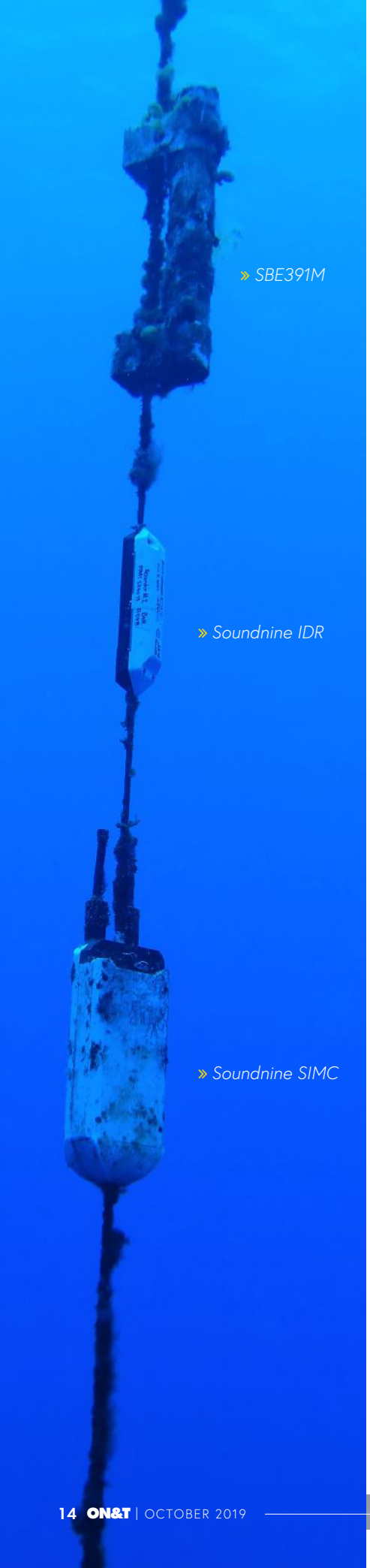


» SBE391M

» Soundnine IDR

» Soundnine SIMC

INDUCTIVE TELEMETRY AND INNOVATIVE MOORING DESIGN ENABLES COST-EFFECTIVE CORAL REEF MONITORING SYSTEM

Researchers at the University of the Virgin Islands (UVI) have long studied mesophotic coral reefs and fish spawning aggregations at the shelf break of the Grammanik Bank south of St. Thomas. Fixed bottom temperature measurements collected since 2005 showed variability at semidiurnal to interannual scales impacting coral and fish populations. More information was needed to understand the vertical structure, sources, and other characteristics of the observed fluctuations.

UVI and CARICOOS (the US IOOS Caribbean Coastal Ocean Observing System) recruited ocean observing consultants Caribbean Wind LLC to develop a water temperature monitoring system to resolve structure spanning the upper mixed layer and along-slope depths to 70 meters. The system required deployment and service using small boats, easy periodic data recovery by a diver without connecting to the mooring, and options to upgrade to real-time data reporting after a pilot deployment. Low power, low maintenance and affordability were also paramount, of course.

Caribbean Wind turned to Soundnine Inc., Kirkland, WA (S9) to develop a solution. S9 worked with Mooring Systems Inc., Cataumet, MA (MSI) to deliver the mooring components including subsurface float, vertical and horizontal wire rope sections and wire rope "Hammerhead" terminations. These cable terminations were coupled to a steel T-joint connected to the first anchor. A loop of steel cable electrically connected the two hammerhead cable terminations allowing inductive communications through both cable sections. (Figure 1, inset photo).

Soundnine (S9) previously developed advanced underwater inductive telemetry products including modems, buoy controllers, inductively coupled sensors and small turnkey buoy systems. S9 leveraged its existing technology to create new instrumentation; a Subsurface Inductive Mooring Controller (SIMC) and Inductive Data Recorder (IDR). The SIMC clamps to the mooring wire, coordinates sampling inductively and logs instrument data. It also includes two serial ports to enable integration with ADCPs or other instruments. The SIMC is powered by a rechargeable battery pack that can be replaced underwater. The IDR, powered by a single AA lithium cell, also clamps to the wire and records all the inductive communications between SIMC and the sensor array, creating a backup data set.

The key to making the system diver-serviceable is the location of the SIMC and IDR just below the surface float at 20 meters. Periodically, a diver equipped with a spare IDR simply swaps a new recorder for old (4 screws each, a 10-minute job). Sensor data are retrieved from the IRD's memory card on shore. About once a year, a diver swaps the SIMC battery pack with a freshly charged one.

Conveniently, the university had three Sea-Bird Electronics SBE 39-IM temperature recorders and one SBE 37-IMP MicroCat CTD. S9's inductive telemetry system is fully compatible with these Sea-Bird inductively coupled instruments. Because of their weight, the Sea-Bird instruments were distributed along the vertical mooring line from below a subsurface float to just

above the T-connection. The horizontal mooring line held four S9 Enduro AT sensors (reporting temperature and three axis accelerometer data) and an Enduro APT, which also includes a pressure measurement. These were distributed along the 80-meter downslope section as seen in Figure 1. The downslope section is anchored at the terminal end and sets of small fishing floats every 3 meters on the cable kept it suspended approximately 1 meter off the bottom, not impacting any corals in the path.

The power-efficient SIMC, Enduro sensors and Inductive Data Recorder have deployment endurances of 2+ years when each instrument is queried consecutively at 15-minute intervals. Technicians configured the SIMC to initiate sampling and retrieve data from all instruments on the two wire-rope sections.

The mooring was deployed 25 July 2018. Divers lowered the anchors (500- pound main, 250-pound secondary) into place with buoyancy bags. The most recent IDR recovery on 29 July 2019 completed a nearly year-long data set. (There was a two-week gap in March 2019 for a preventive SIMC battery replacement and delays in redeployment.) Data return was excellent, although one Enduro (APT) stopped reporting 7 months after deployment (February 2019).

The most notable data feature is the presence and amplitude of the semidiurnal variability in salinity and temperature. When present – in warmer months, below the upper mixed layer – temperature and salinity at a fixed depth can fluctuate as much as 2 PSU and 2° C (Figure 2). The temperature fluctuations tend to keep the mesophotic corals from being constantly subjected to dangerously warm upper ocean summer temperatures in excess of 29° C .

Future Upgrade

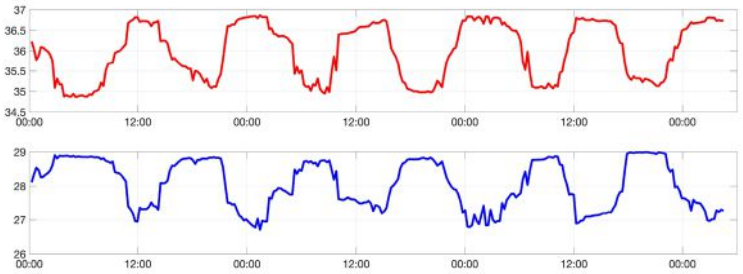
The mooring is scheduled to be upgraded to real-time reporting in early 2020. Divers will add a third wire rope section connecting the deep anchor to a Soundnine Ultibuoy, which will transmit data via cellular modem. The Ultibuoy system consists of a small surface buoy, wire rope mooring, solar-powered buoy controller with inductive modem, GPS and cellular or Iridium telemetry modem and software. Data are delivered to the users' desktop via S9's cloud-based data servers.

Summary

The S9 inductive controller, sensors, and recorders with MSI mooring connectors provided an innovative, robust, low-cost, low-power solution in this instrument string monitoring system. The equipment proved itself in this application by providing accessible low-maintenance long-term temperature and salinity monitoring for coral researchers studying effects of warming ocean temperatures in the US Virgin Islands.

» *MSI T-joint & Hammerheads*

» *Figure 1*



» *Figure 2 - Example of typical semidiurnal fluctuation of salinity (red) and temperature (blue) recorded during September 2018 at 44m depth.*

Authors:

Doug Wilson, Oceanographer, Caribbean Wind LLC
email: doug@coastaloeanobs.com

Doug Bennett, Vice President, Soundnine Inc.
email: doug@soundnine.com