



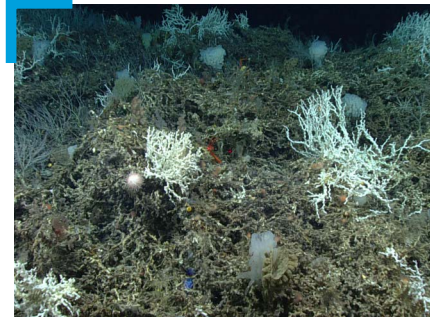
# EXPLORATION NOTES Underwater Robots

## The Challenges of ROV Operations at Sea

If these two forces are minimal, the dive supervisor and commanding officer usually give the “green light” for a dive. This is often not the case in the waters of the Atlantic off the Southeastern U.S. because of the Gulf Stream, which is a strong ocean current that extends along the eastern coast of the United States and Canada, bringing warm water from the Gulf of Mexico into the Atlantic Ocean.

For almost all the ROV dives during the 2019 Southeastern U.S. Deep-sea Exploration, the Gulf Stream was the predominant force on the ship. Surface currents such as the Gulf Stream affect the ship's ability to hold position during a dive and affect how the vehicles travel in the water behind the ship during launch and recovery. Since the Gulf Stream is such a large, consistent, and high-magnitude force, there are also subsurface currents that affect the ROVs during their descent, ascent, and throughout the dive while on bottom.

The ROV team on *Okeanos Explorer* uses an [Acoustic Doppler Current Profiler \(ADCP\)](#) to estimate surface and subsurface currents. The figures below show readings from the ADCP taken at a dive site that was deemed unsafe for dive operations on the day we were there. The figure on the left displays the surface current direction and magnitude, and the figure on the right displays the subsurface current profile throughout the water column. Although the 2.2 knots (2.5 miles per hour) of surface current are much higher than seen at a typical dive site, this alone did not lead to the decision to cancel the dive. With a

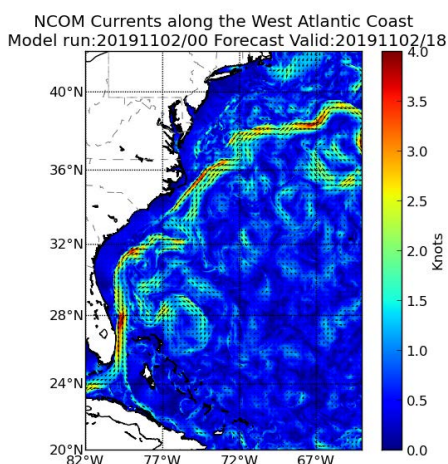


Marine life, such as Lophelia coral and glass sponges, was found to be both abundant and diverse on the Central Blake Plateau, an area through which the Gulf Stream passes. Image courtesy of NOAA Ocean Exploration, 2019 Southeastern U.S. Deep-sea Exploration.

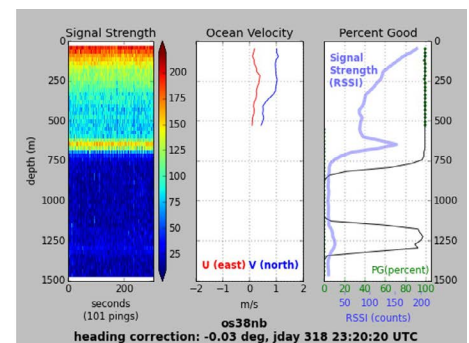
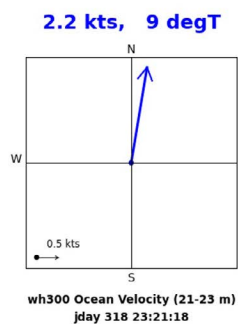
bottom depth of about 500 meters (1,640 feet), the subsurface current profile a current close to the bottom of about 0.5 meters/second (~1 knot, or 1.7 miles per hour). This situation is not safe for the ROVs, and so we made the difficult decision to cancel the dive.

### Why It's Worth It

The Gulf Stream is not all bad though! It is a big reason why these dive sites are so valuable to the scientific community (and so interesting for those who follow the dives online). The warm Gulf Stream currents bring nutrients and help sustain life like that found among the deep, dense, and diverse coral communities that we have documented throughout this expedition. With some of the imagery, samples, and data that have been collected at these dive sites, it is easy to see why diving near the Gulf Stream can be worth its challenges.



The Gulf Stream direction and magnitude is modeled by the U.S. Navy Coastal Ocean Model (NCOM), which is a high-resolution model that offers ocean current data at a 2 nautical mile (2.3 mile) resolution every 24 hours. The navigator, dive supervisor, and ship operators use this model output to roughly estimate expected currents at each planned dive site. Image courtesy of NOAA Ocean Prediction Center.



The conditions on November 14, 2019, were unfavorable for diving. The readings on that day from the Acoustic Doppler Current Profiler (ADCP) show the surface current direction and magnitude (left) and the subsurface current profile throughout the water column (right). Image courtesy of the NOAA Office of Marine and Aviation Operations.

### THINK ABOUT IT...

**Q:** Create a checklist or decision tree for the team to use when determining whether they can launch the ROV today.

Expedition: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/welcome.html>  
Deep Discoverer (image): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1811/dailyupdates/oct30/media/oct30-2-hires.jpg>  
Explorer Profile: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/background/explorers/explorers.html#ritter>  
Deep Discoverer recovery (photo): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/dailyupdates/nov2/media/rov-recovery-hires.jpg>  
Ships and *Seirios* (illustration): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1905/background/plan/media/telepresence-hires.jpg>  
Marine Life (photo): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/nov18/media/coral-hires.jpg>  
ADCP instrument (webpage): <https://oceanexplorer.noaa.gov/technology/acoust-doppler/acoust-doppler.html>  
Navy Coastal Ocean Model (photo): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/nov18/media/gulf-stream-hires.jpg>  
ADCP readings (photo): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/nov18/media/combinedadcp-hires.jpg>