2022 RUCOOL

CENTER FOR OCEAN OBSERVING LEADERSHIP

ANNUAL REPORT

RUTGERS
School of Environmental and Biological Sciences
CENTER FOR OCEAN OBSERVING LEADERSHIP

30 Years in Ocean Observing

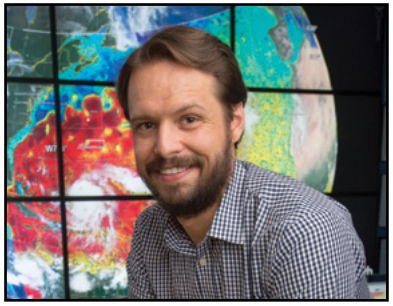
Thirty years ago, a satellite receiving dish on top of the brand new Rutgers marine sciences building was turned on. This signaled the birth of RUCOOL. Since then, this group has had a global impact and changed how oceanography is conducted. RUCOOL was formed to better observe and understand our ocean beyond the century-old practice of limited, ship-based expeditions. To that end, RUCOOL has become an acknowledged leader in pushing innovative research that has developed some of the first ocean sensor-webs, providing 4-dimensional pictures of the ocean and data, that is freely available to any person in the world. The team has innovated the use of satellites, shore-based radars, autonomous ocean robots and ocean models. It has achieved this while also innovating new modes of education and outreach. While there is much to celebrate, RUCOOL is looking forward. In the past, efforts focused on developing and successfully deploying novel ocean platforms, but now these systems have matured. The premium is now focused on producing high-quality data products and scientific understanding to meet societal goals, whether it be hurricane prediction, climate impacts on marine and human ecosystems, safety at sea, or the development of an environmentally and economically sustainable offshore wind industry. RUCOOL is committed to meeting these goals while educating the next generation of ocean leaders.

Scott Glenn
Board of Governors Professor

Oscar Schofield
Distinguished Professor

Josh Kohut
Professor

Janice McDonnell
Associate Professor



Travis Miles
Assistant Professor

Grace Saba
Associate Professor

Alex Lopez
Assistant Teaching Professor

Innovative Research

Listening to the Offshore Living Traffic

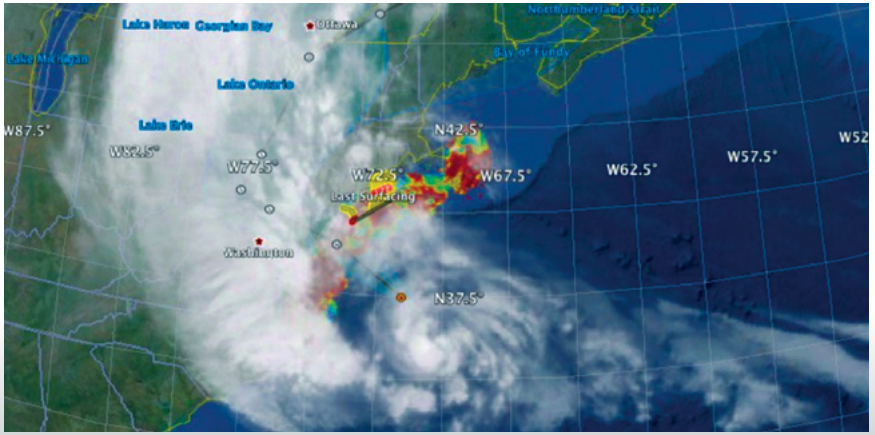
Over the last year, RUCOOL along with Woods Hole Oceanographic Institute and University of Rhode Island partners, outfitted gliders with passive listening sensors capable of detecting the presence or absence of migrating whales offshore New Jersey, in and around the Ørsted Ocean Wind lease site. Partnerships with Ørsted have grown over the past year with a multi-million dollar fisheries monitoring project. This collaborative project between Rutgers and Monmouth universities will conduct shellfish and fin fisheries surveys that will encompass before, during, and after construction of platforms in the Ørsted Ocean Wind farm and will include both traditional extractive surveys (clam dredge, benthic trawl) with non-traditional, non-extractive surveys (glider-based acoustics and telemetry, eDNA). Finally, members of RUCOOL are launching recently funded New Jersey and New York state projects to support the responsible implementation of offshore wind energy in the waters off their respective coastlines. These projects will provide data relevant to ongoing environmental and ecological change in our region and produce seasonal resolution data for physical (Cold Pool), chemical, and biological variables spanning from phytoplankton and zooplankton to pelagic fish and marine mammals. Graduate students in the Rutgers Masters of Operational Oceanography program will use these data to develop data products and conduct hypothesis-driven research. The growing number of Rutgers offshore wind related projects are summarized in this website that was launched this past year: **rowlrs.marine.rutgers.edu**

10 Years Since Sandy

As Superstorm Sandy approached the New Jersey coast, a Rutgers glider deployed off Tuckerton by one of our graduate students provided an ominous warning. The cold bottom water, known as the Mid-Atlantic Cold Pool, had mysteriously vanished from the New Jersey coast, eliminating one of state's natural defenses against hurricanes. Despite the importance of this information, there was no established pathway to communicate these critical observations to the National Hurricane Center where the official forecasts are generated. The unknown dynamics of what happened to the Cold Pool as Sandy approached, the widespread lack of ocean data in landfalling hurricanes, and the lack of a communication pathway to government operational forecasting centers prompted a decade of Rutgers innovation, research and education.

Hurricane Sandy approaches the Mid-Atlantic's ocean observatory operated by RUCOOL. High-Frequency Radar (HFR)-derived ocean surface currents (colored areas) and the location of Rutgers glider RU23 (yellow glider tail) deployed on the strong side of the approaching hurricane are shown below.

Over the next decade, our Rutgers scientists and their graduate students developed a fundamentally new understanding of how the rapid evolution of the coastal ocean feeds back on hurricane intensity. We worked alongside government modeling teams to ensure that the essential ocean features and processes impacting hurricane intensity identified in our research are



properly represented in our nation's operational models. We designed, deployed and demonstrated the value of "Hurricane Gliders" with new storm-response sensing capabilities in multiple hurricanes. A glider Data Assembly Center (DAC) was built by RUCOOL software developers to enable the real-time data flow from any deployed glider to the government's operational centers where the ocean data is assimilated by the hurricane models. And we worked to coordinate hurricane gliders with partners distributed along the U.S. East Coast, Gulf Coast, and Caribbean islands. This ongoing hurricane season marks the fifth year that the U.S. Hurricane Glider fleet has operated to improve national hurricane forecasts by providing official government models over 100 times more real-time ocean data than was available during Sandy.

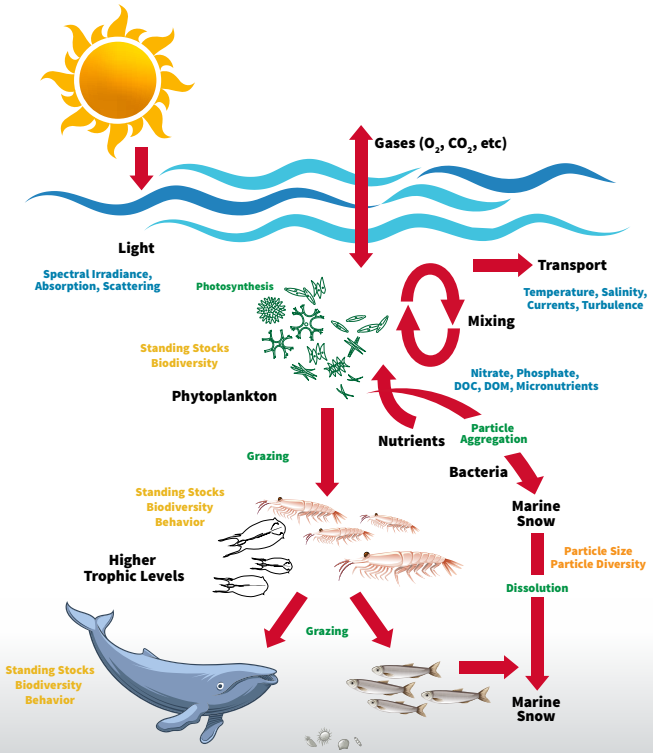
New Ways to Explore the Ocean

While the last half century has been a history of developing underwater robotic platforms, the next 50 years will focus on increasing the range of measurements that can be made from these autonomous systems. To this end, RUCOOL has been leading the community in developing a new generation of sensors to measure a wide range of physical, chemical, and biological variables. RUCOOL has been developing new tools that can measure plankton concentrations, size and health; fish and whale presence; and ocean acidification. The new sensors, mounted on gliders, are changing what can be measured and will help society to responsibly manage natural resources and promote a vital new blue economy.

Scholarly Leadership

Congratulations Grace Saba!

Grace Saba was granted tenure by Rutgers in Spring 2022, recognizing her global leadership in biological oceanography with cutting edge research spanning our ocean planet. Beyond her research on ocean acidification and fish ecology, Rutgers recognized Grace as one of the most dedicated and talented teachers on campus. Of particular note was that over the last Five years, Grace has mentored 31 undergraduate interns in her laboratory. The significant effort in guiding undergraduate research reflects the importance Grace puts on transforming students into hands-on scientists. Her well-deserved promotion reflects Grace's scholarly leadership and we are ***so excited*** she is on our team!



Scholarly Leadership *(continued)*

Building a Global Ocean Observing Network

Building this network took a big step forward last year with the announcement of the investment of a global array of profiling floats that are capable of measuring the physical, chemical, and biological properties throughout the global ocean. This new Bio-Argo array will be anchored with the deployment of ~700 floats globally. Oscar Schofield, part of the international science team, was co-chair of a global virtual meeting hosted by the G7 nations. A full update of the program is outlined in an overview manuscript published in the *Eos Journal* (**https://doi.org/10.1029/2022EO220149**).

Global Climate Change

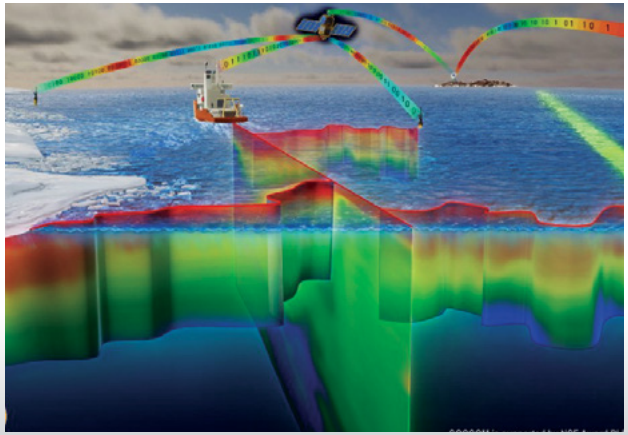
Despite the pandemic, the National Science Foundation's Palmer Long Term Ecological Research (Palmer LTER) program was able to conduct a field expedition along the West Antarctic Peninsula, a region experiencing some of the most rapid warming on the planet. The 8-week expedition was extended for an extra 3-weeks, which enabled scientists to quarantine before the start of the expedition. The Palmer LTER has been building on over three decades of long-term research at its site along the western side of the Antarctic Peninsula to gain mechanistic and predictive understanding of ecosystem changes in response to natural climate variability, long-term climate change, species exchange and loss, food web alterations, pollution, and overexploitation of living marine resources. This project is providing insights into the future of polar systems for this warming planet.

National Leadership

RUCOOL scientists have been chosen, based on their leadership, to serve on numerous national and international steering committees. Scott Glenn has been serving the NOAA Science Advisory Board and the NOAA Environmental Information Services Working Group, both of which are designing the future of the U.S. National Weather Service. Oscar Schofield was chair of a National Academy of Sciences review of the National Science Foundation's polar program and is serving on the Federal Advisory Committee guiding the development of the U.S. Integrated Ocean Observing System for NOAA.

For the People

The Gulf Research Program (GRP) of the National Academies of Sciences, Engineering and Medicine (NASEM) announced in March a $5.4 million grant to the Gulf Consortium for Offshore Risk Reduction Engaging Stakeholders (GulfCORES). The consortium is led by Texas A&M University with Rutgers as a core member supporting the team's HF Radar, glider, hurricane and ocean forecast model transition efforts. Quoting GulfCORES lead PI Steve DiMarco, "Because of the decades-long experience in providing observations that are critical to accurate and reliable forecasts, we have a dream team positioned to improve the well-being of the Gulf of Mexico community." Also this year, RUCOOL received an award from Rutgers Global to extend the Rutgers-Texas A&M partnership to Cuba's Institute of Meteorology and deploy the first HFR



in Cuba, creating an international collaborative network with two additional HFRs the partnership is already operating in Mexico. The HFR network will monitor a choke-point in the global ocean conveyor belt that affects our climate and will contribute to the humanitarian mission of improved hurricane forecasting for the U.S., Mexico, and Cuba.

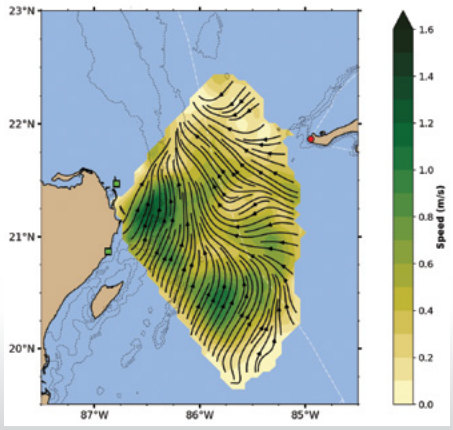
Community Engagement, Beloved Community

Safety at Sea

Lt. Shawn Antonelli is the Command Center Chief for Sector Delaware Bay where he is the search and rescue mission coordinator for the sector. The United States Coast Guard answers approximately 45 search and rescue cases each day. Having the best environmental data to predict the trajectory of items lost at sea is of critical importance. By maintaining the world's largest High Frequency Radar Network, RUCOOL allows for advanced mission planning when conducting a search. The network has been shown to significantly reduce the search area for the Coast Guard which directly translates to a higher probability of a successful rescue.

Forecasting Waves

Understanding the ocean wave field is critical for a range of safety considerations. Rutgers continues to develop the wave measurement capability of its High Frequency Radar (HFR) network. Currently three 13-MHz HFR stations report hourly wave measurements. Recently the Weather Forecast Office Philadelphia/Mt Holly used the radar-estimated wave measurements in an operational weather forecast. Lead forecaster Sarah Johnson was using the HFR wave data to verify that a small craft advisory was necessary on October 6, 2021, when seas were above five feet. Quoting Sarah, "As is often the case with these tropical systems, the guidance tends to hang on to the higher waves a little bit longer than what actually happens. So we still had the small craft advisory up." By October 5, Hurricane Sam was northeast of Newfoundland. The closest it came to New Jersey was on October 3, at 8:00 a.m. Sarah used the HFR wave data to build her confidence to cancel the small craft advisory. The HFR stations had better spatial coverage than the three buoys in the forecast area.



30 Years of Oce

Fred Grassle
Joins Rutgers with a vision of ocean telepresence

Henry Stommel
Had a vision of Omnipresence

Allan Robinson
has a vision of ocean models linked to observation

Graduate Students

Mike Crowley

Hoyle Lee

Richard Styles

Sasha Tozzi

Josh Kohut

Trisha Bergmann

Zoe Finkel

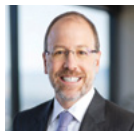
Felisa Wolfe Simon

Ramaya Ramadurai

Rachel Sipler

Hai Pan

Hank Statscewich



Joe Grymski

Louis Bowers

Matt Oliver

Alex Kahl

Awards

Statehouse Resolution 209

Naval Research Collaborator

Rutgers President Teaching/Scholar Award

Cook Team Award

Programs

Swarming Gliders

Biologi

Hudson River Dyna

Building Ocean Observing Networks

Ocean Forecasting

Building Novel Sensors

Ocean Sediment Transport

Coastal Ocean Optics

Glider Hardening

Gulf Stream Forecasting

Offshore Sea Breeze Forecasting

Littoral Battlespace

1985-89

1992

2002

Satellite Dish Installed
RUCOOL Begins!

LEO-15 Cable Installed

First AUV flight

1st CODAR

1st Glider

1st BiStatic CODAR

Wireless Networks

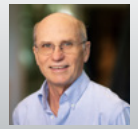
Iridium

Special Issue JGR

ONR Tech Center

1st Antarctic Glider

Faculty



Scott Glenn

Oscar Schofield

Josh Kohut

ean Exploration


Donglai Gong


Filipa Carvalho


Mike Brown


Joe Anarumo


Julia Engdahl


Sarah Murphy


Schuyler Nardelli


Sam Coakley


Courtney Dreyfus


Casey Jones


Laura Nazzaro


Xu Yi


Travis Miles


Greg Seroka


Nicole Couto


Cliff Watkins


Ted Thompson


Ailey Sheehan


Emily Slesinger


Tim Stolarz


Liza Wright-Fairbanks

Statehouse Recognition of COOL

Carnegie NJ Teacher of 2010

arlet Knight Crossing

DHS Impact Award

Statehouse Resolution 144

2 SEBS International Awards

MTS Fellow

MTS Young Professional

ASLO Hutchinson Award

SEBS/NJAES Team Excellence: Twice!

National Education Outreach

Ocean Cyberinfrastructure

Mid Atlantic Ocean Observing

Climate Change in Antarctica

cal Ocean Forecasting

Global Exploration Expeditions

mics

Ship Detection

Building Novel Ocean Sensors Continued

Wave Power Tech

Polar Foodweb Changes

Expanding Coastal Current Network

Offshore Wind Energy

NJ Offshore Wind Forecasting and NJ Coastal Water Quality

Improving K-12 Ocean Education

Increasing Polar Literacy

30 YEARS!

2012

2022

RU27 Atlantic

Irene

Sandy

Special Issue CSR

RUCOOL Becomes a Center

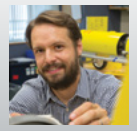
1st OA Glider

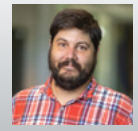
Operational Oceanography Masters

Milestones


Janice McDonnell


Grace Saba


Travis Miles


Alex Lopez

Community Engagement, Beloved Community

Recovering from the Pandemic: Summer Science Programs Back at Rutgers!

K-12 summer education programs at Rutgers were in full swing. After years of disruption and uncertainty, in-person learning returned to Rutgers campuses. Rutgers 4-H Youth Development programs and Rutgers faculty have worked together to prioritize social, emotional, and academic development to young people across New Jersey.

STEM Ambassadors Program

Since 2009, the STEM Ambassador program has engaged Rutgers scientists and engineers from all campuses each year to participate in mentorship and educational activities focused on supporting the development of STEM identity in underrepresented youth from Passaic, Union, Mercer, Essex, Middlesex, and Atlantic counties. These youth then act as Ambassadors in their communities teaching and mentoring younger children at local YMCA and Boys and Girls Clubs, reaching thousands of youth over the course of the year. This summer a record breaking 38 scientists mentored 48 rising 8th and 9th graders from New Jersey's urban centers in Trenton, Newark, Passaic, New Brunswick, Union, and Atlantic City.

Polar Adventure Curriculum

A National Science Foundation project exposed students to a series of online explorations that highlight the research of nine different polar research scientists. Youth engaged in learning about the polar regions through data interpretation and then creatively communicating polar science through a Data Jam. Students were part of the science team of polar researchers,with engagement through face-to-face interactions, videos and hands-on additions to the online learning environment. Upon completion of each module, youth received a digital badge to celebrate their accomplishment. The polar adventure included: **Pack Your Bags! Let's go to the Poles**: Youth learn about the polar regions and reflect on what they would need being a member of a polar research team. **Explore Ice**: In this module, youth learn about glaciers and their changes. **Life in the Extremes** has youth learn about life in extreme conditions in the polar regions. **Data to the Rescue: Protist Placement!** Youth learn about protists in Antarctic lakes. The Polar Literacy Initiative delivered programming to more than 461 people through 15 implementations between Summer 2021 and Winter 2022. Those activities took place across a diversity of settings and formats. Of the 119 youth, for whom demographic data was obtained, 71% were underrepresented minorities and 56% were female.

Involvement in New Jersey Library Programs

The outreach group has coordinated with graduate students and faculty that have been acting as ambassadors in New Jersey community libraries, whose theme for their summer reading program was “Oceans of Possibilities.” The graduate students, faculty, and staff have conducted more than 15 library programs focused on ocean science throughout the state this past summer.

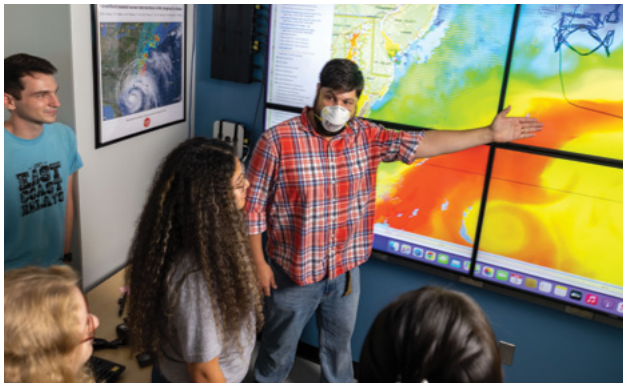
RUCOOL is Proud to Announce the Release of the 2022 4-H STEM Challenge – Explorers of the Deep

This STEM-focused kit was developed by a team of educators and oceanographers in the Department of Marine and Coastal Sciences and the Department of 4-H Youth Development. The kit focuses on the mysteries and adventures of ocean exploration – with ocean robots! Activities were designed to develop observational and critical thinking skills while exploring the interconnected nature between the ocean and humans, regardless of where they live. Kids learn foundational STEM skills while they wrestle with the same questions as today’s top oceanographers and scientists. Activities can be done all at once or individually, making the kit a great resource for classrooms, after-school programs, clubs, families, and more.

RUCOOL Student Experiences

Alexander Lopez who Joins RUCOOL as a Dedicated Teaching Faculty!

Alexander Lopez is taking over as the leader for the new Masters Operational Oceanography program coordinated by RUCOOL. Alex received a B.S. in Physics from The College of New Jersey in 2010, and a M.A. in Teaching in 2011, from The College of New Jersey. He received a Ph.D. from Rutgers, studying ocean circulation and transport pathways on the Mid-Atlantic Bight and Gulf of Maine using numerical models. He then served as a postdoctoral scholar at the Pennsylvania State University, studying microplastic particle fate within Chesapeake Bay.



Big Year for RUCOOL Graduate Students Finishing their Degrees

This was a great year for the RUCOOL graduate students. Three Ph.D. and three masters degree students graduated. Congratulations to Emily Slesinger (hired by NOAA NMFS), and Liza Wright-Fairbanks and Schuyler Nardelli (both awarded the competitive NOAA Knauss Fellowships). Our Operational Oceanography masters students: Ailey Sheehan took a technician position at Rutgers Bivalve Field Station, Theodore Thompson took a position at the U.S. Geological Survey, and Sam Coakley joined the U.S. Climate Variability and Predictability Program.

RUCOOL Mission

RUCOOL is creating knowledge of our ocean planet by pushing the limits of science and new technologies while inspiring future generations of ocean explorers, under eight core focus areas:

Research Focus Areas

Hurricane Science

The RUCOOL Hurricane Science team develops and uses advanced observing technologies and models to better understand coupled ocean-atmospheric processes in tropical cyclones.

Offshore Wind

The RUCOOL Offshore Wind team develops and advances the science that informs decision-making around offshore wind, both at a state and national level.

Polar Science / Palmer LTER

RUCOOL scientists are engaged in polar research using both regional and global climate models, and via large collaborative efforts that utilize undergraduate and graduate fieldwork.

Ocean Acidification

The RUCOOL Ocean Acidification team develops and uses advanced observing technologies to address hypotheses related to identifying and evaluating the drivers of acidification.

Ocean Pollution

RUCOOL conducts a combination of laboratory and field studies to investigate the fate and transport of microplastics in the marine environment to inform potential mitigation strategies.

Fisheries

RUCOOL integrates observations with laboratory and field research to investigate fishes and their habitats to improve stock assessment models and guide existing and future management decisions.

Empowering the Next Generation

RUCOOL is innovating education practices to enable all humanity to be active explorers of their ocean planet, and to develop the next generation of ocean scientists and engineers.

Integrated Ocean Technology

RUCOOL develops and operates state-of-the-art ocean sensor technologies, integrating their data products together to get the most comprehensive 3-D view of the ocean possible.

36
ACTIVE AWARDS
(grants, donations, cooperative agreements)

42 Deployments
22,123 kilometers flown
1133 days at sea

233
UNDERGRADUATES
taught per year

25
COUNTRIES
visited RUCOOL

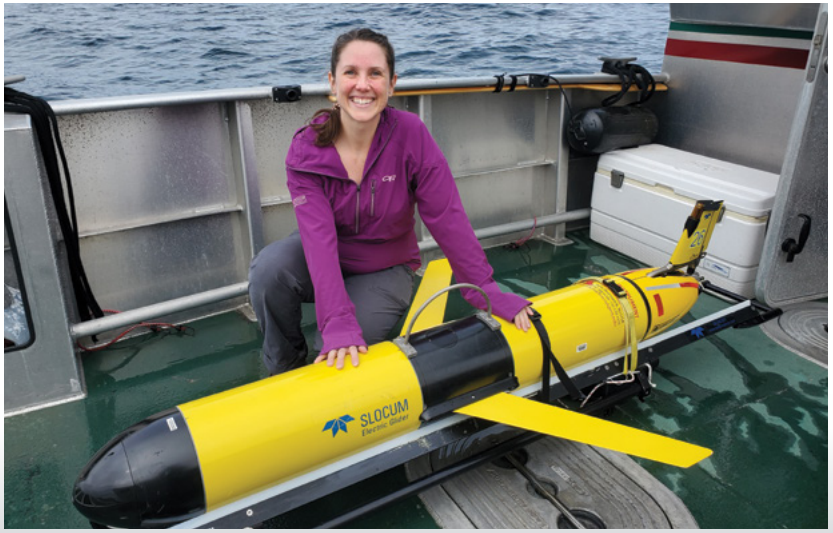
37
Peer Reviewed Publications

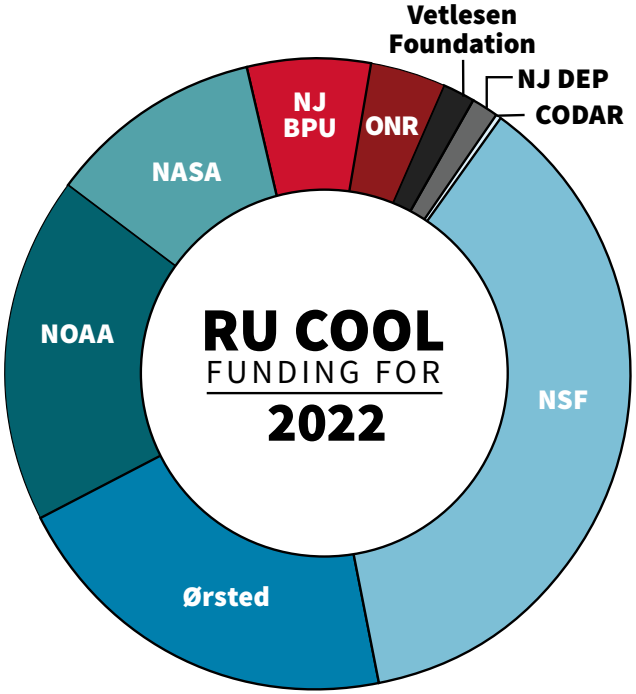
Surface current coverage
172,000 KM^2

$8.9
MILLION
in funding per year

270
COLLABORATORS
140 institutions, 22 countries

15
GRADUATE STUDENTS
annually





NSF $3.3M National Science Foundation

$1.8M Ørsted

NOAA $1.6M National Oceanic and Atmospheric Administration

NASA $975K National Aeronautics and Space Administration

NJ BPU $579K NJ Board of Public Utilities

ONR $336K Office of Naval Research

$150K Vetlesen Foundation

NJ DEP $136K New Jersey Department of Environmental Protection

$25K CODAR Ocean Sensors

RUTGERS
School of Environmental
and Biological Sciences

Department of Marine and Coastal Sciences
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