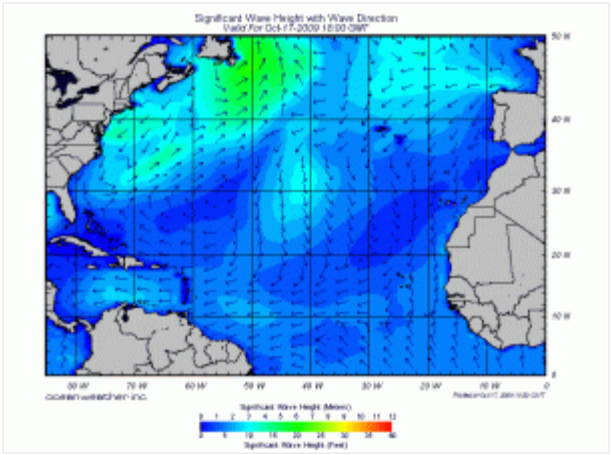
Art Allen and I have been travelling around the U.S. and Europe talking about mapping surface currents with HF Radar and how it is being used to improve the Coast Guard's Search And Rescue planning. At dinner, the conversation inevitably

turns to hiking up mountains. Art is expert at this - he's even an instructor at what they call winter school. My younger daughter and I have become fans of the Appalachian Trail as a result, and Art keeps urging us higher and into more adverse weather. My weekend blogging has suffered as a result, but this weekend is just too stormy. The weather reports are talking of twin northeasters. So lets go to sea instead.

The deployed glider fleet is currently concentrated in the North Atlantic. RU15, RU22 and RU23 are just visible through a break in the storm clouds off the U.S. east coast. Drake is heading away from the Virgin Islands and RU27 is heading towards Spain. Gliders are being prepped in Antarctica by Tina and Alex. Back at Rutgers in the glider lab, vehicles are being readied for California in November, and are being lined up for the big NSF Ocean Observing Initiative Experiment in the Middle Atlantic Bight starting at the end of October.

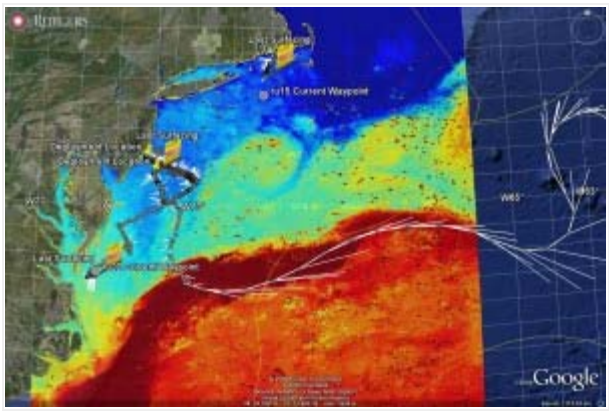


The weather on the U.S. east coast is bad. Northeast winds and large waves. Its not great offshore Spain either. Again, northeast winds. This could help explain some of the currents we are seeing with RU27 later in the blog.

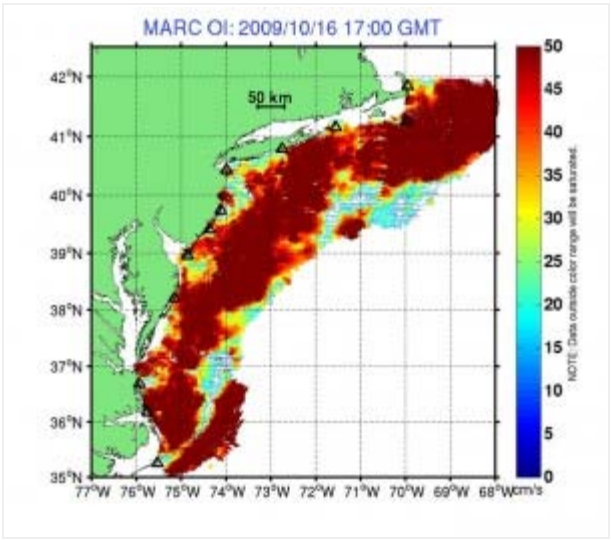


Starting with the Middle Atlantic Bight, we have three gliders deployed on the continental shelf. RU22 is the Integrated Ocean Observing System (IOOS) glider which is on a water mass mapping mission that fisheries scientists will use to relate to their fish distribution data. it will be picked up by the IOOS regional glider port at UMaryland after the storm. RU23 is on a mission for the Navy. It is the first Slocum glider equipped with the rechargeable lihium batteries and it carries the new Seabird pumped CTD. The results of this mission will be presented at the European Glider Organization meeting in Cypress next month. Too the north, our IOOS partners at University Massachusetts just deployed RU15 for an Office of Naval Research mission. It has a full up optics package - they most advanced I've ever had a chance to see. It has 2 Eco-pucks and the Navy's new Beam Attenuation Meter, or BAM sensor as we like to call it. All are providing temperature and salinity data for assimilation by the IOOS ocean modelers at

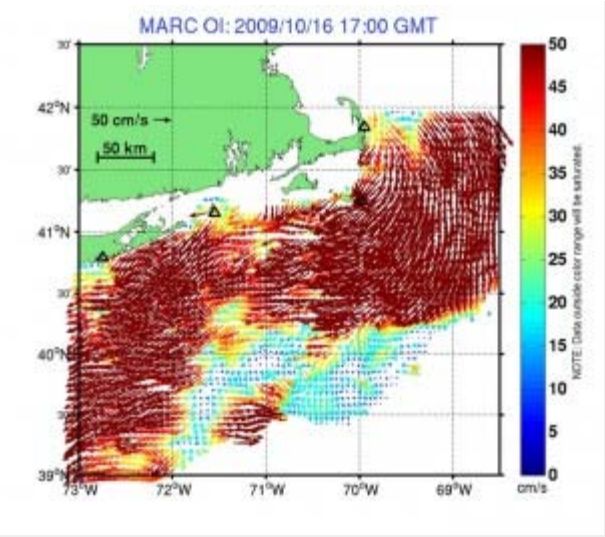
UMass, Stevens and Rutgers. All three IOOS modelers are getting spun up with this dataset in preparation for the NSF experiment beginning at the end of this month. Its going to be quite a party.



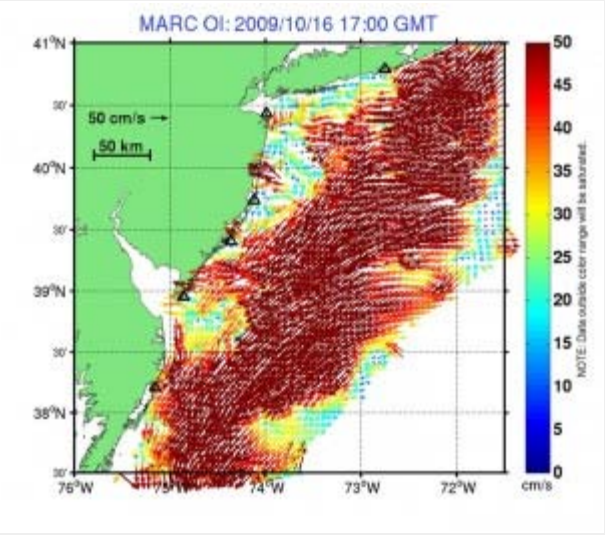
But our most immediate objective was to get RU15 with its hot optics payload into the water before the twin northeasters hit. Hugh, Ethan and Erick from Rutgers worked their partners at UMass, Old Dominion and U. North Carolina to make sure they had the full Mid Atlantic HF Radar network up and running for this storm. Thats good, because last thursday we just submitted an abstract to the February Ocean Sciences meeting in Portland, Oregon to describe this storm. We often submit abstracts based on the results we think we are going to get, but I guess that's the first time I've submitted an abstract based on a forecast. As you can see from the regional plot below, the currents are so strong, they swampped our standard plotting algorithm. Anyone that wants to contribute a good matlab routine for plotting "curly vectors" is encouraged to send us an email. We put it in place and start generating regular plots with it if you are willing to share code.



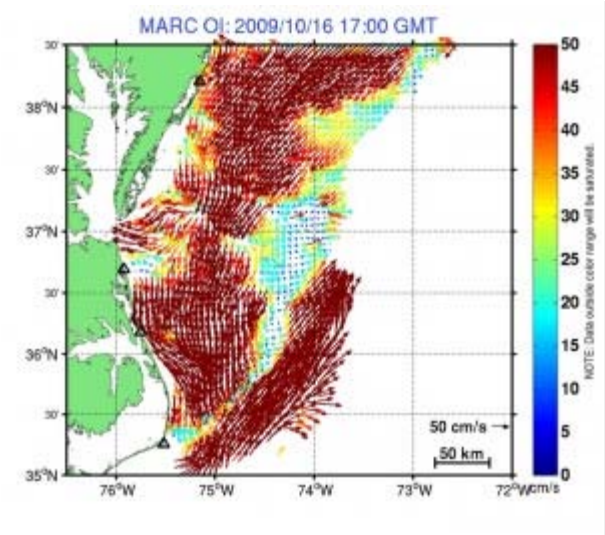
So instead of looking at the full region, we zoom into the areas covered by our three operational centers. Here is the northern region anchored by UMass and UConn. Strong currents near 50 cm/sec or greater heading alongshore to the east.



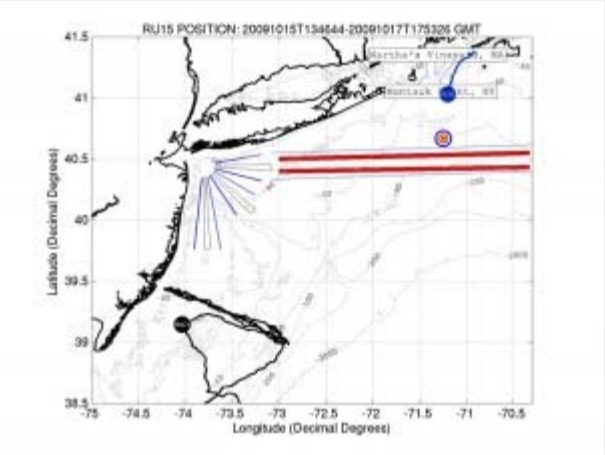
Here is the central region anchored by Stevens, Rutgers and UDelaware. Currents over the entire shelf turning southeast. It looks like the Hudson and Delaware plumes are having some impact during these rains.



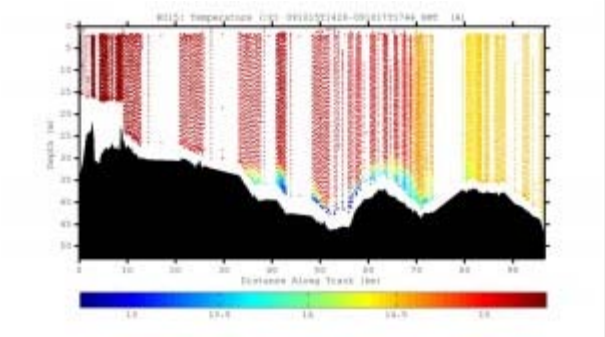
Lastly we to our southern operations center led by Old Dominion and U. North Carolina. Flow remains alongshore, turning south till it hits the Gulf Stream. The strong Gulf Stream currents in the image below can be compared to the high Gulf Stream temperatures in the satellite sea surface temperature image above.



Now lets check in on RU15, where it just left Buzzards Bay on the blue track below. We have this glider on our standard storm sampling plan that switches it to 1 hour surfacings so we can resolve the tidal currents.

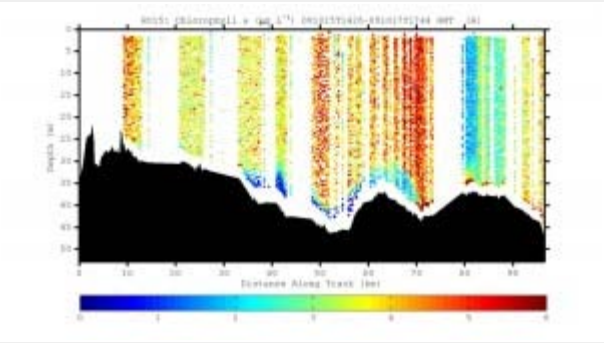


Here are the temperature profiles. The glider is traveling from left to right. The thermocline is deep and just above the bottom as indicated by the warm (red) temperatures above the cold (blue) temperatures. As the storm hits, the water column gets well mixed to in intermediate yellow color.

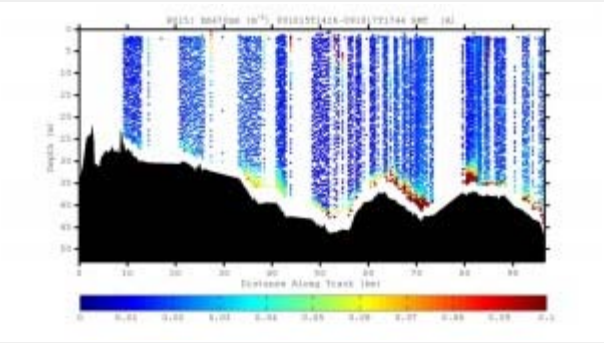


Below is the same section in Chlorophyll. Lots of phytoplankton above the

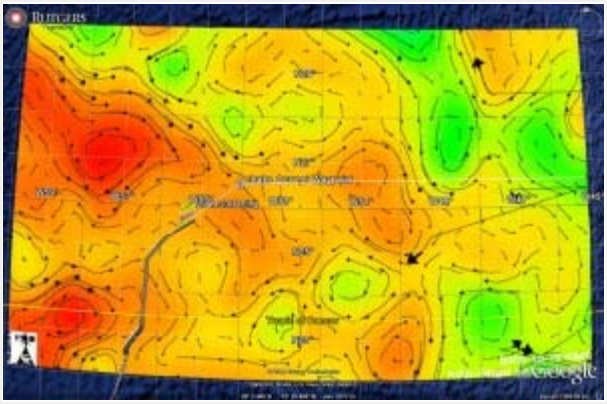
thermocline, nothing beow.



Now, on to my favorite Eco-puck sensor, backscatter at 440 nanometers. Just before the mixing we see the sediment is suspended and mixed below the thermocline. This is what we have seen before. Then after the water column is mixed, we expected the sediment to also mix throughout the water column. But where is it? What is different about this storm than the ones we have been studying from the Office of Naval Research Martha's Vineyard experiment? The abstract keeps getting better and better as the storm progresses. And we continue building the array of test cases for the Community Sediment Transport Model.

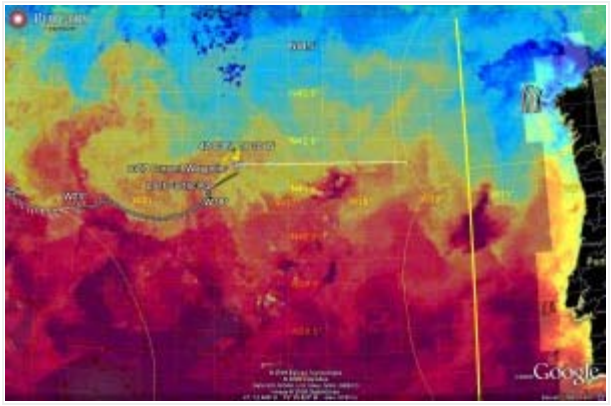


Heading south towards the Caribbean, Drake is making excellent progress through the gap between two clockwise rotating eddies. There are no good routes to the northeast with favorable currents, so we are taking the route with currents perpendicular to our path. Once we get up to about 26.5 N, we'll turn east and head zig-zag along this line downstream with the meandering currents.

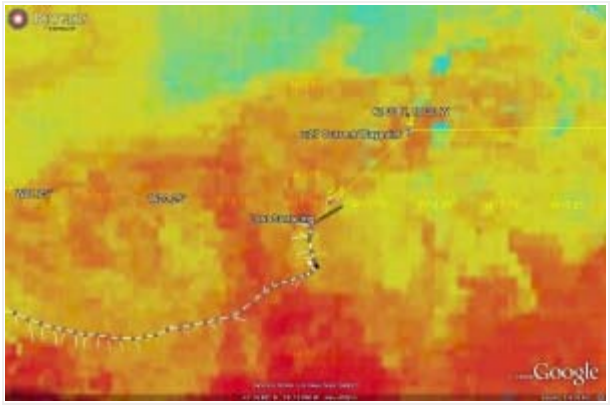


Lastly, we head east to the west coasts of Spain and Portugal, and RU27, also known as The Scarlet Knight. Scarlet was encountering some strong currents to the west that had halted our progress until we turned north to get out of them. We were not sure of the cause, until we just got a gap in the cloud cover and some new satellite Sea surface temperature data. John just readjusted to temperature

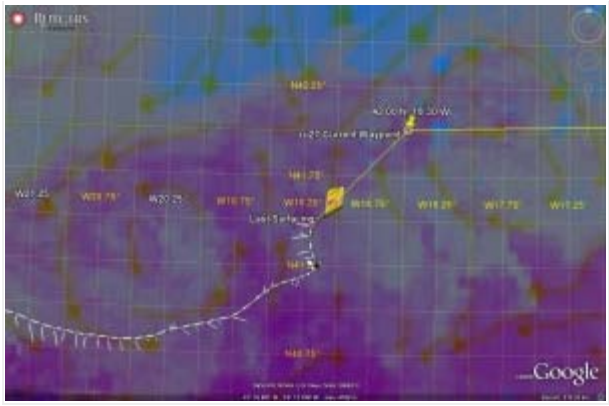
range to cover 16C (blue) to 22C (red) because of the fall cooling, and out popped the answer. We have a pair of counter-rotating eddies lined up along Scarlets path. We are in the warm water filament being entrained along the western side of the eastern eddy. As soon as we hit the wall of this filament, we were stopped cold. We now know our route around is to stay with this water as we head northeast. We'll continue on this northeast path up to about 42 N, and then turn east. Reading the distance along the dogleg from our present position to the outer edge of the European Exclusive Economic Zone, I get a distance of 490 km. Our most recent estimates of Scarlet's speed where 19 km/day and 18 km/day.



Zooming into the pair of counter-rotating eddies, we see the warn filament being drawn to the north and then spliting off, with one branch heading west and the other east. We are exactly where we want to be, on the eastern side of the northward flowing filament so when we split, we follow the split to the east.



Fading out the Sea surface temperature so we can see the surface currents from the altimeter, we get see that the altimeter is getting much of the structure associated with the warm filaments. But we are also seeing strong currents to the west. Could we also be seeing the effect of the strong winds that are blowing from the northeast?



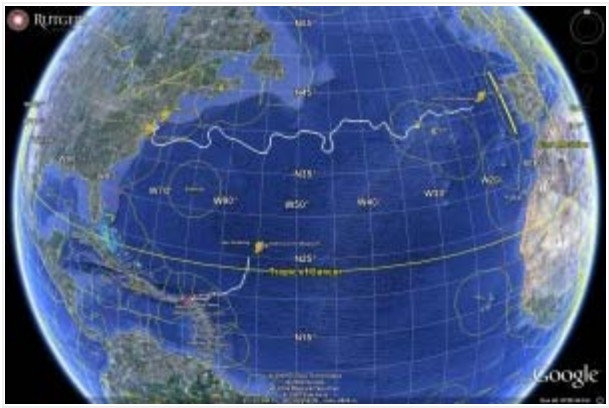
1 Comment

14 oct

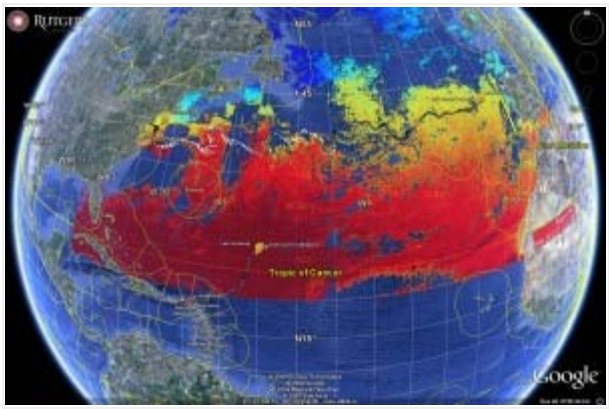
Scarlet and Drake continue northeast

Posted by: Scott in: Atlantic Crossing

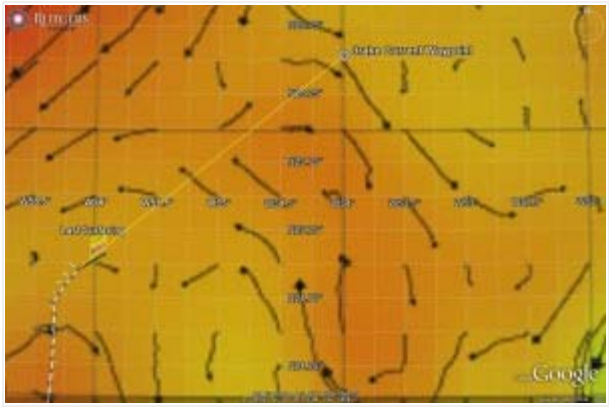
Yesterday Scarlet passed the 6,600 km mark. This morning's path length is 6,622 km. Drake has steadily grown his path length up to 2,318 km. Both are heading to the northeast up to a latitude where they'll turn east. Just like the ships in the pre-chronometer days when the mariners could not tell their longitude.
http://en.wikipedia.org/wiki/Longitude_by_chronometer



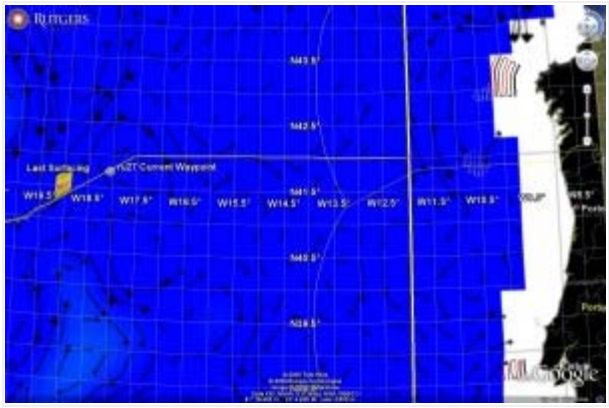
Overlaying the Satellite sea surface temperature composite for the last week we see more and more gaps in the coverage due to the cloudy fall weather. Coverage will continue to degrade as winter approaches. Luckily the satellite altimeters see through the clouds.



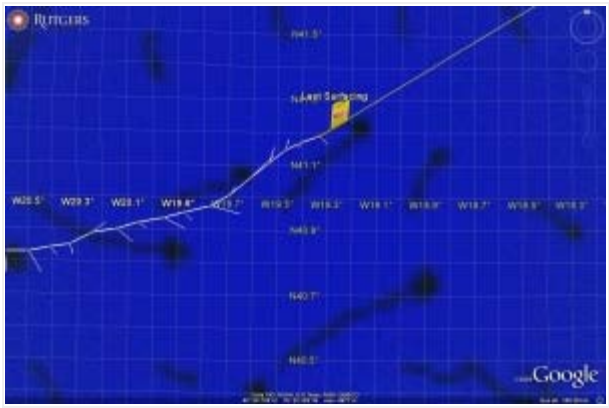
Zooming into Drake, he continues to make steady progress to the northeast, threading the needle between the southwest currents to the right and to the left of the present path. Our intension is to turn east somewhere between 26 N and 26.5 N.



Scarlet also continues on a northeast path up to 42 N, where we will turn east and head toward the European EEZ (thin yellow arcs).



Zooming into Scarlet, the reported currents are generally to the east, the good news. Even with the small currents, Scarlet made about 19 km over the last day. She is slowing down.



Discussions today will be with Teledyne Webb Research to weigh the options for speeding her up, and with Puertos del Estados on the next round of planning for the pick up.

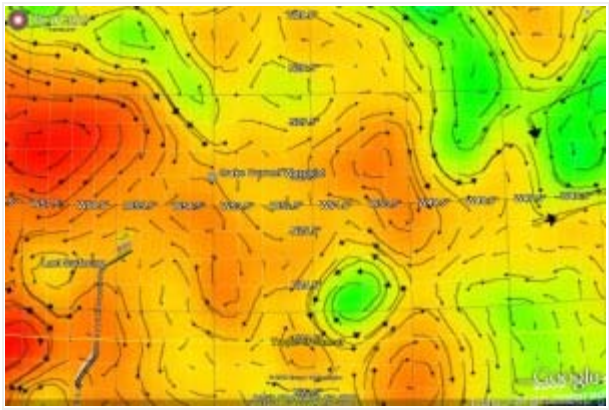
0 Comments

12 oct

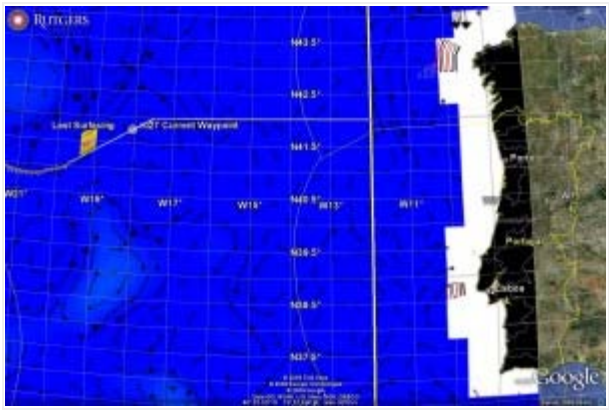
Half a tank left

Posted by: Scott in: Atlantic Crossing

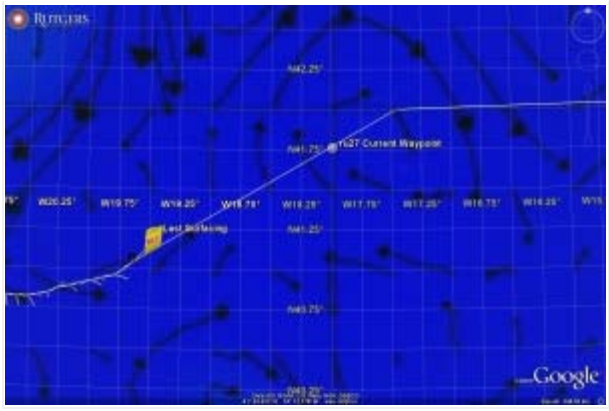
Drake made his turn to the Northeast on Sunday and is now heading up towards 26.5 N. Most of the currents on this northeast leg are expected to be perpendicular to this path. Drake can fly through these quite well - an advantage for a deep glider.



Scarlet is also heading northeast, just like Drake. The general plan is to head northeast up to 42 N. We then turn east along 42 N, crossing into European waters at about 13.5 W. We then have an area we can loiter between 13.5W and 12 W that appears to be relatively safe from the information we can get on our side. The validity of this assumption will be a topic of discussion with our friends at Puertos del Estados later this week. The total distance measured along the white dogleg from Scarlet's present position to 12 W is 660 km.



Zooming into Scarlet's location, we see a nice tail current is helping us along. The tail current is running about 10 cm/sec, and Scarlet's speed relative to the water is running about 20 cm/sec. Dave increased her pitch again over the weekend. We now are around 37-38 degrees, up from 35. It gained us a few cm/sec in vertical velocity, which translates into a few more cm/sec in the horizontal based on our pitch angle. The change did increase our energy usage, moving it back up to 3.5 amp hours per day, but that is not the concern. We still have exactly 50% of our calculated power left on board, so the additional power usage is ok. We are racing the winter waves and the biological growth.



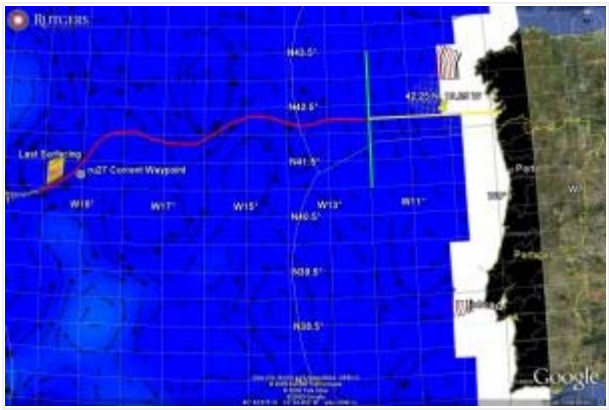
0 Comments

10 oct

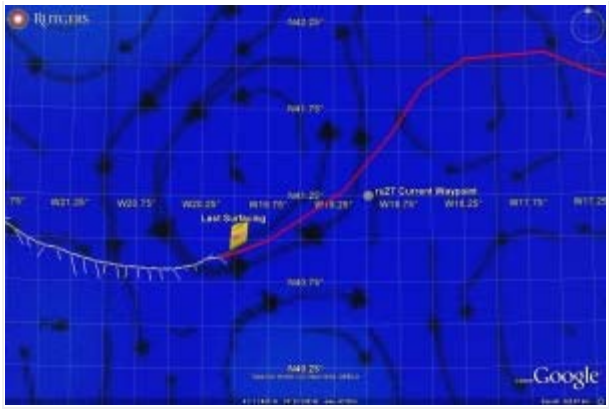
Late night plans

Posted by: Scott in: Atlantic Crossing

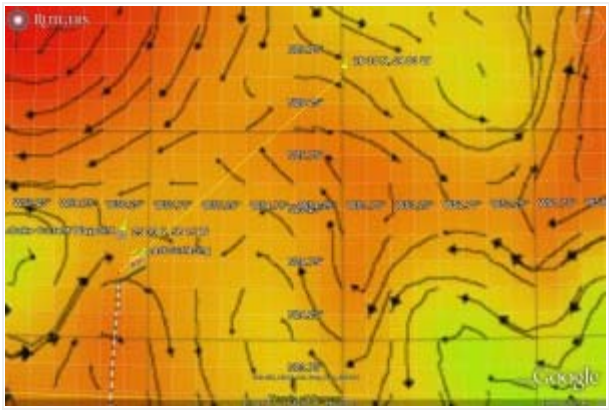
The intense vessel traffic we are seeing off Spain & Portugal is causing us to move our target location for pickup further offshore. We are now looking at 12 W (thick green line in the image below) as the potential line of closest approach. This is inside European waters (thin yellow arcs), but outside of most of the vessel traffic we are seeing. The 12 W line is about 144 nautical miles from Vigo (thick yellow line), or, by ship, a 12 hour steam at 12 knots. Its a good way to remember locations and distances - 12 W is 12 hours out at 12 knots. Scarlet is about 740 km from the 12 W line if you measure pathlength along the thick red line. Assuming 20 km/day, thats 37 days, or mid-November. But Scarlet is slowing down, likely due to biological growth, and we can't count on our ability to maintain the normal clean speed. Our target time of early December for pickup remains our best guess.



Zooming in to Scarlet, she has moved into the clounterclockwise eddy currents. We hope it boosts our speed.



Heading over to Drake, we see he will be ready for a new waypoint tomorrow. We'll head north for another surfacing or two. Then on Sunday, we will turn northeast to 26.5 N, 54.0 W, a waypoint that is about 310 km away.



0 Comments

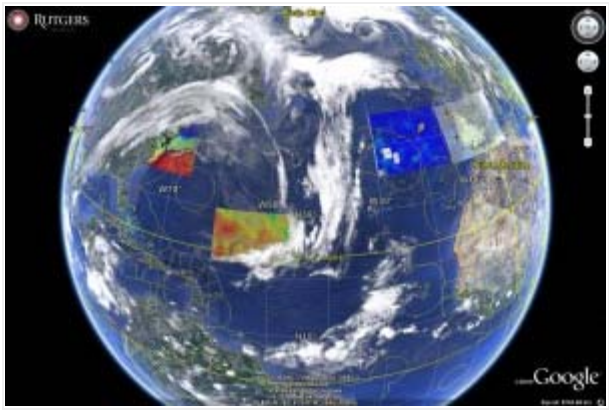
09 oct

Friday Night Fleet Check

Posted by: Scott in: Atlantic Crossing

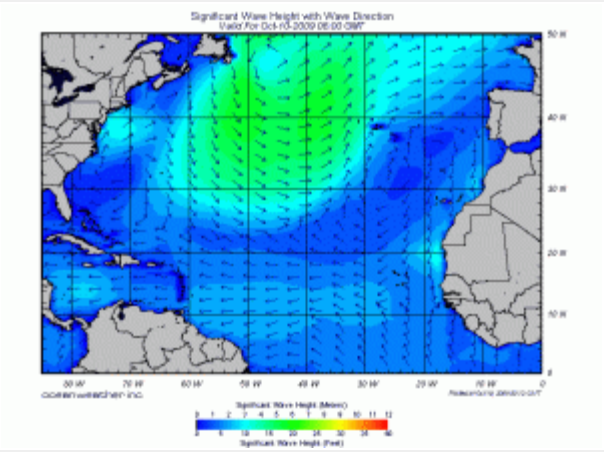
Its 10 o'clock. Do you know where your fleet is?

A quick check of the global view shows we have gliders on both sides of the storm that is currently stirring up the North Atlantic.

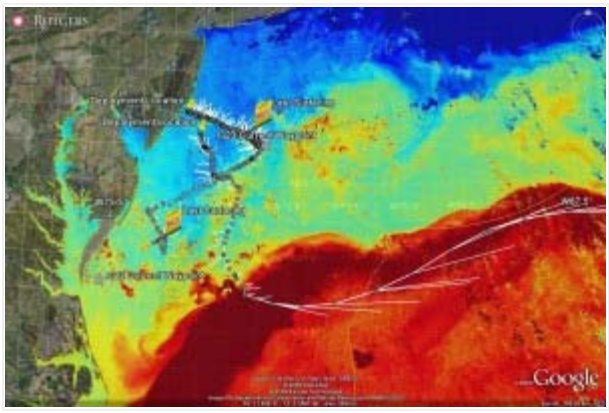


Nilsen reminds us that the storm is on its way towards The Scarlet Knight. Oceanweather has wave heights (image below) over 20 feet high behind the cloud

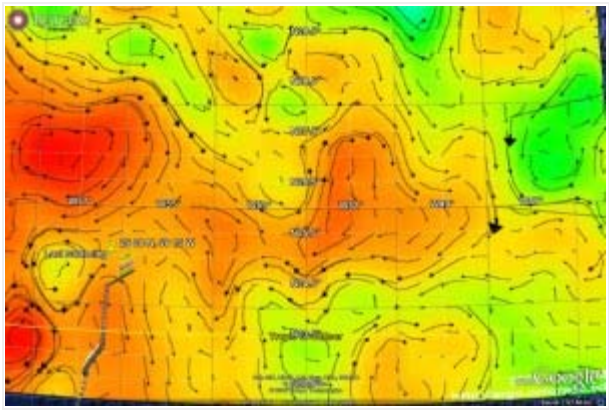
front in the image above. We also see a small hotspot of wave activity back home in the Middle Atlantic Bight.



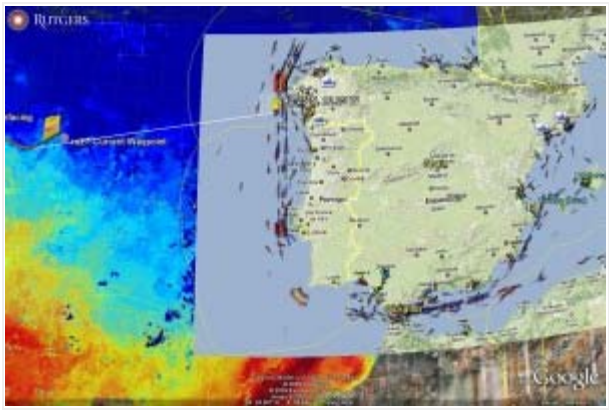
These waves are currently effecting the MAB regional fleet. RU22 is the IOOS glider heading south for pick up by the University of Maryland. Its on a mission to collect IOOS water column data to compare with National Marine Fisheries Service shipboard survey of fish distributions. RU23 remains to the north on the Tuckerton Endurance line on a Navy mission. RU23 has the new lithium rechargable batteries, and its carrying one of the new Seabird pumped CTDs on what we think is its first at sea test on a glider. We are gathering data for the upcoming European Glider Organization (EGO) meeting in Cypress next month.



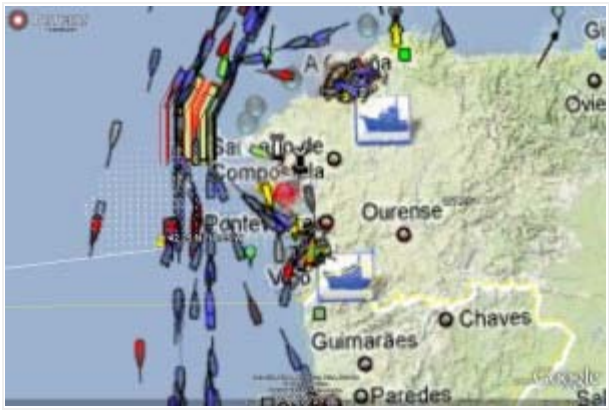
Looking south, Drake continues heading north. Once we reach about 25.5 N, we'll turn more towards the Northeast and continue to 26.5 N. There we'll head east along a mooring array being maintained by the British designed to measure the heat flux across 26.5 N.



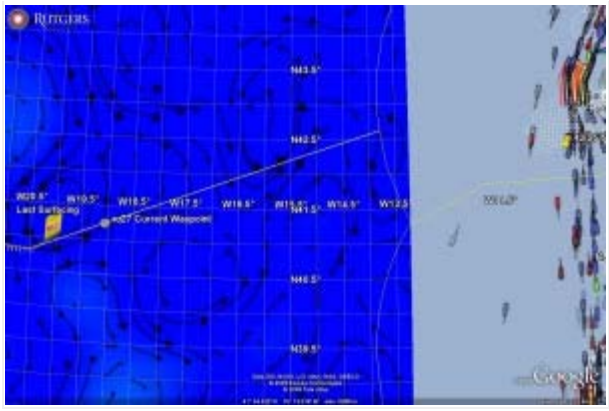
One benefit of having students from our European partners in the Azores and Canaries is local knowledge. They found us an excellent website posting the Automated Information Service (AIS) vessel tracking data. Our students have starting watching this regularly, and have found heavy shipping traffic along the coasts of Portugal and Spain that extends offshore beyond the designated shipping lanes. Lisa grabbed one of the snapshots from today and put it in google earth. The vessel traffic is intense.



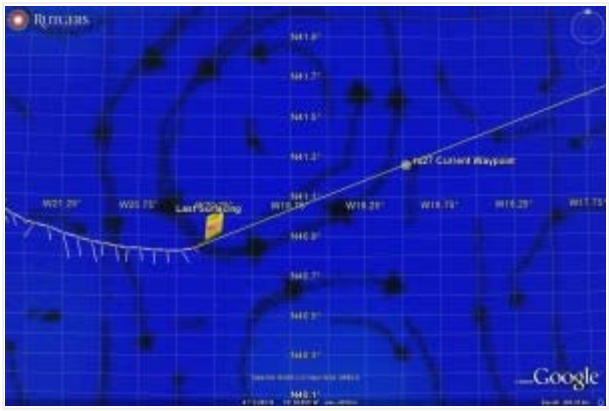
Mike also put the live feed from the Galicia CODAR surface current vectors into google earth, and here is overlayed on the AIS ship traffic. The conclusion is clear. Even though the full field of CODAR surface current vectors (shown in white) extends beyond the shipping lanes, so does the vessel traffic. Even this highly sampled region does not appear safe for RU27.



That moves our primary target location to be even further offshore. Zooming out to view the satellite altimetry, our goal now becomes first crossing the remaining 585 km to the outer edge of the European EEZ (the thin yellow arc), and then slowing moving closer in, loitering in the outer half of the EEZ until we can be reached for pick up by our friends at Puertos del Estando.



Zooming in further, Scarlet is reporting currents in excellent agreement with the geostrophic currents observed in the satellite altimeter data. It looks like we'll be getting a boost to the east over the weekend. Thats encouraging news. Scarlet's vertical velocity continues to drop, likely indicating the growth of a new set of barnacles that is slowing her down. We won't know for sure until we see her again. Till then, we need to fly her as fast as we can, and keep her as deep and cold as we can. We dropped the depth of the surface inflection down from 20 m to 30 m already today. We checked the number of cycles on the buoyancy pump to see if we want to risk even more cycles at the deeper depths. And we increased the pitch on both upcast and downcast by a few degrees as a test to see what happens. We may use more battery at this pitch, but we have over half the battery life left based on the theoretical calculations of the energy on board and the actual measured usage by the coulomb meter.

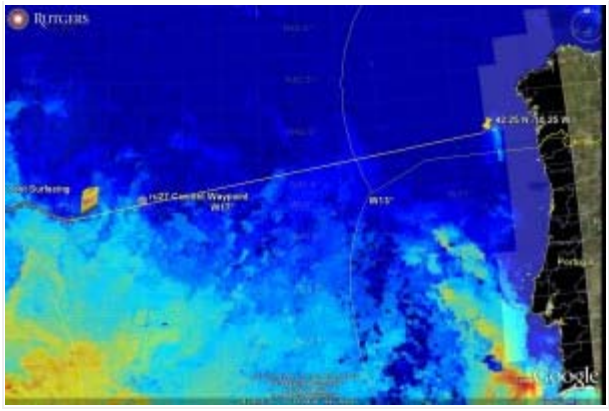


0 Comments

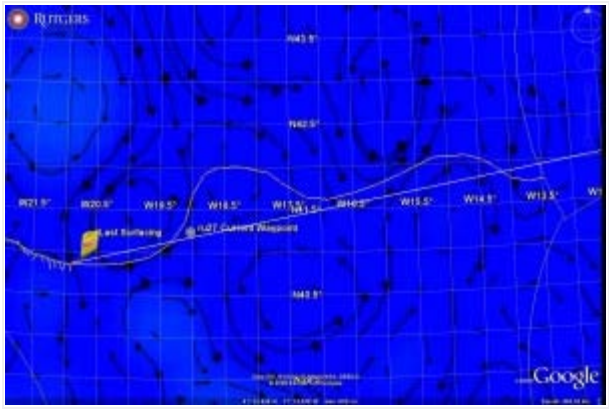
07 oct Back to the Biology

Posted by: Scott in: Atlantic Crossing

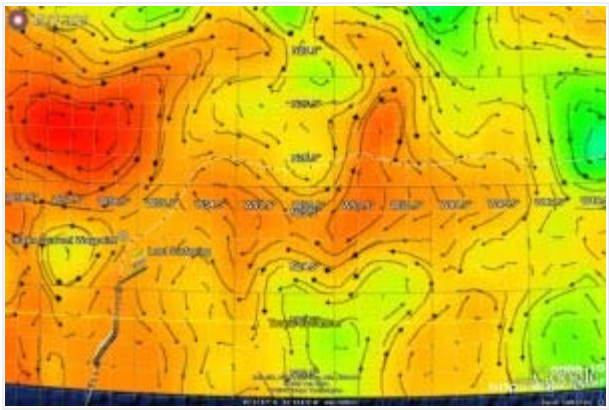
The Scarlet Knight continues east along the temperature front towards Spain and Portugal. Currents are small - about 10 cm/sec and often less. Scarlet is about 625 km from the European EEZ, and she just hit the 900 km mark for distance to the center of the CODAR surface current field of Galicia. We have been making good use of the AIS data on ship tracks and are finding a lot of vesselts operated even offshore of the shipping lanes. We may have to loiter even farther out to sea than we first expected.



Zooming in on the currents between Scarlet's present location and the EEZ lines, a path following the currents (yellow line) adds about 100 km to the journey to the EEZ. The question is can we keep up our average number of kilometers made good per day. The bological growth on Scarlet is continuing, and this additional growth is steadily slowing her down. We are looking for ways to either speed up the glider or slow down the barnacles. We are meeting with our colleagues from Teledyne Webb Research tomorrow in DC, and we'll be going over the options.



Meanwhile, Drake is continuing to fly north into small currents. With Drake, we'll head due north to about 25 N, then turn NE till we get to 26.5 N. From 26.5, we want to start running a section due east, hopefully to the Canaries.



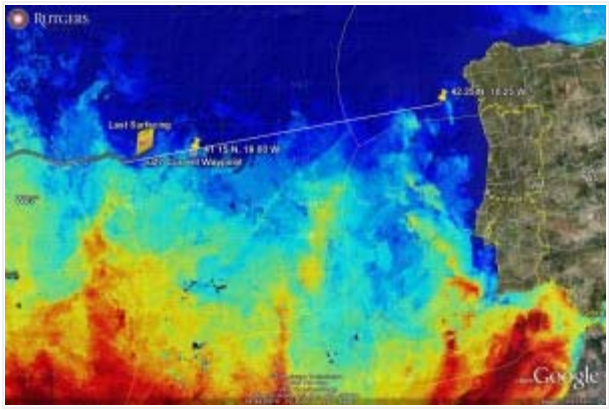
1 Comment

05 oct

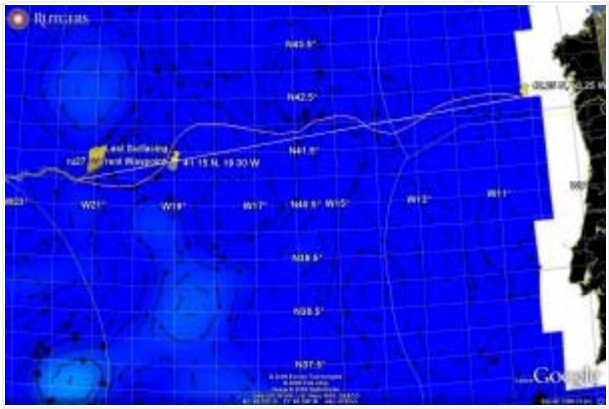
Still much to do

Posted by: Scott in: Atlantic Crossing

We've crossed into the cooler water and see a nice change in the currents. Less than 950 km on the straight line.



Following the currents on today's altimeter map, its a just a bit over 1000 km. Assuming the usual 20 km/day, thats 50 days.



But what has us most worried right now is that the glider vertical velocity is slowing down, just like it did earlier in the flight. It likely means the same thing, barnacles are growing in the seams. That means trying to stay cooler, and get to the pick up point as soon as we can. We don't want to loose our ability to steer as we approach the recovery region, the most dangerous part of any mission. We are flying into waters with extensive shipping and fishing that we need to avoid. And the higher seas for winter are approaching. We have much to do to get ready.

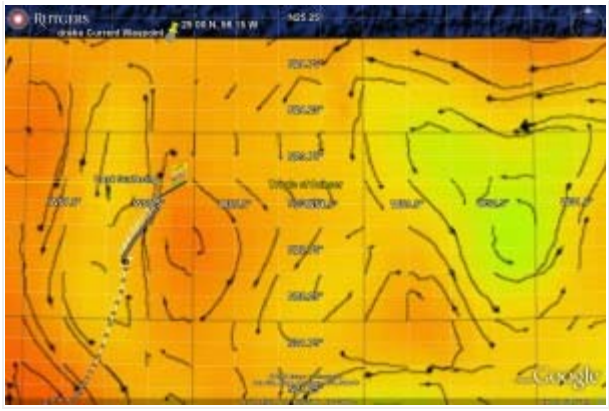
0 Comments

03 oct

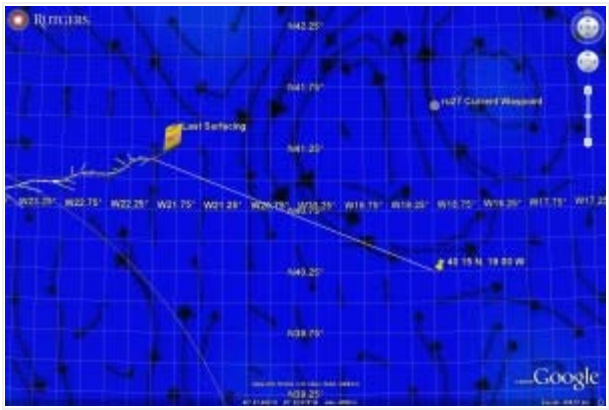
UVM Saturday

Posted by: Scott in: Atlantic Crossing

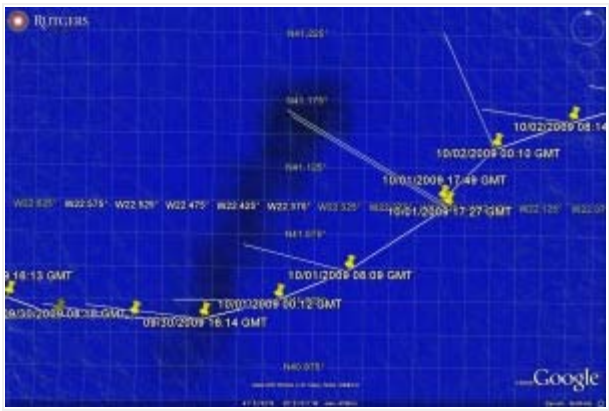
Teledyne Webb's thermal glider Drake continues tracking to the north, finding steady currents in this direction. Yesterday we moved the waypoint to nearly straight north to follow those northward flowing currents in the satellite altimetry below.



The Scarlet Knight continues to fly into a head current that is wobbling around westward. Sometimes the current flows northwest, sometimes southwest. Today it looks like southwest. Just like a sailboat, we repond by tacking. Last week our response was to move the waypoint to the northeast in reponse to the northwest current. With the current switch to southwest, we move the waypoint to the southeast, towards those strong eastward currents in the eddy to our east. We'll email Scarlet this change of waypoint so she can pick it up next surfacing.



The answer to DBL's question posted in the last blog is that the bizzare change in Scarlet's direction was exactly one of these maneuvers. It was put in place by two of our student pilots, Dave K. and Shannon H. They saw that the westward current direction that was slowing our progress was changing direction slightly during one of Scarlet's surface intervals. Rather than just fight this current, they quickly moved the waypoint north before Scarlet left the surface. The result is a quick change in direction to find a better current.



The example above is just one of the great interactions I have with our 30 students everyday. I have even met several of their parents. This blog is their textbook, so by asking questions like this, you are contributing to its writing, and their education. Thanks.

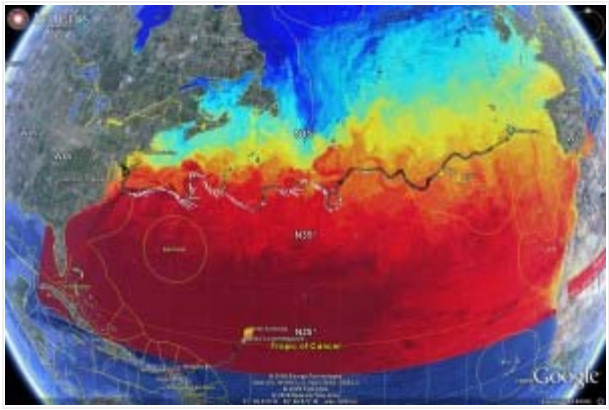
Now, with Drake and Scarlet set for the day, I am off to see another side of college education. Today I get to be the visiting parent at the University of Vermont.

0 Comments

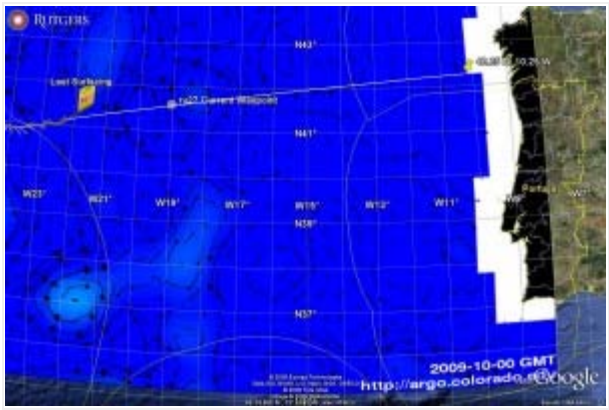
02 oct 999 Kilometers To Go

Posted by: Scott in: Atlantic Crossing

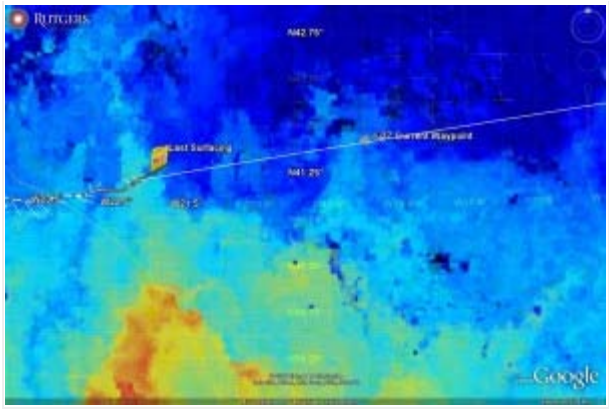
When Scarlet surfaced this morning at 4 am, she had flown a total path length of 6369 kilometers, continuing to increase the world record. But that's not today's news.



At 4 am this morning, Scarlet's distance to our target point in the middle of the Galcia CODAR field dropped to 999 km.



The present path will take us out of the slightly warmer water where we have been flying into a head current, and into to cooler water where we hope to find a more favorable environment.



We have traveled over 81% of the way across, and based on our theoretical calculations, we still have over half a tank of gas. We need to beat the high waves of the approaching winter, and fly faster than the growth rate of any biological activity. We know something is out there, likely barnacles again, that is decreasing our speed. We are flying full speed to compensate. The race is now against time. And its time to burn some energy.

1 Comment

27 sep

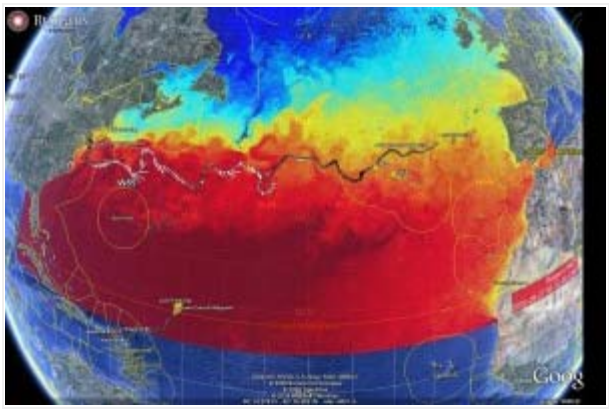
6 Months at Sea

Posted by: Scott in: Atlantic Crossing

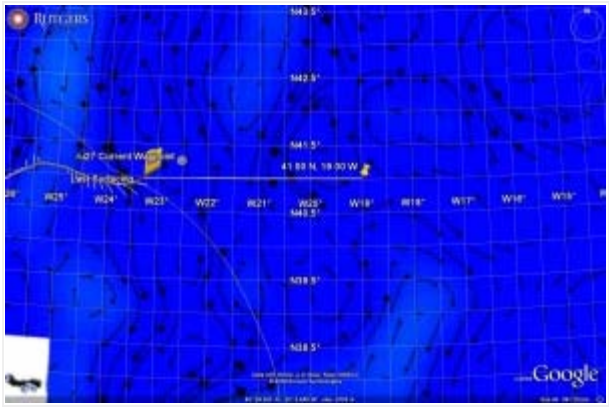
Today is September 27. When The Scarlet Knight surfaces later today at noon, Scarlet will have spent a full 6 months at sea. Over the last 6-months, she surfaced 4 times a day, 3 times for navigational purposes and once a day to tansmit data for the dedicated science mission. Scarlet has so far flown a path length of 6,250 km, breaking the world record set by RU17 last year at 5,700 km. She is about 1,111 km from our target point in the center of the CODAR HF Radar coverage off the northwest coast of Spain near Galicia.

http://www.puertos.es/en/oceanografia_y_meteorologia/redes_de_medida/index.html

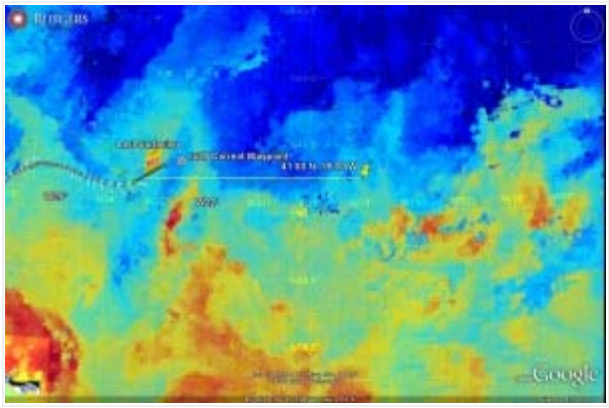
This puts her at about the 80% mark, with about 55% of the power remaining based on our theoretical estimates of battery life.



Zooming into the present location, Scarlet is about to leave the Portuguese EEZ (thin white curve) and head back out into international waters. Distance to the Spanish and Portuguese EEZs associated with the mainland ranges from 325 to 350 km. The new altimeter data shown below has significant evolution in the area between 22 W and 19 W. A new eddy is spinning up near 20 W that is straight to our east. This makes the crossing through the trouble spot identified last week much easier.



Overlaying the satellite Sea Surface Temperature on the altimeter's currents, the agreement is excellent. Warm water is moving north, cold is moving south. The roadmap is good and we have found favorable currents. Progress has been excellent the last day. Scarlet's distance over the ground exceeded 45 km in the last 24 hours by combining her own velocity with a favorable tail current. A good way for her to celebrate her 6 months at sea.



0 Comments

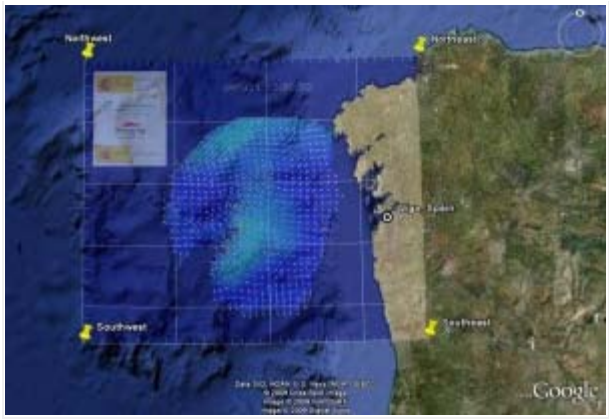
26 sep

The time estimate

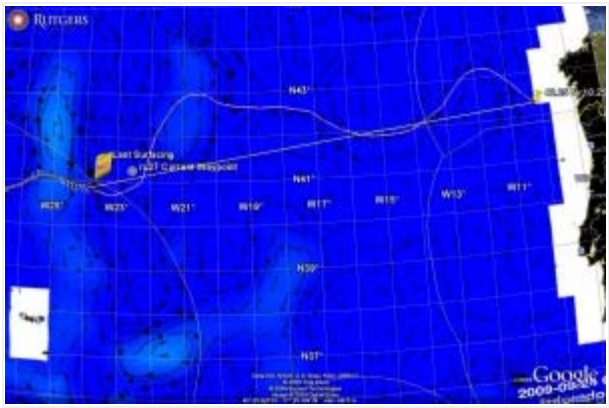
Posted by: Scott in: Atlantic Crossing

An important question keeps coming up for planning purposes. If we do make it across, when will we get there?

Mike Smith, one of the undergrads in our Atlantic Crossing class, has been working with us on the MACOORA Mid-Atlantic CODAR network for over a year. CODAR is a shore-based radar system for mapping surface currents. Following in Evan's footsteps from last year's summer internship at Puertos in Madrid, Mike's team is now working with the Spanish CODAR system off Galicia on the northwestern coast of Spain. Our target is the center of this CODAR current field, which is just offshore the European shipping lanes. If we make it this far, it is very likely that we will have to loiter offshore for a few days waiting for a weather window that allows a pickup vessel to get out. CODAR provides the best real-time current maps that we then use to station keep. Its what our Coast Guard uses to save lives in the Mid Atlantic. And its exactly what we did at the start of the mission, using the real-time CODAR surface currents to pick a route across the busy New Jersey shelf.



Zooming out to the open ocean, we switch to the satellite based altimetric radar system to get surface current maps. The straight (yellow) line distance from The Scarlet Knight to the center of the target CODAR field is now about 1150 km. But thats not how gliders fly. If we follow the currents from the satellite-based radars, we get a line that looks more like the white curve. That white line is just under 1400 km long. Assuming the typical 20 km per day speed for a clean glider, thats 70 days. We'll assume the boost we get from the currents approximately compensates for the reduction in velocity from any additional biological growth. 70 days from now puts us in the CODAR field sometime in early December, just after Thanksgiving break in the U.S.



Thats the best we can do. If Scarlet stays healthy and avoids any catastrophic collisions, timing depends on the unknown biological growth rates, and whether we hit head currents or tail currents.

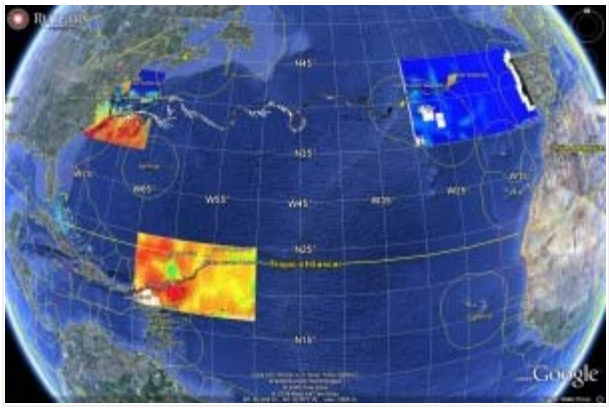
0 Comments

25 sep

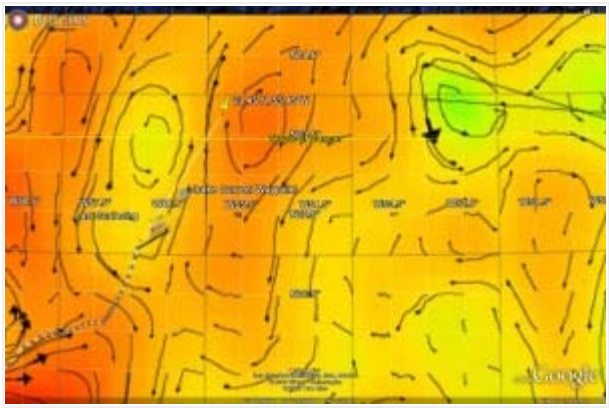
Weekend Waypoints

Posted by: Scott in: Atlantic Crossing

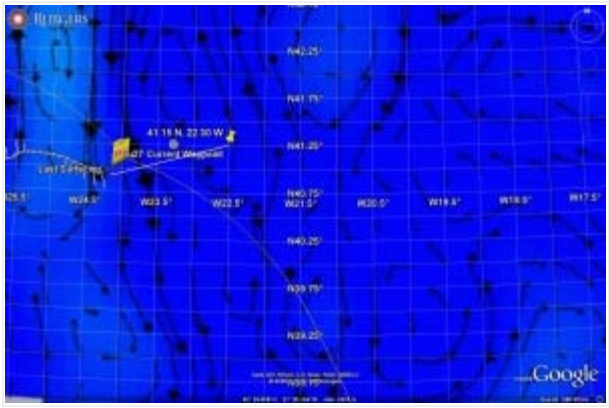
The North Atlantic Fleet has 4 gliders deployed this weekend. The Scarlet Knight (RU27) just north of the Azores, Teledyne's Drake in the tropics, and RU22 and RU23 on a parallel NOAA/Navy mission on the Mid-Atlantic Bight continental shelf.



Frist Drake in the tropics. We continue making progress to the NE, experiencing small depth averaged currents that do not line up with the surface geostrophic currents. We'll move the waypoint north a bit at the next surfacing to keep it at a good distance and head up in between the two eddies, hoping that some of these surface currents extend deep enough to give us a push.

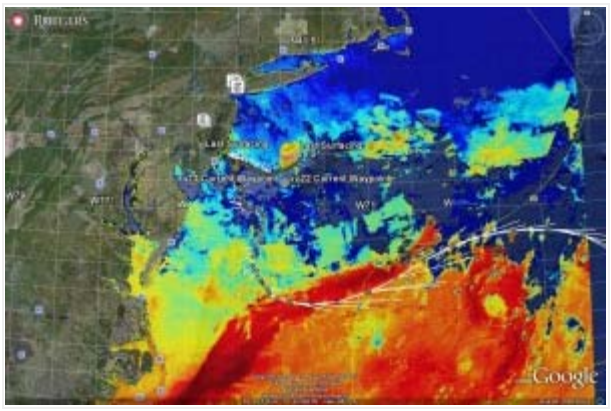


Out by the Azores, The Scarlet Knight is now 1175 km from the target point off Vigo. The waypoint will be adjusted the next surfacing to try to fly perpendicular to the southward flowing current jet and into the next eddy.



Off New Jersey, we have two gliders running side by side across the shelf. RU22 is

the IOOS glider on a MACOORA mission to support fisheries. Running alongside it is RU23, the first to resemble the Navy hardened gliders being built for LBS-G. RU23 is testing the new lithium rechargable batteries and the new Seabird pumped CTD. RU22 & RU23 are running side by side as an extended sensor comparision test between the old Seabird and the new Seabird. At the end of the Tuckerton Endurance line, RU22 will break away and head south on its IOOS fisheries mission. RU23 will turn and return on the Endurance line, heading back to shore. At the beginning of this deployment, we also put RU10 in the water, the first of the NSF smart gliders with the larger computer capacity on board. It was running local tests nearshore while RU22 and RU23 were deployed. The same boat trip simultaneously supported NOAA, Navy and NSF glider missions. While RU22 is heading south towards the UMaryland glider port, RU05 is being prepared with a full optics package for deployment out of the UMass glider port with the intention of heading back to Tuckerton to support the ONR MURI program. All three gliders will provide data that supports the NOAA NE fisheries fall survey, and are being used in preparation for the NSF Ocean Observing Initiative CyberInfrastructure test scheduled to begin in November. Looks like a good weekend watch gliders in your favorite part of the North Atlantic.



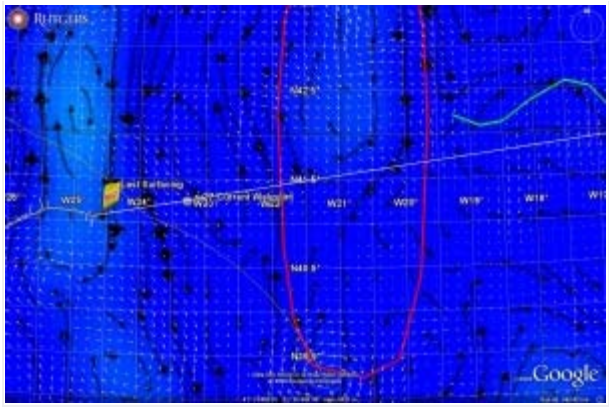
If anyone else is flying gliders out there in the North Atlantic and wants their track posted on the North Atlantic fleet blog, just let us know. We'll figure out a way to get your track feed up on the google earth interface so we get an even better picture of the international fleet.

0 Comments

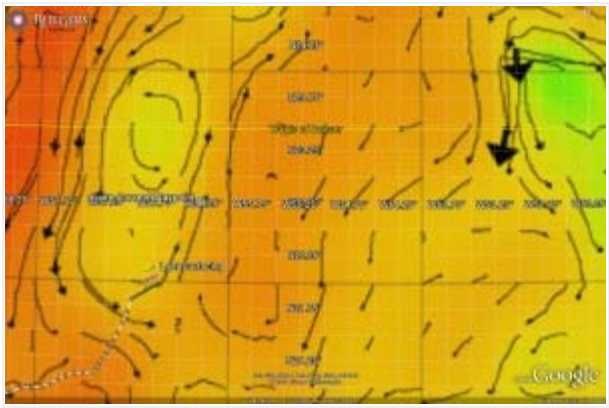
24 sep Scarlet exits an eddy, Drake heads in.

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is crossing into the southward flowing jet on the eastern side of this clockwise eddy. Our target is to cross this jet and end up on the southern side of the counterclockwise eddy just to our east. That should give us a push to the edge of the red oval. Crossing the red oval is the present area of study for our class. We have good agreement between altimetry and hycom just south of the white line that heads to Vigo. Currents are extremely weak in this area. Its about 200 km to cross it, with nothing but Scarlet's own velocity. It will be a long 10 days if that is our route.



In the tropics, Teledyne's Drake continues heading NE in weak currents. We hope to catch some help from the eastern edge of the eddy we are approaching. Its one of the few places we see currents to the NE.



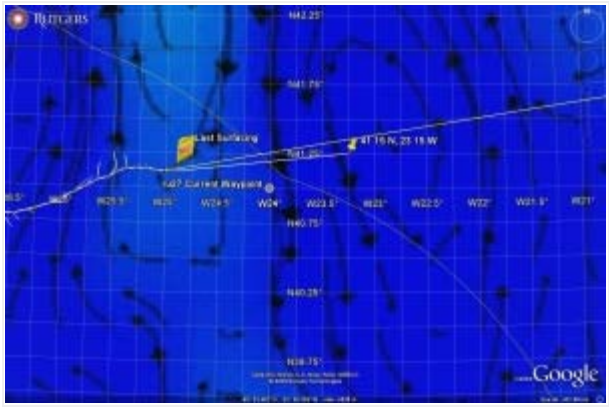
0 Comments

23 sep The jump to full speed

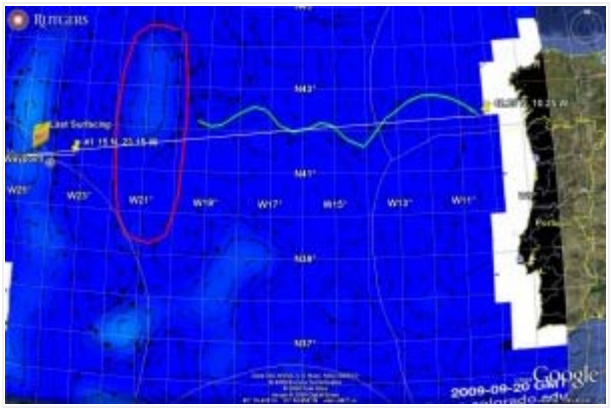
Posted by: Scott in: Atlantic Crossing

The Scarlet Knight continues to speed across the western North Atlantic. There are a collection of reasons, the main one being our friends at Puertos are urging us to get across as fast as possible to avoid the high waves of winter. We also are over 75% across and still have over half the predicted amount of battery life on board. So we purposely speed up Scarlet to fly at our maximum forward speed pitch of 35 degrees. This uses more energy. The second modification grew out of an ONR glider data assimilation meeting in North Carolina last week. Sitting with the Hycom ocean forecasters from NRL, and with all of us looking at how well Hycom was doing in this part of the ocean, we felt this was a good place for a data assimilation test. With what appears to be extra power on board, we turned the CTD on full time, eliminating the need for the morning CTD cast to make the daily Navy assimilation cycle. So for at least the duration of this data assimilation test, we'll keep the CTD full on.

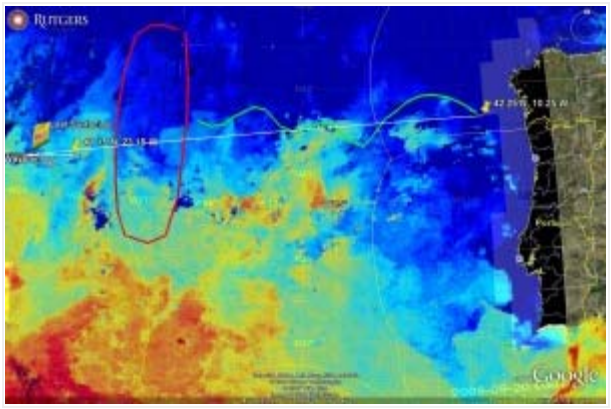
Right now Scarlet is crossing the southern side of a clockwise circulating eddy through a region of low currents on the southern side. This was a gamble we took over the weekend. Should we go all the way around the top of this eddy to the north, or should we try to cut across what the altimeter and hycom say is a low current patch on the south. We decided to try flying directly through the low currents, and sure enough, the guidance was right. As soon as we got into it, the currents dropped to 2-4 cm/sec. We'll continued across this patch and into the counterclockwise eddy to our east.



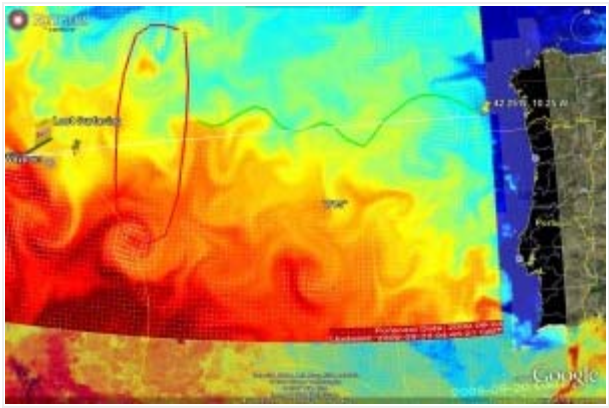
In terms of forward progress, we have just flown past 25 W, so we have less than 15 degrees of longitude to cover. Total distance as the crow flies is about 1230 km. We have flown 6,120 km. The present area of concern is centered on 21W, and circled in red. Beyond this red circle, there is a clear path with a tail current straight across to Vigo. The problem in the red oval is that there is no clear place to cross it efficiently. Do we go up around to the north with the currents, or try to go across the low current zone in the south. We'll be looking at the other products for guidance.



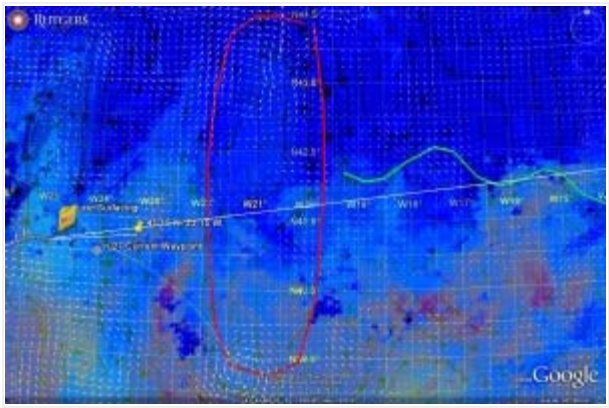
Here is the Sea Surface Temperature imagery showing the cold water inside the oval.



Here's the hycom forecast of SST and surface currents. Again, cold water in the oval. As we noted last week at the ONR meeting, Hycom is providing us excellent guidance.



Now when we zoom in to the hycom currents overlaid on the altimetric currents, we see many regions of excellent agreement. Jets and eddies are seen in both. But one of the major areas of disagreement is right along the yellow line straight to Vigo. The altimeter says we will encounter a head current along this path, while Hycom says the eddy is more round, the adverse currents are further north, and we'll have calm currents if we just follow the line.



This is the perfect set up for a data assimilation test. Some small differences between data and model, an adaptive sampling glider on the scene, and high interest from a lot of people watching. So we'll be working on the Hycom model from this side of the Atlantic while Antonio and Dave Kaminsky work on the ocean color from the other side. The objective is to find us the best route to cross 21 W.

1 Comment

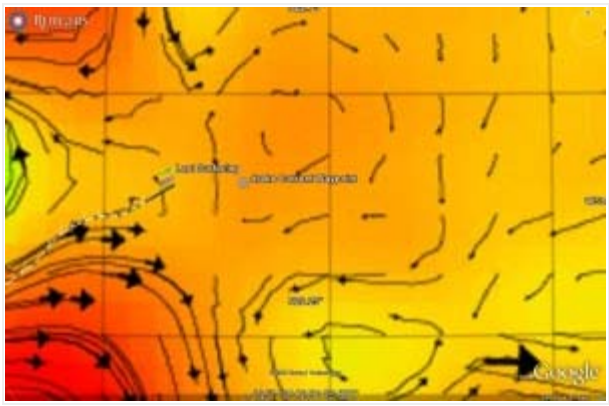
17 sep

Filament to Filament at Full Speed

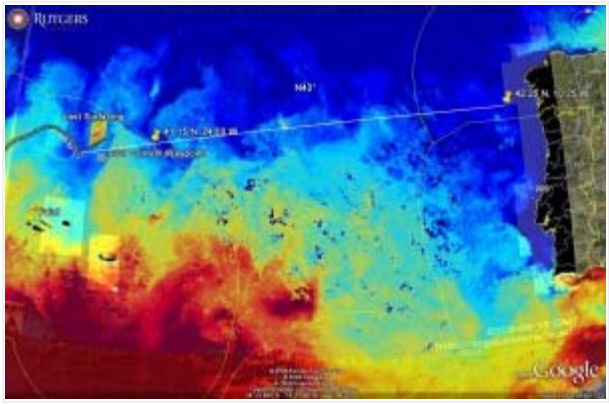
Posted by: Scott in: Atlantic Crossing

Teledyne's Drake continues east leaving the regions largest eddies behind, heading toward the smaller eddy center towards its NE and the route to 26 N. We will continue to close this distance today, setting ourselves up for a Friday waypoint change that should hold us for the weekend. Drake is amazingly easy to navigate. It is one of the differences we are seeing between deep and shallow gliders. The deep depth averaged currents have been so much smaller for Drake, making it easier to choose where you want to go. Scarlet, on the other hand, is a shallow glider, built for speed and built to take advantage of the stronger currents you get in the surface waters. Faster flying and faster currents mean more way point changes. Having the two gliders out at the same time nicely demonstrate how

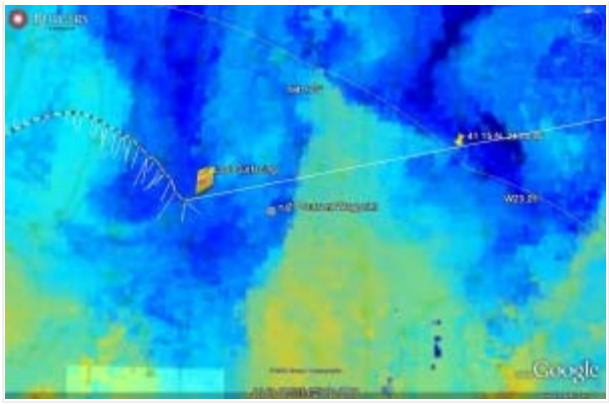
we'll be operating in future science campaigns, where you have a mix of several gliders deployed at the same time, some deep, some shallow, with the exact numbers depending on the type of science mission.



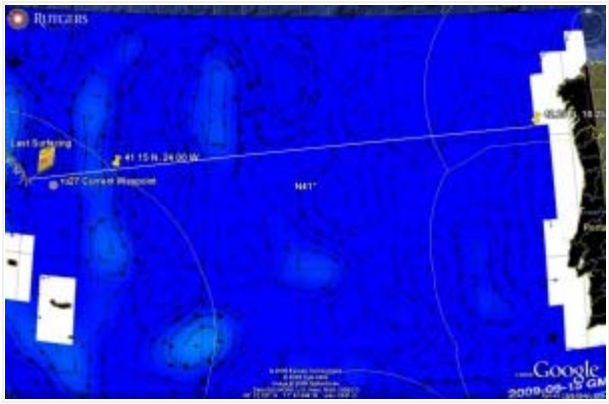
We are now on an approximately weekly phone call schedule with our partners at Puertos del Estado in Madrid. Together we have moved our target point south a bit to 42.25 N, 10.25 W, just offshore the port of Vigo, staying outside of the shipping lanes. With one ship transiting the 10 W shipping lane every 12 minutes, we don't want to take chances with this glider in the region. Exploring how you successful cross this region is a job for another glider on another day. The total distance between Scarlet and this location is just under 1400 km. For back of the envelope numbers, we often take 20 km/day as a typical distance made good, so thats 70 days, with wide error bars. Yesterday we increased the pitch angles that Scarlet is flying. We want to give her as much speed as possible even if it burns more energy. For the rest of this mission, the race is with time. We are racing the coming of winter, and the potential for more biofouling on the glider itself.



Zooming into the Scarlet's location, we were concerned yesterday by the strong currents to the SW, opposite our intended direction of NE. Was our altimetric roadmap wrong? We were getting used to having good guidance products. The satellite sea surface temperature and ocean color images from the Canaries did the trick. In the image below, we see the colder blue water heading south, with the western half curving around to the SW, and the eastern half curving around to the SW. We were still in the western half, so we adjusted our waypoint to pull us out of this part of the filament. This morning's currents reported by Scarlet indicates that move was successful and we are now heading into the colder water that curves to the east. We'll make our new waypoint along the straight line to Vigo.



Zooming back out to look at just the geostrophic surface currents from the altimeter, we see there are still several north-south filaments to cross. We are just east of 27 W, and the filaments extend to 19 W. From 19 W to 10 W, there is a nice current that heads eastward towards Vigo that we are heading for. We'll keep watching this area over the next 70 days or so to see how it evolves.



0 Comments

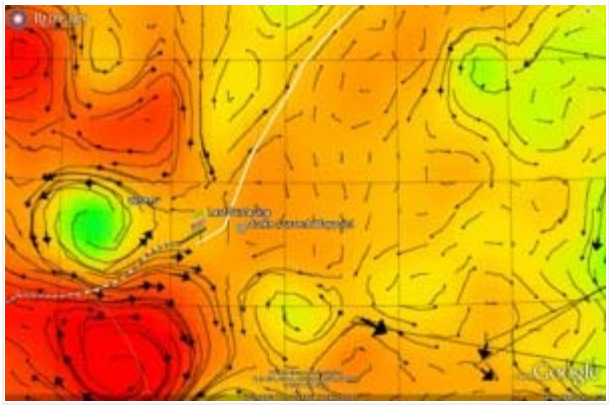
15 sep

Another Semester Begins

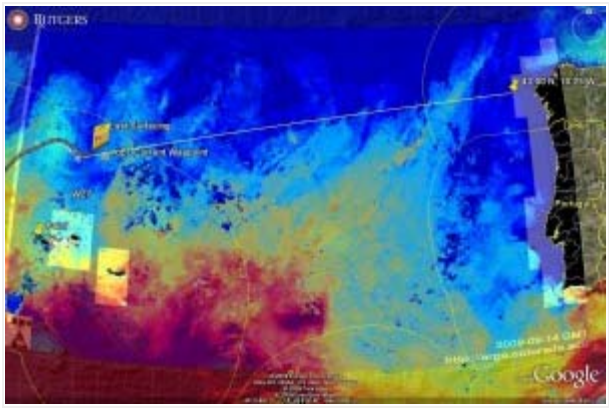
Posted by: Scott in: Atlantic Crossing

Frequent readers of the glider blogs usually know that a break in the blog means trouble. But not this time. In this case it was just the start of classes - our first regular full week here at Rutgers. The Atlantic Crossing class has about 30 undergrads in it this semester. A 10-fold increase over the last 2 years. Nothing like having gliders at sea to build student interest. We also have our graduate student visitors from the Azores and Canaries adding their local knowledge and a slightly different perspective on the last 600 years of maritime history. Josh and I divided the class into 10 working groups this morning, each led by a veteran undergrad from last year. Each student team will work on a different aspect of the Drake and Scarlet Knight missions.

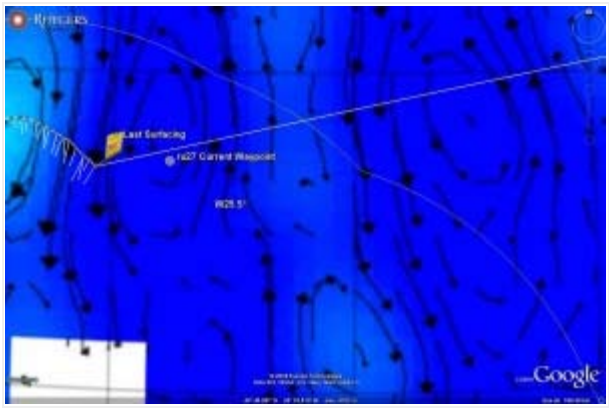
Drake, the Teledyne Webb Research thermal glider, has completed its run in the jet between the two counter-rotating eddies and is heading into slower moving waters. Our objective is to continue riding the currents north (white path) to about 25-26 N, and deterimine if we can occupy on of the historical sections across the Atlantic originally run by the Research Vessel Chain out of Woods Hole. The thermal glider is responding amazingly well to the waypoint changes - an advantage of going deep - 1200 m in this case. The currents are slower, and we can use the glider speed to manuever more.



Moving east across the Atlantic to The Scarlet Knight, she has already crossed the front discussed in the previous blogs and is well within the southward flowing cold water. We'll keep heading her east towards our present estimate of a pick up point - 43 00 N, 10 15 W. This is our estimate of the outside edge of the shipping lanes, to be refined as we get more of the maps into google earth. Distance from our present location is just under 1420 km. Underneath the semi-transparent SST are the geostrophic currents derived from the altimeter. Good agreement appears to be the norm in this part of the ocean.



Zooming into the location of The Scarlet Knight, we see that she is continuing to fly east across a strong jet of southward flowing water. Yesterday we were on the western side of this jet that heads south to Faial. Today we are crossing on to the eastern side, in currents turning around a counter clockwise rotating eddy that should give us a boost towards Spain.

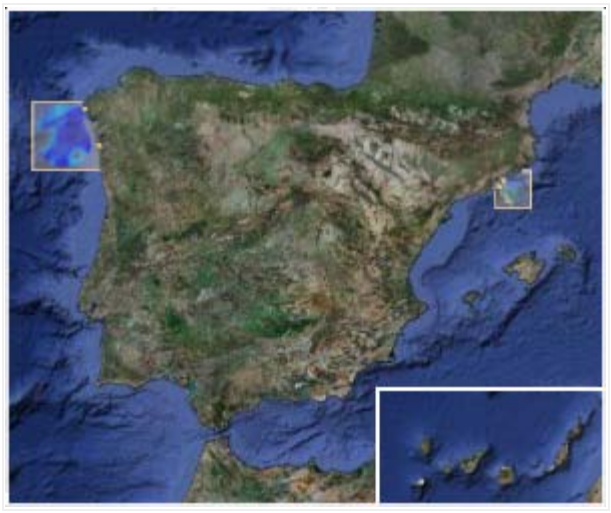


We had a good question on the previous blog entry - do we have to make is to Spain to be successful - or is a pickup in Portugal also a success? For us, a pick up anywhere on the European side is a success. In fact, our Atlantic Crossing class

is planning for an entire series of possible pick up points along the full west coast of Spain and Portugal. We are aiming for Spain because last year, a CODAR HF Radar network was installed on the west coast of Spain near Galicia.

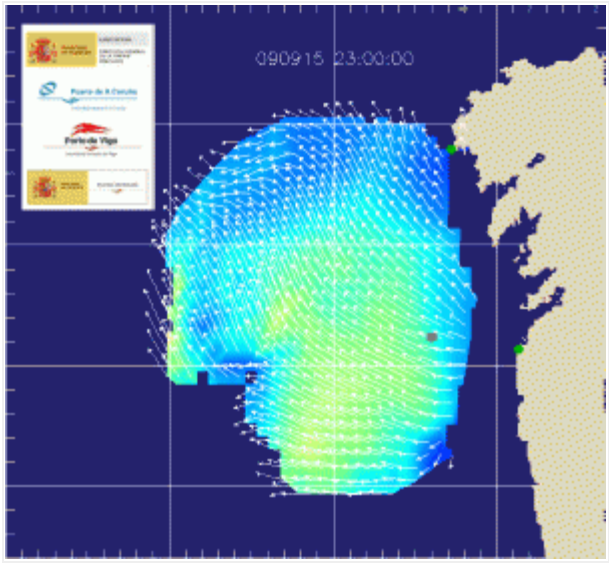
http://www.puertos.es/externo/clima/Radares/Galicia/galiciadeseng.html

This is a significant collaboration by many groups within Spain. The Galicia High Frecuency Radar System is owned by Marina Mercante (the General Management of Merchant Marine), dependent on the Spanish Ministry of Public Works. The installation of the units at Finisterre (A Coruña) and Cabo Silleiro (Pontevedra) lighthouses was posible thanks to an agreement among A Coruña and Vigo Port Authorities, Marina Mercante and Puertos del Estado. The technical-scientific exploitation of data is conducted by Puertos del Estado and two Galician Regional Ministries: Consellería de Medio Ambiente, Territorio e Infraestructuras and Consellería do Mar.



The CODAR (http://www.codar.com/) HF Radar network provides surface current maps every hour in this region offshore Spain. Our job with the glider is to pull up as close as we can to the shipping lanes, and then loiter offshore as we wait for a pick up. Having real time surface current maps as you approach the coast will make it easier for us to manuever the glider, and that will make it easier for our colleagues at Puertos del Estado to help us with a pick up.

http://moises.puertos.es/Redes/DatosRedes.php?codigo=6291&Formato=Grafico&Lenguaje=eng&tipo=map



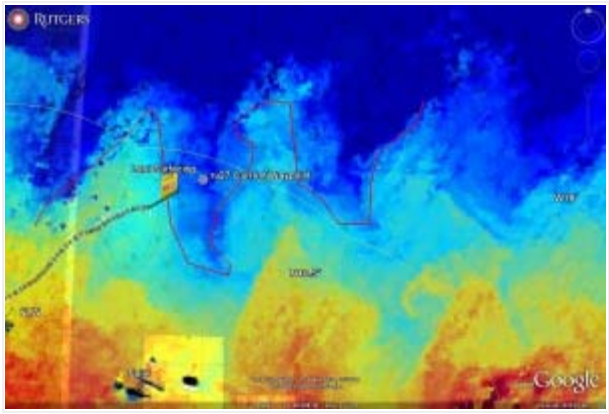
0 Comments

12 sep

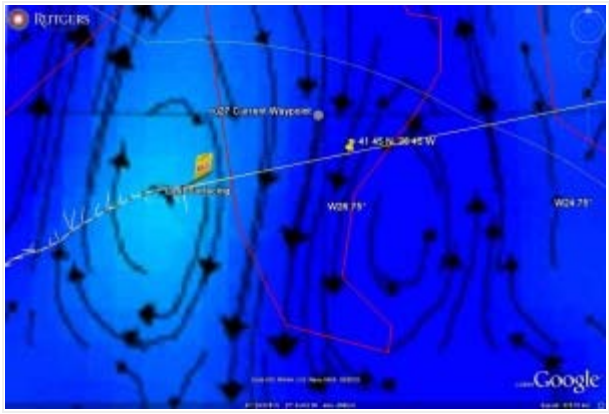
Exploring the Ocean Mesoscale.

Posted by: Scott in: Atlantic Crossing

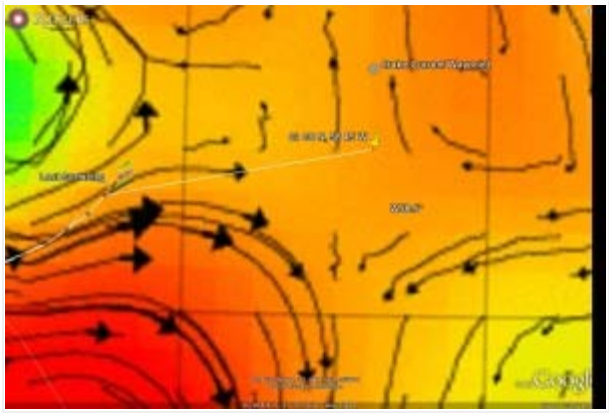
A rainy morning here in New Jersey, perfect for fine tuning our steering on the Trans-Atlantic Gliders. First Rutger's Scarlet Knight is trying to cross a series of three alternating warm and cold filaments. The warm filaments are moving north, the cold ones south, and we are trying to fly east. We are in a warm filament and are 35 km from the edge of the front where we cross into the cold.



According to the altimeter, we just flew across the center of the eddy and have entered the southward flowing side. We need to fly east quickly now, so we can jump into the southward flowing current of the eddy just to our east. As we are advected south, if we don't get far enough east, we continue spinning around in the eddy we are now in. If we do get far enough east, we get whipped around the next eddy towards Spain & Portugal.



Back to the tropics, Teledyne's Drake is doing the exact same thing. We are flying eddy to eddy. In this case we just left the eddy to our south and are now entrained in the eddy to out north. We are using the glider speed to choose an exit point the puts us as close as we can get to our next eddy of interest. We are often amazed how a surface current measured from an altimeter in space can be so well correlated with a depth averaged current measured by a glider that is undulating between the surface and 1200 m, but this highlights the dominating influence of the ocean mesoscale.



In oceanography, the eddy fields we are navigating the gliders through in the above images are known as the energtic ocean mesoscale. http://en.wikipedia.org/wiki/Eddy_(fluid_dynamics) . When we look at our ocean from satellites in space, we see the mesoscale eddies are everywhere. They dominate any image of the ocean, just as the weather patterns dominate any image of the atmoshpere. http://www.gfdl.noaa.gov/ocean_mesoscale_eddies . One of the challenges of climate prediction is that most climate models that include the ocean do not yet resolve this energetic mesoscale. http://www.clivar.org/organization/wgomd/meso/MESO_summary.pdf . This short executive summary of a recent meeting of the world's experts on this topic indicates it may take a generation of researchers to fully understand the impact of the ocean mesoscale on climate. That generation of researchers will be made up of the students currently sitting in our classrooms. This is why government agencies, universities, and companies are working together on projects like this. It is why the COOLroom is on a university main campus, why these two gliders are crossing the Atlantic, and why there are over 100 school districts with letters on board.

0 Comments

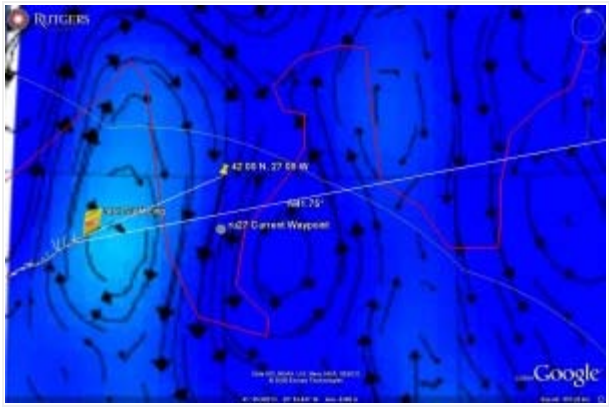
09 sep

09/09/09

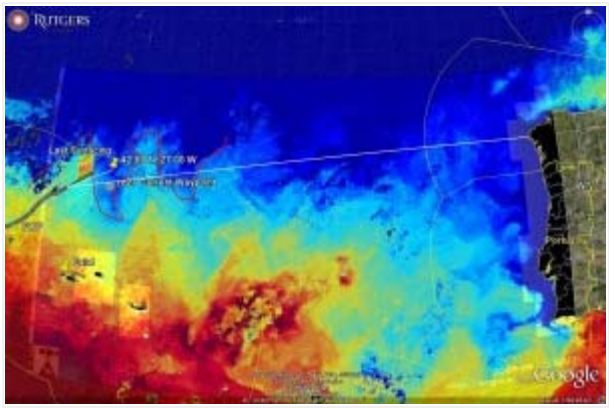
Posted by: Scott in: Atlantic Crossing

Last night I wrote up the blog on the New World Record for along-track distance just set by The Scarlet Knight. I get up in the morning and the next thing in my email box is this image from our friends in the Canaries. Scarlet tacked 40 kilometers onto that total today.

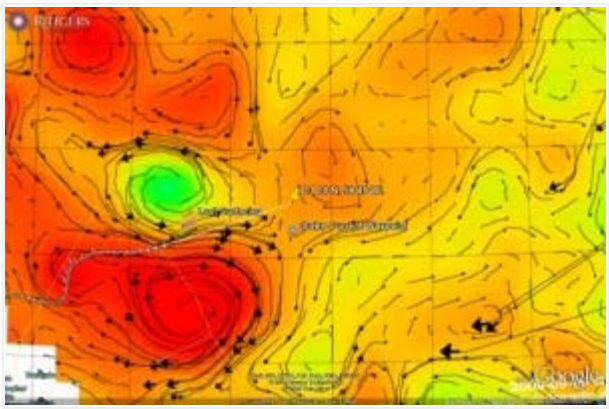
Currents reported by Scarlet are in excellent agreement with the geostrophic currents from the alitmeter. We'll move the waypoint a bit north at the next opportunity. We want to cross the present clockwise eddy a bit north of the center, and enter the southward flowing current in a region that gives us more time to drift south as we fly across it.



Overlaying a semi-transparent SST, the agreement between the temperature and current structure from two different satellites is amazing. We'll continue our general path to the ENE into the cooler water towards the northern edge of Spain.



Back in the tropics, Drake is in the middle of the eastward flow jet between the two counter-rotating eddies. We'll move the waypoint north to start flying across the jet to get to its northern side.



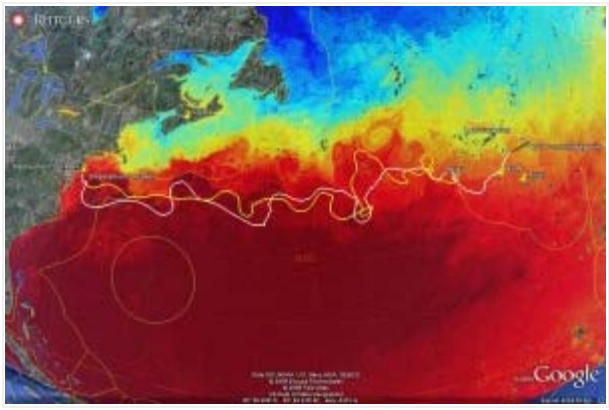
2 Comments

08 sep | Scarlet Breaks the World Distance Record

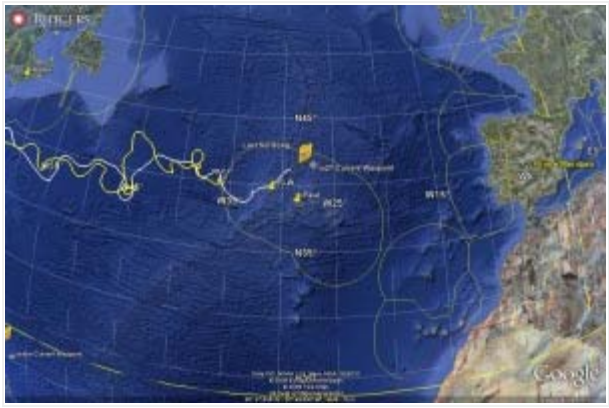
Posted by: Scott in: Atlantic Crossing

The Scarlet Knight (RU27) surfaced at noon today, collected her GPS location, and

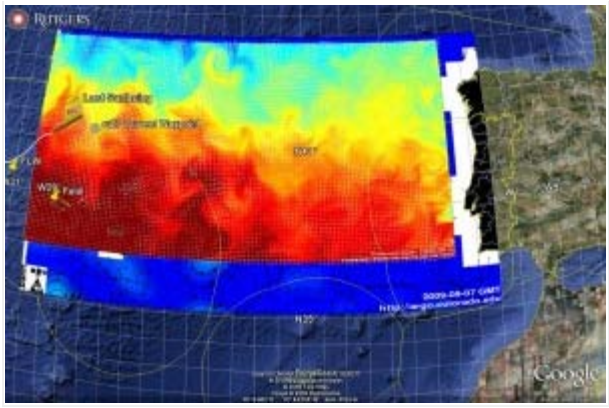
recorded a total path length of 5,702 km, breaking the World Record for alongtrack distance set last year by RU17 at 5,700 km. From now on, every surfacing pushes the World Record higher. The tracks of the two gliders are shown below, with RU27 in white and RU17 in yellow, both plotted over the sea surface temperature that shows today's meandering Gulf Stream. There are remarkable similarities. Most striking to me is the wall both gliders hit near 45 W as they left the Gulf Stream Meander and Ring region and entered the Gulf Stream Extension region. At this interface, both gliders encountered a strong eddy that they had to fly around, a diversion that was followed by a jump to a more northerly course. RU27's improved design as well as the improved environmental guidance has enabled us cover that path length faster than RU17, and to stretch that path length out over a greater east-west distance.



Plotting the tracks over the bathymetry, The Scarlet Knight is now directly over the rift valley of the Mid-Atlantic Ridge, the longest mountain chain in the world. We are leaving the North American Plate and starting to fly over the Eurasian Plate http://en.wikipedia.org/wiki/File:Plates_tect2_en.svg



We've adjusted the areas extracted from the global CCAR altimetry product and the NRL HYCOM forecast model, setting them up to cover at least the region from 30 W to 10 W. This sets up the final U.S. guidance products.



And now the Europeans get to try their hand at flying. In the photo below, Dave Kaminsky (white hat), now in his senior year as a student at Rutgers, is introducing our European students Al, Adrian and Fillipa to the processing and display codes for the satellite ocean color imagery Antonio sends us from the Canaries everyday. The European students will help us get the European guidance products into our Google Earth flight planning displays over the next two months. Displayed on the big screen is the track of RU27 as it crosses the rift valley and breaks the world record.

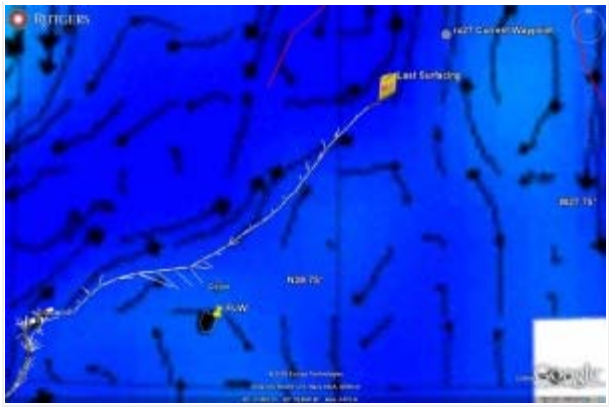
1 Comment

07 sep

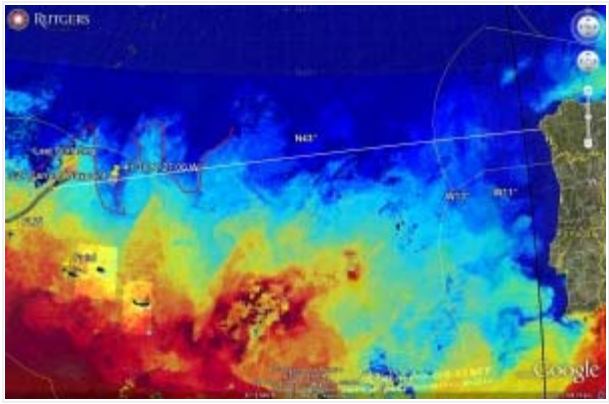
Scarlet turns towards Spain.

Posted by: Scott in: Atlantic Crossing

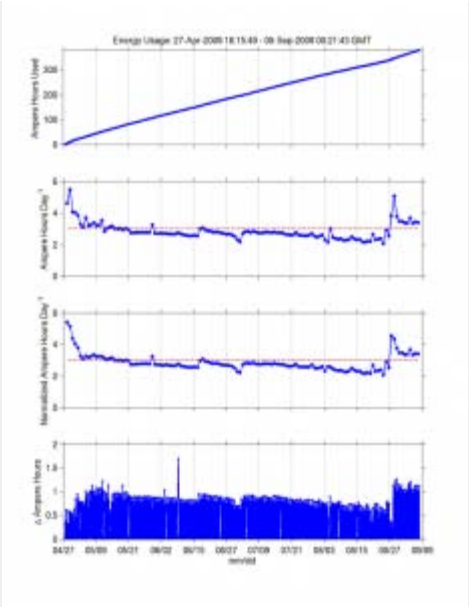
As The Scarlet Knight heads northeast, with current correction turned off, she is doing an amazing job of following the wiggles in the geostrophic currents. A great confidence builder for the roadmaps in the weaker currents of the filament field.



With the current now turning more to the east this morning, it was time to change the waypoint and start flying downstream towards Spain. The new path will take us across this northward flowing warm filament. Then when we cross the sea surface temperature front in about 160 km, we fly into the southward flowing cold filament. We repeat this filament crossing over and over again for about 6 times, and that will take us into the 200 nautical mile limit of Spanish waters. Distance to the Spanish coast just dropped to below 1700 km with today's noon surfacing. The black line on the eastern side of the image is 10 W, the north-south line the ships use for transiting the region. The 10 W line is something we should not approach or try to cross without local knowledge. We hope to contact our friends at Puertos del Estado http://www.puertos.es/en/index.html in Madrid in the morning (their afternoon) to start the strategy discussion.



We have a tail current of about 10 cm/sec, and are gaining about 11 km during every 8 hour dive. Each morning when we do the dedicated CTD cast for data assimilation, we have set Scarlet's pitch to give us the maximum dive and climb rate. We hope the increased drag will help us keep the glider as free of barnacles as we can for the rest of the mission. Energy usage is leveling off at just under 3.5 amp hours per day (third plot in the column below). We could drop the energy use down by shallowing our dive angle to slow us down or by going deeper to use fewer cycles on the buoyancy pump. Theoretically, we are doing fine on power. Right now we want to use the speed while we have it. Our challenge now is the race against time, hoping we can go faster than the new biological growth and the arrival of winter off Spain.



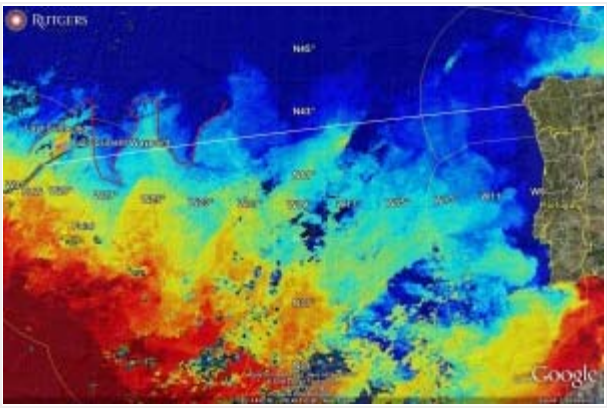
0 Comments

06 sep

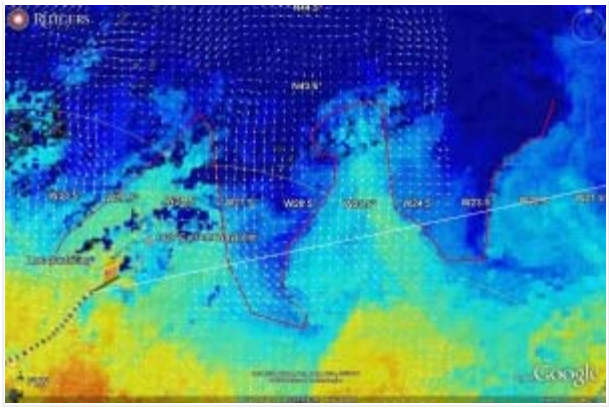
The American Football Field

Posted by: Scott in: Atlantic Crossing

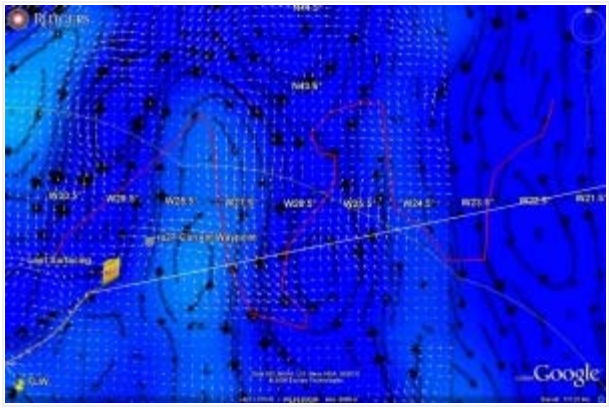
This morning Antonio helped us define the endgame for The Scarlet Knight. The goal line is longitude 10 W. This line of longitude is anywhere between 40 km to 110 km offshore the coast of Spain or Portugal. It is the north-south line that all the shipping follows. Word is that we don't want to try crossing this zone without an escort. We will likely have to stop just before reaching this zone until we know it is safe to pass through or get picked up. Over on the western side of the field we have The Scarlet Knight. She just sufaced at noon and for the first time is east of longitude 30 W. So we have a total of 20 degrees of longitude to cover on our eastward journey. Just like a football game, it does not matter how far north or south we go on this field, so long as we keep clicking off those lines of longitude. If we can cross one degree of longitude every 5 days, we'll be there in December, before the severe winter waves set in.



Scarlet is getting a nice tail current right now, about 10 cm/sec. She made 11.7 km in the last 7 hour segment. We'll keep heading north a bit then turn east to take advantage of the tail current we see here in the hycom vectors overlaid on SST,



and also here in the hycom vectors overlaid on the altimetric currents.



RU27 stats for the football fans: We are east of 30 W. Less than 20 degrees from the 10W goalline. We are 1730 km from Spain. In 62 kilometers we break the distance record set last year by RU17.

0 Comments

06 sep Europe Reinforces the Team

Posted by: Scott in: Atlantic Crossing, Thermal Glider Flight

Sustaining long duration flights can wear you down. Its like running a marathon when you are trained as a sprinter. Going to sea is often a sprint. You have only a small window of time, and everything depends on what you do in your few days of shiptime. You prepare for weeks or months for that one intense sprint. One thing you don't do is sleep. Now we have to maintain a sustained and active presence over months. Interest fades as tasks get routine, but is reinvigorated by both moments of intense stress when something bad happens, and moments of intense excitment when something new is discovered. To help us handle this extra workload and allow people time to rotate in and out, we have received great support from our partners around the Atlantic Basin.

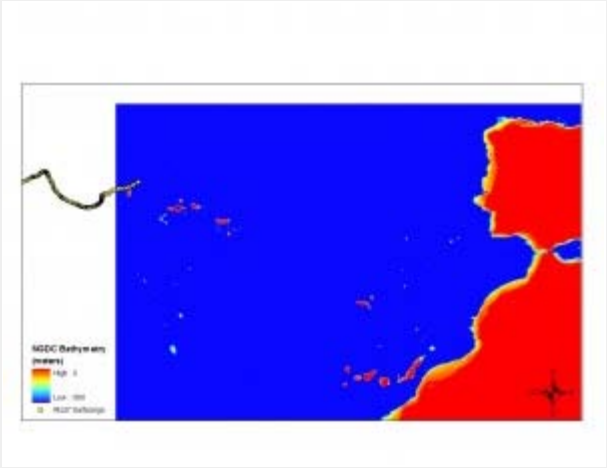
The University of Puerto Rico Mayaguez sent us two students to help over the summer, Samual Rivera Aparicio (Sam on left) and Andre Amador Ramirez (Andre on right). Both helped with the CODAR network this summer, relieving pressures on that system, and also were available for glider deployments and recoveries. Both are now back in Puerto Rico working for the Caribbean Regional Assoication (CaRA) as part of the U.S. Integrated Ocean Observing System (IOOS). They will help with the CODAR testbed we are setting up for the Department of Homeland

Security, and will remain part of our tropical glider testbed at UPRM and UVI.

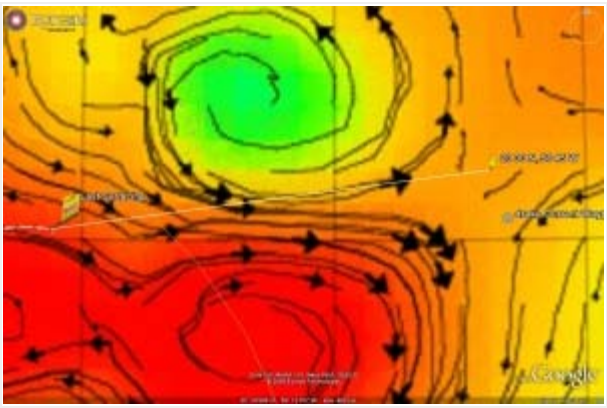
With Drake heading out into the open sea, and The Scarlet Knight deep into European waters, our focus shifts to the European side of the Atlantic. During this first week of September, the Europeans have sent three students to Rutgers to learn about our operations and help out in the COOLroom for about 2 months. On the left is Ana Filipa Miguel Carvalho (Filipa) from the University of the Azores. She is an oceanography grad student with the local knowledge of the European waters. The University of Las Palmas de Gran Canara sent in two computer scientists. In the center is Alvaro Lorenzo Lopez (Al) and on the right is Adrian Martin (Adrian). One of the first things Al and Adrian will do is help us get all the great remote sensing data and forecast model runs that Antonio is sending us from the University of Las Palmas de Gran Canara into our Google Earth control interface. They'll also help with the imagery Ana Martins is sending from the University of the Azores. We don't have enough people to keep up with the vast number of data products the Europeans are providing, so sending two computer scientists was key. They will be working with Filipa as the local oceanographer, and will be mixing in with all of our students, teaching each other about both sides of the Atlantic. As somewhat of a shock to us, over 30 undergraduates showed up for the first day of our Atlantic Crossing class this past week. We had to move the class out of the COOLroom and into a teaching lab.

Below is the first product from the European team. Filipa knew if we took a southern route through the Azores, we would have to worry about seamonts that don't break the surface, but come pretty close. Filipa downloaded a bathymetry set she has used in the past, put it into our GIS with Lisa, and together the just stepped down the color bar in 100 m increments starting at 100 m. The first seamount along the northern route does not appear until the range of the color bar is increased to a depth of 500 m. They located the peak of that single seamount at a depth of 492 m. The Scarlet Knight is now flying to a depth to 150 m as a precaution to limit wear on the buoyancy pump. We won't know for sure if this was a necessary precaution until after recovery, but we are taking it anyway. And

the bathymetry map says we have a clear route for crossing the Mid-Atlantic ridge. No seamounts.



Back to flight control, Drake has made the turn to the east, and the currents have rotated clockwise, from NE to E to SE, in very good agreement with the CCAR geostrophic surface currents. As Drake continues moving east, we will be moving the waypoint north. The next waypoint will be about 45 minutes to the north, helping Drake to cross the streamlines we see in the map and move from the southern clockwise rotating eddy it is now to the counterclockwise rotating eddy to our north.



More on The Scarlet Knight later. She is doing fine. Over 30 kilometers clocked in the last 24 hours.

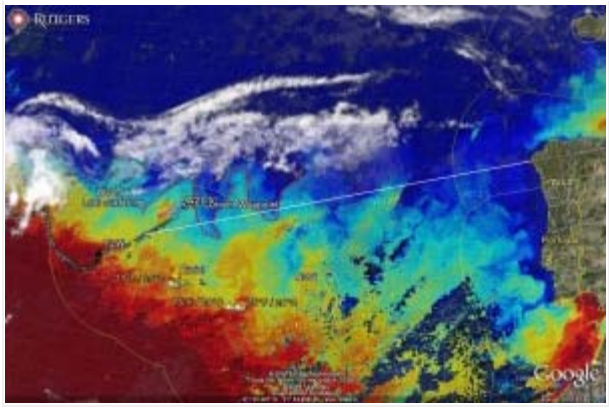
0 Comments

04 sep

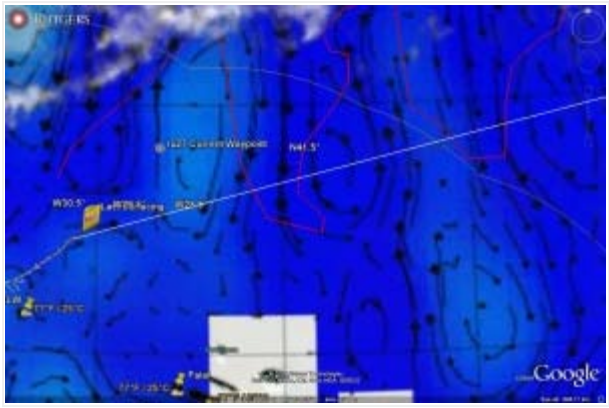
Less than 1800 km - as the crow flies.

Posted by: Scott in: Atlantic Crossing, Thermal Glider Flight

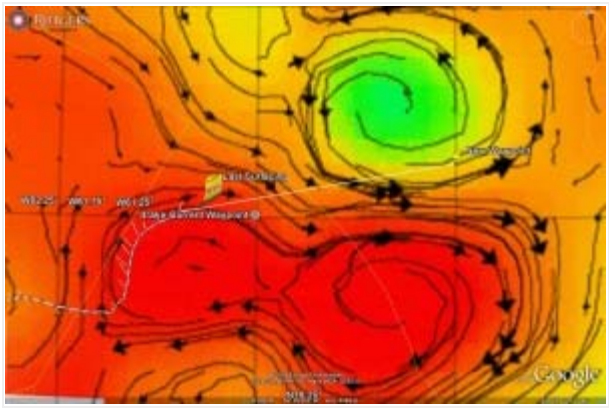
At noon today, The Scarlet Knight was 1780 km from the northwest corner of Spain, heading east into the series of warm and cold filaments. Clouds are to our north - should be good satellite imagery today.



Zooming into the local region and looking at the bathymetry, Scarlet is heading a bit more to the north to avoid the head-currents we would encounter if we headed straight to Spain. We'll head in this direction for a bit, them catch a ride from the northward flowing currents, and head back east. Ocean currents have been low today, just a few centimeters per second. Scarlet flew 25 kilometers in the last 24 hours. 1 km/hour is a typical back of the envelope speed estimate for a clean glider.



Back in the tropics, Drake has made the turn to the east in the southern clockwise eddy. We have begun to steer Drake to the ENE, crossing the eastward flowing streamlines so we can fly into the counterclockwise eddy to our north.

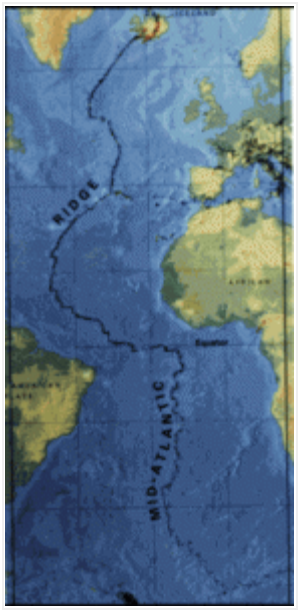


0 Comments

03 sep

Heading to the mountains!

Posted by: Oscar in: Atlantic Crossing, Atlantic Crossing Seminar



RU27 is about the cross one of Earth's largest features, the Mid-Atlantic Ridge. While we pass over this amazing feature, we hope we don't actually encounter it. The Mid-Atlantic Ridge is well below the crush depth. The Mid-Atlantic Ridge is a spreading tectonic plate boundary in the sea floor located along the floor of the Atlantic Ocean. This system is the longest mountain range in the world. It separates the Eurasian and North American Plates in the North Atlantic, and the African Plate from the South American Plate in the South Atlantic. The Mid-Atlantic Ridge runs from 333 km south of the North Pole to Bouvet Island offshore South Africa. The Mid-Atlantic Ridge is about 10,000 km long and connects a series of oceanic ridges. RU27 this labor day weekend will fly over a deep valleys that run along the axis of the ridge. This ridge is the actual boundary between adjacent tectonic plates.

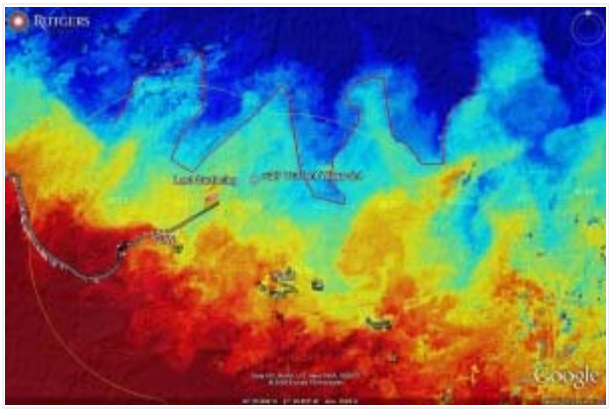
The ridge was first suggested to exist by Matthew Maury in 1850. He was a giant, who was nicknamed the Pathfinder of the Seas and the Farther of modern Oceanography. Wow, like when in Wayne's world when they encounter Alice Cooper, "We are not worthy!!!". The Pathfinder of the Sea was made famous by books, the most important being the Physical Geography of the Sea. This is considered the first published work of oceanography. This grand intuition was confirmed by the greatest oceanographic cruise of all time the HMS Challenger. The scientists onboard found this massive undersea mountain chain (hoping to deploy a transatlantic cable). Later future giants of oceanography Marie Tharp, Maurice Ewing, and Bruce Heezen discovered the large valleys, mountains, and cliffs. These are the large features, which tonight RU27 is heading to. This weekend the we should be passing over the Mid-Atlantic Ridge. So as the weekend grills stoke up and cold brew is pulled from the Coleman cooler, toast Ru27 out in the North Atlantic.

0 Comments

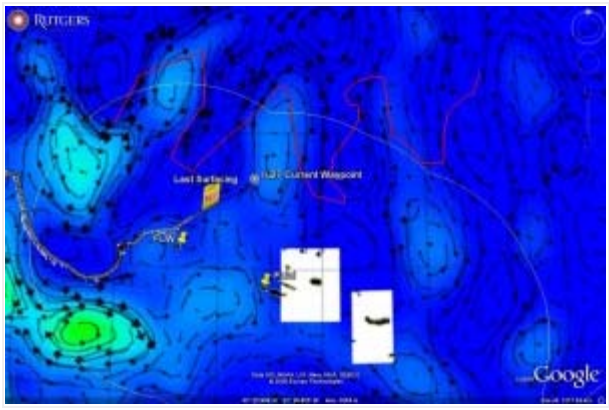
02 sep — The Amazing HYCOM

Posted by: Scott in: Atlantic Crossing, Thermal Glider Flight

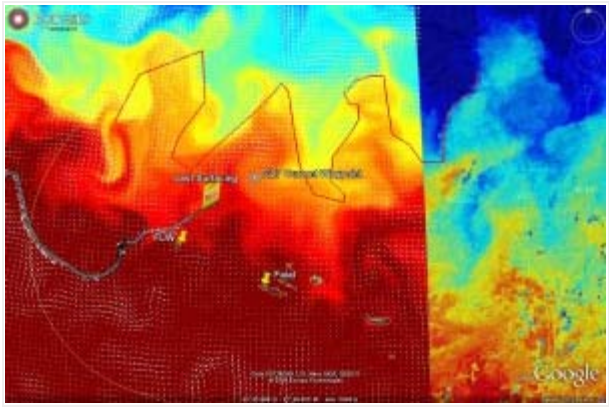
I have been in the ocean forecasting business for 3 decades (yikes), and I am still amazed by what we discover about the ocean models as we path plan for this trip. On the sea surface temperature map, we've outlined the front that defines the series of warm and cold filaments we are flying into.



Next we superimposed the digitized front from the SST on the altimeter map of surface currents, and the agreement was amazing. This is builds confidence that we our roadmap, in this case constructed from two different satellites, is good. I pretty much left it at that last night. Two independent measures of the structure, and they both agree.



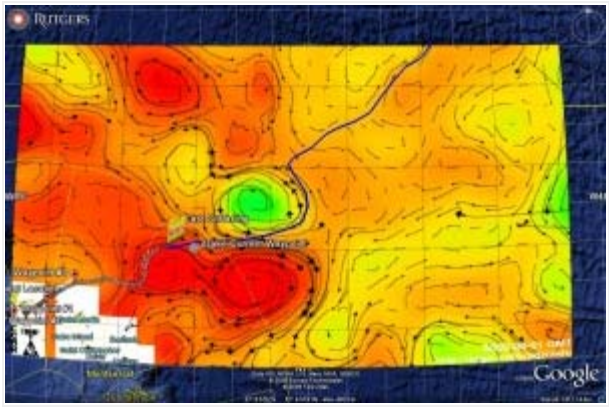
So all day today I am working with Art Allen at the Coast Guard looking at the HYCOM model output, and comparing it to drifters and CODAR surface currents on the Middle Atlantic Bight continental shelf. So tonight I figured I would check out how HYCOM was doing by RU27. Below is the HYCOM surface currents and the model forecast SST with the same red line from the satellite observed SST overlayed. Again I was just amazed at the agreement between the model and the two different satellite datasets. Hats off to the modelers, but now, a proposal.



We have the opportunity to do an Observing System Simulation Experiment right here, except it would be real instead of simulated. Usually we fly these long distance glider missions along fronts, trying to find favorable currents that also usually run along the fronts. But data assimilitive models want data along paths that run perpendicular to fronts. Thats why a glider is one of the most efficient adaptive sampling systems we can build. It uses the ocean currents to move it along a front, but unlike a drifter, the gliders can use their own velocity to zig-zag back and forth across the front as the currents take it downstream. As RU27 heads east across these filaments towards Spain, even though we are flying straight, we will be crossing a series of filaments as the front zig-zags beneath us. We can collect all that data and email it down to Stennis Space Center every morning where they assimilate it into the HYCOM model. We could check how much influence the glider data has on defining the structure of these filamements that are already looking pretty good in the surface data.

But what about Drake? Ever since class yesterday we have been talking about the

historic sections in oceanography, like the transatlantic section by the R/V Chain back in 1957 that ran just a bit north of where Drake is right now. Now that is a goal. Lets head northeast. We can shoot the gap between the eddies, whip around the eastern side of the northern eddy, then jump out and follow the northeastward currents up to about the latitude of the historic lines. Time to repeat a little history.



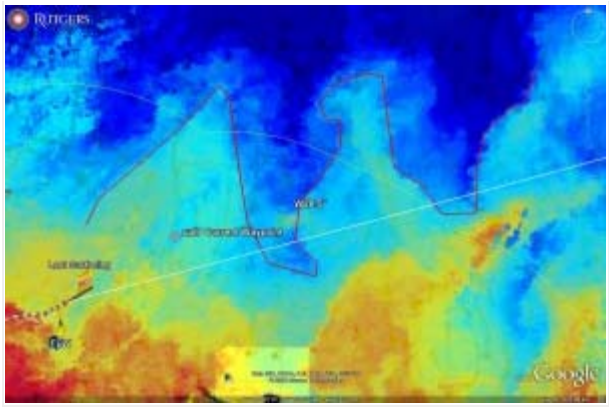
0 Comments

02 sep East of Flores

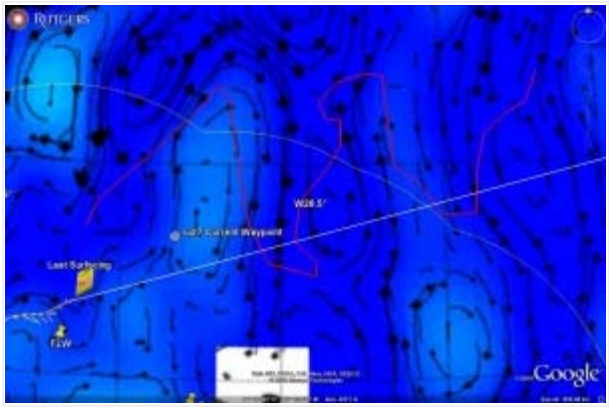
Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is now east of Flores and Corvo, heading northeast with a slight tailwind of about 10 cm/sec. The 4 am surfacing clocked 14.5 km in 8 hours. We have the power useage down to 3.5 amphours/day. Based on the theoretical amount of power on board, we have about 6 months of power at this rate. Dropping the power useage down to 3 amphours/day buys us another month, and the ability to winter over at sea if we need it. But so many things can go wrong in the high waves of a Spanish winter, we are thinking that it is better to use our speed now to see if we can beat the winter. Another good reason to use the northern route. The colder water will slow the biofouling, and help us keep up our speed.

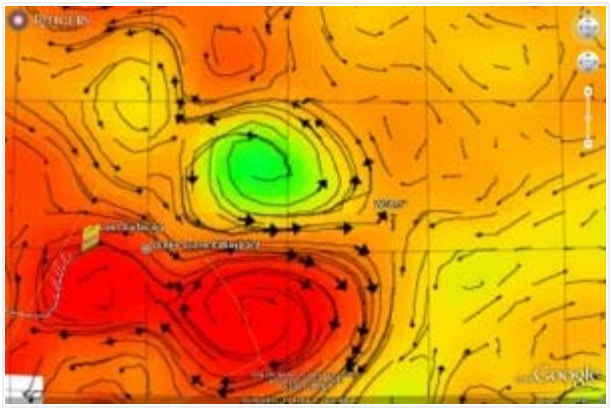
Below is a slightly transparent SST image overlayed on the altimetry. We've outlined the front that indicates the edges of the filaments running north-south that are so common in this region. These alternating bands of warm and cold water are where we are heading. The white thin white line heading to the northeast is leads to the most northwestern corner of Spain.



Now removing the SST from the image reveals the underlaying current pattern derived from the altimeters. Warm water filaments are flowing north, cold water filaments are flowing south. Scarlet is now heading northeast in one of the northward flowing bands. If we look south of the white line along a more southerly route, we see lots of adverse currents. So the physics & the biology are saying we should stay north, just as Antonio said on Friday.



Back to the tropics, Drake is doing well flying up the western side of the clockwise circulation and is now starting to turn east as it approaches the eastward jet along 22 N for the run between the two eddies.



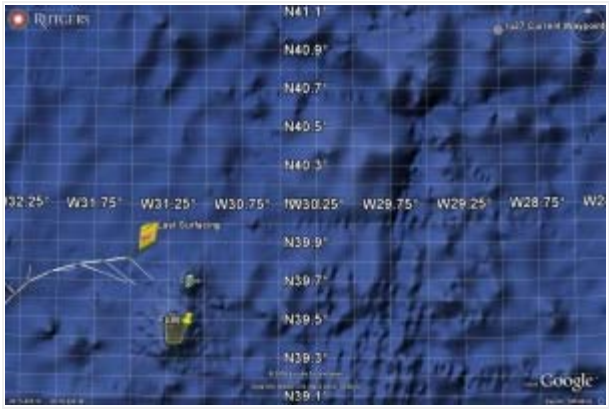
0 Comments

01 sep

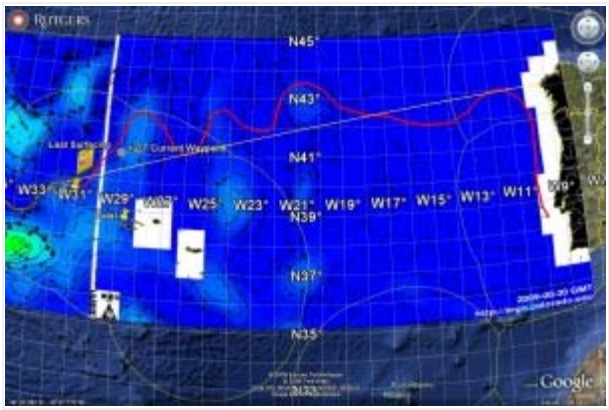
Approaching the Island of Corvo

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight has travelled 5,460 km since it was deployed on April 27, we are in the middle of the North Atlantic, and tonight we have to worry about hitting land. We just travelled 45 km in the last 24 hours, Flores is 40 km away, and the smaller island of Corvo is only 35 km away - almost directly in our path. We'll be getting very close by noon tomorrow. Just to make sure, we'll shallow up the dive depth a bit, moving it up from 150 m to 100 m, and point ourselves a little more to the north for a couple of segments.



One thing we like about this filament region is that the satellite SST and altimetry are in pretty good agreement. Both have long filaments of northward flowing warm water and southward flowing cold water. Our target is the northwest corner of Spain, just under 1885 km away. Once there, we can ride the coastal current south and wait for a pick up. To get to that northwest corner, we'll follow a route where we are pushed north and south by the currents in the filaments. We'll use most of Scarlet's newfound speed to get us east. One path through the filament field could look like the path drawn below.



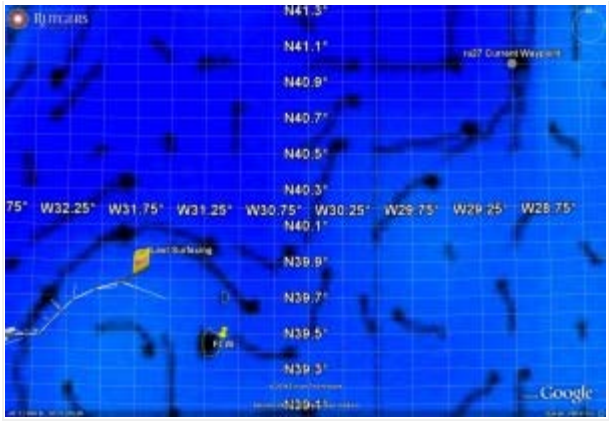
1 Comment

31 aug

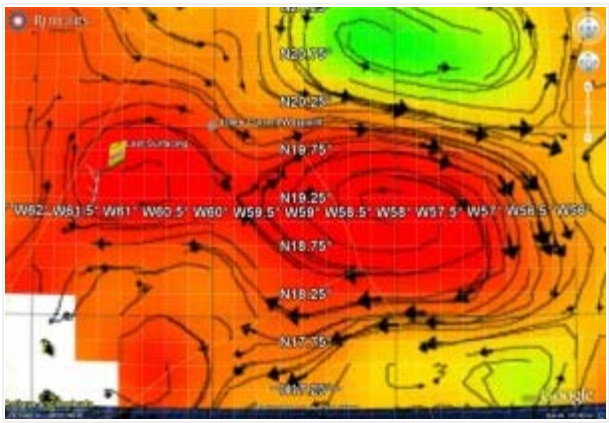
Scarlet & Drake

Posted by: Scott in: Atlantic Crossing, Thermal Glider Flight

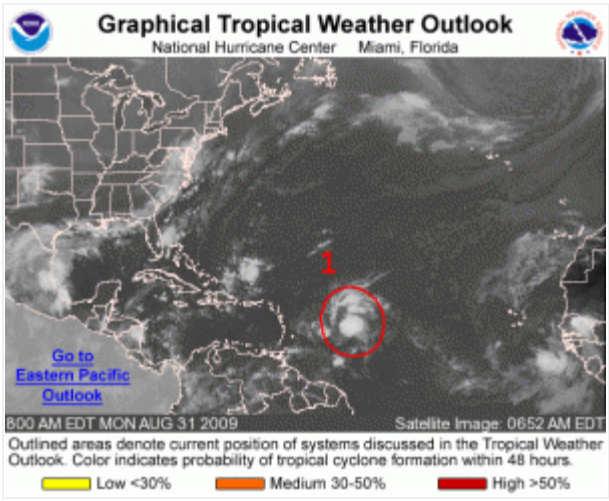
Scarlet made 16 km in an 8 hour mission. She likes the speed. Today we look into the power tradeoffs of slowing her down. The altimetric roadmap looks amazingly good - we are flowing this meandering current northeast to 41N, then we'll turn east into the filament field.



Same dance in the tropical North Atlantic. Drake is using the altimetric roadmap to get to that jet along 20 N, then turning east.



NOAA National Hurricane Center is monitoring the area of low pressure circled below, givong it a greater than 50% chance of tropical cyclone formation in the next 48 hours.



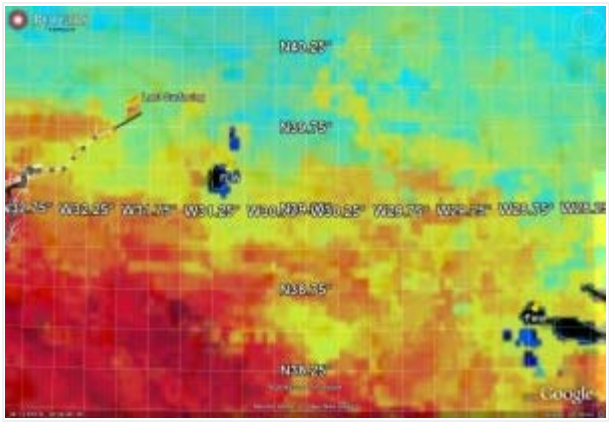
0 Comments

30 aug

Lessons (Re)Learned

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight just flew nearly 15 km in her last 8 hour segment, and our field team has made it back to Faial by air. Chip just got internet access and logged in with a “Go Scarlet Knight”. We all hope they are getting some rest on dry land and look forward to talking to them in the morning. The Nevertheless is still transiting from Flores to Faial with just the crew on board with all of our equipment, a much more roomy ride I am sure. We look forward to their arrival soon in Faial.



We learned much from this trip. We can now answer the question that we agonized over since the loss of RU17 in October of 2008, specifically, what was growing on us and where. Now we can protect ourselves in the future, building better gliders for longer missions for the entire global fleet. On this trip we also developed new ways to inspect a glider at sea, and, in the short span of a couple hours, how to reballast at sea if necessary. We also learned a lot about our team and how it works together to problem solve. Nothing that we did not already know - we are up to about 165 glider missions so far - but nevertheless, it is worth reiterating.

Every time we go to sea, we are up against the unknown. This mission was no exception. We had no idea what to expect when we saw Scarlet for the first time in 4 months, we were in seas we had never before visited, and we were on a boat we had only seen in photos. But one thing was certain, we had to go now to save this mission, and this was the only way to get there. Something we have learned and relearned from 165 glider missions is to not swarm the ball. Each person has to play their own position if the team is to succeed. In this case, the team set up three lines of defense in our game with the unknown. Our first line was the hand-picked field team aboard the Nevertheless. They were divers and glider experts, able to get the technical job done, but more importantly, possessing the experience and skills to bring everyone home safe and whole. Our second line was the shore support team that gathered in the COOLroom where all the real-time data feeds were collected and analyzed. They had tracked this glider for 4 months, and knew her every move. Our third line was the many experts (Clayton Jones at Teledyne Webb Research, Vince Cardone at Oceanweather, Antonio Ramos in the Canaries, Duncan Sweet in the Azores, …) located on both sides of the Atlantic that we consulted as needed. We were using the full depth of our bench, and we would need it to deal with the fatigue that was sure to set in. By the time the field team was on site, they would be tired from the daily difficulties of living on a small and constantly moving vessel. The COOLroom team would track their work hours, so we too would be tired, but we would not be seasick. The third level of distributed experts would be the fresh set of eyes, relieved from the daily pressures, but available when we needed them most. In those critical final 2 hours of the 22 hours that the Nevertheless was on site, Teledyne Webb Research had the experts that provided that third line of defense. It took real-time communication between all three layers to consider the options, balance the risks, make the right decisions, and produce an outcome that resulted in a glider that was fit for flight. Declaring The Scarlet Knight fit for flight at 11:15 am eastern time on Friday will likely go down as the most critical decision of this entire mission. It was a team decision made by individuals in all three layers communicating as they applied their diverse expertise to the pieces of information they had. Together we constructed a composite view of a new situation, and developed a response. Thinking broadly, as

we close out 2009, and enter our third decade of ocean observatory development in the U.S. and around the globe, the lesson relearned in the 22 hours Nevertheless spent with RU27 should not be overlooked.

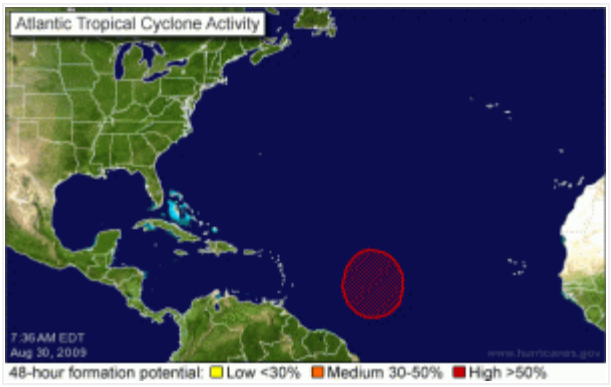
1 Comment

30 aug

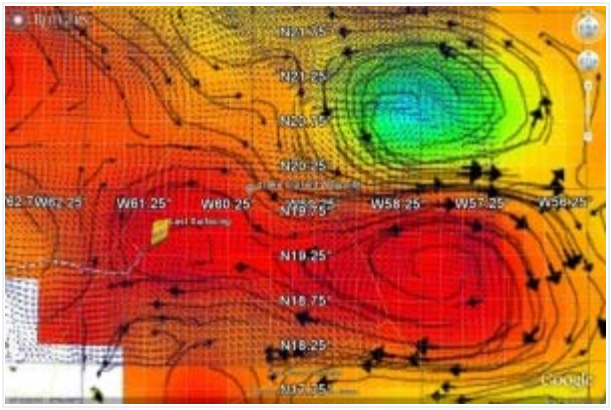
Scarlet redlines the power curve.

Posted by: Scott in: Atlantic Crossing

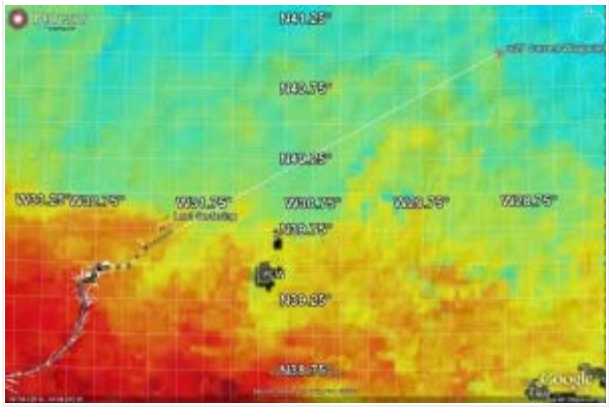
The Atlantic Tropical Cyclone season continues. NOAA National Hurricane Center has identified an area of potential Tropical Cyclone potential that will be heading towars Drake.



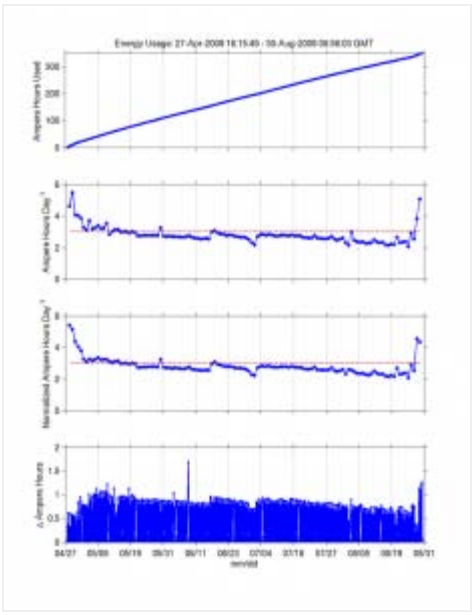
Drake continues to head northeast to meet the storms. Image below if an overlay of Hycom surface currents (blue), geostrophic surface currents from the altimeter (black) and depth averaged currents from Drake (white). Good agreement is observed between all three. Hycom and altmetry agree there is a strong eastward jet along 20 N, and that is where we are heading. Drakes currents agree well with Hycom. The northeast heading of Drake combined with the northwest currents produces the path to the north. We'll use these currents to help swing us around this eddy and into the currents along 20 N. As we approach 20 N, we'll move the waypoint downstream to the east.



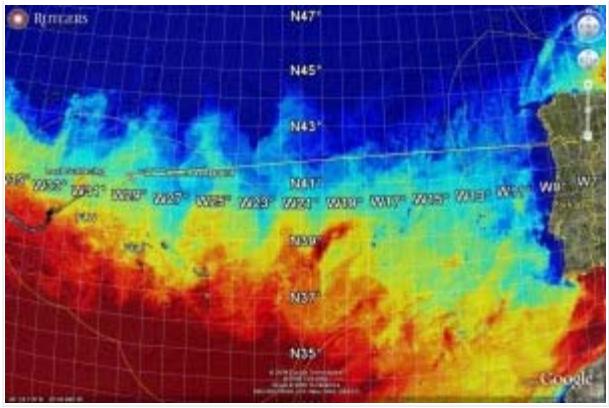
Scarlet continues to rocket along. Since making the turn to the northeast, she has slown over 19 km in 16 hours. Thats as good as a glider fresh out of the box.



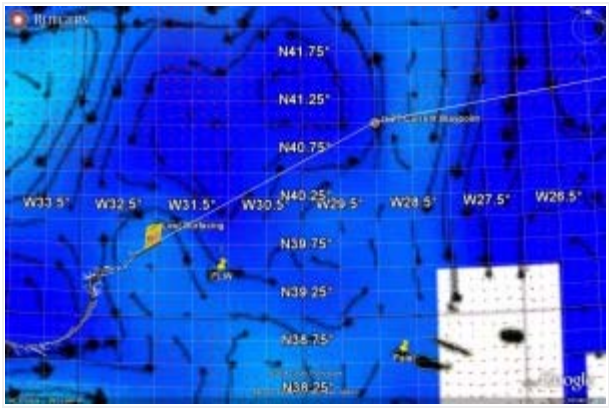
Speed is not cheap. It comes at a cost of higher power usage. For the first time in months we are above the red line in the third graph below. Normalized amp hours per day is the key plot. We want this plot below 3 amp hours per day, and we are running above 4. We'll let Scarlet run for the rest of the weekend, it will give us some important tuning data. Then on monday we'll start redoing the energy calculations. Is it better to sprint now when we can or save our energy for later in the game? One thing we will do is cut the data tranfer file size back again to save power there.



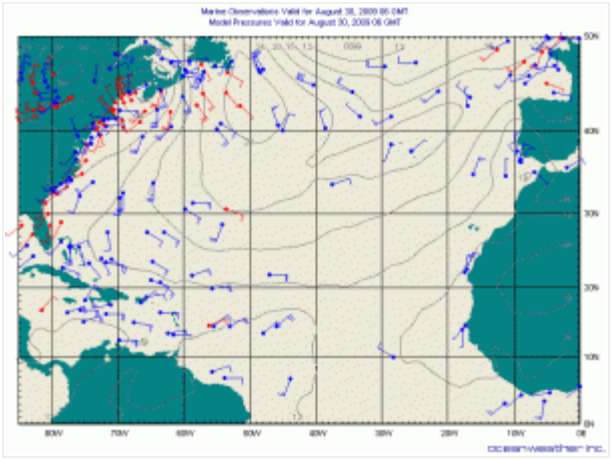
We are heading for the filament field of the eastern North Atlantic. We have about 5 or 6 bands of northward and southward flowing water to cross before we see the cold water of the coastal upwelling zone off Spain and Portugal. Total distance of the dogleg course plotted here is just under 2000 km.



Plotting a course to about 41 N takes us through a region of weak currents where the hycom model and the altimetry disagree almost everywhere you look. Classes start up again on tuesday, and the first task for the students will be to explain why this is ok.



Below is a hint on one of the reasons.



For the students, this blog is your text book. You can't get any more current than that. The text is being written while you take the class. We also have 3 students joining us from the Azores and the Canaries on tuesday. They will provide valuable local knowledge as they help us meet the challenges of this final 1/3 of our journey.

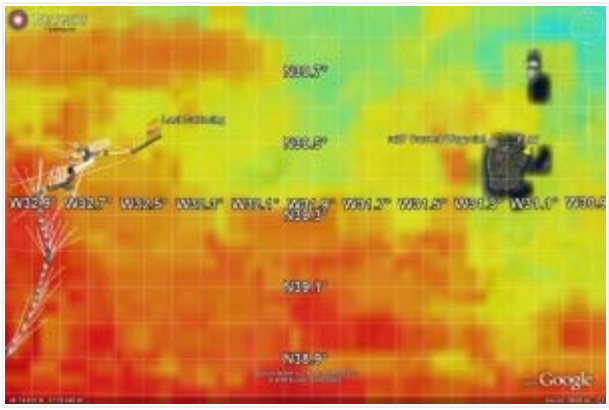
0 Comments

29 aug

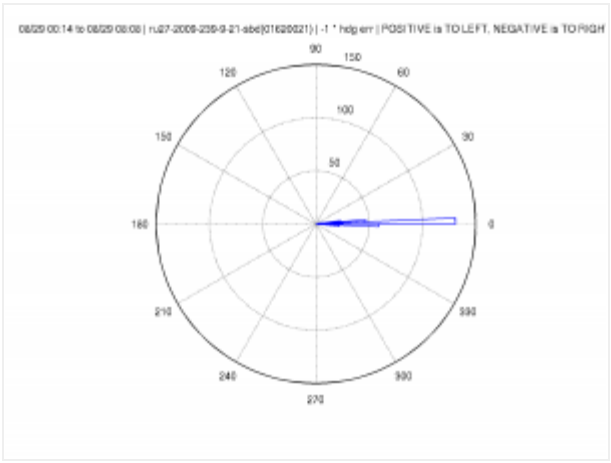
She's a Rocket

Posted by: Scott in: Atlantic Crossing

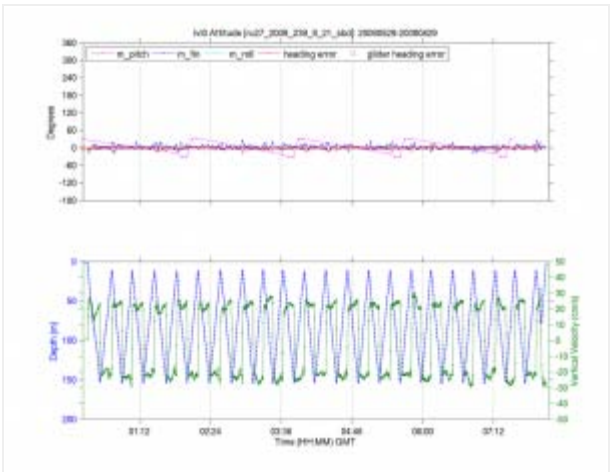
The Scarlet Knight is wasting no time leaving this piece of ocean behind. She is rocketing towards Flores, flying over 8 km in 8 hours into a head current. Once again, Scarlet lives up to her reputation as a fast glider.



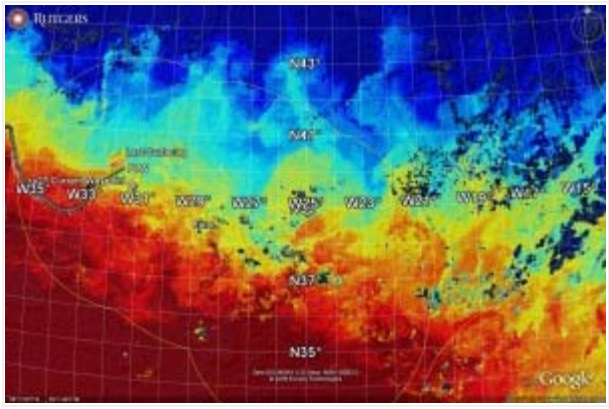
Her heading is beautiful. She is averaging about a 2 or 3 degree to the left heading error. Big change from the 360 degree spins to the right we saw just a few days ago. We can even use the fin offset on Scarlet to correct for this small difference.



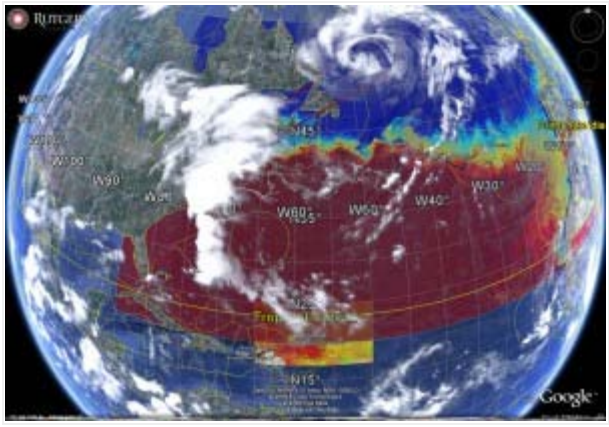
The heading and yo profile plot below is awesome. We'll need to change the y-axis scales on the heading error plot back to the pre-launch scales. Vertical velocities are abck up to 20-30 cm/sec. The yo's are symmetric on upcast and downcast.



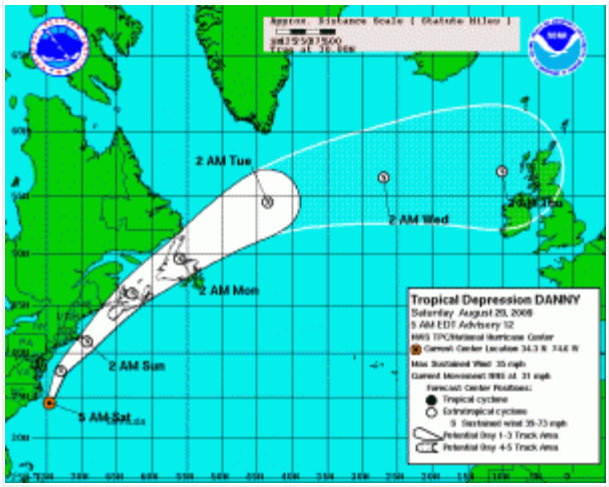
Guidance from the European side says we should head northeast from here, favoring the northern route to the mainland. So we've reset the waypoint to the northeast and will pass it on to Scarlet at the noon surfacing. We'll be heading into that field of filaments to our east. Each of these filaments are elongated in the north-south direction, so most of the currents are running north-south. This is when we'll need Scarlet to use her speed and fly downfield. Its also when the U.S. football analogy comes into play. It matters less how far north or south the currents move us. We are trying the head downfield to the east, until we cross the goaline. The goaline just happens to be 2000 km away. On the U.S. football field, considering the full mission, I make us out to be on the 35 yard line. With the speed we gained from the visit by the Nevertheless, we are again first down and 10, heading northeast to the filament field. We don't know what to expect there, but European guidance again is that the biology will be worse if we head east along the southern route.



Back to our west, what is left of Tropical Storm Danny is sitting off of the U.S. east coast, heading north. It no longer looks tropical in the cloud images.



Checking in on the NOAA National Hurricane Center, the remnants of Danny will move past New Jersey today and be in the U.K. by Thursday. 5 days to cross the Atlantic.



We now eagerly await the return to shore of the field team. The Nevertheless should be making landfall in Flores sometime today.

1 Comment

28 aug A Community Victory at Sea

Posted by: Scott in: Atlantic Crossing

20 Years ago, Henry Stommel described the serene Nonamessett Mission Control Center for the fictional Slocum Mission.

http://tos.org/oceanography/issues/issue_archive/issue_pdfs/2_1/2.1_stommel.pdf

The last 22 hours were probably more like his initial control center crammed into the attic of the Bigelow Building at Woods Hole, the same attic I sat in to write my Ph.D. thesis. Several people predicted that the last 22 hours will make or break this mission. They were all correct.

First, we must thank the 6 people - 2 crew, 4 scientific party - that sailed on the Nevertheless out to The Scarlet Knight (a.k.a. RU27) to find out exactly what was going on. Their dedication and hard work, all within tight space and time constraints, answered the major remaining questions from last year's flight of RU17. Specifically, what organisms are growing on the glider, how many, and how do the different coatings work to protect us? With this information, we can begin designing the future global fleet of shallow Slocum gliders. From Rutgers, Tina, Chip, Dan and Dena made up the scientific party, Hans and his brother made up the crew. Duncan from Mid Atlantic Yacht Supply arranged the entire trip. Without their work, we would not be smiling tonight.

Second we thank the community that got us this far. It was Rutgers Alumni that provided the initial seed money. In various forms, this was matched by Teledyne Webb Research, NOAA, and Rutgers itself. The scientific community on both sides of the Atlantic has provided us with better weathermaps and roadmaps on where to fly. In the U.S., we use Oceanweather for winds and waves, the NOAA National Hurricane Center for tropical storms and hurricanes, Rutgers, UMaine and NASA for satellite SST and ocean color imagery, the University of Colorado for satellite altimetry, NRL and the HYCOM Consortium for ocean forecasts. From overseas, we use data from the University of Azores, the University of Las Palmas on Gran Canaria, and the Nansen Center in Bergen, Norway. Antonio has already sent his congrats to the field crew on the Nevertheless along with a the latest ocean color image and guidance on a route to help keep us barnacle free. The engineering community has built us an even better glider than last year. Teledyne Webb Research gets significant credit here. At the post-RU17 hotwash at Teledyne Webb in Falmouth last fall, we went over everything that went right and everything that we knew went wrong with RU17. That feedback loop to the manufacturer is critical

to the rapid transition of all gliders into the global fleets we are now building. To the core engineering work from Teledyne Webb, we add the improvements and additional testing of the lithium batteries by Electromchem, and the different antifouling coatings and guidance provided by Severn Marine Technologies, Mid Mountain Materials, and E-Paint. This year we know where to go, and RU27 has the power to get us there. We are still over 1 month ahead of the pace set by RU17 last year.

Lastly, we thank the full range of agencies that have supported the development of the COOLroom. Starting with a converted dive closet in a series of ONR-sponsored Coastal Predictive Skill Experiments at the Tuckerton field station in the late 1990s, it has evolved into the present main campus location that serves as the collaboratory for ongoing observing projects sponsored by federal (NOAA, DHS, NSF, ONR, DoD, NOPP, DoE, NASA....) and state (NJDEP, NJBPU) agencies and foundations (Moore, Vetlesen). The COOLroom was the communication hub for this trip, controling RU27 even while the divers were holding it, and calling in to every world expert we needed when we needed them for critical guidance. The COOLroom serves as the hub of activity for our growing list of collaborators at U.S. and international glider ports. In the very early part of this mission, there are the additional glider ports at UMass and UMaryland if we needed them for a quick abort. This specific flight uses international glider ports in Halifax with Dalhousie & Satlantic, the Azores and the Canaries. In fact, graduate students from the Azores and Canaries are joining us September 1 to spend a semester at Rutgers, learning how to fly gliders and helping with the final 1/3 of this mission. What we learn through collaborations with these glider ports is shared in collobarations with other glider ports in the Virgin Islands and Puerto Rico in the tropics, at Palmer Station in Antarctica, and Svalbard, Norway in the Arctic.

Today this growing international community of friendly collaborators earned itself a victory. The Scarlet Knight has been declared fit to fly. The COOLroom was like a NASA mission control center movie - “Clayton, fit to fly?”, “Fit to fly”, “Oscar, fit to fly?”, “Fit to fly”, “Dave, fit to fly?”, “Fit to fly”, ”Tina, she is fit to fly, pull your divers. Dave, send her down.” We are back on the mission and are continuing our journey, having never left the water during the 22 hour data gathering visit by the Nevertheless. Antonio’s email from this morning demonstrates the community is ready to continue and is on the job. In the final third of this mission, we will continue to encounter challenges along the way. Our international team grows more seasoned by the day, and has proven itself today by collecting the most important data of this mission - the biological fouling data on what works and what doesn’t on a shallow upper ocean glider.

We have a great victory to celebrate. RU27 has flown from U.S waters to European, and was just checked out for the final leg of its journey. We are heading east, and we have a new motto we have learned from our friends in the Canaries – Force wind and honour all.

Good luck RU27.

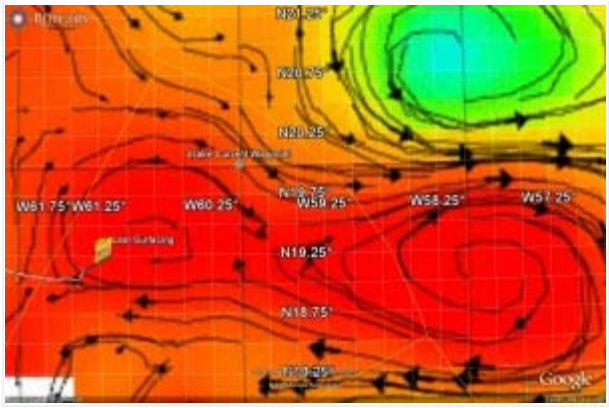
1 Comment

28 aug

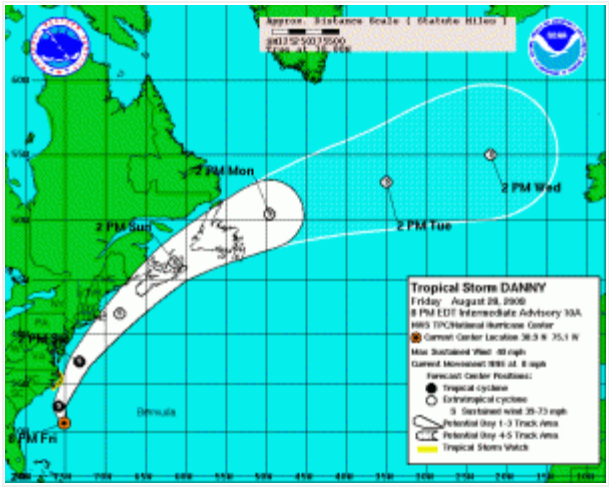
The Rutgers - Teledyne Webb Fleet is set for the night.

Posted by: Scott in: Atlantic Crossing, Thermal Glider Flight

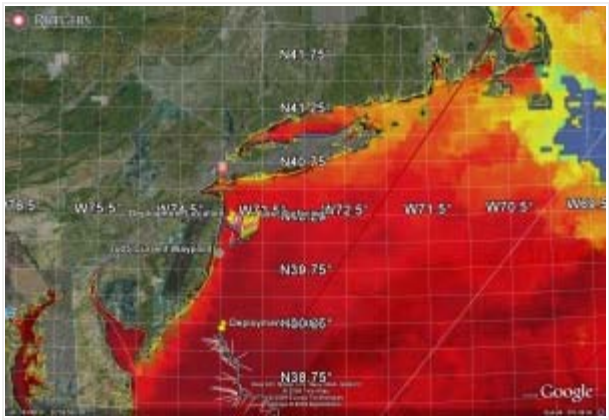
Drake, the deep thermal glider, is heading back out into the open North Atlantic from the Virgin Islands. There are two strong eddies in the altimetry, and Drake is heading for the strong current jet to the east that runs between the eddies along 20 N. Drakes waypoint was just reset, and it looks good.



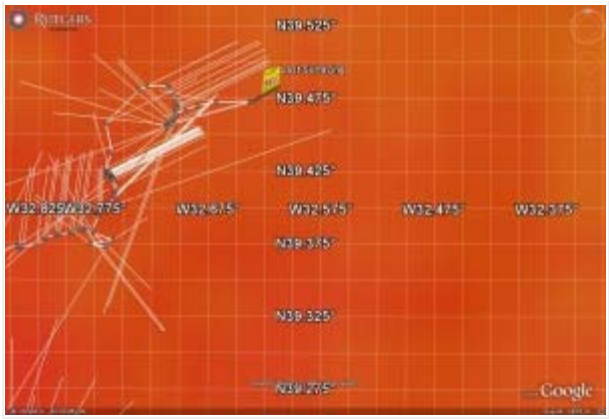
Back to the east coast of the U.S., Danny is heading up the coast, is currently south of Hatteras, and will be offshore NJ tomorrow afternoon.



RU05 is patroling the NJ inner shelf for the NJ Department of Environmental Protection. We'll turn RU05 offshore at midnight when it next surfaces to head for deeper water as the Danny passess.



And out of that jumble of surface positions and current vectors, RU27 emerges, heading east. Scarlet is on her first 8 hour segment since the Nevertheless arrived only yesterday.



0 Comments

28 aug

22 Hours Later - We're flying.

Posted by: Scott in: Atlantic Crossing

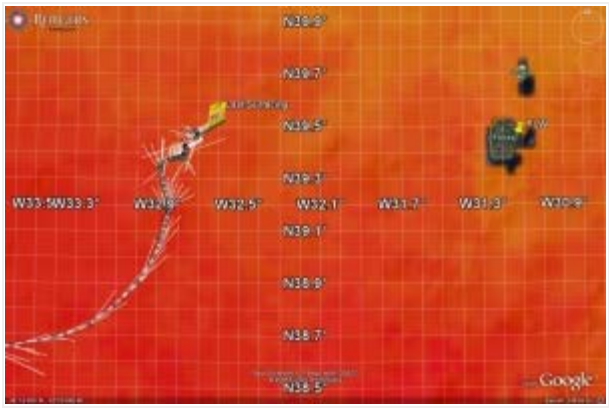
The Scarlet Knight is back. Great job by the Captain, Crew and Scientists on board the sailboat Nevertheless. Great call on the weather by Vince Cardone. Thanks to Clayton Jones at Teledyne Webb Research for keeping the audio line open to his office. And thanks to all the people that worked through it with us in the COOLroom.

Here's the story, picking up from where we left off last night with the field crew heading back to the Nevertheless for the night. With the divers back on board, we started a planned series of test dives, the first test to take 30 minutes. We sent RU27 down about 8:50 pm, expecting a call back by 9:20. The call never came. All we could assume was that for some reason, RU27 could not get back to the surface. But we knew she was a good climber. One thing we had not had a chance to blog about yet was the tuesday night scare we just experienced as the Nevertheless left the harbor in Faial. On Tuesday night, Scarlet was asscending from 150 m, and something held her motionless at a depth of 73 m for three minutes. This triggerred a reversal in direction, but at this depth, that pushes the pump in to fast, causing a back voltage, turning the pump off and then triggering an abort. The abort behavior brought Scarlet rocketing to the surface despite something trying to keep it at depth. But now, on thursday night she was overdue, down well past 30 minutes, and well after the short 3 minute time period for being held at depth had long expired. Our next oppurtunity was at 90 minutes, with an abort triggered by no communications. It was a long hour waiting, but once again, Scarlet proved herself and called in after the 90 minute time had expired. We downloaded the files, and to our surprize, it had no subsurface data in the file. The glider could not dive. it was late, we were getting tired, the field crew was trying to sleep, so we set it to drift for the night.

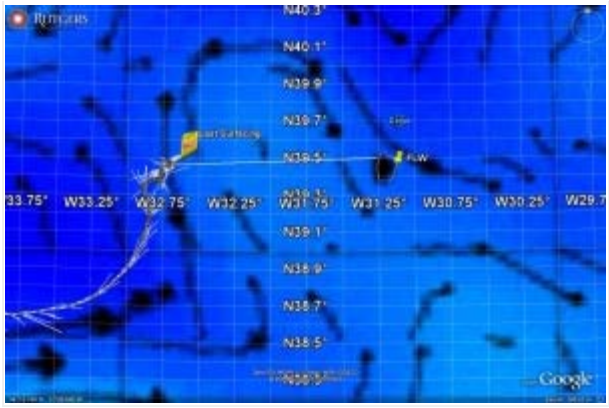
In the morning the divers tied a rope and float around the tail as a safety device. We commonly use these on the initial test run of any glider - just in case. We tried to get it to dive, and it couldn't. Had we lost weight? We added a standard pick point to the top that weights 70 grams. The pick point couldn't get it to dive. Wind was increasing and so were the seas. Tina cut some lead strips and Chip wrapped 150 grams of lead around the pick point. If this didn't work, she would have to come out of the water and back to shore, ending the mission. Dave set it to dive, and we all listened to Tina's play by play over Iridium. Finally, after 4 very long minutes of set up, Scarlet started its first dive since she was inspected by the divers. Down to 15 m and back. We had established the most important fact - the glider worked. We just had to find the proper ballast point while she was in the water at sea. Normally Dave does this in the lab, and we ballast to within a gram or two. Now, at sea, we knew our ballast point had changed after the barnacles were removed, but all we knew was 220 grams was too much, and 0 grams was too little. And time was running out. Wind had picked up to over 10 knots, seas

were building, and we had less than 2 hours left on site. Again, we were faced with an important decision. We could put the divers in one more time. If the test worked, we could continue flying. If it didn't, we would have to pull the divers and the glider up onto the boat and head back to shore for the proper ballasting. Clayton was on the phone with Dave, Oscar and me. We went through every scenario possible and its consequences. The final decision, after consulting with the field crew, is that there is no way we had 220 grams of barbacles on the glider, and that all the zincs were intact. The 220 grams of ballast required to get the glider to submerge was also the weight required to work against the rope holding the surface float. With that theory, we told the divers to remove the 150 grams of lead, remove the rope, and leave the pickpoint. If we gambled wrong with too much weight, the glider sinks to its crush depth and blows the emergency weight. Too little weight and we don't fly. We decided 70 grams was our best option. Dave gave the command, Tina gave the play-by-play. If it didn't sink, we were done. If it sank to fast, we were done. Tina called out every wave that sloshed over the glider, and every move - the air bag deflates, the nose goes down, and it sunk beneath the waves. We got the first half right. Tina saw it go out of site, the divers following it down, filming all the way. Now if we can get back to the surface. Tina starts calling out she can see them again. They are getting closer to the surface. The glider came back up. They saw it inflate the airbag, and the phone rang in the COOLroom. We just completed our first untethered dive since the inspection. Dave started downloading the files. The divers are at the surface. Winds and waves picking up. The data plot shows 12 cm/sec down, 15 cm/sec up, a small difference we can deal with, and the pitch was only 20 degrees. We can increase the pitch to build the speed. We are good to go. The divers want to see one more dive. Dave sends it. A perfect dive, filmed from start to finish. Tina pulls the divers on board. Dave sets the glider to a deeper depth, and a steeper pitch. The Nevertheless heads for Flores at 11:15, just 22 hours after sighting RU27, and before the weather hits. The glider comes up, reporting vertical speeds up to 30 cm/sec. She's clean, and fast again. Track plots say she is holding a course within a few degrees. We can fix that with a small fin offset, just like in April. Scarlet is back, and still fast.

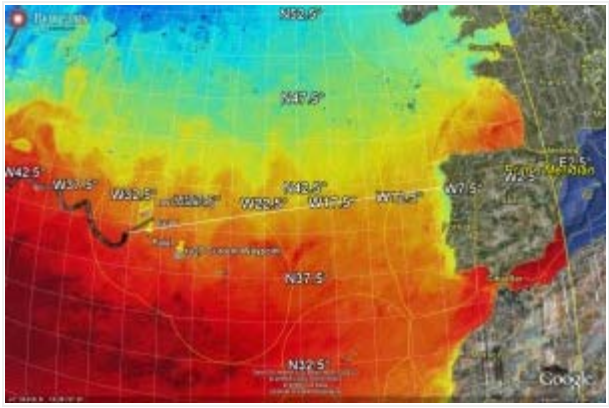
Here's our location, about 80 nautical miles from Flores. Nevertheless should be back in port tomorrow morning.



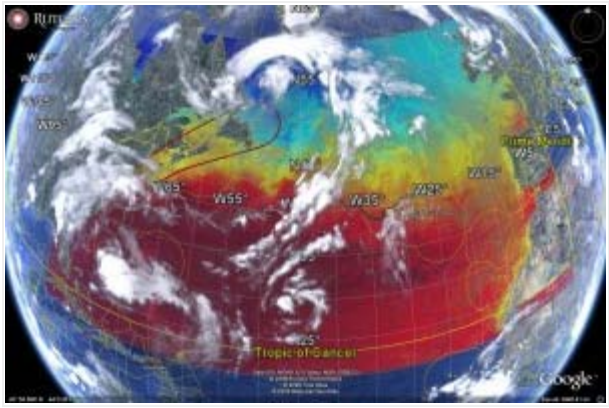
The altimetry says we have a loop in the current that then heads to Flores. We changed the waypoint to Flores, and will try to make this loop.



2000 km exactly to the border between Spain and Portugal.



Hurricane Danny is heading up the eastcoast, and will be crossing over Newfoundland on monday.



We found the best 22 hours we could find to be on site. The field crew did an amazing. The distributed shore support provided the guidance that was needed. All enabled by the communication network, and all before lunch. Another day in the COOLroom. And Scarlet is flying.

2 Comments

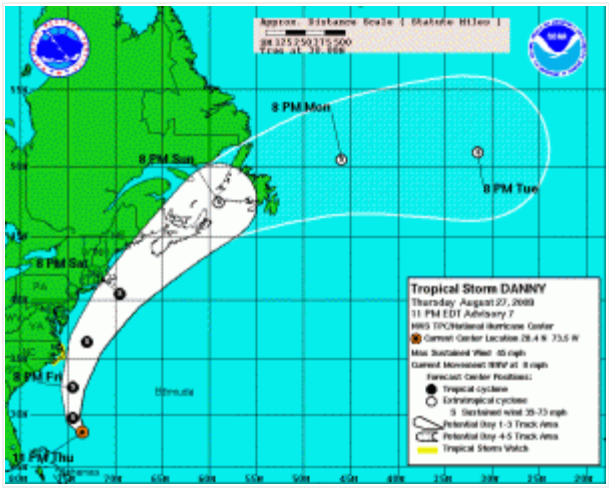
28 aug

Tomorrow begins at 6 am east coast time.

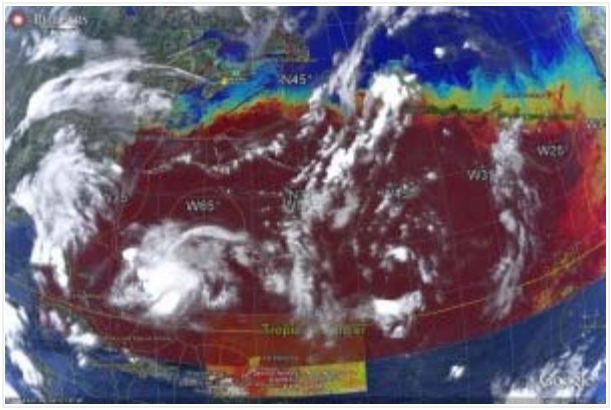
Posted by: Scott in: Atlantic Crossing

Hurricane Alley. First Bill, now Danny. Same path. Vince Cardone at Oceanweather

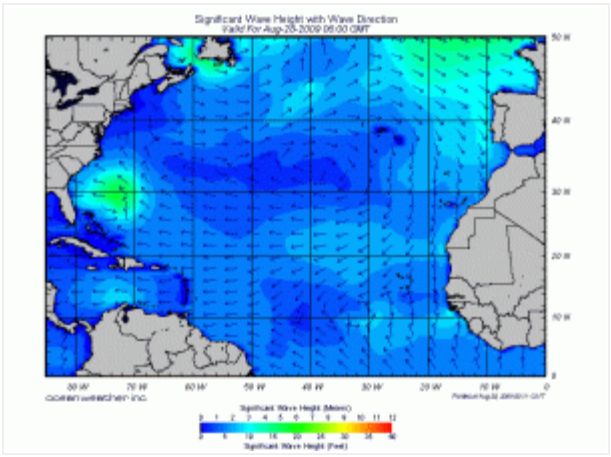
called this one spot on. He said wait for Bill to pass, then get out to The Scarlet Knight and back again before the next hurricane forms. Hurricane Center forecast has Danny up in Newfoundland on Sunday, about the time the Nevertheless should be pulling into Flores.



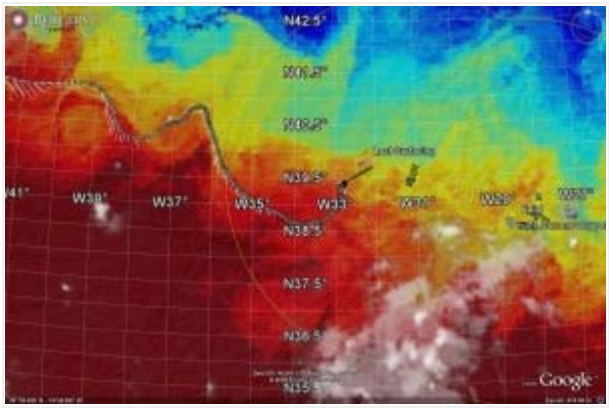
Hurricane Center says satellite shots show Danny's circulation is not well organized, and it may have already transitioned to extratropical. Looks disorgnanized in google earth too.



Waves are big with Bill near the U.K., and big with Danny near the U.S., but smaller in the central gyre of the North Atlantic.



The Nevertheless looks like it is getting good clear weather in between the clouds. First quarter moon tonight, if they are up. Boat crew had a long day.



Its been a long day both at sea and on shore. Nevertheless meet up with The Scarlet Knight (RU27) just after 1 pm east coast time today, August 27. Thats exactly 1 month from the launch date, nearly to the hour, and 5,330 km from the launch point off the Nee Jersey coast. As they approached, Tina relayed the play by play over the Iridium phone. Barnacles was the problem. The yellow body of the vehicle was clean, thanks to Hank Loeb's coating. The barnacles were found attached to the the small seam between each glider piece and the connector rings. Just touching the barnacles made them all off, we presume because of the coatings and the less than a millimeter thick seam between glider pieces. And there was a small cresent of barnacles above the buoyancy pump. First we did a still photo survey, then a video survey of the glider as found. Then we did a series of three dives where the divers followed the glider down and back up, watching the fin trying to compensate for the drag to the right. We then did a full inspection of the exterior of the vehicle while it was there. Most barnacles were brushed off through the inspection process. All looks good on the glider but everyone is tired. We'll regroup in the morning. Broadcast starts about 6 am. Time for sleep.

http://rucool.marine.rutgers.edu/index.php/COOL-Room-Web-Cam/COOL-Room-Web-Cam.html

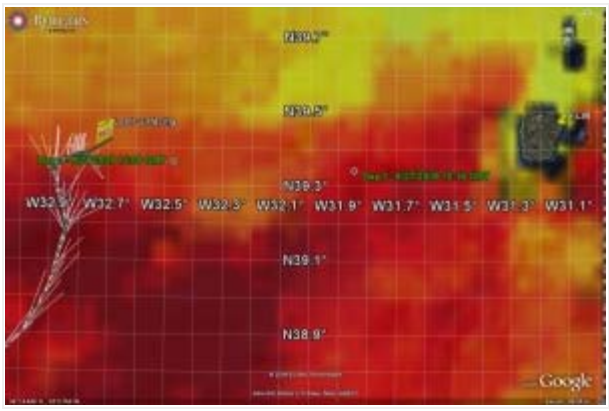
0 Comments

27 aug

14 nautical miles to go

Posted by: Scott in: Atlantic Crossing

Spirits are running high on the Nevertheless. Winds are down to 6 knots. No wind sea. They are speeding up. Only 14 nautical miles to go. They'll be there by 1 or 1:30 our time.



http://rucool.marine.rutgers.edu/index.php/COOL-Room-Web-Cam/COOL-Room-Web-Cam.html

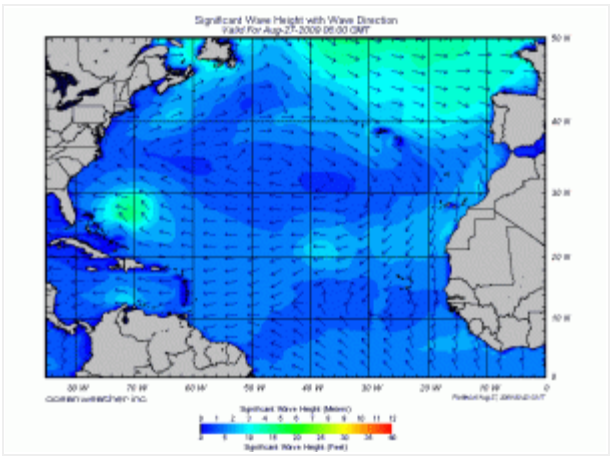
RU27 just surfaced. Dave switched over to single yos. 90 minute no comms call back for all you glider fans. Nevertheless will call in between 12:15 and 12:30.

4 Comments

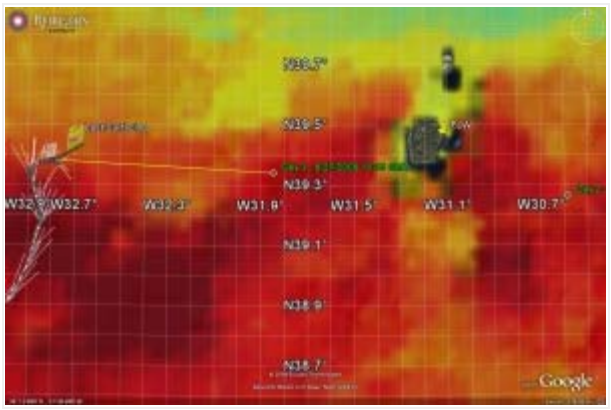
27 aug | Winds Low, Spirits High

Posted by: Scott in: Atlantic Crossing

Tina just called in for their morning report from the sailboat Nevertheless. They made better progress during the night - their speed is up to 5 knots. The report back is that winds are low and spirits are high. People are feeling better on day 2, and Chip is making his dive plans. The Oceanweather wave forecast below has the region of higher waves following the remants of Bill heading northeast towards the U.K., leaving calmer seas for us.



Plotting their current position below, we see the Nevertheless is just under 45 nautical miles from RU27. Maintaining 5 knots gets them in position about 9 hours after their last report. That works out to about 19:00 GMT, or 3 pm our time. If this holds, they'll get their first look at RU27 during daylight hours today, August 27.



Looks like there will be a lot of activity at noon today. Scarlet will surface and we'll put her on short mission segments to wait for Chip to pick her up on the Freewave radio modem. We'll turn the sound feed from the COOLroom on for the 12 noon call in and just leave it on as we approach Scarlet for this first encounter after exactly 4 months at sea. Follow along at:

http://rucool.marine.rutgers.edu/index.php/COOL-Room-Web-Cam/COOL-Room-Web-Cam.html

Good luck Nevertheless.

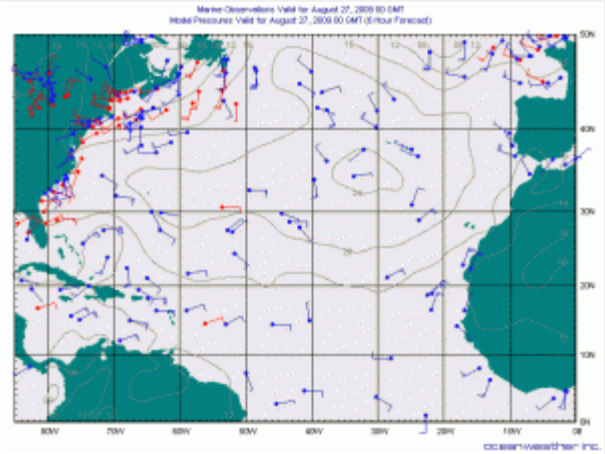
1 Comment

27 aug

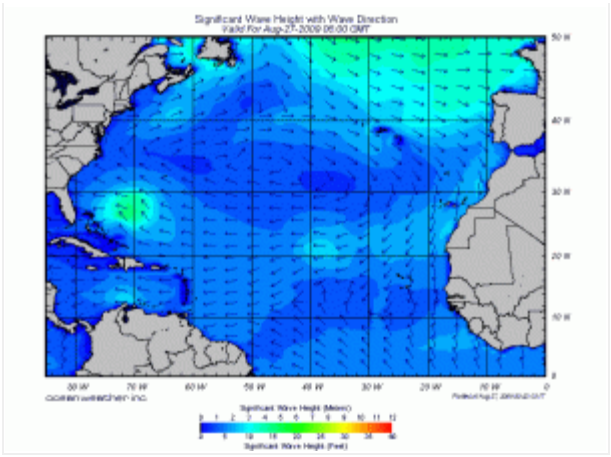
A warm welcome, and then the waves.

Posted by: Scott in: Atlantic Crossing

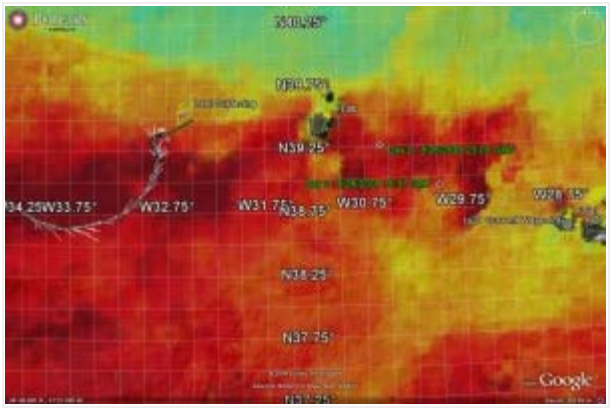
Our field team arrived in the Azores tuesday afternoon. Four people, hand picked for the trip. Tina is the marine biologist, having spent time working on the Ocean Biogeographic Information System (OBIS) at Rutgers before joining the COOL group. Her weekly summaries appear on the transatlantic webpage. We want Tina's eyes on the glider to deterime what kind of organisms we are dealing with. Dan is the underwater photographer. He will be taking video of the glider and the biology it is now carrying. Chip is also from the COOLgroup, and is probably our most experienced field tech, traveling all over the world on glider and CODAR deployments. Chip is a diver with glider experience, so his main job cleaning this glider so it is fit to fly. Dena films and produces documentaries. She is the fourth member of the team and will do all the topside video. The team was welcomed at the airport, taxied over to Mid-Altantic Yachts with all their luggage, and the transatlantic sailboat Nevertheless was loaded. Dinner on shore then off to sea from Faial at dusk.



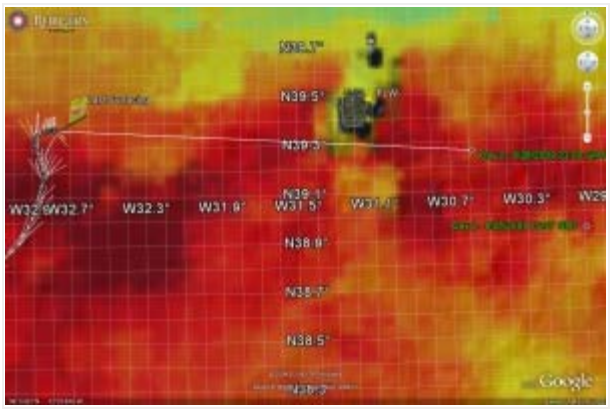
Wednesday proved to be a longer day than expected. Winds were from the west and building a 3-4 foot shorth period windsea. They also had the decaying 9 foot, long period swell from the remants of Bill. Oceanweather's wave maps indecated they were right on the boarder between the larger waves to the northeast and the calmer seas of the central North Atlantic to the south.



Heading into the wind and windsea slowed the progress of the Nevertheless. Typcial cruising speed of 8 knots was cut in half to about 4 knots. Tina called in from the boat over the Iridium satellite phone, the same system The Scarlet Knight uses, with regular position updates. Their spirits are up, but you can tell they are experiencing that first day at sea when you are still getting your sealegs.



Zooming in, the Nevetheless was exactly 100 nautical miles away from The Scarlet Knight at dusk on Wednesday evening. If they continue cruising at 4 knots, they meet up with Scarlet sometime around nightfall on Thursday night. That means all dive operations will be postponed till Friday morning. The 8 am to noon window Azores time is 4 am to 8 am U.S. East Coast time. We'll be in the COOLroom, and will again turn on the audio feed to the webcam. Chip will use the time thursday night that they are near the glider but can't dive on it to download data.



The Nevertheless has scheduled another noon call in for today (Thursday). We'll know how they are doing, get a wind and wave report, a position update, and

resetimate the time they'll get on site. Present plans for adding the live audio feed are noon to 1 pm thursday and 4 am to 8 am friday. Website is:

http://rucool.marine.rutgers.edu/index.php/COOL-Room-Web-Cam/COOL-Room-Web-Cam.html

0 Comments

26 aug | Live, From The Azores, ...

Posted by: Scott in: Atlantic Crossing

We are turning on the audio feed to the COOLroom webcam intermittently over the next few days. We expect a call in from the Research Vessel NeverTheLess today about noon U.S. East Coast time. You can hear what we hear by logging on to the webpage below and turning up your volume.

http://rucool.marine.rutgers.edu/index.php/COOL-Room-Web-Cam/COOL-Room-Web-Cam.html

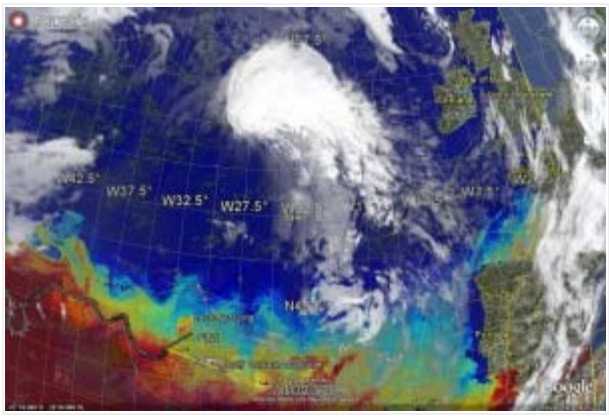
We'll see how it works.

0 Comments

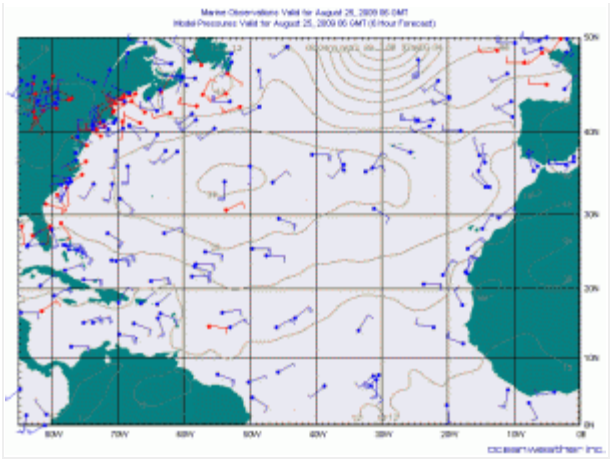
25 aug | Goodbye to Bill

Posted by: Scott in: Atlantic Crossing

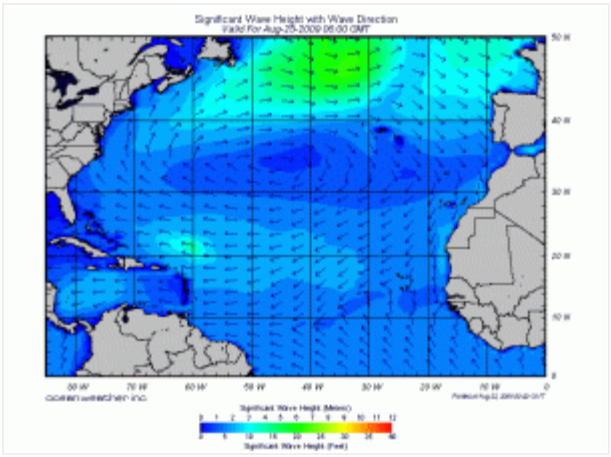
The National Hurricane Center has stopped issuing Tropical Storm Advisories on Bill. The storm passed well to the north of RU27, and continues to head towards the United Kingdom. Back here in New Jersey, Bill dropped a lot of rain. Mostly street flooding and downed branches and power lines. Driving in to Rutgers I noticed the road up the hill to Charles Lindbergh's old house was closed - must of had more damage.



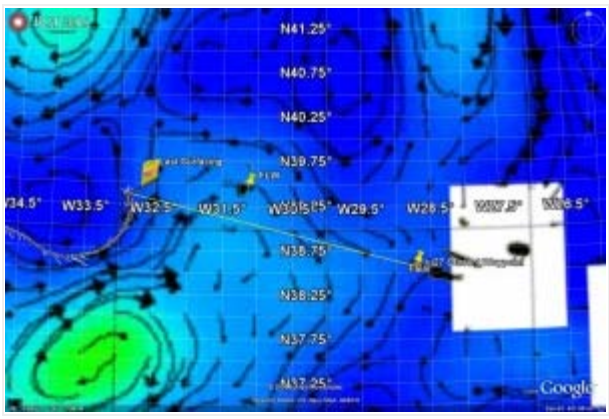
Here is the atmospheric pressure pattern and the ship observations of the winds from Oceanweather. We see the large basin-scale high pressure system over the North Atlantic, with winds running about 10 knots south of the storm near the Azores.



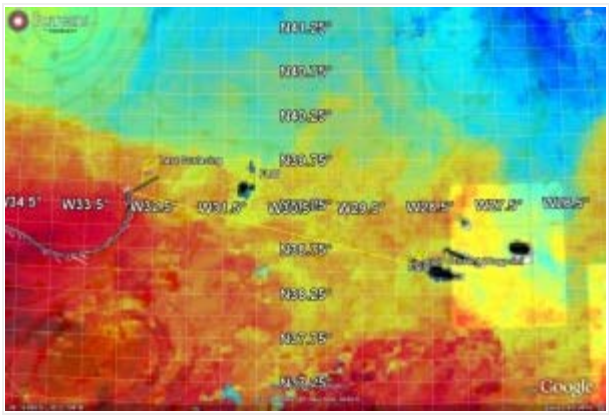
Looking at Oceanweather's wave forecast, the high wave activity is moving across the Atlantic with the storm, staying north of the Azores. Seas are currently about 7-8 ft in the vicinity of RU27. They are expected to decrease as Bill continues to head towards the U.K. Before leaving for the Azores, we checked in with Vince Cardone at Oceanweather about the cruise plan to visit RU27. In talking with Vince, we decided the plan would be to wait for Bill to move east past the Azores, then to head out on the boat immediately after the storm as the seas were dropping, and before anything else develops in the Canaries.



Zooming into the location of RU27, we are currently 370 kilometers, or 200 nautical miles from Faial. Assuming a conservative speed of 6 knots, thats about 33 hours of sailing. If we leave Faial later tonight (August 25), it means we arrive on August 27, exactly 4 months after RU27 was deployed on April 27th.



A quick look at the satellite imagery says we are still in the 23-24C water, about 73-75 degrees F. Not too cold for the divers, but they'll need a bit of a wet suit if they plan on spending some time in the water.



1 Comment

24 aug

RU27 spins, Drake cruises in uncertain oceans, and the COOL family is great!

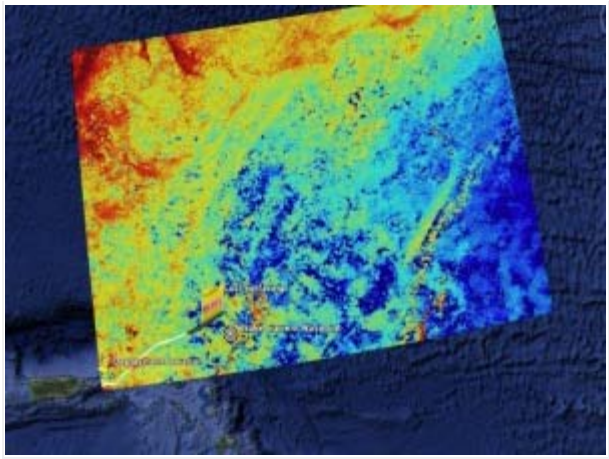
Posted by: Oscar in: Atlantic Crossing, Thermal Glider Flight

Life in the COOL room is always intense. Today was a typical day, and while it sounds like I am complaining, I am not. I am addicted to it. That probablly does not say much positive about me, but know what you are and enjoy the ride!

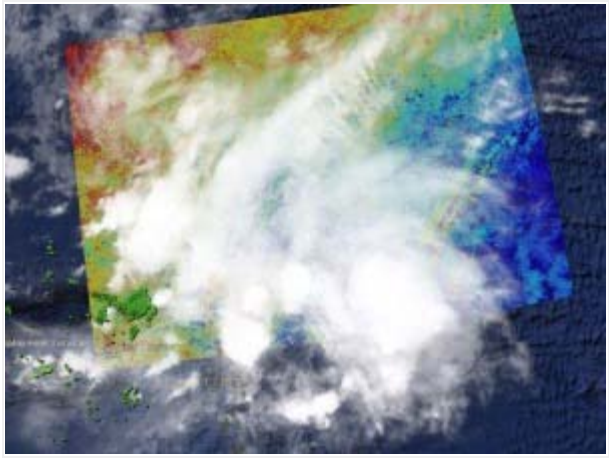
Drake is heading due East which is awesome given the confused currents in our current position (see below)! There is nothing like a clean deep water flying glider! Man, compared to the headaches of a bio-fouled 200 m Scarlett, Drake is cruising. Of course Scarlett has been to sea almost 4 months and has set the world's distance record, and while RU27 may be limping tonight, this afternoon a RUCOOL team was dispatched, a small group but the best, to snag some photos ofRU27 as she continues her underwater to Europe. Regardless we do stop tonight to appreciate Scarlett has reached European waters! As our Spanish partners would say tonight we raise our beers to our field team heading to sea "**Force Wind and Honor All**"!

While that was going on, we had a more local issue to deal with. RU05 was a Rutgers glider we deployed with the NJ State of Department Environmental Protection (DEP) last week. It was cruising off the NJ coast surveying the coastal water quality over the weekend, demonstrating how this technology can benefit the State needs. We were cruising and encountered a well-meaning fishermen who spotted her. There was an old deployment date on the side of the glider and like all the fishermen off New Jersey, he was great and COOL, and rescued an asset from our group he thought was in trouble. He called once back onshore, and our the CODAR team was in the neck of the woods working on shore sites and swung and retrieved the glider. It will be dusted off and redeployed this week and meet up with State DEP vessels. So we tonight we also toast the State DEP for partnership and the NJ fishing community who always got our backs! "**Force Wind and Honor All**"

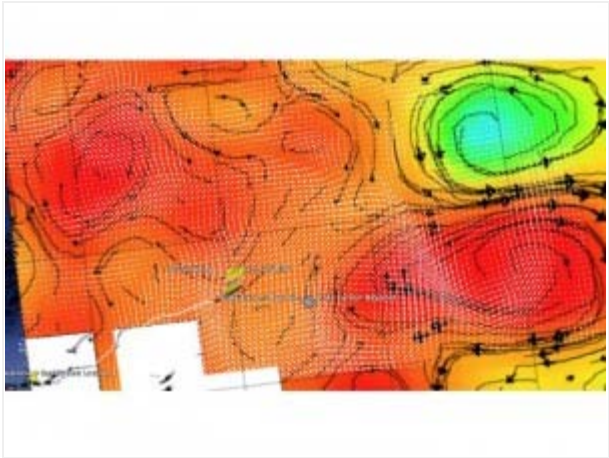
Meanwhile Drake continues heading East. The SST looks, weird. Is it cold like the satellites say?



It is not, there is unfortunate cloud cover that clearly has contaminated the imagery.



So lets compare the HYCOMM forecast (white arrows below) and altimetry (colors and black arrows), this will blaze a clear path! Unfortunately while there are many agreements in the these data sets, there MANY discrepancies. Drake will have to sort the right data sets in the coming days, but given the due east heading the glider we are cool. So we will reconcile the discrepancies in the coming days.



But in all the chaos, there are times you stop and feel good. Our COOL group, and all the assocaited partners from Teledyne Webb/CODAR/Satlantic/SeaSpace, and our priceless academic partners are a large wonderful crazy family. Tonight we celebrate as our COOL family is bigger as we welcome Riley to our chaos! We also

toast Courtney and Josh who are two the people who allow the rest of us to be crazy. Josh and Courtney are central to our team and without them well we would suck. The Kohut family is central to us and tonight we celebrate their new family member! "**Force Wind and Honor All**"

0 Comments

24 aug

The Boat

Posted by: Scott in: Atlantic Crossing

Its Sunday night. We have assembled a dive team to check out what is growing on The Scarlet Knight. The information they will collect is invaluable. We need to know what surfaces are getting fouled, and which ones, if any, are still clean. One plan for basin-scale monitoring of the ocean is to use Argo drifters for the deep (1000 m) data they collect every 10 days, and use gliders in the more rapidly changing upper ocean where they can fly into and out of eddies and across fronts, and where they can respond to changes and sample on the more rapid times scales of the weather. To implement upper ocean gliders in a basin-scale network, we need to know what we can do to keep them clean.

The away team leaves tomorrow night for the Azores. They fly Newark to Lisbon, than back to Horta on Faial. The rest of us stay behind and monitor the glider condition from the COOLroom.

http://rucool.marine.rutgers.edu/index.php/COOL-Room-Web-Cam/COOL-Room-Web-Cam.html

The University of Azores large research vessel is already at sea on an experiment, so we went to our friend Duncan Sweet at Mid-Atlantic Yacht Services to see if he could find us a charter.

http://www.midatlanticyachtservices.com/

The 54 ft sailboat is called Nevertheless. The plan is to arrive by plane in Horta on tuesday afternoon, and depart on the boat later on tuesday evening.

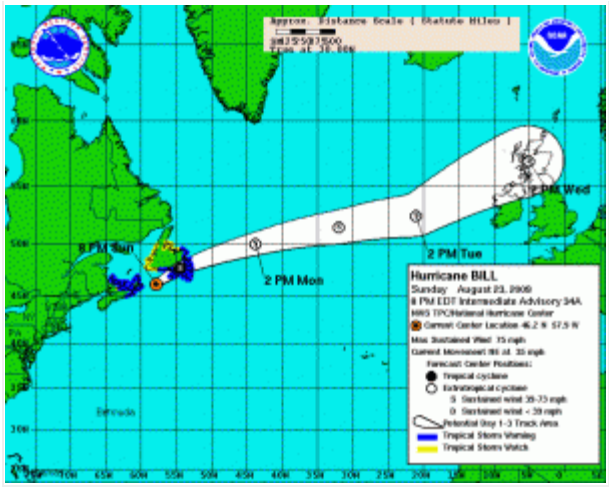
3 Comments

23 aug

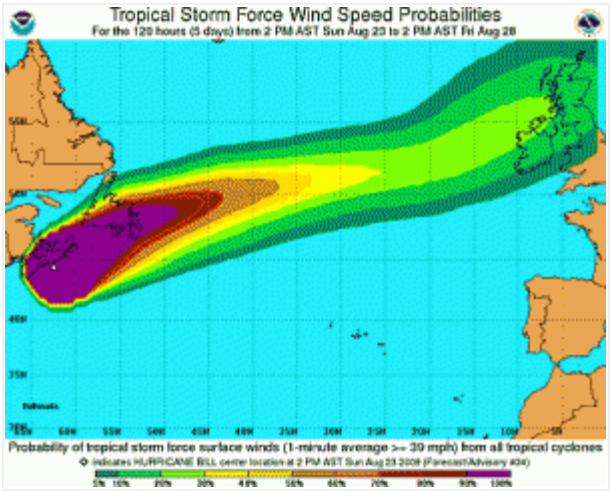
Bill Update - Sunday Night

Posted by: Scott in: Atlantic Crossing

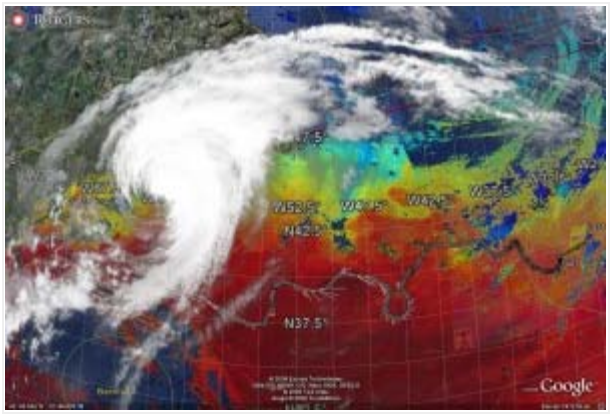
Bill is still a hurricane, with winds down to about 65 knots as it heads towards Newfoundland. It continues along this track, well north of the Azores, until 2 pm Tuesday, when it turns left, interacting with what will be a larger low pressure system over Iceland.



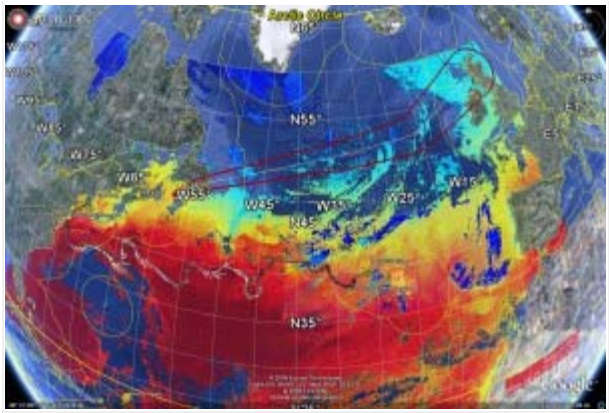
Winds diminish along this track, with tropical storm force wind probabilities also remaining well north of the Azores.



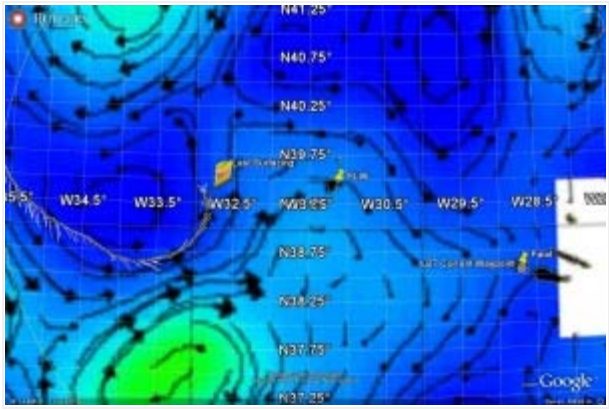
Bill has begun its extratropical transition, with upper level winds expanding out to the north and east. The cloud tops span nearly the full distance from RU05 off the NJ shore to RU27 off the Azores. Transition is expected to take another 12 to 24 hours.



Forecast track compared to RU27 keeps Bill well to the north. Closest approach is 1300 km about monday night.



Zooming in on The Scarlet Knight in the altimetry, we are in the region of northward currents and are slowing the branch point to the north.



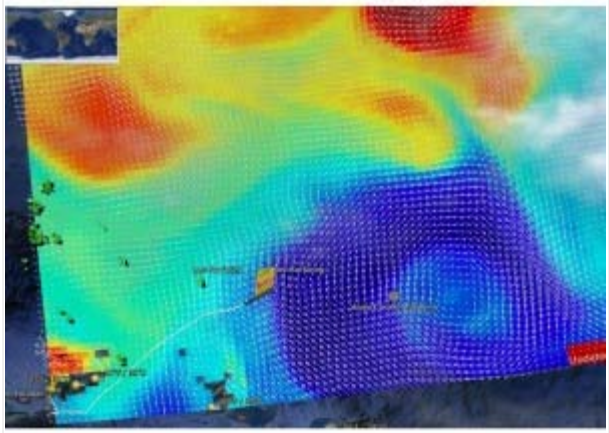
0 Comments

22 aug Head East and shoot the GAP!

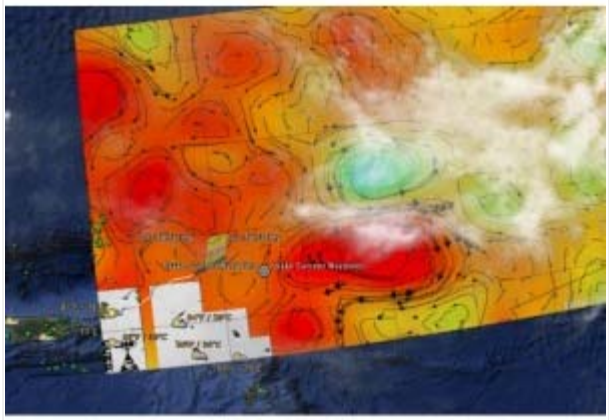
Posted by: Oscar in: Atlantic Crossing, Thermal Glider Flight

Drake survived the edge of Hurricane Bill. The HYCOM model forecasts and altimetry clearly show us our path for the next few days. The HYCOM forecast compares well with altimetry, so head east , shoot the gap and then surf East out into the deep Atlantic ocean.

The HYCOM forcast shows two large eddys rotating in opposite directions. Our goal is to shoot the gap in-between these eddys. Given this, we will head East we should be able to catch the current which will push us north and then eventually we will swing, be sucked, east.



Drake's progress is good and we are feeling good this weekend for the way point due east. Only a weeek in and already a Hurricane. It is going to be a fun long journey!



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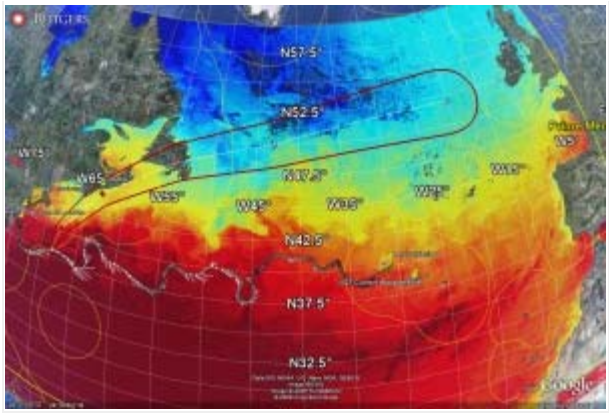
22 aug

Update on Bill

Posted by: Scott in: Atlantic Crossing

NOAA National Hurricane Center updated track and forecast for Hurricane Bill has it completing its extratropical transition by the time it passes Newfoundland. The remnants then move rapidly eastward back across the Atlantic, passing over 1300 km north of RU27 and being well east of our location by 2 pm tuesday. We are thinking a tuesday night departure from Faial is still a good plan.

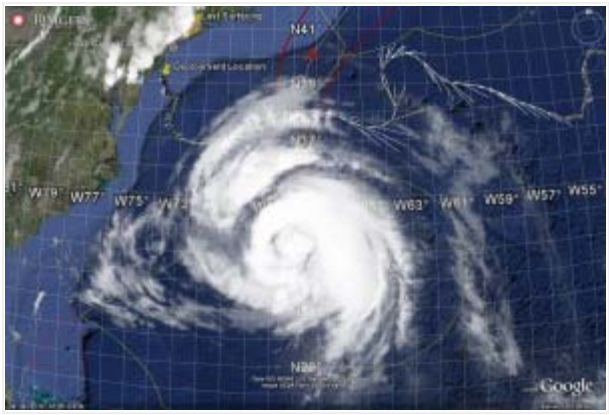


0 Comments

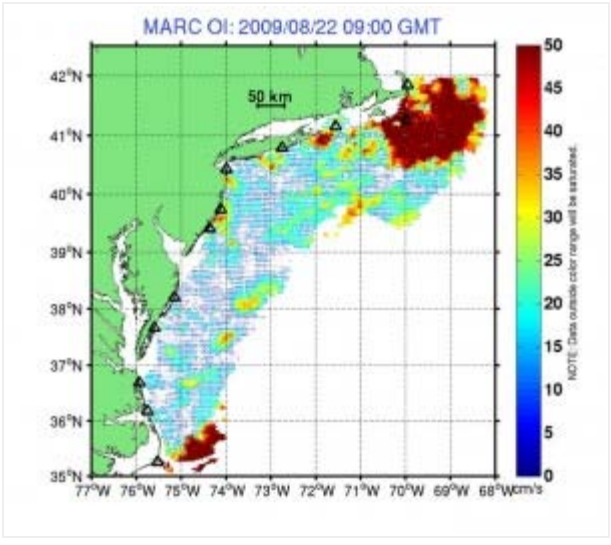
22 aug | Weekend update for cruise prep

Posted by: Scott in: Atlantic Crossing

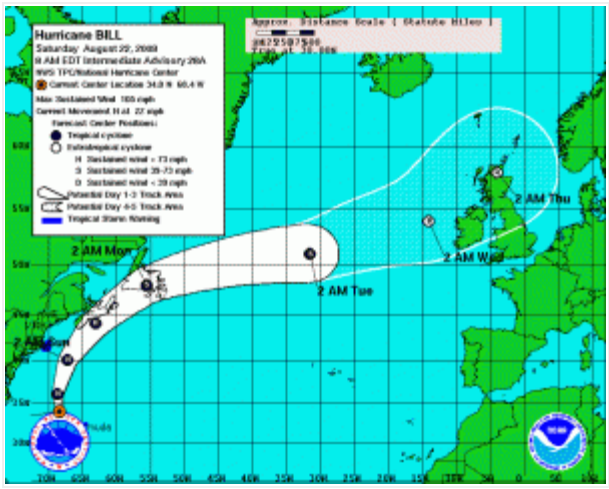
Hurricane Bill is over Bremuda, east of Cape Hatteras and offshore.



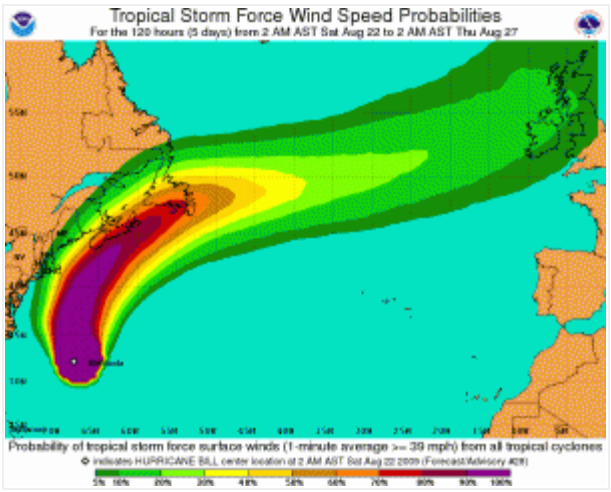
In preparation, the MACOORA HF Radar group went all out and got the full Mid-Atlantic Network up and online for the storm. You can follow along at http://marine.rutgers.edu/~codaradm/hfr_viewer.php



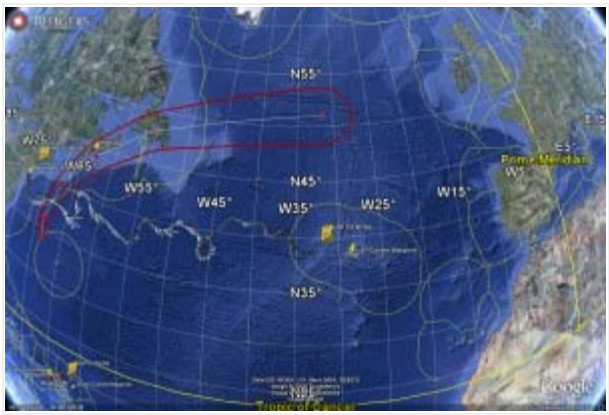
Hurricane Bill is heading north and is expected to remain offshore the U.S., passing over our friends in Halifax on Sunday around 2 pm. National Hurricane Center expects extratropical transition to begin early monday morning and be complete by tuesday morning, with the extratropical remnants weakening as it recrosses the Atlantic. Forecasters then have it turning more towards the north and slowing down as it reaches the United Kingdom wednesday.



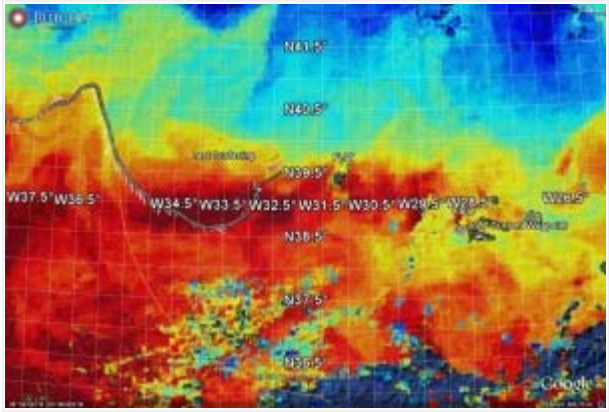
Tropical storm winds remain well north of the Azores, so it will only be the waves that we will be worried about.



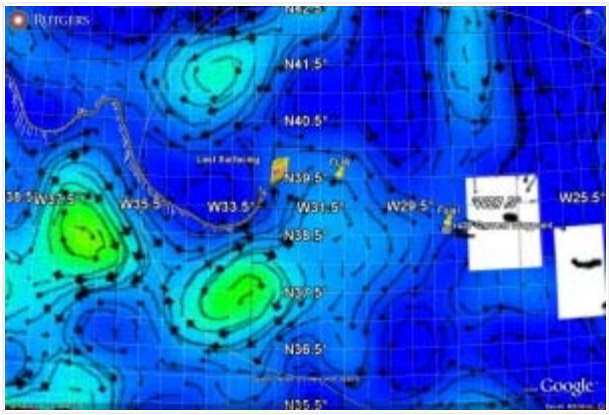
Bill is forecast to pass 1,300 km north of RU27 at 2 am on Tuesday. Our plan is to leave Faial tuesday night after the storm has passed by. Wednesday is a transit day, allowing any seas to subside. Arrive on site on thursday morning.



RU27 is heading north, approaching the strong front in the SST about 70 km to our north. We are moving about 8-10 km per day, so in about 5 days, we'll be almost up to the front.



Geostrophic currents from the altimeter indicate we presently are in a northward flowing current, and as we approach the SST front, the current splits into two branches, one heading east, the other heading west. We are eexactly in the middle of the flow heading towards the branch point. The recent curvature in the path of RU27 appears that we are favoring the branch that heads back to the west.



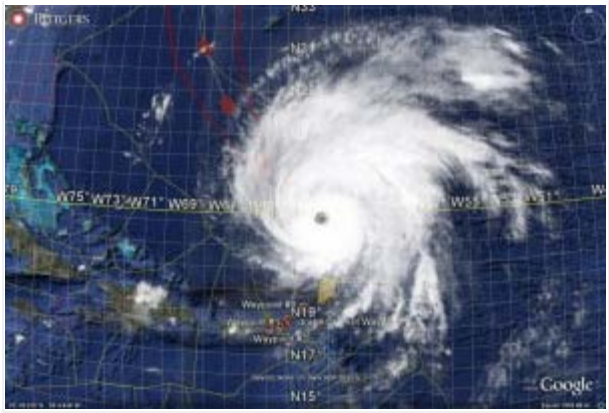
0 Comments

20 aug

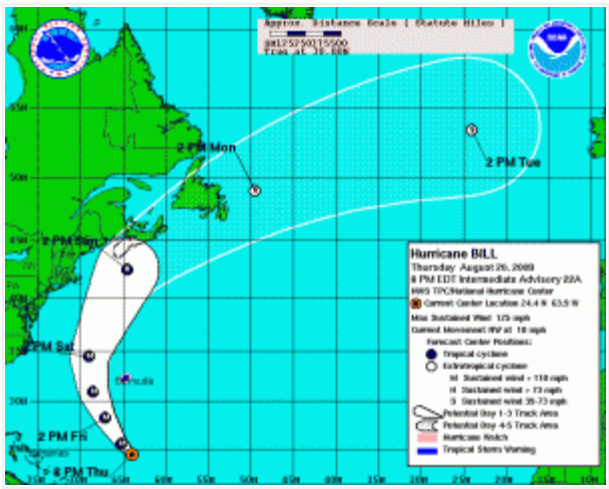
Hurricane Bill

Posted by: Scott in: Atlantic Crossing, Thermal Glider Flight

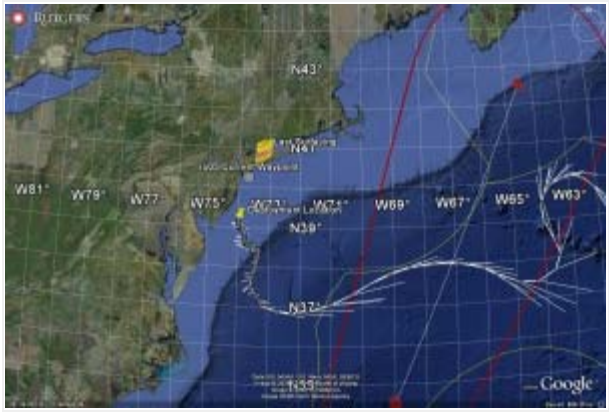
Hurricane Bill tracked just north of Teledyne Webb Research's thermal glider Drake. Over the last few days Glider Drake was heading northeast towards the track of Bill. Now that Bill has passed, Drake is heading east towards a pair of eddies we see in the altimetry.



Bill is forecast the curve north, missing the U.S. east coast as it passes to the west of Bermuda. NOAA National Hurricane Center reports Bill is approaching the warmest water its seen so far, so it is expected to again strengthen to Category 4. Oscar just sent us an email indicating NOAA is also reporting the world just set a new record for ocean temperatures
http://news.yahoo.com/s/ap/20090820/ap_on_sc/us_sci_warm_oceans

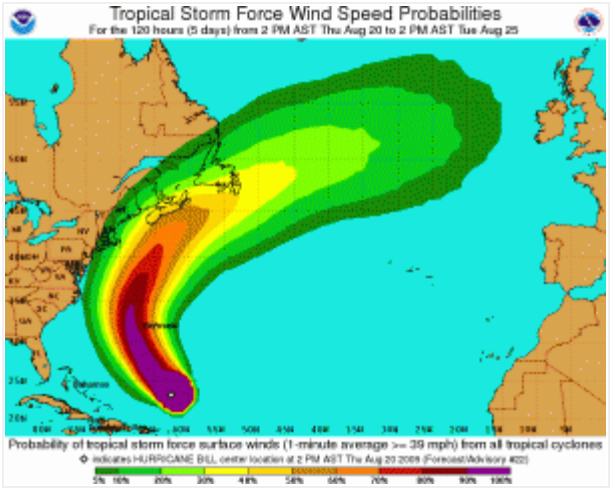


With Bill heading north along the east coast, we put RU05 in the water today, sending it out of New York Harbor and onto the shelf. RU05 is a veteran Teledyne Webb Research glider from our initial purchase in 2003. Its seen action everywhere from the Antarctic to the Tropics. Today is heads out on an Oxygen sampling mission for the New Jersey Depertment of Environmental Protection. It will also be offshore, ready in case Bill heads our way.

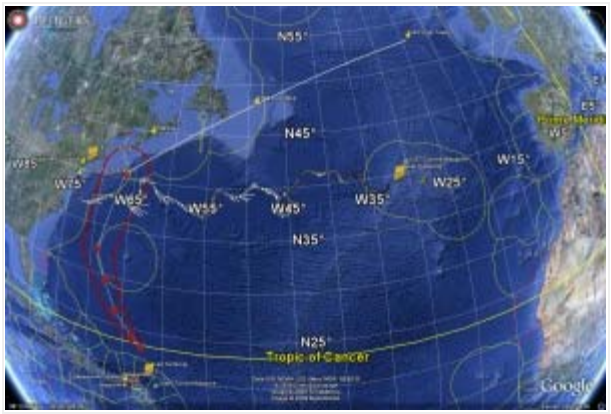


Even further downstream we see the Tropical force winds are forecast to remain

well north of the Azores and RU27. If the track changes, we'll also be there to catch the effect on Bill on the northern waters.



Looking at where we expect Bill to be next week, we see the forecast has it arriving in the United Kingdom sometime tuesday night. We were planning a boat trip from the Faial to RU27. Originally we planned to leave Monday morning, but that would put us at RU27 about the same time as Bill's closest approach. Our friends in the Azores have said we'll be fine, but just in case, we'll delay by 36 hours and wait till Tuesday night after Bill has made landfall in Europe before heading out.



0 Comments

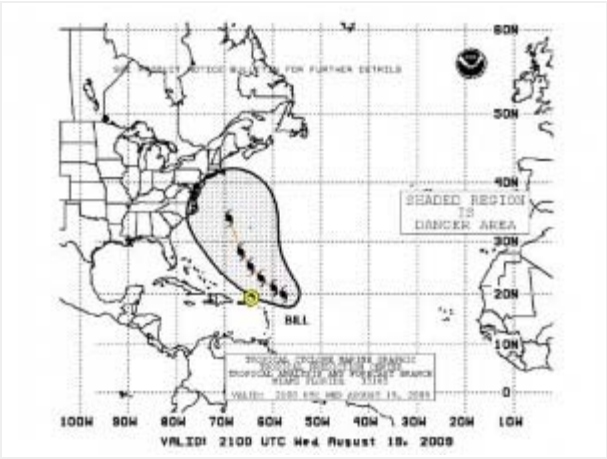
19 aug

Bill in Carribean, coming soon to the North Atlantic

Posted by: Oscar in: Atlantic Crossing

Pictured above is the USN Trenton as it is being dragged during a Hurricane. Being New Jersey proud I figured it was an appropiate opening as tonight Scarlet continues her spinning waltz and Drake is surfing-riding out Hurricane Bill (below). Both gliders will be impacted by Bill, Drake today and tonight, and Scarlett will have her turn maybe by late next week.

Scarlett was the focus of much discussion the last few days. And the team continues test after test to improve steering. This is scary given goal of Drake to follow the blazing historical path of Scarlett. We will be choosing the next waypoint for the Drake tomorrow, tonight we see how it handles the Category 4 storm. So far the path of the glider has been remarkabley straight, but the next call in will be the key. Of course with a storm this size, we just hope for a call in given Drake is on the border of the “Danger zone” of the Hurricane tonight as determined by the National Hurricane Center.



The “Danger Zone” is often defined by the Mariners’ 1-2-3 Rule and is highlighted in the shaded area in the map above. The 1-2-3 Rule refers to the rounded long-term NHC forecast errors of 100-200-300 nautical miles at 24-48-72 hours, respectively. The contour defining the shaded area is constructed by accounting for those errors and then broadened further to reflect the maximum tropical storm force (34 knot) wind radii forecast at each of those times by the NHC. In these zones, users are advised to continually monitor the latest Forecast/Advisories from the NHC and proceed at their own risk. Tonight Drake is operating at its own risk.

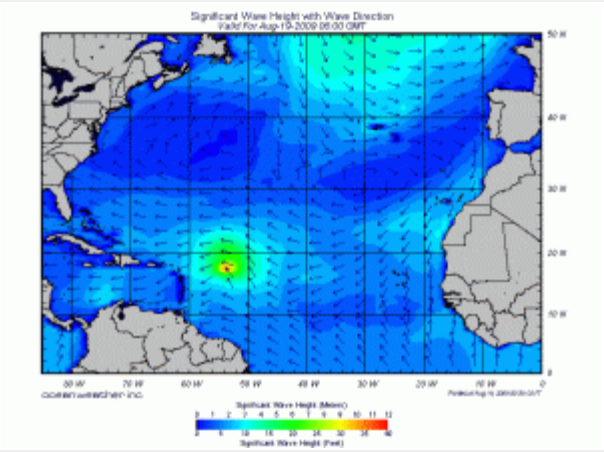
0 Comments

18 aug — Update from a glider pilot

Posted by: Oscar in: Atlantic Crossing, Thermal Glider Flight

From RU students: “Drake has got some huge waves headed his way… over the past couple days we watched the storm grow and waves are currently up to mid to high 30’s ft.”

That is cool, big question is if Drake should go goofy foot?!



0 Comments

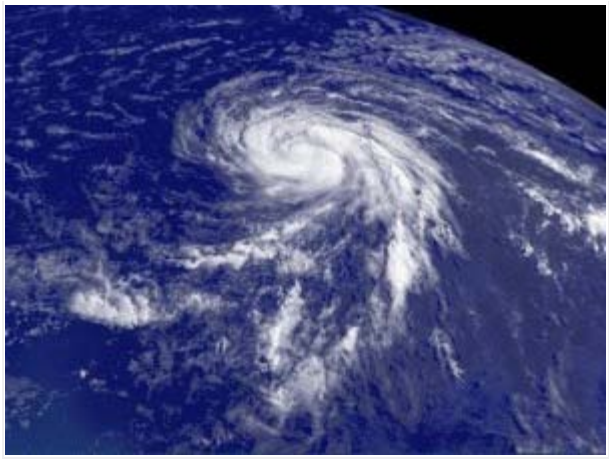
18 aug — Drake is back in the game, one thought,,,, Bring on Bill!!!

Posted by: Oscar in: Atlantic Crossing, Thermal Glider Flight

Teledyne-Webb have been working it overtime, and Drake has been repaired. Drake is back in the water, and there is one to test if we are ready,,, let’s cross the Atlantic! Maybe we can offer some reinforcements for RU27 which valiantly fights off the !@(^!(*^!@*^ biology (note: I am a biologist so am allowed to say that). Gliders repairs were anchored by our partners at Teledyne-Webb and now it is time to fly! The Drake thermal glider was relaunched and navigated through the Caribbean islands and is now heading out to sea. It is now in beautiful deep blue (Case I for the optical oceanographers reading the blog) water.

For those who do not remember the unique aspects of Drake, a quick refresher is that Drake being a thermal glider is next stage of glider evolution as it is a vehicle that utilizies a buoyancy drive that harvests the thermal structure of the ocean. This is a fundamental step forward from traditional glider technology where a pump pulling/pushing a volume of water in/out of the glider to change the buoyancy of the system. The pump in the traditional glider uses a great deal of power which then limits the length of time that glider can remain at sea. The patented thermal engine consists of a heat exchange tube, accumulator, valve manifold, and both external and internal (to the pressure hull) bladders. The heat exchange tube is comprised of an outer aluminum pressure vessel that is filled with a wax like chemistry tuned to undergo a phase change at 10 C. In the center of the wax is a flexible hose which can be filled with mineral oil. In operation, the glider leaves the surface by opening the valve and allowing oil from an external bladder to enter into the pressure hull to an internal bladder thus decreasing vehicle volume to cause the vehicle to descend. At the surface then, the accumulator, backed by 3000 PSI Nitrogen is pre-charged with oil and the wax in the thermal heat exchange tube is in a liquid state. As the glider dives it passes through the 10 C thermocline into colder waters and the wax begins to freeze, contracting and allowing oil to be drawn into the flexible center hose in the heat exchanger from an internal bladder. Inflecting at the bottom of its 1200 m deep dive, the valve turns again and the accumulator pushes oil to the external bladder overcoming the hydrostatic pressure, increasing vehicle volume causing the vehicle to rise. Again, traversing the 10 C thermocline into the warmer surface waters of the ocean, the wax melts, expanding and forcing the oil in the middle hose out at high pressure into the accumulator thus re-charging the system for the next dive. The harvesting cycle continues over and over as the glider makes its way along collecting and periodically transmitting water column information back to the ground control station. Again, when we speak of this we do a major bow to the master on high Doug Webb and his drinking buddy Henry Stommel. Also without a stalwart, and fellow drinking buddy, Clayton Jones, we would be nowhere.

So tonight Drake heads to sea. So we have tried and failed a month ago, but tonight have new technology and will enter an undiscovered ocean full of nasty biology looking for a meal. So if that is not daunting enough, what else can be thrown in our path. Answer is simple,,,, Bill.



So what might the path of the Category 3 hurricane be???

It looks good for Drake if Hurricane current projections hold true, however the uncertainity remains significant. Regardless a storm like this is big and dangerous, so even if we do not have a direct hit, waves/turbulence/etc will be be intense. So we all head out to sea tonight, and Bill will choose his path and will only get stronger as he moves across the Atlantic. Bring it on….

0 Comments

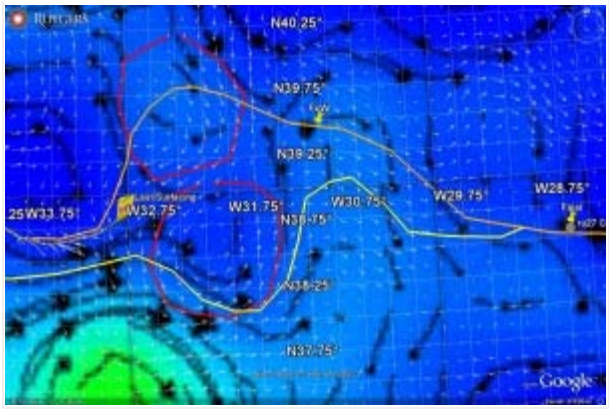
15 aug

Biology Never Sleeps

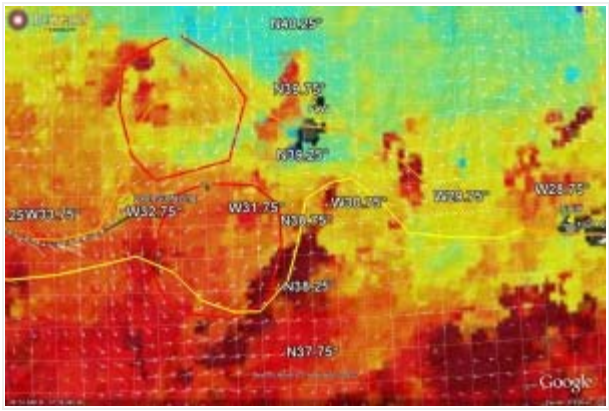
Posted by: Scott in: Atlantic Crossing

We continue to struggle with ways to loose whatever is on our right side. Backwards flight, slow flight, fast flight. Whatever it is, it continues to slow our progress and reduce our ability to fly between eddies. People want to know what it is and where it is. Chip is assembling his dive team. We want photos and samples.

Less than 200 km from Flores. two possible paths, one in the altimetery to the south (yellow).



A second in the SST to the north (orange).



0 Comments

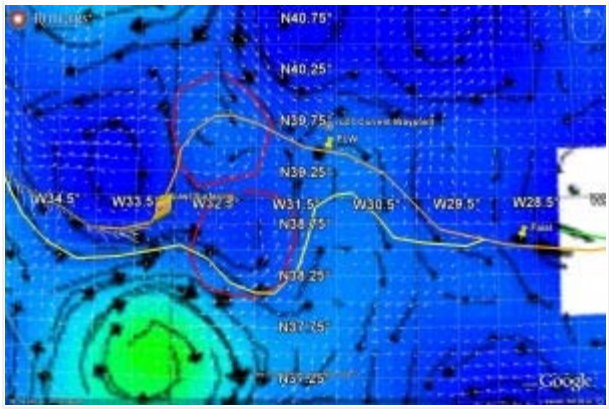
14 aug

A no-spin CTD cast.

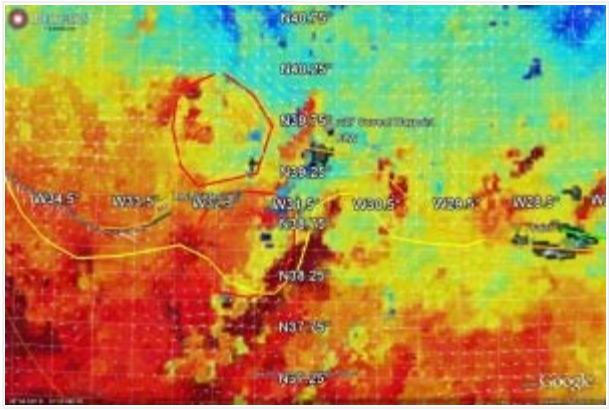
Posted by: Scott in: Atlantic Crossing

The Scarlet Knight had a good night. We still have a pull to the right, but we are doing a decent job of compensating. The morning CTD cast had no spins. The 8 hour segment from last night had an occasional spin interspersed with times when it tracked fine. We are doing well for over 80% of our flight time.

We have 2 road maps. Below is hycom currents (white) and ccar currents (black). I've circled two eddies in hycom in red. We can't go between them, so we have to go around. The yellow route goes south around the southern eddy. The orange route goes north around the northern eddy.



The southern eddy is more distinct in the altimetry and hycom results above. The northern eddy is more distinct in the sst and hycom results below.



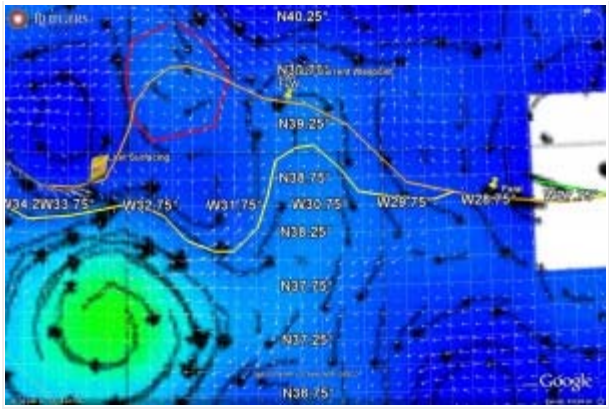
We'll try to use ocean color as the tie breaker. If we go around the northern eddy, our waypoint will remain Flores. If we try for the southern route, we'll need to change the waypoint to Faial. Amazing that both choices are withing range of land.

0 Comments

13 aug — Favorable currents and more testing.

Posted by: Scott in: Atlantic Crossing

Following the yellow line east to about 30.5 W, this morning's updated HYCOM has excellent agreement between the forecast surface currents and the geostrophic current maps produced by CCAR from the altimeter. Thats nearly 300 km of a good roadmap. Currents are favorable. We continue to explore our flight parameter space today, taking advantage of the favorable currents to test the full range of options. Sometests we have wanted to do for weeks but have postponed, like a test with the fin turned off. Others, like yesterday's two moonwalks, we also run. The first moonwalk descended tail first, then shot back up with the nose full up and battery all the may back for the full mission. The second moonwalk descended tail first, then came back up nearly level. We are back to our normal settings and we'll see how we do at noon.



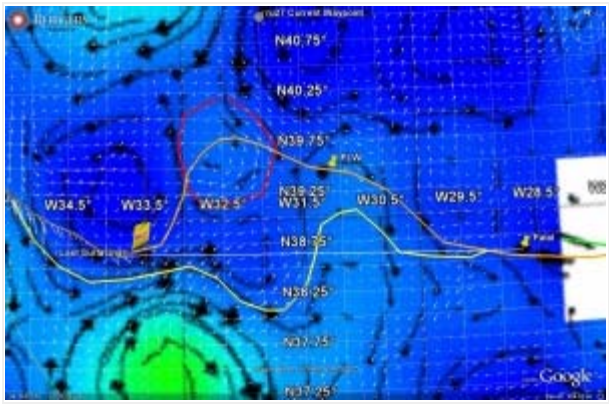
0 Comments

12 aug | Currents good, testing continues.

Posted by: Scott in: Atlantic Crossing

Currents remain favorable to the east, so it remains a time for experimentation in our flight parameters. Our 0 fin offset is working well. Steering control on the left is rapid. Steering on the right is slower. We increased to top inflection depth to 35 m with no reported problems. CTD says the base of the thermocline is at 38 m. Can we eek out another 3 m? 40 m gave us trouble with too much pressure. The randomness of the steering behavior is gone. This is good and bad. Its bad that it is there, but now we know what we have to work with. As we fly, something on the right side of the glider pulls us to the right. The fin compensates for this for a while, keeping us close to course until it can no longer hold it. The glider starts pulling more right until it crosses 180 degrees heading error. Once that occurs, the fin goes hard over the other direction and rapidly spins us to the right to zero heading error. So the flight pattern holds the course for a bit till it can't anymore, then turns into the spin to reset back to zero.

To compensate for the rightward pull, we have made the waypoint to the NE. The result will be an eastward velocity. In the pathplanning roadmap below, I've circled in red a clockwise circulation that appears in hycom and the latest atlimetry. It means the orange path will require an even longer excursion north, away from Faial. Currents along the yellow path drawn several days ago appear to be more distinct. The thin straight line to Faial is 240 nautical miles, or a 24 hour steam at the typical 10 knots of research vessel.



0 Comments

11 | Gone Crunchy

aug | Posted by: Scott in: Atlantic Crossing

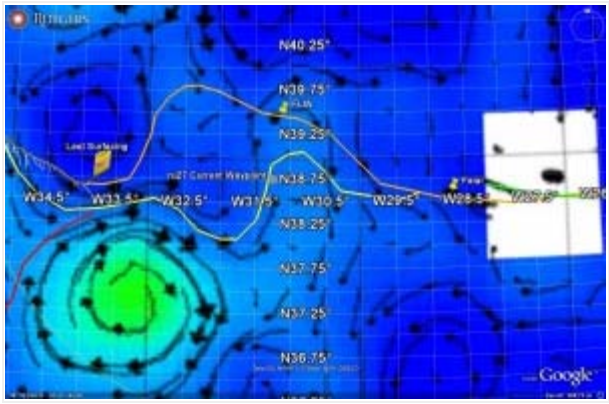
Since 2006 I have used the McDonalds in Sturbridge, MA as the summertime COOLroom. Our family usually spends the first couple weeks of August and many weekends up here at our lake house in the woods on Hamilton Reservoir. New Jersey magazine describes my hometown of Hopewell as being located in New Jersey but that it screams Vermont (in New Jersey we scream). Hamilton Reservoir in Massachusetts is even more Vermont, with a small general store we reach by boat and the addition of cell phones only a recent annoyance. Since our entire observatory is designed to be operated from our homes over the Internet, all we need is a WiFi connection and a cup of coffee to run the entire network. The development of this capability was required for us to support the ONR Shallow Water 2006 Joint Experiment on the outer New Jersey shelf. We've been using that capability for every experiment ever since, including this one. If necessary, you can run things over a cell modem or an IPhone, but the WiFi gives you full access to all the visualization and interactive products at a speed you can live with. So on many summer mornings in August, you'll find me at McDonalds in Sturbridge, right at the corner of Interstate 84 and the Mass Pike. Until today. The WiFi at McDonalds has been down for 2 days, forcing me to go elsewhere in search of connectivity. Just down the street, away from the familiar setting of a highway rest-stop, I found an old house that was converted to the Sturbridge Coffee House with a free WiFi sign out front. I found my new control center. I've traded the Egg McMuffin with bacon and cheese for a vanilla muffin top with fresh raspberries. I share the front room with other laptop users, so I am in with my own kind. And now, through the Internet, I have the amazing privilege of spending an hour at sea.

Our glider had a difficult night. As we said yesterday morning, we were going to try some additional tuning to the steering, and last night, we really explored the flight parameter space. We had previously found that going slower improved our ability to track a course on the upcasts. We adjust our speed by changing our pitch, and we found a pitch angle of 26 degrees worked well for upcasts. We also noted that over the weekend, most of our steering issues were confined to the downcast. Using what we learned from our tuning of the upcast, yesterday we also set the glider to go slower on the downcast, changing the pitch on downcast from 35 degrees to 26 degrees. The result has been named the helo-glider, even though the apparent rapid spins were just an artifact of the plotting. The heading error on downcast hung around 180 degrees, while on upcast it hung around 0 degrees. The helo-glider turned out to be an excellent product for station keeping. With that realization, Dave changed the flight parameters back to the steeper 36 degree dive on downcast, and we were back again to what we had before. The 4 am full excursion CTD cast looked just like the previous one.

As a result we have a whole set of new parameters to send to The Scarlet Knight at noon today. We are adding data to the science data file that comes back since we are doing good on power and we can use the additional steering info for a few of our final tuning runs. We are setting the fin offset to zero, so we can use the full excursion of the fin in both directions to steer. We are going to try to increase the depth of the top inflection from 30 m to 35 m. The CTD from this morning has the strongest thermocline we have seen the entire flight, about 22C at the surface and below 16 C at 40 m. Ideally we would want to stay below this layer, but we did not like the behavior of the buoyancy pump when we inflected at 40 m. At 40 m the pressure pushes the buoyancy pump in too fast, it generates stray electricity, and the glider shuts it down to prevent it from frying its own electronics, resulting in an abort. It just one of the examples of how the glider knows how to save itself. The 30 m inflections look fine. So today we'll try something in the middle, say 35 m inflections to stay out of whatever is sitting on that thermocline.

The satellite altimetry updated this morning after skipping a day. Its shown below, and we are moving into the jet between the counterclockwise eddy to our north and the clockwise eddy to our south. The currents reported by the glider are turning more and more to the east. This is a good time to test parameters. The currents are favorable, and we want to stay with them. If the currents were against us, we would be doing everything we could to fly out of them and into a more favorable region. But with tail-current, we are good to test every kind of behavior possible so

we'll know what we need to when Scarlet has to fly. We continue east, towards Flores, and are planning for the biological sampling mission.



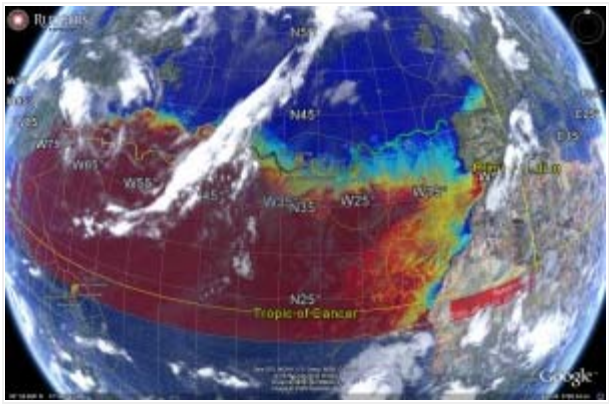
0 Comments

10 aug

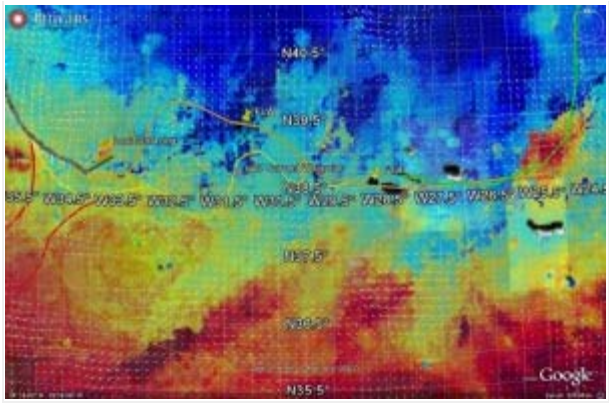
Uncertainty in the roadmaps

Posted by: Scott in: Atlantic Crossing

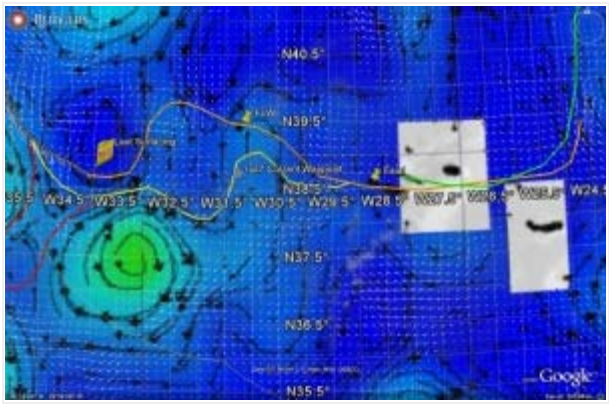
Eastern North Atlantic remains relatively cloud-free. Thats good - we need some clear ocean color imagery. We are quickly learning that every region appears to have its own best combination of data sources for path planning, and it probably varies by season.



The Sea Surface temperature imagery reveals some of the features, but nothing is distinct. In a few places Hycom circulation vectors (white) agree with the features in the SST, but again, there is little that stands out.



Same conclusion comparing hycom to altimetry. Agreement in some places, disagrement in others. The main agreement seems to be that currents are generally small, and therefore hard to detect in the data and assimilate into the forecast model.



Our best comparisions continue to be with the altimeter's geostrophic currents and the advection of the phytoplankton in the ocean color imagery. Based on that comparision from the end of last week, we'll continue to use the altimetry as our roadmap and continue east across the base of the cold eddy, using its counterclockwise circulation to push us east. We'll also work more on tuning the flight parameters today, a process that is becoming more and more continuous over time. We had a bad segment with 7 spins yesterday, then this morning a good segment with only 1 spin. It remains random, as best we can tell so far, and heightens the uncertainty.

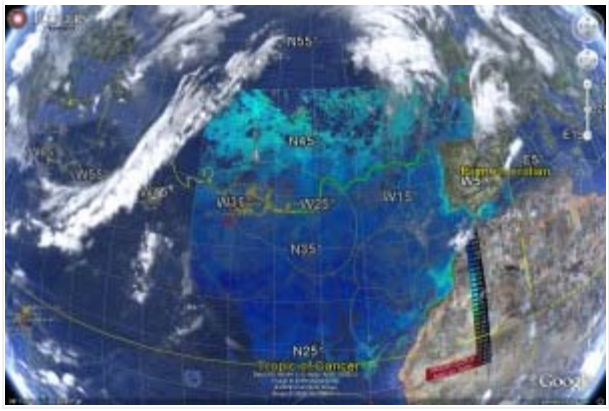
0 Comments

09 aug

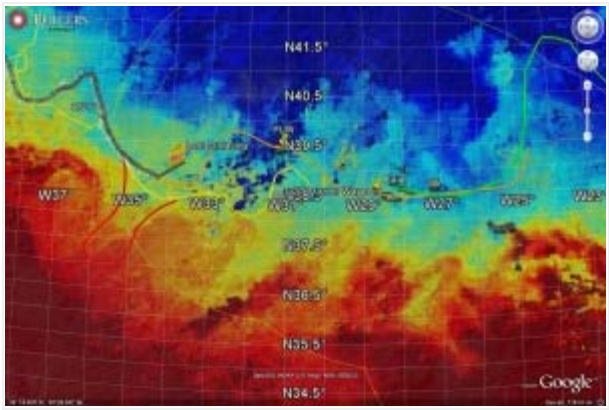
Reaching the southern side of the cold eddy

Posted by: Scott in: Atlantic Crossing

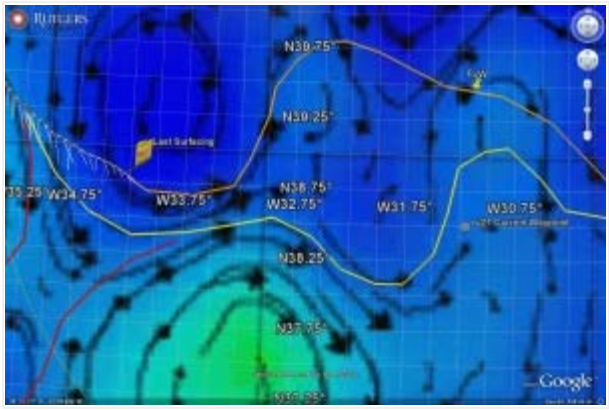
Clear skies over the eastern North Atlantic perfectly frame the ocean color imagery footpring provided by the Canaries. I suspect we'll be seeing emails from Antonio with fresh images when we awaken tomorrow.



SST is not a helpful as ocean colot in the summer, but we still see some of the major features we are encountering, like the warm eddy we just left behind to our southwest. The important thing here is all of our potential paths are staying a s cold as possible.



Zooming into The Scarlet Knight, she is reporting currents have turned much more to the east and remain perfectly aligned with the CCAR geotrophic currents from altimetry. Our waypoint to the ESE is giving Scarlet an additional southward component to catch those stronger currents on the southern side of this cold eddy. As we hoped, we are deep into this eddy. We'll continue this course at the noon surfacing, likely switching to due east by shifting the waypoint 15-30 minutes north at the 8 pm surfacing.



Distance to Flores is about 350 km. Thats about the distance between New York and Boston. Its about what we cover on a normal 4 week Endurance line on the NJ Shelf - 2 laps out and back. RU27 made 19 km along track in the last 24 hours.

Assuming favorable currents and few fans from the deep, that makes it about 3 weeks to Flores. I would double the estimate to get the most likely range, making it somewhere between 3-6 weeks. Once we pass Flores, we are in less than 1/2 day range of the research vessels in Faial. We really want to see this glider, and come back with about 1,000 pictures. Biologists want a sample of what is growing on it. Battery usuage remains just below the target of 3 amp-hours/day so we have plenty of power for the full mission. Number of iridium redials has a long history of zeros, indicating no drops and good connections each time, so our communications are also good to go for the full mission. One pressure sensor appears to be clogged, but thats why a glider has two, so the second pressure sensor remains good to go. The occasional spins on the glider are even more random, sometimes none, last night one to the left and two to the right, further supporting Antonio's suggestions of an occastional passive passanger like a jellyfish. Our monday focus remains on steering, and comparing the satellite ocean color with the satellite altimetry to get the best path to Flores in this region.

0 Comments

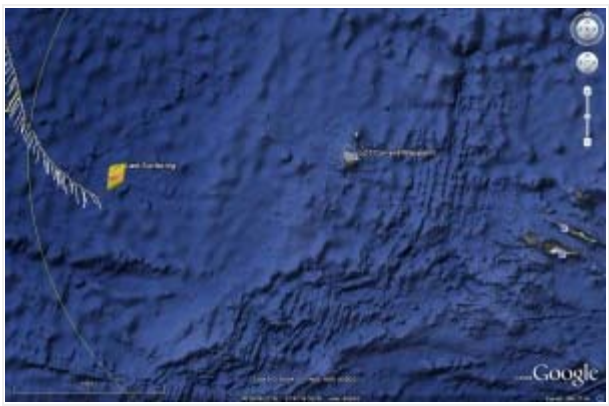
08 aug

Pilot Humor

Posted by: Scott in: Atlantic Crossing

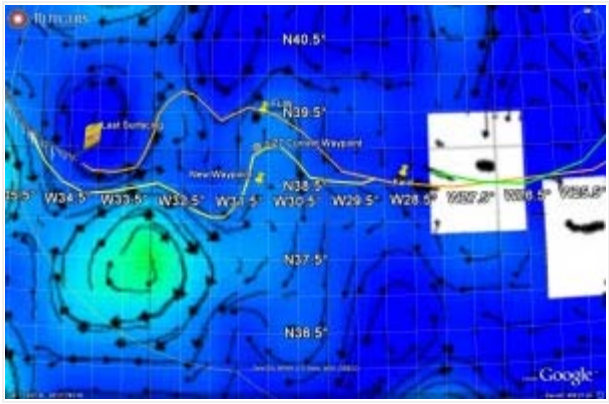
It was a long week. After crossing the path of RU17, we found ourselves flying a glider that kept trying to do no-roll spins to the right. The single yo CTD segment looked worst, so we turned off the sampling and switched from 8 hour to shorter 4 hour sampling segments. We tried different pitch and fin settings, even flew one segment into the turn. As we were about to prepare for a moonwalk segment where we fly the glider backwards in a tail-first dive, the spinning suddenly switch to two turns to the left, then stopped completely. Antonio in the Canaries has been sending us the ocean color images and watching the glider flight behaviors. Antonio is thinking the randomness of the glider behavior looks to him more like a passive passenger like a jellyfish getting caught than an active passenger like a remora. Maybe it was the warm eddy we were in that also supported a field of jellyfish. We are out of that warm eddy and now deep into a cold eddy and the spinning behavior has stopped. Our average heading error is now within 10 degrees of our intended course almost every time, and often comes up with just a few degree error. With the average heading error under control with adjustable parameters like our fin offset and pitch, it is time to retune the gains in the fin motion to bring down the rms heading error - a job for monday. In general, the slower we go, the larger we make the gains. With the improved tracking, we also set RU27 back to 8 hour missions, and tomorrow morning, between 4 am and 5 am, we'll resume CTD sampling. We are settling back into our routine.

With the pressure of an unknown flight problem subsiding, there is a true sense of relief running through the lab. With their new found time, the younger folks decided it was time to play a trick on me. In the thursday night IM session, we decided on a waypoint that would essentially head us ENE and compensate for the expected pull to the right, heading us due east. When I rechecked the glider in the early morning after the 4 am surfacing, I found they had put the waypoint on land.



Zooming into the waypoint, you can see they placed it directly in the center of Flores, less than 300 km away. We have a preset limit of 500 km for the maximum range to a waypoint so we don't mistakenly send in the location of Palmer Station in Antarctica. Now for RU27, for the first time in a long time, there is land well within our normal waypoint range and in the right direction. Dave A. said he has been waiting over a year for this opportunity. Ok, it may not be a joke for the grand masses, but for us, after the intense week, we all got a bit of tension relief from a waypoint set on land. Score one for the young people.

Part of getting back to the normal routine is the pathplanning that occurs 2 or 3 times a day. Discussions with Josh last night developed our strategy, we would move the Flores waypoint south in 30 minute increments as we swung around the bottom of the cold eddy into the stronger currents to the east. This is the start of the yellow path we had been talking about for the last week. The new development in the altimeter surface current map is shown with the orange line. If we stay in this cold eddy a bit longer than our original yellow line plan and head up its eastern side, we can follow it up to the base of another cold eddy that will whip us east directly into Flores. The orange path has strong currents all the way to Flores, an advantage over the yellow path that uses the warm eddy to our south. Another thing we like is that we currently are not encountering the jellyfish spin problem in this cold eddy, so we want to use it as long as possible. Lastly, we are having very good luck comparing the satellite altimetry with the statellite ocean color images we get from the Canaries. It gives us greater confidence in the currents we are seeing in the altimerty when we see the same patterns in the advected phytoplankton.



0 Comments

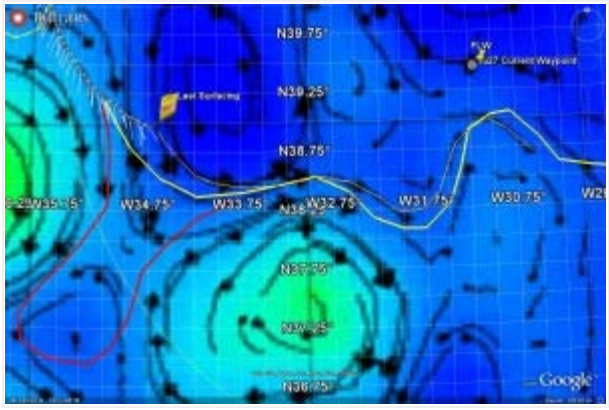
07 aug

Our unseen friend has left us

Posted by: Scott in: Atlantic Crossing

Whatever or whoever was spinning us around for the last week since passing RU17 appears to have grown tired of the ride and left. The spins have stopped. We are tracking our course with the normal deviations we saw before the spinning began. We typically do see the deviations grow with time, since we assume small things grow on the glider, they slow us down, and over time, we have to increase the gains on our fin motion to compensate. But this spinning behavior is very difficult to explain with the small growth we expected. I was talking to Bill Boicourt yesterday morning about how the spin abruptly changed from a week of spins to the right, and then just 2 spins to the left. We talked about how we would have to sneak up on this glider so as not to scare away any of the potential passengers, if that indeed is the cause of the spinning behaviors. But with the spinning stopped, we readjusted the settings on our fin offset, and are continuing to re-optimise our pitch settings to the new conditions. It seems like every segment of this flight throws new challenges at you. And that realization has left a big impression on us as to how glider training should evolve in the future. Long missions on simulators through ensembles of ocean forecasts, with different challenges regarding the condition of your vehicle and the accuracies of your roadmaps tossed at you.

But for now, the mission at hand. We are steering Scarlet a bit more to the east, in between the two geostrophic current streamlines that are just to our east. We'll try to follow the thin yellow line that is close to the thick yellow line we drew several days ago.



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06 aug

Mysteries of the Deep.

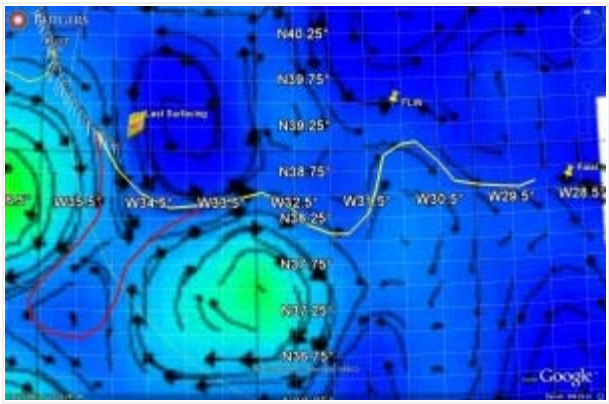
Posted by: Scott in: Atlantic Crossing

Ever since we crossed the path of RU17 late last week, we have been watching RU27 react with these intermittent 360 degree spins to the right. We have looked for a pattern and have not found one. Initially it was focused on the downcasts, with the spins occuring on some of our descents, but the ascents looking fine. We also went through a day or so when only the upcasts were spinning. We did a series of pitch changes on upcasts to determine our best pitch, and then it switched back to affecting the downcasts. Other times it affects a series of a few upcasts and downcasts in a row, and other times we have a clean series. It does seem that the 8 pm surfacing tends to report the most spins. One test we did is set the fin to turn into the spin, and see how many times we go around with a fixed amount of drag. We spun 19 times around to the right in a 4 hour test. About 5 per hour - or about 40 spins per 8 hours. That sets our yardstick, and confirmed that even with all the spinning, our dead reakoning is still good enough to get an estimate of the currents out of the glider. This is a big relief. It is important to know that the glider reported currents are good, and what a really bad segment will look like. So after 2 days of tests, we settled on new pitch and fin settings, and a heading compensation for the expected average pull to the right which has been about 20 degrees. Everything was finalized for 8 pm and sent to the glider. We were back on our normal schedule of 8 hour surfacings, with optimized settings, and were

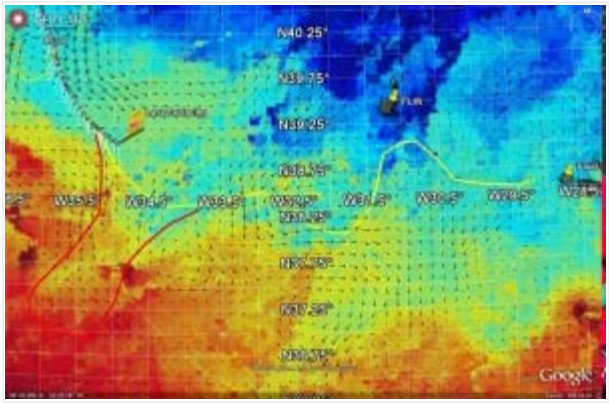
continuing our track east towards Flores.

So what happens this morning? We open the plot to see how many spins to the right we did as a gauge of how good or bad the segment was. A few spins to the right is not bad. 6 or 8 spins to the right during an 8 hour segment would be on the bad side. We pop up the heading data and we see only two spins - a good night - but they are different. Both spins are to the left, not to the right. Whatever is causing the intermittent drag has switched sides. How can that happen with simple biological growth? Who are you? And why are you spinning our glider? That will be our mystery for today.

Back to path planning. Below is The Scarlet Knight's present location. We are doing everything we can to fly ENE, perpendicular to the glider currents to keep us along the yellow path in the geostrophic currents derived from the satellite altimetry. Scarlet is reporing currents to SSE, in excellent agreement with CCAR altimetry. If we catch the yellow line, we have a clear path to Flores. We already are within range of the Research Vessels at Faial if we need them, but we are still fine, still flying east the majority of the time but perplexed by the recent changes in heading behavior.



Below is the same view looking at the satellite sea surface temperature and hycom surface currents. As with last time, you can trace the path along the yellow line and gain confidence in both the sst and hycom predictions. Even better than this SST is the ocean color image Antonio just sent from the Canaries. Dave K., one of the student pilots, usually puts these into google earth when he gets in. The fronts show up even better in the ocean color, especially in the summer. Antonio certainly was right about that.



1 Comment

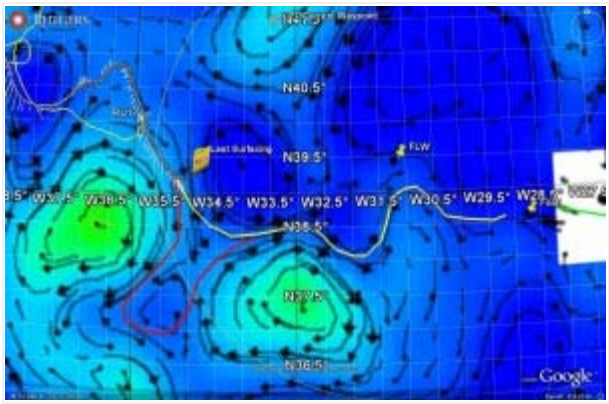
05 aug

We are still flying east.

Posted by: Scott in: Atlantic Crossing

Yesterday's series of tests confirmed our ability to fly and certainly rasied spirits. You start to worry about about the numbers you are getting back from the glider as to the reported currents and directions, but we confirmed that these are closer than we thought. We did one tests were were intentionally turned the glider to the right, in the same direction we are being pulled, adn completed about a dozen spins in 4 hours. That essentially makes us a drifter. We drifted south, and the current vector reported was south. Confidence restored. A few more tests with the pitch battery. Mostly fast ascents versus slow ascents to see the difference in steering. We'll know those results later today.

But right now we are going to concentrate on flying the Scarlet Knight towards the yellow line. We'll continue sending this glider east by compensating for the pull on the right hand side. The moonwalk is for more desperate times.



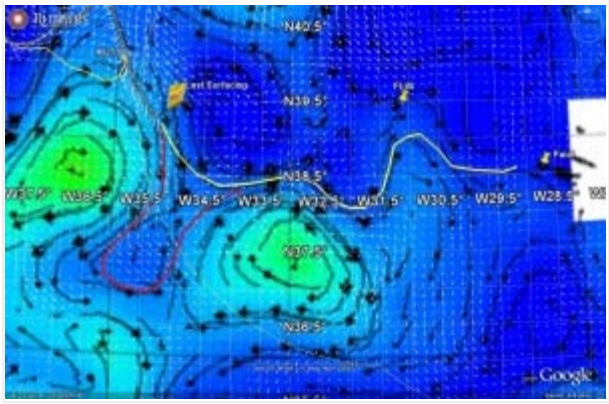
0 Comments

04 aug

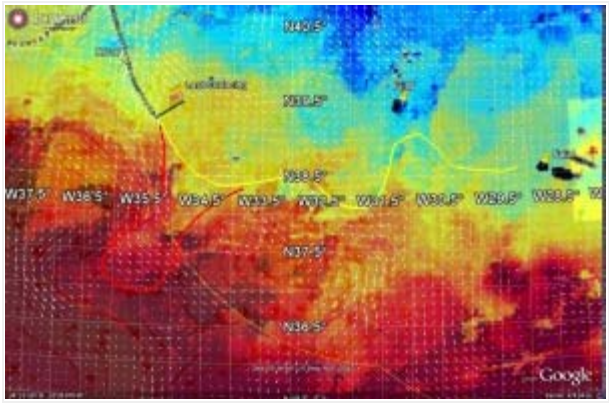
A clear path - can we reach it?

Posted by: Scott in: Atlantic Crossing

Recently updated altimetry gives us a direct path to Flores and Faial (yellow) and an indirect path (red). Its like the road from the New Orleans airport to NRL in Slidell, Mississippi. Do I take 610 straight across, or do I just stay on I-10 and head south for a loop through the French Quarter for some donuts first. As usual, the black arrows are the geostrophic currents from the CCAR altimeter product and the white arrows are the surface currents from the Navy Global Hycom.



Displayed on the satellite image, we see some remarkable agreement between HYCOM and the SST along the yellow route. We hope that is the one we can take.



The uncertainty is now moving over to the glider itself, and what is causing the drag on the right side. Pitch is normal, roll is normal. Vertical speed is slow, but that always happens over time. The new thing is the increasing amount of drag on the right, the side opposite the CTD. There are times that it can spin us in a circle. We ran a series of data collection missions over the weekend, and have charted out a series of test missions based on that analysis. We are changing from our standard 8 hours between surfacings to 4 hours between surfacings so we can run a series of fin setting and pithc setting tests. Moonwalk is on the list, scheduled for sometime tomorrow.

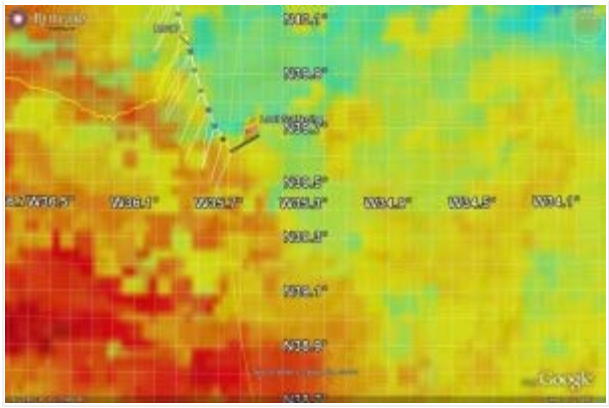
Lets see if we can shake and get back to flying straight.

0 Comments

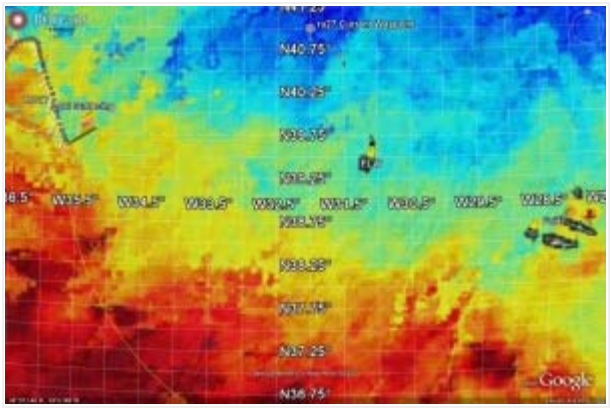
02 aug European Territorial Waters

Posted by: Scott in: Atlantic Crossing

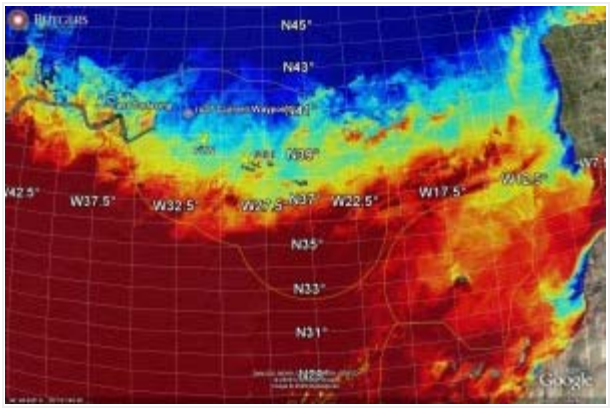
On Sunday morning, August 2, at 08:23:45 GMT (4:23 am U.S. east coast time), The Scarlet Knight surfaced in European territorial waters. Scarlet surfaced 1 mile (1.6 km) inside the thin yellow arc indicating the Portuguese territorial boundary around the Azores. She has flown a distance of 4,974 km from her launch point off New Jersey on April 27.



Scarlet is about 370 km due west of the island of Flores (FLW airport is marked on the map). If we can get close to Flores, we are within a 12 hour range of the University of Azores Research Fleet based in Faial. We need to see her condition, so a visit is being planned. The biologists need samples of what is growing on her and where, and we can't take a chance on loosing that opportunity if we are going to design better gliders in the future. Getting the biological samples to shore has now become a mission priority.



From Flores, it is then about a 1900 km leg to the boarder between Spain and Portugal.



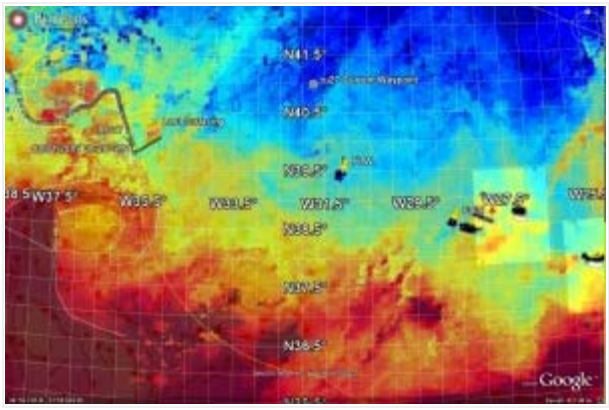
Fly straight Scarlet Knight.

0 Comments

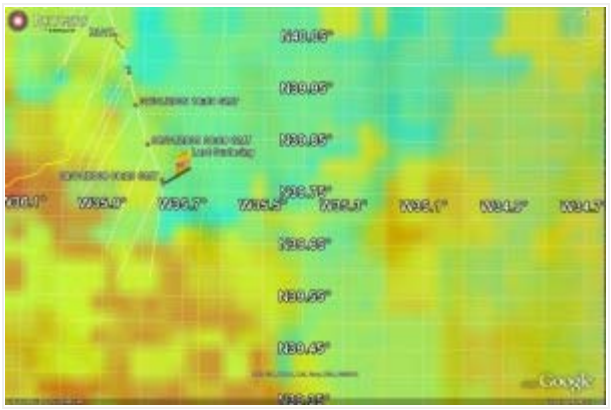
01 aug There's something about the biology here

Posted by: Scott in: Atlantic Crossing

A semi-transparent SST image is overlayed on the geostrophic currents from the altimter and our two eddies of interest line up perfectly. We have a roadmap. 400 km to Flores (FLW).



Zooming into the Scarlet Knight, we see improvements in the currents reported by the glider, and we are less than 9 km away from the Azores EEZ.



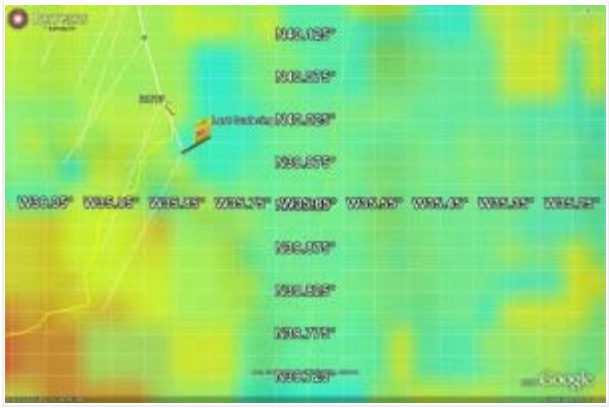
We now have to deal with the biofouling. Something is attached to us, and pulling us to the right at seemingly random times. We have increased the size of our diagnostic files we transfer during every surfacing to further investigate the problem. There are times when something pulls us to the right in a flat spin that we can't pull out of even with the fin hard over. And then it goes away and we are flying fine. The end result is that our distance made good along a desired heading is reduced, and that reduces our ability to navigate through an eddy field. The value if this glider just increased exponentially. We need to find out what this is so we can protect future gliders from it.

0 Comments

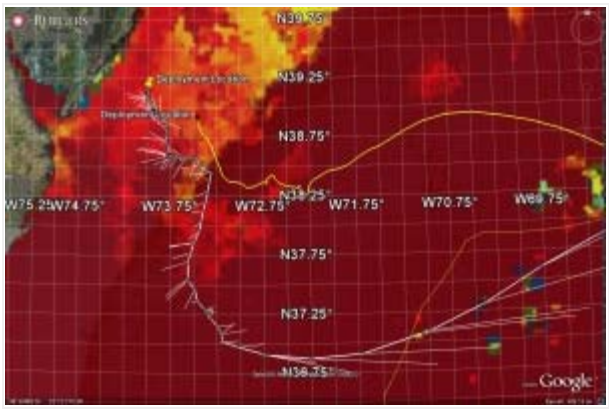
31 jul 1 Mile East of RU17

Posted by: Scott in: Atlantic Crossing

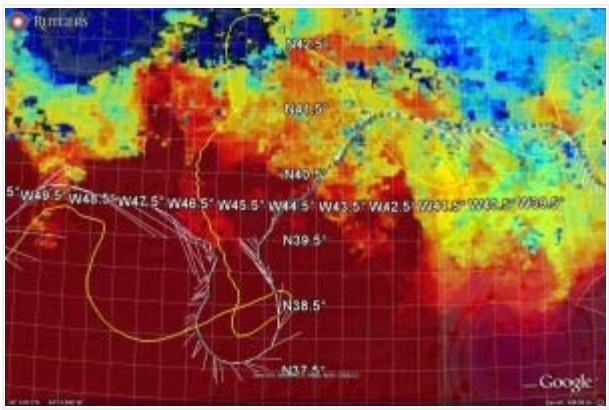
The Scarlet Knight, glider number RU27, just crossed the eastern end point of RU17/s track from last year. We are now at longitude 35 degrees, 50.47 minutes West. We have just flown 1 mile farther east than RU17. We are in new territory, less than 19 km away from the Azores EEZ.



Way back in April, we also started RU27 (white line) closer to shore than RU17 (yellow line). RU17, because of its indirect route, still has longer total distance flown. But RU27, with its more consistent speed and steering, and with the improved environmental guidance, has done much better in distance made good along a west to east line.



Looking along the full track in between, the region around 45W, just east of the Grand Banks of Newfoundland, seems to be a trouble spot for gliders. Each track has large excursions from the west to east line due to eddies.



0 Comments

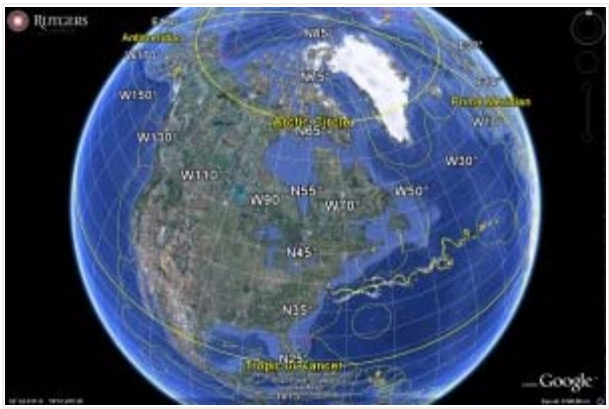
30 jul

1 Mile Shy

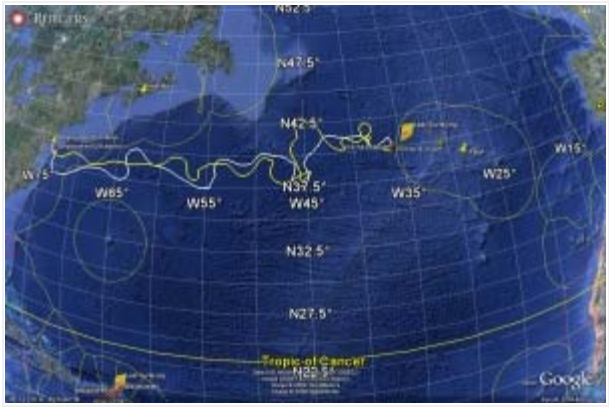
Posted by: Scott in: Atlantic Crossing

First, a quick check on the Global Fleet. RU07 is flying in a fjord on the island

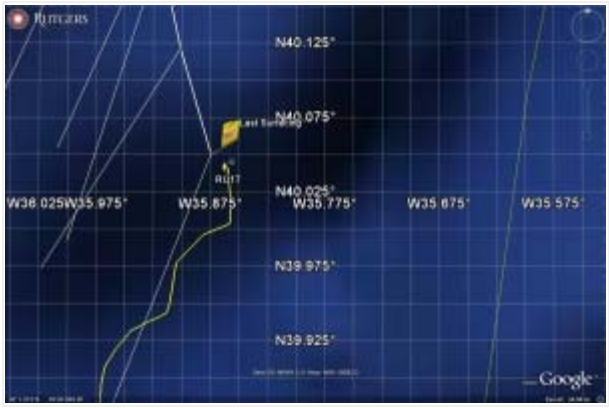
of Svalbard, Norway. RU21 is flying in Prince William Sound in Alaska. Drake, the thermal glider, is flying off St. Thomas, Virgin Islands. And RU27 approaching the Azores.



Next, lets zoom in to the track of RU27 (white line) from this year and RU17 (yellow line) from last year. RU17 stats - 5,700 km in 5 months and 1 week. RU27 stats - 4921 km in 3 months and 3 days.



Final zoom into the location of RU27. The Scarlet Knight is exactly 1 mile (1.6 km) from the last reported location of RU17. I don't think we could get much closer if we tried. We are less than 23 km from the yellow arc of the Azores EEZ. Currents are increasing and turning more southerly. Good news for the students.



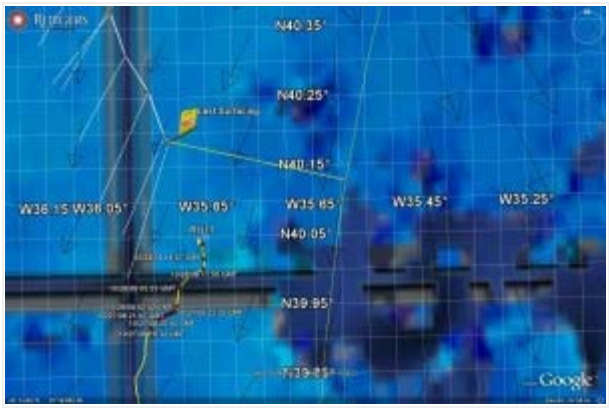
0 Comments

30 jul

Morning Update.

Posted by: Scott in: Atlantic Crossing

Scarlet's 4 am and 5 am surfacings are plotted here. The short segment from 4 am to 5 am is timed to collect the full CTD profile for assimilation by HYCOM. RU27 is 17 km north of the last reported location for RU17, and just under 30 km west of the Azores territorial waters as marked by the thin yellow arc. Glider and HYCOM currents are mostly south. We are flying Scarlet east.



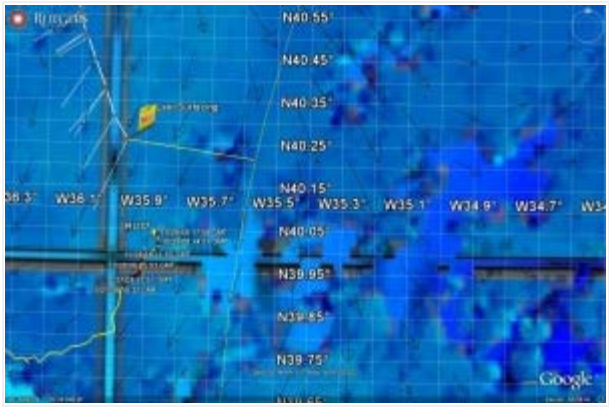
0 Comments

30 jul

33 Kilometers due east.

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight continues heading south and east. The white flags flying from the RU27 glider track are the currents observed by Scarlet, the field of black arrows are the surface currents from the Navy HYCOM, and all are overlaid on the ocean color image received earlier today from Antonio in the Canaries. The match up between HYCOM and the glider currents is uncanny. It still amazes me each time I look and see agreement like this between an ocean forecast and a local observation. Dave and Shannon set the waypoint tonight at 8 pm as due east. The currents from Scarlet and HYCOM are SSW. You add those up, and we are going to track amazingly close to the last known location of RU17, just 25 km to our south. And its not like we are trying to hit it. We are heading for the Azores, trying to make our best path. Only 33 km between us and their EEZ.
But something keeps drawing us south to the track of RU17. Everyone says there is a big fish waiting for us there at 50 m.



0 Comments

29 jul

And that, my friends, is why we do it. Everyday.

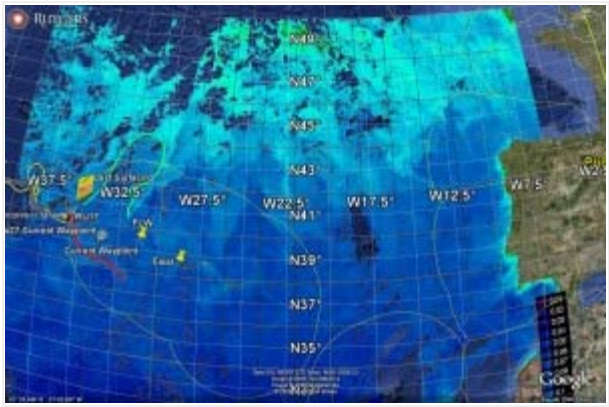
Posted by: Scott in: Atlantic Crossing

It happened. Again. Just like last year. That special day in a teachers life when your students demonstrate they are ready. You've worked all year for it, never quite knowing whether the transformation would really happen or not. Would this year's group of students rise to the occassion? Would they form a team that can accomplish more than any one of them individually? Or is the whole idea of undergraduate students trying to fly an underwater robot across the Atlantic unrealistic? More than once over the past three months it seemed like the last of these three questions was winning. But one thing we have learned - Even when it seems like the wrong side is winning, you can't stop. You got to keep going. And keep trying. Keep talking. Keep blogging. Keep flying east. Because if it does work, and the students catch on, you have done your most important job. And you have accomplished the primary goal of this mission - Education. Its why NOAA sent us across in the first place. Its why Teledyne Webb Research chipped in half the money. Its why the Rutgers alumni are one of our largest contributors. Its not just about this glider and this flight. All of the people directly supporting this mission believe in the importance of science and engineering education for our young people, and that we need to prepare them to live in a global community. And thats why we build gliders, and with the help of our friends on both sides of the Atlantic, try to build the community that will fly them across.

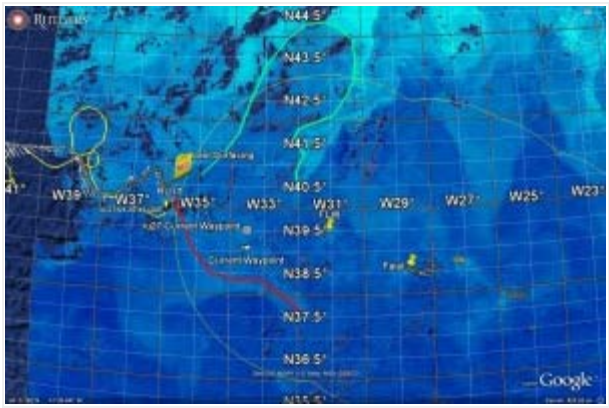
So what just happened 3 months into this flight? It was Dave Kaminsky's email late last night. I count eight "!" in his email. Last week, Dave was looking over all the RU27 heading and yo data. We had talked about the glider starting to show some heading variations at the top inflection points in its dive profile. Colin, another one of the students, was plotting up the glider temperature data, and they noticed this was occuring at the base of the thermocline. On Friday last week, Dave asked permission to deepen the top inflection depth. We had tried this once before, and we knew 50 m was too deep, resulting in an abort due to too much pressure pushing the pump back in. We told him we would try his test in small increments beginning on monday when people were around to watch it. Dave and the other students spent the weekend watching and steering. Each had a job. Anthony was watching the fin offset to make sure we minimized our average heading error. Colin watched the CTD data and Dani worked on currents. Nilsen monitored the satellite coverage and the storms. Shannon and Dakota watched the glider speed. Emily, Shannon and Dave did the path planning. Dave changed the waypoints, taking over the job from Tina. On monday, Dave got to try his test. He pushed the depth of the top inflection from 35 m to 40 m. The students sat in the COOLroom, waiting for the telephone to ring signalling an abort. But it didn't ring. It flew the full, 8 hour segment. Dave's new depth test worked. It flew below the thermocline the entire time. Anthony's setting for the fin offset resulted in average heading errors of less than 1 degree. The glider flew 25% farther in this test 8 hour segment than the previous segment. The students had succeeded at increasing the dive depth and adjusting the fin offset, resulting in better tracking of the heading and more distance made good. They had done it. The students had designed an experiment for a robot 4,700 km away in the middle of the North Atlantic, and it had worked. The evening emails announced their results. The transformation was a step function. It happened in the middle of the night, with that one discovery moment when they suddenly realized they knew something that no one else knows. And they were going to announce it to the world with exclamation points!

Then the importance of the global viewpoint came through with a series of emails from one of our collaborators across the Atlantic, Antonio Ramos from the Universidad de Las Palmas de Gran Canaria. Antonio operates a satellite data reciever at their University, and is part of the network of ground stations providing path planning data for this flight. The U.S. ground stations can only see the

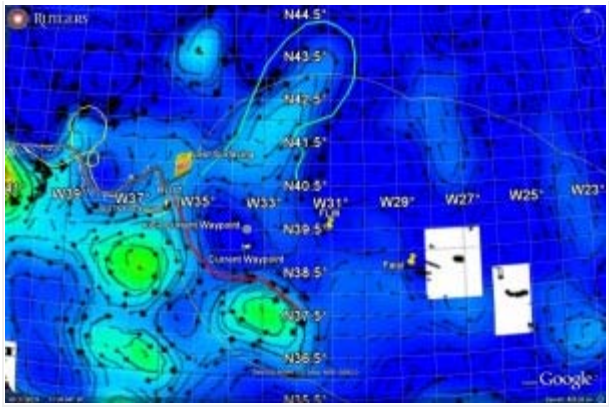
satellites over the western half of the Atlantic, so we rely on European ground stations for the full resolution data over the eastern half. We have been recieving their satellite sea surface temperature feed for some time, but recently Antonio started compositing and sending us the MODIS ocean color data he collects. The summertime heating of the sea surface often blurs the temperature signature of the warm and cold eddies we are searching for. The ocean color shows us the phytoplankton distributions, and it is in these distributions that the eddy field lights up, especially in the summer. The eastern North Atlantic was having some clear weather, and Antonio was emailing image after image with growing excitement as the eddy field was revealed one satellite pass at a time. Dave and Shannon just took the images Antonio sent us and flipped them into Google Earth. Below is the most recent. The eddy field along the entire path between RU27 and Spain is visible in the changing phytoplankton concentrations.



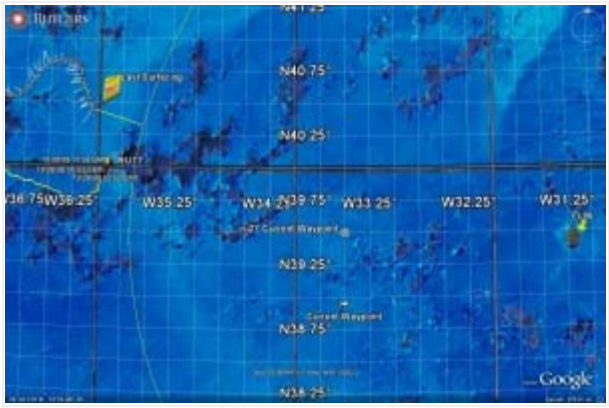
Zooming in a bit to the regional scale around the Azores, I've highlighted two features in the ocean color image. The long dark blue feature that runs north south along 32 W is highlighted in green. A faint light blue feature to our southeast is highlighted in red. Both of these represent advection patterns illuminated by the biology.



We now take those lines highlighting the biological fronts and overlay them on the physics, namely, the geostrophic currents from the CCAR satellite altimetry product. The alignment is perfect. The long dark blue feature along 32 W is perfectly aligned with the clockwise circulation in the eddy (light blue) to our northeast. The red line shoots right between a group of two clockwise eddies (green) and one counterclockwise eddy (dark blue) to our southeast. Our confidence in the roodmaps just shot up. Knowing what lies ahead changes the game. We know where we want to go and what our options are for getting there. We are no longer just reacting to what the glider is reporting. We can plan.



Zooming in again, we move to the immediate region around The Scarlet Knight, indicated here by the RU27 tail fin. The currents are starting to turn to a more favorable direction as we move into that lighter colored band of water that is flowing in between the three eddies. Our waypoint is perpendicular to this current, and flying us more into this band of phytoplankton. But as Dave noted before, we'll try to stay below the thermocline where most of the phytoplankton is concentrated.



Also in this image, we plotted last years track of RU17. RU17 was lost after 5 months and 1 week at sea just 20 kilometers from the Azores territorial waters, shown here as the thin yellow arc. RU27 is currently only 40 km north of the last reported location for RU17, and about 46 km shy of the Azores territorial waters. It took us 5 months and a week to get there with RU17. We are only 3 months and 2 days into the mission of RU27. Scarlet remains a fast glider.

1 Comment

28 jul

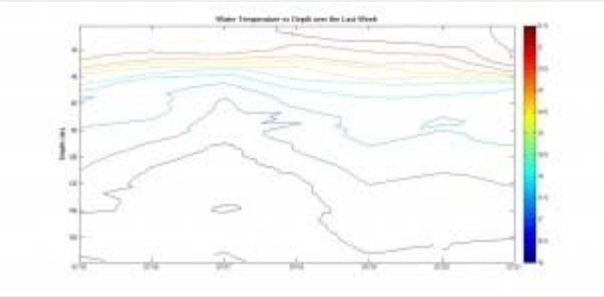
RU27: SEGMENT ABORT

Posted by: student in: Atlantic Crossing

At 17:53 GMT (1:53 PM ET), RU27 aborted her 12pm-8pm segment. Her error: the buoyancy pump.

Beginning Monday, July 27, 2009, we began an "as safe as it gets" trial-and-error test to keep RU27 flying deeper. We had been seeing a large amount and variation of anomalies in RU27's vertical flight path and patterns at her deflection point from climb to dive. Her deflection point had been at 35m for some time. After some research looking at RU27's CTD data and YO profile plots, we discovered that there was an evident pycnocline between about 30m-50m (shown in the image below). The pycnocline is an area of rapid density change due to varying temperatures and salinities. This is a potential problem for two reasons: (1) Being that the vehicle is solely buoyancy (density) driven, this area of sharp density fluctuation can cause

the glider to abruptly sink, float, or change her pitch, roll, heading, etc, causing inconsistent flight, and (2) Small biological organisms (ex: plankton) can potentially settle out within this sharp density layer; if we are constantly flying through this layer of biology with every YO (or dive and climb), this can increase the biofouling on the vehicle by exponential amounts. With those two reasons at hand, we made a decision: fly RU27 deeper to attempt to fly under the pycnocline.



We had tried to fly RU27 deeper about 2 and a half months ago, but to no avail. The vehicle aborted almost immediately due to a discrepancy between two components of the software dealing with the buoyancy pump and varying pressures at depth. However, this type of abort error is just about as minor as they can get, so a consensus was reached; were willing to gradually push RU27 deeper and deeper under the surface.

On Monday, July 27, 2009 we sent RU27 a new command during her noon surfacing to deflect 5m deeper: at 40m. After 8 grueling hours of hoping-for-not and waiting-for an abort, she surfaced at her regular surfacing time of 8:00pm. The data came back to us here at the COOLroom at Rutgers University, and it was smiles from ear-to-ear all around. She was flying beautifully. Her vertical flight was near perfect, especially for a submersible that had been deployed for 3 months that day, and she was flying 1-2km further per segment than she previously had been for some time. With this uplifting and incredible data, we decided to continue our deep test and drop her another 5m the next day.

That next day came, and today we retasked her at noon again to deflect at 45m. All hopes were high, but less than two hours into her segment, she called home to Rutgers with an abort. The abort was due to the pressure discrepancy with the buoyancy pump - the effects of the higher pressure at that depth was simply too great for the current software on the glider to handle or understand; therefore she aborted her segment. She was, however, able to perform two full YO's; meaning that she performed one full deflection without any errors at 45m. The vertical flight profile during these two YO's are shown below, and they show a perfect deflection from climb to dive (encircled in red).

We retasked her to deflect at 40m again, and so far so good. She is flying ten-fold better than when she was deflecting at 35m, so we are more than satisfied with a deflection depth at 40m at this point. However, ultimately our goal is to be able to deflect as deep as 50m without any errors. This is due to the fact that: yes, right now 40m is an optimal deflection point for her….but we don't know what the ocean holds for her for the remaining 40% of the way across the Atlantic.

Dave & Shannon

1 Comment

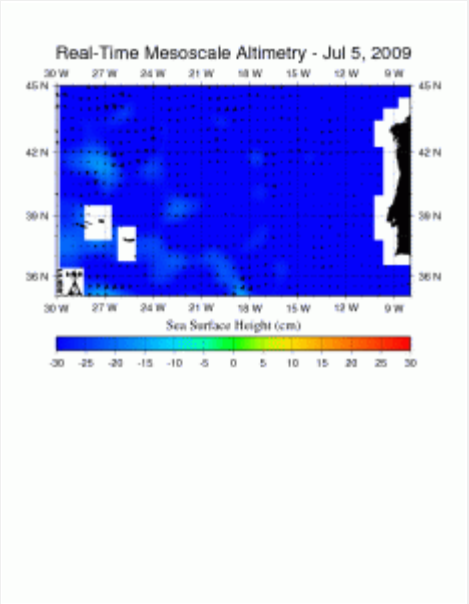
24 jul

North We Go

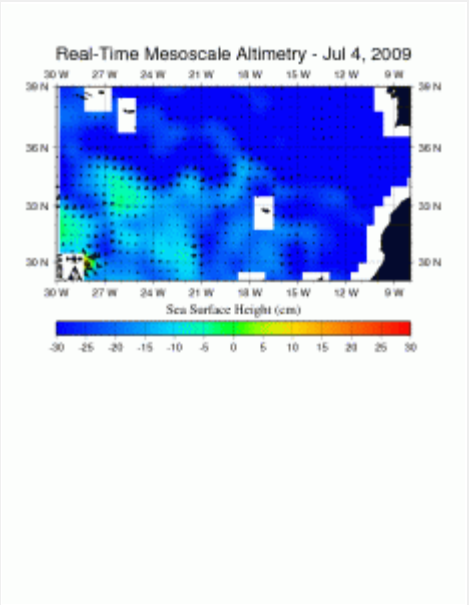
Posted by: student in: Atlantic Crossing

We have decided to attempt to barrel through the eddies and take the northern route to the Azores. Below are a few animated gifs showing the currents, north to Spain, south to Africa, and around the Azores Islands themselves. These images will help us while navigating this area. I will continue to compile data and make the images longer, with more recent data.

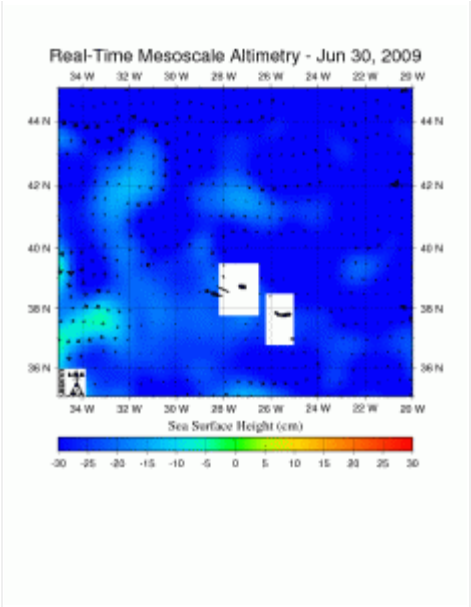
** that you have to click on the video in order for it to be animated. It will open in another browser. And the text box under the image is for that image, so the first image is the Northward current to Europe.



Northward Current to Europe



Southward Current toward Africa



Currents around the Azores Islands

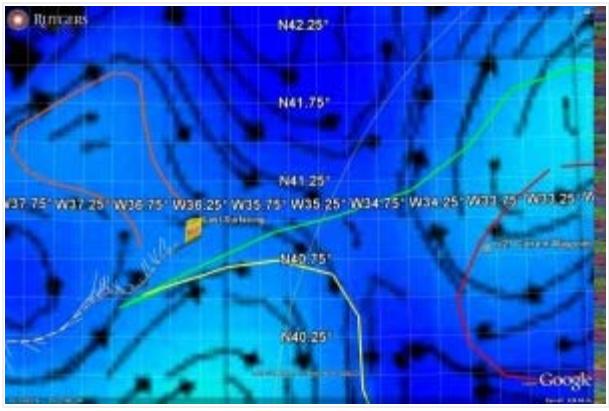
-Emily

0 Comments

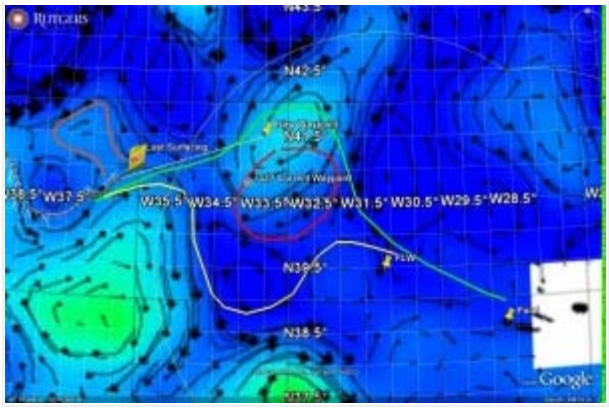
24 jul Resuming a Northeast Course

Posted by: Scott in: Atlantic Crossing

Zooming into The Scarlet Knight's present location, the eastward direction we gave her overnight looks like it pulled us out of that water heading northwest into that small clockwise circulation outlined in orange. The currents have dropped sharply to a very small value, and, direction is highly variable.



Zooming out to the regional scale, we can now move the waypoint a bit more north, and resume heading in the northeast direction, jumping out of this green sea surface high and across to the next green sea surface high located to our northeast.



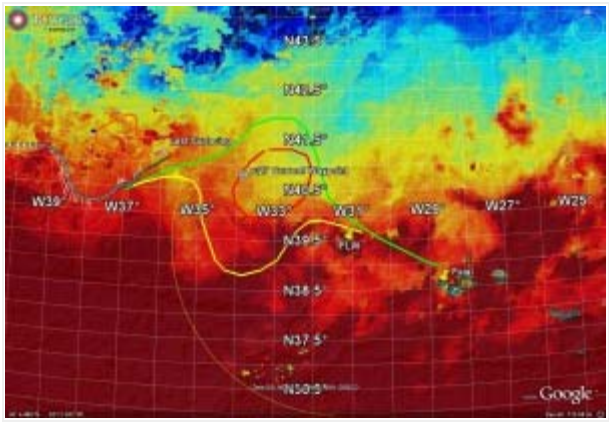
Looks like we have a good handle of where we want to go on the map. Back to work on the vertical behavior.

0 Comments

23 jul | 14 Degrees of Biology

Posted by: Scott in: Atlantic Crossing

It all slows down on this side of the ocean. Every day adds a few more kilometers. Last time I uploaded the altimetry image. This time the Sea Surface Temperature. If we follow the green path to the north, it is about 350 km to the crest of the path, then about 300 km to Flores (in this case indicated by the airport call letters of FLW). Once we hit Flores, we are about a 12 hour transit away from the University of Azores' research vessel. So thats where we want to be. 650 km from where we are now.



We are doing fine by the oceanographic roadmaps for pathplanning. Colin plotted the entire history of the water temperature today and only on 1 day during this entire trip did the glider's CTD temperature drop below 15 C. The growing concern is the biology. To all of our shock tonight, Dave set the fin offset to -14 degrees. Something is pulling us hard to the right and Dave A. had to boost the fin offset to 14 degrees to the left to turn us back to the left. We are doing a good job of holding our course - Dave K. checked the average heading error and it was about 1.5 degrees, mighty fine for even a freshly deployed glider. We are left wondering what has attached to our right side. Dave A. is planning a Michael Jackson moonwalk with the glider - fly it backwards for a bit to see if anything can be dislodged. But anytime you fly backwards, you are also taking a risk you might make things worse or damage something. Scarlet is only 95 km from a European country's EEZ. We'll hold off on the moonwalk until we are inside European waters and closer to Faial incase we break something. Unless, of course, whatever it is gets so much worse that even with the fin hard over we can't keep on course.

Then we have no choice.

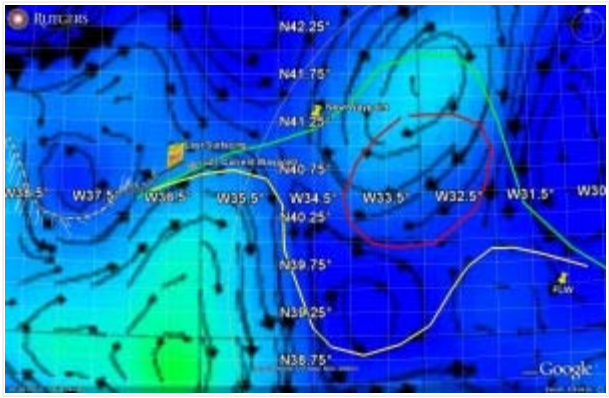
0 Comments

22 jul

Slog in the horizontal, all attention on vertical

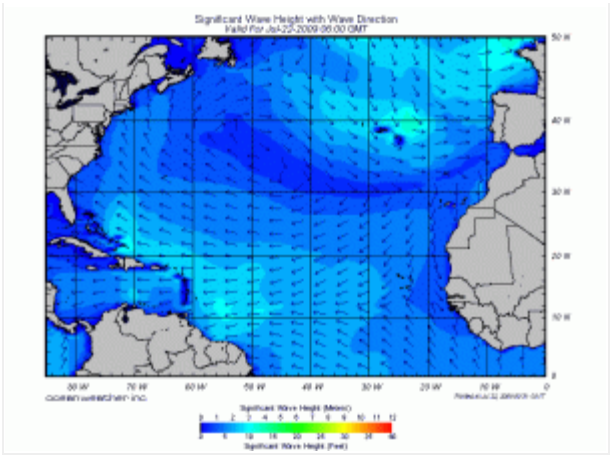
Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is continuing to slog its way to the northeast, perpendicular to the currents. The reported currents are to the northwest, into that minor clockwise feature to our northwest. Instead we want to follow the yellow or green lines. Either one gets us around the westerly currents circled in red, and brings us into Flores. We are now 103 km away from the Portuguese EEZ. Fuel gauge says we have used 1/4 of our available battery life. The batteries have been warm (>15C) the entire time, so we have no reason to lower the expected battery life. Colder water reduces the amount of energy you can pull out of them.



All the attention the last few days has been focused on steering, and adjusting what we do in the vertical to keep us heading along the desired track. As the glider slows down, you need to move the fin more to get the same lift, and the same turning moment, so we mess with the gains as the biology slows us down. We were starting to pull to the right a bit, so we increased the fin offset to negative 7 degrees to compensate and turn her to the left. Anthony, a veteren student pilot from the flight of RU15 to Halifax and RU17 just emailed that the average heading error was down to about 3 degrees. Much better. We tried another adjustment and we see how that does tomorrow.

Nilsen, another one of the students, keeps track of our satellite communications. Last night he called for a trifecta - high waves around the Azores as pictured in the Oceanweather forecast below, low density from Colin's CTD cast plots of RU27 data, and all Iridium satellites low on the horizon at 5 am. Scarlet has not missed a call since the early days back in the Gulf Stream, so we were beginning to wonder if it was still worth it to keep track. Sure enough, 5 am came and no call from Scarlet - first missed call in many weeks. Normally this would cause a lot of worry. But Nilsen called it spot on the day before, so we were braced for the missed call. Nilsen called for good satellite coverage at noon, and Scarlet called in like clockwork. Another reduction in uncertainty.



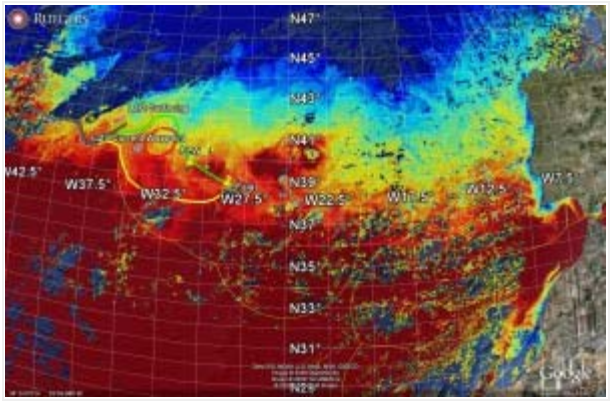
0 Comments

19 jul

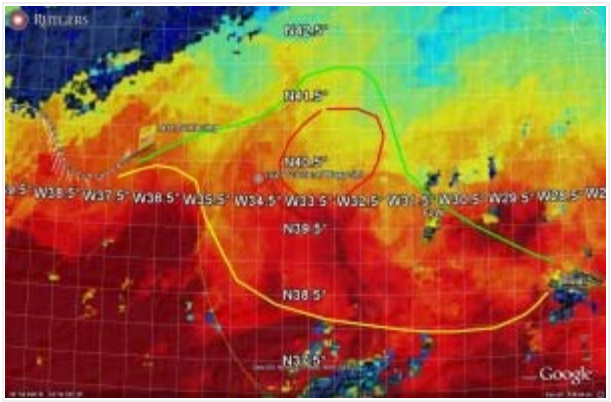
Out of one eddy, into another.

Posted by: Scott in: Atlantic Crossing

No clouds over the eastern North Atlantic yesterday means good satellite Sea Surface Temperature (SST) imagery today. Below is posted a single day's worth of imagery. Almost complete coverage of the full route to Spain. Check out the upwelling band of cold water along the coast of Spain and Portugal.

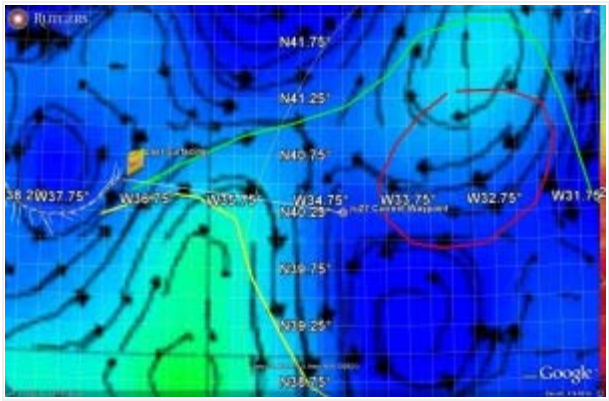


Zooming into the regional view, the SST shows us we are in the present water mass for about 100 km, then we have a band of southward flowing colder water for 100 km, followed by a band of northward flowing warm water for another 100 km.



Zooming in to the local scale and popping up the altimetry product, we see that

yesterday's setting of Scarlet's waypoint to be perpendicular to the current is enabling us to pull ourselves away from the cold eddy to our west and into the warm eddy to our east. Two paths are still available, the green path to the north and the yellow path to the south. We'll keep the waypoint perpendicular at the noon surfacing.



0 Comments

19 jul

Scarlet Focuses our Eyes

Posted by: Scott in: Atlantic Crossing

As The Scarlet Knight makes her way east towards the Azores, we have been jumping from eddy to eddy, using the boost from the eddy swirl velocity to increase our speed. A striking difference from last year has been the availability of the NRL Stennis Global Hycom Forecast.

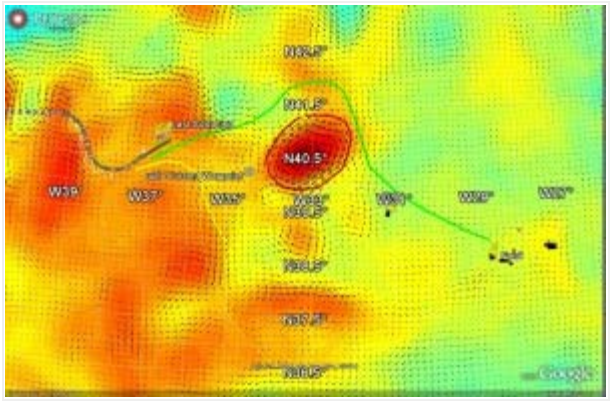
http://hycom.rsmas.miami.edu/ocean_prediction.html

Having a data assimilative global ocean forecast model available is an amazing concept in itself, but the idea that it also gives reliable maps of the mesoscale eddy field required for glider navigation is something I never expected so soon. It is probably one of the most significant differences between RU17's flight last year and this year's flight with RU27. When I met with Bob Rhodes from NRL Stennis in January of this year, one of the goals we set for this mission was to provide RU27's data on a daily basis to the Navy in a way that fit into the daily global HYCOM forecast cycle. Our goal was simply to raise awareness. All the people watching Scarlet would also be watching the different data and and model products used for navigation, providing another set of eyes. The extra eyes and the additional data would feedback to NRL forecasters information on how well the model was doing.

One thing we have found was that the NRL Global HYCOM forecast has been an invaluable asset as we are crossing the complex eddy field of the Gulf Stream Extension region. The forecast currents often line up with the sea surface temperature products, the raw altimetry products, and the glider currents themselves, increasing our confidence in the model both locally and as a roadmap for defining the path ahead. The result is a significant reduction in uncertainty, the most perplexing aspect of at-sea glider operations. The reduction in uncertainty fundamentally changes your perspective from simply reacting to what is happening now to planning for what is going to happen tomorrow.

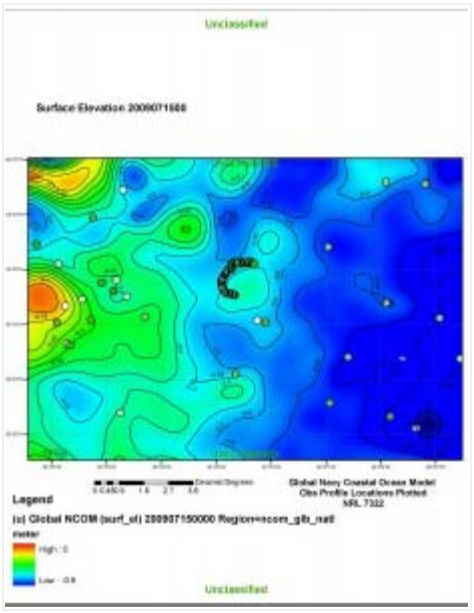
Then we hit an anomaly in the path planning for The Scarlet Knight. The situation at longitude 33 W sent us straight back to last year. We had multiple guidance products that did not agree, and you would not know which one was right until you got there. The issue was the strong clockwise circulation around the eddy in the sea surface height field (red) centered near 40.5 N, 33 W and circled in red. While all the products a couple eddy diameters away from this location seemed to agree,

this eddy was different. It was in different locations in our standard HYCOM and CCAR altimetry products. Normally this would be called a success, since both products at least had an eddy. But the difference in location has a major impact on glider path planning. For Scarlet, the difference was strong head currents that would stop us dead, or strong tail currents that would sweep us to our destination.



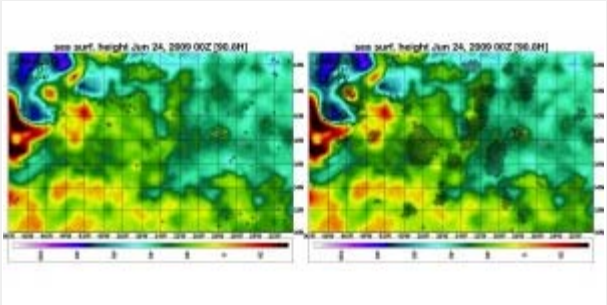
Normally a small model-data difference like this would have little impact. But there is something about a robot at sea that is depending on you for guidance that tends to focus your attention. I gave the above maps to our NRL Stennis colleagues showing that the glider had to cross or go around this area of uncertainty to reach the Azores. Gregg Jacobs saw this as a likely operational scenario for the Navy. If the Navy glider pilots asked them for guidance on a specific eddy, would the ocean forecasters be able to trace back in the data stream where that eddy came from?

The first thing NRL checked was the other forecast products. Indeed NLOM, NCOM and HYCOM all had the eddy in different locations. This highlights the value of having multiple forecasts, and points to a likely cause of the difference being what data is assimilated or how the data is treated. Jim Dykes found that NCOM (below) had a surface drifter in its assimilation data set, shown here circulating clockwise around an eddy that is located farther north than the eddy in HYCOM.

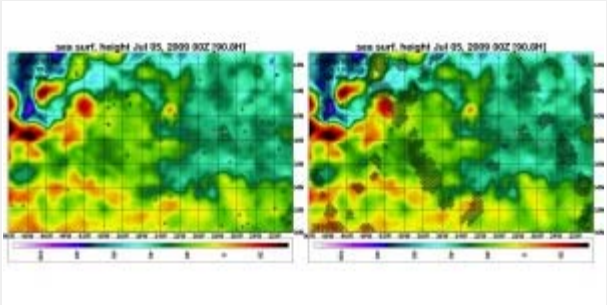


The major breakthrough came when Ole Smedsted made an animation of the different ARGO drifters and satellite altimetry datasets that are going into the HYCOM. The left diagram shows the ARGO drifter locations that are assimilated every day. The right side shows where synthetic MODAS profiles are constructed from the altimetric sea surface height analysis and are then assimilated. The MODAS profiles are only generated when there is a change in the sea surface

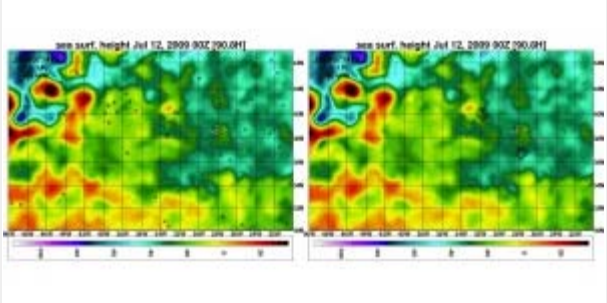
height analysis. June 24 (below) is the most data rich image in the last few weeks. On the left is a single ARGO drifter located near 40 N, 33 W, and on the right is a swath of MODAS profiles produced by the altimeter that focus around the southern side of this eddy.



By July 5, the eddy at 40 N, 33 W has fully spun up, but because there is no difference in the SSH field between now and then, no new MODAS profiles are produced on the right.



This process continues through July 12 (below), the day we looked at this, with the ARGO drifter adding data on the right to reinforce the eddy, but the altimetry on the left not kicking in to knock it down.



By looking at this specific eddy, and how it was generated by the model, the NRL researchers discovered a new feedback loop they could add to the assimilation scheme that would prevent eddies like this from creeping into the analysis. The new result helps not only this case, but also any other location in the global ocean that might occasionally experience the same artifact. By focusing our attention on this eddy for one brief moment, Scarlet contributed an improvement to the data assimilation scheme that will benefit the entire global ocean model.

This is exactly what Doug Webb and Hank Stommel were talking about in Hank's backyard just before he wrote the futuristic account of The Slocum Mission for the journal *Oceanography* back in 1989. I wasn't there, but I'm told Hank said that we will learn so much more about the ocean by racing gliders across it. Last week at NRL, I was there for one of those learning moments.

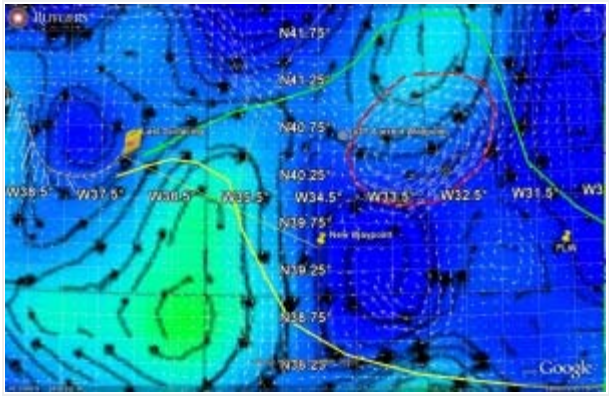
0 Comments

18 jul

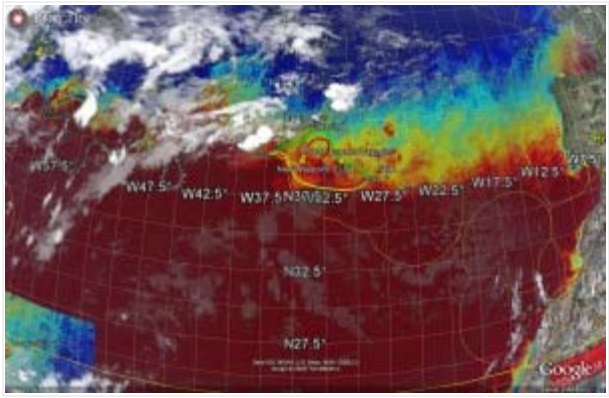
Eastern Atlantic Lights Up

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is now bending around the counterclockwise low (darker blue) developing the sea surface height just to our northwest. We are exactly 150 km from the Portuguese EEZ as indicated by the thin yellow arc. To continue our path to the east, the altimetric roadmap (black arrows) says we need to jump a streamline or two over to our right so we can follow the arrows that are turning clockwise around the sea surface high (green) to our southeast. Of course, that assumes our roadmap from yesterday's altimetry is good, and that the roads have not changed overnight. This will put us in the region where we again have the choice between a more well defined southern route (yellow) and a less defined northern route (green). The northern route is less well defined because of the counterclockwise eddy in the forecast (white arrows outlined here in red) that our friends at the Naval Research Lab recently identified as an artifact caused by the data assimilation scheme. That eddy is actually a bit farther north and weaker in the altimetry (shown here) and also in the NCOM forecast. So why are we considering the less certain physics of the northern route? Its because of the biology. The northern route is a bit colder, and we are doing everything we can to stay colder and deeper to slow down the biological growth. All indications are that we are doing fine with battery usage, so keeping the batteries warm to increase their available power is not the issue at this time. Staying cold and deep to slow the biology is preferred.



Zooming out to the large scale, we see the eastern half of the North Atlantic is nearly cloud free. This is going to help with long-term mission planning as the satellite datasets come in over the next few days. We are already receiving data from the University of the Azores, and the University of Las Palmas de Gran Canaria turned their datasets and models on for us this week.



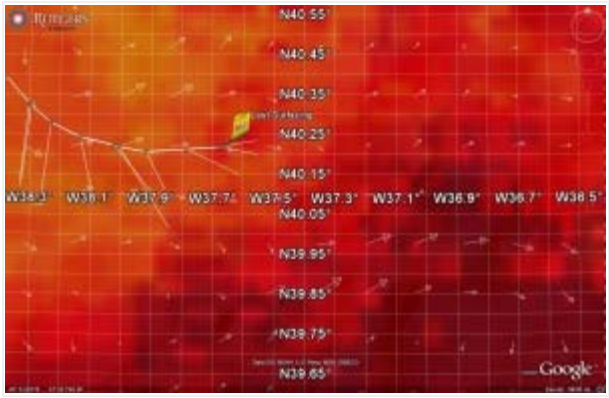
0 Comments

17 jul

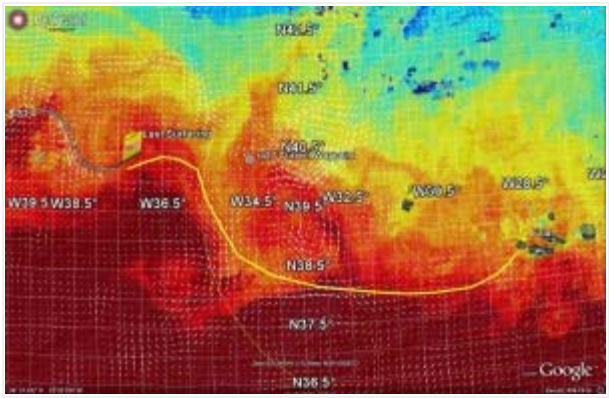
Back up on the eastern side

Posted by: Scott in: Atlantic Crossing

Zooming to The Scarlet Knight's track, we see the currents have turned to due east this morning, and we are starting the climb back up the eastern side of the U shaped trough.



Zooming out to the regional scale, we've plotted the HYCOM model currents (white arrows) over the Satellite sea surface temperature. HYCOM currents are lining up with the clear fronts in the SST image. A southern approach to Faial (thick yellow line) is clear in the imagery and HYCOM. The northern approach is developing in the satellite altimetry products. We'll be reaching the another decision point early next week. Right now we are less than 180 km from the Portuguese waters surrounding the Azores (thin yellow arc).



0 Comments

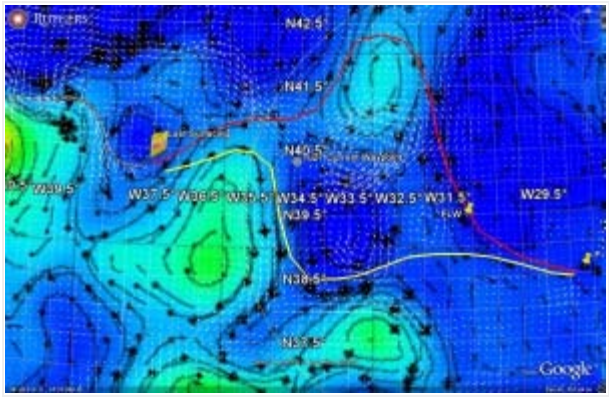
16 jul

Tina at the Wheel

Posted by: Scott in: Atlantic Crossing

I just returned from a great visit to the Naval Research Lab at Stennis Space Center in Mississippi. i flew down Sunday and returned very early thursday morning. So Tina has been at the wheel. Balancing the educational aspects of letting the students fly and the judgement of an experienced pilot is often difficult, but Tina did great. She has been easing Scarlet down and around the bottom of the "U" shaped trough and is now bringing us up the eastern side. It was pretty scary heading down into this, since the currents kept going south as the trough deepended and deepened. We kept wondering if we had been pulled through the bottom and were heading south into very difficult territory - warm temps and westerly currents - a bad combination for a glider trying to stay clean and head

east. But this morning we found that all was fine, and that the currents had turned to the east. With that, Tina turned the glider at noon and set it on a new path to the east. The objective is to keep crossing east into the streamlines that had north and east rather than continuing to circle th low (dark blue just to our northwest). With the students, they also mapped out two routes to Faial, a northern route shown in red and a southern route shown in yellow. The students noticed that the northern route was becoming more and more viable as the clockwise eddy it circles gets more and more round. The southern route has persisted for many days, and is pretty much found in both the altimeter-derived geostrophic currents (black arrows) or the Naval Research Lab's HYCOM forecast model (white arrows).



We are not sure which route we'll take, but its nice to have options. You don't always get to choose the option with a glider, so you sometimes have to just live with whatever the ocean gives you. In this case, it looks like we have two good options. The big uncertainty remains near 40-42 N, 33W, where the different products have a different location for the clockwise rotating eddy. This difference was inspiration for the Great Eddy Hunt NRL just conducted to help us out. It is a typical operational scenario - the Navy has a glider in one location, they want to send it to another location, but there is an eddy in the way. Is there a way you can tell if the eddy is real from the data? The prize was an R.U.COOL baseball cap - I always carry spares. I think I owe them a whole box. I'll write up the story over the weekend.

0 Comments

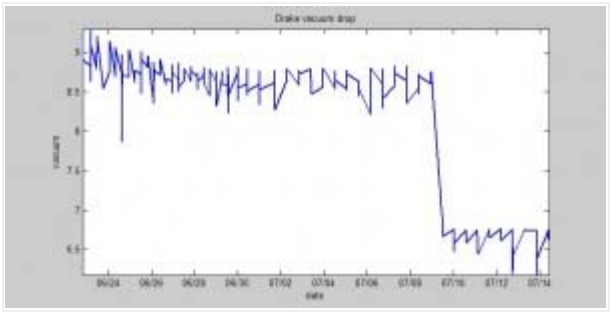
16 jul Danger Will Robinson!

Posted by: Oscar in: Atlantic Crossing, Thermal Glider Flight

Tonight we have three gliders in the Atlantic. One heads to the pick up points and prepares for recovery by the Norwegians in the fjords of Svalbard. The hero of the day RU27 as it has has turned East and we approach the EEZ of the Azores. The third glider, the Drake glider, which we hoped to head east however is limping tonight.

We received info from John Dingess that the Drake glider appeared to have developed an interior leak in the air pump system. This resulted in the vacuum decreasing since the 13th. Current diagnosis of what appears to be happening is that an internal leak in the air tubing is resulting in the aft air bladder not inflating

properly, thereby causing the tail to not come up high enough when the glider surfaces. The same air pump moves the oil internally from the forward bladder to the center reservoir. What is disturbing is given the tubing is leaking internally means that the air pump pressure cutoff switch never activates, so when the glider is climbing or at the surface, the air pump runs constantly. We are bleeding power. Our energy usage has increased to the point were it will quickly lead to a death at sea for Drake. This means we have hit a wall. It is time to readjust, lick our wounds, heal, and then head back to sea. All great journeys have twists and turns, and so we are in retreat phase of this epic journey. The Teledyne Webb team did a great job of diagnosis and planned our plan of action.



Given this, Teledyne Webb/Rutgers is turning the glider around and we head back to St. Thomas for recovery, repair, and re-deployment. To reach St. Thomas safely we will to shut off the Argos and the CTD. We will adjust how the glider flies by increasing the number of yo's per segment to keep the glider underwater for as long as possible. At the surface, we will change the surface dialog as we will not reliably have the dialog, so no files sent back. We are plotting a course back, and the power budgets back to St. Thomas. Current guess is that we around 80 days of power back St, Thomas, that should be fine, but until we are back who knows. So we return to the islands, we heal, we think, and then we head back out to sea. To challenges best yet overcome. On my first cruise in the Sargasso Sea, I worked across from English scientst who would make his measurements, and as he finished before he retreated for a gin would look up and say "never realize your dreams to early in life." For the thermal glider, this was not our time, but tomorrow is.

0 Comments

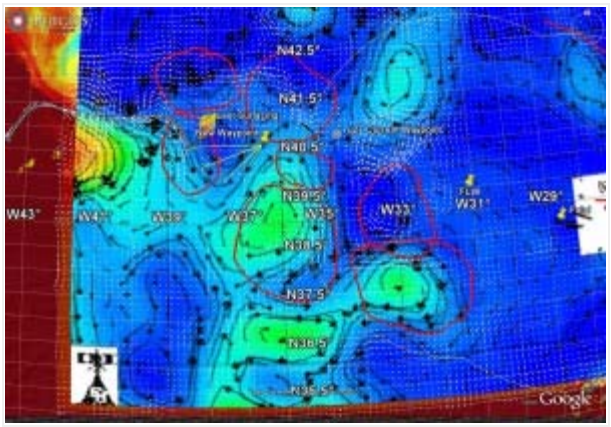
14 jul | Spinning Around the "U"

Posted by: Scott in: Atlantic Crossing

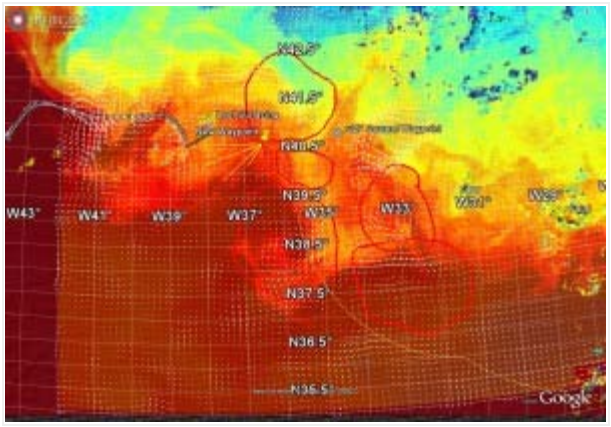
On Sunday morning's blog we decided to fly around that U shape in the altimetry currents centered near 38W that takes us southeast to about 40 N before it turns back northeast. it was a fortunate decision, since the Scarlet Knight also decided to take the same route, but pretty independently of our wishes. We are not quite sure what Scarlet's thinking was, but the major factor influencing our descision was the new SST imagery that came in over the weekend that said the clockwise eddy near 33W along the northern route was more likely in the laess favorable CCAR altimetric location, and not the preferred HYCOM model location. Again today I am

at NRL where they run the Global HYCOM, and yesterday we started going back to look into the datasets that put the eddy in one location versus the other.

For now the Scarlet Knight is progressing quickly down the western side of the "U". Current speeds are up to about 45 cm/sec, and are mostly to the south, in general agreement with both the CCAR geostrophic currents and the hycom model current. We would feel much better if the much smaller east-west component of the glider current was a little to the east in better agreement with the product guidance, but we'll have to learn to live with this small westard component. To navigate around this "U", we start with setting a waypoint on the eastern side, due east of our present location. That way we fly perpendicular to the currents, crossing streamlines towards the center where they are more likely to come around back to the north. As we go across the bottom, and up the eastern side, the waypoint continues to attact us like a magnet, in the end pulling us downstream with the current. That was the plan Sunday morning. Its Tuesday morning, and it is still a good plan.



We aslo are getting some clear cloud-free sea surface temperature imagery from the satellites. We have not had the luxury of a clear image in a few weeks. The warm (dark red) wall that runs east-west in the image is about 95-125 km to our south, depending on where you measure to. At this front we will see a change in the currents. Altimetry and Hycom both say the currents head east along this front. We hope they are right.



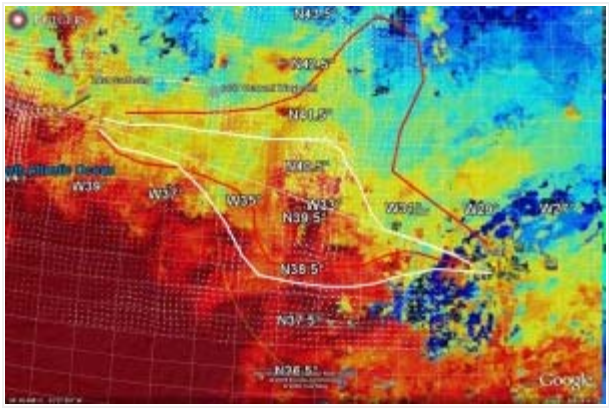
0 Comments

12 jul

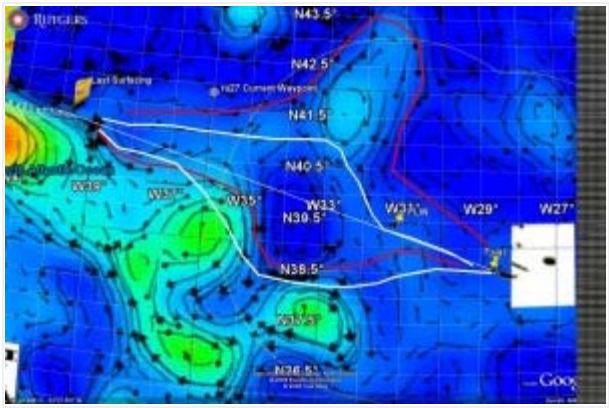
Choosing the Approach Path

Posted by: Scott in: Atlantic Crossing

Discussion since Thursday has focused on choosing an approach to the Azores. We are 680 km from Flores, but 910 km from our desired fly-by of Faial where we have the advantages of a modern oceanographic research institution. Based on the guidance available Friday, two routes were found, a southern route and a northern route. Based on the HYCOM and SST imagery, the two white lines below indicate the potential northern and southern routes.

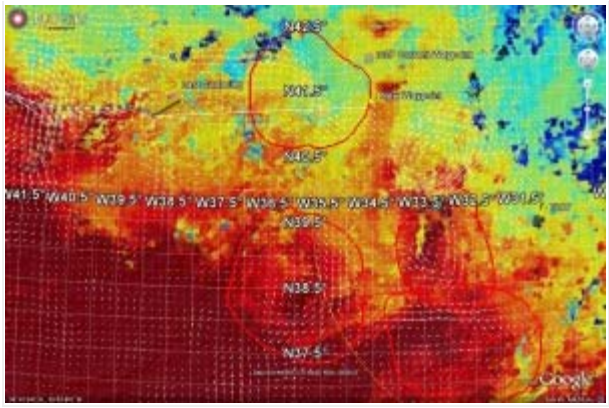


Based on the altimetry below, the two red lines represent the potential southern and northern routes. The southern routes from all three guidance products are in good agreement. The northern routes are not, with the greatest uncertainty being the locations of the eddies near 33 W. HYCOM and CCAR have the eddies in different locations.

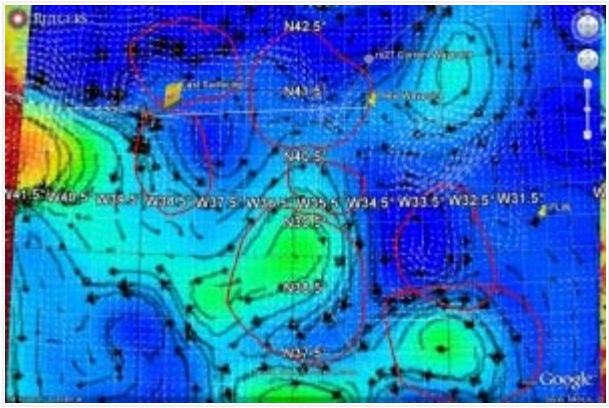


On Friday, the preference was for the northern route. The reason was the water would be slightly colder, and it would help slow the biological growth on the glider. That was fine on Friday, when we had equal probability of the CCAR and HYCOM eddy being right. So on Saturday we checked for ARGO floats and kept waiting for clear SST.

Over the weekend additional SST imagery was added by NASA and the University of the Azores as the region began to clear. Below is an overlay of the updated hycom surface currents with the new SST. We note several areas of significant agreement in the clearing region. All the eddies along the southern route are well defined in the hycom model and the swirling temperature patterns. There is a warm band in the sst along 34 W that does not swirl around the HYCOM eddy centered at 40.5 N, 33 W.



Switching over the overlay of the hycom currents on the ccar altimetry product, we note even more regions of agreement between hycom and ccar with red lines. Agreement along the southern route is very good. But currents near 41 N, 33 W are flowing in opposite directions. If you look at the location of the clockwise eddy in the CCAR product below, it agrees with a cold band of water that is circulating clockwise in the sst above. The evidence indicates that the ccar eddy location is likely correct, and the direct path to the Azores along the northern route is blocked.



That leaves the southern route as the preferred path, even though it is warmer. It looks like Scarlet already made that decision for us over night. This morning she reported she ran into a wall of southward flowing water running about 22 cm/sec, faster than the glider can fly. For us, than means we set the waypoint due east, and use it to spin us around the "U" we see in the ccar product above, first heading south, then east, then back north.

0 Comments

11 jul Partnership & More Importantly Friendship

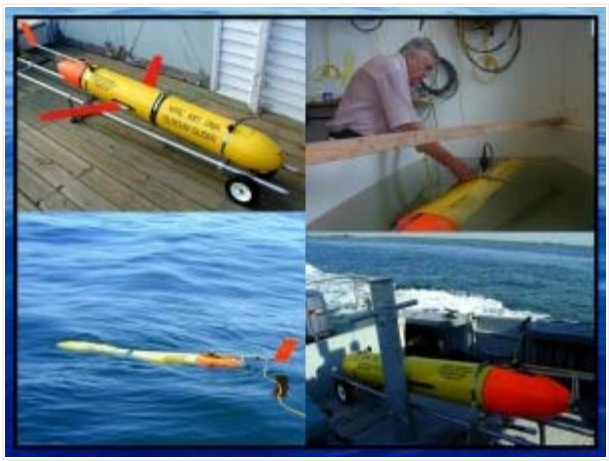
Posted by: Oscar in: Atlantic Crossing

Most great journey's in the ocean often represent partnerships between a "band of brothers/sisters". The journey of the RU27 across the Atlantic as well as the 164 glider missions spanning the Arctic, Antarctic, Atlantic, and Pacific oceans has only been possible because of the great partnership between Teledyne Webb Research and the Rutgers COOL room. The partnership began in the late 1990's during the Coastal Predictive Skill Experiments conducted offshore Tuckerton New Jersey. The pictures below were collected during summer of 1999 and show the first tests of the Webb glider in the ocean, with Doug Webb in the corner checking on the glider ballast. Note in those pictures there is still rope tied to the tail as we were excited just to have a few successful vertical profile. How far we have come in a decade! Since those early days, the group has since flown gliders over 62,000 kilometers underwater and has collected over 375,000 vertical profiles in the ocean. The

group has integrated in a range of new sensors into Webb gliders spanning optical and physical sensors. The group has modified glider hardware and software. RU27 represents a culmination of these joint efforts and when the glider makes it to the other of the "pond", it will be a joint victory. The next stage of the partnership and glider evolution grows now with start of the crossing by the Drake thermal glider. This new venture builds off the RU27 journey and uses novel thermal technology. The blog for the for the Drake journey will be posted to a Thermal Glider Flight blog (http://www.i-cool.org/?cat=41). So if addicted to RU27 excitement, when it reaches Spain, don't go cold turkey just hop aboard the Drake.

Yours truly,

Rutgers & Teledyne Webb Research

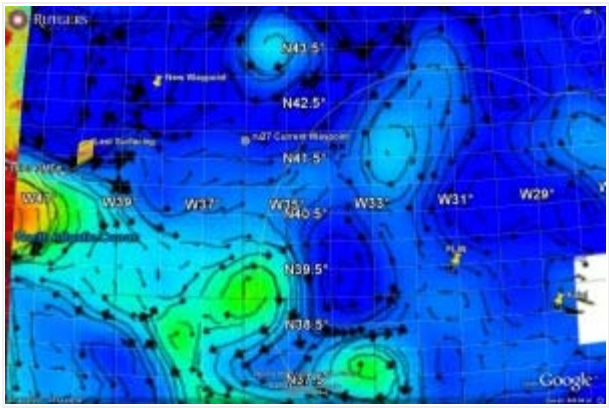


0 Comments

08 jul Setting up for the Azores

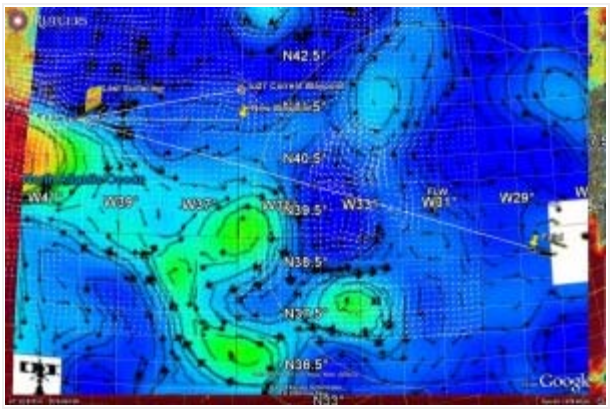
Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is reporting the 8 pm currents as nearly due east, indicating we are leaving the clockwise circulation of the orange eddy centered to our southwest. The reported currents are in perfect agreement with the CCAR altimetry product. Up the CCAR wizard score by another point.

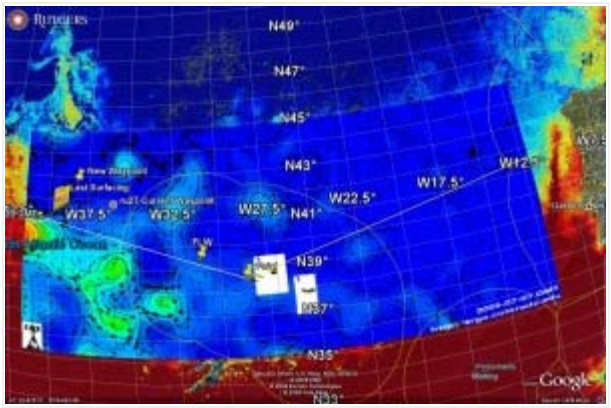


Overlaying the HYCOM surface currents (white vectors) on the CCAR altimetry, we see a generally broad eastwardly flow in the altimetry. Embedded within this is a thin eastward flowing jet in the hycom currents. Even though there is a slight difference in the predicted currents, in either case, we can start flying due east to get into favorable water by these guidance products. Our short term goal is an approach to the Azores, either the closest island of Flores or the island of Faial.

Faial is a bit farther away, but it is also the home of the University of Azores, Department of Oceanography and Fisheries http://www.horta.uac.pt/ . We visited them during spring break before we started this flight.



Below is a quick look at the new CCAR altimetry region John just put together for this phase of the flight. In the background is the global sst product from NASA. Google earth says we are 800 km from Flores, 1000 km from Faial. From Faial to the Spain/Portugal border is about 1700 km. Following the direct lines we see plenty of eddies to navigate.



We still have a long ways to go. Hope we can keep the biology at bay.

0 Comments

08 jul Biology Blip Compilation: YO Anomalies

Posted by: student in: Atlantic Crossing

Biology is one of the scariest factors of sending a glider out, especially one which is on a mission never completed before. That fear factor is amplified exponentially more when that mission is a task as daunting as crossing an entire ocean. Biology is such a scary factor because we are so helpless about it. We can counter physical elements by looking at our data and imagery and use that knowledge to use currents which could be potentially helpful to our advantage and to avoid potentially hindering currents. We can counter chemical elements by using protective paints and anodes to prevent and delay corrosion. But biology is in a world of its own: we are, for all practical purposes, helpless against biology in the ocean…and our glider data from RU27 has been giving us some conclusive evidence of that.

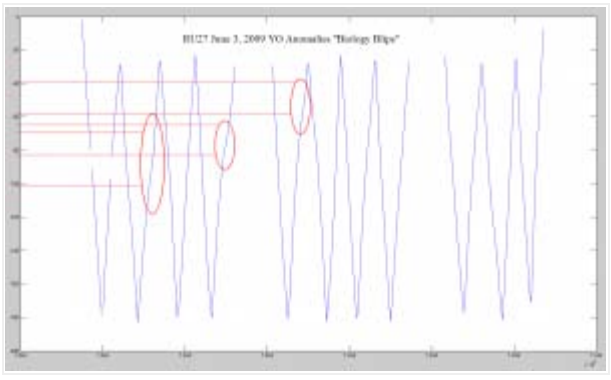
We have taken two new precautions for this flight across the Atlantic: (1) the teflon “anti-biofouling” coating to attempt to prevent or delay algae, barnacles, or remora from growing on or attaching to the glider, and (2) we are trying to keep RU27

deeper during its climb-to-dive deflection to try to avoid all of the biology towards the surface. RU27 is currently climbing to a depth of 35 m and diving to a depth of 180 m. While climbing to only 35 m is most likely keeping us out of a lot of biology closer to the surface, biology exists at all depths, salinities, temperatures, and pressures of the ocean - in every last trench and crevice.

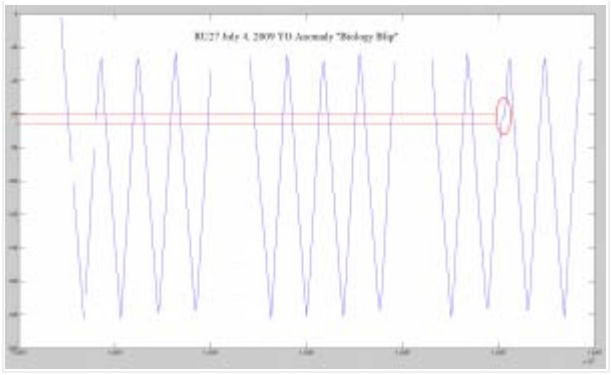
Biology can come in two forms as far as a glider, in this case RU27, is concerned: (1) Passive Biology: these biological organisms, such as algae or barnacles, pose no immediate threat to the glider. However, over time they can and will decrease the speed and consistency of the flight characteristics of the glider due to the added weight and decreased hydrodynamicity, quasi-respectively. Therefore, this will eventually become more and more of a problem as more and more time passes that the glider is in the water untouched by man. (2) Aggressive Biology: these biological organisms, ranging from remora to squid to dolphins to porpoises to sharks to whales and everything both beyond in between, pose an immediate threat to the glider. Some interactions can be meant as commensalistic, but end up being parasitic, such as a remora attaching to the bottom of the glider for a free ride. This type of problem is indeed an issue, but more than likely an inevitably harmless and temporary one. Other interactions, such as a shark attack or a whale breaching and landing on top of a surfaced glider, could easily render a glider effectively dead or sunken. We are essentially helpless against these biological interactions. If something is going to happen, it's going to happen. It's just one of those many risks of sending a glider out into the open ocean. We can take little precautions and such here and there to try to counter or prevent biology interactions, but the biology is so unpredictable and uncontrollable that our once-considered valiant new efforts to counter biology could be rendered useless and helpless with just one animal big and strong enough to damage the glider, or even a bunch or small, sessile organisms to weigh us down enough to keep the glider from completing its mission.

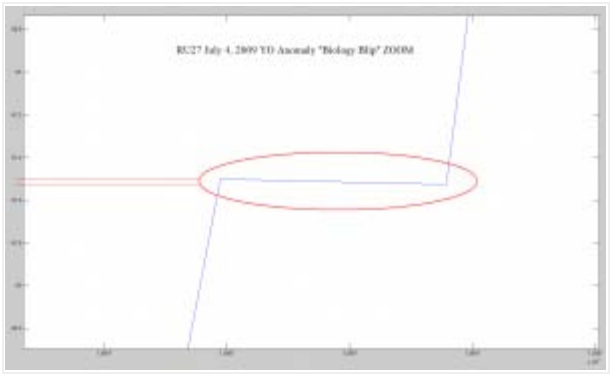
The glider data from RU27 has showed us three separate occasions where a biology encounter was a strong possibility. We can see this from the YO profiles, or vertical flight path profiles. These are basically plotted as depth over time.

The first day where we saw a YO anomaly was on June 3, 2009. In fact, there were 3 separate YO's (one dive and climb) where an anomaly was seen during the climb phase of the YO. Below is an image of the plotted data, with the anomalies encircled in red. These anomalies occurred between approximately 40 m and 100 m; within the upper half of the effective flight depth.

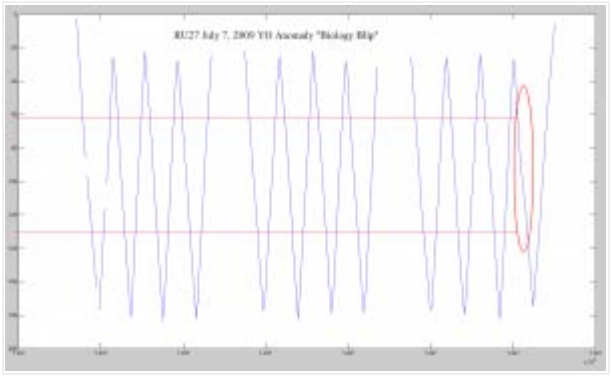


The second day that a YO anomaly was recorded was on July 4, 2009. This was the post prominent and abrupt anomaly we've seen yet during RU27's flight. Below are two images of this anomaly: the first being an image of the full plotted segment, and second being a zoomed image of the anomaly, showing it to have occurred between 61.4 and 61.6 m; again within the upper half of RU27's effective flight depth.





The third and so far final day of a biology encounter was last night, on July 7, 2009. This was a very slight anomaly, but enough to be recognized. Below is the image of the plotted glider data, which shows the anomaly to have occurred over a stretched area from approximately 60 m to 130 m, between the upper and lower halves of the effective flight depth of RU27.



These anomalies are best explained by biological encounters, as there are no known physical characteristics which could cause such drastic flight changes. Luckily, however, none of these biological interactions have seemed to permanently affect RU27, as she is still flying well and as predicted at this point of her TransAtlantic crossing.

-Dave

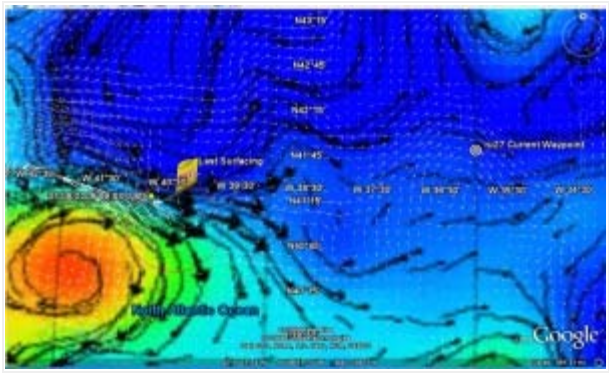
0 Comments

08 jul | Hycom or Altimetry??

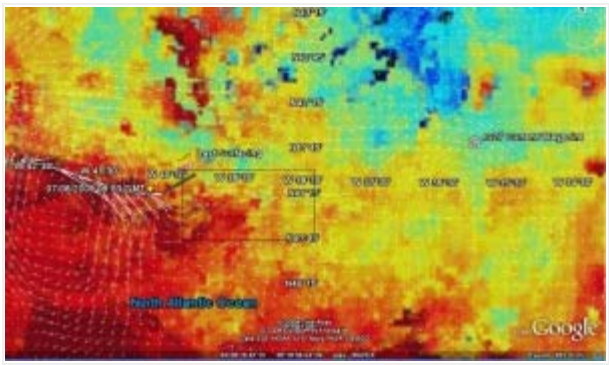
Posted by: student in: Atlantic Crossing

We narrowly squeezed through the northward and southward eddies that were threatening our eastward progression. Hycom says that we are now in an eastward moving jet which, if this is true, will be perfect. Its hard to tell though. The currents from the glider currently agree with both the altimetry and the hycom, which one do we believe? Hycom says that we are almost in the jet and the southward currents are not that big of a threat, while the altimetry says that we there is a greater possibility that we could be pulled down south.

Comparing the SST to the Hycom we see a bit more of an agreement. SST shows the jet meandering northward around the warm water finger at about 39'30W.



In order to play it safe we decided to take a waypoint East North-East. Hycom and SST may be right and we may be in the jet, making it safe to fly due east but we do not want to take the chances and loose any northward ground that we have made.



The issue on which data source to rely on is going to become even more apparent at about 36'W where hycom says there is a small eddy that altimetry does not pick up.

If there really is an eddy, do we ride the northern side of it and fly north to the islands or do we take the southern end of it and fly south to the islands? Which direction is better for approaching Spain? Lets explore the other data sources for the remainder of this week and decide if we want to gain more northern ground or slowly take the glider south.

-Em

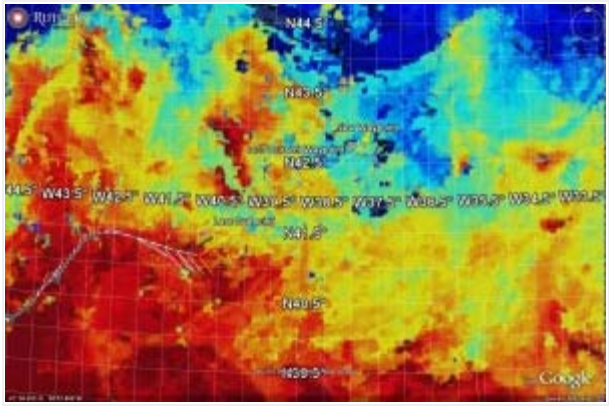
0 Comments

07 jul | Sliding east along the SST front

Posted by: Scott in: Atlantic Crossing

That front that appeared in the satellite Sea Surface temperature imagery along

41.5 N is still visible, and lines up very well with the strong currents in the altimetry and the hycom model. We are going to fly The Scarlet Knight along its length staying on the warm side. The ocean currents reported by the glider are all to southeast, so we aim the glider perpendicular and fly to the northeast. We hope the strategy results in an easterly trajectory that keeps us from getting pulled around for a lap in the eddy's clockwise rotating currents. To accomplish this, you simply choose a waypoint to the northeast, and every time the glider surfaces, you keep shifting the waypoint in small steps to the east.



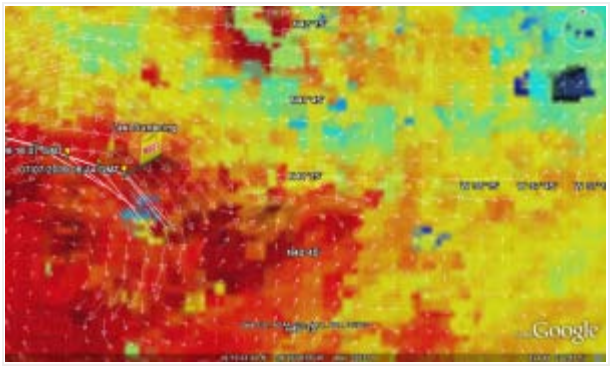
0 Comments

07 jul Incredible Data Consistency

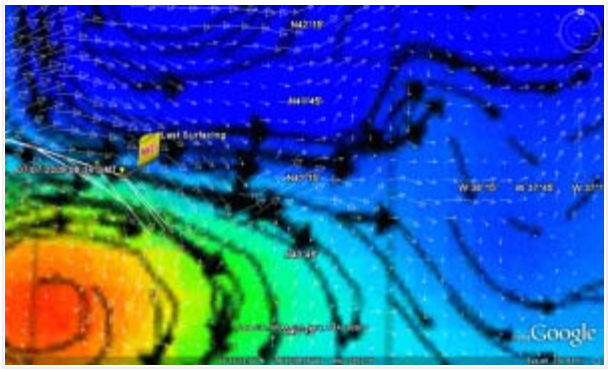
Posted by: student in: Atlantic Crossing

Our primary data methods are all showing beautifully consistent features, and even better than that: they are all showing a strong eastward current which we should be able to ride for a good 500 km or so. RU27 is only about a day or so away from jumping into this current. This current should take RU27 within practically an arms reach or two away from the Azores; a milestone point for this TransAtlantic crossing.

This image shows the HYCOM ocean prediction surface current model against SST. There is a clear consistency in the strong eastward which begins at the eastern edge of the eddy that RU27 is currently in. This is some of the best HYCOM modeling we've seen yet.



This second image shows the same HYCOM current model again against Altimetry, with both data forms having that same consistent eastward current feature. This also means that SST and Altimetry are lining up. This is a great moment for our primary data sets!



This eastward current should give RU27 a nice boost through the eddy field towards the Azores and ultimately towards Spain.

-Dave

0 Comments

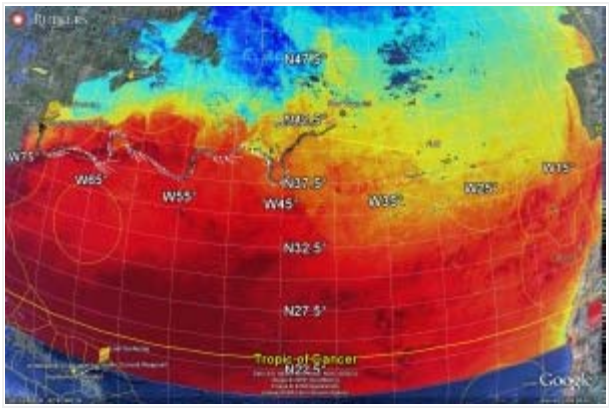
06 jul

42 W - Crossing the Half Way Line

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight surfaced at noon today and reported its Longitude as 41 degrees, 49.27 minutes West, officially crossing over onto the eastern side of the half-way line of 42 W. Undersea Glider flight is like football -the objective is to cross a goal line. It doesn'tt matter where you cross that line, as long as you get across it somewhere. For The Scarlet Knight, the lines of longitude running north-south across the North Atlantic are the grid lines of our football field, and The Scarlet Knight just crossed the 50 yard line. We are on the European side of the playing field. To get there we flew 4,270 kilometers in 70 days. Last year it took RU17 a full 91 days to reach the half-way line, so The Scarlet Knight is 3 weeks ahead of RU17's pace.

From here the Scarlet Knight is now 1800 km past Halifax, our first international checkpoint, and 900 km from Flores, our second international check point. In 520 km, we cross the EEZ of Portugal. It will be in the national waters of our scientific partners in the Azores.



Today, at this milestone point in our flight of The Scarlet Knight, I had the privilage of talking to Doug Webb, the founder of Webb Research - now known as Teledyne Webb Research - and the inventor of the Slocum Glider. It was a day to celebrate this flight of The Scarlet Knight, and to discuss plans for our next Altantic Crossing with one of the new Teledyne Webb Research thermal gliders named Drake in a project sponsored by the Office of Naval Research. Drake just finished its sea trials in the Virgin Island Testbed, and is now heading out to the northeast into

the open Atlantic. You can see its tail in the lower left corner of the above image.

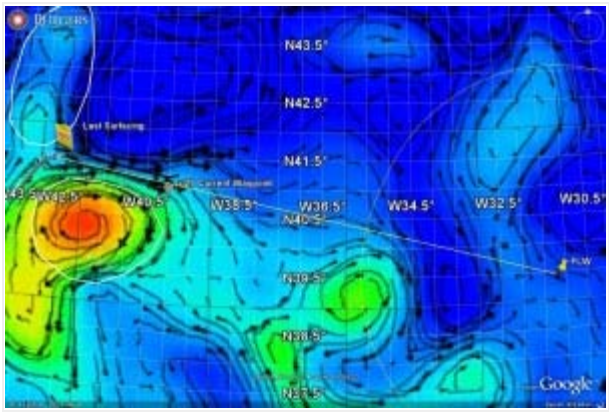
Today really demonstrated for us the importance of the National Ocean Partnership Program (NOPP). We began working with Doug Webb and Clayton Jones in a NOPP project in 1998. That partnership has lasted for over a decade. Teledyne Webb Research provides the state of the art technology, we provide the science questions and the students. Research, eductional, and technology demonstration projects then help set the stage for the big NSF science plans for regions like the North Atlantic basin. Its a good day to be an oceanography student.

0 Comments

05 jul | 999 Kilometers to Flores

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is now crossing into the eastward flowing currents found along the northern side of that clockwise rotating eddy (orange color) centered just to our south. We are now 999 km from the center of the Island of Flores in the Azores http://www.azores.com/azores/flores.php .



2 Comments

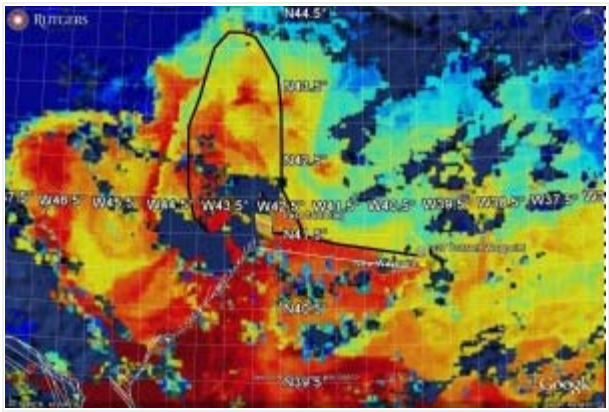
04 jul | July 4, 2009

Posted by: Scott in: Atlantic Crossing

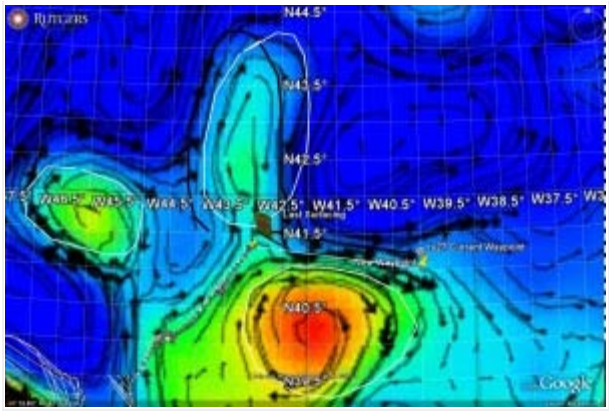
A great day to be home with your families cooking cheeseburgers on the grill. Its cloudy back home in central New Jersey, but today I'm up in western Massachusetts with my kids watching the sun rise over the lake. Just before heading north Bob Chant and I were talking about how far our community has come in the last decade. Just 10 years ago, July 4 was the last day we spent with our families before starting our month long ONR Coastal Predictive Skill Experiments in Tuckerton, NJ. Over 100 scientists and students would gather in Tuckerton for a month to study a 30 km x 30 km box of coastal ocean more intensely than any place else in the world. Physically it was all we could do, and it required what is known as "radical collocation" of people to an isolated coastal lab. It was great scientifically, but it took its toll on our families.

So much has changed. Our testbed has grown from a 30 km x 30 km postage stamp to the world ocean. The research team is globally distributed and linked by the Internet. The Slocum Gliders enable us to be at sea in the middle of the North Atlantic for a few hours each day, giving us the time to cook those cheeseburgers with the kids. The capability will change the face of oceanography. Back here in the U.S., give our universities the chance (education still takes time), and we'll soon look more like the people of the U.S.

Now back to the middle of the North Atlantic and The Scarlet Knight. NASA grabbed a great satellite SST image last night as the clouds in the great atmospheric sine wave slowly moved east. Zooming in below I've outlines 2 features with a thick black line. There is generally warm water over that clockwise eddy we saw to the north of The Scarlet Knight. This is the eddy we want to avoid. There are strong north-south oriented fronts in this image, consistent with the oval shape we have been seeing in the Colorado altimetry. To the east of the Scarlet Knight is a very strong front, also highlighted with a black line. This is the northern edge of the clockwise eddy we want to be in. The Scarlet Knight is in the ineteraction zone between these two features. Rather than let the ocean choose for us, it is time to use our own velocity to influence the decision.



Yesterday we moved the waypoint to a due east location in favor of the guidance provided by the Colorado altimetry. Here the black line from traced from the image above is overlaid on the altimetry from yesterday. It shows the Scarlet Knight in the interaction zone, and the SST front above lines up perfectly with the strong currents in the altimetric roadmap. Score a wizard point for Colorado today. Based on this information from two independent satellites, we now have a lot more confidence in our path for the next 200 km. We'll try to fly directly parellel to that front in the SST imagery. We'll use all of our speed available to move us from the northward currents we are presently experiencing to the more easterly currents we expect to see a few 10's of kilometers to our east. Happy 4th.

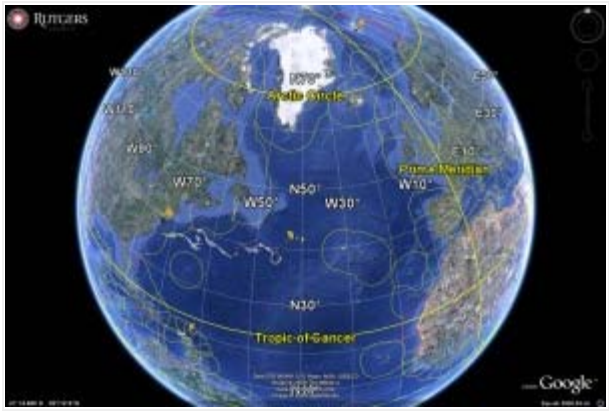


1 Comment

03 jul An Introduction to this Summer's Global Fleet

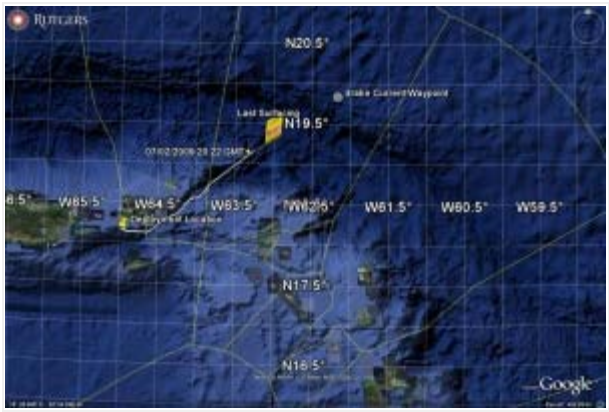
Posted by: Scott in: Atlantic Crossing

Here is a quick look at the different deployments of the Slocum Gliders made by Teledyne Webb Research (http://www.webbresearch.com/) that we are now covering in the COOLroom (http://marine.rutgers.edu/cool/auvs/?page=deployments). There are 6 glider tails in this view of google earth. To RU27, The Scarlet Knight, we add two Slocums up in Norway, two on the NJ Shelf, and one in the Virgin Islands.

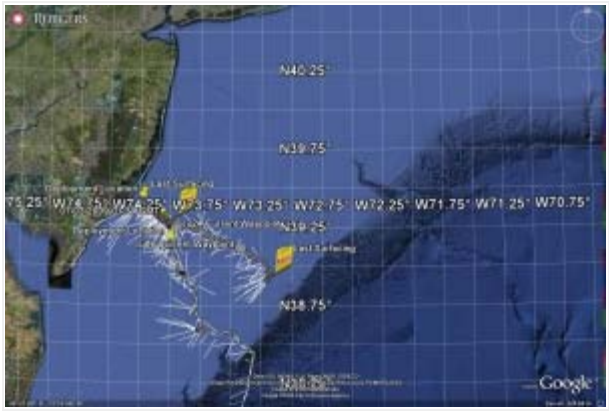


Zooming into the fjoirds of Svalbard, we have RU07 and a Norwegian Slocum Glider, Freyja, flying in tight quarters with some strong tidal currents in a collaborative education project with Norway.

Teledyne Webb Research's new Thermal Glider, Drake, is flying off of the Virgin Islands heading out into the open ocean on an Office of Naval Research project.



And two Slocum gliders are flying on the NJ Shelf. RU06 was just repaired and is out on a test deployment before being shipped to Antarctica for the next southern hemisphere summer's NSF experiements. RU24 is carrying the new FIRE sensor for a NOPP project.



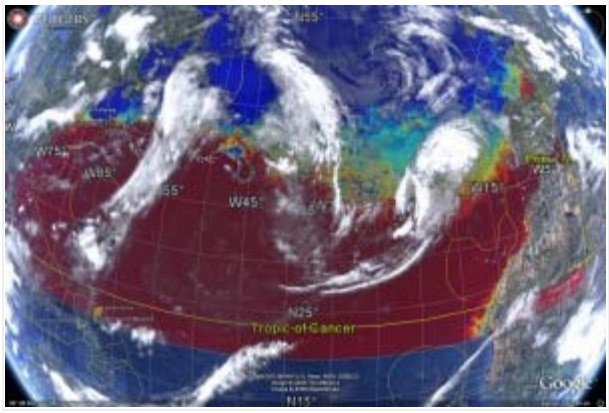
Sometime in the next couple of weeks we deploy another Slocum Glider in Alaska as part of the NOAA-led Integrated Ocean Observing System (IOOS) in collaboration with the Alaska Ocean Observing System (AOOS). We'll have to find a google earth view that includes at 7.

0 Comments

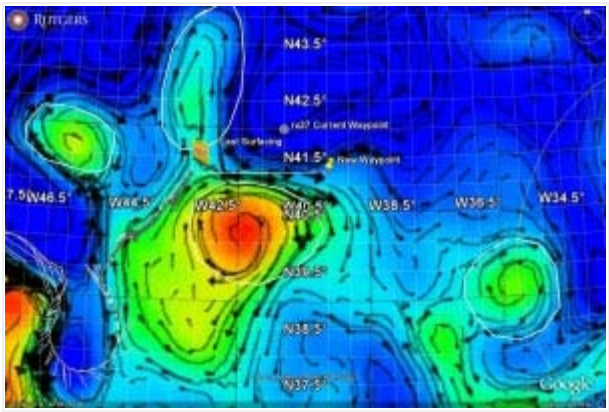
03 jul What's Downstream?

Posted by: Scott in: Atlantic Crossing

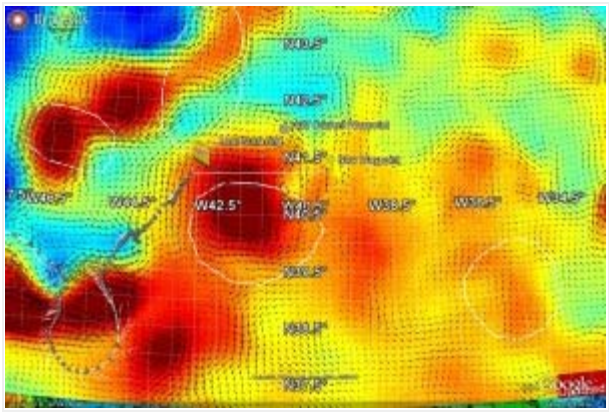
Clouds in the great basin-scale atmospheric sine wave persist. Still no clear satellite Sea Surface Temperature coverage over The Scarlet Knight.



Moving on to the satellite altimeter that does see the ocean through clouds, the CCAR sea surface height and resulting geostrophic surface currents are shown below. We've circled 3 sea surface highs (orange, green) in the eddy field. The Scarlet Knight is trying to shoot the gap between the two clockwise circulating eddies in the center of the image.

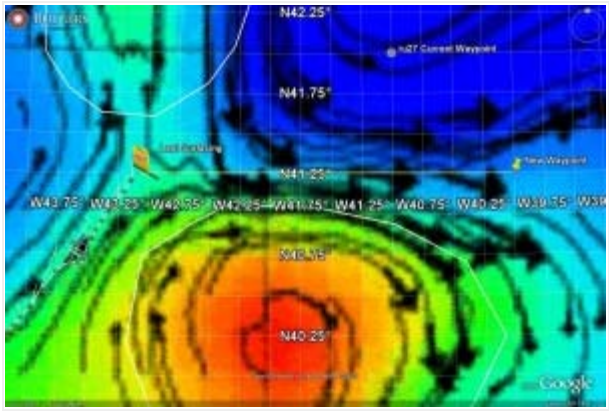


Looking at the HYCOM forecast below, in this case depicting the model generated sea surface height and the model surface currents, we see good agreement between the model current field (straight black arrows) and the glider currents (white flags along the trackline). The model currents say we are fine, that we will be swept around the northern side of the southern eddy, resulting in an eastward path.



Zooming in on the altimetry, we again see excellent agreement between the glider currents (white) and the geostrophic currents (black curly vectors). But the

downstream story is very different. The altimetry product says we are going to be swept north around the western side of the northern eddy. Which one is right? Both the HYCOM and altimeter products are in good agreement where the glider is now, but the just a few 10's of kilometers downstream, have very different results. If HYCOM is right, we should continue heading northeast. If the altimeter is right, we need to make a quick turn at noon to straight east. Since we can't afford the immediate consequences of the altimeter being right, we are turning to a new waypoint that is due east at noon.

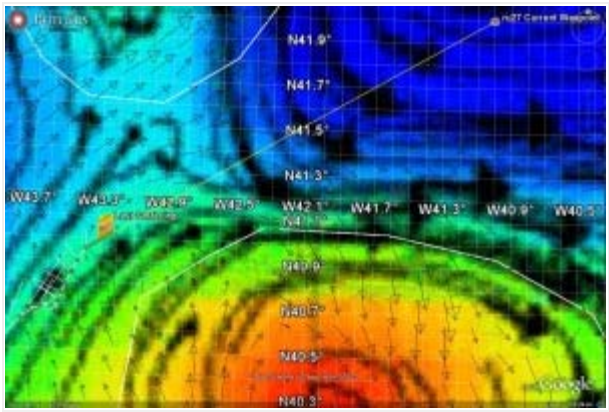


0 Comments

01 jul | More Glory for HYCOM

Posted by: Scott in: Atlantic Crossing

The image below is a composite of the Altimeter Sea Surface height in colors (red is high, blue is low), the resulting geostrophic currents as the thick curly vectors, the HYCOM forecast currents as the straight thin black vectors, and the glider currents as the white flags extending from the glider track. Our objective is to shoot the gap between the two clockwise rotating eddies, and stay within the southern eddy so that we get swept around to the east. The currents reported by the glider remain in remarkable agreement with the HYCOM forecast. The glider currents are rotating clockwise as the glider heads downstream to the northeast. We'll keep our waypoint to the northeast for the night. Likely sometime tomorrow we start making the turn.

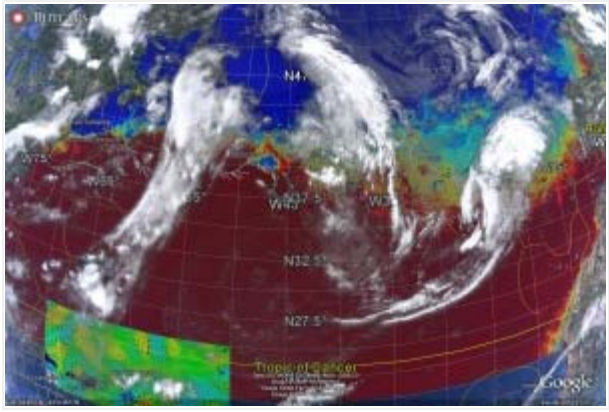


0 Comments

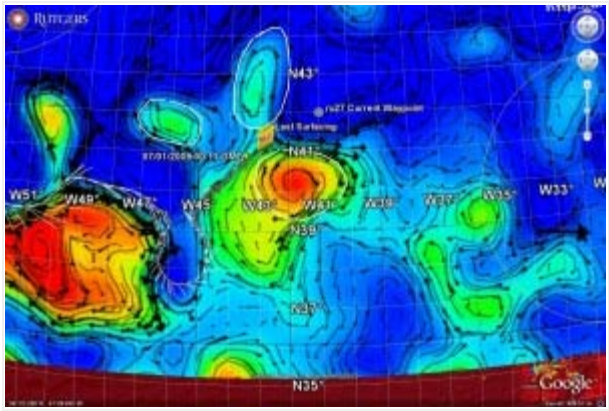
01 | U.S. Navy Scores a Point

jul | Posted by: Scott in: Atlantic Crossing

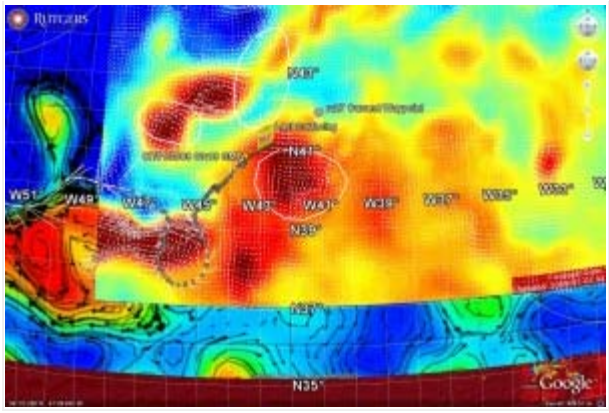
Clouds from the big sine wave remain overhead. No SST today.



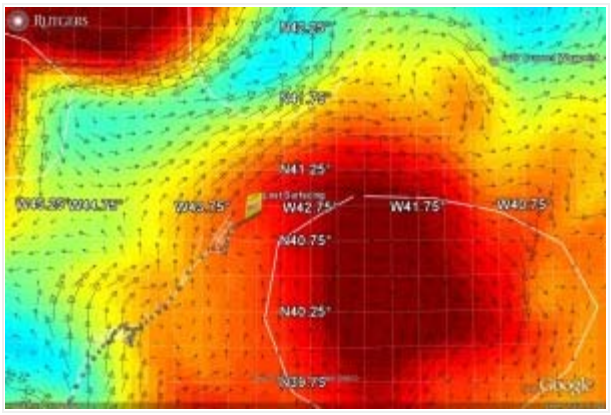
Moving on to altimetry, we have drawn white lines around three counterclockwise circulating eddies. These are observered as highs (orange or green) in tghe sea surface height map below. The The Scarlet Knight's is trying to shoot the gap between the two eastern clockwise circulating eddies. But the currents reported by the Scarlet Knight do not agree with the altimetry. The altimeter indicates we are in the middle of a broad current heading northeast, while the glider found a strong shear zone in the middle of this region and we are on the slow side.



Checking the Navy HYCOM model forecast, we have plotted the model's sea surface height and the model current vectors. We've retained the 3 white ovals from the altimetry image above. Two of the eddies are in the same location in the model and the raw altimeter data. The northern most eddy is not. So we can expect HYCOM and the altimeter data to give us two very different views of the currents in this gap.



But if we zoom into the HYCOM results below, and look inside the eastern most eddy which both the altimeter and the model have in the same location, HYCOM has a strong front with a shear zone in it right where the Scarlet Knight is sitting. It even has the glider currently located on the slow side of the shear zone. This is amazing. Can a model be that accurate? The Navy's wizard score just went up by one point.



So the Scarlet Knight is doing what we planned. It is approaching the shear zone, and currents are turning. We what to cross the front and sit just on the southern side. We may have a roadmap here, but just to our north, there is significant differences between the forecast and the altimeter data, with one saying we'll head east, and the other saying we would head north. This is a very interesting situation. If our mission today was to improve the forecast, we would fly directly into this region of greatest uncertainty to find out why the altimeter and the model disagree. But today we are on a different mission. We are going to skirt the southern side of this jet till we are beyond the uncertainty of the interaction zone.

0 Comments

30 jun | The Issue with Scales.

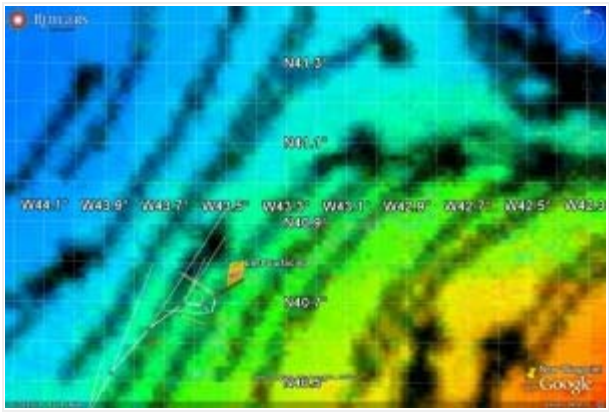
Posted by: Scott in: Atlantic Crossing

Ana Martins, our University contact in the Azores, just posted an excellent comment on the June 3 blog on our first encounter with something biological. Check it out by scrolling down to the 4th comment at:

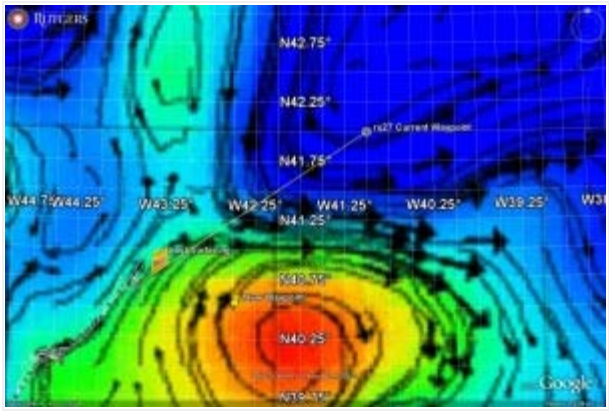
http://www.i-cool.org/?p=2538#comments

We have our biological challenges. Today we are dealing with a physical challenge. Check out the scale of the horizontal shear in the currents being reported by The Scarlet Knight over the past 24 hours. The short yellow line I drew just south of

the present location is only 8 kilometers long. Within that short distance, the currents went from 46 cm/sec to the northeast, down to nearly zero, and then back up to 15 cm/sec to the west. Meanwhile the geostrophic road map from the satellite altimetry says no worries, all currents are running to the northeast. The issue is scale. The satellites looking down from space only see the larger scales of the major highways, but the small glider feels every bump and wiggle in the road.



So what do we do? If we continue east, we head straight into the current and into the center of the larger clockwise circulating eddy (orange). If we head north to try to get back into the strong currents flowing to the northeast, we risk being swept into the clockwise circulation of the smaller oval shaped eddy (green) to our north. That would also delay progress. So we pick a comprimise and head in the northeast direction by setting a distant waypoint. Because the waypoint is so far away, small changes in our position have little effect on our flight direction. We'll try to maintain this direction until we see the currents increase as we try to just skirt those few streamlines that whip around the larger eddy and carry us east towards the Azores.



1 Comment

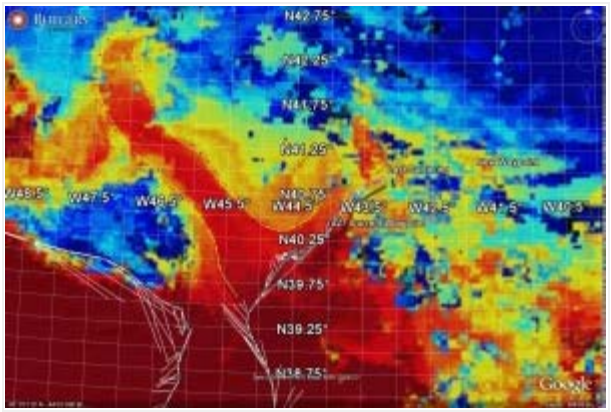
29 jun

The Most Difficult 125

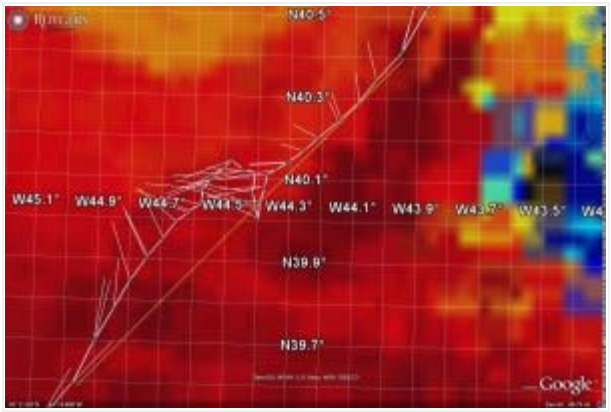
Posted by: Scott in: Atlantic Crossing

So why the break in the blogs last week? A few have asked, so this blog covers the missing piece. Followers from last year already know that less frequent blogs mean (a) difficulty with the glider, (b) we are even more busy at work than usual, or (c) kids. Last week was our perfect storm of excuses. We ran into the most difficult 125 km of flying we have done on this entire trip, we had a whole range of ocean observatory meetings and education programs here at Rutgers and abroad, and four of us here in Marine Science had kids graduating high school. For now we'll focus on the difficult flying.

Sunday's image below shows the feature we had to cross, a warm squirt of water heading northwest that I've outlined in yellow. At the time, we did not know about this connection between our present location and the squirt that ran up to a warm eddy to the north. All we knew was that the altimeter said the currents should be to the northeast, and that the glider currents did not agree. Every direction we turned seemed to lead us into a headwind. It was not until after we made it across that the clouds cleared to show us that we had just crossed the feeder zone for this squirt.



Zooming in below on the section of track that runs across the base of the warm squit, I've drawn a yellow line from where the currents were to the northeast on Friday, June 20, until they went back to northeast on Sunday, June 28. The distance is 125 km. First the currents starting pushing us northwest, and the glider track bows out in that direction. We continued flying northeast, hoping to get out of it until we encountered a strong headcurrent from the northeast that stopped us dead. If we tried to fly northwest to get out of it, all we knew was that we would likely be forced into the squirt and be swept farther into that eddy to our northwest, opposite of our intended direction. Rather than risk this, we adopted a new exit strategy, and doubled back on our path. We changed our course and tacked to southeast. We ran in this southeast direction for a bit more than a day to get in a better position. Then we turned back to the northeast and gave it a second try. This time we broke through. To help us break through, we kept the glider at the steep flight pitch angle of 35 degrees to give us as much forward velocity as possible duing this 7 day period.



0 Comments

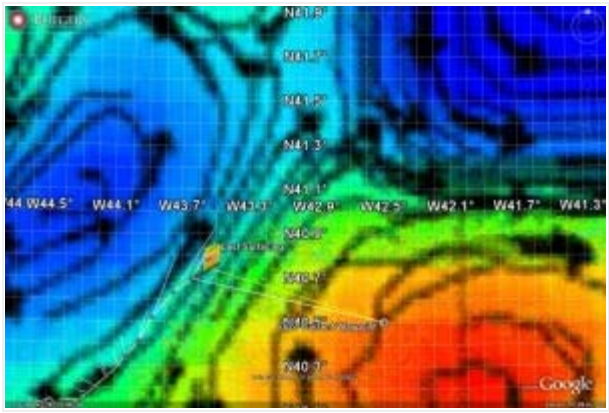
29 jun

Approaching the Turn

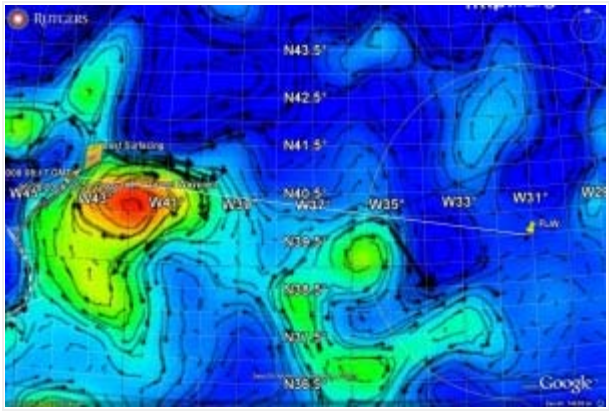
Posted by: Scott in: Atlantic Crossing

Glider currents this morning are running to the northeast, parallel to the

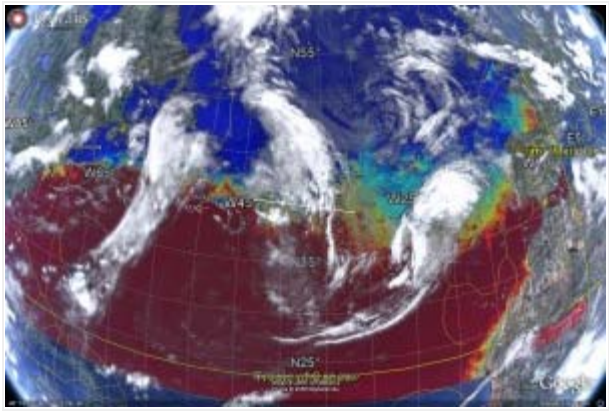
geostrophic currents in the altimeter data. Just downstream of our location, the current splits into two paths, one turning left and heading north, the other turning right and heading east. We want to be on the right side of this current to make sure we turn east. To accomplish that, we'll continue heading towards the core of the eddy. As we spin around the corner, we'll head deeper and deeper into the core.



As soon as we make the turn to the east, we then have to start flying back out of the eddy so we can exit on the eastern side. The distance to the Flores Airport (FLW) is 1075 km. There are favorable currents along this line all the way to 35 W.



The sine wave in the jet stream is now covering us with clouds. We'll have to wait to see whats downstream in SST.

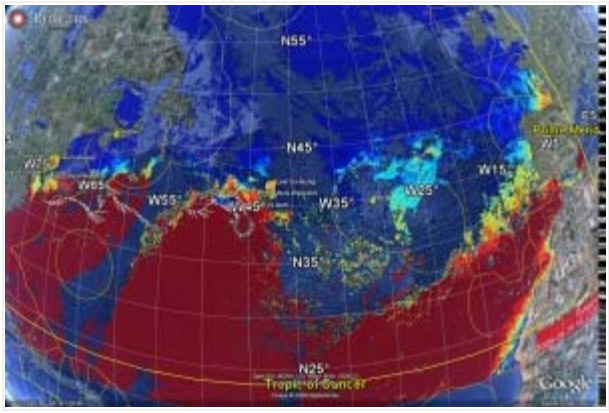


0 Comments

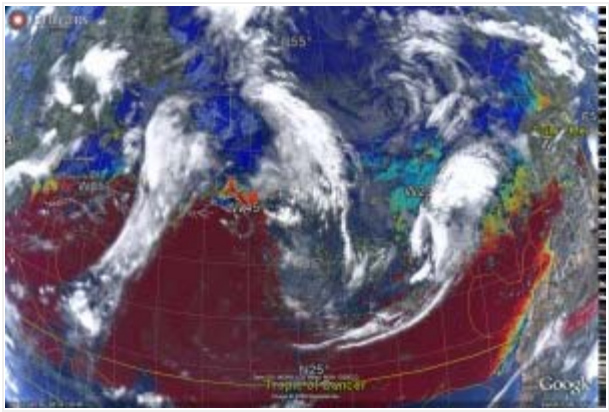
28 jun — A Basin-scale Wave in the Jet Stream

Posted by: Scott in: Atlantic Crossing

Below is the full basin-scale SST image from yesterday. Clear areas with good data interspersed with bands of no-data. The region outline in the previous blog is in the middle of the iamge.



Turn on the clouds in google earth and a basin scale sine wave in the Jet Stream appears. As the Jet Stream flows towards the east, it loops around our western side, around us to the north, and then back down along our eastern side. We are in the clear area just under the crest in the sine wave.

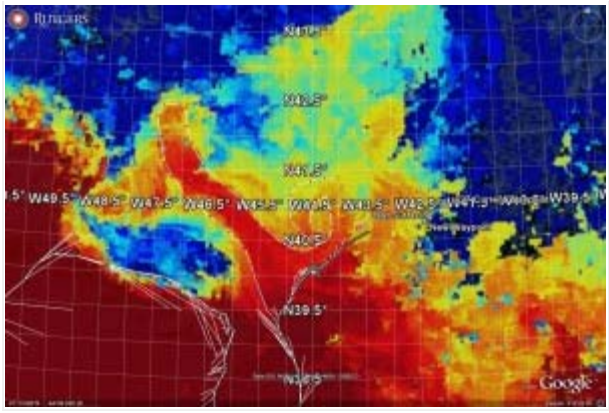


0 Comments

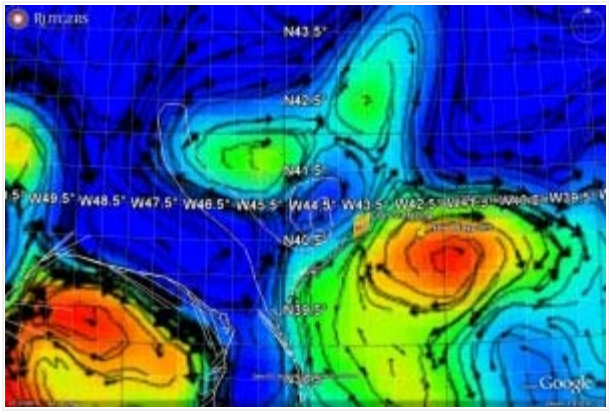
28 jun — Crossing the Warm Jet

Posted by: Scott in: Atlantic Crossing

The new SST image from yesterday shows what we just accomplished with the Scarlet Knight. A warm jet of surface water oultined with a white google earth path line is shooting off to the northwest. I've also outlined a distinct spiral observed in the SST just to the northeast of the jet. The Scartlet Knight crossed the base of this jet heading northeast, encountering strong head-currents the entire time.



Overlaying the traced SST lines on the Altimetry, we see how well the SST features line up with the major currents derived from the altimeter, both the clockwise currents around the sea surface high and the counterclockise spiral around the low. Yet the altimeter still does not do a good job of resolving the currents at the base of this jet in the location we just crossed. The amazing thing is that we made it, into a head current the whole way. Teledyne Webb Research builds a mighty fine glider.



0 Comments

28 jun

Sunday Morning Waypoint

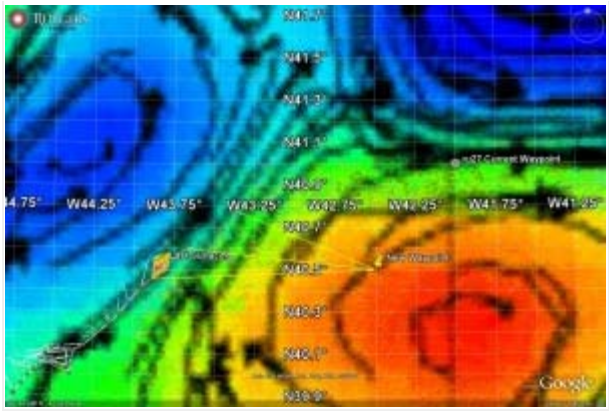
Posted by: Scott in: Atlantic Crossing

John's message to Starfleet last night had the perfect forecast. The currents would turn, and they turned at 4 am, and we would need to shift the waypoint south.

The new waypoint is 40 30 N, 42 30 W. It is also a little bit west from the last one.

The image below shows the plan. The white google earth Line is 30 km long from the last surfacing to where we expect to be in three 8-hour segments.

The yellow Path lines show various angles to the expected path of RU27. As John said, the idea is to dig deep into the eddy to make the turn to the east that occurs at 43 W. Once we do that, we need to get back in the center of the jet to get out of this eddy and catch the next one.



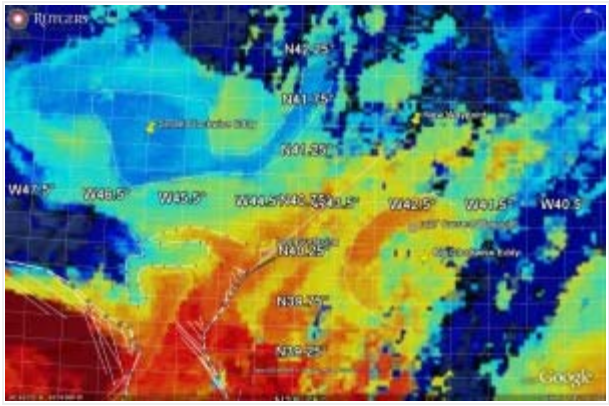
0 Comments

21 jun

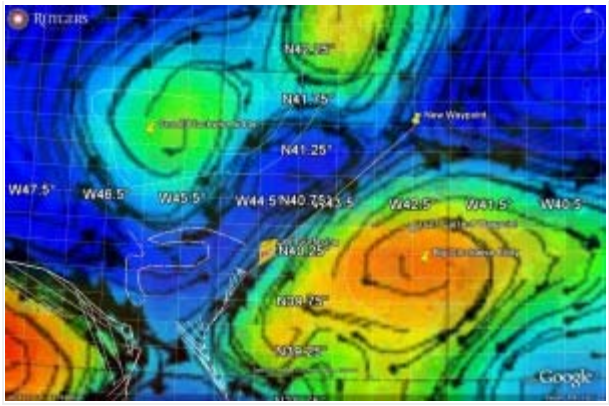
Small Scale Eddies

Posted by: Scott in: Atlantic Crossing

Yesterday we received from NASA a clear SST image from the cloud gap over The Scarlet Knight. Here we zoom in on the region just around the glider and start idenitifying the features. We see the Big Clockwise (rotating) Eddy to our east, and the Small Clockwise (rotating) Eddy to our northwest. We drew a pathline around the core of the Big Clockwise Eddy, and another pathline around the outer edge of the Small Clockwise Eddy. In between these two major features, and just to the west of the glider track, we see some warm and cold filaments forming in the front between the warm and cold water. We have also drawn pathlines around these filaments. The filaments appear to be wrapping themselves around an even smaller counterclockwise rotating eddy. The currents now being reported by the glider are consistent with this new small feature. It looks like the glider currents are identifying the water that is flowing into the warm filament that is wraping around this small eddy.



When we take these same pathlines we found in the SST and overlay them on the altimetry, we see how well the features line up. While there is not a closed counterclockwise circulation cell in altimetry, we can see how the filaments are being advected in this pattern by the neighboring flows.



The combined dataset indicates that our need is to get northeast as fast as possible to avoid getting entrained in that warm filament feeding into the small counterclockwise eddy. To accomplish this, we'll move the waypoint a bit further north. We'll stay perpendicular to the present glider currents, and try to make our way northeast and beyond this filament. Once we pass this feature (about 40 km from now), we can again start worrying about split in the current about 180 km downstream.

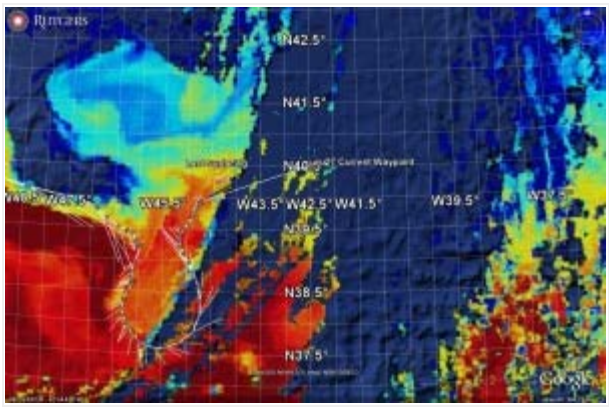
0 Comments

20 jun

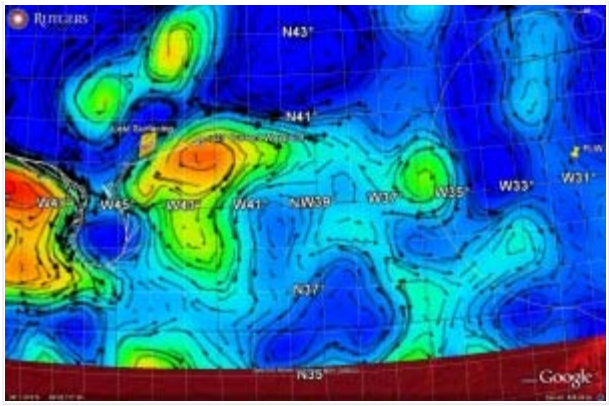
New imagery just in

Posted by: Scott in: Atlantic Crossing

The clear SST imagery is starting to arrive from NASA. Here is the first pass. A clear spot right over The Scarlet Knight. She looks good with the present trajectory. Currents to NW are decreasing. But we'll keep heading in this direction till we get a clear shot of what is downsteam.



The new altimeter data that just arrived from Colorado shows why. About 180 km downstream, the currents split, with one path on the right going east nearly to Flores, and the other path on the left turning 180 degrees to the left and doubling back on itself. It is very important for us to be on the right side of this current in about 180 km.

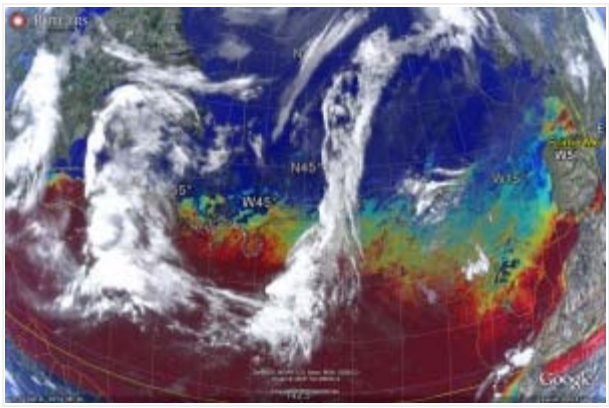


0 Comments

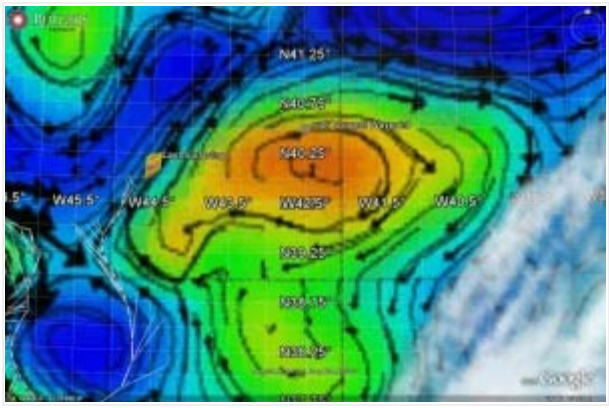
20 jun | Better data tomorrow?

Posted by: Scott in: Atlantic Crossing

Scarlet is sitting in the gap between the clouds. We should have better SST imagery from NASA available to us some time tomorrow.



Zooming in on the altimetry with the clouds left on, we still see no explanation for the northwest direction of the currents. Only alternative is to check the satellite ocean color imagery.

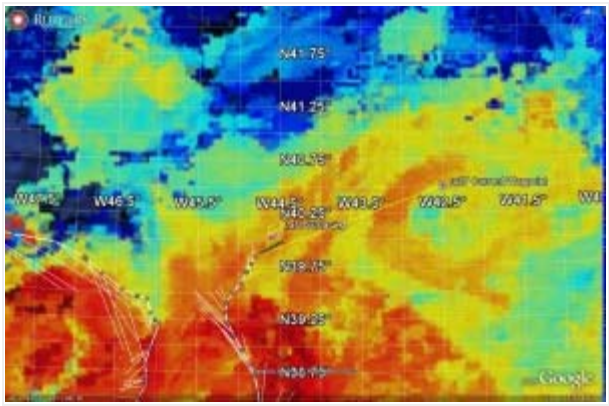


0 Comments

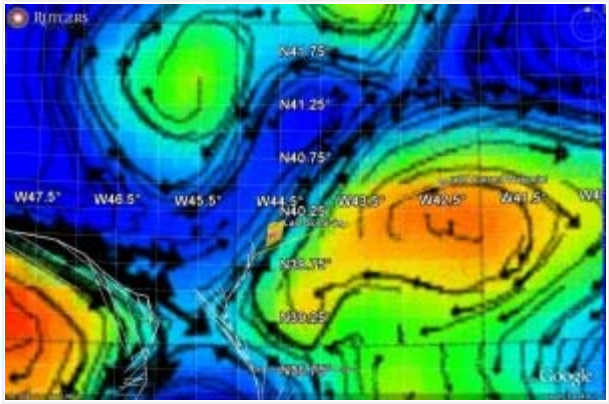
19 What happened to the easy weekend?

jun | Posted by: Scott in: Atlantic Crossing

Taking advantage of the tailwind was supposed to make this an easy weekend. So what happens? Its 8 pm on friday night and Scarlet surfaces to tell us that the most recent current vector has turned to the northwest. But how? We are heading into that clockwise rotating eddy to our northeast centered near 40 N, 42 W. Currents should also be to the northeast. Instead they are northwest, heading toward that distance clockwise rotating eddy near 41.5 N, 45.5 W.



Checking the altimeter, the is no sign of a current connecting Scarlet's present location with the eddy to the northwest. Everything should be going northeast, except its not. There must be a smaller scale feature in the flow that is not being resolved by the altimeter and its surface expression is not being seen by the SST sensors. It makes this part of the journey difficult. Our roadmaps are far from perfect, and this area in particular is difficult to read.



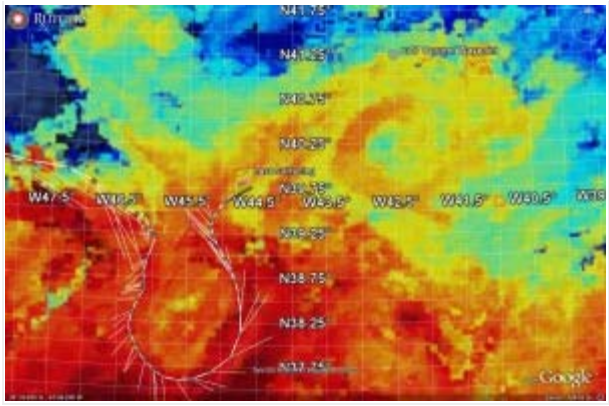
So what do we do? The same thing as we did in the cold eddy we just lew out of. We fly perpendicular to the most recent current vector towards a region with more favorable velocities. And you keep watching and hoping.

0 Comments

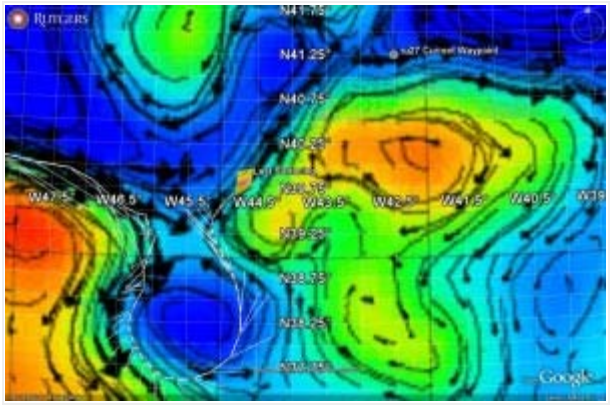
18 jun Found the Tailwind

Posted by: Scott in: Atlantic Crossing

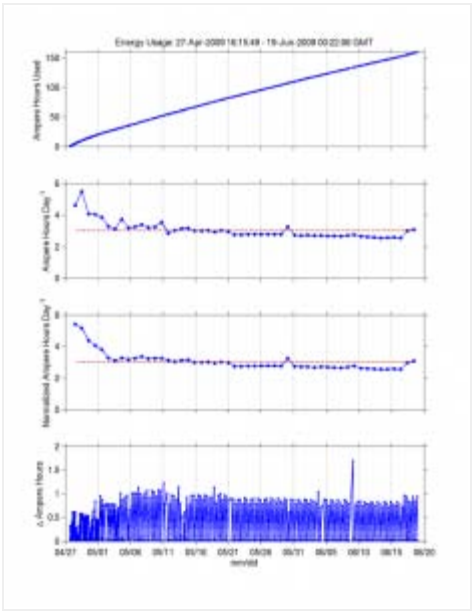
At noon today the currents whipped around to the Northeast. 8 pm was the same, northeast currents. We are out of the cold eddy and heading northeast towards the warm eddy.



Altimetry says we are lined up with the geostrophic currents - whats the big deal? Why all the worries?



Several bets were made on this one. Would we make it out or would we be spun around again. This time we manage to fly out of the eddy and win. We had extra speed available, so we used it. But it cost us some energy. The third plot in the series below shows the normalized amp hours per day jumped from 2.75 to 3.0 after we increased the speed.



We'll throttle back tomorrow at noon to go back to our energy saving flight characteristic. We don't like to do too much at 4 am. We'll also start dealing with

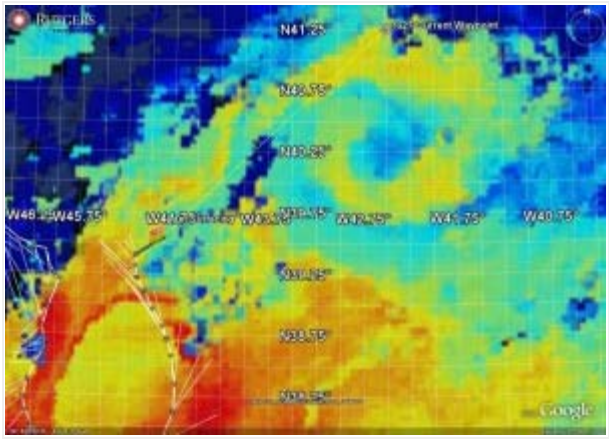
the biofouling that is starting to develop. But thats for tomorrow. Tonight we sleep, and The Scarlet Knight flies northeast with a tail wind.

0 Comments

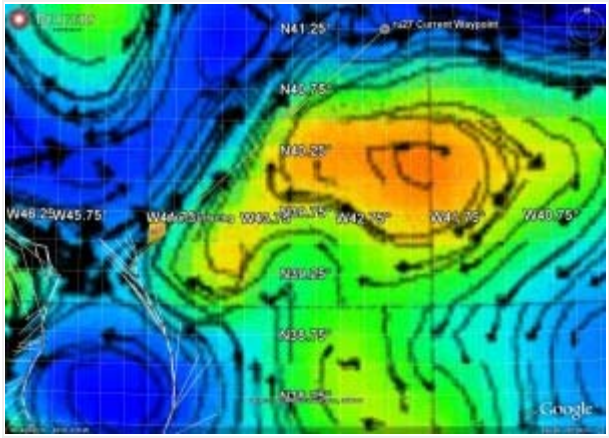
18 jun | Bend it Like Beckham

Posted by: Scott in: Atlantic Crossing

No time for words this morning. The pictures tell the story. Glider currents are decreasing and rotating toward the east as we leave the eddy on the north side.



We hope to ride the current we see in the altimetry up to the north then turn east around the high (orange) in the sea surface height.



We'll keep our speed up at least until we see the east-west component of the current turn to east. Then we can go back to our power saving mode.

0 Comments

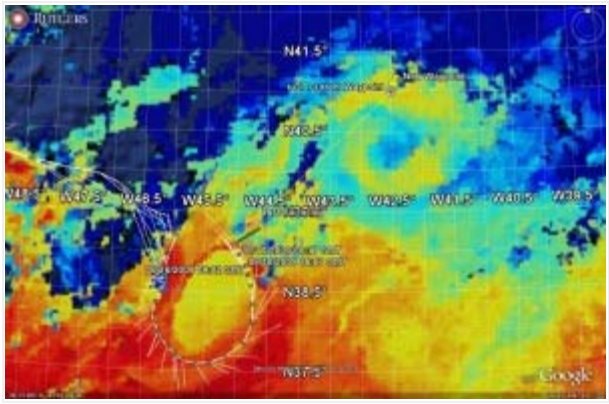
17 jun | Rigged for Speed

Posted by: Scott in: Atlantic Crossing

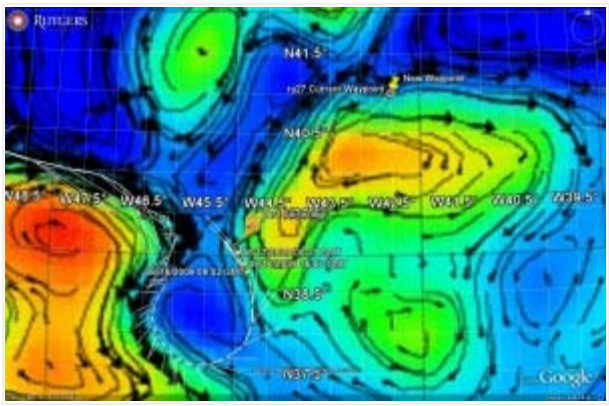
We continue looping rapidly around the counterclockwise rotating eddy, and are trying to exit on the north side without getting spun around for a second lap. To accomplish this, we continue to update the waypoint every 8 to 16 hours so that we are always flying outward and approximately perpendicular to the current. To help us along, we throttled up to full speed by increasing the buoyancy pump

motion from 90% to the full range, and increasing the dive and climb angles from 26 degrees to 35 degrees. It costs us a little in power, about 10-15% based on the initial look. But this is one of those cases where we need the speed.

The sst image below shows we are just leaving the colder elliptical core of this eddy and are now in the ellipical ring of warm water that is being pulled around the outer edge. The glider-derived swirl velocity of this eddy peaked at 70 cm/sec. The present glider velocity is now down to 62 cm/sec, further evidence we are moving in the right direction. But will we make it?



The satellite altimetry below indicates we should. That the stronger currents should start heading northeast. But the glider is reporting currents to the northwest. We'll keep flying northeast and hope the ocean currents we see start to line up with the data.



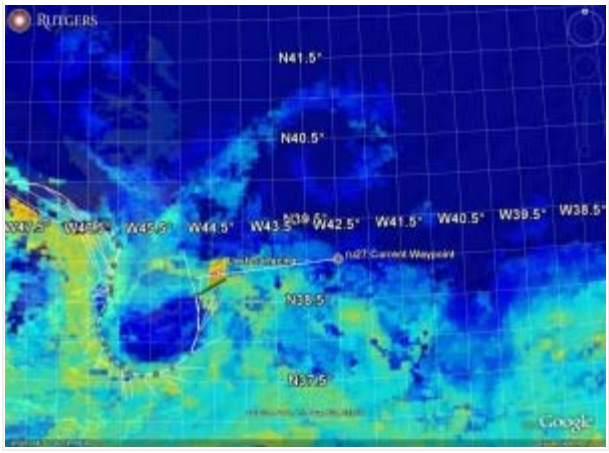
0 Comments

15 jun

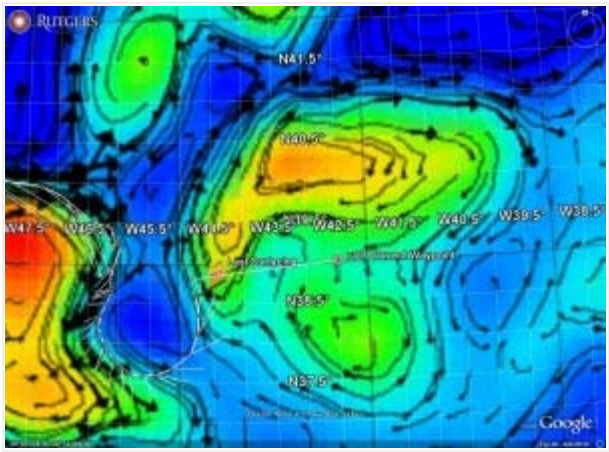
Looking for the Exit

Posted by: Scott in: Atlantic Crossing

Over the weekend we were doing everything we could to fly into the cold eddy. Now we doing the same to fly out. SST image below tells the story. Glider reported currents are increasing, up to over 70 cm/sec, so we are really covering some ground. Over the weekend we were looking at 1300 km to Flores, now we are less than 1200 km away. We want to exit this counterclockwise rotating eddy on the northern side, and then continue north into the clockwise rotating eddy to our northeast, hoping for a similar boost in speed.



Both of these eddies can be seen in the Sea Surface Height image below. We are moving counterclockwise around the low (blue), and at 8 pm we moved the waypoint to a new position in the east. The objective is to fly into those currents heading north and continue around the high (orange). We don't want to get pulled around the low for another lap. We should know by morning if we are successful.



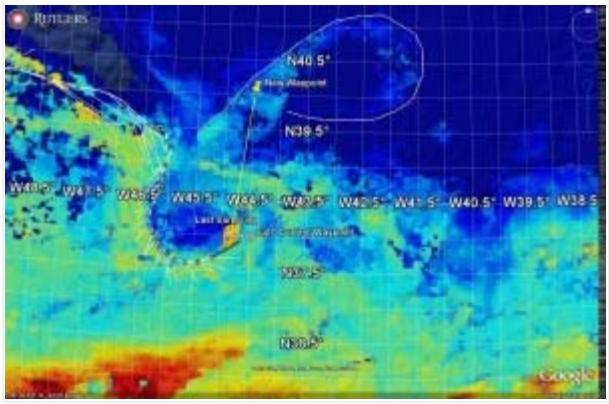
0 Comments

14 jun

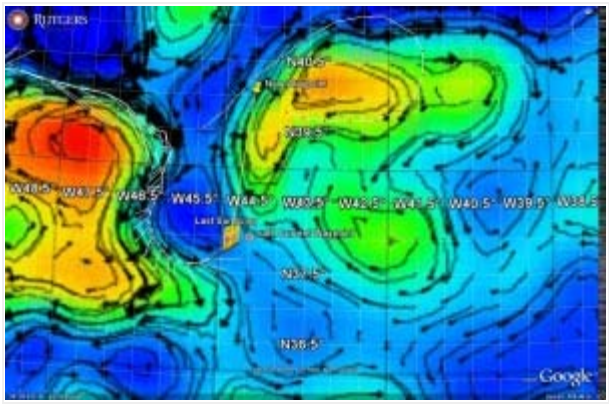
Physics is Your Friend

Posted by: Scott in: Atlantic Crossing

Rounding the southern side of the counterclockwise rotating cold eddy, the currents continue turning, at this point heading straight east at more than 50 cm/sec. For us, east is almost always a good current direction. With this development it is time to switch to a new waypoint, as usual heading nearly perpendicular to the current, and try to make our way north. The satellite Sea Surface Temperature image shows us where to go. There is a clockwise rotating warm eddy to our northeast that I've outlined with the white line. We'll head to the new waypoint in the warm water that is getting pulled around this clockwise circulation feature.



If we now pop up the sea surface height map from the altimeter, we can see the glider is flying around the southern side of the low (blue) in the sea surface height. Leaving the white line from the SST image above shows us that the warm water swirling around the eddy in the SST is also swirling around the high (orange) in the sea surface height. Just like the high and low pressure systems we see on weather maps, we use satellites to measure the sea surface height, and physics gives us the geostrophic currents. If only we had similar laws for the biology.



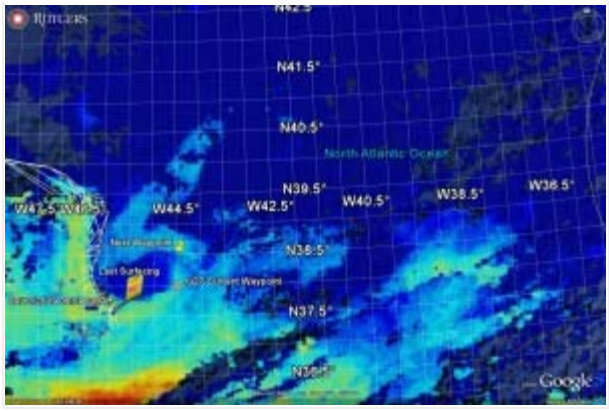
0 Comments

13 jun

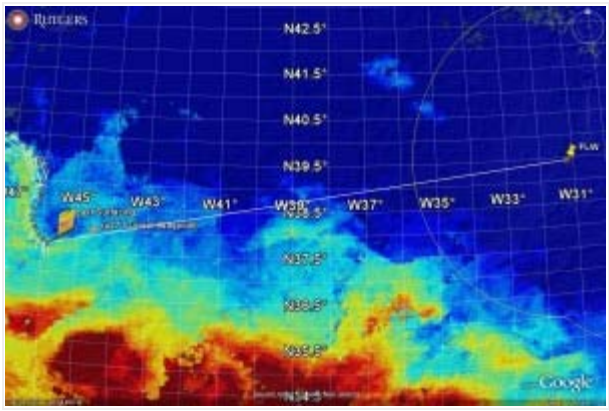
Starting the Turn to the East

Posted by: Scott in: Atlantic Crossing

Zooming in, we continue to fly along the outer edge of the cunterclockwise rotating eddy. We are starting the turn to the east along its southern boudary. Currents are southward, waypoint is perpendicular to the east. We a good till the currents change.



Zooming out to view the next landmark, we can see the island of Flores now less than 1300 km to the east. FLW is the 3-letter code for the Flores airport. Its over 1650 km back to Halifax.



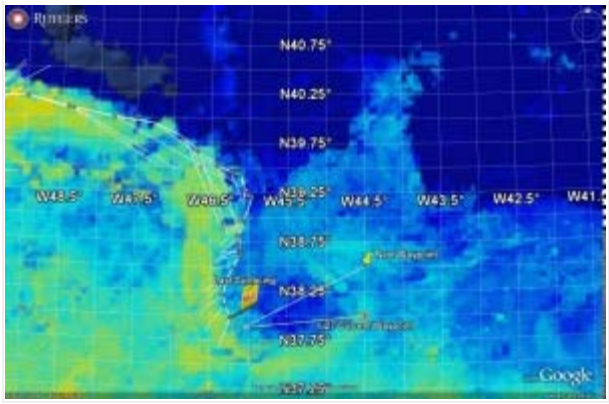
0 Comments

12 jun

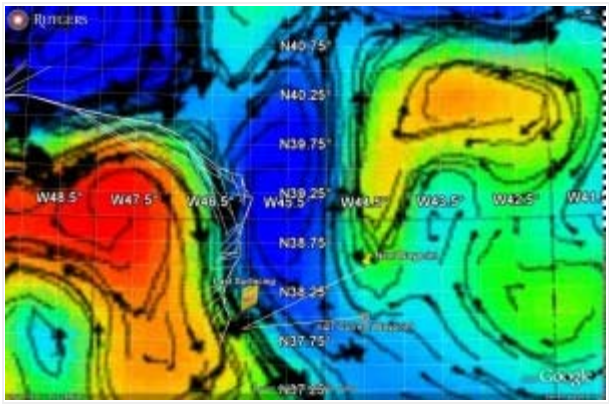
Progress

Posted by: Scott in: Atlantic Crossing

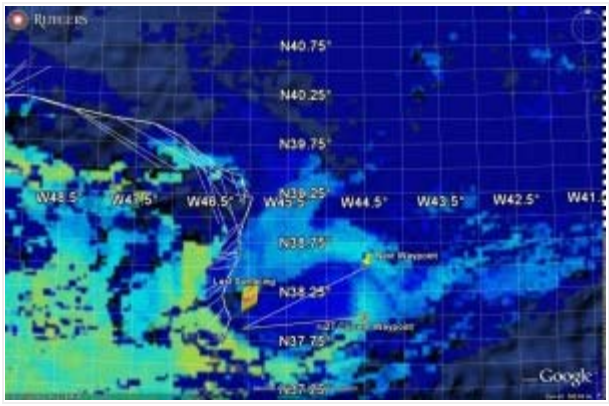
This weekly composite of NASA Sea surface temperature imagery from the MODIS sateliite shows the progress we have made since passing the tail of the Grand Banks. The Gulf Stream was heading east until it hit this wall of cold water that was running north-south along 46 W. We tried going around the wall to the north, but the intense currents would not allow that. We were pushed south with the majority of the warm water. You can see how little warm water went north along 46.5 W in this image. The Stream had made the decision for us, and we were taking the southern route around. We tried crossing near the top, along 39.25 N for a bit, but that got us nowhere. We would fly east, and the currents would flow west, resulting in no progress. And the altimetery said we had about 140 km of those conditions to fight if we continued with that plan. That left us with the plan to go around the eddy to the south, a longer route, but one with a tail wind. From the image below we see the Scarlet Knight is at the interface between warm and cold, a place where we expect strong currents, and is heading south.



Poping up the Colorado Altimetry, we also see the strong bend to the south in the Gulf Stream as the cold water wall (blue) is approached. We are heading south with the strong currents on the western side (orange), and soon will be trying to jump across to the east to the next warm eddy.



Last is the most recent satellite sst shot from NASA that we received last night. We are starting to make progress to the east along the bottom of the eddy. Sometime in the next 16 to 24 hours we'll move the waypoint a bit north from its current position.



0 Comments

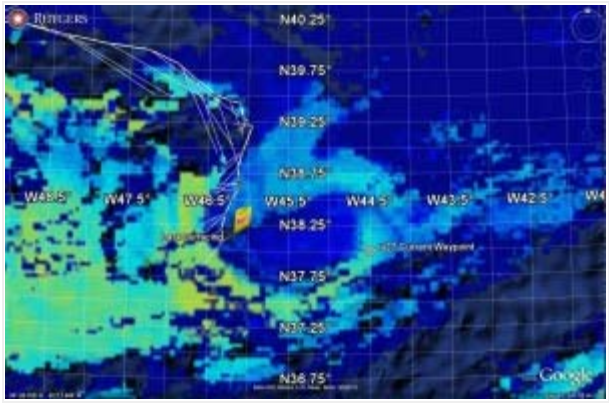
11 jun

A rare find

Posted by: Scott in: Atlantic Crossing

NASA came up with an amazing satellite image tonight. As the MODIS satellite passes over The Scarlet Knight, it peaks through a gap in the clouds and catches a

snapshot of that counterclockwise rotating cold eddy. We are just inside the spiral of cold water that is being advected south before it turns east. The glider currents are starting a rotating to follow this water as we approach the southern side of the eddy. The waypoint is off to the east, a good direction to be flying. We are good for the night.



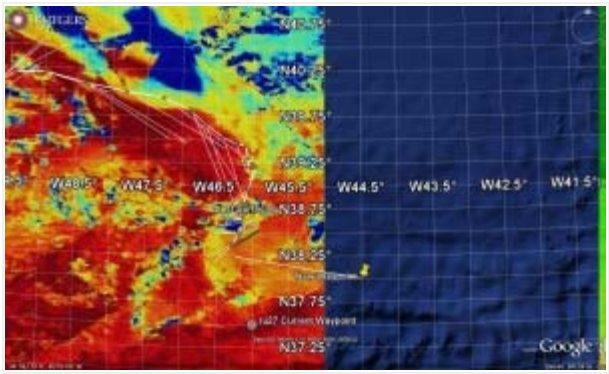
0 Comments

11 jun

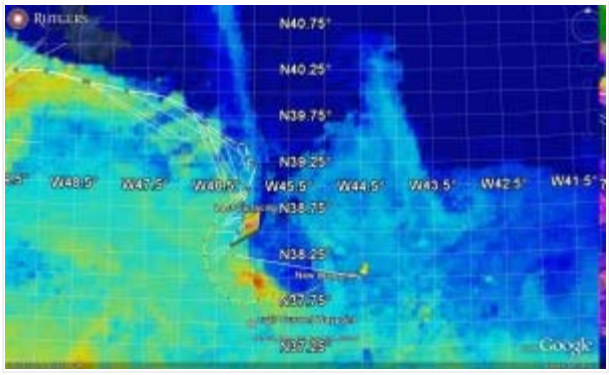
Heading South in the Eddy

Posted by: Scott in: Atlantic Crossing

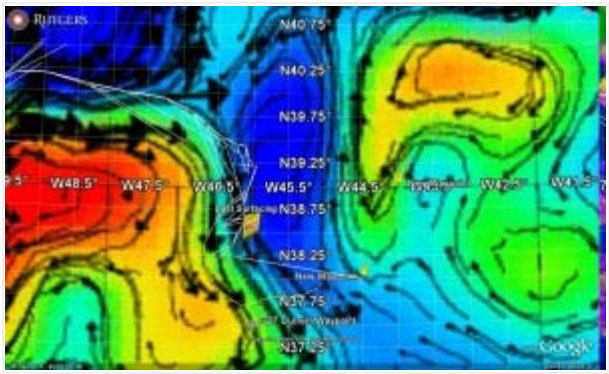
With our locally acquired 1 km resolution satellite imagery, we were just able to reach far enough east to get a clear shot at the cold ring we are in. The image is explained the westward currents we were seeing in the glider data. Westward currents aren't what you want if you are heading east, so where do we go? We did try flying east for a couple of segments, but the currents were to strong, and we didn't make any progress. Back north is out of the question, since the currents to our north are very strong against us. The only way out is south. So yesterday we turned The Scarlet Knight south to get out of the corner we were in. The plan is to try to fly around to the southern side of this eddy and start turning back east. As soon as we turned south we started picking up speed, making 14 km in one of the segments last night. This morning the currents started turning going from west to southwest. This was great news to wake up to, and we hope this trend continues. Now we'll start moving the waypoint and turn us more to the east, keeping our glider direction approximately perpendicular to the current.



We can look at that same configuration in the global 4 km resolution MODIS satellite imagery from NASA. We are going to try to fly across that cold squirt and into the warm patch to the east.



The Colorado altimetry below shows the currents we face. We should see the currents increase to the south, and we need to fly east across them before we get swept too far south.

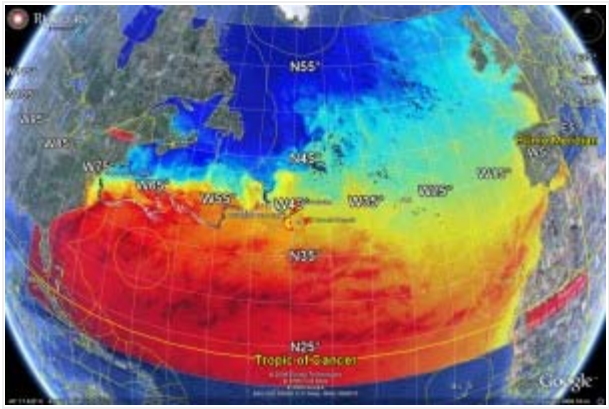


0 Comments

09 jun A Confidence Builder

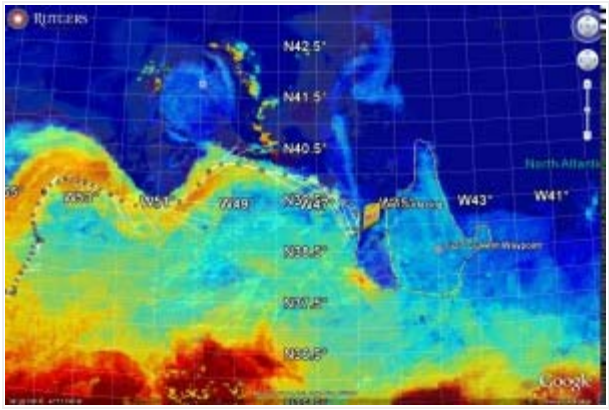
Posted by: Scott in: Atlantic Crossing

Thanks to Gene Feldman at NASA yesterday. John was able to download the MODIS imagery from their real-time system and started compositing a full North Atlantic product. Its global data at 4 km resolution. It nicely complements the local 1 km data Ana Martins started sending us from the Azores.

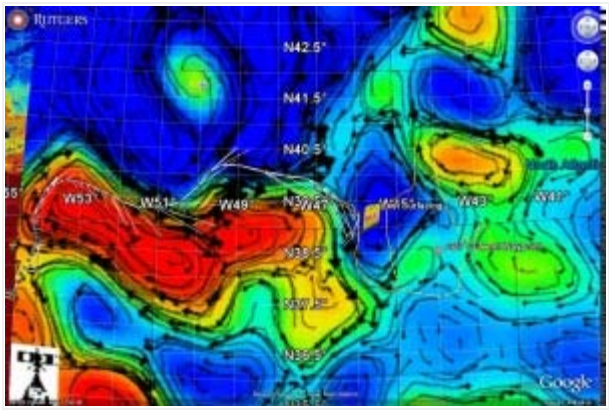


Zooming in to the region with The Scarlet Knight and enhancing the SST, we see a series of clear Gulf Stream meanders that we followed east. We are now heading

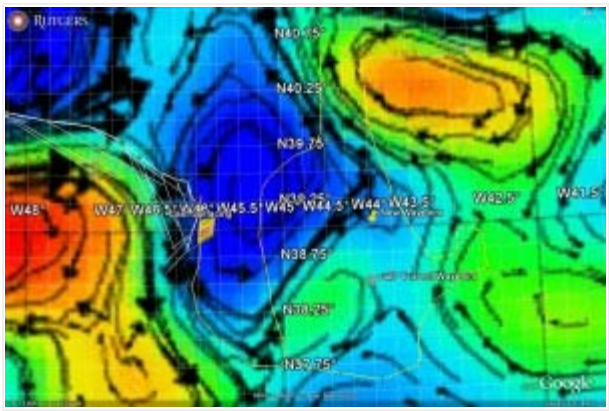
south just on the western side of that squirt of cold water that extends south between 45 W and 46 W. We are just on the outer edge, our waypoint is 90 degrees to the left of the current direction, and is heading us across the cold water and into the warm. But which way is the warm water moving. To figure this out, I first outlined the warm patch and cold squirt witha yellow path line.



Flipping over to the Colorado altimetry, we see the cold squirt and the warm patch are lined up directly over a counterclockwise rotating cold eddy. The cold squrt is moving south, and the warm patch is moving north.



Zooming in even further to the scale of the eddy, we see how well the SST and the altimetry agree. The northeast side of the warm patch is even being entrained by the clockwise rotating warm eddy (orange) to our northeast.



And now, with a little help from our friends, our path is clear, and our waypoint is good. It is a great day to be at sea.

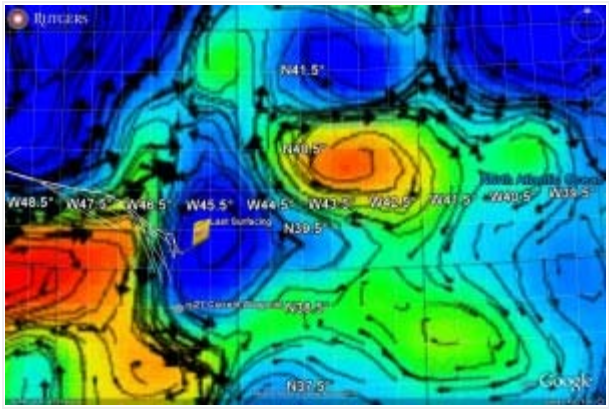
0 Comments

08 jun

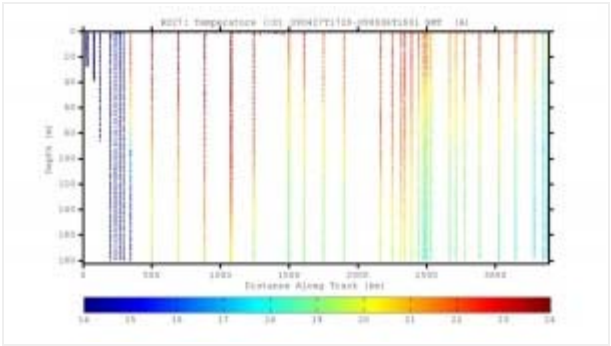
From Push to Pull

Posted by: Scott in: Atlantic Crossing

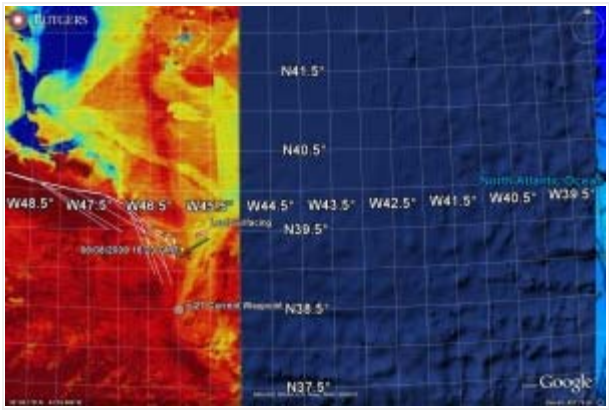
The Colorado altimetry updated this morning, indicating that the Scarlet Knight had just entered the western side of the large cold eddy centered near 39.5 N, 45.5 W. But was the eddy really in that location? All of our roadmaps agreed there was a cold eddy somewhere nearby, but our own statellite SST said it was farther east, and the Hycom forecast had it farther north. How do you fly around the edge of something if you are not sure where it is?



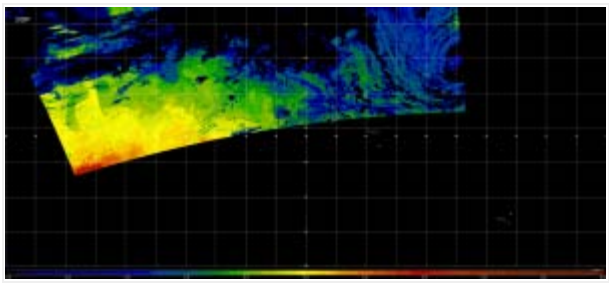
We can start by looking at Scarlet's data. The currents reported by the glider increased to the south then decreased, consistent with us entering the cold eddy. The CTD data below indicates that the last temperature cast (on the right) is colder top to bottom than the previous ones to the left. Its almost all 18C now, and it was near 24 C near the surface.



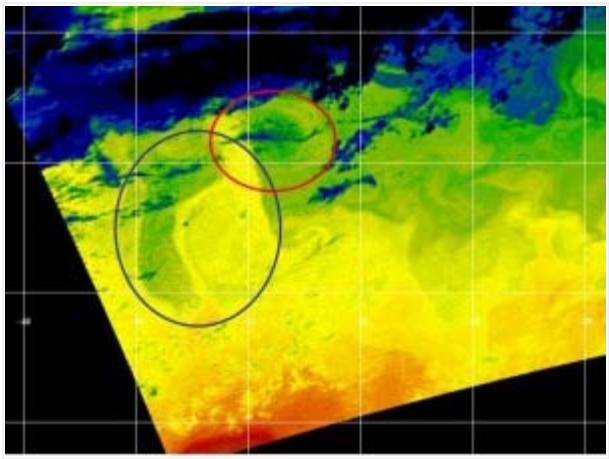
So Scarlet is telling us not to believe our SST. And no wonder. We are at the very edge of our coverage. Only some of our overpasses reach out that far.



Over spring break we visited Ana Martins from the University of the Azores, Department of Oceanography and Fisheries. http://www.horta.uac.pt/ They operate a satellite receiver very similar to ours. Ana sent us the below image this morning. It has beautiful coverage directly over the Scarlet Knight.



Zooming into the left had side of the image, the Azores SST image clearly shows the cold eddy extending between 38 N to 40 N, and 44W to 46 W. It is highlighted by the blue circle. You can see the counterclockwise circulation in the eddy. Scarlet is about at 39 N, 46W, just on the western edge of that circulation that is heading south. Up in the northwest corner of the cold eddy is a warm eddy with its clockwise circulation indicated by the red circle. Both of these eddies match up with the features seen in the global altimetry product.



So now we have a roadmap we trust. And we have made the big switch. It is no longer our own U.S. satellite stations that are providing the data to pushing us across. We have switched over to the European satellite stations, and with Ana's image this morning, they have started to pull.

0 Comments

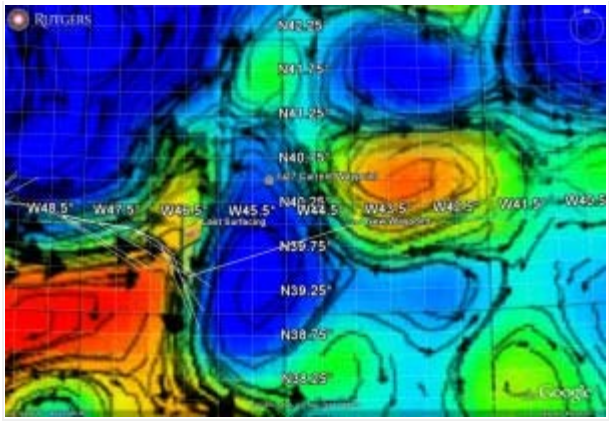
06 jun

3 Different Roadmaps

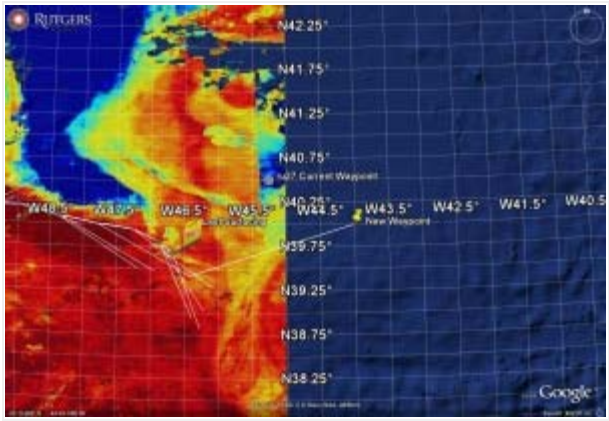
Posted by: Scott in: Atlantic Crossing

So where is the big cold eddy? Thats the question we are trying to answer today.

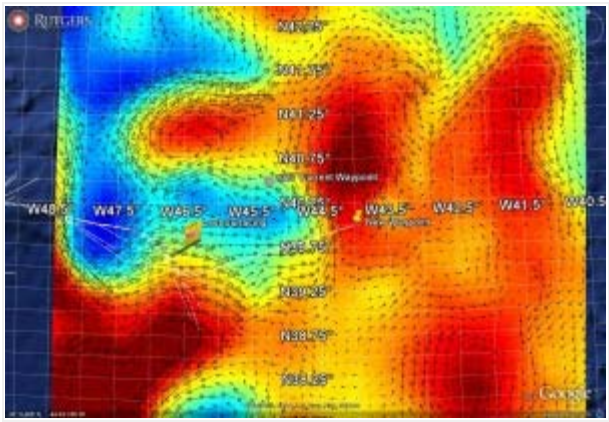
Below is the pure altimetry product. It says the center of the cold eddy, located near 39.25 N, 45.5 W, is directly east of The Scarlet Knight. The currents being reported by the Scarlet Knight are to the SSE, and line up pretty well with this interpretation. It says we are now in the cold ring.



Below is the Sea Surface Temperature image. The cold water being advected around the cold eddy is still to our west, and we are in the warm water that looks like it is making a left turn to the north, avoiding the trip around the eddy.



Now the HYCOM forecast, in this case showing the combination of sea surface height in colors and surface currents in black vectors. HYCOM assimilates both the altimetry and the sst to make a forecast. HYCOM says the cold eddy is to our northeast, and we are ready to swing around the bottom of the eddy. In this case too, the currents line up pretty well with the currents reported by The Scarlet Knight.



So what do we do? No worries. We are no longer in the Gulf Stream Meander region where there is only 1 path. Here in the Gulf Stream Extension region there are many eddies and multiple paths, some of which change every few days. In our case, we keep flying perpendicular to Scarlet's reported currents. The SST interpretation is falling out of favor. The altimetry and HyCOM forecast says we are

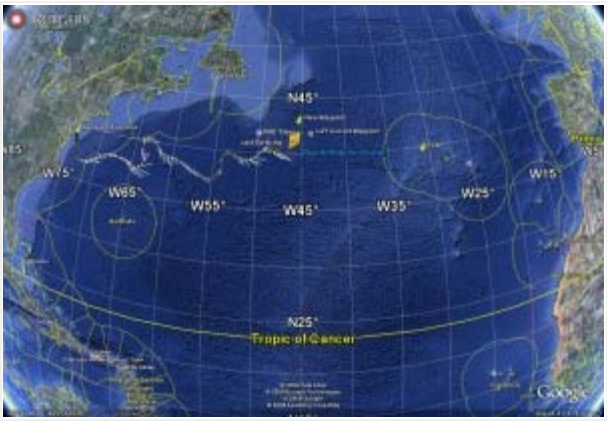
using the cold eddy to whip us around the bottom to the east. We'll ride the ring no matter which location turns out to be right.

0 Comments

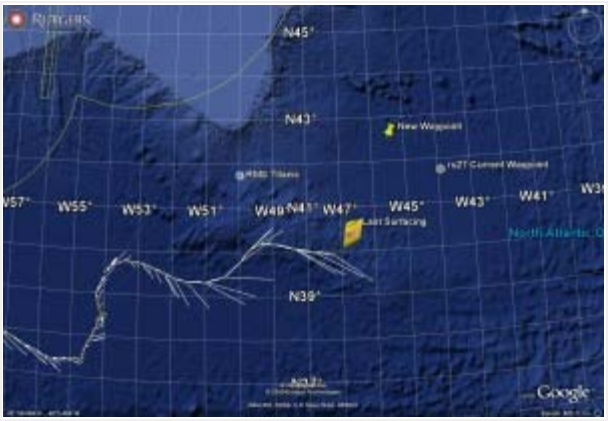
05 jun | Milestones and Statistics

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight achieved some major milestones over the last week. Most importantly, Scarlet is now east of the Tail of the Grand Banks of Newfoundland. http://en.wikipedia.org/wiki/Grand_Banks The tail is the southern most extremity of this productive fishing ground made famous in the book "The Perfect Storm". For us, after 39 days at sea, we are leaving the Gulf Stream Meander and Ring region, and entering the Gulf Stream Extension region. In that time we have flown 3232 kilometers. For distances, we are 2300 km from New Jersey, 1470 km from the Halifax glider port, 1375 km from the airport on Flores in the Azores (FLW), and 3180 km from the mainland of Spain & Portugal. The Sage-O-Meter on the Transaltantic Crossing webage http://rucool.marine.rutgers.edu/atlantic/ says we are nearly 42% across and we have used nearly 12% of our estimated battery life. This first third of the journey goes quickly. The middle third in the Gulf Stream Extension region is slower and more challenging. There is no swift Stream to follow, but instead a series of eddies that we jump between.



Zooming in we see that we just passed 280 kilometers south of the Tail of the Grand Banks, and 180 km south of the Royal Mail Ship Titanic.



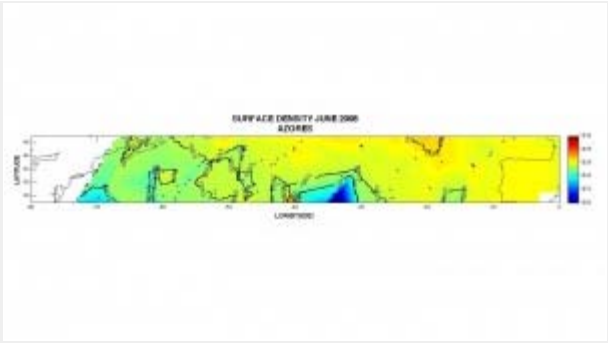
0 Comments

05 jun | A Major Decision: Northbound to Colder Waters

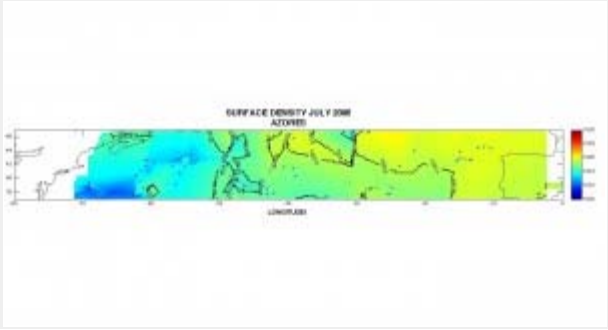
Posted by: student in: Atlantic Crossing

As we entered the COOLroom this morning, a major decision awaited us. We had the usual task of choosing a new waypoint for RU27 as she delves deeper into the eddy field; but this waypoint choice would inevitably determine the fate of RU27's flight path. The question at hand: north or south. Should we take the northern or southern route through the Gulf Stream eddy field extension? The decision: **NORTH**. There were several factors to consider. Of the most important included:

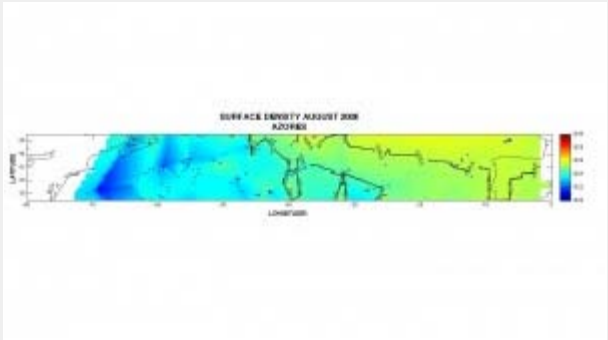
(1) Density: since RU27 has not being cooperating well with lower-density waters due to being a bit tail-heavy, we need to pick a route through waters with a high enough density to enable RU27 to call us with the fewest, or ideally no missed calls. If the water is dense enough, RU27 shouldn't have any problems lifting her tail out of the water to connect to a corresponding satellite, eliminating our missed calls. A density of 1025.5 kg m-3 seems to be the magic number to aim for (or denser) to be able to obtain a connection. Any less dense than that, and we start to see problems connecting and resulting missed calls. The northern route contains colder waters than the southern route, and therefore will contain higher-density waters. Looking at density data images from ARGOS drifters during RU17's flight last summer (below, sequential from June, July, and August of 2008), we can see that the lower density 1024.5 water which we are trying to avoid will be right on RU27's tail as we venture further north. Otherwise, if we took the southern route, we would practically be flying right into it.



Density - June 2008



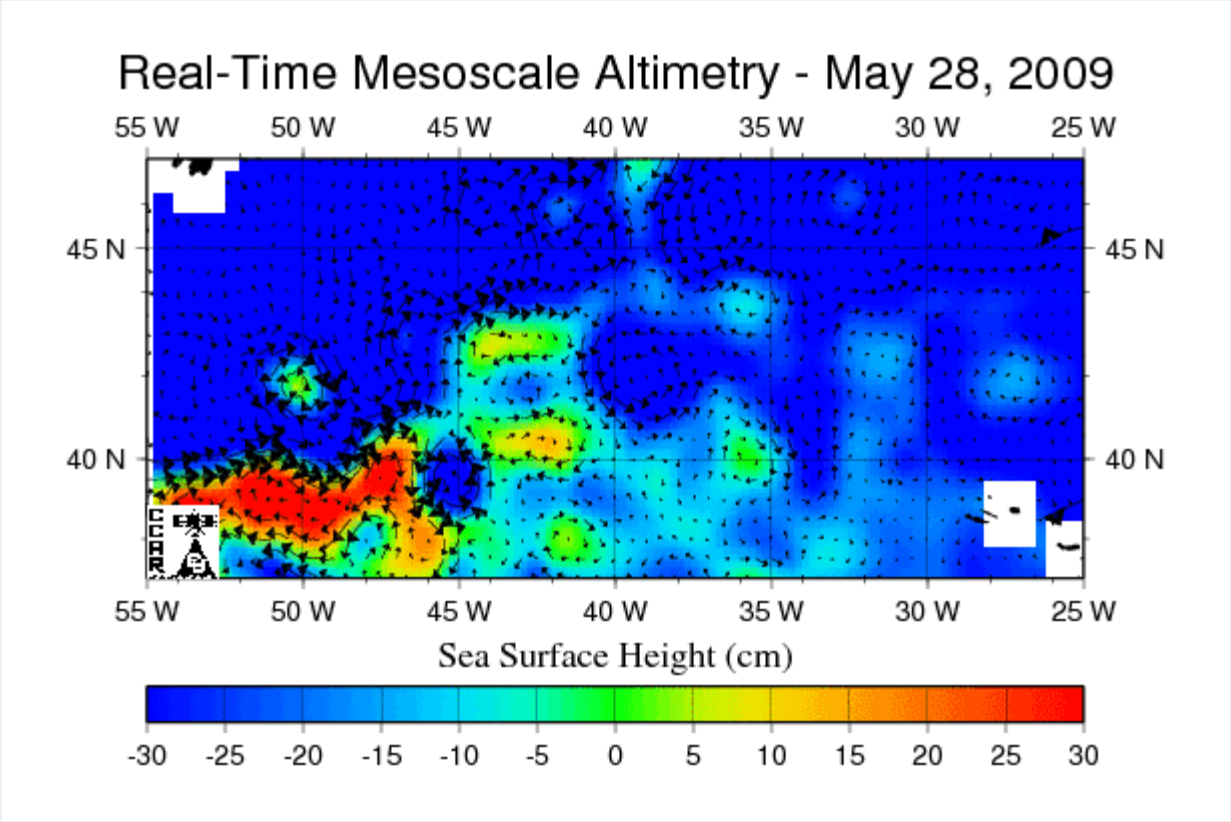
Density - July 2008



Density - August 2008

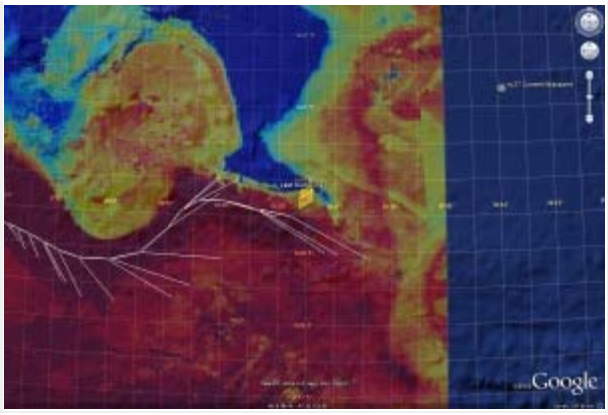
2) Water Temperature Seasonality: water densities do not remain constant throughout the year. As the strong summer sun beats down on the ocean, water temperatures increase daily. As water temperature increases, water density decreases. As summer is just beginning out in the middle of the Atlantic, water density will be ever-increasing throughout August, making it increasingly difficult to obtain a connection to RU27. Therefore, the northern route seems to be the better choice as the waters are colder than those of the southern route, giving us an edge to stay in higher density waters to best ensure connectivity (although satellite coverage is an equally vital issue).

(3) Currents: RU27 relies heavily on currents to be able to make it across the Atlantic before…well…we all die. Okay, maybe that's overexaggerating a little…but in all seriousness, gliders are naturally slow; hence why speed-enhancing currents are vital to RU27's voyage across the Atlantic considering our limited battery life and our race to beat the monstrous waves off of the coast of Europe at the end of this year. Not only do we need to choose a route that will have currents that RU27 can catch a ride on to continue eastward, but the route also needs to be the most stable and consistent with the fewest westward-going currents. A surprisingly consistent eastward current is evident along the northern route at 44°N between 45°W and 25°W. By animating and comparing recent altimetry images, we have seen that this eastward current, though not as powerful as the Gulf Stream, has remained relatively consistent and unaffected by eddy movements and variations surrounding it. Therefore, this seems like an optimal current to the north for RU27 to surf eastward. If it remains consistent, RU27 will be able to ride this current for over 1,500 kilometers. Below is the animated altimetry, from May 28, 2009 through June 4, 2009.



Altimetry Animation: May 28, 2009 to June 4, 2009

RU27 is currently riding the north wall of the Gulf Stream, at its fastest region, just a few kilometers off of the north edge of the Gulf Stream wall, as you can see in the image below. RU27's current readings are matching up beautifully with the SST.



June 5, 2009 18:02 GMT 72-hour Composite SST

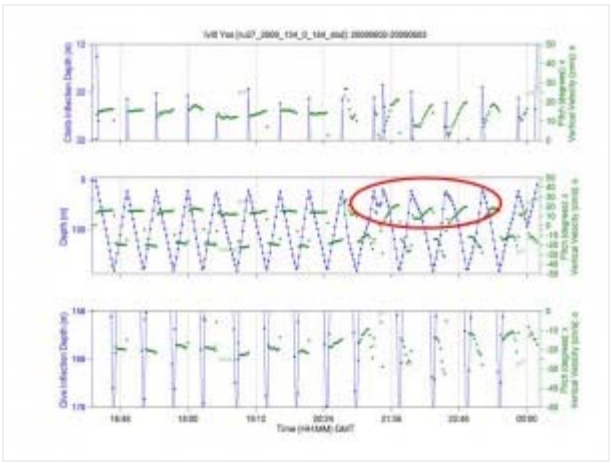
-Dave & Emily

1 Comment

03 jun | We're Not Alone - First Encounter

Posted by: Scott in: Atlantic Crossing

Yesterday evening, as we continued to approach the Grand Banks, we were greeted by some friends from last year. The blue points in the middle graph showing the time series of the glider's depth is supposed to be an evenly spaced sawtooth pattern, undulating between 20 m at the top and 180 m at the bottom. About 6 pm local time yesterday, as the sun was setting, we see a strange behavior in the yo profile highlighted in the red oval. The glider tries to inflect at 20 m and head back down but it gets stuck at the base of the thermocline, waits a bit, and then has to turn around and come back up. The next few yos indicate it is having trouble sinking at the beginning of each dive. The problem with diving looks to be getting better in the last few yo's and then its time to head to the surface to end the segment.



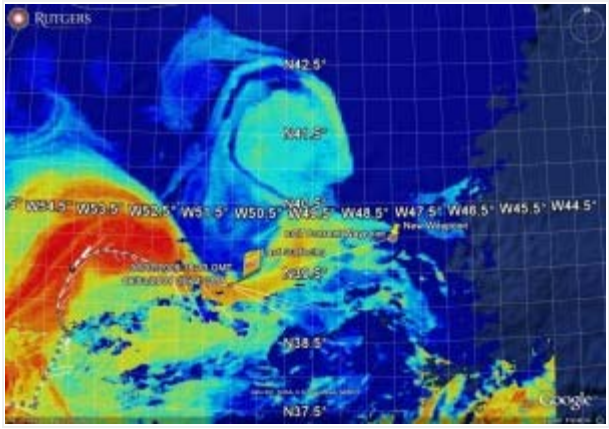
Our biological friends are back.

4 Comments

03 jun | Skimming along the North Wall

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is rounding the bottom of the meander trough, skirting the edge of the Gulf Stream just on the warm side of the North Wall. Currents are up to 150 cm/sec, and are swinging around to the east. The waypoint was successfully moved to the new location for the rest of the morning. Later today we'll move it back and start heading northeast into the meander crest and that distinct warm core ring centered at 40.5 N, 50W. The trick will be to not get caught in the warm core ring, but to stay in the Stream, shooting us eastof the Tail of the Grand Banks into the Gulf Stream Extension region.



We'll soon reach the edge of our locally-acquired data coverage. That means a switch to lower resolution global products until we get in range of the European side.

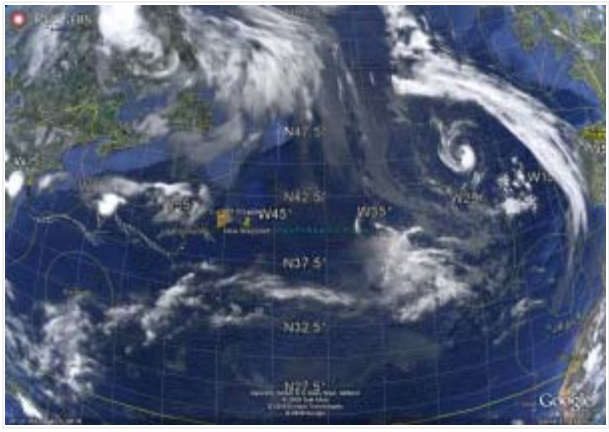
0 Comments

02 jun

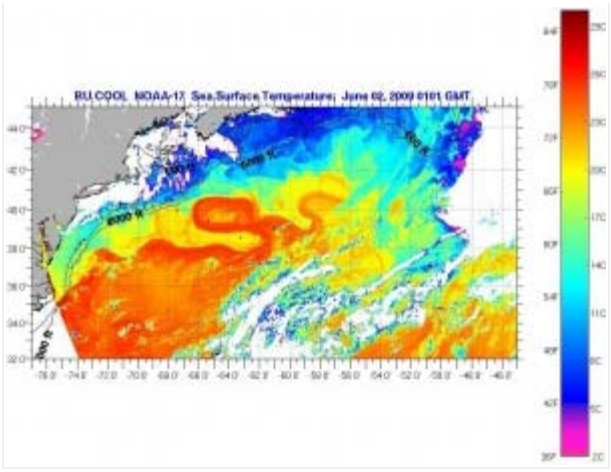
Ping Pong

Posted by: Scott in: Atlantic Crossing

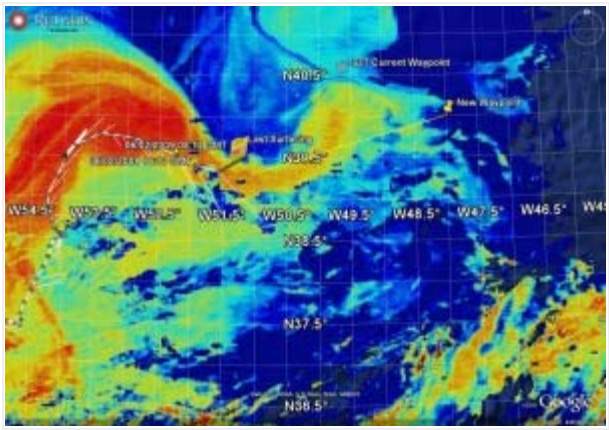
Clear skies over much of the North Atlantic. Storm center has moved quickly to just north of the Azores.



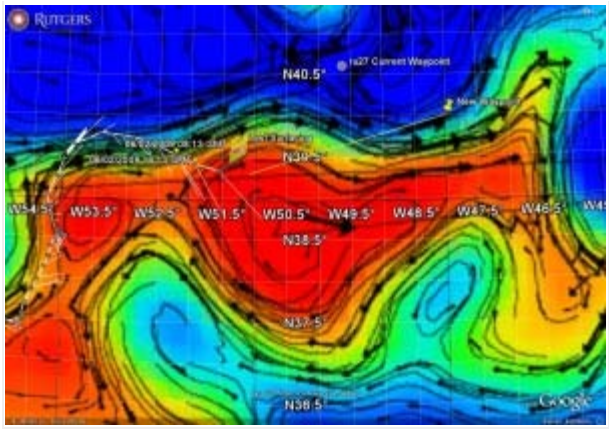
Taking advantage of the clear skies, lets first look back at where we have been. The most dominating feature is the huge warm core ring extending between 67 W and 72 W along the 40 N Latitude line. The ring is 400 km long and 200 km wide. New York City to Washington DC is about 330 km. Glad we made it past this event.



And where are we now? Just a few hours ago the clouds clears over the Scarlet Knight and revealed we are well into the Gulf Stream, approaching a trough in the wave that continues to grow. The waypoint Dave, Shannon and Emily chose did exactly what was needed, it pulled us closer and closer to the North Wall of the Gulf Stream to find the faster currents. We are up to 101 cm/sec, and the current is turning from southeast to more east. We are approaching the trough. To keep from flying across and out of the Stream into the cold water, John just left a message in Scarlet's mailbox to move the next waypoint southeast to 40 N, 48 W. We will be flying in this direction overnight to get us across the bottom of the trough. Then in the morning, we'll likely switch back to the same way point we have now and head back to the northeast into the crest. That crest ant the warm eddy to its north are along 50 W, the Tail of the Grand Banks. About 130 km to get to this transition point. About a 2 day run at this speed. Then we move on to the eddy field of the Gulf Stream extension. The region where the altimetry is often the best indicator of the currents.



The image below illustrates just how scarey that is. The SST above is hours old. The altimetry below is over a day old. The meander in the altimetry is out of phase with the SST. The SST images says we are entering a trough, and the SSH says its a crest. Its not that there is a problem with the altimeter, it just used several days of data to make a map. In many places the Gulf Stream moves fast, and the image is distorted. Luckily the rings in the extension region move slower, so there is less smearing.



0 Comments

02 jun

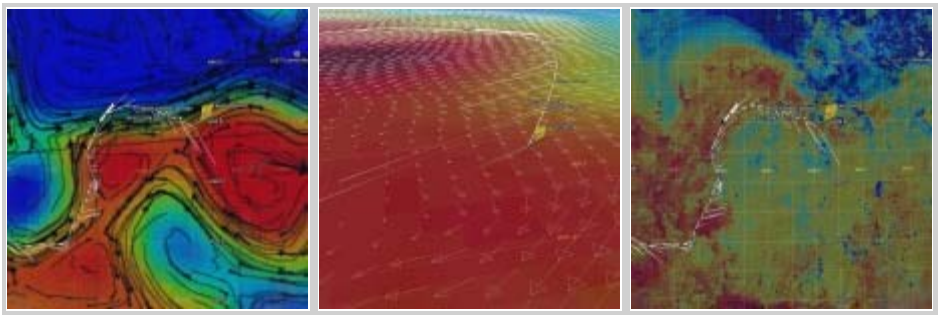
Data Decision Making & Undergrad Student Pilot Team

Posted by: student in: Atlantic Crossing

The undergrad student pilot team is back for the summer! Our warm welcoming back was abruptly interrupted by some difficult decision making regarding which of our data types to base our piloting decisions on. Our different data types have not been agreeing with each other recently, and has been making it extremely difficult to make piloting decisions to fly RU27 through the vigorous and every-changing eddy field. Ultimately, after over 24 hours of extensive discussions and consideration, we chose a new waypoint for RU27 relying primarily on the Altimetry data and Sea Surface Temperature composite data instead of the Surface Currents and Sea Surface Height Models.

As Scott mentioned in the last entry, the cloud cover had been an issue in causing poor SST imagery. However, the cloud cover has finally passed and we are beginning to get better and more consistent SST imagery once again. We chose to rely on SST since, when available, it always been a very reliable data source for piloting decisions - so that was a relatively easy decision. Although it's 10-day average is one full day behind, we chose Altimetry because it had become a reliable source for RU17's flight through the eddy fields. Another reasoning behind choosing SST and Altimetry over the models is the fact that the models are essentially a forecast, or educated guess, while the SST and Altimetry are real data - regardless of their consistency or time-delay issues.

Below are some images which show the aforementioned points [Image 1: RU27 with SST Composite Data - RU27's path appears to agree with a warm current being displayed by the SST imagery. Image 2: RU27 with Altimetry Data - although it's average is displayed on a time-delay of 24 hours, and the data doesn't match perfectly with RU27's path, an eastward pattern is visible and relatively compatible. Image 3: RU27 Current Readings vs Surface Current Model - RU27's current readings clearly do not match up with the Surface Current Model at this time.]:



The waypoint we chose, which you can see in the first two images, is eastward enough to keep our momentum across the Atlantic, but northward enough to keep us from getting pulled southward into tome turbulent eddies.

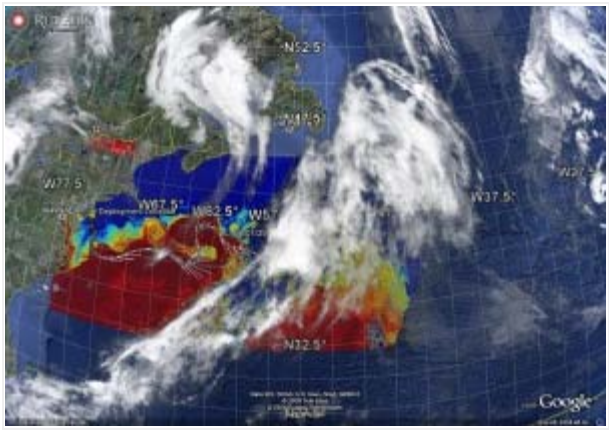
-Dave, Shannon, and Emily

0 Comments

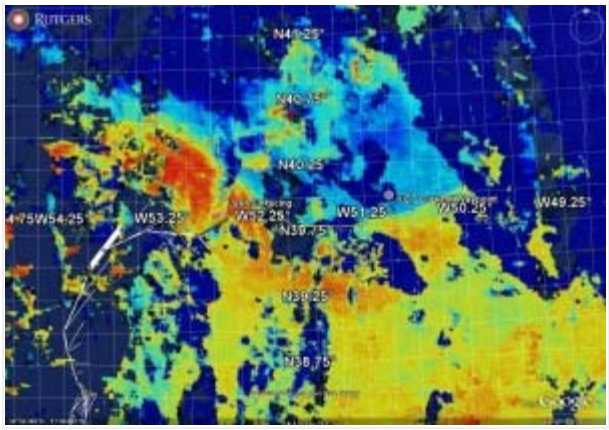
01 jun A Quick Glimpse through the Clouds

Posted by: Scott in: Atlantic Crossing

Good satellite SST imagery is on the way. The Cloud front that is sweeping east across the Gulf Stream is clearing out the air and leaveing a trail of clear SST viewing behind it. Behind the front to the east, the stream and its meanders are clearly visible. One of the larger meanders we had to navigate around has now formed a large Warm Core Ring. Ahead of the front and to the east, the air is still very coudly or partly cloudy, and you can see the speckled SST below it, indicating poor visibility.



Zooming into the location of the Scarlet Knight, we see one quick glimpse of the Stream throug a narrow break in the clouds. Instead of a straight eastward shot to the Gran Banks that we saw in yesterday's altimetry, we see that a small wave has developed in the Gulf Stream. I've outlined the north wall of the Gulf Stream with a thin yellow line. The altimetry will likely pick this up in a couple of days. The wave explains why the glider current vectors are to the southeast instead of straight east as expected from the altimetry. We are riding downstream from the wave crest to the trough, so thw currents are to the southeast. The Current Waypoint on the image cause the glider to use its velocity to fly deeper into the Stream, and hopefully find increasing currents. Currents have increased steadily since last night. 17 cm/s, 25 cm/sec, and now 37 cm/sec.



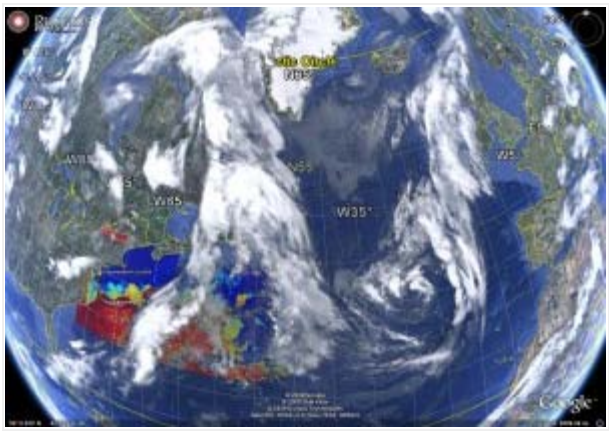
0 Comments

31 may

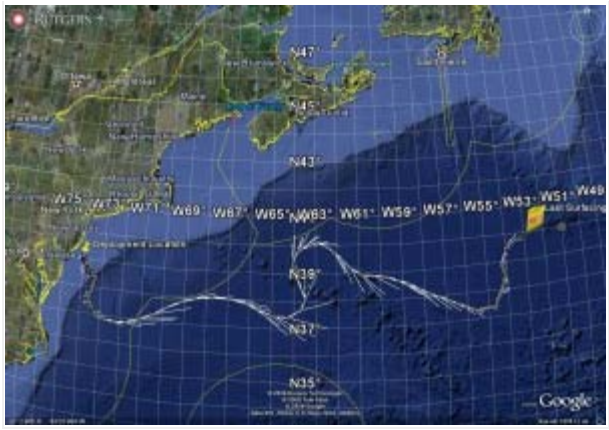
Back to 40 North

Posted by: Scott in: Atlantic Crossing

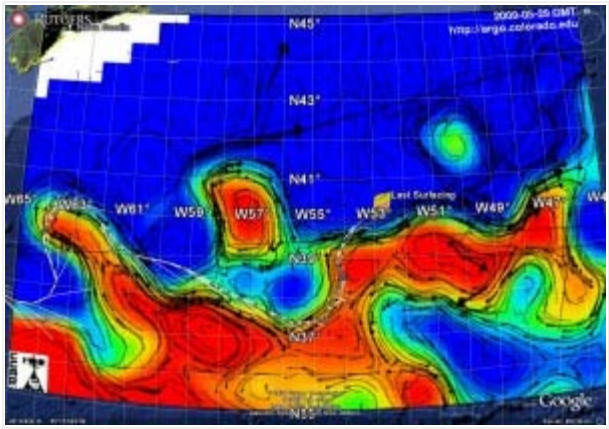
The Scarlet Knight spent the last week or so down south near 38 degrees North latitude. I spent the same week up in Oslo near 60 degrees North. Its marked on the google earth image below. The weather in Oslo was exactly the same as the weather in New Jersey. When I was in either place, it was out of the clouds and sunny, both places in the 70's during the day. We have now both returned to 40 degrees North latitude, but the weather over the Scarlet Knight remains cloudy. Hopefully we get good imagery after that front to our west passes by us and brings the clear air in behind it.



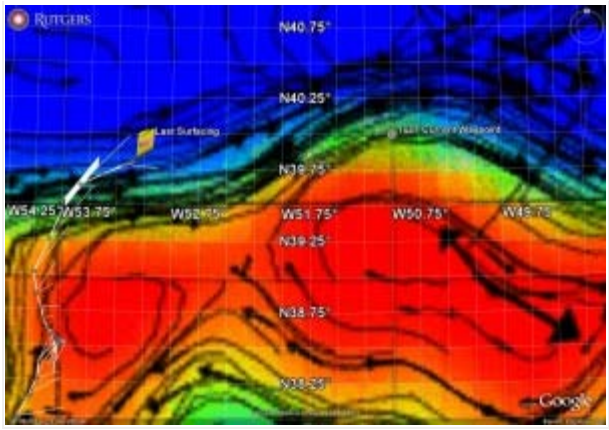
Looking at the track of the Scarlet Knight since deployment, we are just under 300 km from 50 W, a longitude that marks the Tail of the Grand Banks. It is the eastern boundary of the Gulf Stream meander and ring region. After passing the Grand Banks, our navigational strategy changes. Instead of looking for a steady Gulf Stream current, we start navigating the eddy field of the Gulf Stream extension region, flying eddy to eddy to eddy. The thin yellow lines in circular arcs on the plot are the boundaries of the Exclusive Economic Zones, the EEZs of each country. You can see we jumped out of the U.S. EEZ as soon as we could and have remained in international waters since then, occasionally skirting the edge of both U.S. and Canadian waters on the meandering trip down the Gulf Stream.



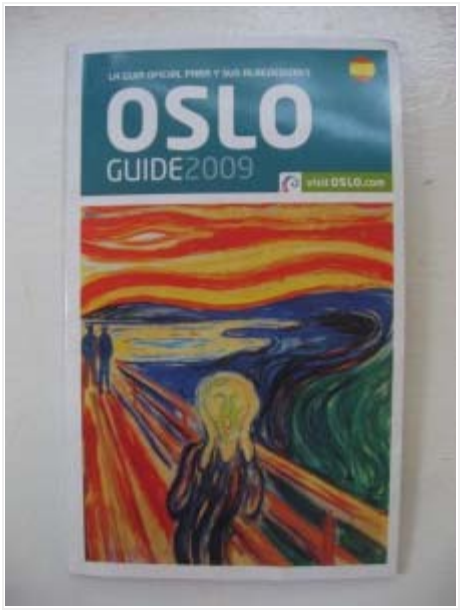
Since it is cloudy, there is virtually no SST, so we move directly on to the regional view from the altimeter. The most recent image indicates that we did what looks to be an easy job of following the meander trough near 55W around to the south and back up again. The altimeter tends to do that, make what you just did look easy. The hard thing is that you don't have this map when you are actually flying it. You have the map from a couple days ago. So the major features are likely there, they may just have different shapes or be in slightly different locations. You have to adjust the map in your mind based on what the glider is reporting. And it is sometimes difficult to over come that drive to just fly east than to take guidance from an uncertain map. In this case, we trusted the maps, despite their uncertainty. We just put our heads down and steered to the northwest, away from our destination, to get back to the Gulf Stream highway. It was a very intense meander system we just flew through, and both the glider and the guidance did well.



Zooming in to the local situation, and compared to what we have just been through, the Gulf Stream is relatively intact and straight to the tail of the Grand Banks near 50 W. Navigation should be easier than what we just did. We'll use this time to recheck our flight performance and prepare the guidance datasets for the second third of the journey, the eddy field of Gulf Stream extension region.



Zooming in even further to the hotel lobby in Oslo, I was reminded every day that we were not the first to use this color palate for the ocean.



0 Comments

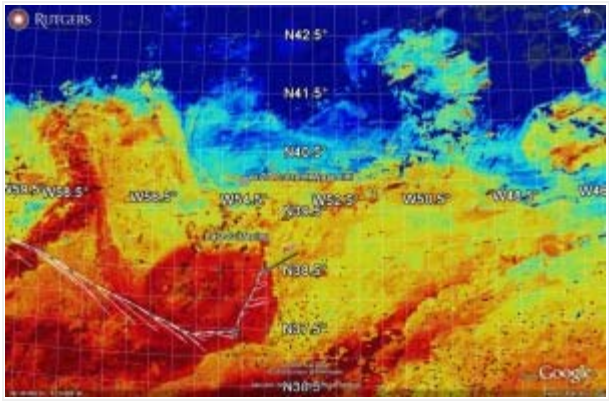
26 may

Into a Headwind

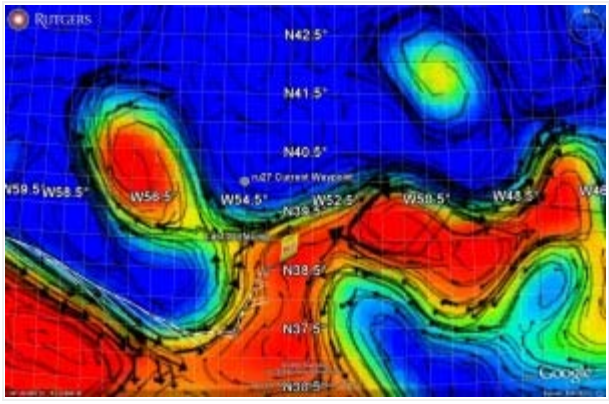
Posted by: Scott in: Atlantic Crossing

That band of clouds is right over the top of us. Clear to the north and south. When it does move, we should get some good Sea Surface Temperature Imagery.

Below is a 3-day composite of SST images, most from 3 days ago. As soon as we crossed the front from the warm water (red) to the colder water (yellow), we ran smack into a head current. We are trying to fly to the northeast to catch the Stream, and the current is pushing us in the opposite direction to the southwest. The current speed and glider speed are similar, so we don't expect much progress if we maintain this course.



The glider flight manual says that if you can't fly into a head current, the best move is to fly perpendicular to the current into a region with a more favorable currents. Our choices are southeast or northwest. The altimetric map of sea surface height below provides the guidance. Flying southeast puts us further into the slow current zone in the center of that high (red) band where the sea surface topography is relatively flat. Flying to the northwest puts us in the sharp gradient between the high (red) and the low (blue), and the faster currents. The warm core ring continues to break off. Hopefully this does not cause us a problem. As soon as we see currents heading north again, we'll mover the waypoint back to the northeast and again try to head downstream.

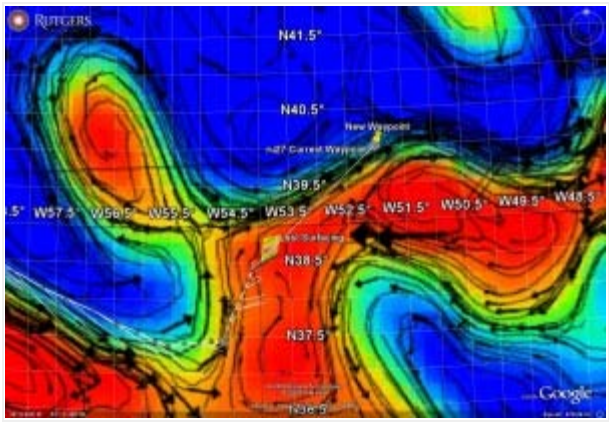


1 Comment

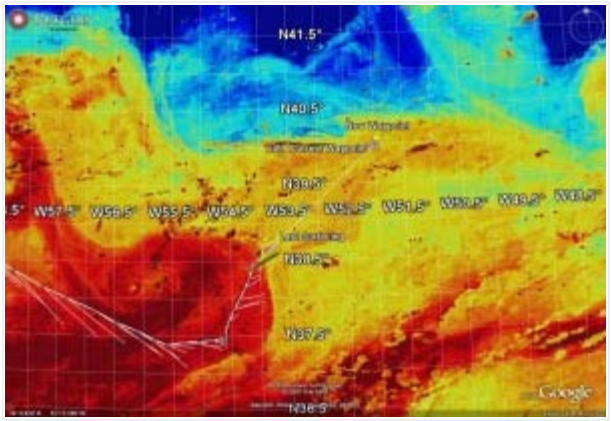
25 may — Noon Altimeter and Glider Data is in.

Posted by: Scott in: Atlantic Crossing

Today's altimetry is starting to line up more with what we observed with the glider. Thats they altimetry is. Working in real-time, it tends to show you what you wished you saw a few days ago. Looks like our present course to the northeast will keep us out of the warm core ring formation. We'll continue on this course till we rejoin the Stream heading east.



For completeness, here is the sst. Little change. 260 km to the waypoint.

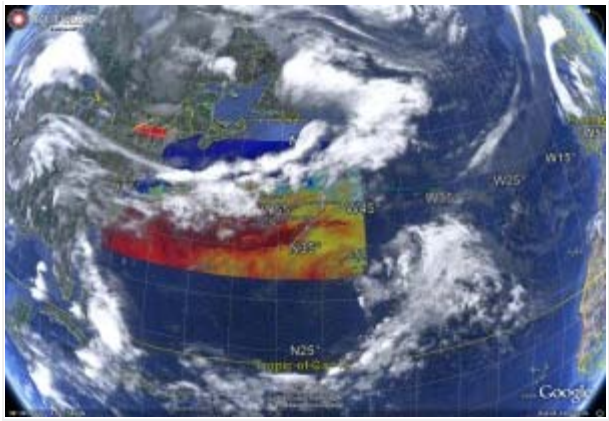


0 Comments

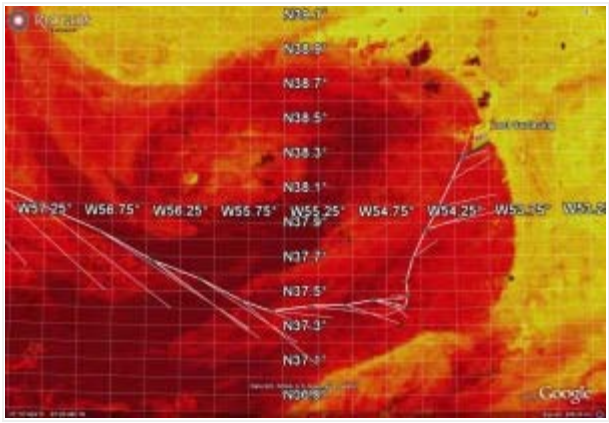
25 may — Time to Exit the Cold Core Ring

Posted by: Scott in: Atlantic Crossing

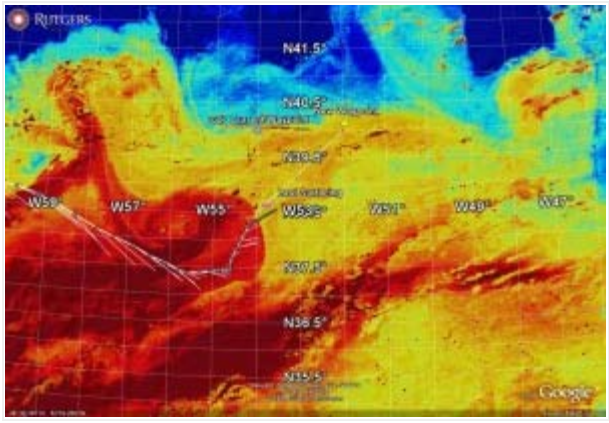
Clear to the north, clear to the south, and clear to the east. But a band of clouds is found that runs along the same latitude as the Gulf Stream.



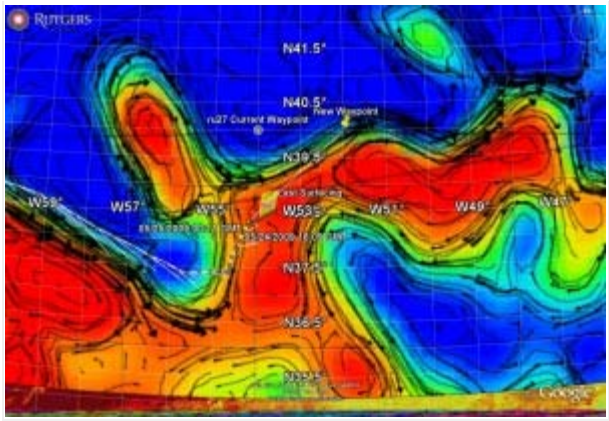
Zooming into a composite Sea Surface Temperature image from the last 72 hours below, we see the swirls of warm water wrapping being wrapped around the Cold Core Ring. The Scarlet Knight is riding these currents north along the easstern side of the ring. We'll now start to fly out of it towards the northeast so that we don't get swept around for second lap.



Zooming out to a regional scale below, we see that the northeast corner of the cold core ring appears to be rejoining a piece of the Gulf Stream that is heading east. that is our target. At noon we'll move the waypoint east, giving us a course to the northeast that goes down the middle of that piece of the Stream. It also gives us a target no matter how far the cold ring sweeps us around.



Checking with the altimetry from yesterday, we see the new path keeps us away from the Warm Core Ring formation event to our northwest.



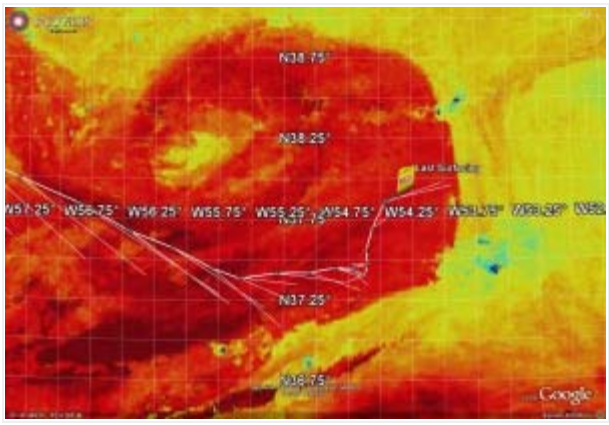
The altimetry typically updates about the time of the glider's noon surfacing. Clouds will likely prevent new SST from arriving. We'll see what the glider currents are, and adjust if we need to. Energy use is remaining about 2.75 amp hours/day, and we have detected a small reduction in the speed of the glider with the new pump settings. The speed reduction is small, so we'll keep these energy saving settings for now. If in the future we need extra speed, we know where to find it. .

0 Comments

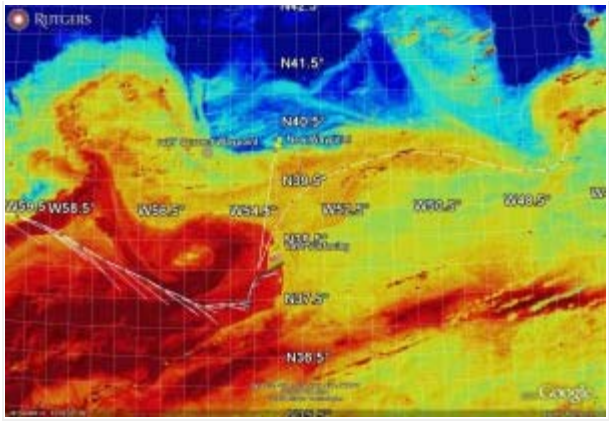
24 may Back in the Stream & Heading NE

Posted by: Scott in: Atlantic Crossing

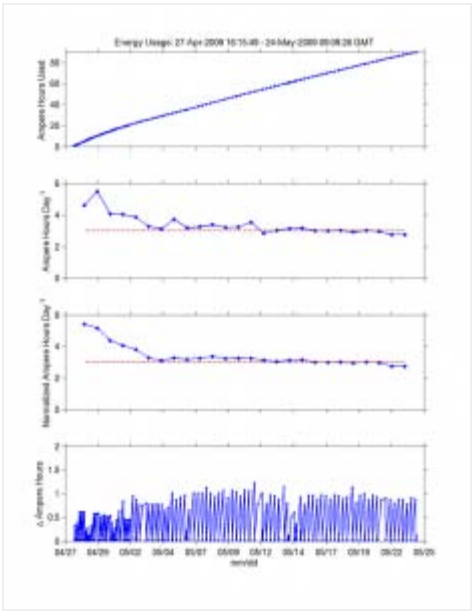
Scarlet has made excellent progress flying to the northwest overnight, getting deeper into the cold core ring and finding the strong (greater than 50 cm/sec) currents heading to the northeast. What a change from being suddenly stranded outside the ring yesterday. Scarlet is quick. So far, she can move when we need it. The SST below nicely shows the warmer water swirling around the colder core of the ring located to our west.



Now that our short term task of getting back into the ring was accomplished, we can go back to long term path planning. Zooming out below, we see the complictated region we are entering, and the possibilty that the warm core ring formation identified in the satellite altimetry is also occuring. There appears to be a route that cuts off the warm core ring, and swings off to the northeast. I've added a digitized path that goes along this track, bending off to the east and heading downstream. We'll make the waypoint tagential to the path, almost due north, and almost perpendicular to the observed currents. This should get us a bit deeper into the Stream.



And how is our power usage? We now have a second day under 3 amp-hours /day. We are hovering around 2.75. (third plot from the top in the figure below). The change was an increase in the size of the deadband on the buoyancy pump. A larger deadband reduces the chatter in the pump. Buoyancy pump chatter pulled a lot of the energy out of the batteries on our first long-duration trip to Halifax with RU15 last year. Dave just widened it a bit again. This change reduces the amount of water we pull in and push out for each cycle, so there is some savings there to, but we are seeing little effect on speed.



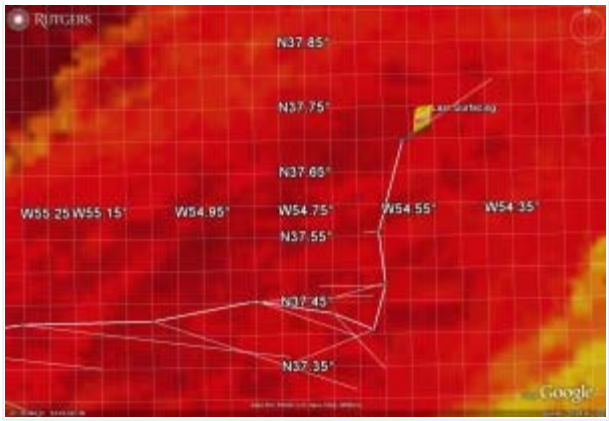
0 Comments

23 may

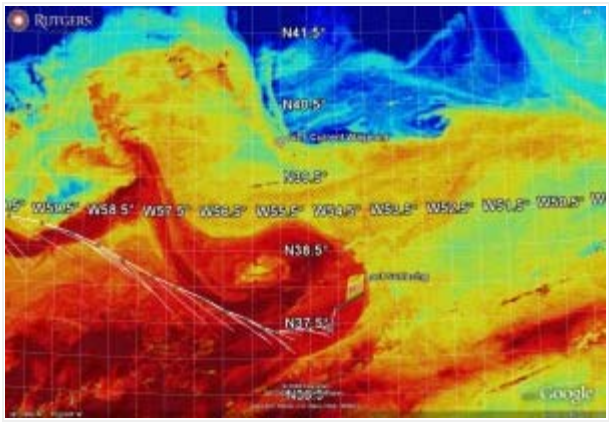
And Back In

Posted by: Scott in: Atlantic Crossing

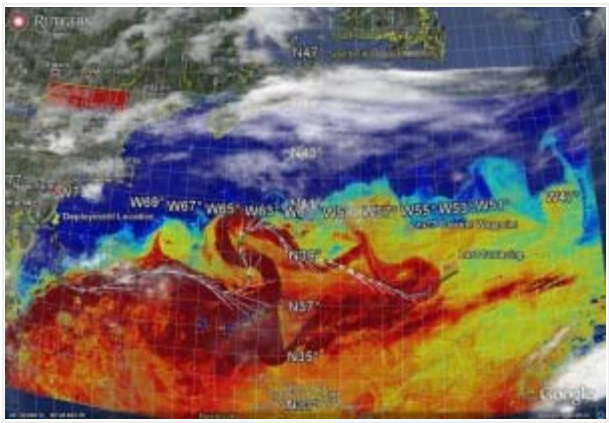
After spining out of the newly formed cold core ring last night, we truned the Scarlet Knight north at the 5 am surfacing. With virtually no currents to help, we flew her through across strong shear zone and by the 8 pm surfacing, and flown into a current that is now running northeast.



Zooming out in the image below, we moved the waypoint to the northwest, flying approximately perpendicular to the current in the hope of finding stronger currents to spin us around the cold ring.



And zooming out one more time, we see another amazing shot of the full Gulf Stream. Clouds are confined to the areas of colder water to our north. That meander between 65 W and 62 W is getting very big. Glad we crossed it a few days ago when it was smaller. No such luck with the meander system we are presently in near 55 W. Its a complicated system, and we are in the middle of it. I can't imagine trying to make sense of it without the satellite view.

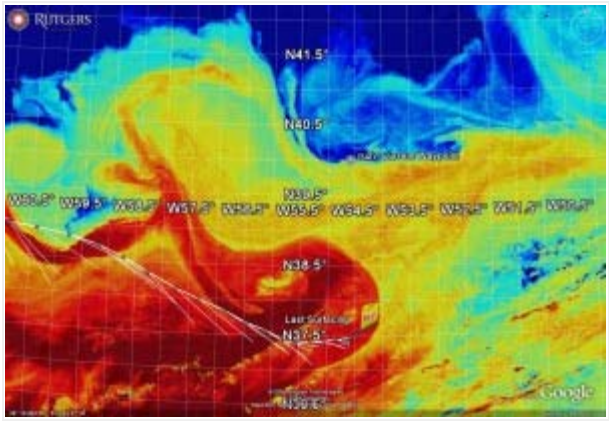


0 Comments

23 may Spin Out

Posted by: Scott in: Atlantic Crossing

We changed the enhancement on the new satelite SST imagery this morning so that it now covers the range 16C to 24 C. It clearly defines the Cold Core Ring to our west, and our new path. Despite what the altimetry says, the Gulf Stream had enough of us and tossed us out in the sharp turn around the bottom of the cold ring. So Scarlet will fly north this weekend and jump back in.

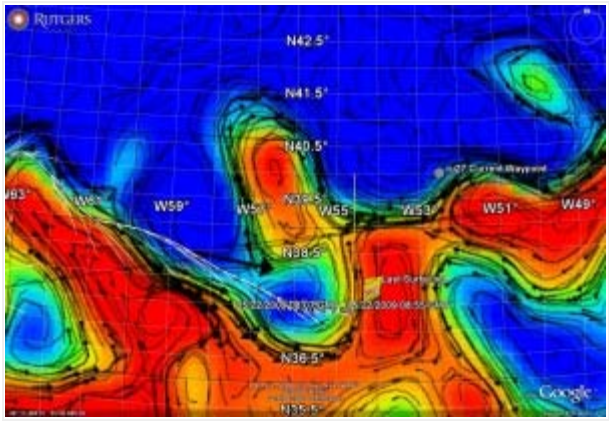


0 Comments

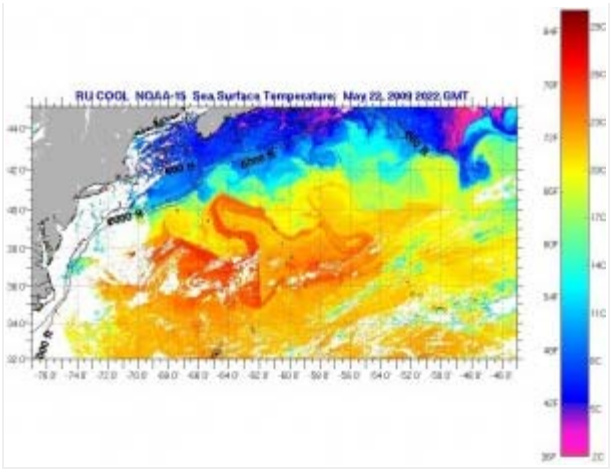
22 may Switching Roadmaps

Posted by: Scott in: Atlantic Crossing

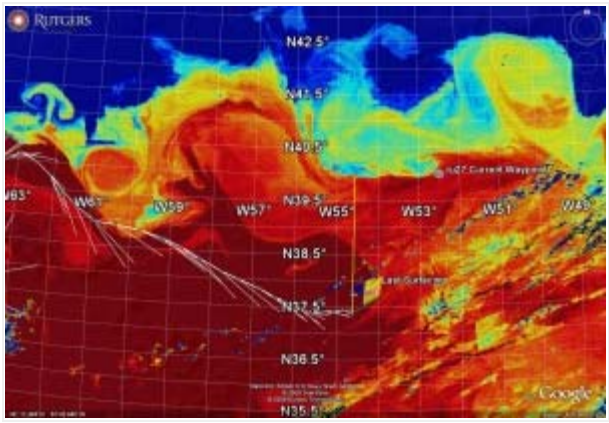
Altimetry says a Warm Core Ring just formed centered at 40 N, 56.5 W. It also says the Scarlet Knight should be moving north. Fast. But thats not the case. The glider is stalled, hardly moving. Time to switch roadmaps. Sea Surface Height is not helping.



We are in luck. Last night we saw clearing skies. Checking the satellite Sea Surface Temperature we see a very different picture of what is happening. The SST image instead has a Cold Core Ring forming that is centered near 38 N, 56 W. Thats what we are in.



Zooming in on google earth, we are on the southeast side of the new Cold Core Ring. The center is cleary visibile just below 38.5N, 56 W. The piece of the Stream we were just in has evolved very rapidly. It propagated about 100 km eastward from where we rode it south, and its closing off the Cold Ring. Altimetry says the Stream is forming a Warm Core Ring in the top image, and the SST is saying the Stream is forming a Cold Core Ring. I can't ever remember seeing such a significant discrepancy. But the Scarlet Knight is out there, and she is telling us which roadmap to believe. We'll follow the SST, and turn Scarlet due north tonight. We'll follow the eastern side of the ring north, and jump out on the northern side. At least thats the plan based on this roadmap.



0 Comments

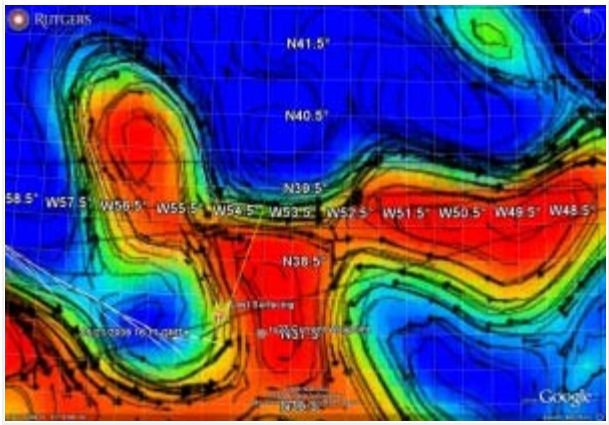
21 may

Gambling with the Gulf Stream

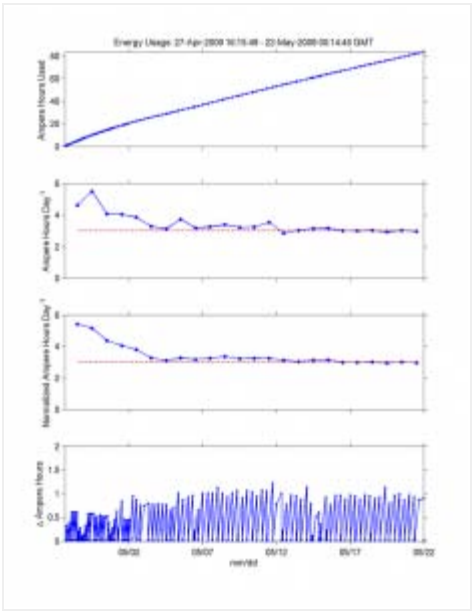
Posted by: Scott in: Atlantic Crossing

gulf_stream (click to download the avi file).

The satellite-derived Sea Surface Height map below illustrates our gamble. As we fly east, we should soon see a strong current to the north. If Scarlet only make it partially into this current, it could pull us all the way around that meander crest that looks like it is about to pinch off as a Warm Core Ring. The total distance around is 900 km, but the currents are strong the entire way. If we can fly deeper into the current, away from what we call the north wall of the Gulf Stream, we may be able to take a direct route the the same location, a distance of only 200 km. Currents along this route will be slower, since we'll be away from the north wall.



So 900 km with strong currents or 200 km with weaker currents, if we can get there. Our job the next few days is simple. Fly east and keep flying east. See where the current takes us. If the Warm Core Ring looks like it is going to break of before we get there, we can fly normally. If it looks like the meander is staying a meander, it may be a time to adjust our dive angles from +/- 26 degrees to +/- 35 degrees. The 35 degree angles give us more speed, but cost us more in power. Energy use has been steady at 3 amp hours/day (third graph down on the plot below). 3 is our target, and we are holding steady on that value.

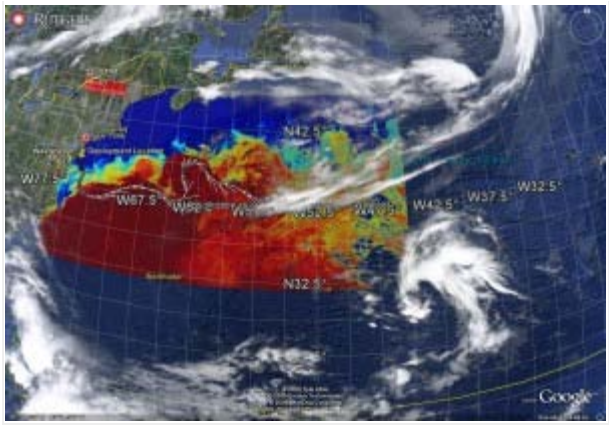


1 Comment

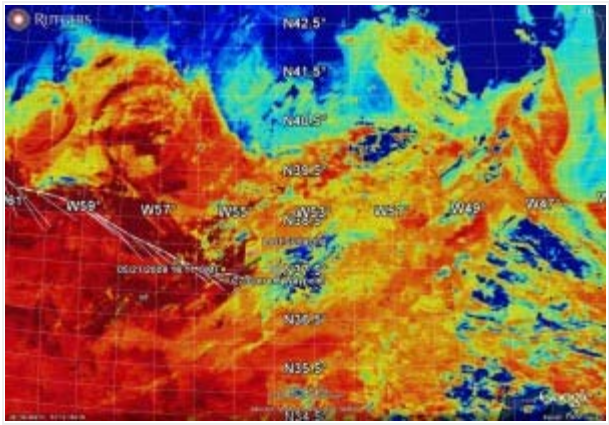
21 may | Many Satellites, One Glider

Posted by: Scott in: Atlantic Crossing

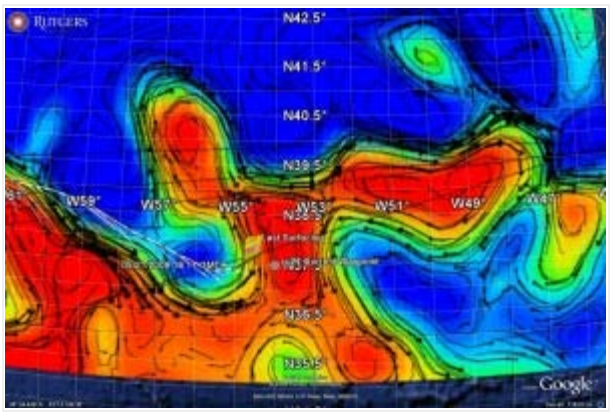
Weather satellites indicate there is a band of clouds is parked directly over the path of The Scarlet Knight. But it looks like fair weather is on the way. There is a big circle of clear weather over the region, just not over us.



The Sea Surface Temperature satellites provide some guidance, but faint clouds seem to be everywhere. Below we have composited 3 days of imagery to see that Scarlet is approaching the eastern edge of that warm water with the counterclockwise circulation.



With little guidance from the SST, we turn to the altimetric satellites that give us the Sea Surface Height (SSH). The reds are highs and the blues are lows. We are flying through a low and about to reach its eastern side. There we hope to find a northward flowing current to carry us downstream.



0 Comments

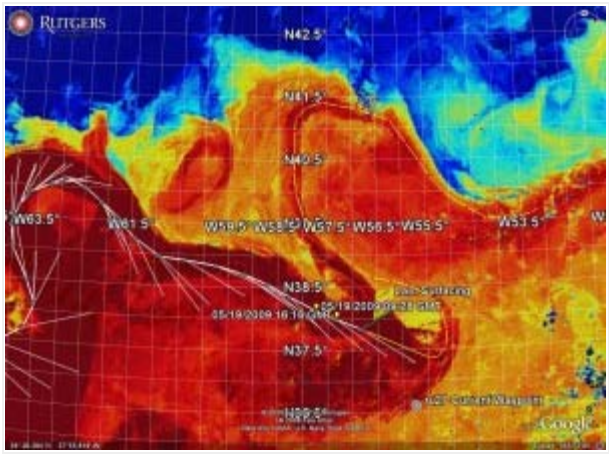
20 may

The Swift Ocean Currents

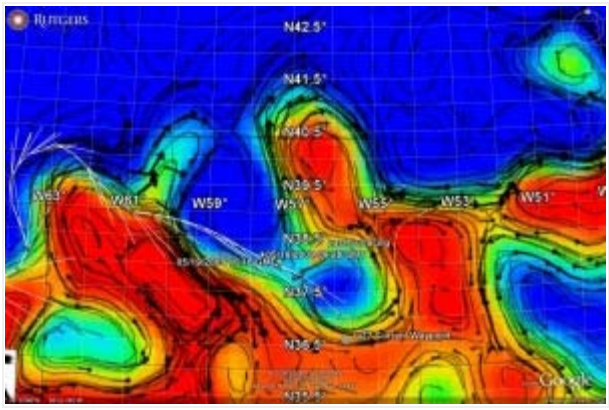
Posted by: Scott in: Atlantic Crossing

http://www.youtube.com/watch?v=4_wLatK7sXg

The Scarlet Knight is heading deep into a Gulf Stream meander trough that is interacting with a Cold Core Ring. Its a 600 km excursion, about the distance from Boston to Washington. If we just follow the Gulf Stream, it looks like we have to go down around this Cold Core Ring, back up north to the crest of the next meander, and then back south again. We want to use this Gulf Stream to push us, but the excursions around these meanders total about 1200 km (yellow line). Even with the push from the Gu;f Stream, that is a long way.



Instead of relying solely on the Sea Surface Temperature (SST) roadmaps for guidance, we can also check the satellite altimetry. Here the Sea Surface Height (SSH) measured by the satellites is then converted to Geostrophic currents. The reds are highs in the ocean surface, and the blues are lows. the current flows with the High on the right and the Low on the left, just like the atmospheric weather maps. In the ocean weather map below, Scarlet is heading down the meander trough that is strongly interacting with the Cold Core Ring. The interaction is so strong that the ring is being absorbed by the Stream to form one long meander.



The important message from this map is that the large meander creast just downstream of us appears to be breaking off to form a Warm Core Ring. The location where it is about to pinch off is our bridge across. The new route (shown by the yellow line) is only about 400-450 km, about 1/3 of the distance. To try for this route, it is important for Scarlet to be positioned on the southern side of the Gulf Stream, well away from the North Wall that we typically follow.

The one thing to remember - just because we have a map of the swift ocean currents that help gliders get around, it doesn't mean that the map is right. The only way to find out is by flying it.

0 Comments

18 may

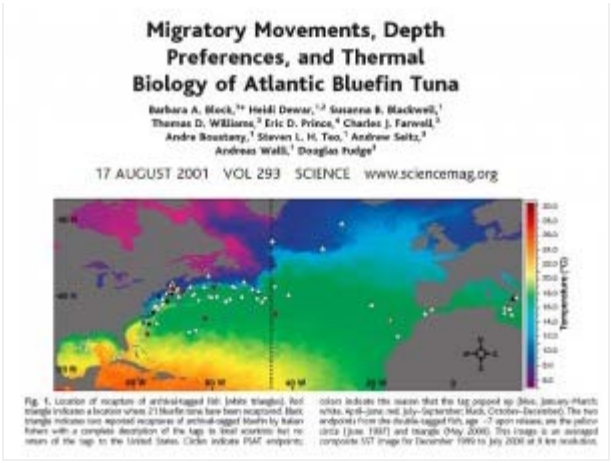
What else is migrating in the Atlantic tonight?

Posted by: Oscar in: Atlantic Crossing

RU27 is cruising well as it continues its migration across the Atlantic. While we are novices at navigating the ocean basin, well Scott is not, biology over evolutionary time has evolved to exploit the major currents of the oceans for their migrations. We have much to learn from the organisms and how they use the ocean. Unfortunately, learning from them is a race against time. They are hard to track and the technology is just starting to mature. One good example for the Atlantic is the bluefin tuna.

Atlantic bluefin tuna fish grow to close to 10 feet and weigh over 1000 lbs. They are powerful fish swimming the seas from the tropics to polar latitudes and for me are SO delicious. At the end of the day, that is the problem as since the early 1980's the Atlantic bluefin tuna have been considered overexploited. This is a concern for all of us, because these fish are a beautiful & important part of the ecosystem, they are economically valuable, and they are tied culturally to many maritime nations. So ultimately we have a need to manage this fishery carefully, and many great groups have been working on this problem, see the links below to the true experts and champions! The problem doing this work in the ocean, is the fish are really hard to follow as the fish move fast and like RU27 they appear to use the currents.

For these tuna, 2 major stocks are recognized in both west and east Atlantic. The eastern stock is considered to reside in the Mediterranean Sea and the western stock breeds in the Gulf of Mexico. Early on it was assumed that there was some low level communication between the populations however data suggested that the Atlantic bluefin are capable of making rapid trans-Atlantic crossings. This is important as the Western Atlantic breeding populations have declined over the last 30-some odd years. To understand the connectivity, scientists (Not us because we are not that smart) initiated an electronic tagging program the late 1990's for the bluefin tuna. These data have shown the bluefin tuna dive to depths of >1000 meters and often make trans-Atlantic migrations between the Gulf of Mexico and eastern Mediterranean. These data are critical for the future management and conservation of this fish. The next step to building a trans-Atlantic management system will be to combine the RU27 technology, radio-tagged fish, and all the ocean navigations tools. This is a project for the future, but as we are still pushing the envelope of the glider technology, and the fish tagging scientists are pushing the envelopes, we can right now just scheme. But WHEN RU27 makes it across, for all those interested, join the team as this will be one of the great future applications.



Migratory Movements, Depth Preferences, and Thermal Biology of Atlantic Bluefin Tuna

Barbara A. Block,[1*] Heidi Dewar,[1,2] Susanna B. Blackwell,[1] Thomas D. Williams,[3] Eric D. Prince,[4] Charles J. Farwell,[5] Andre Boustany,[1] Steven L. H. Teo,[1] Andrew Seitz,[1] Andreas Walli,[1] Douglas Fudge[1]

17 AUGUST 2001 VOL 293 SCIENCE www.sciencemag.org

COOL links: (FOR STUDENTS THESE ARE REALLY COOL!!!!!!!!)

http://www.tunaresearch.org/

http://www.topp.org/

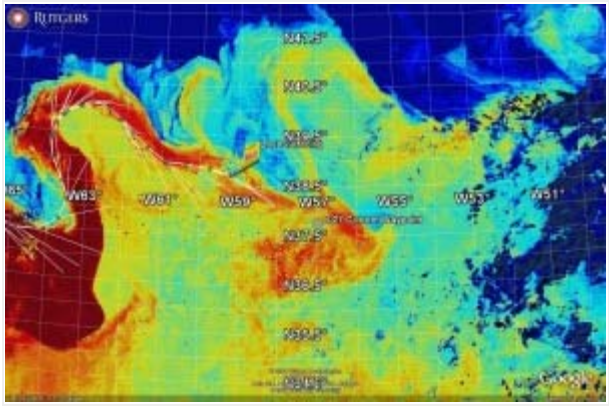
http://topp.org/topp_blog

0 Comments

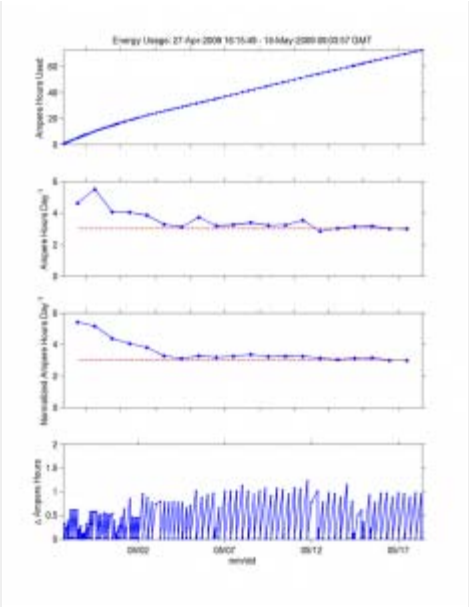
18 may A Good Weekend for Scarlet

Posted by: Scott in: Atlantic Crossing

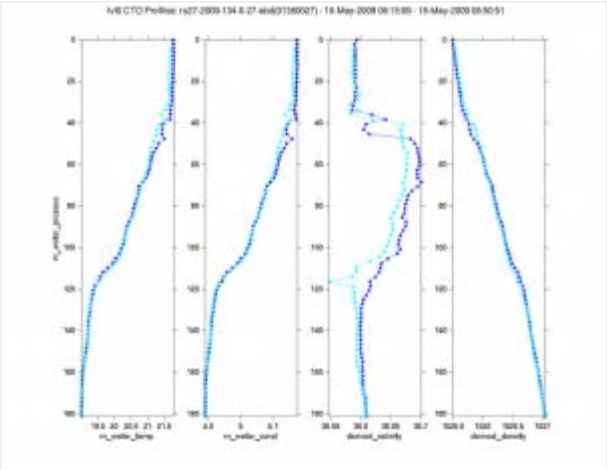
Scarlet's execursion to the northeast on Saturday night put us back in the high velocity core of the Gulf Stream. On Sunday about noon we turned back to the southeast, and are riding 150 cm/sec currents down into the meander trough. I also noticed no missed calls over the weekend. Seems that Scarlet and her shore crew have worked out an agreement.



We'll gather today in the lab and go over the weekend flight performance. Energy use if right on target, averaging exactly 3 amp hours /day over the weekend based on the third plot below. Maybe we should spend less time talking to Scarlet and just let her fly.



Scarlet sent the morning CTD data back and its off to be assimilated. Surfaced mised layer is about 40 m. About 150 m we start to find the top of the Gulf Stream's famous 18 C waters.



0 Comments

17 may

Still flying well 20 days in...

Posted by: David Aragon in: Atlantic Crossing

Scarlet, ru27, is a class of AUV which stands for autonomous underwater vehicle. How much autonomy a glider has, as well as any other AV or robot, is always up for questions and often needs clarification.

We routinely fly our gliders with a pretty high level of self-control. We can describe our actions in a high level, such as 'fly here like so and talk to us every 6 hours', or 'linger here and try not to drift too far until we tell you otherwise'. Mix science commands into that and you have a complete vehicle operating itself and performing useful action. Typically this is how we fly our vehicles as this approach tends itself to ease of operation/monitoring, scaling, and just general consistencies cross-gliders.

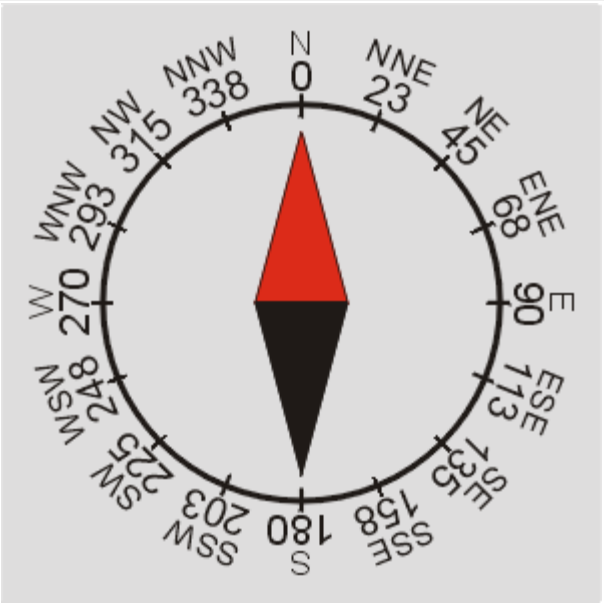
Scarlet, however, we have decided to be a little bit more stern in how she is to fly

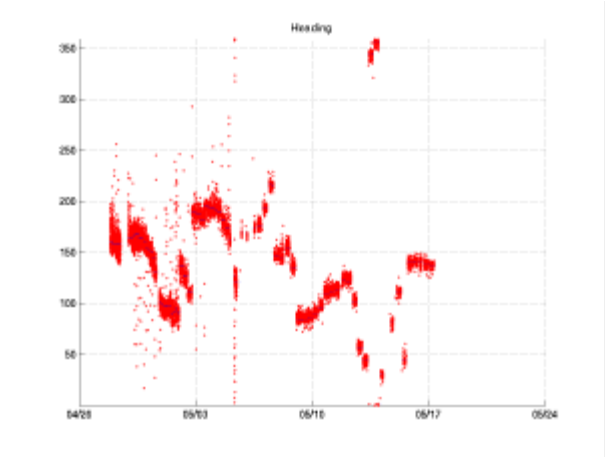
up and down and left and right. This means that in some regards she isn't listening to all the feedback coming from her input sensors and making adjustments based on them. Why would we do this? There are two reasons that make this approach beneficial, at least for now…

1. From our test flights and the live data coming back to us, we think we can fly her just a bit better than she can herself. This is possible because right now she is clean and static (very little changing right now over time as far as her shape, weight, drag, anything…) which leads me to our next point:
2. We can look for changes in the parameters we use to control her and if they change, something about the vehicle or perhaps something in the environment has changed. This allows us to track changes, adjust, and learn from them. The alternative means Scarlet makes her own adjustments and without some work we won't know that she may be trying extra hard to turn right, because she corrected it herself without explicitly telling us.

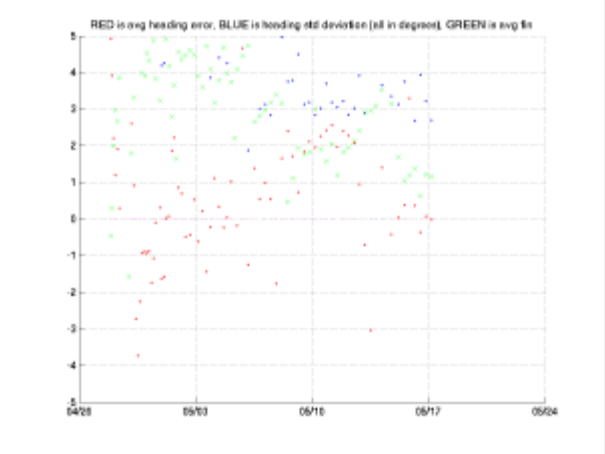
In concern of power usage, we keep the data coming back very small. Each time she surfaces we get as much data as in the text of this post. From this small amount of data we need to monitor, plot, and analyze considering its only a partial set from a much longer time period. We can tell if anything has changed, if we need to make an adjustment; essentially monitoring how she has been flying.

We have only made one such adjustment since deployment and that has been to a fin parameter which helps us travel in the right direction. This change happend right around the time we entered the Gulf Stream. The first plot is simply our direction, in degrees, we want to point the glider in blue and the red 'haze' is our actual direction of pointing.





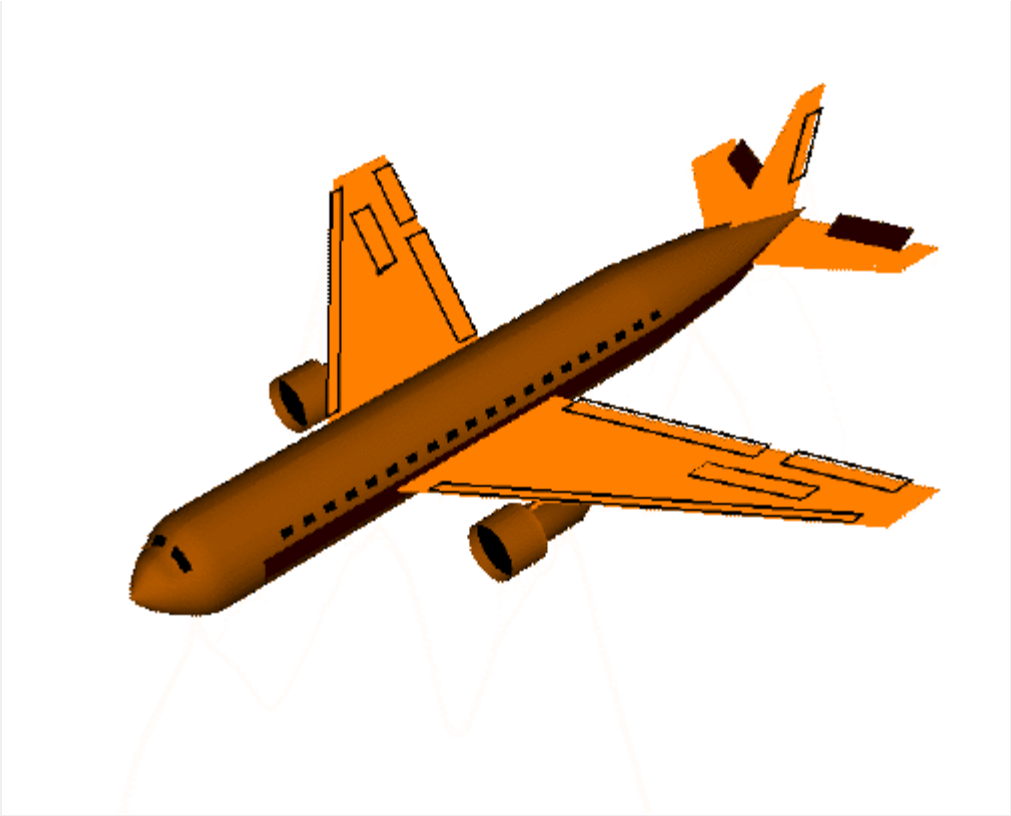
We can see in the beginning how 'noisy' our flying was, and then as time goes on we maintain a 'tighter' grip on the direction we really want to fly in blue. That 'tightness' can be measured from the Standard Deviation. What's another quick way to judge how well we are pointing towards Spain, or wherever we want Scarlet to go? The average value of the direction our nose points. We can subtract from that the direction we wanted to go to see 'how close' we actually went that direction, this is called 'heading error'.



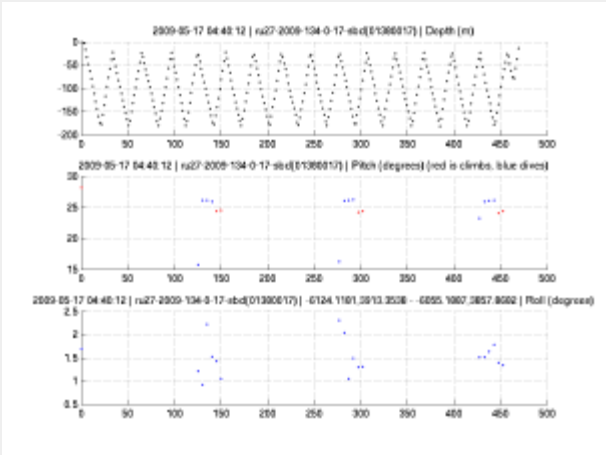
This plot shows each time the glider swims, 6 hours, 8 hours, no matter, what our average 'heading error' and standard deviation are. Both we would like to be small, near 0 degrees.

We can see when we entered the Gulf Stream, between 5/3 and 5/10 our values began to change. This was our first big change to our glider. The change was likely an environmental change such as density, but it is relatively minor. We have disabled the ability for Scarlet to detect this change so we made our adjustments between 5/10 and 5/17 and tracking the red, average heading, we can see that the change was beneficial as it has drifted back to 0 degrees average heading.

Moving onward, we all know that gliders must go up and down through the water column with an angle in order to move forward. If they went straight up and down we would travel only with the currents. With the little blip of information we receive we need to feel comfortable in how she is flying. Below is a plot of very important flight variables, depth, pitch (angle), and roll.



The following plot shows 3 plots. Depth. Pitch during climbing and diving. Roll. One thing to note is the small amount of data coming back from 8 hours of swimming, and how we use that to decipher if the vehicle is flying properly.



With all that said, Scarlet is as flying as good as she has ever 20 days into the mission. Soon, in 10+ days, we will be starting to get into territory that few other of our vehicles have gone: deployments greater than 30 days...

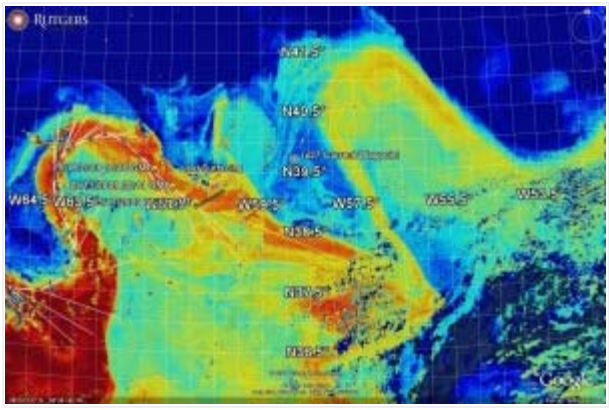
0 Comments

17 may

Sunday Morning

Posted by: Scott in: Atlantic Crossing

We are currently flying northeast into the small meander crest. There is a clearly visible warm ring to our northeast that we need to avoid. We'll turn towards the southeast again at noon.



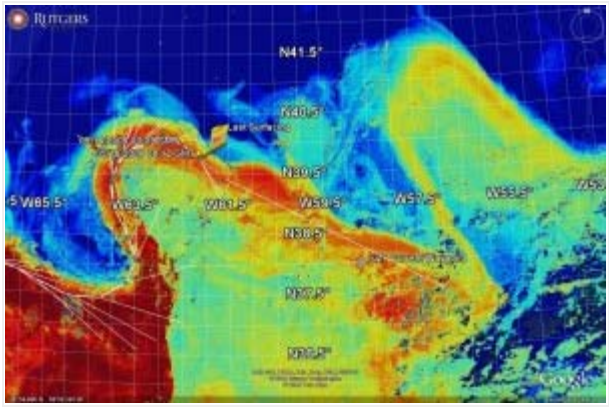
0 Comments

16 may

The Independent Younger Sister

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is back in the center of the warm Gulf Stream, and currents are running 100-105 cm/sec. We are making about 40 km of distance for every 8 hour underwater segment. About half of what we were doing when we first entered the Stream and the currents were approaching 200 cm/sec. Our Current waypoint is about 350 kilometers away, straight down that long straight strectch of the Gulf Stream that heads southeast. If we maintain this speed, its about 3 days to the waypoint. Sometime Sunday or Monday we'll move that waypoint southeast to the bottom of the trough. Somewhere near 37.5 N, 57.0 W. The yellow line that extends parallel to the stream from this point is 450 km long. Once we get within that 450 km range, we'll start looking for the next waypoint.



Energy useage remains good, still hovering around the targeted 3 amp-hours per day despite all the communications testing we did over the last two days. After adding a few internal sensor values to the information Scarlet sends back to us, we now understand the reason for the two missed calls discussed in the previous blogs. If you compare Scarlet (Glider number RU27) with last year's RU17, we see that RU27 is a faster climber, but RU17 would hold her communication tail higher out of the water. This is because RU27 is more tail heavy, and RU17 was more nose heavy. The differences are minor - measured in grams. To make up for the lower tail on RU27, we increased the time at the surface that Scarlet looks for an Iridium satellite. Based on the Iridium satellite schedule, we find that every time any of its 66 satellites are within a 60 degree cone overhead, she has no problem dialing home and connecting. Since these satellites move fast, one enters the cone about every 10 minutes. The image below shows us that the 8 pm call last night was brought to us by Iridium 39, the satellite sitting inside the 60 degree cone over Scarlet.

The end result is that RU27 will be able to use her climbing ability to her advantage. She will be a lot better at getting herself out of trouble when the biology comes knocking. RU17 was the great communicator. More willing to share her troubles and ask for help from shore. On normal flight days, you probably would not even notice the difference.

Just like our kids and our students, every robot is different. Growing up in the same house or being built in the same lab, they each have their own individual strengths. As we said on launch day, we will soon learn more about Scarlet's personality. We now know she is going to be more independent than her older sister.

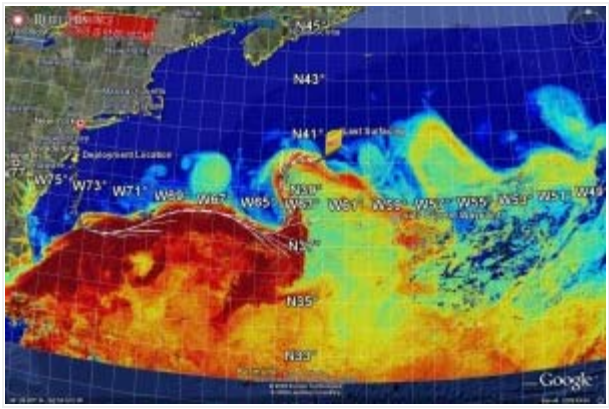
0 Comments

15 may

A Full Gulf Stream

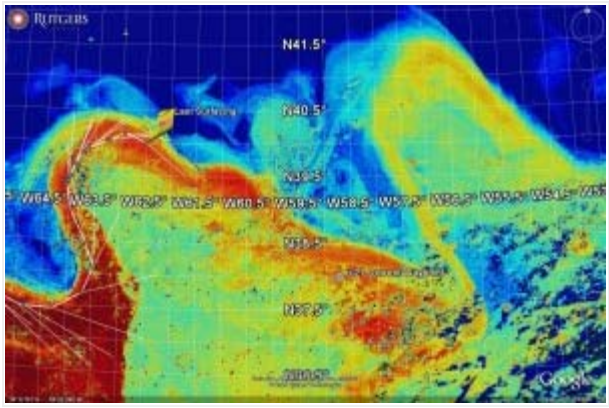
Posted by: Scott in: Atlantic Crossing

A rare find. Complete coverage of the Gulf Stream. And its a meander-fest. And the next one is even bigger. The trough we are heading into is farther south than Washington DC, and the crest that follows extends as far north as Boston. Our job is to keep the Scarlet Knight in the middle of that warm water ribbon, and use that velocity to get us east.



Zooming into Scarlet's present location shown below, you can see we were hugging the inside of the turn as we rounded the crest, and the Gulf Stream velocities

dropped. Overnight last night we starting flying to the northeast and continued in this direction until noon. As we approached the middle, the currents increased. Then about noon we turned the glider to the southeast, and started the big 600 km slide down into the trough. We a running with a tail current that exceeds 100 cm/sec.



0 Comments

15 may

A glorious past leads to a bright future

Posted by: Oscar in: Atlantic Crossing

NOAA's Office of Coast Survey focuses on ensuring safe, efficient and transportation. It is the Office of Coast Survey that provides nautical charts that cover the coastal waters of the U.S. and its territories. This is incredibly important, but the Coast Survey has a grand history, which is nicely tied to RU27 that cruises the ocean tonight. As NOAA has been critical to getting us a RU27 along with the other Federal agencies, we look back at some ocean science history. If you hate this stuff, jump ahead to Scott's next piloting decision.

The great Alexander Dallas Bache

In 1843, Coast Survey was appointed a new leader Alexander Dallas Bache, the great-grandson of Benjamin Franklin who had already been a great explorer of the Gulf Stream. Bache demonstrated great science leadership, maybe he was carrying the yoke of famous great-grandfather. Bache charged his agency with several bold and far-reaching challenges. He asked them to figure out what are the limits of the Gulf Stream? Does the Gulf Stream vary with season? Can it tracked by physical, biological or chemical or geological properties? Does the current velocity of Gulf Stream vary with depth. Many of these questions require the type of data being collected tonight as RU27 continues to cruise north and east. Bache's directives spanned physical, chemical, geological, and biological oceanography and also touched on the interaction of meteorology and oceanography. His plan called for repeated transects taken across the Gulf Stream at right angles of the current, seasonally over a long period of time. WOW sounds like a modern oceanography expedition! This vision was rewarded with great success.

Bache's captains found the "cold wall" the high-temperature-gradient zone that marks the transition between the cooler inshore waters north of Cape Hatteras and the warm Gulf Stream waters. Their collected ooze with shell and coral fragments from the oceanic deep waters which excited biologists to question what life thrived in the dark abyss. They collected data that showed that the Gulf Stream was dynamic and varied in space in time. These great insights came at great costs. On one survey 11 people died during a hurricane in 1846, there is a monument to their memory in the Congressional Cemetery.

This NOAA history preceded the Britain's Challenger Expedition and Matthew Fontaine Maury, the "Pathfinder of the Seas," who served as head of the U.S. Naval Observatory. So RU27 moves tonight following in the grand legacy of the early scientists/sailors of the Coast Survey who illuminated much knowledge of the Gulf Stream.

0 Comments

14 may

The Chinese Dragon

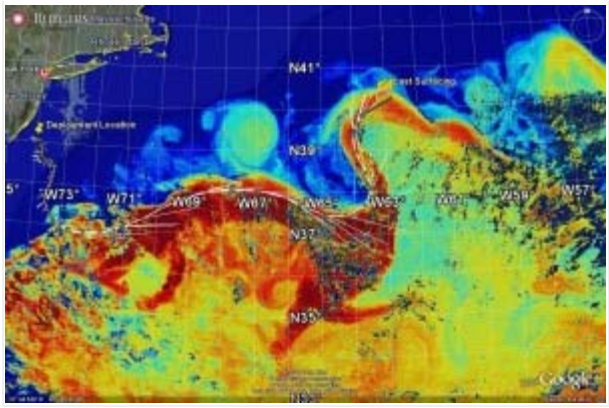
Posted by: Scott in: Atlantic Crossing

So why are Chinese Dragons good and European Dragons bad?

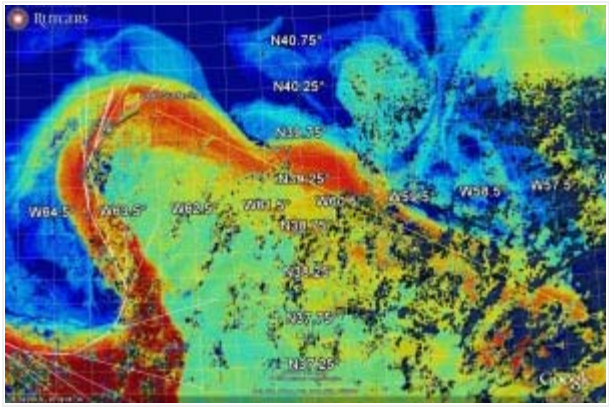
One thing I noticed is that European dragons tend to fly, and Chinese dragons appear to meander in space on 4 legs.

http://en.wikipedia.org/wiki/Chinese_Dragon

Today the Gulf Stream looks a lot more like a Chinese Dragon, powerful and benevolent. I can see 4 legs, and I don't see wings.



Thats good. We'll need the good luck. Zooming in in the image below you'll see lots of surfacings since 4 am this morning. Lots of chatter, automation and communication adjustments today. After last night's missed call, we added more call backs when we do experience no communications. Then the biggest change today was doubling the allowable time at the surface from 5 minutes to 10 minutes to give the Iridium phone more time to connect. We'll also started timing the connections so we can better understand what is going on. Hopefully with our 8 pm surfacing tonight and the new waypoints we just sent, we are back to a routine. Changes in flight and communication parameters are expensive in terms of energy, and once we get off of our schedule, its hard to get back to that same daily efficiency. I'm not even going to look at the energy usage plot tonight. We definitely spent our share of energy.



The Scarlet Knight's flight plan is to head east for 8 hours till 4 am, conduct a CTD cast, then turn southeast and ride down the ramp into the trough to 57 W. The yellow line we added is 600 km long. Thats a long stretch of straight Gulf Stream. The trouble then starts just east of 57 W where the Stream takes a sharp left turn to the north. What parts are Gulf Stream and what parts are rings are difficult to determine in this region, and the models are just as complicated. We'll have to switch over to alitmetry for guidance.

0 Comments

13 may

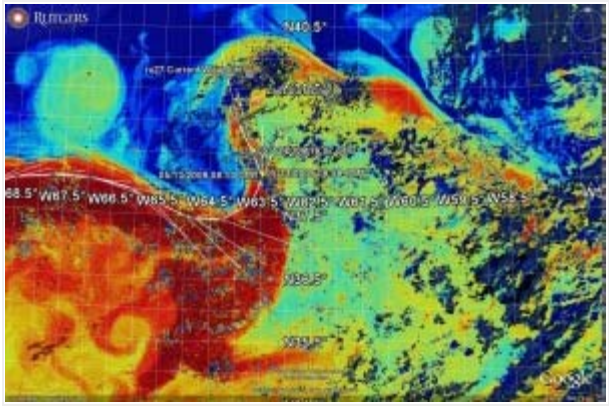
You're Grounded!

Posted by: Scott in: Atlantic Crossing

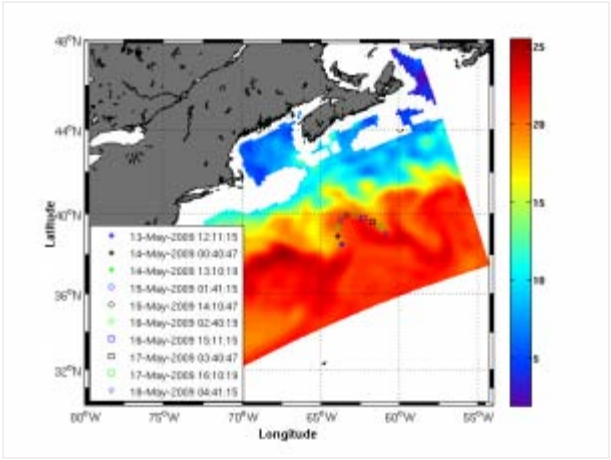
So we are sitting around after dinner and I'm waiting for the 8 pm phone call. No call. My kids said when she calls in for no comms (that means no communications in glider-speak), tell her she's grounded.

Sure enough, The Scarlet Knight called in exactly 1 hour later, but I didn't ground her. John was IM'ing and Dave was emailing. A new satellite Sea Surface

Temperature (SST) map had just come in. The Gulf Stream meander had moved east, and we were headed for the edge. Dave changed the waypoint. Moved it more to the northeast. John sent her on her way. We had surfaced only 14 km away from the north wall. Thats still fine, but we don't want to get amy closer. Especially as we approach a meander crest. We could get spun out of the Stream by the warm filaments it sheds, or get caught in that small eddy near 40.5 N, 63.5 W. So John set it up to switch to a due east heading at the 4 am surfacing. That will put us away from that edge of the Gulf Stream and get us more in the middle.



Below is the UMass Dartmouth model results showing the location of The Scarlet Knight over the next week if it was just drifting. The model forecasts that we will make it around this meander before it breaks off, even if all we can do is drift.

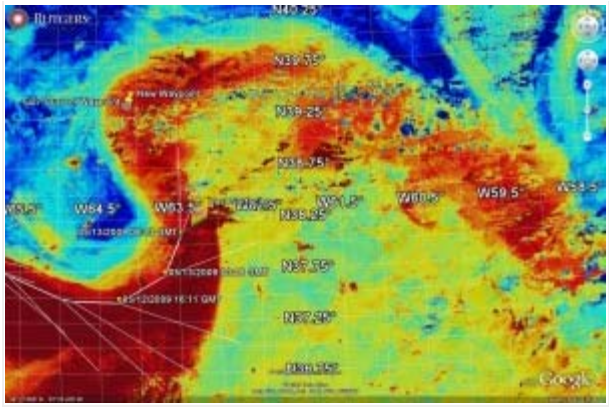


2 Comments

13 may The Overnight Turn

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight continues its turn around the meander trough, and the new waypoint we set last night is now the current waypoint to lead it around. All while we slept - just a shore based computer and a glider computer texting each other in a few minute phone call in the middle of the night.



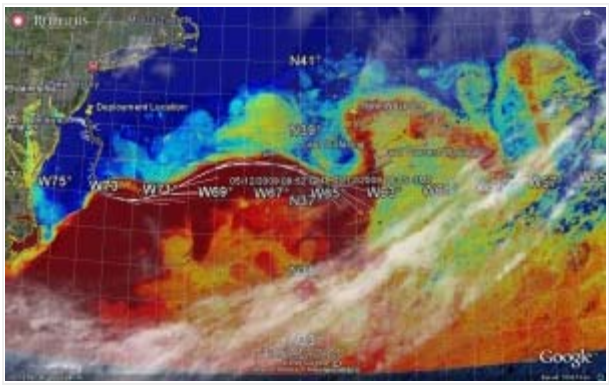
0 Comments

12 may

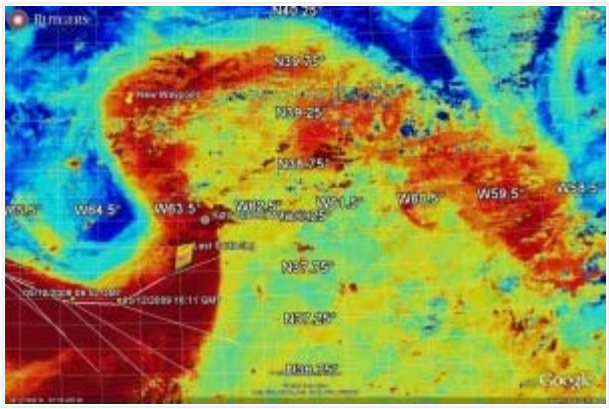
The Race

Posted by: Scott in: Atlantic Crossing

Clouds to our south, but only light clouds over us, and clear to our west. We should have some good satellite imagery by morning. Warm (red) Gulf Stream is well defined in May. The Scarlet Knight is heading around the bottom of a meander trough, starting to work its way around a “S” shaped turn in the Stream.

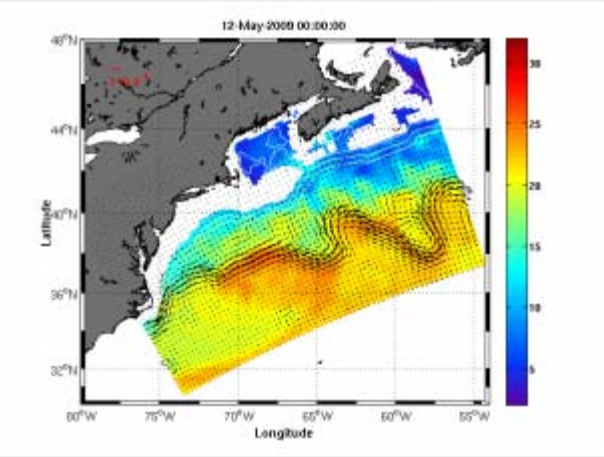


Zooming into the glider location, we are now flying towards the northeast. Look at those current vectors turn. At the next surfacing (4 am local time), we will turn the glider towards the new waypoint up in the northwest corner of the S.

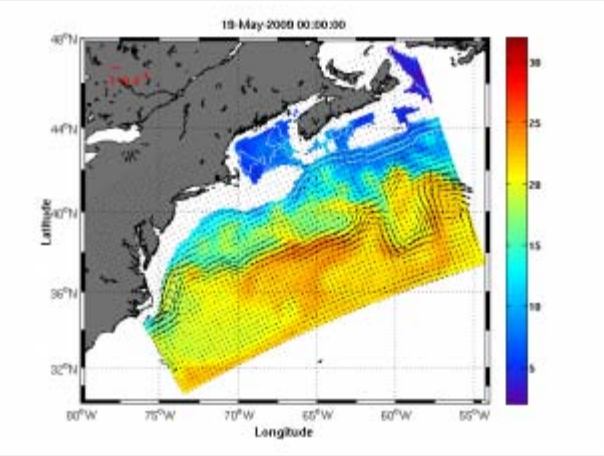


An “S” shaped meander like the one above won’t last that way for long. It will either break off a Warm Core Ring to the north or a Cold Core Ring to the south, straightening itself out in the process. But which one will form, and when? To

answer these questions, we turn to the forecast below. First we show the forecast model result from UMass Dartmouth for today. Here we choose the 100 m depth level, since The Scarlet Knight is gliding between 20 m and 180 m, so 100 m is exactly in the middle. And we plot the forecast current vectors on top of the colors representing temperature. We see the S-shaped meander between 60 W and 65 W.

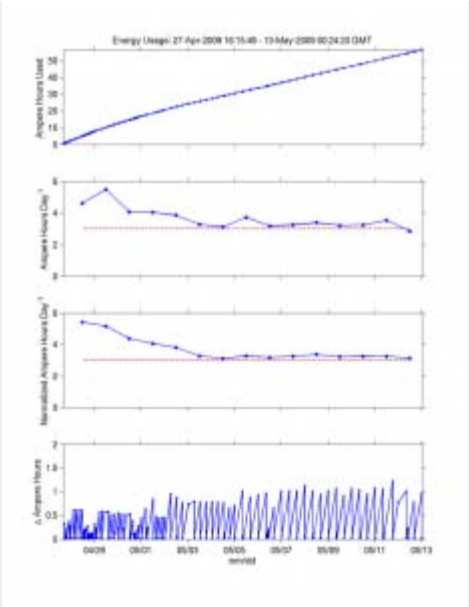


Below we look at the same currents and temperatures at 100 m, but now they are the forecast fields 7 days from now on May 19. The S-Shaped meander between 60 W and 65 W has evolved. The forward face (eastward) of the meander crest remains approximately stationary near 60 W, but the rear face moves eastward. The trough the Scarlet Knight is now transiting moves from about 65 W to 63W, catching up with the forward face and steepening the meander crest. The Gulf Stream water we are about to enter with the glider gets left behind in the process.



So the race is on. We need to get around the meander crest we are now approaching before it is left behind by the steepening of the wave.

Meanwhile we keep trying to lower that energy use curve. Of the 4 plots that we usually look at below, the important one for this purpose is the third, the normalized amphours/day. We want to inch this below 3. We are getting close. At our flight status meeting today we tossed around the next round of ideas to reduce energy use further. Today at noon we reduced our fin offset from +4 degrees to +2 degrees to help us track a course. We'll test this overnight, and if all looks well, further reduce the amount of flight data we send back. This includes reducing the number of pressure records by 1/2, and since we are flying well, reducing the number of undulation (or yo's as we call them) that we do send flight data from 3 to 2. Again, we reserve most changes for noon, so they will go into effect tomorrow. Then we'll see if we hit our energy target.



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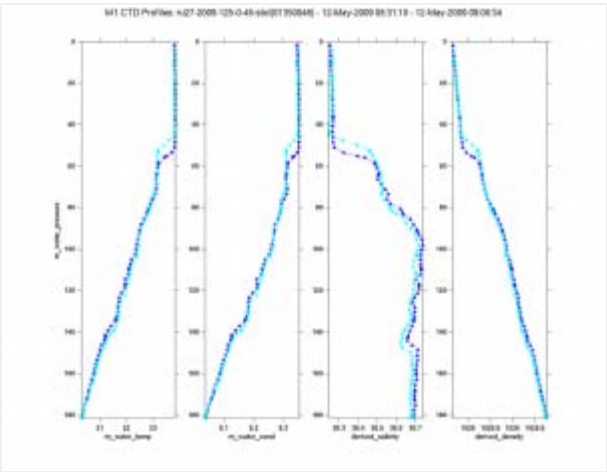
While we reduce the flight data, we keep the CTD sensor data running at high resolution. Below are profiles of temperature, conductivity, salinity and density derived from the CTD sensor. Every morning at 4 am local time, we turn the sensor on, collect a full yo (1 downcast and 1 upcast) of data, surface and send it home to Rutgers for processing. The down arrowheads are the downcast, and the up arrowheads are the upcast. The processed profile data then is sent to the U.S. Navy in time for their daily assimilation run, and to UMass Dartmouth for their Gulf Stream Forecast.



0 Comments

12 may

Some history on a beautiful spring day

Posted by: Oscar in: Atlantic Crossing

Today RU27 cruises south of Nova Scotia. It represents our first international off-ramp on the ocean Turnpike (give me some slack, I live in Jersey) if we were having troubles. This is based on a long history of collaboration with friends in Canada. Our first lithium battery glider flight test was a flight from NJ to Halifax in Canada. The flight, which was successful, ended when old friends from Dalhousie University and Satlantic Inc. picked up the glider after it had transversed our shelf, cut into the Gulf Stream and then headed north. This spirit of partnership is one of the hallmarks of the sea going culture and the oceanographic community where the successful return of brethren at sea is always the hallmark for success. For us, the

spirit of collaboration for ocean observatories was formalized years ago.

The 2005 Oceanography Society meeting in Paris was one turning point in the promotion of international collaborations. Discussion at the meeting focused on how best to collaborate, share data, and begin to form a coherent network. This coalescing collaboration was reminiscent of the atmospheric observing community in the early 1900s when the telegraph first connected individual weather forecasters from different countries independent of official government organizations. It became clear there was much to be gained by sharing expertise and limited observational assets. Although enabling technologies continue to be demonstrated locally or even regionally in many places around the world, we remain capacity limited if we try to address the challenges of globalization. Seeing the collaborative spirit at the Paris meeting as a way forward for the working scientist, at a Paris sidewalk café, John Cullen from Dalhousie University initiated the International Consortium of Ocean Observing Labs (I-COOL). Plans for the first collaborative I-COOL deployment followed the next morning with John Howarth from the Liverpool Bay Observatory proposing a glider mission coordinated with his ongoing shipboard cruises. Collaborations continue today, fueled by the need to sample the ocean with new satellite, HF radar, glider, and AUV-based technologies. Our objective is to distribute the technologies developed locally in the Northeast regional test bed to the global marketplace. Currently, I-COOL often focuses on providing platforms and expertise that enable local scientists to demonstrate success and hence fuel local funding for programs that contribute to the larger I-COOL effort. There have already been many successful collaborations with European, Australian, and Caribbean scientists. So today, RU27 seems to be fine, so we will continue our East, instead turning north for our friends John Cullen, Marlon Lewis, Katja Fennel and Scott McLean for help. But as we pass by, we tip our hats to our Northern partners.

The most famous and bearded John Cullen!

0 Comments

12 may

Our first missed call

Posted by: Scott in: Atlantic Crossing

Wasn't I just writing about this?

Every now and then something happens and the Iridium satellite phone call just does not go through. That happened to us today at noon local time.

The Iridium satellite communications system uses a constellation of about 66 satellites in low earth orbit. You need to be able to see one of these satellites to call it, so you have to be outside. Your call then bounces satellite to satellite until it can reach a ground station. Your call is routed through the ground station and onto standard land lines to its final destination, which in our case is a phone bank in the lab capable of dealing with 8 simultaneous Iridium calls. You can see an

illustration in this video.

http://www.youtube.com/watch?v=AHmDq2L2Eu0

Sometimes, for reasons unknown, something in the network messes up and the call does not go through. Maybe we did not have a good lock on the satellite we were trying to call, we are not sure. What we do know is that it is very rare. Still, on a long trip, even a rare event has to be considered. Didn't I just say this happened 3 times with RU17 during its 5+ month journey?

So what happens when we miss a call? What happens when your kids are out driving around in the car and they miss a call? Yes, exactly. You panic. You assume the worst. No matter how many times you have been through this, the feeling is always the same, especially on the first missed call of a mission. You tell yourself to just be patient, there must be a reason, everyone is probably okay, and your robot will call again as soon as they get the chance.

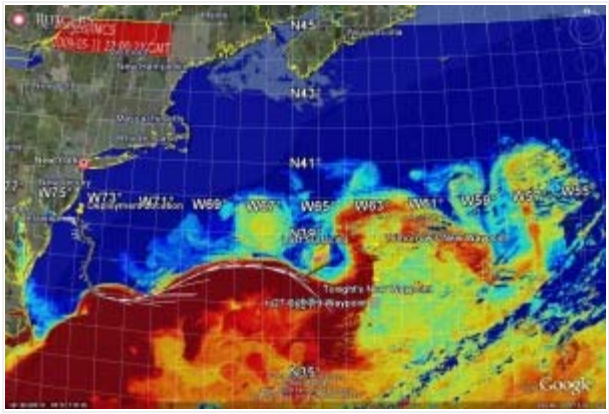
So today we missed our first phone call at noon. Was The Scarlet Knight lost at sea? Did it not make it back to the surface from its last dive? Where we done?

One thing we knew was that The Scarlet Knight had at least made it to the surface. The ARGOS satellite network picked up a location and coded message. ARGOS is used for the emergency locater system on all the gliders, so it runs whenever we are at the surface, so all it needs is for a satellite to pass overhead, and we get it. So at least we had that. We knew it made it to the surface - so why no call, and where was it now.

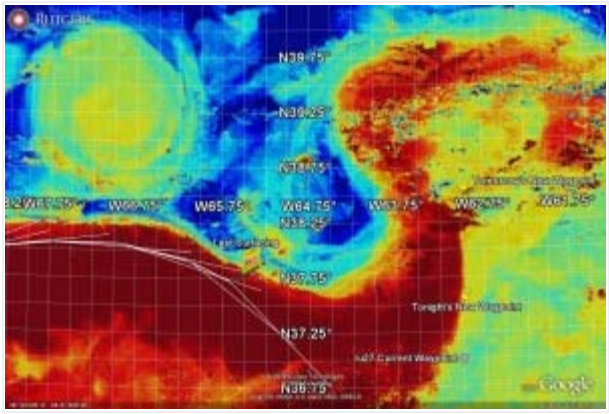
So we waited. We watched the Space Shuttle launch. And we waited. Then, precisely 9 hours since its last communication, exactly as programmed, The Scarlet Knighted texted John on his IPhone. She said she was back at the surface because we had not spoken for 9 hours, and we had told her that if this happens, she should call.

With that, we set about preparations for the next set of waypoints. We had clear weather, and we are sliding dowm the Gulf Stream into a trough. We adjusted the waypoint a bit to the south to run parallel to the Stream. But we would have to watch it, and check in again later in the evening for another course chagne.

At the 8 o'clock surfacing we found currents to the south were increasing, and we did not to get tossed out to the south was we rounded the meander trough. We turned to due east, planning to head straight across the base of the meander. Tomorrow we'll start making the turn around the trough.



Below we zoom into the S-shaped meander system we are approaching. We are leaving a perfectly circular Warm Core Ring behind. Today Avijit is running his Gulf Stream forecast for the IOOS Mid Atlantic Regional Coastal Ocean Observing System. He'll be using the satellite imagery and the glider data as input. He posts results on tuesdays. I know Avijit from our days together at Harvard. We were both there as post-docs working for Alan Robinson, back when we produced the first dynamical ocean forecast model adopted for operational use by the U.S. Navy. Today we are help to adapt the first gliders for operational us by the U.S. Navy. We'll work the glider side here at Rutgers. Avijit will handle the forecast for us. And tomorrow we'll know. Will theis remain an S-Shaped meander? Will one side break off into a ring? Will be make it through in time before we get trapped in a new born ring? We'll know tomorrow through Avijit's and Jen Clark's eyes.



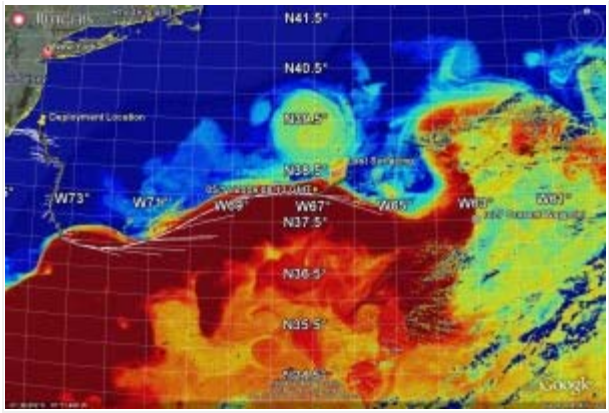
0 Comments

11 may

Clear Air and a Good Map.

Posted by: Scott in: Atlantic Crossing

The warm (red) Sea Surface Temperature of the Gulf Stream is clearly visible against the cool blue waters of the Slope Sea. The Scarlet Knight has rounded the meander crest and is sliding down into the trough. We will move the current waypoint south 1/2 of a degee to 37 S. This will adjust our trajectory to fly straight down into the trough. Tonight will make the changes to start the left turn to the north around the meander trough. In this case, we want to stay away from the southern side of the Gulf Stream and any Cold Core Rings that may be there.



0 Comments

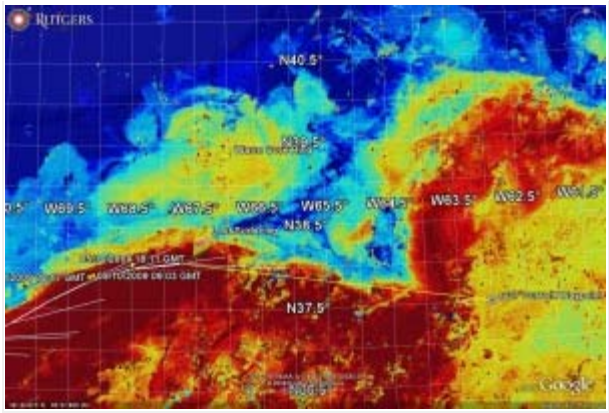
10 may

Ben's Gulf Stream

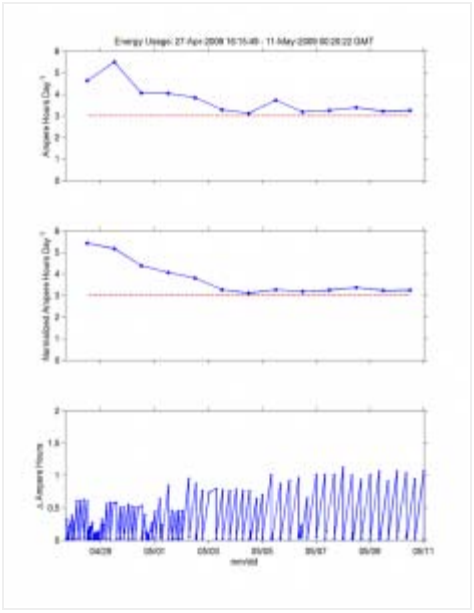
Posted by: Scott in: Atlantic Crossing

http://www.youtube.com/watch?v=rR5TFWNLtOc (Wait for the Maya graphics near the end).

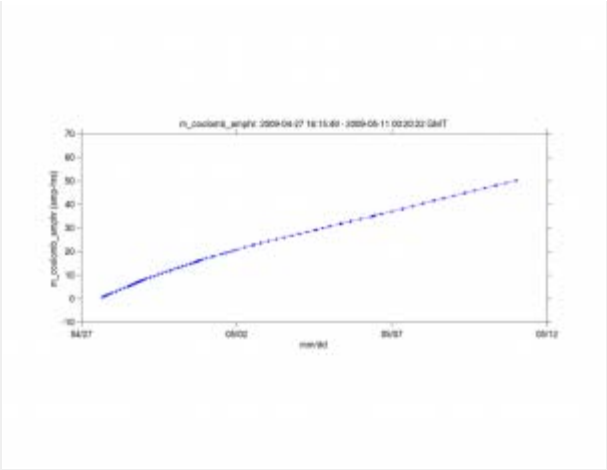
The Scarlet Knight is rounding the top of the meander crest tonight. Another record breaking segment. We traveled 68 km. Observed current speed of 193 cm/sec. We'll inch that waypoint south a bit tomorrow morning and start the slide down into the trough located near 64 W, about 420 km away.



And now for a look at energy. Power is everything. Everything we do is designed to take as little as power as possible. In effect, we are racing to see how little power we can use. In the series of three plots below, the one to concentrate on is the normalized energy usage per day, the center plot. The objective here is to get the daily power usage of the glider down to below 3 amp-hours/day, shown here as the red dotted line. We set 3 as our design target. If we can somehow get below 3, we will be using even less energy than we had planned. You can see how we used more energy in the shallow water of the continental shelf, and how our daily energy usage steadily dropped as the water got deeper and deeper.



The next plot shows the total accumulated energy use since deployment. You can clearly see the change in slope from the earlier part of the record with higher energy use per day followed by the present slope steady slope. Our total is about 50 amp-hours used so far. We have several estimates of how much power we have on board. The estimates range from 900 amp-hours to just over 1000 amp-hours. Much depends on the temperature of the water. Warmer temperatures push you to the higher end, colder temperatures push you to the low end. Since we'll be in both, our actual power likely will be somewhere between these two, and will depend on the details of the path we take. So warm temperatures are good for our batteries, but bad for the biofouling we may experience.



2 Comments

10 may

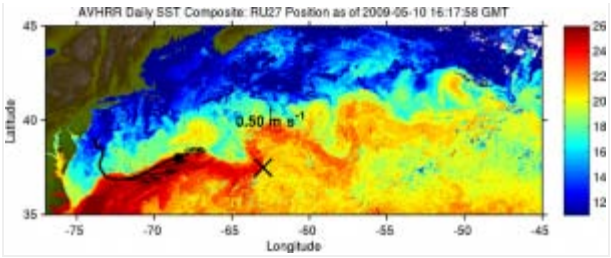
Gulf Stream 101

Posted by: Oscar in: Atlantic Crossing, Espresso & Biospace

Winslow Homer's picture of the Gulf Stream

The Gulf Stream is a central to our efforts to cross the Atlantic ocean. This is because as can be seen in the RU27 velocities, it is rapidly moving (I mean really rapid) current. The Gulf Stream originates in the Gulf of Mexico, exits through the Strait of Florida, and follows the eastern coastlines of the United States and Newfoundland before crossing the Atlantic Ocean (Figure below is a SST from today's data page showing the warm Gulf Stream in which hopefully RU27 remains!). The rapid currents are driven by the process of western intensification. This is the intensification of the western arm of an oceanic current, usually a gyre in an ocean basin. The trade winds blow westward in the tropics, and the westerlies blow eastward at mid-latitudes. This wind pattern applies a stress to the subtropical ocean surface with negative curl in the northern hemisphere. The resulting transport is equatorward. Because of conservation of potential vorticity, that transport is balanced by a narrow, intense poleward current, which flows along the western boundary of the ocean basin, allowing the vorticity introduced by coastal friction to balance the vorticity input of the wind. Really geaky, but wind drives large ocean currents that runs into a barrier (land) and the currents in the northern hemispere are driven north in the Atlantic. That large raging current is our ticket for cruising at least 30% our journey if we are lucky!

Western intensification of Gulf Stream provides northward accelerating current offshore the east coast of North America. At



about 30°W, 40°N, it splits in two, with the northern stream crossing to northern Europe and the southern stream recirculating off West Africa. The Gulf Stream influences the climate of the east coast of North America from Florida to Newfoundland, and the west coast of Europe. Although there has been recent debate, there is consensus that the climate of Western Europe and Northern Europe is warmer than it would otherwise be; and that this is due to the North Atlantic drift, one of the branches from the tail of the Gulf Stream. The power of the Gulf Stream has long been considered a potential source of energy ever since its discovery by Juan Ponce de León in 1513. We here in the tri-State also have some nice Gulf Stream history, as our local historical figure Benjamin Franklin (Old map below) studied and mapped the current in detail. Also the lore of the Gulf Stream was captured by the famous artist Winslow Homer (Figure at top of the page). Looking at Winslow's painting, I have one thought,,,, I don't like those sharks.

Some good links and references can be found at:

Fernandez-Armesto, Felipe (2006). Pathfinders: A Global History of Exploration. W.W. Norton & Company. pp. 194. ISBN 0-393-06259-7.

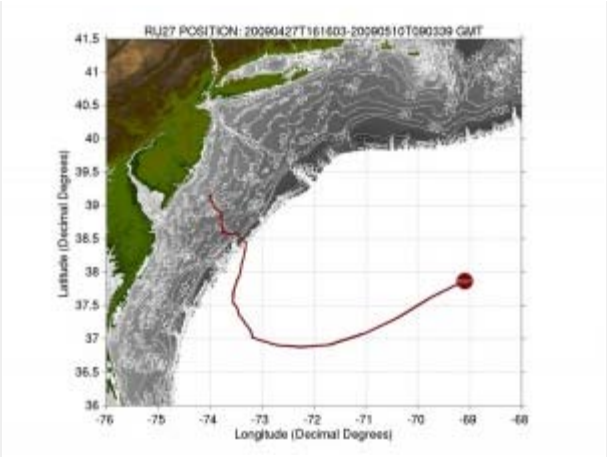
Matthias Tomczak and J. Stuart Godfrey (2001). Regional Oceanography: an Introduction. Matthias Tomczak, pp. 42. ISBN: 8170353068.

0 Comments

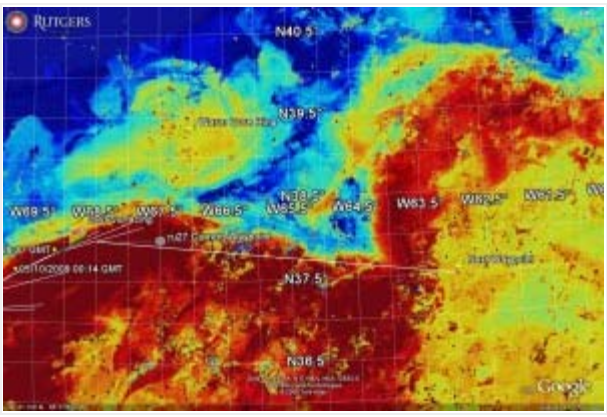
10 may Staying Clear of the Warm Core Ring

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is making excellent speed as are travel downstream with the Gulf Stream Currents. Our standard track plot below looks like a rocket launch. Maximum observered current remains just over 180 cm/sec. Maximum segment distance underwater is up to 64 km. We are about 140 km from the next waypoint, and we'll be closing that distance to near zero close to tonight's 8 pm local surfacing. So we need to move the waypoint.



Below we choose a point (37 30 N, 63 00 W) far enough downstream that we won't blow by it even if Scarlet misses a phone call. Last year RU17 missed 3 phone calls during its 5 months at sea. Thats not many, but you have to always be prepared for a missed Iridium call. As we round the top of the meander crest, we also want to make sure we stay away from the Warm Core Ring labeled in the picture and sitting just to our north. Just last week we were begging for warm core rings to help us cross the Slope Sea. Now we are working to avoid them. Getting caught in a warm core ring required you to spin around it for a lap to get bakc out where you started. We loose about a week of energy in the process. So as we round the top of the meander crest, we keep a little southward component in the glider flight direction. The new waypoint is 485 km away from the expected noon surfacing location of The Scarlet Knight.



We'll likely stay on this course through the night as we cross the meander crest, keeping an eye for any indication that the Warm Core Ring is causing us trouble. Then tomorrow morning we'll adjust the waypoint again to optimize our path down the forward face oof the meander crest and into the trough. Gulf Stream roller coaster. No loops.

0 Comments

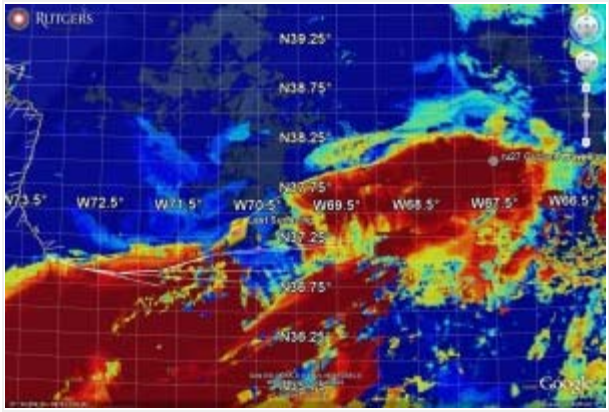
09 may

More speed & distance records

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight, Rutgers Glider Number RU27, is taking best advantage of its 8 hour underwater segments. Last night she flew just over 60 km without phoning home, blasting that distance record. Speeds are just inching over the previous

record set by RU17. We are just over 175 cm/sec for Gulf Stream currents, and nearly at 220 cm/sec for the Glider speed over the ground. We are speeding downstream to a waypoint 320 km away at the top of the next meander crest.



On most Glider missions, we typically run 6 hour underwater segments, meaning 4 surfacings per day. Every surfacing is an Iridium satellite phone call, and phone calls are the second largest power draw on the robot. The largest power draw is the buoyancy pump, which cycles about the same number of times per day no matter how many times you surface for a quick chat with your folks back home. So the switch to 8 hour segments means fewer phone calls for navigation. It also means we can add in a phone call to communicate data. So every morning starting about 4 am local time, Scarlet starts a full range CTD cast, flying from the surface down to 180 m depth and back up again. It phones this data home immediately, where it is posted on our webpage, and transmitted to three groups of ocean modelers, including national centers in the Navy and at NOAA, and to our Regional IOOS partner at UMass Dartmouth.

May is a good month for viewing the Gulf Stream in the satellite Sea Surface Temperature imagery, so we arrived at a good time. (If anyone asks, we'll claim we planned it that way). In May the clouds are fewer, the atmosphere is drier, and the summer sun has not yet warmed the sea surface, so we have a very good contrast between the Stream and the Slope Sea. I still remember that sequence of Gulf Stream forecasts we made in May of 1988 that turned into a standard Navy test case for all future Gulf Stream forecast models. We'll be relying on these forecasts in the Gulf Stream region, on the satellite altimetry from the University of Colorado, and on the satellite SST imagery we collect here at Rutgers and at the University of Maine. But even beyond the data and forecasts, we also have available the experts on how to interpret the data. Having what we call "domain experts" available to interpret what all the real-time data streams mean is something that is often neglected in the design of ocean observing systems. In this Gulf Stream phase of our mission, we are lucky to have our long time friend Jenifer Clark watching over our shoulder. Jen is easily the greatest Gulf Stream domain expert of all time. She knows the Stream better than anyone on the planet.

http://users.erols.com/gulfstrm/

Its good to know our students are learning from the best.

0 Comments

08 may

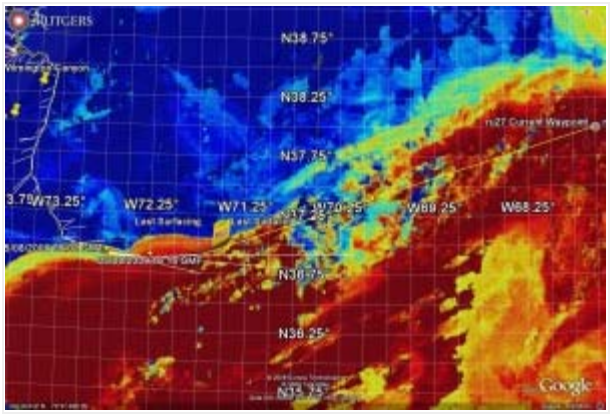
Go Speed Racer

Posted by: Scott in: Atlantic Crossing

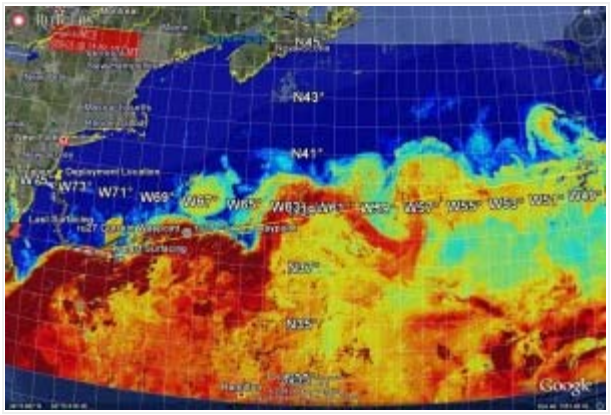
http://www.youtube.com/watch?v=auszi9bUr3o

The weather over The Scarlet Knight is clearing, and we are starting to see the

ocean surface again. The satellite thermal imagery of Sea Surface Temperature reveals a Gulf Stream that looks like Avijit's forecast. The dark red is the Gulf Stream, and the blue is the Slope Sea. The Gulf Stream meander crest to our east has propagated downstream to 68 W, and the Gulf Stream meander crest to our west has grown and propagated downstream right at us. Like surfers, we skiped the first wave and caught the second. And we are now well within the Stream, getting a boost of about 135 cm/sec, bringing our total total speed downstream up to about 175 cm/sec for the last 8 hour segment. Thats nearly 50 km over the last 8 hour segment - the farthest distance we have ever flown with communicating with the glider. We'll continue doing these long segments, with 390 km to the waypoint at the top of the next crest.



Zooming out to the long-view, we see the full length of the Gulf Stream extending from our present location and meandering out to the Grand Banks of Newfoundland. Total distance to the Grand Banks is 2000 km. This is the next phase of our journey. Following the meanders of the Stream, trying to stay with the high velocities and not get spun out into a Warm Core Ring to the north or a Cold Core Ring to the south.



As we continue east, we move further and further away from our Gliderports in the Mid-Atlantic. If we developed any trouble early in the mission, we could just turn around and head back to the Rutgers pick up point in Tuckerton, to Wendell at UMass Dartmouth, to Bill at U. Maryland or to Harvey at U. North Carolina. Any of these 4 Mid-Atlantic Gliderports are available for local work.

But in about a week, Scarlet will be too far to go back to the Mid Atlantic, and our closest Gliderport will be Halifax. That means we'll be relying on our friends at Dalhousie University and Satlantic. They picked up RU15 on our first lithium-powered test flight back in the spring of 2008.

http://www.youtube.com/watch?v=QLQAPdFITPQ

They'll be our emergency landing point for few months. Once we get past the

Grand Banks, the next Gliderport is the Azores. Earlier today Anna at the U. Azores was telling us about the beautiful clear satellite imagery of the Gulf Stream bifurcation zone just beyond the Grand Banks. She clearly saw one branch of the Gulf Stream heading northeast towards northern Europe, and the other branch heading straight east to the Azores. That branch to the Azores is the one we want. The distance may not be that different, but having the Azores as an emergency Gliderport is critical. Anna was talking to us about the possibility of sending some of her students out to Rutgers in the early fall. It will be a good time for them to visit. Anna's students could help us pilot The Scarlet Knight past their home islands. Nothing like local knowledge of the sea when you are flying the your gliders in far away places.

0 Comments

08 may

Bio-Fouling 101

Posted by: Oscar in: Atlantic Crossing, Espresso & Biospace

Bio-Fouling 101: RU27 continues cruising in the Gulf Stream tonight, which is a great step forward. Our goal is to use the speed of this current as much possible to head as far East as quickly as possible. There are many reasons why we obsess riding this Gulf stream as far East as quickly as possible. First, the sooner we make it across the faster we can declare victory! But to make that happen, we need to maximize the amount of distance we cover as quickly as possible. This will require we keep the time we have maximum glider speed and maneuverability for as much of the journey as possible. There is some problems that we will have to deal with. One issue is bio-fouling, which has plagued humans since they have been going to sea. Bio-fouling is the undesirable accumulation of microorganisms, plants, algae, and/or animals. It is horrible, it is athlete foot squared, it is finding snails living in your apartment in the furniture (not that it would ever happen to anyone….).

Humans have been dealing with bio-fouling since they have been going to sea. Early sailors used various mixtures (train oil, rosin, brimstone, tar, pitch, etc.). A brilliant suggestion was provided by Charles Perry in 1708, who suggested using copper sheathing. The copper performed very well in protecting the ship hull from worm and weed. Geeks later figured out that copper in sea water produced a poisonous film of oxychloride that totally hurts marine creatures. This poison film also washed away, leaving so the marine life could attach itself to the ship. From about 1770, the Royal Navy set about coppering the bottoms of the entire fleet and continued to the end of the use of wooden hulled ships. The process was so successful that the term copper bottomed came to mean something that was highly dependable or risk free. The problem, copper is heavy so it is not an option for the glider. Therefore we have focused on a new approach. We have coated the glider in a unique Teflon skin, we hope that this special surface will have the critters slipping off the skin. Over time however some animals will stick, and the fauna will build up and this will result in a decrease in speed and maneuverability.

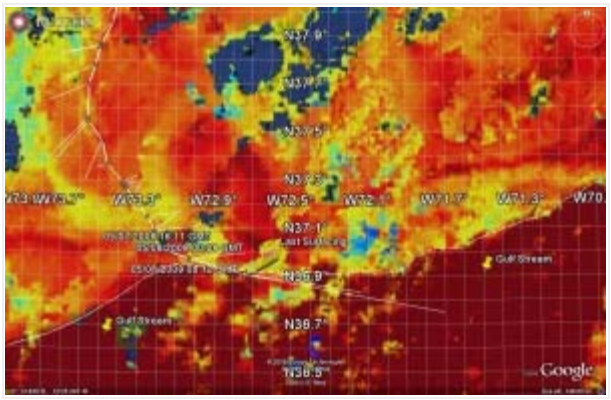
Biofouling is generally divided into microfouling (biofilm formation and bacterial adhesion) and macrofouling (attachment of larger organisms, of which the main culprits are barnacles, mussels, polychaete worms, bryozoans, and seaweed). These micro and macro critters are coming, we will need to live this. But their growth takes time so the further we get the better. So tonight as RU27 surfs the mighty Gulf stream, we can just say "Go fast and go far". So for the RUCOOL undergraduate glider pilots, be smart so we can "Go fast and go far".

0 Comments

08 may Gone Plaid

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight has made the jump into the Stream. Currents are up to 93 cm/sec and increasing. Time to inform Halifax.



http://www.youtube.com/watch?v=NP6DXoNKITc

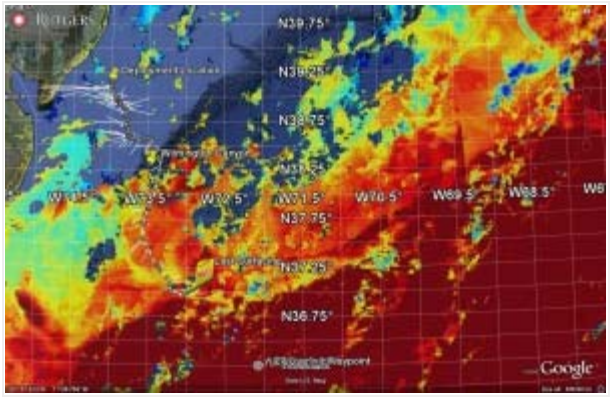
Later today we will change the scaling on our satellite imagery displayed in google earth. The present scaling is set to enhance the Slope Sea. Today we move to a scaling designed to enhance the Gulf Stream.

1 Comment

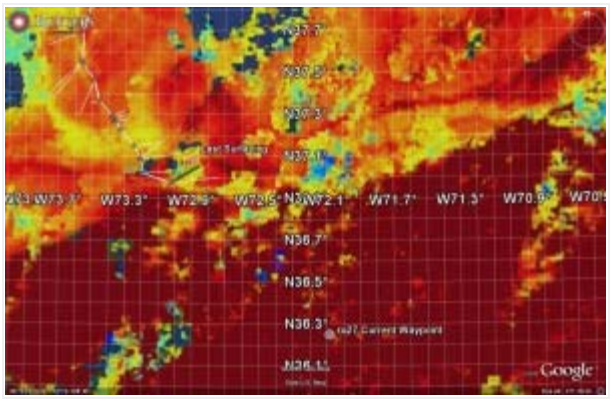
07 may 10 Days and into the Stream

Posted by: Scott in: Atlantic Crossing

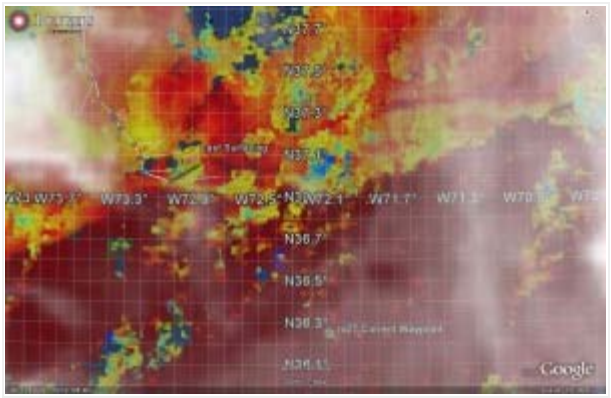
I can't believe it. The Scarlet Knight is a fast glider. At the 8 pm (local) surfacing this evening, we found ourselves just 2 km away from entering the Gulf Stream. After only 10 days at sea as recorded on the Atlantic Crossing webpage, http://rucool.marine.rutgers.edu/atlantic/ . Currents had already turned east and were picking up. We had moved a bit south, and the Stream moved a bit north, closing the distance. Yep, if you are trying to enter the Gulf Stream, its always good to be aiming at the front face of an eastward propagating meander. You head for it and it heads for you. So much better than trying to catch the rear face.



Below is a zoom in on the event. You can barely see a 1 km square pixel or two between the dark red of the Gulf Stream and the ;ast surfacing location of the Scarlet Knight.



And here are the clouds overlaid. We are just barely visible in the patchy clouds overhead.



I can't believe we are jumping into the Stream already. Based on last year's experience, I was planning 3 weeks to get to the Stream. Last year RU17 had to beat across the Slope Sea, fighting filament after filament of warm water the Gulf Stream kept shedding. Then we were in Estonia giving our Integrated Ocean Observing System (IOOS) talks at the UNESCO meeting for the Baltic Sea, and flying RU01 as part of a NATO exercise. After days of getting nowhere, Lisa enhanced an image and found an eddy for us. Sitting in the back row of the conference after our talks, we retasked RU17 to ride the eddy into the Stream. Satisfied, Josh and I spent the rest of the evening wandering around Estonia with our University, NOAA and Navy partners.

This year was so much easier. We have a fast glider.

0 Comments

06 may

A Critical Decision

Posted by: Scott in: Atlantic Crossing

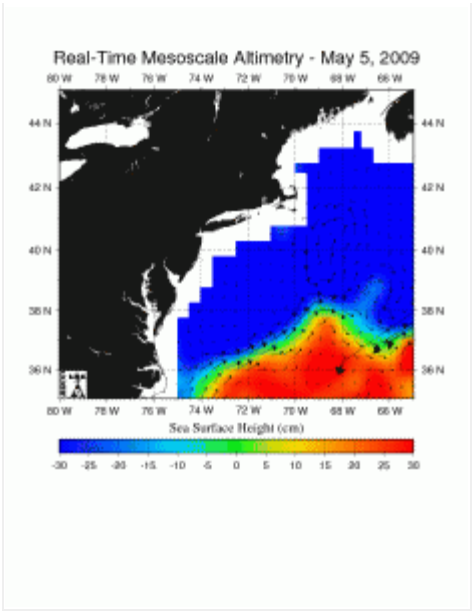
We are having a great day at sea. We have some amazing technology, and we have people across the nation already chipping in to help.

We started the morning with a surprize. The Scarlet Knight, like all Slocum Gliders, have backups for the backups and sensors for everything. Anything that moves or even thinks of moving is sensed. So this morning, The Scarlet Knight surfaced

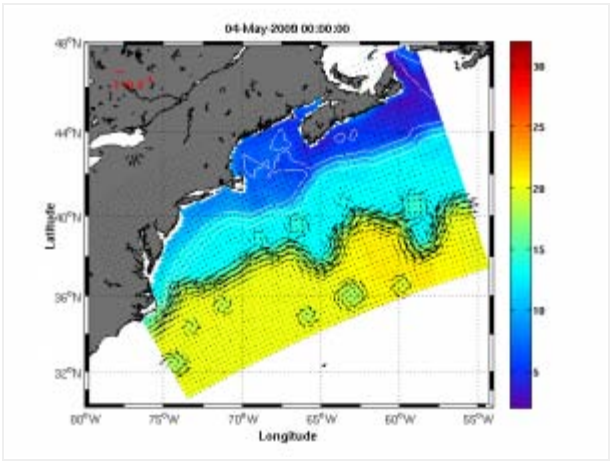
unexpectedly. She called John on his IPhone while he was in his car driving to work. She told us she came to the surface to report that she did not like the way her buoyancy pump was behaving on one of the inflections. Dave was still home, so he changed the yo behavier, downloaded a diagnostic file, and sent her back on her way. Still, anything potentially wrong with a buoyancy pump could be especially bad news. It has to work flawlessly for months and months if we are to make it across. The engineers at Teledyne Webb Research responded immediately. They began simulating the situation in the lab, and we shared all of our data. It was 9 am, and the next surfacing was 12 noon. We needed to know the health of our glider by noon so we could take any action that may be required. In these situations the thought of an early recovery always gets into your head, just at the time you need to concentrate on identifying the potential problem and solving it. Within a few hours that seemed much longer, the larger group had the issue figured out. We had lowered to "climb to" height for the yo's to 40 m, from 15 m the night before. If you try to pull in the water at depth to inflect and head back down, the water pressure acts to push the pump in, causing it to generate some excess voltage. It looked like we generated something over the tight threshold allowed. This stopped the pump to avoid damage. When the pump stopped, the glider sensed there was no motion on the pump, and if the pump doesn't move when its supposed to, it says there is something wrong that I need to report right away, I'm heading for the surface. With that, we adjusted the thresholds, and prepared for the next surfacing to transmit the new settings.

Also at noon we had to set a new way point. We were at a critical decision point. We are approaching the Gulf Stream, but it was very cloudy, so we could not see the best route. We knew there was an eddy in the way, so we had to decide which way to go around. Should we head east and try to catch a meander crest that was downstream of us. Or should we continue south and try to catch the next crest. It was another day where a turn right or left decision had to be made, and there was no data to tell us which would be better. We call it dealing with uncertainty. Its something oceanographers do everyday. We knew all the data we would have at noon was the glider data itself, so we worked out two scenarios. If the glider currents were south or west, we would take the southern route. If the glider currents were east or north, we would go east. We prepared the new waypoint "go to" files and waited. The phone rang the usual three rings. Currents were northeast. We transferred the new settings for the buoyancy pump. We transferred the revised science data file list. But when it came time to transfer the new waypoint file, we said no, we are changing the plan. We are heading south, straight south at the Stream. In the seconds it took to transfer the files, John had plotted the new position in google earth. The glider was still making excellent distance over the ground heading south despite the currents. We decided that with the buoyancy pump fix in, we could deepen our dives and just bull our way through these currents, avoiding the worst ones in the 40 m thick surface layer identified in the 4 am glider CTD profile. We turned south. It was decision we would soon appreciate. I'd like to say it was based on data rather than intuition, but it wasn't. We just looked at that glider progress and said this is not the time to stop.

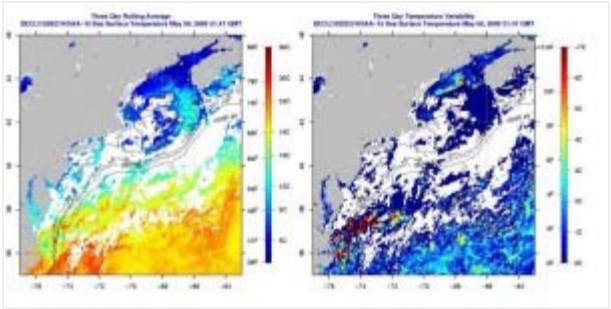
So to deal with the uncertainty, did we make the right decision. We checked in with our friends. First the satellite altimeter folks at U. Colorado. While the altimeter may not resolve the little eddies we are trying to use in the Slope Sea, the altimeters can't miss the Gulf Stream. The image below shows that the meander crest to our east had moved rapidly downstream. If this data was correct, and we had turned east to try to catch it, we never would have made it. The meander was moving much faster than us. The image also shows a meader crest leaving Cape Hatteras and pushing the Stream north. If that was correct, it was coming right at us.



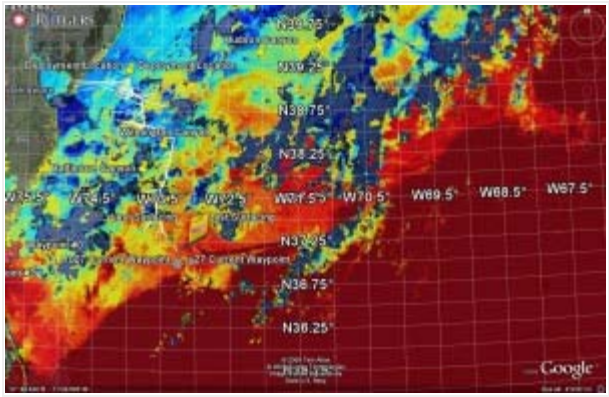
So next we went to our friends at UMass Dartmouth. At UMass, Avijit is running a regional ocean model as part of the Integrated Ocean Observing System (IOOS) program. The Mid-Atlantic is one of 11 of the IOOS regions, and in our region, Avijit is one of our three ocean modelers. Avijit concentrates on the outershelf, slope and Gulf Stream. His model forecast confirmed the interpretation that one meander crest had propagated rapidly by us, and that another one was forming by Cape Hatteras.



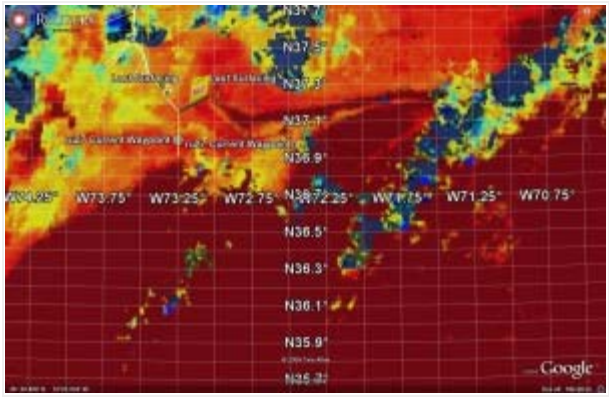
University of Delaware is another one of our IOOS partners. At UDel, Matt produces a composite declouded sea surface temperature product. Taking a 3 day average and squniting through the cloud breaks, you see the Gulf Stream meander at Hatteras has formed.



So we take the 3-day composites, and insert them into google earth. We see in this enhancement designed to emphasize the slope water that a dark red Gulf Stream meander is heading right for us. We will head south to catch it. Also check out the sticks along the white glider track. They represent the currents observed by the glider at each surfacing. Its a new feature John just added today.



So lets zoom in. We are heading south, and the Gulf Stream is heading north, closing the distance. Yesterday we were about 80 km from the Gulf Stream. The google earth ruler shown as the yellow line here indicates that tonight, we are only 28 km from the Gulf Stream.



It is a great day to be at sea. Thanks to all our friends for their help today.

2 Comments

05 may — The Big Switch is Turned On

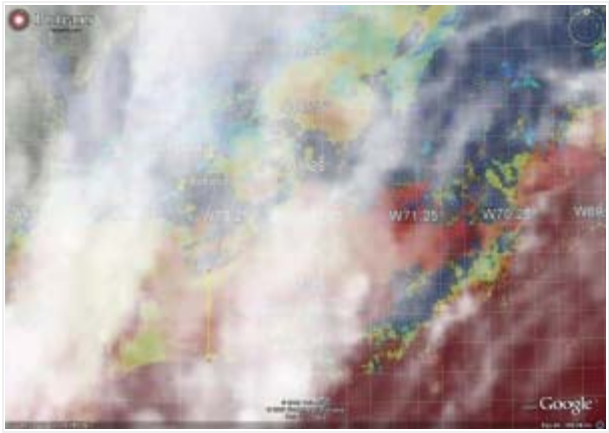
Posted by: Scott in: Atlantic Crossing

Last night we ran our first automated CTD cast with The Scarlet Knight. The CTD returns a profile of temperature and salinity. We translate the data into a format called KKYY, and email it to the Navy for assimilation into the numerical ocean prediction models. The improvement over last year is that the CTD now can be fully controlled from shore without having to stop and restart the mission on the glider computer. This is an important test for the Navy. We don't have to preprogram our planned CTD sampling. And we don't have to stop what we are doing to change it. Everything can be done automatically and on the fly. All the Navy gliders will need this capability. Since it is our job to provide training, we figured we better practice with it a bit ourselves first. So we all got up at 4 am last night to watch the computers turn the CTD on, and one hour later turn it off. It was beautiful. At least to us. We knew it meant sleep was in our future.

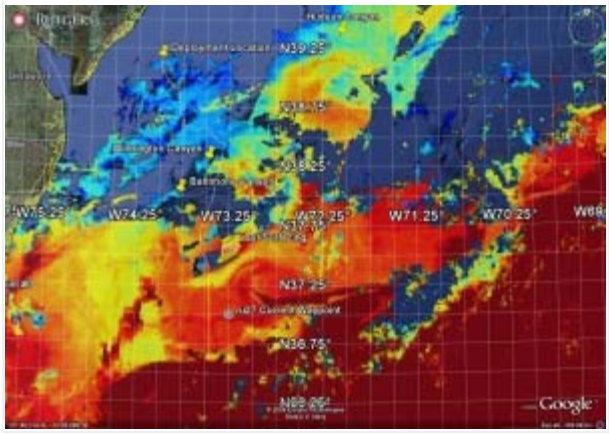
In the morning we checked out data processing scripts, and generated the usual

matlab plots of the data - checking that the downcasts were overlaying the upcasts. These things are so much easier to calibrate in deepwater than in that intense New Jersey summer thermocline on our continental shelf. Tonight that same CTD data were shipped off to our Navy friends at Stennis. There they will be checked and combined with all the other data available for assimilation into the Navy's ocean model. That will provide an initial condition that is used by both the Navy and by NOAA to produce ocean forecasts. We'll be using those forecasts for our path planning.

Speaking of path planning, where do we go with the Scarlet Knight from here? A quick check of google earth reveals we are still flying under the clouds. No help from the satellites today. The CODAR covers the shelf, not the slope sea, and the the altimeters do not provide the resolution we need to see the offshore eddies. Meanwhile, the forecasts are difficult to interpret in this region because so much of the circulation is controled by the meanders of the Gulf Stream, which can often be in the wrong location. Its an especially difficult region to forecast. I much prefer the wind dominated shelf for the meandering regions of the Gulf Stream. One of our IOOS MARCOOS partners, Avijit Gongopadhyay at UMass Dartmouth, speciallizes in forecasting in this difficult region. We'll use his product for guidance.



Till then, at least we can remove the cloud layer on google earth. And we can composite 3 days worth of sea surface temperatures observed through small holes in the cloud deck. Below is the result, enhanced to highlight the variations in the slope sea. We are about to leave the southern side of a counterclockwise eddy, and we have to decide whether to turn east and chase the Gulf Stream, or turn south and fly straight into the Gulf Stream. Its 110 km to the Stream and into a head current if we go east. Its only 85 km south to the Stream, and we have some component of the current with us. So we'll head south. But soon we'll run into that warm patch of water centered on 37.00 N between us and the Gulf Stream. Because we don't know the currents in that feature, tonight we are practicing flying deep beneath the shallow thermocline. Many of those features we see in the SST images are observed in the CTD casts to only extend to a depth of about 40 m. So tonight we are setting our glide envelope to between 40 m and 180 m. The deeper number, 180 m, is our "dive to" depth. The shallow number, 40 m, is our "climb to" depth. In the morning we'll see how the glider flies in this configuration in case we need to use it.



The other piece of unfinished business for tomorrow morning is to check our flight parameters after the overnight run. This morning we took our best shot at tuning the pitch battery motion, and continued to reduce the size of the science data file we are sending across by satellite phone. All of this saves energy. We'll see how we did, and make some further fine tuning adjustments for the noon surfacing tomorrow.

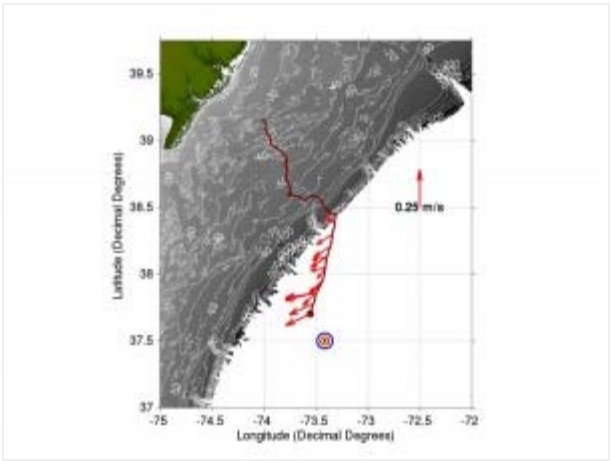
But for now, its goodnight RU27. The Scarlet Knight is on her own for the evening, flying under the watchful eye of the computers in the COOLroom. We'll be asleep.

1 Comment

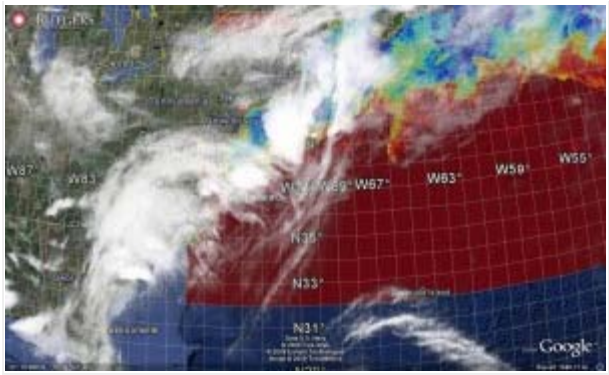
04 may Under a Band of Clouds

Posted by: Scott in: Atlantic Crossing

The Scarlet Knight is heading southwest. We are flying her southeast, but the strong currents to the southwest trend. Anything south is good at this point. We are hoping to catch a rid on that eddy we saw a few days ago, but currents don't look lie they are turning. We are trying to stay away from the surface, and the eddy may be only affecting those surface waters.



So what to do next? In the Slope Sea, sea surface temperature gives you the best clues. The altimeter doesn't have the resolution we need for these features. But today is all clouds. A long band of cloud cover covers the entire U.S. east coast, except for Jersey. Fortunately, the glider is no longer in New Jersey. So we'll have to deal with the clouds for some days it seems. We even checked if there were any ARGOS surface drifters in the area. There were none. So all we have are the single glider's sensors.



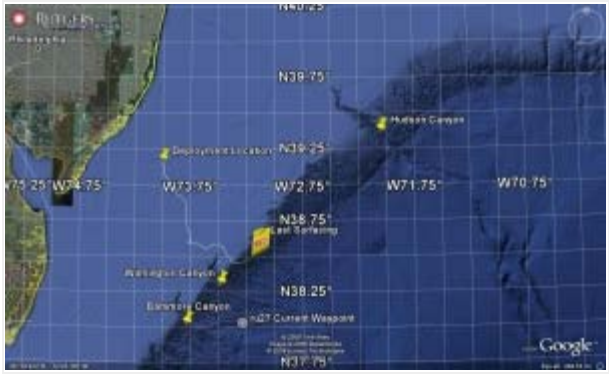
Tonight we'll try a CTD cast about 3 am local. See what we are getting for density structure. We'll use that and the glider's reported currents to guide tomorrow's waypoint choice.

0 Comments

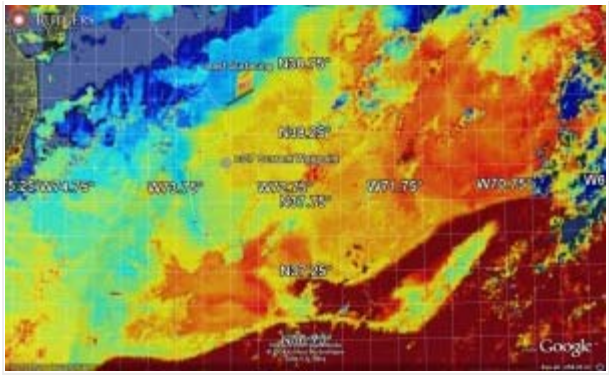
02 may Off the Shelf

Posted by: Scott in: Atlantic Crossing

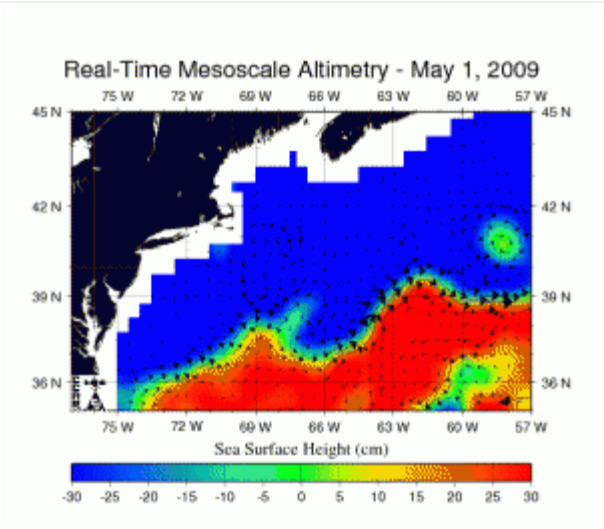
The Scarlet Knight crossed the shelf break earlier today, putting us in deepwater where the challenges switch. The shallower shelf water has a lot of traffic we have to try to steer around, including fishing vessels, deployed fishing gear, and shipping activities. Deepwater challenges are interpreting and navigating the eddy field. Now that we are in deepwater, we'll start increasing the depth of our dives, first to 140 m, and then to 180 m to take advantage of the extra flight time we get when the bottom is thousands of meters away.



From this location, we'll head straight south to start. That should put us in the eddy barely visible in the Sea Surface Temperature (SST) map below. The track we have already covered is shown in white. The path we are planning to follow is shown in yellow. Click on the figure for an enlargement. The western side of the eddy is visible from the cold water that is being pulled off the shelf and is heading offshore along the western side of the eddy. We'll follow this eddy around and exit somewhere on the southeast side. From there we'll try to catch one of the wavelike meanders and head downstream.



Just to make sure, we checked the geostrophic currents derived from the satellite altimeters by they University of Colorado. Their products were critical for our path planning in the eddy field downstream of the Grand Banks. Unfortunately as straight up altimtery product doesn't help us much as we try to cross the Slope Sea. Experience has shown it is great for putting the Gulf Stream in the right place.



Next steps —

By tomorrow morning we should be settled into a regular series of full depth dives for us, 10 m depth at the top and 180 m depth at the bottom, 6 hour surfacings. We'll get our first look at how The Scarlet Knight is performing in deepwater compared to the test cruise. By monday we will have retuned the battery positions so we can optimize our dive angles, and we will start up the automatic scripts to operate the glider during the day so we can watch them.

The Navy is going to be very happy with all we have learned in less than a week at sea with The Scarlet Knight. We are learning a new control system they will be using that provides greater flexibility for turning systems on and off. Yes, it gave us a real scare the first day out when we where having trouble automating the commands to turn the temperature and salinity sensor on and off. But now we know all the options and how they can interact, we have gained an education we will need to use in future research work with high powered optical sensors that we have to use even more sparingly. We also need to know all the tricks so we can teach them to the Navy's operators. They'll need to know all the capabilities too. Even one day out, you learn more at sea about your vehicle and how it operates than you can spending months on the bench in the lab. We knew we would learn more about The Scarlet Knight's personality once we were out at sea. What worried us at first has now built our confidence and trust in the vehicle.

0 Comments

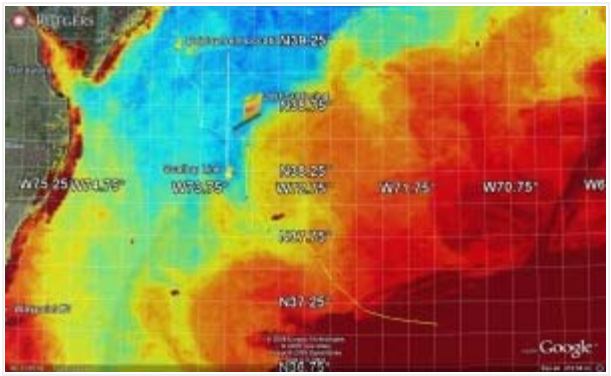
02 may

Past the Scallop Line

Posted by: Scott in: Atlantic Crossing

Yesterday we got word that there was a lot of scalloping activity in the fishing grounds known as Elephant Trunk. Click on the map below for an enlargement that shows the area. The eastern side of Elephant Trunk runs along 73 30 W longitude. To be safe, we turned the Scarlet Knight east and did our best to fly straight out of the box. We also completed our first test 6 hour underwater segment to increase our speed across the line.

Google earth image below shows that just tonight we made it past the eastern edge of the scalloping activity, shown here as the scallop line along 73 30 W. As we passed it about 8:30 pm local tonight, we turned Scarlet to the southeast, our effort to fly perpendicular to the depth contours and fly across the shelf break as fast as possible. We'll like start crossing the shelf break early tomorrow morning. We usually avoid the surface in these locations because there often is a log of fishing activity. Once we are in deep water, we'll turn south and follow the yellow line around the western side of that slope eddy, exiting on the southeast side. Then its into the Gulf Stream.



So after tomorrow we should be a lot more relaxed. Even though we have run over 100 missions on our shelf, it is still one of the more dangerous regions for a glider because of all the other fishing, shipping and recreational vessels. Once we get into deep water, we'll be safer from concentrated vessel traffic, and we can retune the glider flight parameters for deep 200 m dives.

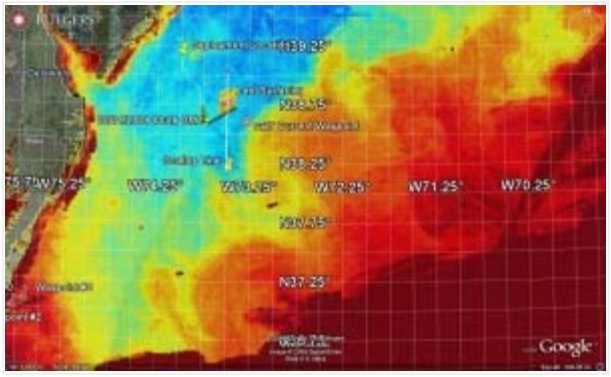
0 Comments

01 may Day 3 - More testing & Heading East

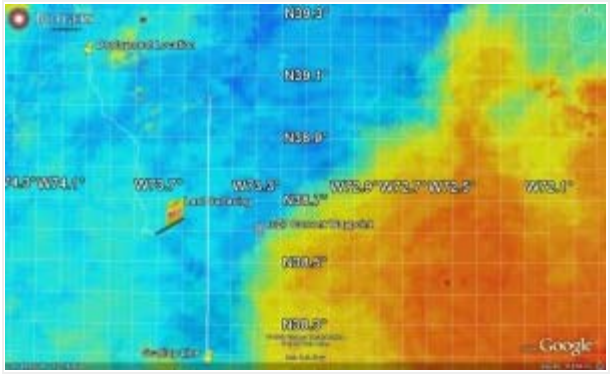
Posted by: Scott in: Atlantic Crossing

RU27, The Scarlet Knight, is flying well on its third day at sea. It remains in everyones mind a fast and agile glider. We hope we can retain this speed thoroughout the trip. Today's decision was which direction we choose for going around Wilmington Canyon, to the north or south. We are shooting for the slope water eddy that is pulling water off the shelf just on the offshore side of the Canyon. The decision was made based on information from the scallop fisherman. They told us that there are lots of scallop boats out there today, most are more inshore, but all are remaining inshore of the 73 30 W line. We decided it is best to

get offshore of this same line as soon as we could, and started heading directly east to the north side of Wilmington Canyon. At least we have successfully crossed the shelf break 3 times north of Wilmington. We have never crossed in between Wilmington and Baltimore Canyons.



Zooming in on the glider track, you'll see the small loop we did today. Thats when we slowed down for a second test of the software to cycle the CTD on and off. The CTD gave us a bit of a scare on tuesday when we couldn't shut it on or off by computer. We had to do it manually like we did for RU17. Visions of people staying up all night to get those early morning profile plots for assimilation in the models struck enough fear in us to go through a series of test cases on a simulator, run them on a glider in the lab, and then test them out on the Scarlet Knight. We were able to get the automated on and off switch running tuesday night, but we wanted to run through those same tests using the operational computer script before crossing the shelfbreak. Everything worked so we are good to go.



Next step is to settle down into a routine. We are working our way up to a 6 hour segment below the surface. We are getting into deeper water, so we'll continue to increase our yo depth. And once we get across the shelf break, we'll pause again for a deepwater tuning of the flight parameters.

0 Comments

30 apr

Two Days at Sea

Posted by: Scott in: Atlantic Crossing

RU27 was deployed on April 27. We used two boats for this deployment. Rutgers R/V Arabella carried RU27. The Seatow vessel Hatteras from Atlantic City carried a dive team. We would be filming this glider on its first few test dives.

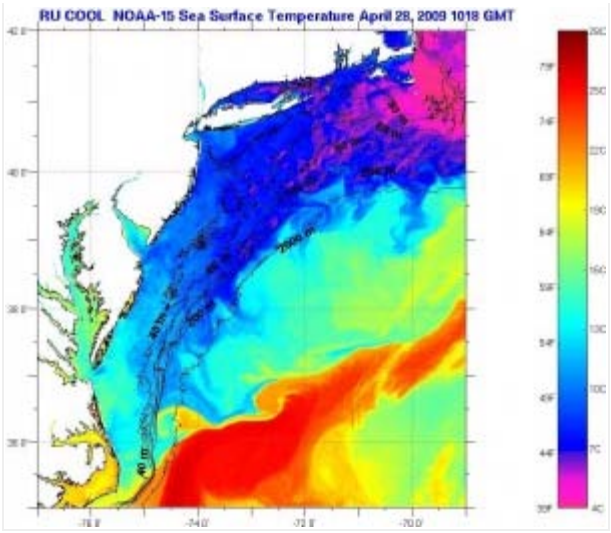
We left the Rutgers Marine Field Station in Tuckerton, NJ just before 9 am on

monday and headed offshore to the southeast till just after 11 am. Our water depth was over 30 m, so we where far enough offshore. We usually only head out to about 15 or 20 m, but we had pulled the altimeter off this glider to leave more weight for batteries, and we did not want to take a change getting close to the bottom and getting sand in the nose. Divers where in the water by about 11:30 and the deployment process and initial test flights began. We did three test dives to 25 feet with the divers following the glider down. The dives tested the overdepth emergeny ascent, diving till it hit an intital test depth of 25 feet, then doing an emergency ascent because it was over our designated depth. Chip and Dan where the divers in the water, and Chip said they could not keep up with RU27 on the ascents. This was good news. We designed RU27 to have the ability to make quick ascents based on the RU17 experience with biology. This glider can peg the atitude sensor on ascents, using almost all its buoyancy to build upward speed.

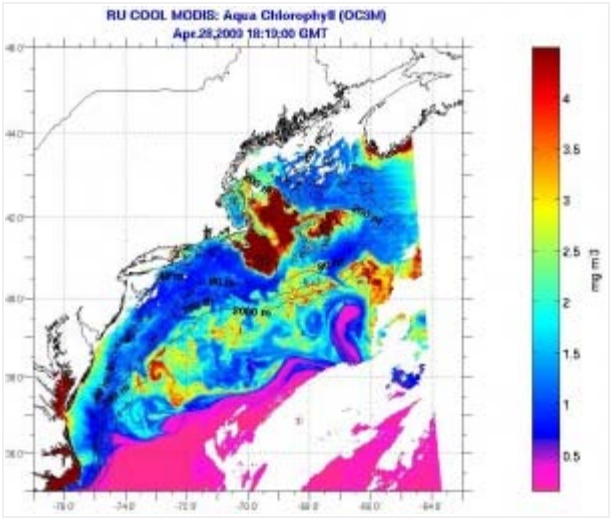
After the divers were back on board the Seatow Hatteras, we did three 15-minute test missions. We set RU27 to fly between about 8 m and 20 m, and did our first eyeball tuning of the flight parameters. Battery positions were adjusted for dives and climbs to get us near the desired 26 degree pitch. RU27 is well tuned in terms of weight and balance. We are moving the pitch battery less than 1/2 inch each time, and that will save us energy. We had just over 1 and a half degrees of positive roll, negligible by most standards. We moved the fin zero offset to 4 degrees to compensate for what appeared to be a bit more drag on one side to improve the steering. We'll recheck all these parameters once we get in deepwater and can do full 200 m depth glides.

With the successful tests of manually turning the CTD on and off, we transferred control from the freewave radion modem on the Arabella to the Iridium satellite phone connected to the COOLroom in New Brunswick. From there we are heading RU27 out along the line to the head of Baltimore Canyon. There is an eddy in the Slope Sea on the offshore side of the canyon that we want to catch. However, we don't want to cross at canyon, since fishing activity is often more intense near the canyons. We like to find places between the canyons and slip across by staying deep. So later today we'll decide whether we cross the shelf break north of Wilmington, or in between Wilmington and Baltimore Canyons. The total distance of the line between Tuckerton abd the shelf break is 150 km. RU27 is flying well, consistently making over 1 km distance per hour.

Sea surface temperature (SST) image below shows the eddy just off the shelf break that we are heading for. It is centered near 39 N, 73W and can be identifed by the cooler shelf water in blue being pulled off and wrapped around its southern side.



The eddy is even more visible in the ocean color image below. The band of high chlorophyll water in red being pulled around the eddy from the offshore side and swirling into the center.



0 Comments

27 apr Deployment

Posted by: student in: Atlantic Crossing

I was deployed a little before noon today, April 27th! I am currently swimming around off the coast of NJ.

1 Comment

26 apr The Dedication

Posted by: Scott in: Atlantic Crossing

We have a tradition. Our friends in the UK will say it only qualifies as a habit. But it is what we do on the night before a major launch. Everything that can be done has now been done. So on this very night, we take the time to write a dedication

when we should be sleeping.

We have over 160 glider missions completed since 2003, but only a handful are blogged, and only 3 have beed dedicated in the past. Mission 100, our first Point A to Point B flight from Massachusetts to New Jersey, was dedicated to our first IMCS Director, Fred Grassle. Our flight to Halifax with RU15 was dedicated to our students, who would soon be taking over the long-duration runs. RU17's flight nearly to the Azores was dedicated to Doug Webb, the inventor of the gliders and the founder of Teledyne Webb Research.

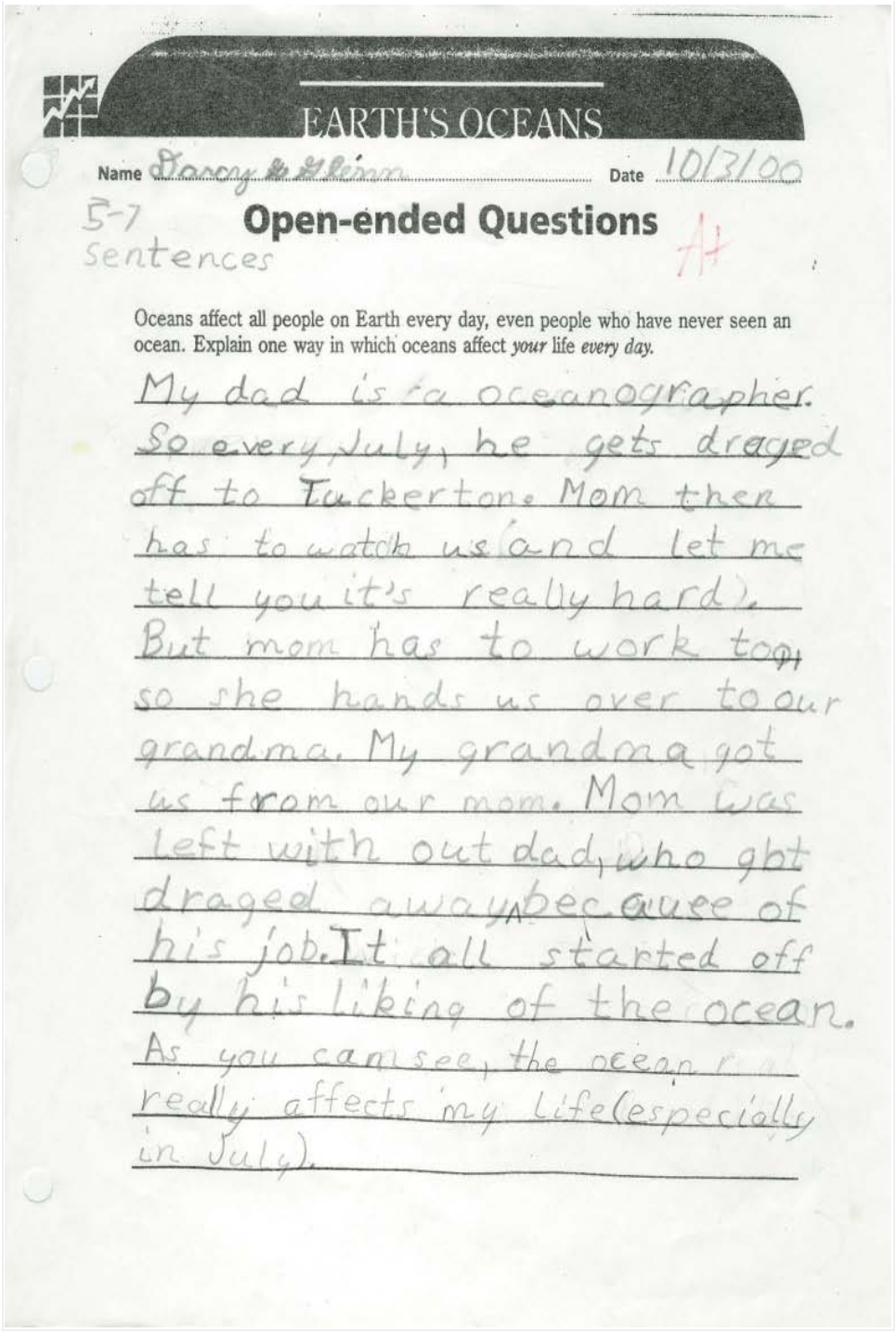
Tonight, on behalf of all the scientists, engineers and students that are working long hours to make this flight possible, we dedicate this flight of RU27 to our families.

For our students and the younger ones in the lab, their immediate families are likely to include their parents. So to their parents, we say thanks for understanding when the kids came home and told you they were going to be oceanographers. We all know the money is short and the hours are long, but it is the life of an adventurer and an explorer. They will go to sea, they will see the world, and ultimately, they will be the ones employed to help save the water planet. With rapid climate change and continued population growth, their generation will need oceanographers more than ours.

For the many scientists and engineers that have dedicated their time and energy to this project, their families often include spouses and kids. One magazine article described the gliders as our obsession, which is probably true. We have our families, and we have our obsession with flying underwater robots. Thanks for allowing us the luxury of splitting our time between the two. We all know these robots can be quite demanding at times.

And for my own family, who still seem to deal with me even though I am either away on travel or home attached to my laptop and cellphone, thanks for giving me the additional time I will also need to spend with RU27. Even though I will not be at sea, we all know that just as it was for RU17, my mind will often be out there with the gliders. Everyday I will be wondering what RU27 is seeing, how it is flying, and where it should go next. And everyday, I will be able to go to sea just by logging into my laptop.

The concept was inspired by something one of my daughters wrote in 2000. She was in second grade, and we had just flown our first unteathered glider mission with Webb Research during a month-long experiment in residence at Tuckerton. My daugher was asked how the ocean affects her life, and her reply was it takes me away. This is one reason why I build ocean observatories. It is one of the few ways I have found to be in more than one place at the same time. It is how we will continue to explore our planet, and still be home for dinner on most nights.



EARTH'S OCEANS

Name Sonny & Allison Date 10/3/00

5-7 sentences

Open-ended Questions

A+

Oceans affect all people on Earth every day, even people who have never seen an ocean. Explain one way in which oceans affect *your* life *every day.*

My dad is a oceanographer. So every July, he gets draged off to Tuckerton. Mom then has to watch us and let me tell you it's really hard). But mom has to work too so she hands us over to our grandma. My grandma got us from our mom. Mom was left with out dad, who got draged away because of his job. It all started off by his liking of the ocean. As you can see, the ocean really affects my life (especially in July).

So thanks again to all who helped with the flight of RU17, and the recently completed build of RU27. Thanks to Teledyne Webb Research for getting the glider to us, to Electrochem for the batteries, and to Hank Loeb for the hull coatings. We will soon be relying on another set of friends on both sides of the Atlantic to help with the flight. Their real-time data and model forecasts are required for the path planning that will get us across before the batteries die.

We are only hours away from the start of the historic mission ahead of us. Its time for sleep. We'll be on the radio a lot tomorrow.

Good luck RU27.

0 Comments

26 apr | Tomorrow is the BIG DAY! Leavi...

Posted by: student in: Atlantic Crossing

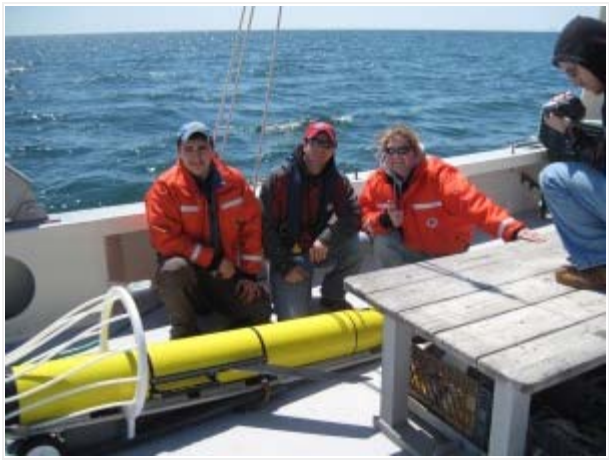
Tomorrow is the BIG DAY! Leaving from Tuckerton at 8am and heading offshore for deployment. Wish me luck!

0 Comments

25 apr | Friday Test Flight

Posted by: Scott in: Atlantic Crossing

Three Rutgers Alumni - Dave, Ethan and Tina - aboard the R/V Arabella are preparing to launch RU27 for a series of four test flights. Ethan downloaded his camera before heading off to California to visit CODAR Ocean Sensors.



In the photo below RU27 is in the water and you can see Atlantic City in the distance. If you can see Atlantic city, you likely still have cell phone coverage. We had video from the boat displayed live in the COOLroom for the entire test mission. We'll try the same on monday for the real launch, but expect we'll loose the video signal before we reach the deployment site.

We checked the results of the test flight today. Everyone agreed the results were good and still look good. RU27 got Tina's thumbs up for launch on Monday. Tomorrow we do the final checklist, seal it up, and get it loaded in the van for Monday.

0 Comments

25 apr

Friend & Foe

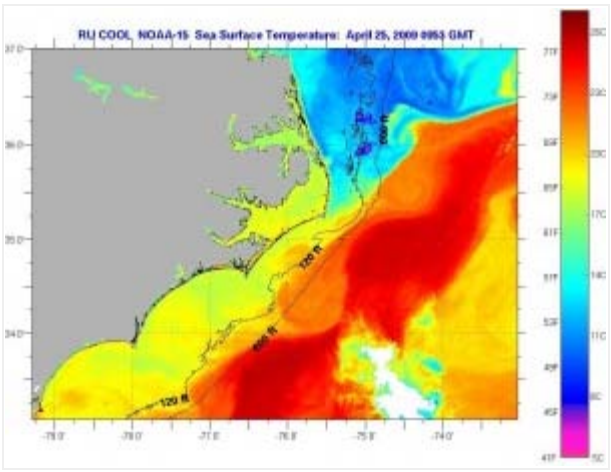
Posted by: Scott in: Atlantic Crossing

Biology.

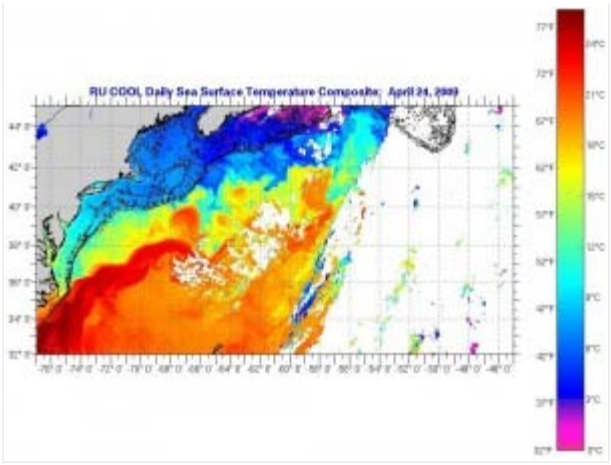
Ask anyone prepping for this glider flight what their greatest fear is, and they'll all tell you the same thing. Biology. Its going to grow on us, latch onto us, bash us, slow us down, hold us underwater when we are trying to surface, spin us in circles when we are trying to fly straight, and just be an overall nuisance. Except when it is time for path planning.

Here is the present situation, two nights before launch.

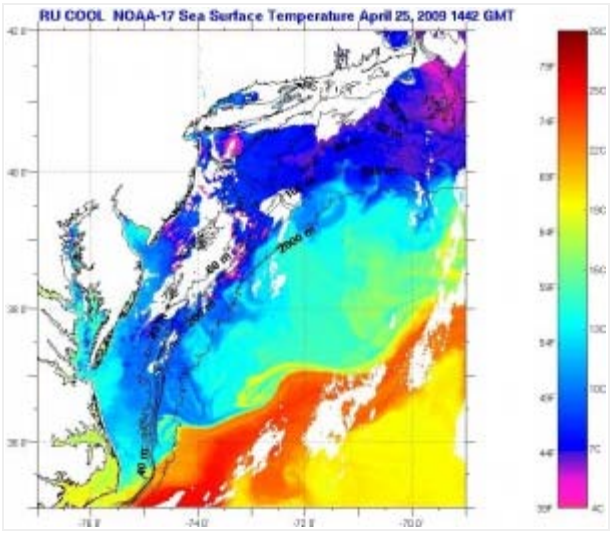
Below is a SST map by of the Gulf Stream leaving Cape Hatteras. There are two meander modes in this region, large and small, and we are clearly in the large meander mode time. The stream can stay in one mode for months, then quickly switch to the other. I worked on this with Curt Ebbesmeyer back in the 1980's. Curt's name will come up again later when we are getting near the Azores. He is know for tracking ocean spills, and in his new book I hear there are places we need to avoid. The thing about these meanders is that the forward face ahead of the meander crest often has a sharp front, while the rear face behind the crest has a strong frontal eddy that shoots hot Gulf Stream water back at you. The best way to enter one of these meander crests is from the forward face. You can sit in front of it, and let that meander crest propogate downstream to the east and pull you right in, just like it is doing to that cold water on the Mid-Atlantic Shelf. The rear face is much more difficult, trying to run against the strong currents of the counterclockwise eddies that form behind the meander crest.



The situation downstream from Hatteras looks exactly the same. A relatively straight Gulf Stream heading northeast to about 70 West. Its just that the meanders grow and slow down as they propagate downstream. Based on the situation at Cape Hatteras, we'll want to approach the meanders on their forward faces for a clean run into the Gulf Stream.

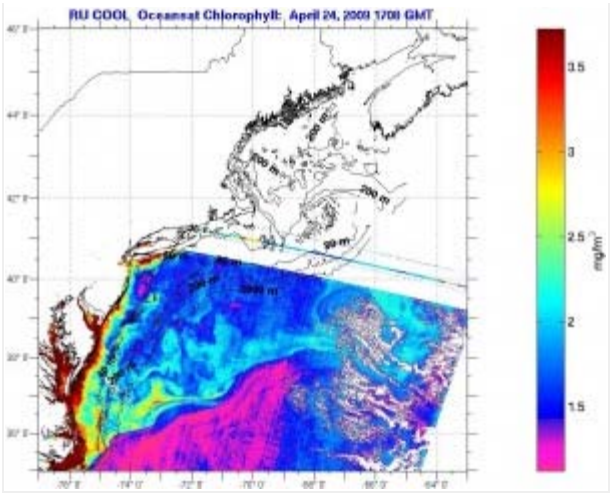


So how do we get there. Below we zoom into the Mid-Atlantic Bight where we see the cold blue waters of the continental shelf, the hot red waters of the Gulf Stream, and the intermediate temperature green waters of the Slope Sea. The Slope water is difficult to cross because of all the eddies that are difficult to see. Our favorite route across the slope water is to jump into a Warm Core Ring and use it to spin us across, but there are no Rings in sight. We'll have to settle for small shelf break eddies. You can see several of them between the 200 m and 2000 m isobaths along the serrated edge of the shelf break front that seperates the blue shelf water from the green slope water. But they appear to swirl in both directions. Which one should we choose? We want to use one of these to shoot us into the middle of the Slope Sea - we don't want to get stuck flying into a head current. And after we get into the Slope Sea, how do we get out ? The temperature is the same everywhere? How can we tell which way the currents are flowing?

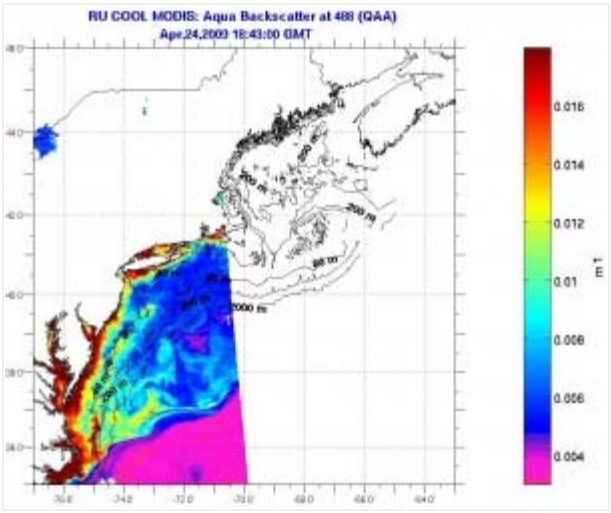


So what do you do? You find yourself a biologist. The one below is from India. We track not only the U.S. satellites in the COOLroom, but also the Indian Oceansat and the Chinese FY1-D. All we did here was apply a standard SeaWiFS type Chlorophyll algorithm and the structure in the slope sea just lights up. The Gulf Stream is pink, so there is little Chlorophyll. The coast is red with high Chlorophyll. The mid-shelf front is visible as the mid-shelf Chlorophyll peak. We'll be flying through this soon. Then there is a clear shot of an eddy sitting right at the shelf break 73 W. On the eastern side of this eddy, you see the blue water going south along 72W all the way to the Stream, hitting it upstream of a meander crest. Thats our route.

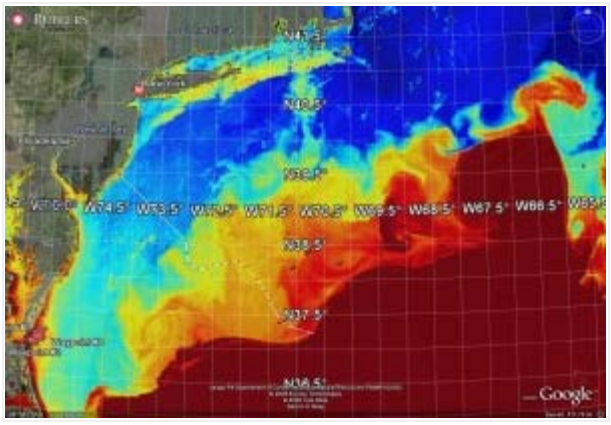
Below is a similar Ocean



color shot from the U.S. satellite about an hour later using a more advanced navy algorithm. The eddy is at 73W is clearly visible, and the clear water at 72W shows us a route to the Gulf Stream. How this looks when we actually get there remains to be seen. Its a lot better than the model forecasts John was showing us last thursday. The models had no route to the Gulfstream that did not encounter strong head currents for most of the trip. We thought we would have to head down to North Carolina and have Harvey Seim help us deploy.



The propose route is traced in Google Earth over the enhanced satellite imagery. We'll head across the shelf to about 38.5 N, 73.0 W, around the southern side of the shelf-slope front eddy, and then head southeast in the cooler orange water rather than the warmer red water. The warmer red water looks like the back side of a frontal eddy at Hatteras. Its an area to avoid. But without the biology, we never would have found it. The models say there is no solution for us. The biology says there is.



0 Comments

24 apr

Its the Spring

Posted by: Scott in: Atlantic Crossing

Five months and a week ago we ended the RU17 "Across the Pond" blog on our first attempt to cross the Atlantic with an underwater robot. Five months and a week is also the length of time we flew RU17 on its world record breaking distance flight last year. In that final blog entry, we said we would be back in the Spring.

Below is what I believe is the Chinese character for "Early Spring". One of my daughters made it in preschool. I think it means good luck. I sometimes wonder if it is hanging upside down.

And here is RU27. 5 months and 1 week to build, modify and test. It looks to me like it also means good luck.

We certainly had a good test flight today, so perhaps it is true. Dave, Tina and Ethan took RU27 out on Rutgers R/V Arabella and deployed it in 20 m of water. They completed 4 tests. First we ran Josh Graver's RUGAIN test to find the moveable pitch battery positions for 26 degrees pitch, the most power efficient forward speed, and 35 degrees pitch, the fastest forward speed. Most of the time we will be running with dives and climbs at 26 degrees to minimize our power usage. Sometimes we'll want to speed up for a bit to do something like fly into or out of an eddy. Then we use the extra energy and fly at 35 degrees pitch. The battery position tests allow us to preset the forward position for dives and the aft position for climbs so we don't waste time and energy trying to find the proper pitch angle. We just move the battery forward or back to the now known locations for this glider. Dave also ran a full forward and full aft bitch battery test. We pegged the pitch sensor at 50 degrees on ascent. RU27 can really move if we need it. We are taking bets on when that will happen. How many months till the first Remora remora event. The forth test was for steering, at the standard cruising pitch of 26 degrees. We found postive 1 to 2 degrees of roll, but the sruprizing thing was that it does not appear to need any fin offset correction to the steering for it to track a course. We'll work more with the data tomorrow, but it looks like we are close enough to zero roll that we can't measure the impact on steering. All in all, RU27 performed superbly. Near as we can tell, it is ready for flight.

The plan is to meet Saturday at Rutgers and take another look at the data, and make the Sunday preflight checklist. We board the R/V Arabella early monday morning and leave the dock at 8 am. Weather looks to be warm, winds light, waves low. We'll head out to about the 30 m isobath or so and then deploy RU27. After running through a standard series of short diagnostic flights, we'll transfer control from the Arabella at sea to the COOLroom on shore in New Brunswick. John and our students will take over flight controls from there.

0 Comments

24 apr

Test Flight Today!!! Can't wai...

Posted by: student in: Atlantic Crossing

Test Flight Today!!! Can't wait to dive in and tryout some missions.

0 Comments

23 apr

Hey everyone don't forget, thi...

Posted by: student in: Atlantic Crossing

Hey everyone don't forget, this Saturday is Rutgers Day! Come by the Cook Campus and watch us fly a glider in Passion Puddle!!!

0 Comments

21 apr

How Many Pieces Does It Take?

Posted by: Tina in: Atlantic Crossing

So just how many pieces are there to a glider? In this picture you can see most of the major components of Scarlet, including her chassis, hulls, battery packs, wings and wing rails. Do you think you could put her back together?

0 Comments

19 apr

News Travels Fast

Posted by: student in: Atlantic Crossing

Looks like word is traveling fast… http://tinyurl.com/cvy2js. Thanks for spreading the news, I am definitely excited and ready to go! Can't wait to hopefully make this years mission a success.

0 Comments

17 apr

After a long night I have been...

Posted by: student in: Atlantic Crossing

After a long night I have been put back together. Today will be spent ballasting and hopefully a test flight tomorrow. Almost Done!

0 Comments

13 apr

Send a Letter

Posted by: student in: Atlantic Crossing

There is still time before my deployment to send me a letter to take across the Atlantic. Check it out at http://tinyurl.com/cjjjvy

0 Comments

10 apr

What a success!

Posted by: student in: Atlantic Crossing

What a success! Thanks to everyone that came out tonight to Glider-pa-looza. We appreciate your support and hope you had as much fun as we did! Next stop Spain. Currently we are nearing the final stages of completion with RU27 and then will have to pick a deployment date. (end of next week hopefully) So stay tuned and don't forget to check out the facebook site, our twitter page, and of course the blog. Thanks again.

0 Comments

08 apr

Glider-pa-lozza 7-9pm tomorrow...

Posted by: student in: Atlantic Crossing

Glider-pa-lozza 7-9pm tomorrow (Thursday) at the Cook Campus Center. Come check it out. Free food and giveaways!

0 Comments

08 apr

Ballasting Tests

Posted by: Tina in: Atlantic Crossing

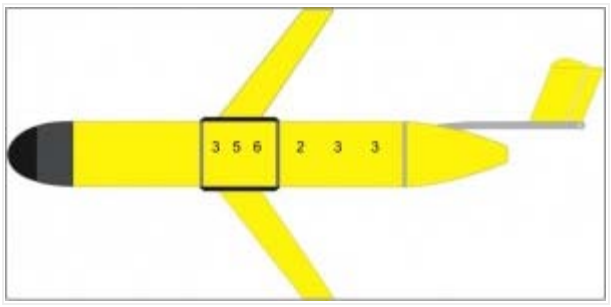
We've been working on building the battery packs for RU27. For the pitch battery design we are deciding between adding one extra battery to what RU17 had or two extra batteries. By adding two batteries we will add about 20 days onto our flight duration, but this makes our pitch battery heavier so we will use more power to move it. Decisions are still being made about the final battery pack and whether or not one or two battery packs will be added. A lot of time lately has been spent at the ballasting tank.

Within the glider there are three different places for batteries. The fore hull is where the pitch battery goes, the payload bay or middle hull, and the aft hull. Both the payload and aft hulls can have different configurations or placements of batteries, and it is our job to decide where to put all of them. This becomes a problem when we have to balance the glider, both side to side, and front to back. If Scarlet is heavier in the front she will sit and fly unevenly, the same if she is tail heavy.

The glider has twenty four different spots within the payload and aft hulls to place twenty two batteries. From that point out, it is sort of like a puzzle in trying to figure out which are the most efficient places for the batteries.

Our initial attempts left the glider front heavy causing her nose to sink. Eventually after many trips to and from the ballasting tank we decided upon the most efficient

placements for the batteries. A 3,5,6 battery configuration in the payload bay and a 2,3,3 battery configuration in the aft which can be seen below.



0 Comments

06 apr Glider-pa-looza!

Posted by: student in: Atlantic Crossing

This Thursday April 9th 7-9pm Glider-pa-looza at Rutgers Cook Campus Center! Hope to see you all there! I am even going to try to make an appearance!

0 Comments

02 apr Currently in pieces all over t...

Posted by: student in: Atlantic Crossing

Currently RU27 is in pieces all over the lab. Most of today was spent working on the pitch battery configuration. The original design was giving us a little bit of a problem. Now that we sort of have a possible solution we will need to ballast again. In addition, we will also do an extensive pitch test during the ballast. Don't forget everyone, next Thursday April 9th from 7pm-9pm there will be a glider presentation in the Cook Campus Center. Everyone is invited so come check it out!

0 Comments

01 apr Results of ru27 Burn Wire (in tank) Tests

Posted by: heifetz in: Atlantic Crossing

As part of the glider preparation plan we test how a glider would recover by releasing extra weight after a certain amount of time.

The Glider blew it's weight somewhere between the 46-48 hour mark. Video exists, its a dramatic event but choppy frames. The video was only 23 hours long total which is incorrect given the video shows the glider entering and exiting the tank (a span of a couple days, perhaps we can investigate the video further). So using knowledge that it was checked at 7pm and by 9pm it was shot, we conclude about 46-48 hours.

Apparently the batteries ran down at some point during the mission, and basically did not reset, but continued to try to run lastgasp.mi over and over, never resetting the computer.

glider was pulled out of tank, argos pinging.
opened glider, removed main power, noted air bladder stopped inflating (confirmed with John, air bladder is not run on emergency power)

pulled emergency power, all quiet
tried sped up test using only emergency power applied. Glider begin pinging argos after about 5 min, exact time I can get tomorrow.
All in all, not too bad. Thank you for your time John and Pete.

Video of the event:

0 Comments

25 mar

Check out some really neat pho...

Posted by: student in: Atlantic Crossing

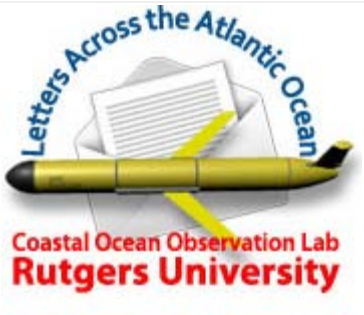
Check out some really neat photos from Antarctica. RU05 is chilling down there with the penguins. http://tinyurl.com/dhn66l

0 Comments

24 mar

Send a Letter Across the Atlantic Ocean!

Posted by: heifetz in: Atlantic Crossing



This month, Rutgers University scientists and students will send an underwater robotic glider, on a mission to cross the Atlantic Ocean. We invite classrooms around the country to participate in this exciting adventure.

The 3,300 mile voyage will take at least 6 months for the slow-moving low-energy glider to cross the Atlantic. The ocean is a harsh environment, and the glider will encounter many challenges on its journey. But if it is successful, it will mark a new era of oceanography providing scientist with a new tool to monitor the Earth's ocean and climate. Never before has an underwater robot successfully traveled an ocean all on its own.

Classrooms are encouraged to send us a a message to send to Europe in the glider, just like a "message in a bottle." We will post letters on the mission web site. If the

glider reaches Europe, we will send postmarked letters back to your class.

In composing their letter, your class might consider the following questions:
- Do you think that the glider will make it?
- Who were the other adventurers who crossed the Atlantic?
- What do you think the glider will encounter on its journey?
- What do students know about the ocean?

You can follow the Glider on the Rutgers Atlantic Crossing site, where you can read the latest blots from the student pilots, check out the latest underwater data from the glider and learn about about the kinds of ocean critters the Glider may encounter on its journey. You can even subscribe to the Glider's Twitter feed or befriend it on Facebook.

Go HERE to upload your letter:
http://rucool.marine.rutgers.edu/atlantic/bottle/index.html

0 Comments

23 mar | Christening event went great! ...

Posted by: student in: Atlantic Crossing

Christening event went great! Thanks to everyone that came out and showed support. Stay tuned and don't forget to check out the blog!

See pictures on Flickr site:
http://www.flickr.com/photos/rutgers_cool/sets/72157615843951590/

0 Comments

20 mar | News from Svalbard

Posted by: student in: Atlantic Crossing, Atlantic Crossing Seminar, RU27 Atlantic Crossing Preflight, Undergraduate Operations

Hey guys

Sorry for the delay getting these posts up, we know how anxious you all are to hear how we are doing up here in the far north



. Starting with the trip over, all flights went smoothly and we ended up in Longyearbyen on Svalbard Sunday afternoon where we were instantly taken aback by the allure of the surrounding snow covered mountains. However we were surprised to see a thermometer actually read -20° C. Longyearbyen is a small mining town actually founded by an American who's last name was longyear (byen is Norwegian for city). The town is pretty small only having about 40 km of roads and is set up with a main street running through the middle of the town with most housing just a short distance away.

After entering the airport, we saw Mark(professor at Cal Poly) and Geir(professor at NTNU/UNIS) waiting for us with their NORUS sign where the rest of our company also gathered. The group ranges from the Rutgers undergrads to graduating seniors mastersand post doc students from Cal Poly and NTNU and the accompanying professors. Later that day Geir and Mark took us on a tour of a near by mountain where we saw a greater view of the surrounding area along with fish and seal drying racks, sled dog kennels, giant satellite dishes, the Northern Lights Observatory, and Santa's house! Unfortunately we were all a bit under-dressed so we weren't too keen about leaving the van for long periods of time. Starting that night we had the first of many meals from the Kroa restaurant where we have had a variety of local dishes including grilled and raw whale, stockfish, fish cakes, venison, and reindeer. On Monday we had our safety training session for snowmobiling, but we were all disappointed to find out there wasn't enough time to go to the shooting range where we were supposed to learn to defend ourselves from possible polar bear attacks. Afterwards Geir gave us a tour of the UNIS(University Center in Svalbard) building and we got settled into our conference room where we were given a quick overview of what we would be doing over the course of the week. Tuesday we met back in the NORUS room and each of the professors, Mark(Cal Poly), Geir(NTNU/UNIS), Chris(Cal Poly), Jorgen(UNIS), and Oscar(Rutgers) through teleconference gave talks on their backgrounds and what work they are currently doing. Wednesday, the professors let the students take charge of the conversation and we came up with what was posted on our blog from the 18th. On Thursday we went snowmobiling (or as the locals call it, snow scootering) to Barentsburg, which is a small Russian settlement west of Longyearbyen. Over the past couple days there had been some wind and precipitation so the trails had a covering of loose snow. This lead to all of the American students tipping the snowmobiles, but luckily no one got hurt. Overall however it was an amazing journey riding over the glaciers and through valleys to our destination. Barentsburg is a small Russian mining town that had some success while the Soviet Union was still in one piece, but since then they have gone pretty far down hill and many of the buildings are now worn down and abandoned. But upon arrival we went to a restaurant where they were waiting for us with a nice hot meal of soup, chicken, and wafers. The ride back was a completely different experience from the ride there because the sun had set behind the mountains by the time we left the settlement, so we traveled by twilight and the headlights of the snow scooters. After returning back to town we sat down to a fancy dinner of scallops, reindeer, spiced ice cream and a variety of wines after which we all

sleepily returned to our rooms. Finally today we had a quick session reviewing what we have covered this week and then gave our blessings to part of our group, as they had to leave. Tomorrow we plan on taking a quick trip to the Svalbard museum and after lunch going on a hike to the ice caves and exploring so we will give you an update on that later.

Hope everyone else is well!

0 Comments

20 mar

Pictures from Svalbard

Posted by: Katie in: Atlantic Crossing, Atlantic Crossing Seminar, RU27 Atlantic Crossing Preflight, Undergraduate Operations

Here are pictures form the island! Included are the tour around the island, and the snowscooter trip to barentsburg!

1) Neilsen with frosty

2) the NORUS group at dinner

3)Dinner!

4)The three of us in front of the 'watch for polar bears' sign

5)The mountains

6)Dani and I off the plane in Svalbard

7) View from the hotel in Tromso





0 Comments

18 mar

Day 3 and 4 at Azores

Posted by: student in: Atlantic Crossing

Tuesday 3/17
We woke up this morning and met Ana and Igor, physical oceanography that works with satellites and the mathematical interpretation, at the Institute where we discussed altimetry and gliders. We discussed how the research that they are doing in the Azores can be improved with gliders; they have an actual need for the gliders.

We had lunch again with Ana and her colleague who we call Sunny. The food was delicious. After that Ana showed us the different museums that we should see, we spent the afternoon at the whaling museum. It was fascinating to see the history and learn that the whaling factory closed only 74 years ago.

We utalized the fact that we now have a car, and took a ride up to Monte da Guia and saw the spectacular view from the top of the mountain. From the top of the mountain we could see the DOP (the Department of Oceanography and Fisheries) boat and we noticed that it was towing something behind it. Shannon pulled out her telephoto lens and we could see that it was some sort of marine mammal. We raced down to the bottom of the mountain to where it was being towed in and learned that it was a juvenile beak whale that they found off the coast of Faial.

We had Saint Patricks day dinner at a fantastic restaurant!

3/18
Ana showed us on a map all of the places that we should visit this morning before our presentation. And then….we were off!!

Our tour around the mountain began at the waterfalls at Varadouro, which were incredible due to the extraordinary amount of rain that we are experiencing! Then we ventured our way to Capelinhos, passing two light houses on the way. There was the Vulcao dos Capelinhos, where we were pelted with rain and volcanic sand, caught all on video by Dakota! We ate lunch with the scenic 9ft waves at Faja, and then drove around the rest of the island back to the house.

Our presentation began at 3 today and we had a fair crowd show. The presentation went extremely well and there was a lot of interest. We are having the students over to the house for pizza later tonight in an attempt to talk more. They are already interested in sending students to Rutgers so that we can play host!

Beak whale

1 Comment

18 mar

SVALBARD UPDATE! :D

Posted by: dbholden in: Atlantic Crossing, Atlantic Crossing Seminar, Undergraduate Operations

Greetings from the coolest place on Earth–literally!

Besides the beautiful scenery here, the NORUS workshop has been very productive. The purpose of NORUS is to establish an international partnership between Norway and U.S. students and to study the effects of climate change on biological interactions. We have had a lot of professors educating us about the Arctic so that by 2011 we can address biology and climate interactions in the Arctic and eventually publish our findings.

After collaboration, we have plenty of ideas and objectives for the next workshop in the Fall of 2009 in San Luis. We decided we wanted to focus on biology-ice interactions and how organisms are affected by ice melt-off, so to obtain our goal we want to measure nutrients, algae blooms, attenuation and currents. We are taking this project one step at a time, but for now the procedure to implement this problem is as follows:

1. The area of research in the Arctic needs modelling.

2. Send a glider/REMUS to test fluorometry, productivity and bathymetry of ice edge

3. Send out the glider twice: Spring 2010 and spring 2011

4. Those focusing on biology need to figure out which sensors they need so that Rutgers and Cal Poly can check to see if we could supply instruments.

Also in NORUS we discussed what Rutgers can do to help Norway advance technologically. The Norway part of the group LOVES the idea of putting a glider into Norway and have it travel to Svalbard! Therefore Rutgers and Cal Poly must identify the sensors we have and do not have for the gliders/ AUVs and then notify the Norwegians; this will then determine the amount of research we can do in the future. As for RU, we were discussing how effective CODAR would be in Norway along with the glider.

For more info about NORUS, go to http://norus-svalbard.blogspot.com/

In other news, everybody gets along so well here! There are 15 people involved, 10 of them as students. We laugh, drink, and are very merry :). Not to mention that you can't go wrong with the scenery here!

That's all for now!

2 Comments

16 mar

Ola from Azores!

Posted by: student in: Atlantic Crossing

3/15
Ola from Azores! We have been here for about a day and a half and we have already learned an extraordinary amount. After traveling for about 21 hours, with only 3 hours of sleep, we arrived at Horta, Faial at 3 pm local time. Ana Martins, from the Oceanographic Institute, met us at the airport and gave us a short tour of Horta and then brought us to our beautiful house. The two story 3-bedroom house that we are staying in comes complete with a garden in the backyard where figs, plantains, oranges, giant radishes, carrots, and lettuce is being grown.

After freshening up we walked down the mountain from our home to downtown Horta to have dinner at Peter Cafe Sport. This cafe, which is were we are sitting while we write this blog, is famous in part because the owner of the cafe rowed out to Joshua Slocum while he was passing the Azores to bring him fresh fruit. We haven't had the opportunity yet to tell the locals at the bar about our Slocum glider but we will. We also learned that when boats dock, the crew paints a tribute on the rocks in an effort to leave a piece of their mission in history. We saw several transatlantic murals, and we thought that it would be amazing to have the RU27 follow Joshua Slocum's trip and then paint a mural.

Then we hiked up the mountains back to the house, where Shannon and I painfully

beat Josh and Dakota at an AMAZING game of cards

3/16
This morning we woke up and were picked up at the house by Joe, he is the cousin of the owner of the house, to go grocery shopping. The hospitality of the Azoreans is unbelievable. We picked up some breakfast and lunch items and boxed milk and then ate breakfast at the cafe inside of the store and then Joe brought us back to the house.

We met Ana Martins and a colleague of hers at their office for a tour of the Institute. We started at the oceanogra

Ana talking with Josh in the lab

phic department and met some of the graduate and post-doc students from all over the world; Russia, Italy, France, Germany, Ireland, and Portugal. We learned about the engineers in the department, what they are working on and the training process that they go through. We discussed glider training so that when the glider passes the islands they can work with it.

We also got a chance to see the satellite room and the office where they interpret the data in Matlab to create very similar images to the ones that our lab creates. We discussed sharing data between the universities to improve the data collection of oceanographic labs on both sides of the Atlantic ocean. It will also be extremely useful to have local information and data to use when planning the glider path. There is the Azores current that Ana suggests we take to get to Europe the fastest.

After visiting the oceanographic department we went to the ecological and chemistry department were we learned about the local fisheries and the environment of the hydrothermal vents. Ana, who does a lot of work with satellites, is working on linking that data to the fish data and their relationship to NAOs which is very similar to Josh's FATE project. We were also able to see mussels from the hydrothermal vents that have been living in the labs for about two years.

Every lab that Ana brought us into gave us an in depth discussion about what they were working on and were extremely intrigued in what we are working on. I have a feeling that there is going to be a large crowd when we give our discussion on Wednesday. We not only learned about topics related to RU27, but we also learned about other opportunities in which we can partner with the university.

Mount Pico

That's all for now folks

-Emily, Shannon, Dakota and Josh

1 Comment

13 mar | RU27 Recovered from Test Flight!

Posted by: student in: Atlantic Crossing

RU27 was successfully recovered this afternoon from its test flight along the Endurance Line off the coast of New Jersey. Final preparations to the glider will be made over the next several days as we prepare to launch for its underwater flight across the Atlantic.

Dave

0 Comments

12 mar | Operation Atlantic Crossing is...

Posted by: student in: Atlantic Crossing

Operation Atlantic Crossing is now underway. Check out the new Atlantic Crossing Blog for more info! http://www.i-cool.org/?cat=38

0 Comments

12 mar | Welcome!

Posted by: Tina in: Atlantic Crossing

Hello everyone and welcome to the Atlantic Crossing Blog! In just a few short weeks RU27 will be deployed and it will begin it's long journey across the Atlantic. Our scientists, researchers, and students have been working hard to bring you some new features this year. One new development is the integration of the Ocean

Biogeographic Information System (OBIS) to the gliders flight. For the first time we will be attempting to figure out some of the biological interactions the glider will have. Check out our homepage for more information. **http://rucool.marine.rutgers.edu/atlantic/** If you've always wanted up to the minute glider info but don't always have time to check the site your now in luck. Join us on Twitter (Twitter Name: RU27) and keep yourself in the loop. You can also "Tweet" the glider a comment or wish it good luck. We would love to hear from you! Lastly, if your a facebook nut like many of us are, become friends with the glider. Find out when the gliders birthday is, if its currently in a relationship, or whether its a boy or a girl! Here at Rutgers we are all excited for this years expedition to start and we hope you'll share in our enthusiasm and follow along!

0 Comments