

*Cruise Report*  
**2016 NOAA Ship *Pisces* Expedition to Carolina Canyons  
(PC-1605: August 24-September 4, 2016)**

By

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## **Introduction**

Submarine canyons continue to be areas of high interest to federal and state agencies tasked with research and management responsibilities, particularly those for deep-sea corals. Most canyons are poorly known, but based on data collected during previous investigations, many scientists and managers believe submarine canyons provide refuge for a variety of fauna including corals, fishes, and other animals.

Beginning on August 24, 2016, a multidisciplinary team of scientists and engineers (Table 1), aboard NOAA Ship *Pisces* spent 12 days-at-sea exploring three deep-water canyons off the coast of North Carolina. Specifically, the team targeted Keller, Pamlico, and Hatteras canyons.

With the overall goal of surveying suspected deep-sea coral habitats associated with these canyons using the AUV *Sentry*, the primary objectives for this mission were to:

1. survey canyon and inter-canyon slope environments to characterize benthic habitats and identify areas of coral presence;
2. conduct multibeam mapping in canyon and slope areas where data are missing or incomplete;
3. assess geological features to characterize canyon morphology;
4. conduct CTD sampling; and
5. collect water samples and monocoore samples during specific CTD casts.

This cruise marked the first of several missions scheduled to take place off the Southeast U.S. with the aim to collect contemporary scientific information needed by managers to protect and conserve deep-sea coral ecosystems. Several NOAA line-offices (National Marine Fisheries Service, Office of Ocean Exploration and Research, National Ocean Service), other government agencies (Bureau of Ocean Energy Management, U.S. Geological Survey), and regional resource managers are interested in deep-sea coral habitats in this region.

## **Narrative of cruise results**

Despite numerous challenges, the research team was able to address each of our objectives.

**Objective 1.** The research team completed three AUV dives between 700 and 1900 m depth, for a total of 50 hours of bottom time covering 71 km distance over ground (Table 2). Strong surface currents (4 knots) prevented the science team from surveying Keller Canyon. Further south and outside the direct influence of the Gulf Stream, AUV *Sentry* completed one successful dive in Pamlico Canyon and two successful dives in Hatteras Canyon (Figures 1-3). Based on the preliminary analysis of the >50,000 collected images, the team documented the presence of deep-sea corals and sponges in both of these canyons (Figures 4-5). Additionally, a variety of fishes, crustaceans and cephalopods were observed in many of the images. Furthermore, AUV *Sentry* collected optical backscatter, oxidation-reduction potential (ORP), dissolved oxygen and temperature data along the imaging path (Figure 5).

**Objective 2.** The research team mapped the head of Hatteras Canyon using the ship's ME70 multibeam system to generate maps of bathymetric features. Although numerous mapping

priority areas were identified, the ME70 was nonfunctional for the majority of the cruise. AUV *Sentry*, outfitted with sidescan sonar, collected bottom profile data during the three imaging deployments.

**Objective 3.** Images revealed a variety of habitats, including smooth canyon walls and flat sedimented plains. The morphology, and presumably the underlying geology, of these two canyons are quite different than that observed in canyons further north.

**Objective 4.** AUV *Sentry* collected CTD data during all imaging deployments (Figure 5). Additionally, seven CTD-Niskin casts were completed during the mission. Three casts were made at the Cape Fear landslide site; the remaining four casts collected water column data along the axis of Hatteras Canyon (Table 3).

**Objective 5.** Water and monocoar samples were collected during seven CTD casts (Table 3). A series of four core samples, taken along the axis of Hatteras Canyon, was collected at depth intervals comparable to those sampled in nearby Norfolk and Baltimore canyons. These cores, sectioned into layers, resulted in 74 samples. Additionally, 56 liters of water were filtered while at sea. Analyses of these sediment and water samples will provide information on the amount, composition, and quality of food available to benthic organisms living in the canyon environment. Further processing of these samples for isotope analyses will be conducted by personnel at USGS in Gainesville, Florida.

Due to poor weather conditions (tropical depressions passing through the study area) the ship traveled further south, outside the original study area. At this southern, more inland location, the science team collected three core samples at a landslide area off Cape Fear to support research interests of USGS colleague, Jason Chaytor. Analysis of these core samples will further understanding of sediment flows as well as provide better estimates of the timing of recent underwater landslides. These samples were shipped to J. Chaytor (USGS, Woods Hole, MA) for processing.

### **Outreach**

This cruise, designated a NOAA Office of Ocean Exploration and Research signature cruise, was highlighted on the OER website:

<http://oceanexplorer.noaa.gov/explorations/16carolina/welcome.html>.

Daily logs were posted while at sea. At-sea scientists engaged with students in North Carolina and Florida as well as answered questions posted to the website. Cruise highlights were also linked to the North Carolina Museum of Natural Sciences.

**Participant list****Table 1.** List of participants of 2016 expedition to the North Carolina Canyons aboard the NOAA Ship *Pisces* (PC-1605).

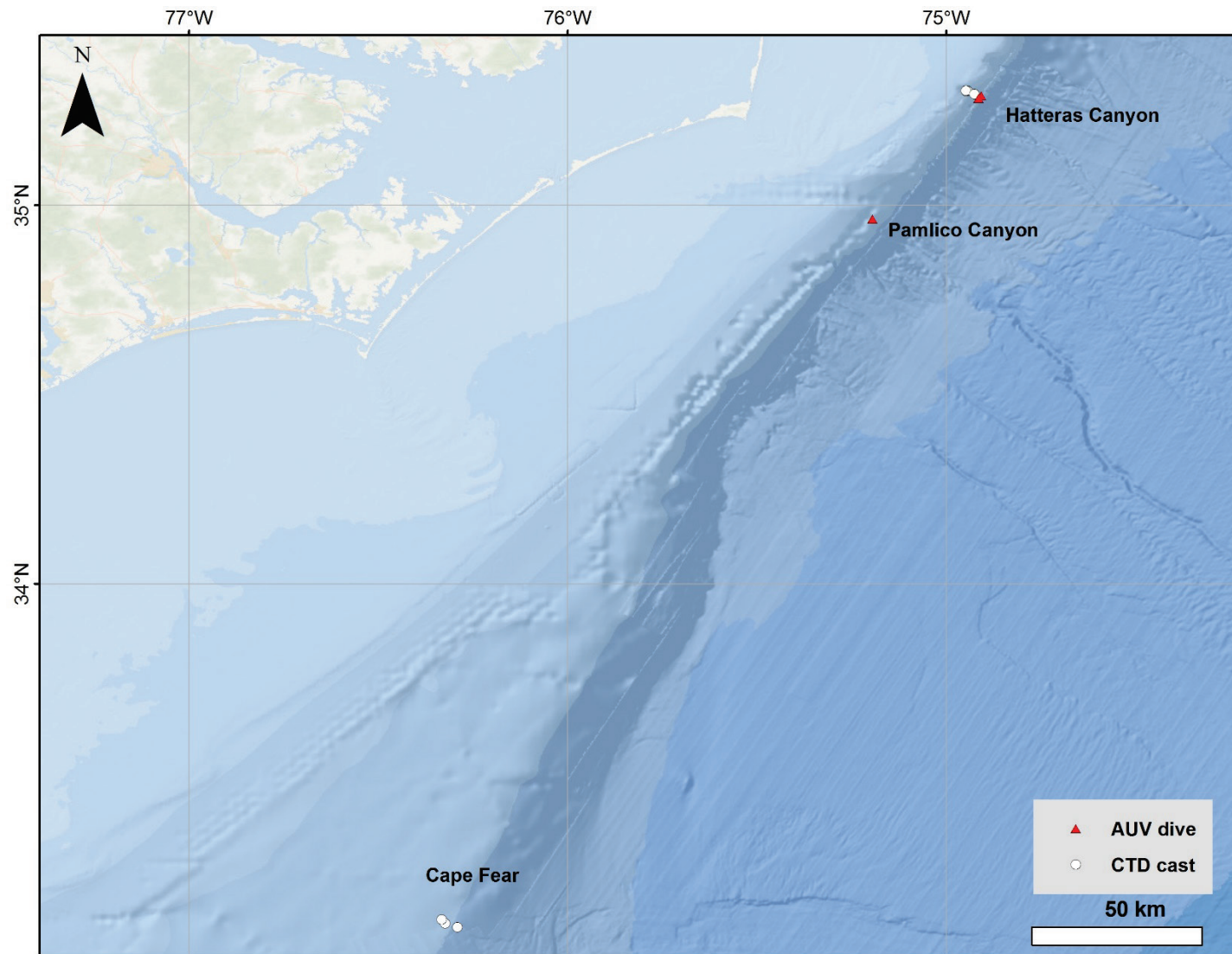
<b><u>Name</u></b>	<b><u>Role</u></b>	<b><u>Affiliation</u></b>
Martha Nizinski	Chief Scientist	NOAA National Marine Fisheries Service
Amanda Demopoulos	Scientist	United States Geological Survey
Elizabeth Shea	Scientist	Delaware Museum of Natural History
Elizabeth Baird	Science Educator	North Carolina Museum of Natural Sciences
Katie Wagner	Web Coordinator	NOAA Office of Exploration and Research
Shelby Bowden	Scientist	College of Charleston
William Hefner	Scientist	College of Charleston
Carl Kaiser	AUV <i>Sentry</i> team lead	Woods Hole Oceanographic Institute
Michael McCarthy	AUV <i>Sentry</i> team	Woods Hole Oceanographic Institute
Justin Fujii	AUV <i>Sentry</i> team	Woods Hole Oceanographic Institute
Zachary Berkowitz	AUV <i>Sentry</i> team	Woods Hole Oceanographic Institute
Molly Curran	AUV <i>Sentry</i> team	Woods Hole Oceanographic Institute

**Table 2.** Dive summary table for three AUV *Sentry* dives conducted during the 2016 expedition to the North Carolina Canyons aboard the NOAA Ship *Pisces* (PC-1605). Note that the dive number corresponds to the number assigned by the AUV *Sentry* team.

Locality	Dive no.	Start date (UTC)	Start time (UTC)	Start latitude	Start longitude	End date (UTC)	End time (UTC)	End latitude	End longitude	Bottom time (h:min)	Mean survey depth (m)	Distance surveyed (km)
Pamlico	391	2016/8/28	12:36:13	34.96415	-75.19467	2016/8/28	21:26:46	34.96050	-75.20728	8:51	964	12.83
Hatteras	392	2016/8/31	12:54:12	35.28972	-74.90775	2016/9/1	15:14:50	35.27373	-74.89338	26:21	1221	34.48
Hatteras	393	2016/9/1	23:08:41	35.28340	-74.91470	2016/9/2	14:01:54	35.27773	-74.90058	14:53	999	23.60

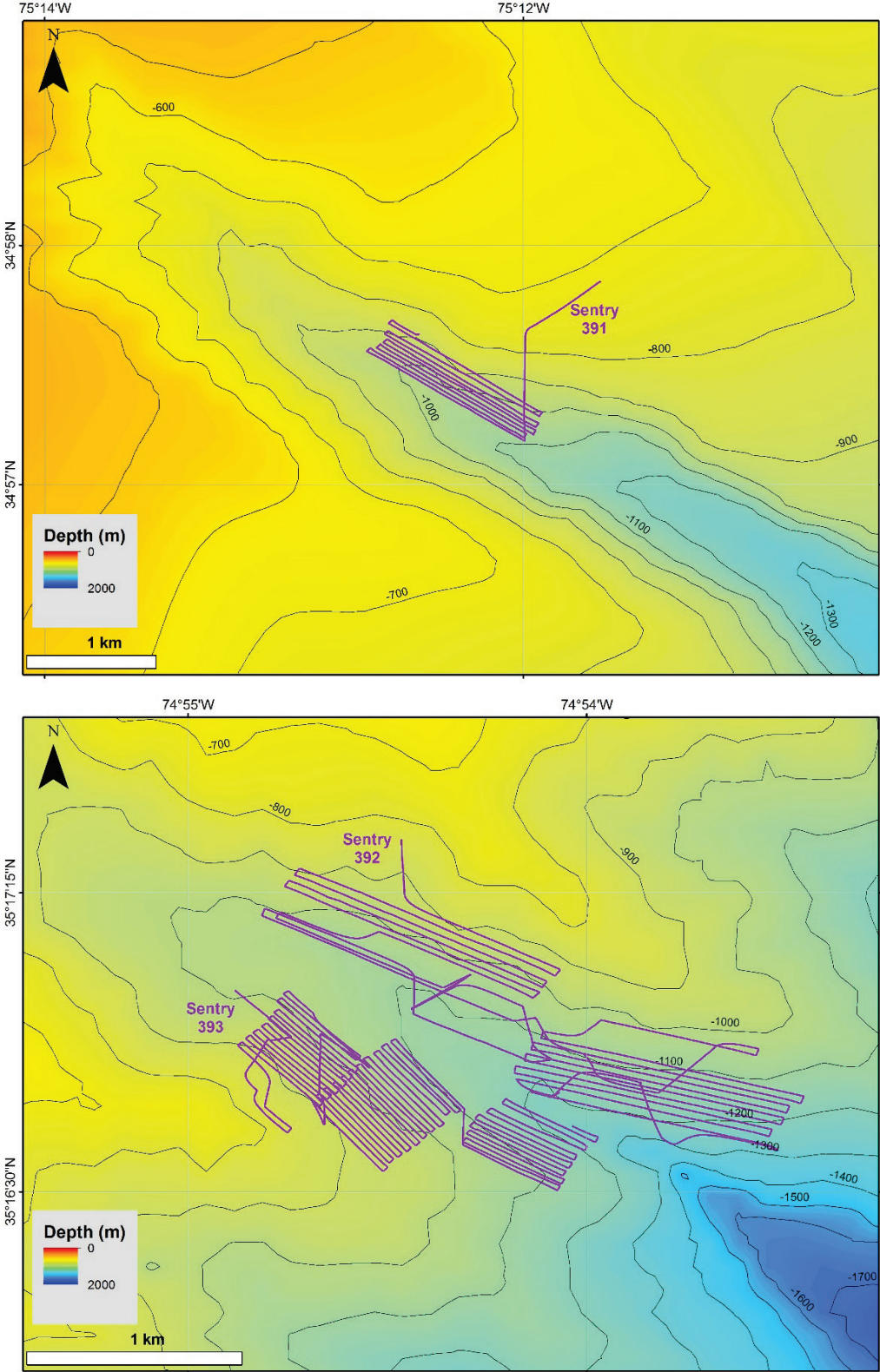
**Table 3.** Inventory of CTD casts conducted during the 2016 expedition to the North Carolina Canyons aboard the NOAA Ship *Pisces* (PC-1605).

Locality	Station	Date (UTC)	Time (UTC)	Latitude	Longitude	Max. depth (m)	Bottom temp. (°C)	Sound velocity (m/s)	Bottom pressure (dbar)	Bottom salinity (‰)
Cape Fear	CF1	2016/8/30	19:20:40	33.10268	-76.32427	932.04	4.582	1484.50	940.795	34.997
Cape Fear	CF2	2016/8/30	20:31:32	33.11217	-76.33388	893.71	4.602	1483.95	902.024	34.999
Cape Fear	CF3	2016/8/30	22:01:25	33.09281	-76.29133	1052.97	4.357	1485.59	1063.165	34.985
Hatteras	HC5-A	2016/9/1	17:27:00	35.30122	-74.94723	511.26	5.958	1483.11	515.637	35.049
Hatteras	HC5-B	2016/9/1	18:23:22	35.30310	-74.94398	522.43	5.798	1482.66	526.908	35.046
Hatteras	HC5-C	2016/9/1	19:23:14	35.30279	-74.94795	468.54	6.418	1484.24	472.499	35.068
Hatteras	HC8-A	2016/9/1	20:39:25	35.29435	-74.92593	766.03	4.894	1483.02	773.058	35.004

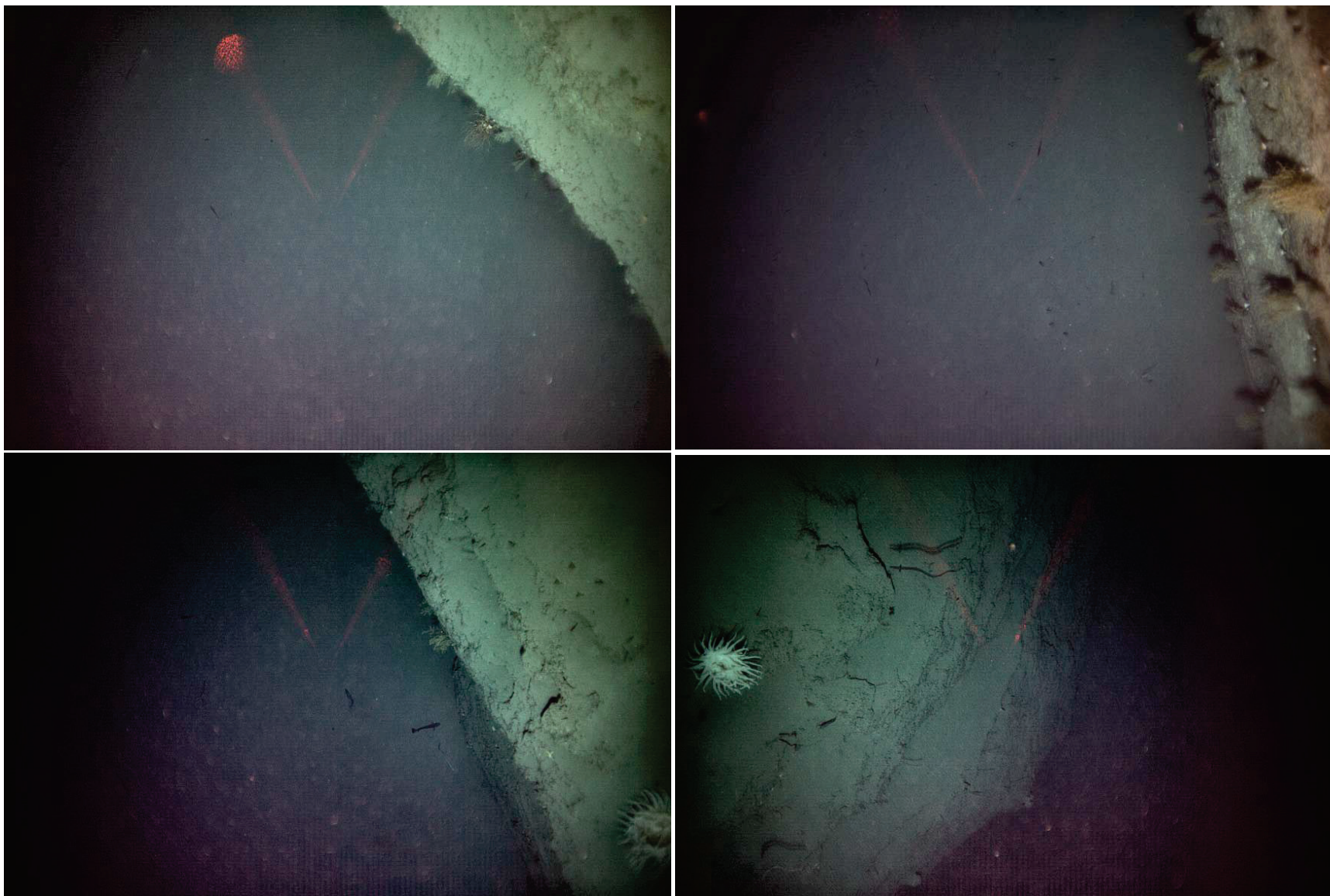


**Figure 1.** Map showing the locations of the three AUV dives and seven CTD casts conducted during the 2016 expedition aboard the NOAA Ship *Pisces* (PC-1605).



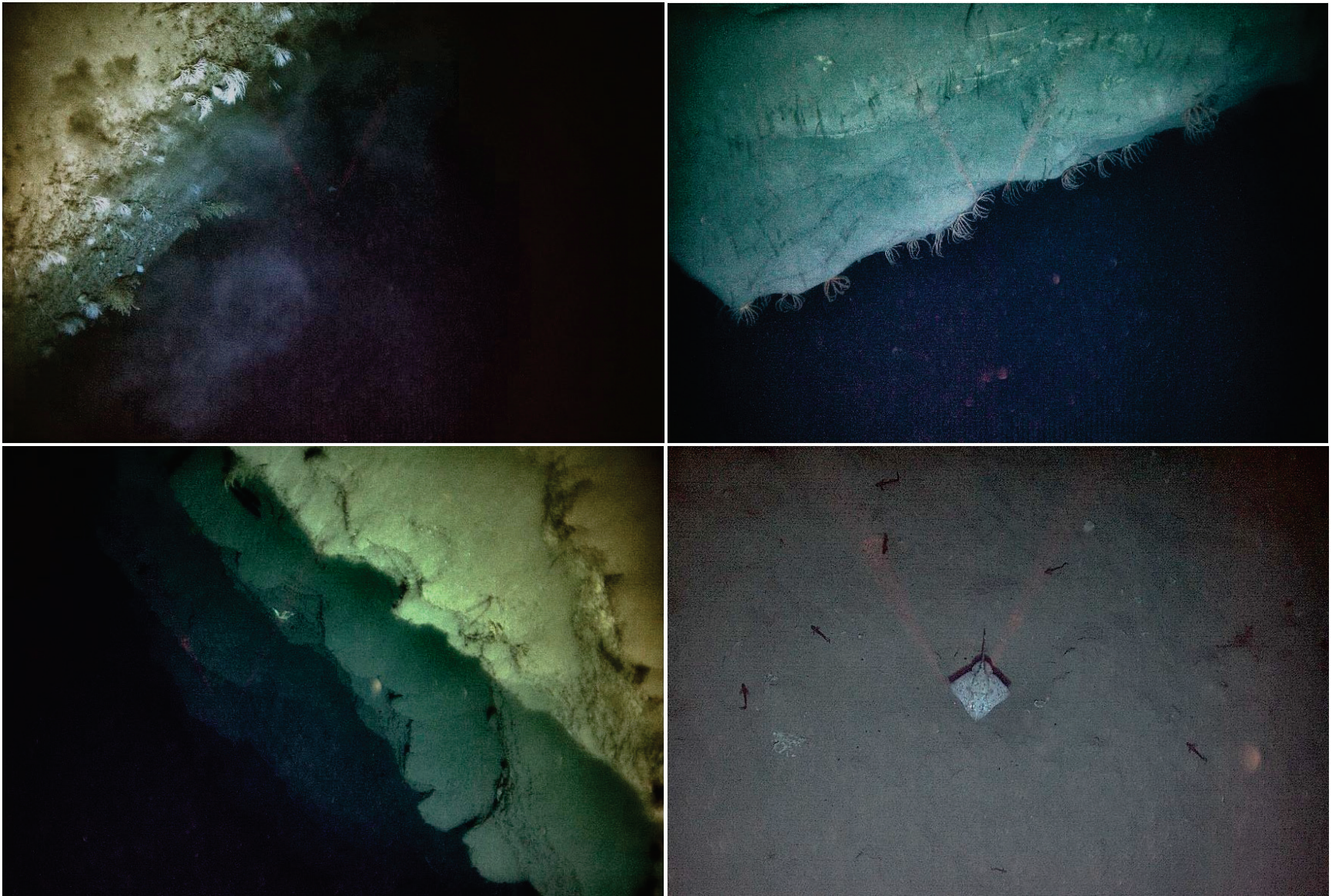


**Figure 2.** Dive tracks of the three AUV *Sentry* dives conducted during the 2016 expedition aboard the NOAA Ship *Pisces* (PC-1605) including (top) dive 391 in Pamlico Canyon, and (bottom) dives 392-393 in Hatteras Canyon. 100 m contour lines are shown in black.

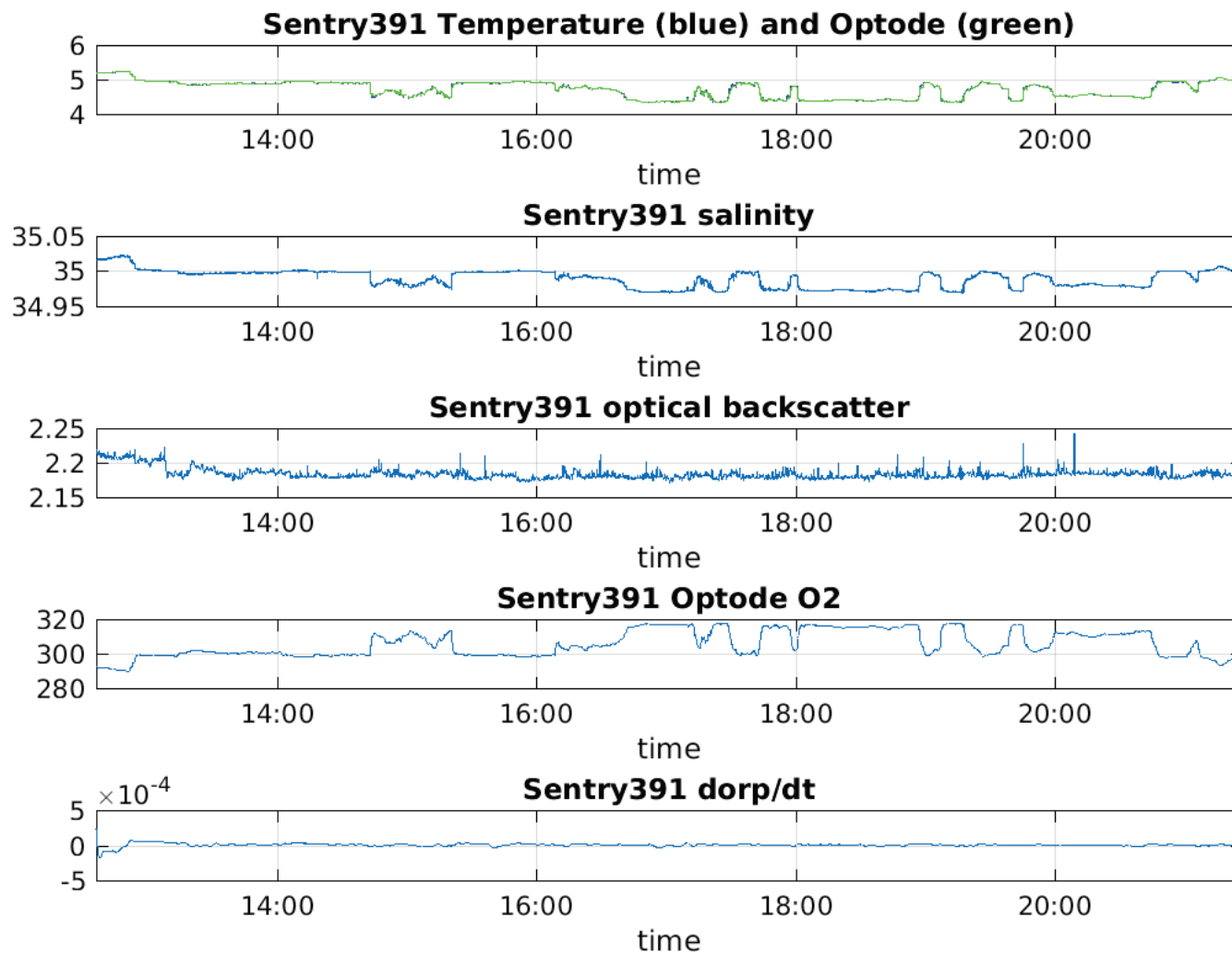


**Figure 3.** Bottom images taken by AUV *Sentry* in Pamlico Canyon during 2016 expedition aboard the NOAA Ship *Pisces* (PC-1605).





**Figure 4.** Bottom images taken by AUV *Sentry* in Hatteras Canyon during 2016 expedition aboard the NOAA Ship *Pisces* (PC-1605)



**Figure 5.** Time series plot of environmental data collected by AUV *Sentry* sensors during dive 391 in Pamlico Canyon. Plots are representative of the environmental data collected during the three AUV dives conducted during the expedition. From top to bottom: temperature, salinity, optical backscatter, dissolved oxygen, and oxidation-reduction potential (ORP).