

The Voyage of the Scarlet Knight

Ship-based Oceanography

Advantages

- We can see exactly what's going on at that moment.
- We can make many measurements at once.
- We can obtain “high-resolution” data.

Disadvantages

- It's expensive!
- During storms, even Oceanographers can get seasick.
- We only see what's going on when we're out there.

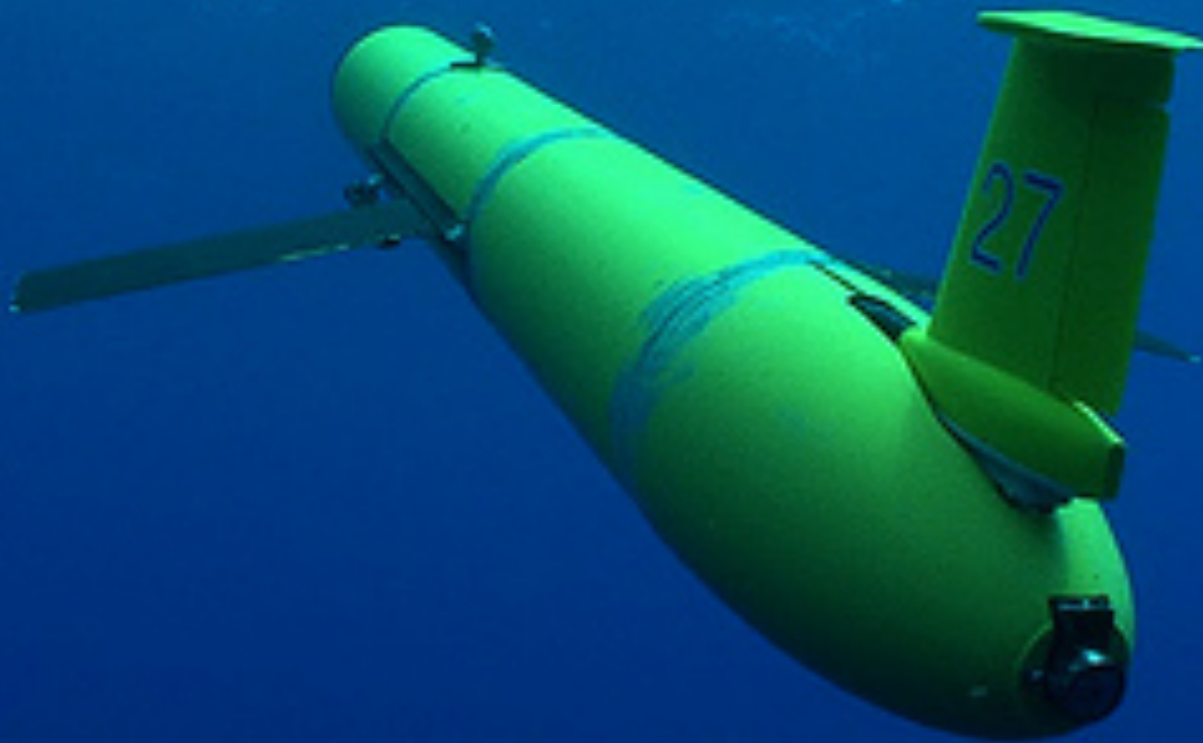


A New Way to Explore the Ocean

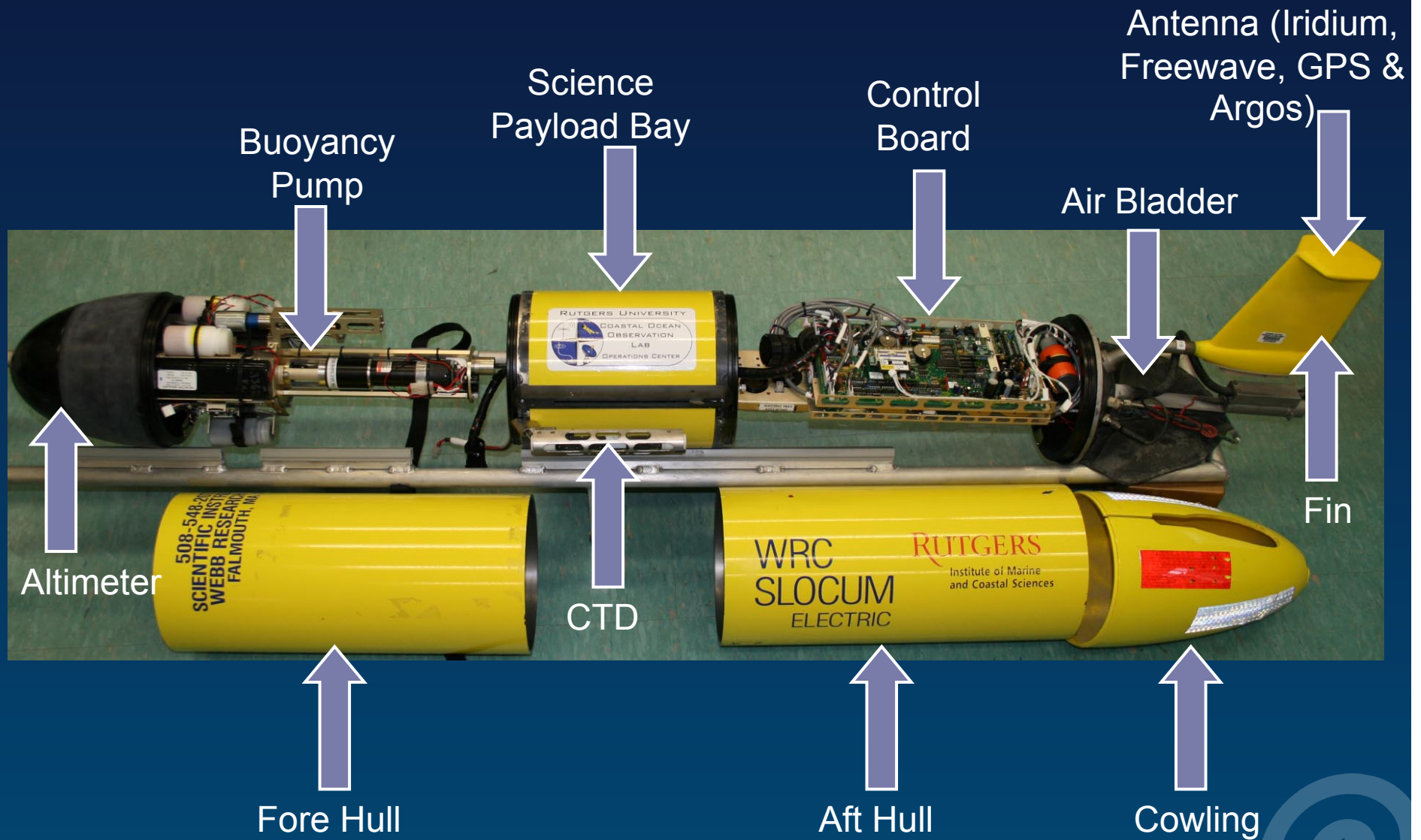
Underwater Gliders

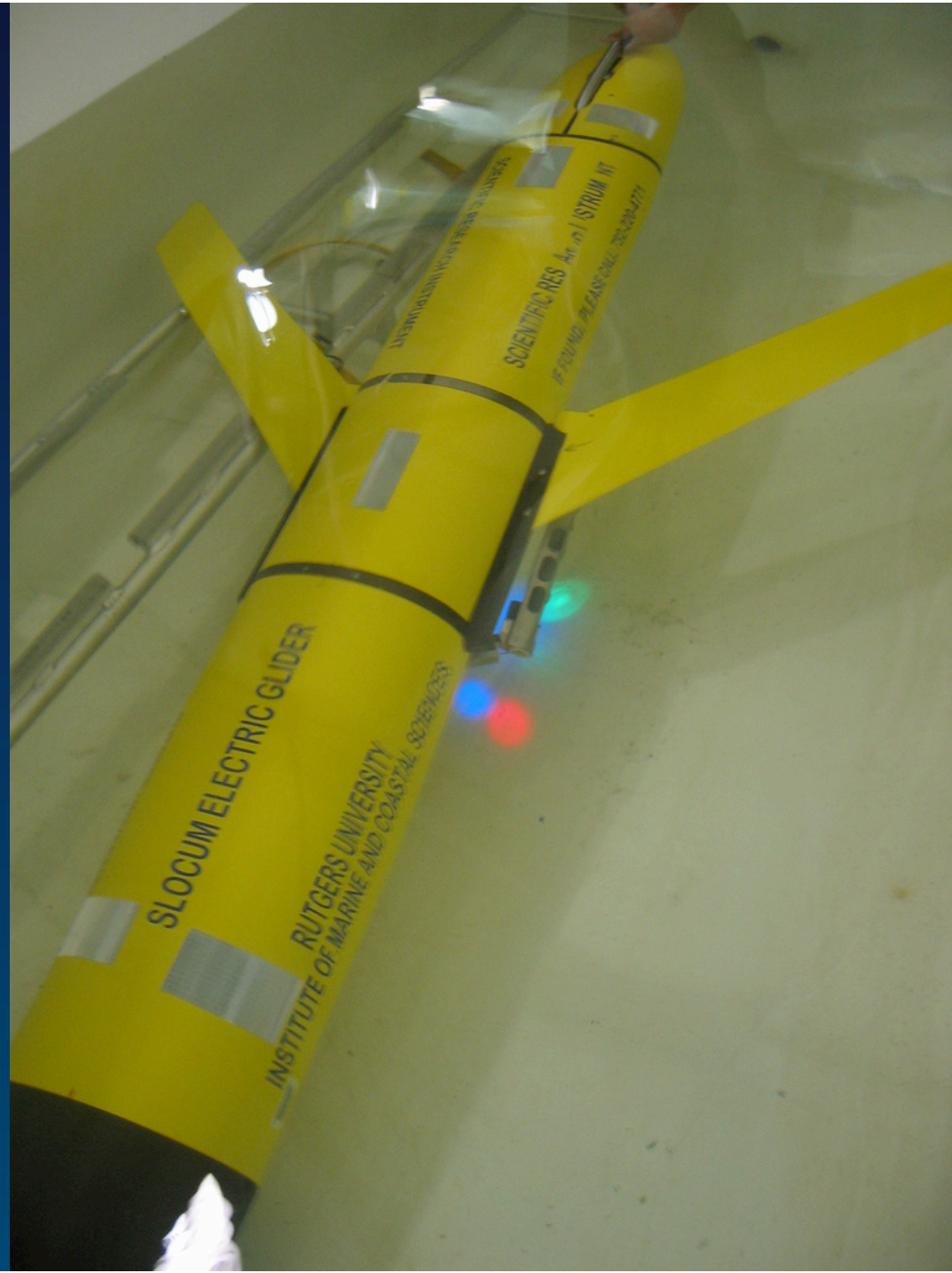


How does a
Glider
work?



Anatomy of a Glider







How do Gliders "Fly"?

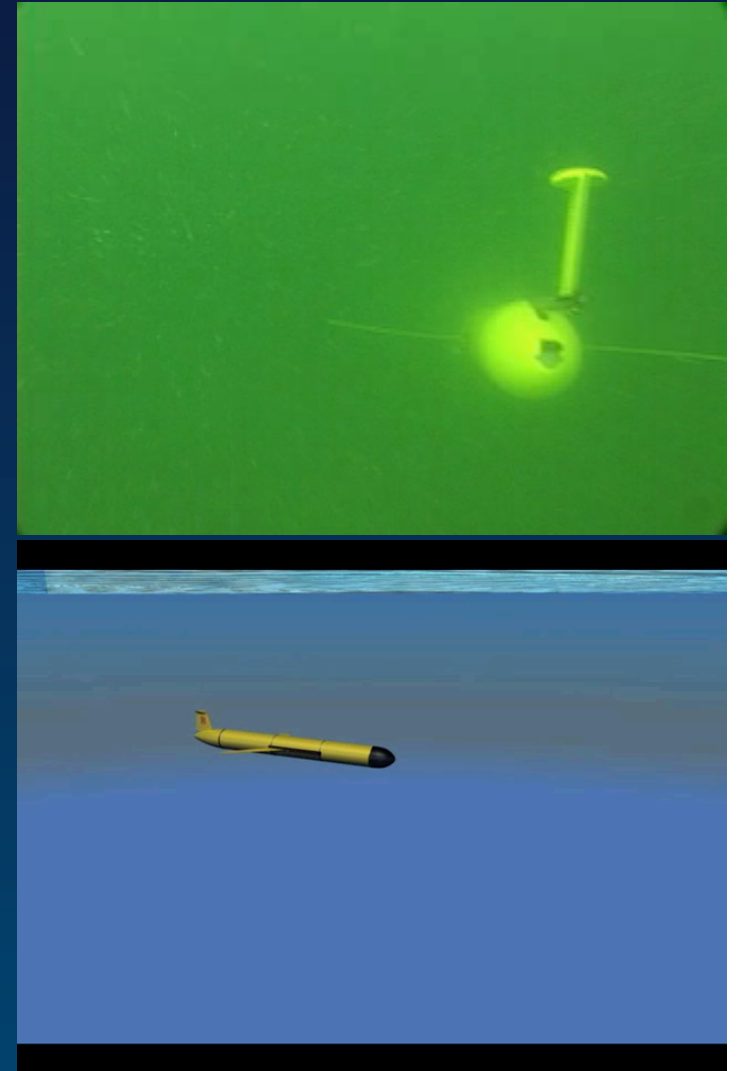
Buoyancy pump in ← the glider pulls in 0.5 L of water

When surfacing to connect glider inflates air bladder

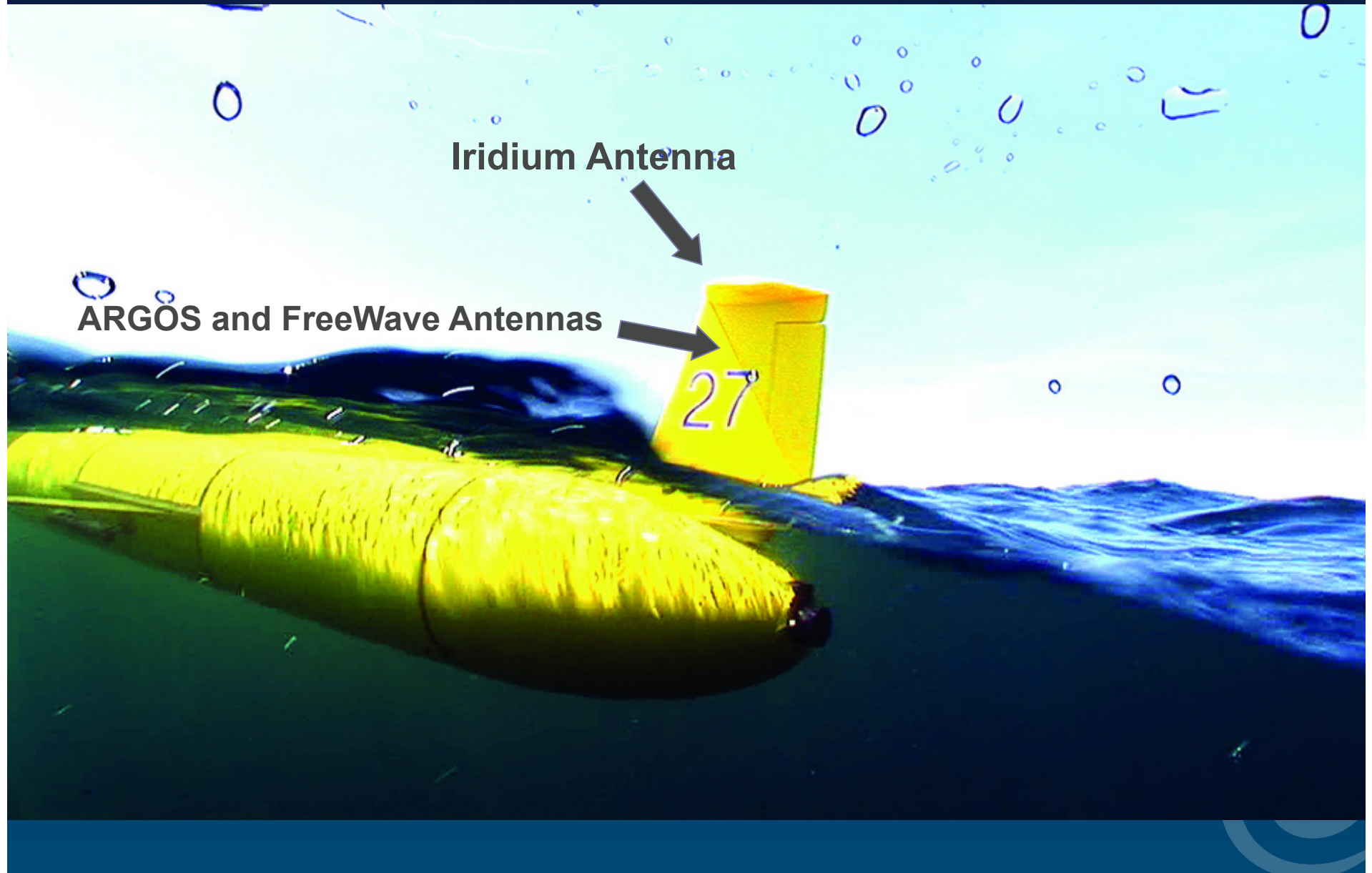
Glider begins to dive downward

Push pump out → glider inflects and begins to climb to the surface

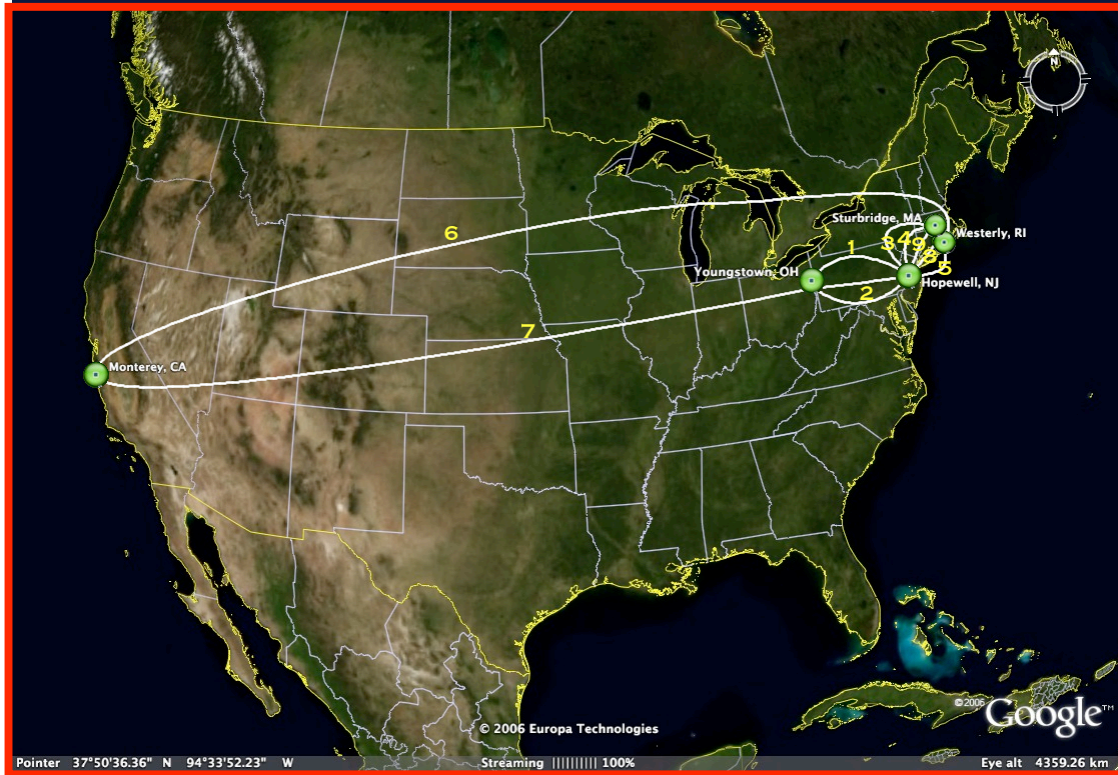
one dive and one climb is called a 'yo'



How do Gliders Communicate?



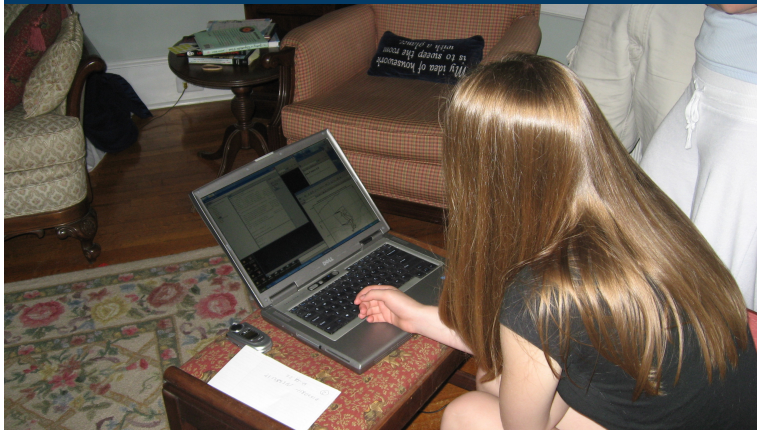
Sustained Observatory Operations from Multiple Locations



McDonald's WiFi



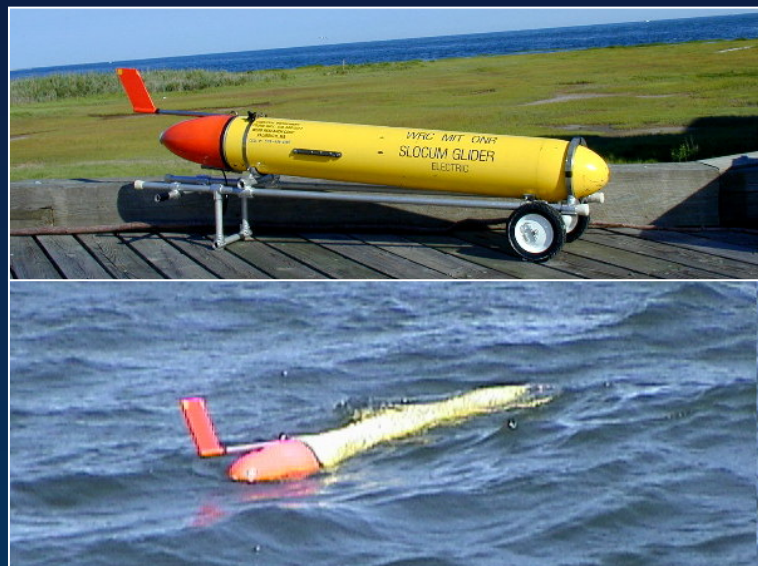
My Living Room — Glider Recovery in Hawaii



Glider Development: Enabling science over many scales (Beginning 1999)

Inner-Shelf (30 km)

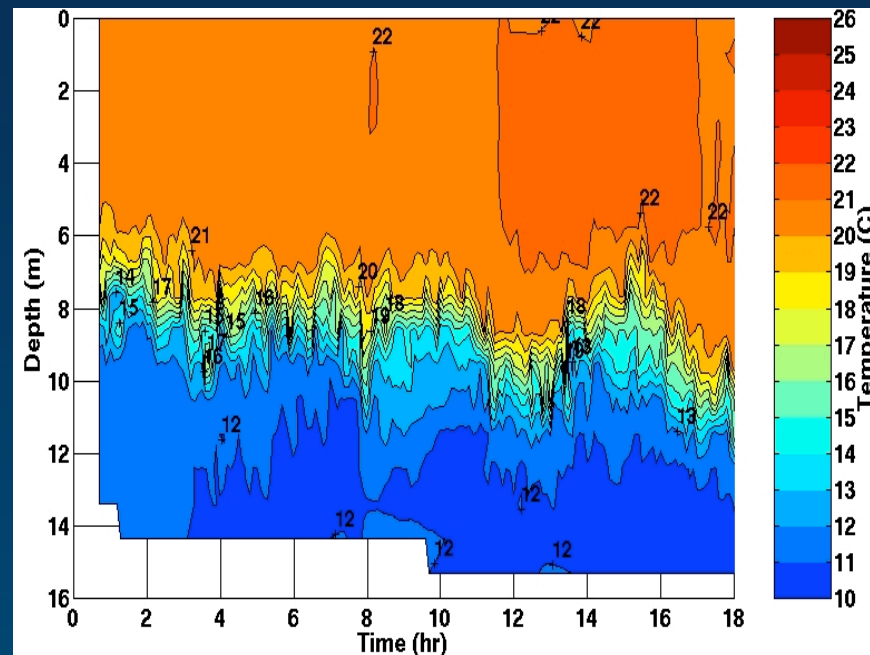
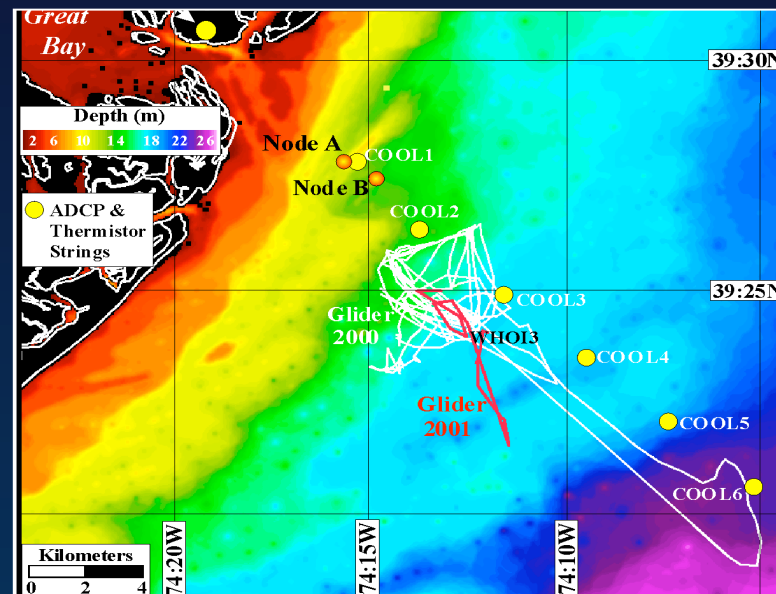
10 day missions



Enabling Technology: Line of sight communication, CTD, alkaline batteries

Scientific Impact:

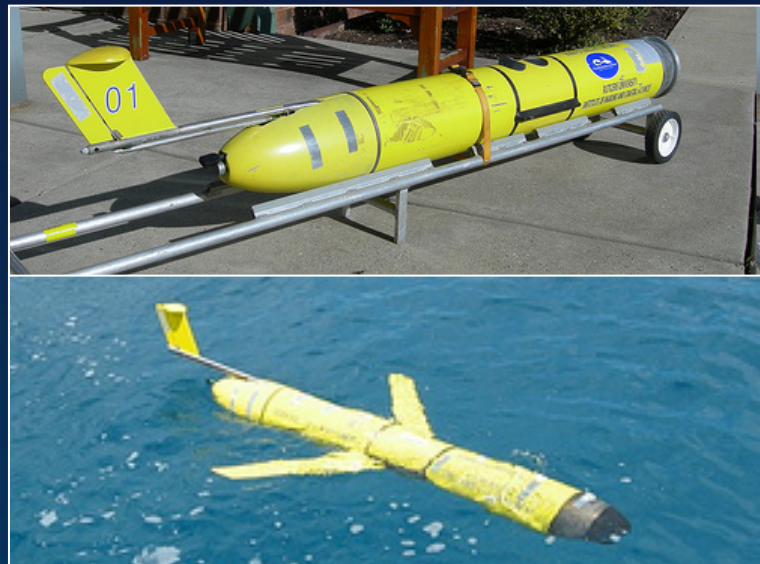
- Coastal upwelling
- Inner shelf sediment transport
- Near-shore phytoplankton blooms



Glider Development: Enabling science over many scales (Beginning 2003)

Mid-Atlantic Bight (500 km)

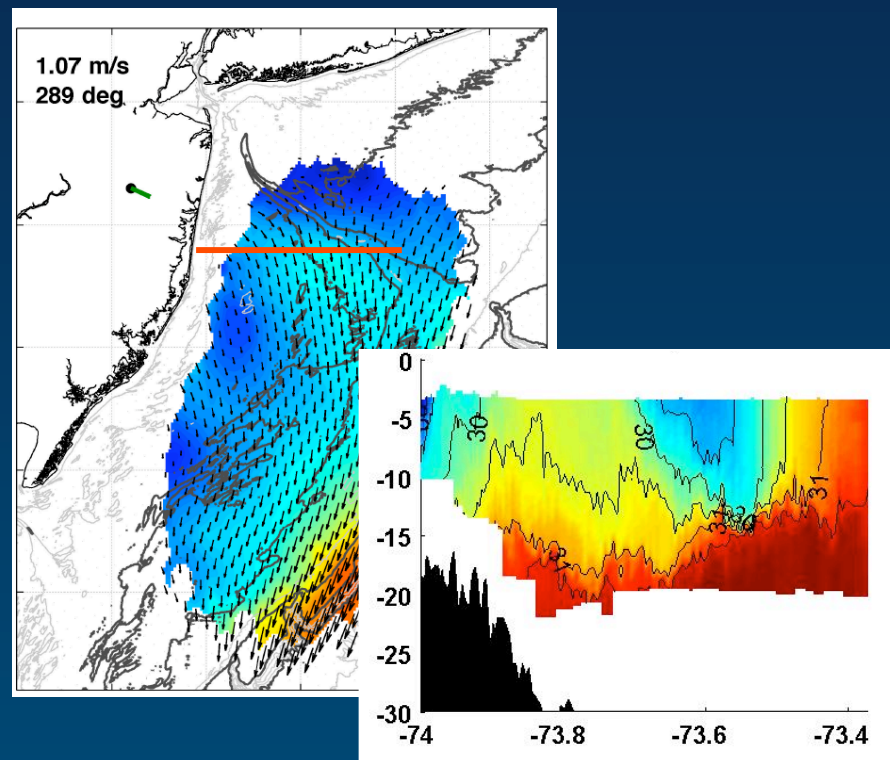
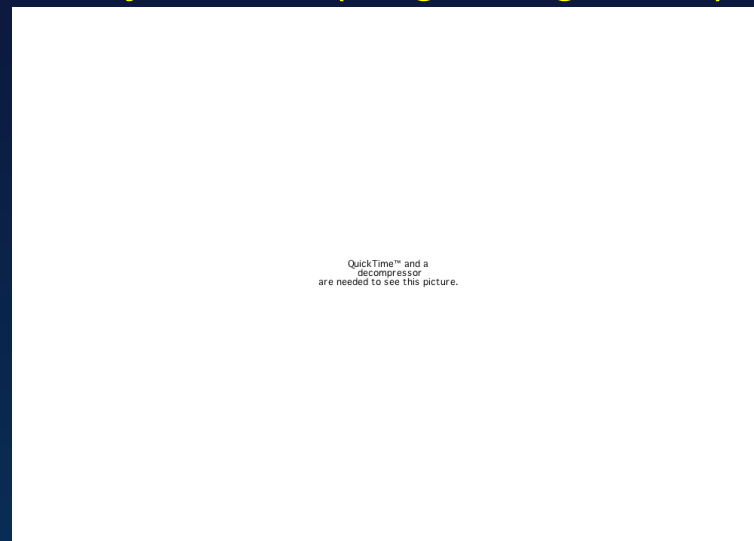
30 day missions



Enabling Technology: Satellite communication, CTD, alkaline batteries, modular science payload

Scientific Impact:

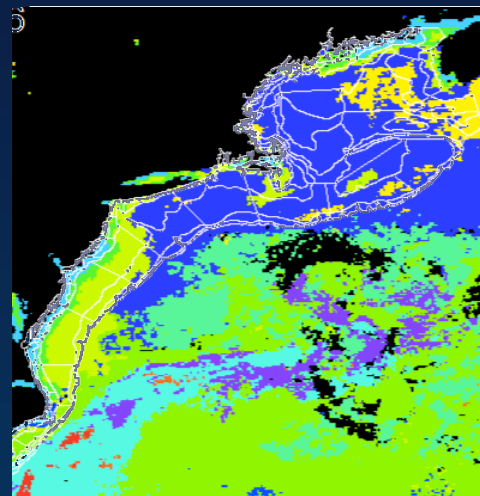
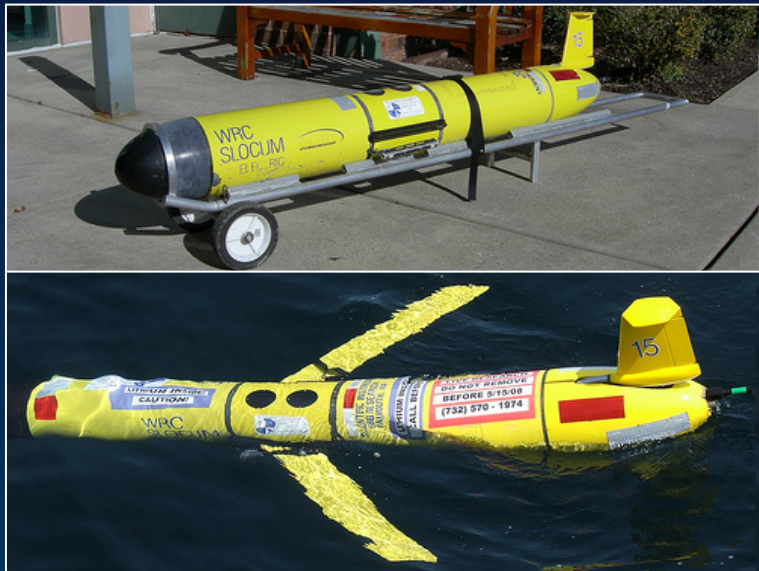
- River Plumes
- Ecological indicators for migratory fish
- Role and response of the ocean to tropical storms and nor'easters



Glider Development: Enabling science over many scales (Beginning 2008)

Large Marine Ecosystems (2500 km)

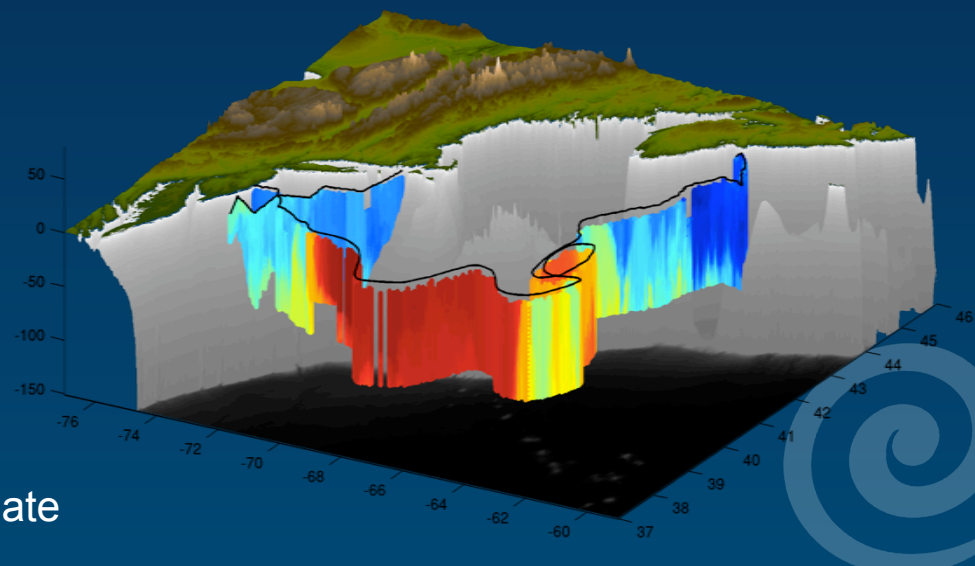
60 day missions



Enabling Technology: Satellite communication, CTD, *lithium batteries*, *Digifin*, modular science payload

Scientific Impact:

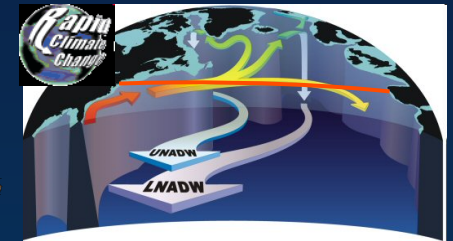
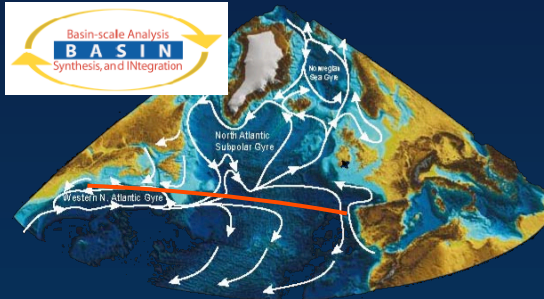
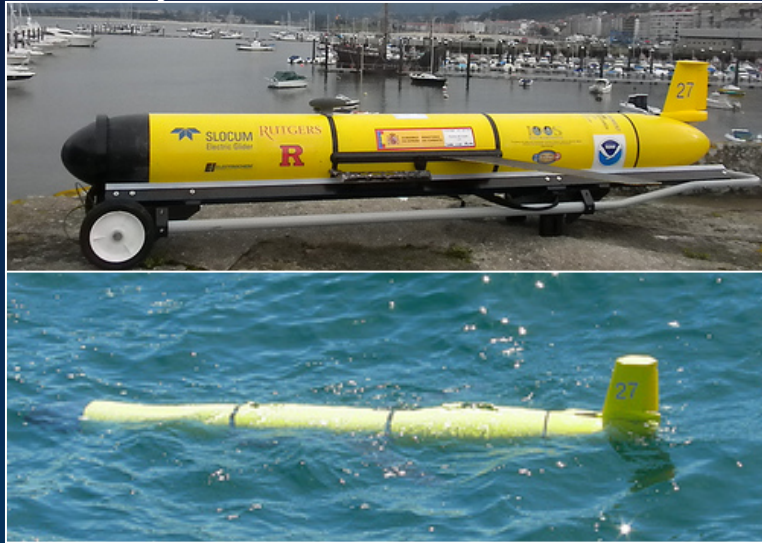
- Flux of heat and freshwater from the north by the Labrador Current
- 'Coldpool' life cycle and impact on ecosystem dynamics
- Multi-decadal oscillations and impact on climate



Glider Development: Enabling science over many scales (Beginning 2009)

North Atlantic Basin (5000 km)

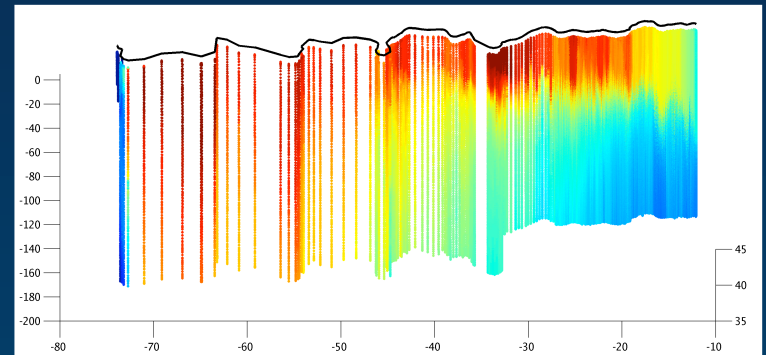
300 day missions



Enabling Technology: Satellite communication, CTD, lithium batteries, Digifin, *stretch science payload*

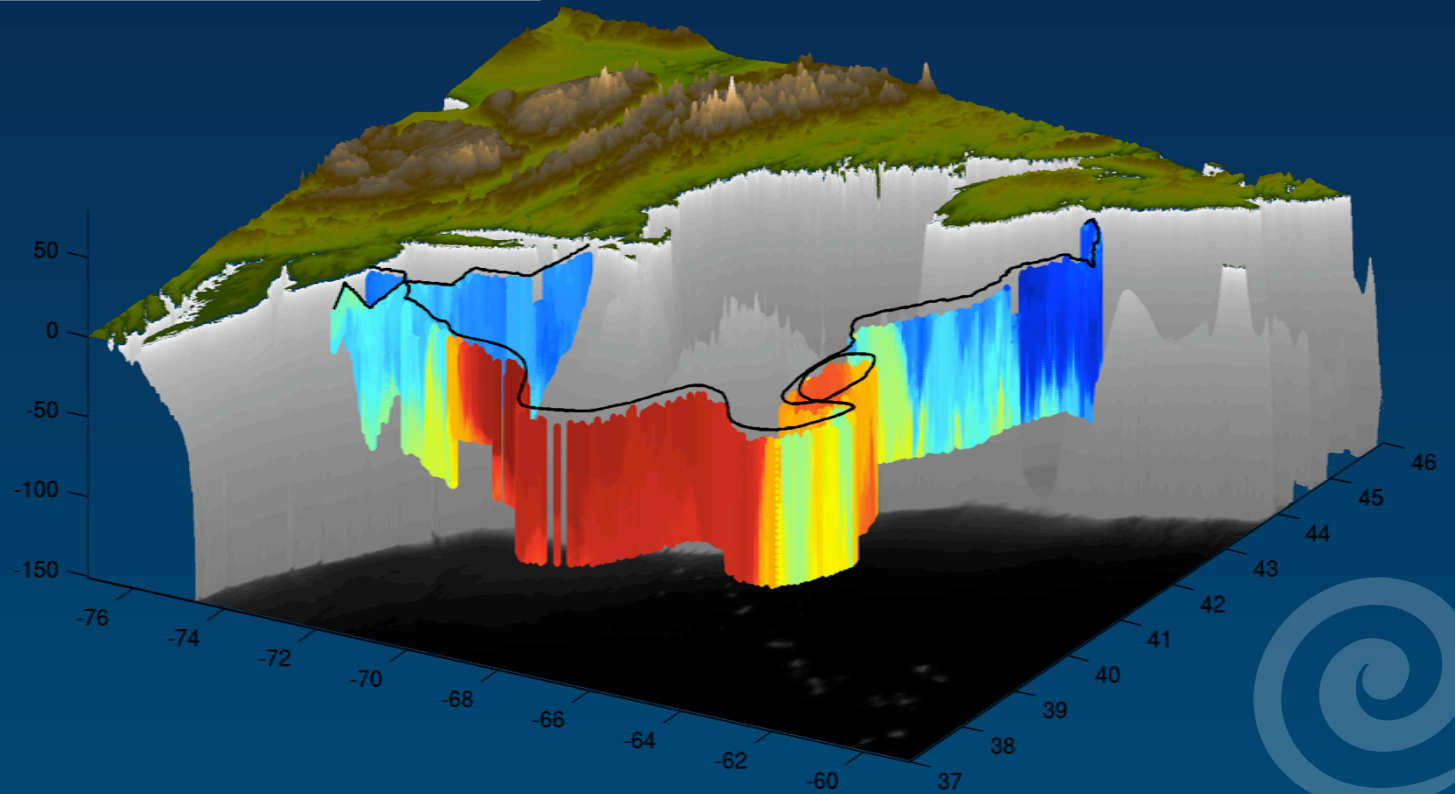
Scientific Impact:

- Feedback loop between climate and ecosystems
- Impact of rapid climate variability on ocean circulation
- Tropical storm generation and intensification (ocean/atmosphere exchange)



RU15

The first glider to fly from one country to another



The voyages of

RU17

&

RU27

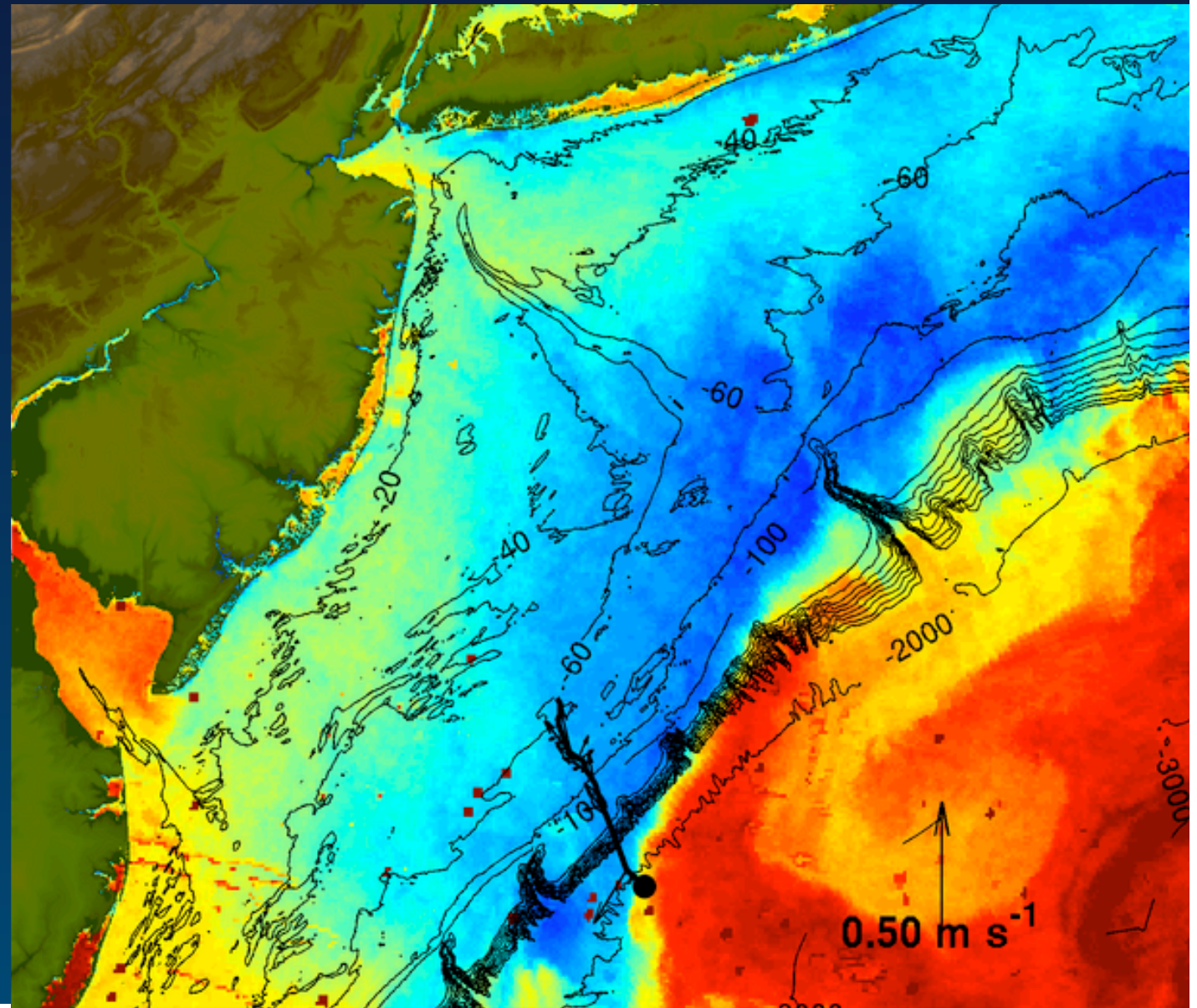


The Adventure Begins...

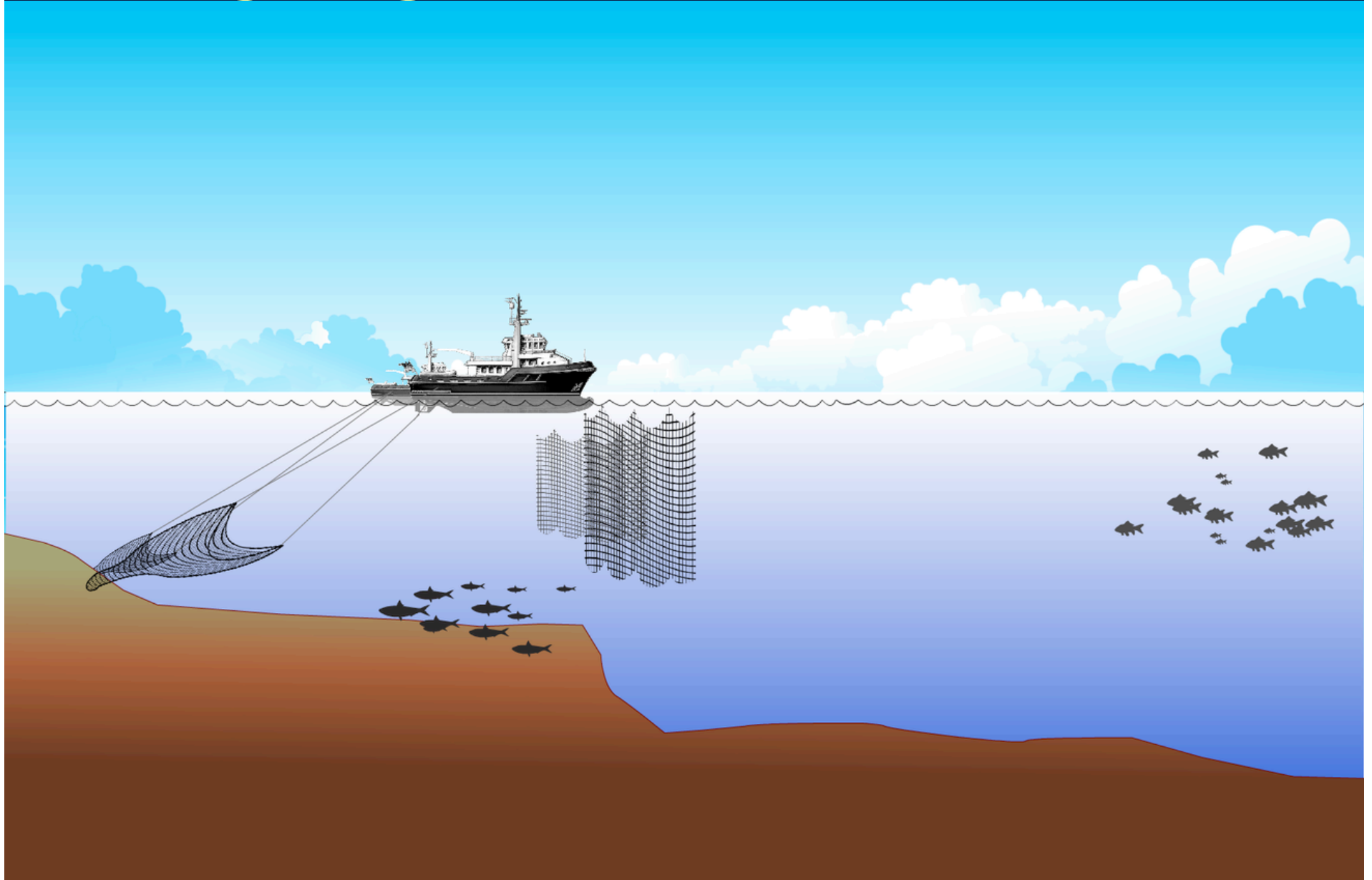


The Voyages of RU17 and RU27

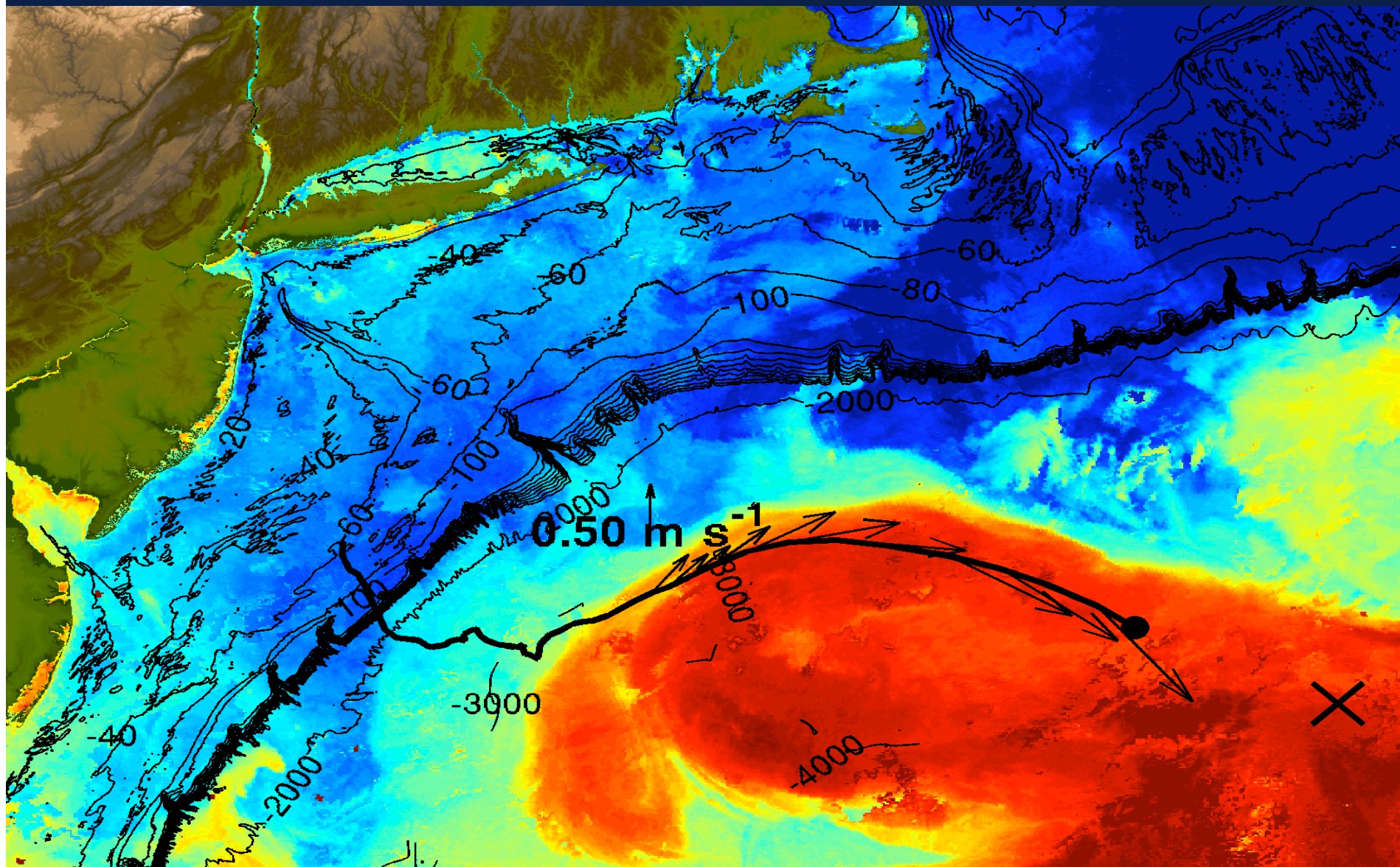
Crossing the Shelf Break



Navigating the Shelf Break



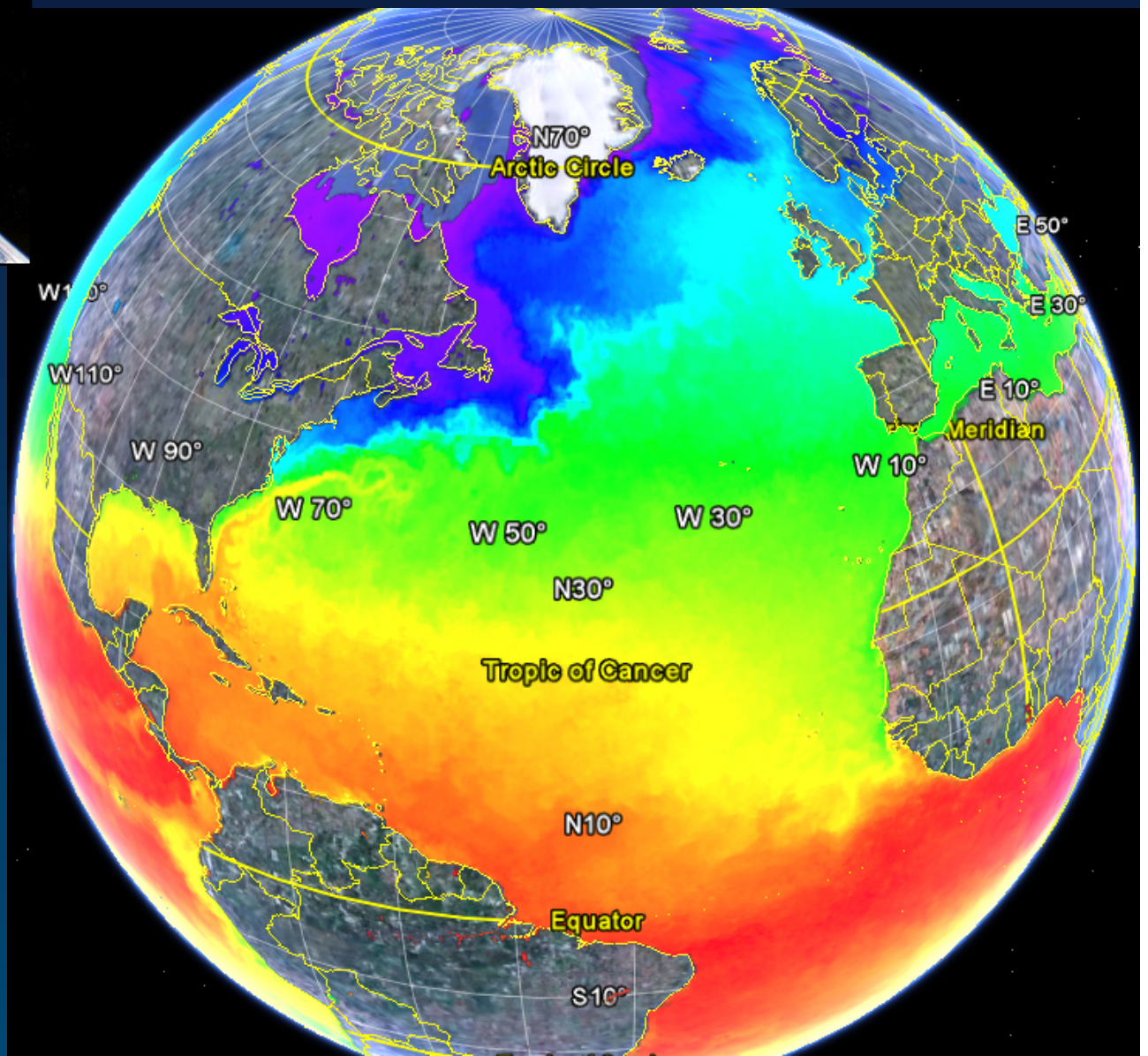
Catching a ride on the Gulf Stream



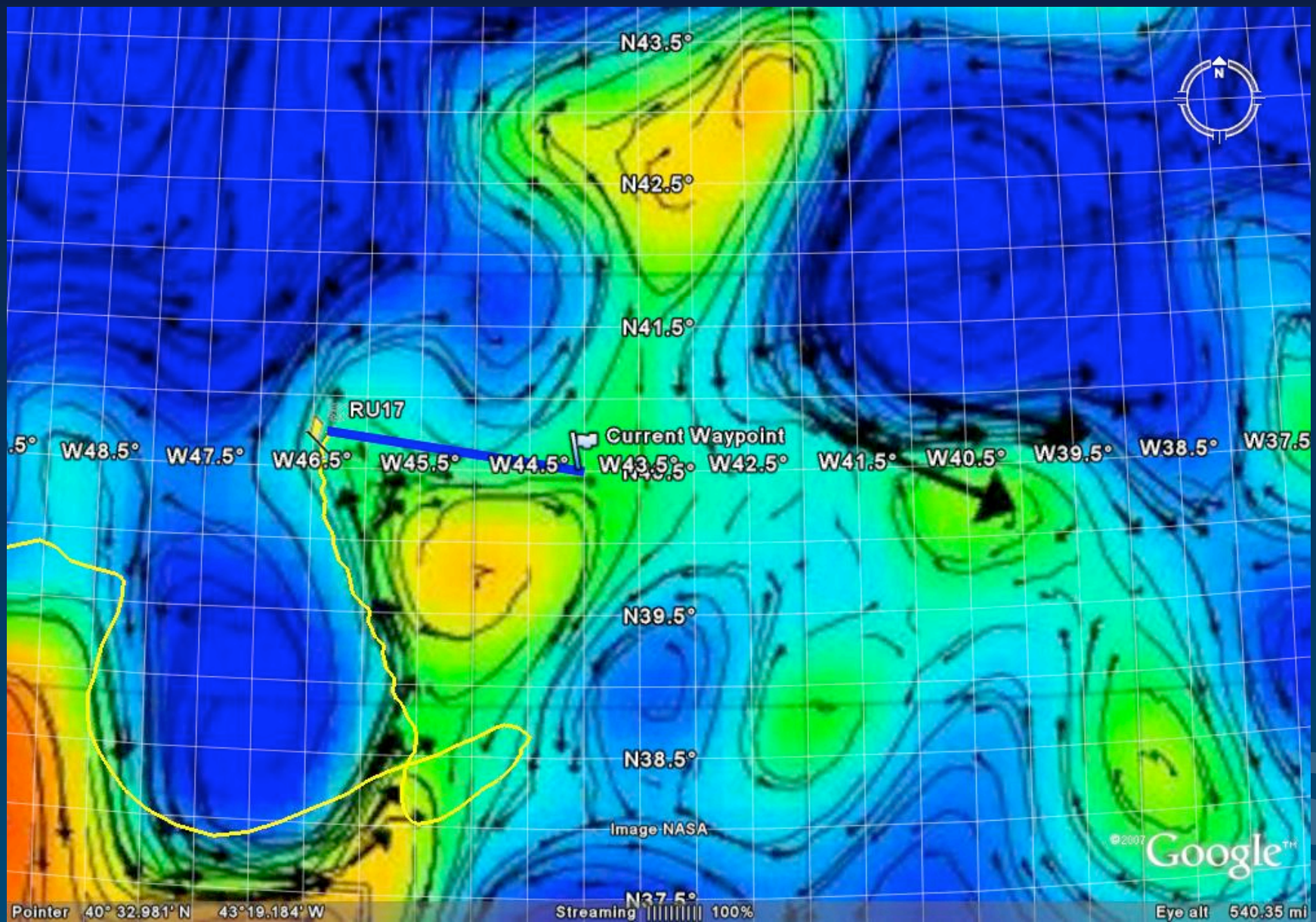


Satellite Data

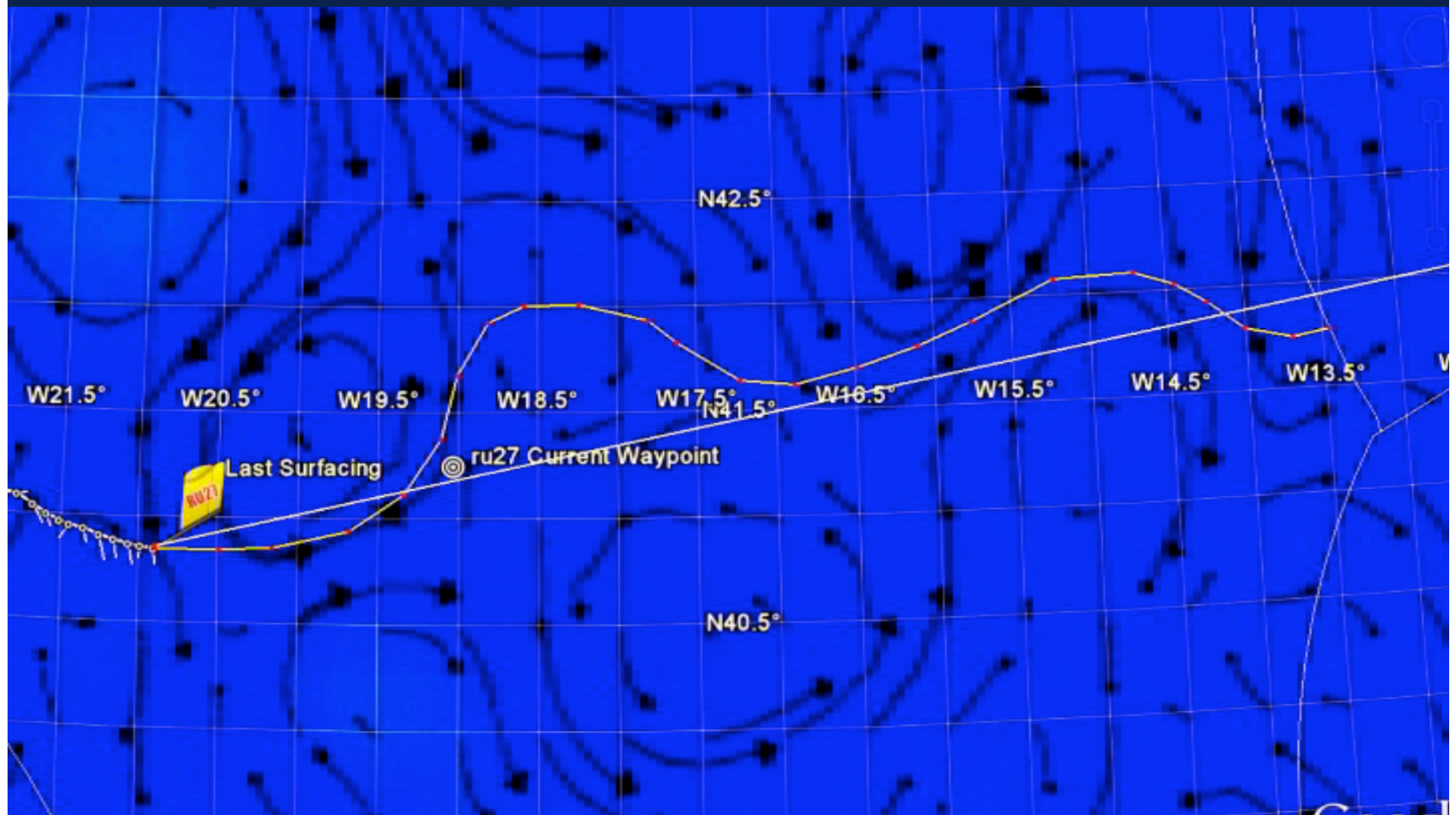
Sea Surface Temperature



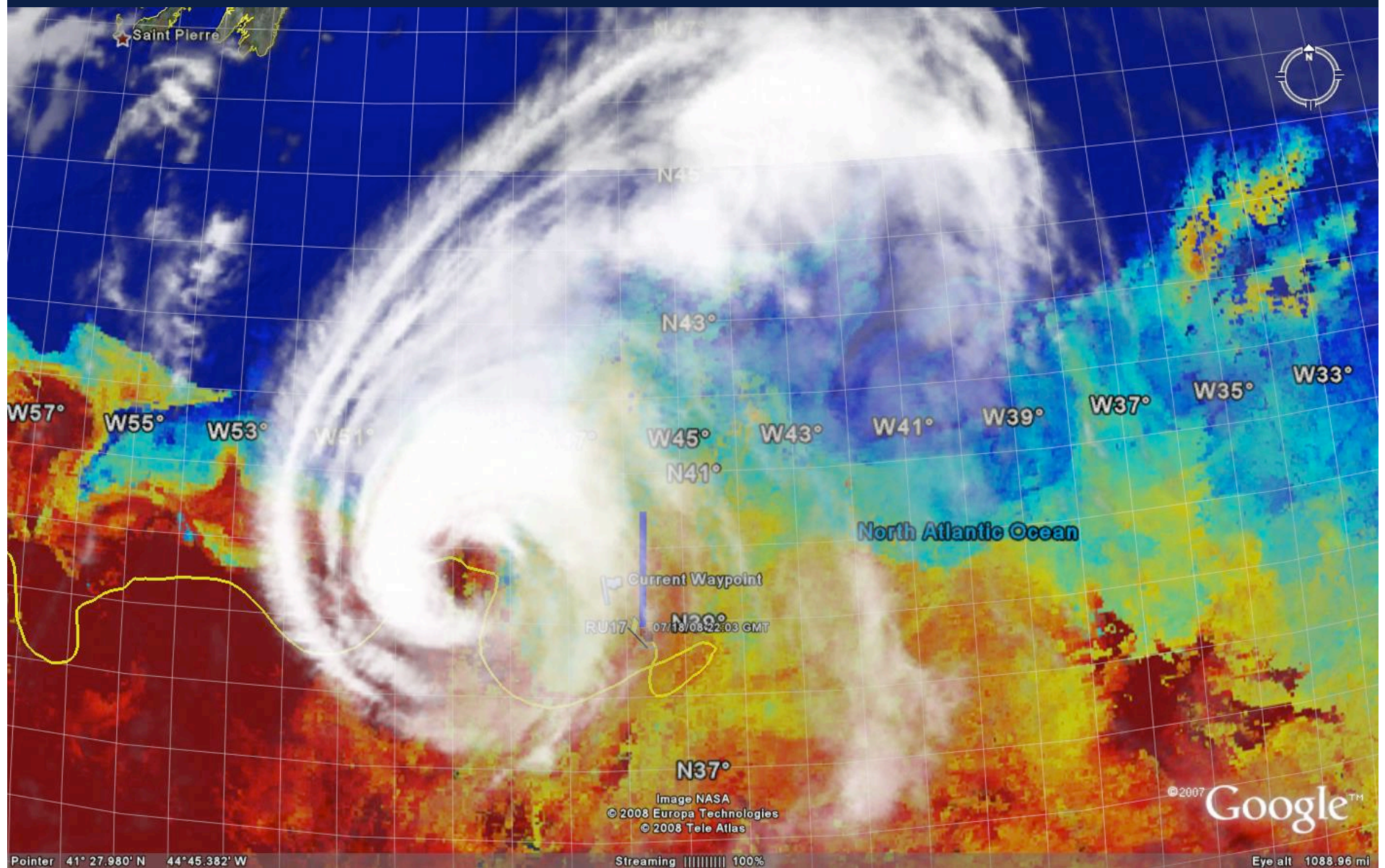
Flying in Eddies



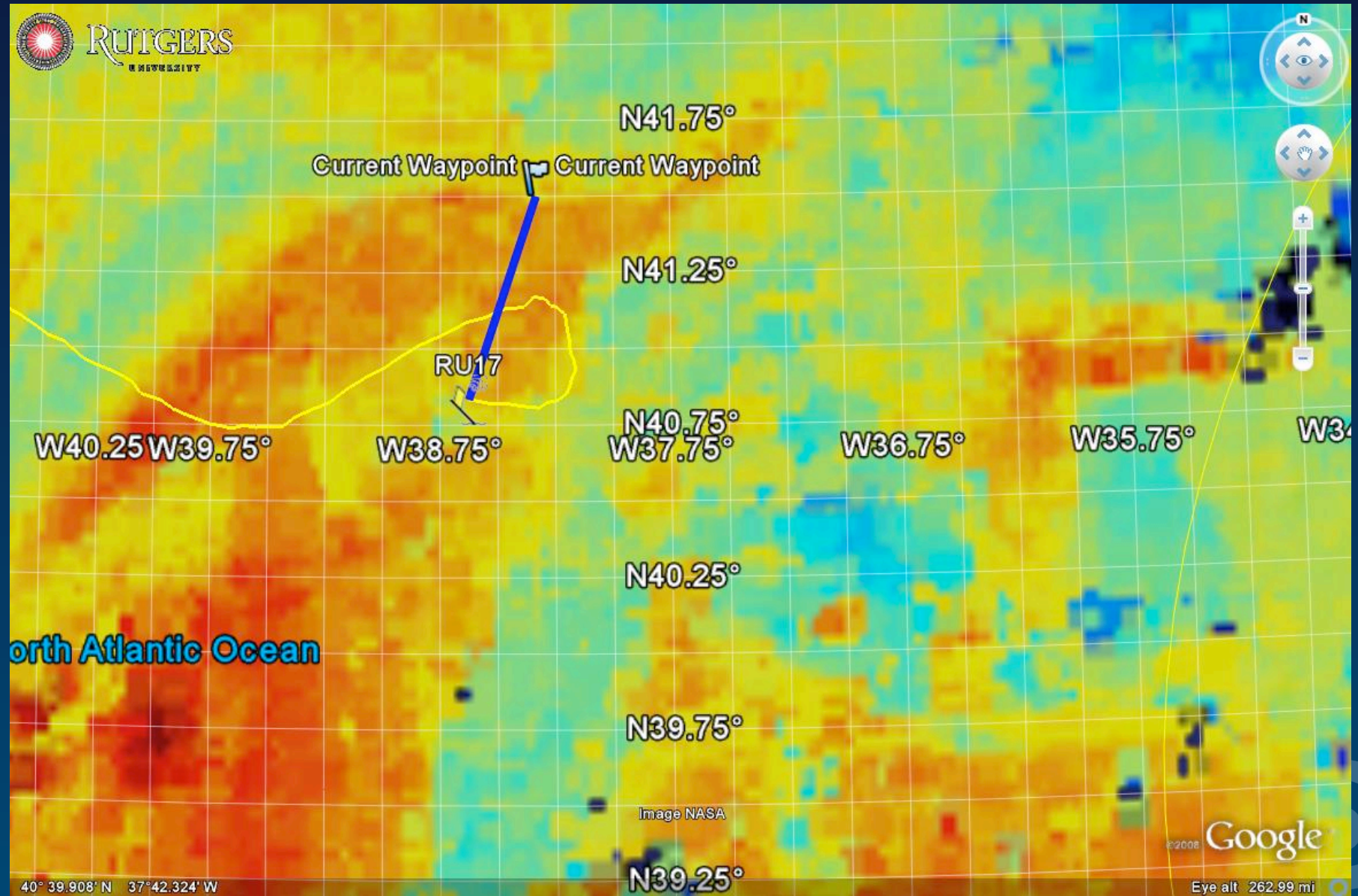
Flying in Eddies



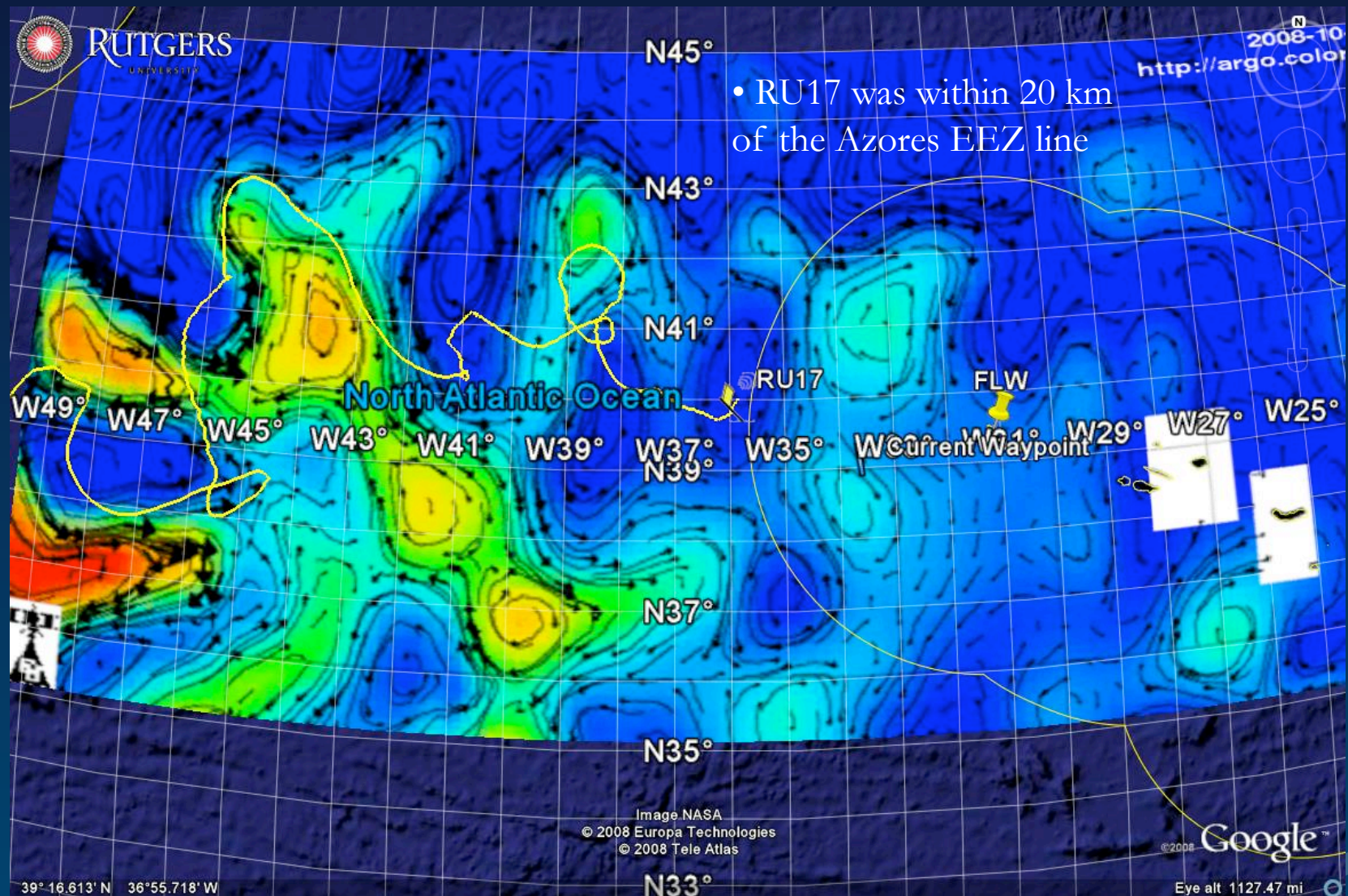
On July 19th, 2008 Tropical Storm Bertha passed over RU17



On September 22nd RU17 gets stuck in an eddy



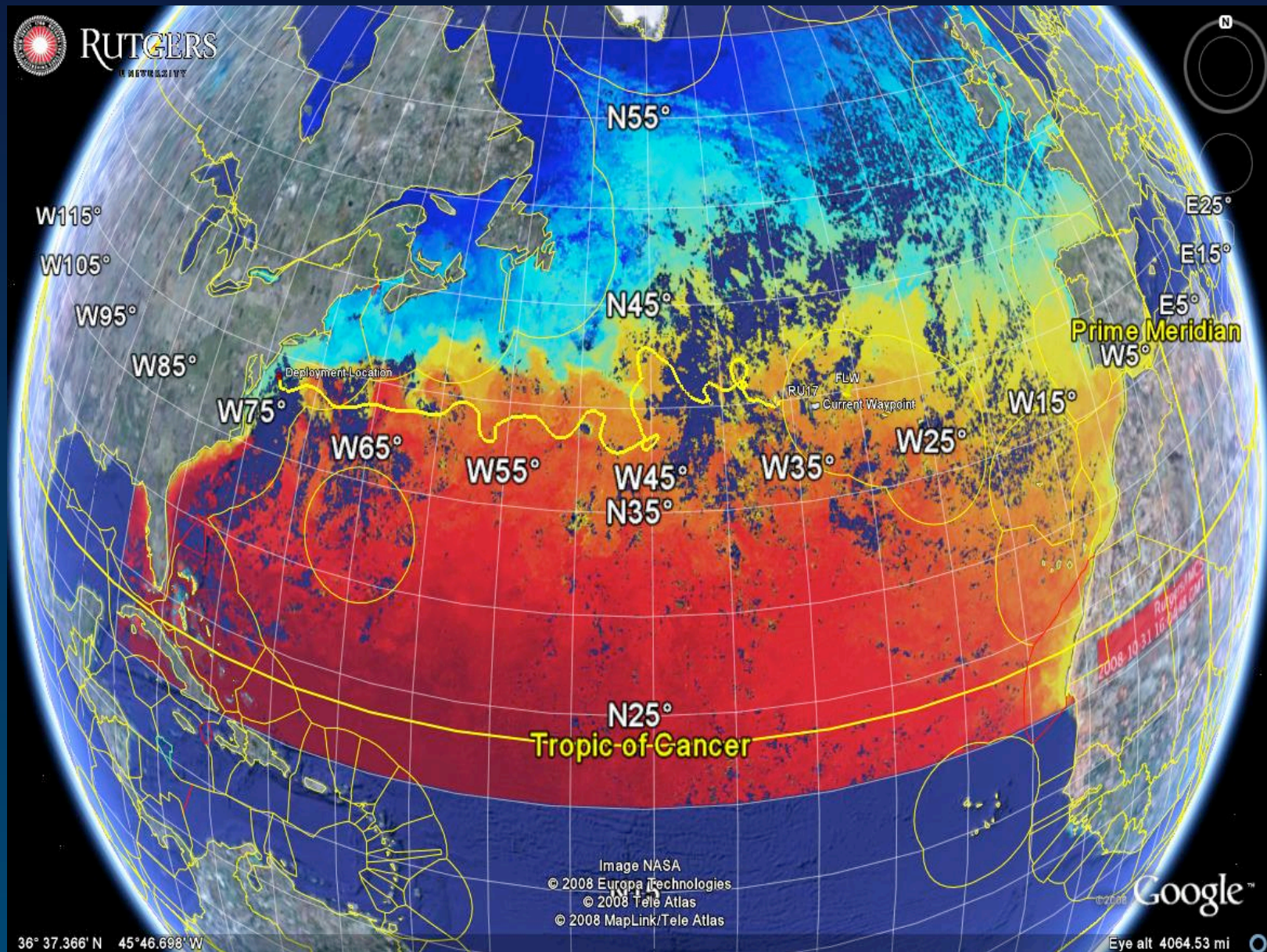
On October 28th we lost connection with RU17



- Leak detect voltage drops to 0.42 volts
- Lost connection with RU17

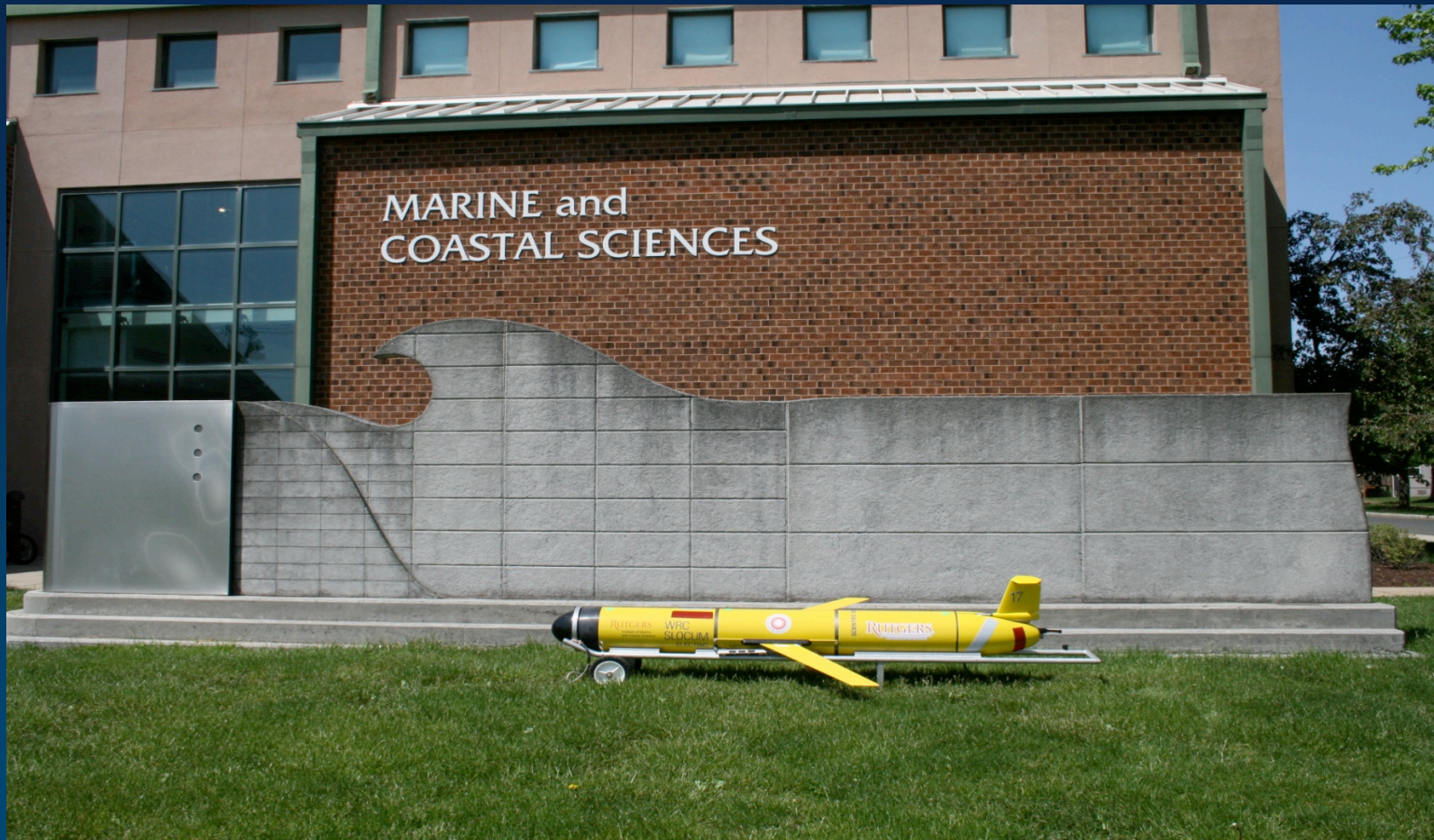
CIENTIFIC RES

RU17's full path



RU17 Accomplishments

- RU17 flew a record breaking distance of 5,700.59 km
- RU17 spent 160 days at sea (5 months and 1 week)
- Increase in student involvement, partnership, and outreach

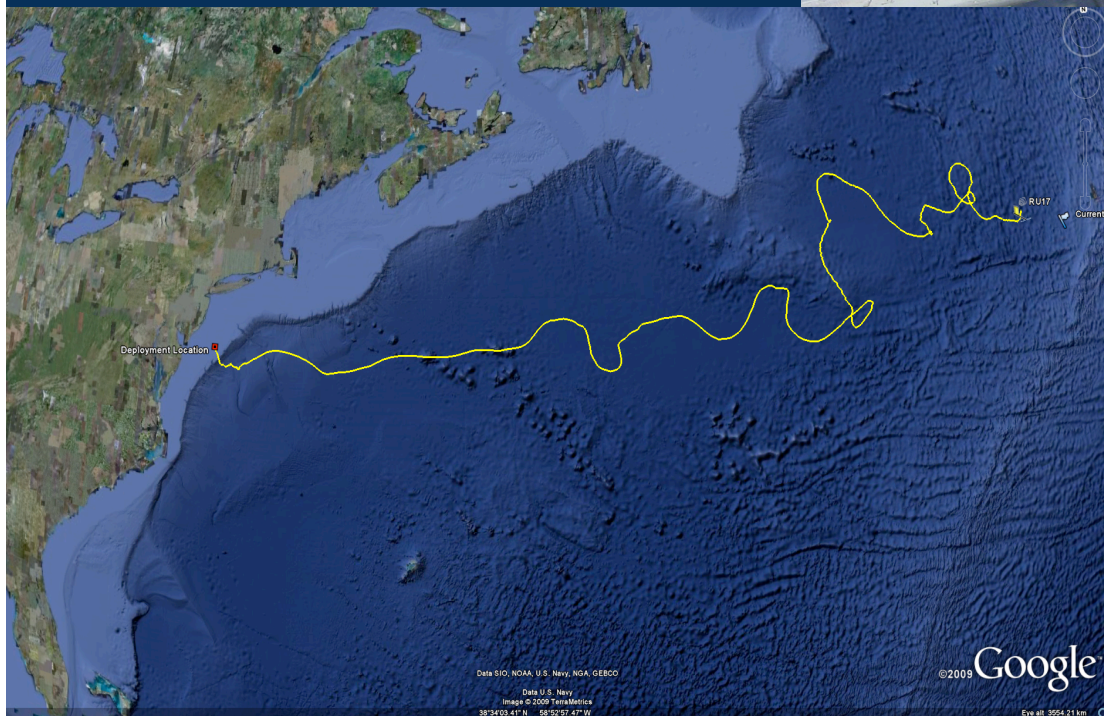
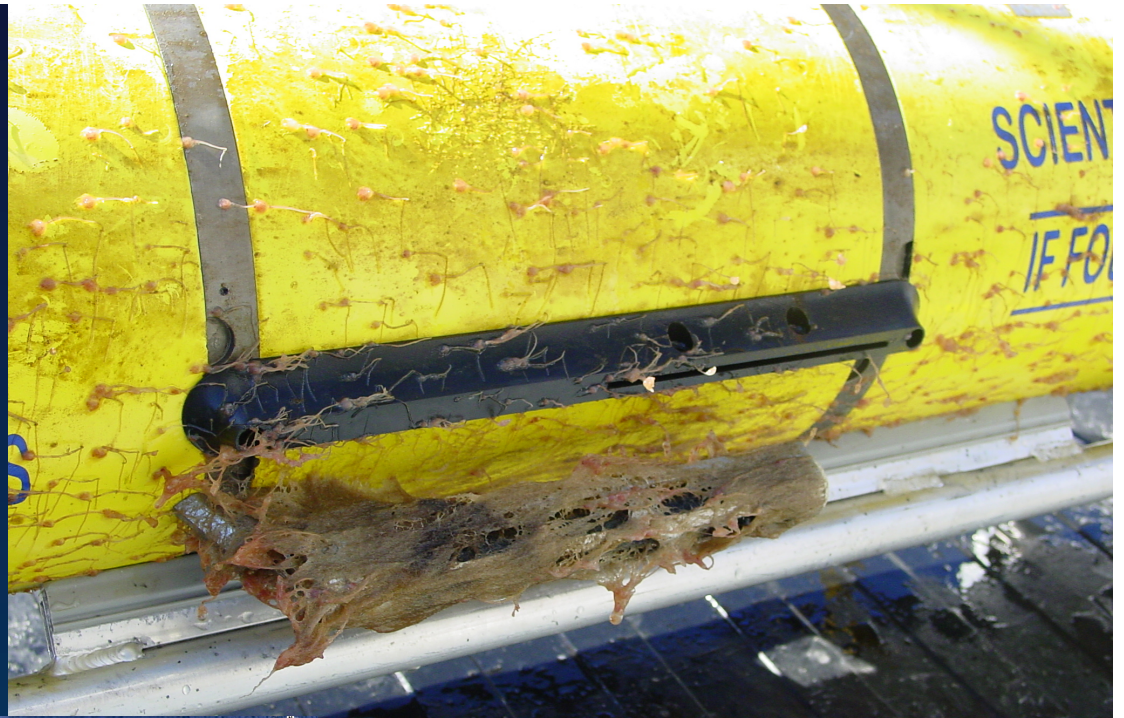


Changes made to RU27

- Reinforced CTD Mount
 - CTD mounts to glider on both ends so it is sturdier
- Pressure Sensors
 - Now plastic rather than metal to prevent corrosion
- 200 meter pump
 - RU17 had a 100 meter pump
- Biofoul Precautions
 - Rubberized hull coating
 - Biofoul paint
- Aerodynamic Wingrails
- Coulomb Meter
 - Measures the amount of power left in the batteries
- Software
 - Better software for flying deep

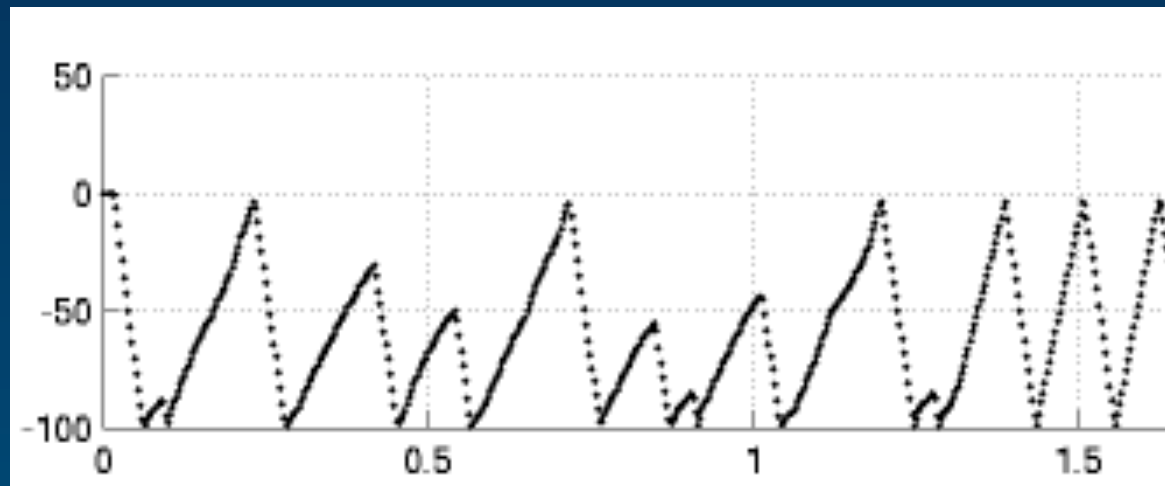


Biofouling



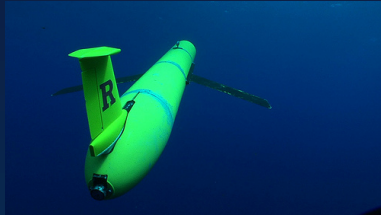
Remoras

Remora are visual predators, and cannot see well at night. To help move through the night, they attach themselves to other fish to get a free ride.



Mission Complete: Scarlet Knight is the first underwater robot to cross an ocean basin

221 Days
7,409 km
11,000 Dives
11,000 Climbs



Energy equivalent of 8 minutes of power for lights on the Rockefeller Center Tree.



Tuckerton, New Jersey, USA



Baiona, Galicia, Spain

Mission Complete: Scarlet Knight is the first underwater robot to cross an ocean basin

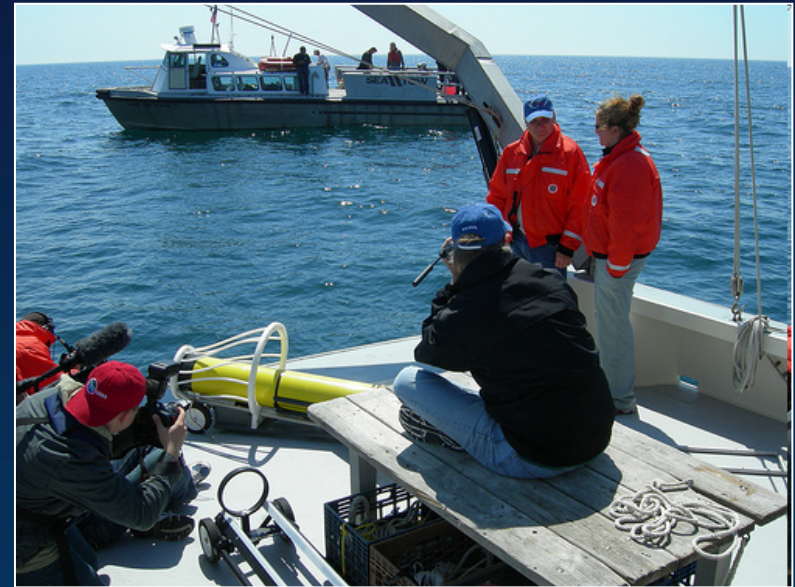
A hero's Welcome, December 9, 2009



Documenting the Story

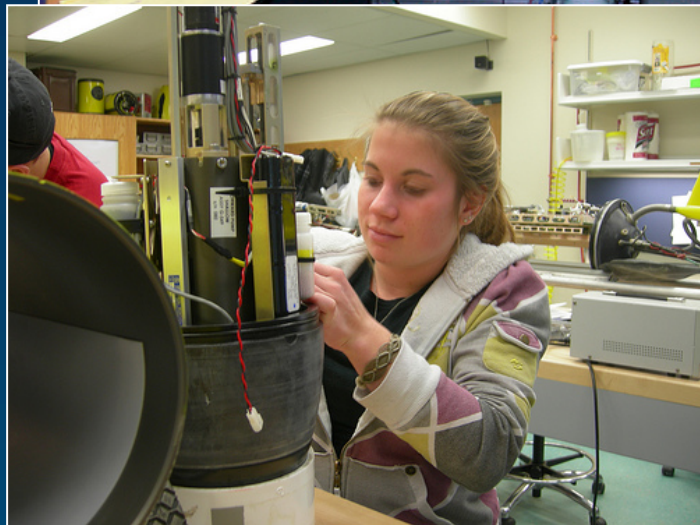
Dena Seidel, Writers House

Rutgers, The State University of New Jersey



Exciting the Next Generation in Science and Engineering

Building an International Community



HMS Challenger Mission – 1872-1876

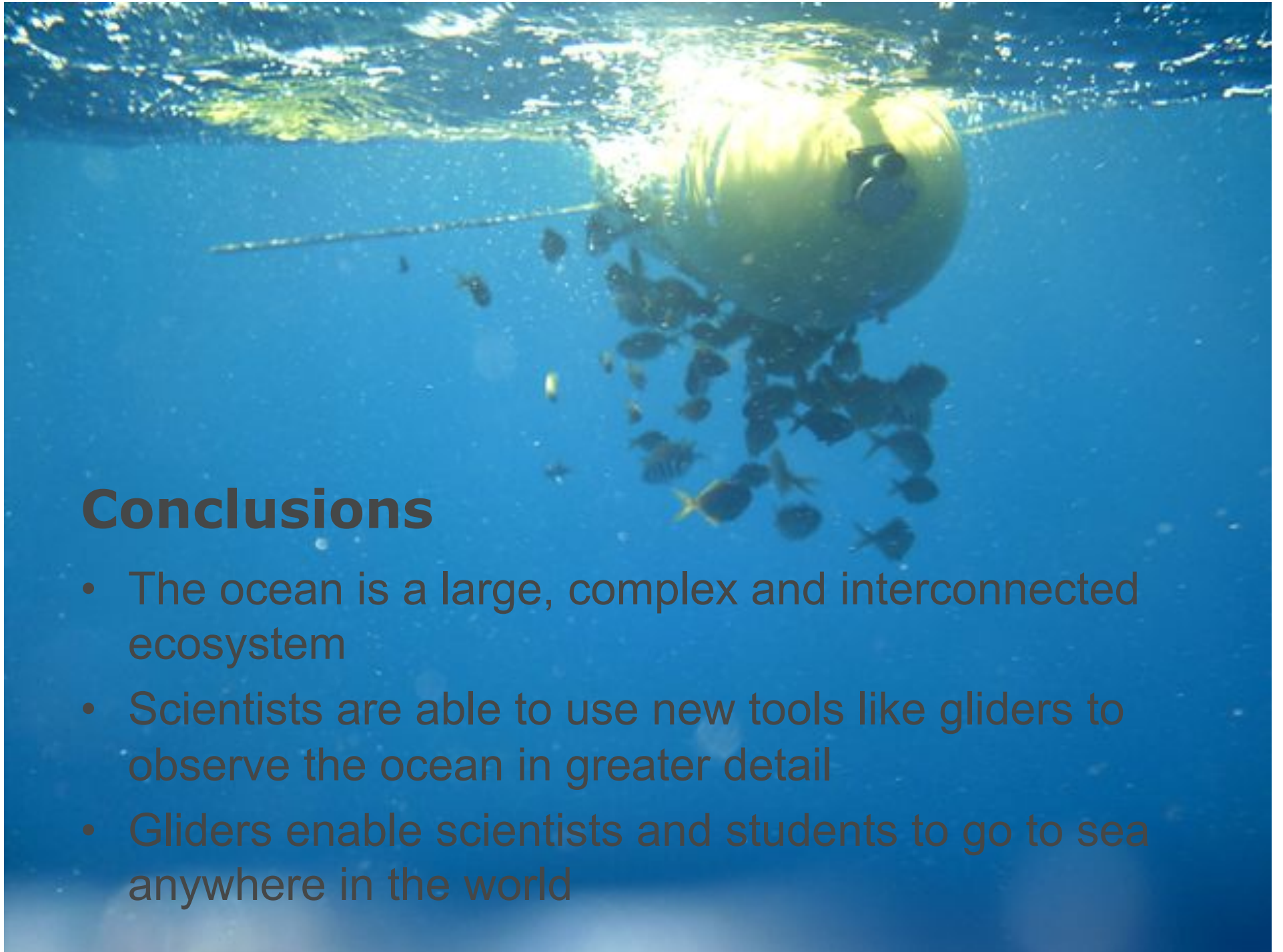
First Dedicated Global Ocean Science Cruise



Can a globally distributed network of early career scientists & students repeat the Challenger Mission with a coordinated fleet of underwater robotic gliders?



2012 - ????



Conclusions

- The ocean is a large, complex and interconnected ecosystem
- Scientists are able to use new tools like gliders to observe the ocean in greater detail
- Gliders enable scientists and students to go to sea anywhere in the world