Integrated Management of the Ocean: HAB Detection and Prediction at the Naples, Florida NWLON Station, 2007-2009

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1 Background

Sensor technologies for harmful algae detection have been developed and employed throughout the Gulf of Mexico and other regions to aid in harmful algal bloom (HAB) identification, bloom forecasting, and early mitigation of potential public health, economic, and ecological impacts. To mitigate the impact of the toxic harmful algae *Karenia brevis*, in 2005 NOAA's National Ocean Service (NOS) formed the Global Leadership in Integrated Management of the Ocean (GLIMO) Partnership entitled "Red Tide Prediction to Benefit Public Health and Coastal Economies." Among the numerous project objectives were the integration of new technologies with existing observing systems and a cost-benefit analysis of biological sensor enhancements to NOS water level and coastal meteorological stations. To support these objectives, the NOS Center for Operational Oceanographic Products and Services (CO-OPS), in partnership with several other NOAA offices, Mote Marine Laboratory (MML), Naval Research Laboratory, and the University of South Florida, implemented a demonstration project to test the BreveBuster, an optical phytoplankton discriminator developed by MML. The BreveBuster was installed at the Naples, FL NOS National Water Level Observation Network (NWLON) station in February 2007.

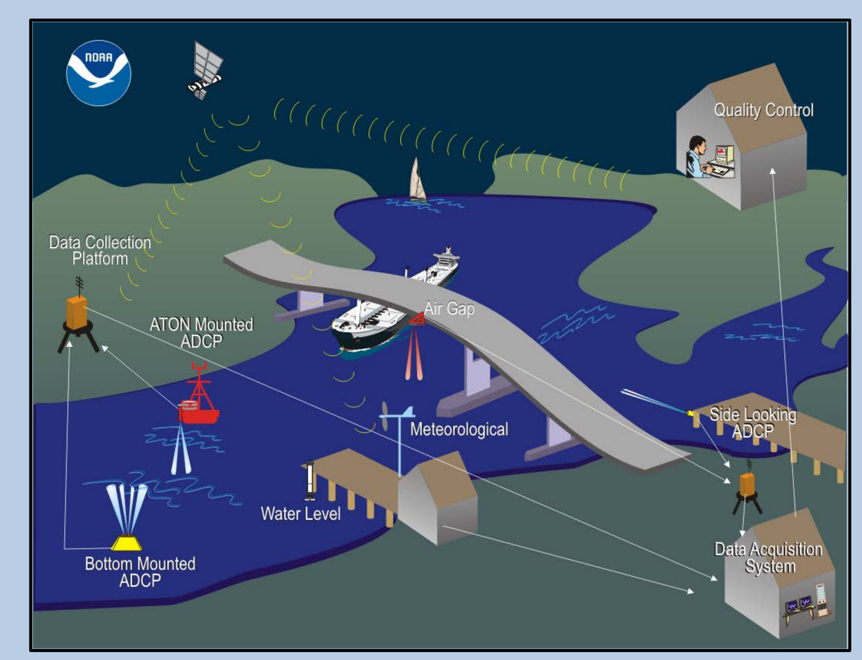


Figure 2: *left*: side view of BreveBuster at the top of the mount, before lowering the sensor into the water; *right*: NOAA data telemetry network

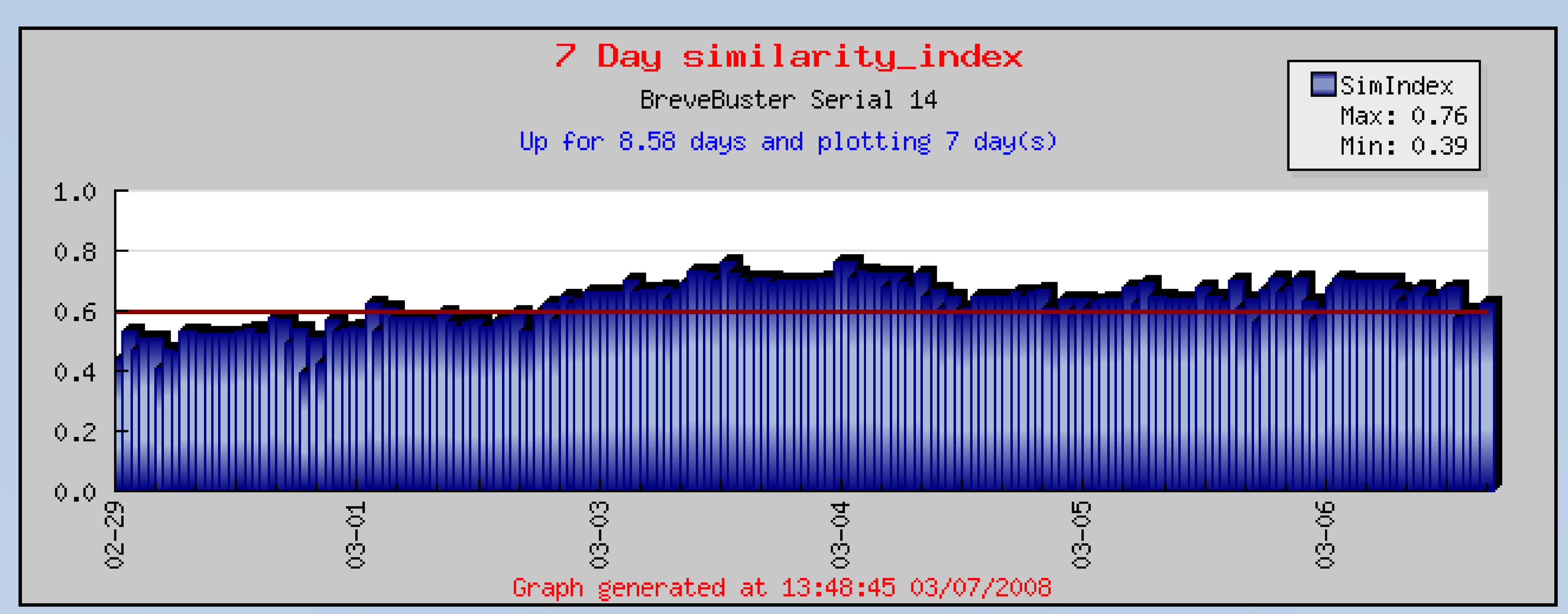
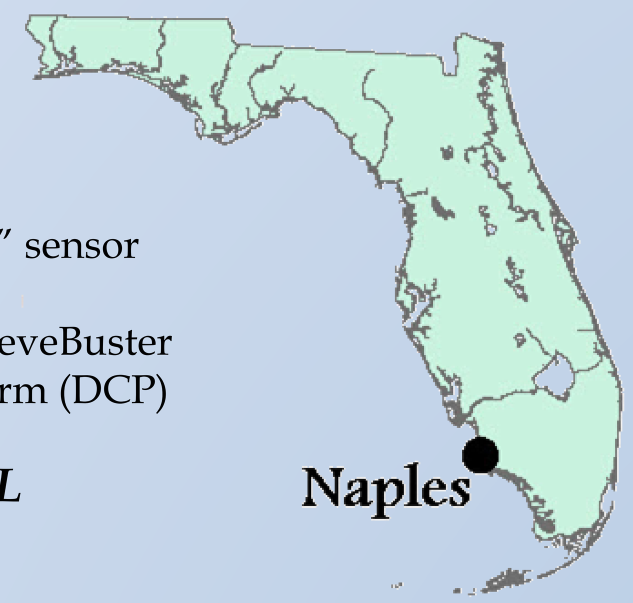


Figure 3: Plot of BreveBuster similarity index values from February 29 to March 7, 2008. Similarity index values between 0.6 and 0.8 indicate that *K. brevis* is a significant fraction of the phytoplankton community biomass present.

2 Project Overview



Pre-Deployment Preparations:

- field reconnaissance and site selection
- sensor mount fabrication
- functional testing of the HAB "BreveBuster" sensor by CO-OPS, MML, & Sutron Corporation
- development of software to interface the BreveBuster with the Sutron Xpert data collection platform (DCP)

Site Selection: ***Naples Pier - Naples, FL***

Project site selected for the following reasons:

- past frequency of HAB events in the area
- proximity to shallow water and MML (for sensor maintenance reasons)
- presence of the Naples NWLON station at the pier enabled:
  - CO-OPS personnel to check system during routine maintenance visits
  - testing of system integration with the existing CO-OPS observation network

Installation: ***February 25, 2007***

- BreveBuster sensor was successfully installed at the Naples Pier in Naples, Florida (Collier County) by CO-OPS and MML on February 25, 2007.
  - required equipment: BreveBuster sensor, mounting platform, related hardware, and the Sutron Xpert DCP

Operations: ***February 2007 to June 2009***

- a BreveBuster was deployed at the site from February 2007 to June 2009
- sensor data was stored on the DCP and transmitted to CO-OPS FTP via the Geostationary Operational Environmental Satellite (GOES) system
- data were available to the public via a public FTP site and through the MML website
- the sensor was swapped regularly for routine maintenance, trouble-shooting, and instrument upgrades

3 Instrumentation

The BreveBuster sensor, an optical phytoplankton discriminator developed by MML, measures the optical absorbance characteristics of the surrounding sea water to detect the presence of *K. brevis*, the algae responsible for the "red tide" phenomena. Each hour, a water sample is pumped into the instrument and through a liquid waveguide capillary cell (LWCC), and illuminated with a light source. The BreveBuster optically detects *K. brevis* blooms by comparing light absorption by particles in ambient water to the light absorption fingerprint that is characteristic of *K. brevis*. That comparison yields a Similarity Index (SI), which is related to the fraction of phytoplankton community biomass contributed by *K. brevis*. SI values below 0.5 indicate less than 10% *K. brevis*; values over 0.8 indicate greater than 90% *K. brevis* (Kirkpatrick et al. 2011).

The sensor at the Naples site was programmed to sample once per hour at a predetermined time, with each sample taking 3-4 minutes. At the completion of the sample cycle, the data were sent to the DCP, where they were stored and made available to be polled by a remote device. The data were also sent hourly via GOES to the CO-OPS data servers, and uploaded onto the FTP site. To save power, the sensor went into sleep mode between samples.

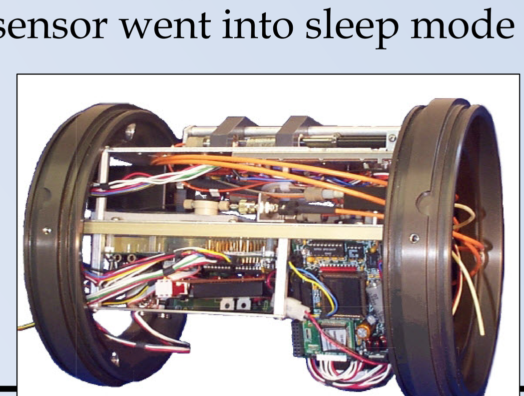


Figure 1: Front view of BreveBuster on the inside

Table 1: BreveBuster sensor specifications

Electrical	
Voltage	12Vdc
Current	400 ma
Current (sleep mode)	0.01 ma
Mechanical	
Weight	13 kg
Diameter	21 cm
Length	31 cm
Data	
Sample Period	5 min to1 hr (programmable)
Sample Cycle Duration	3-4 min
Baud Rate	9600-115200 (programmable)
Data Format	ASCII text
Data Output	RS232

4 Lessons Learned

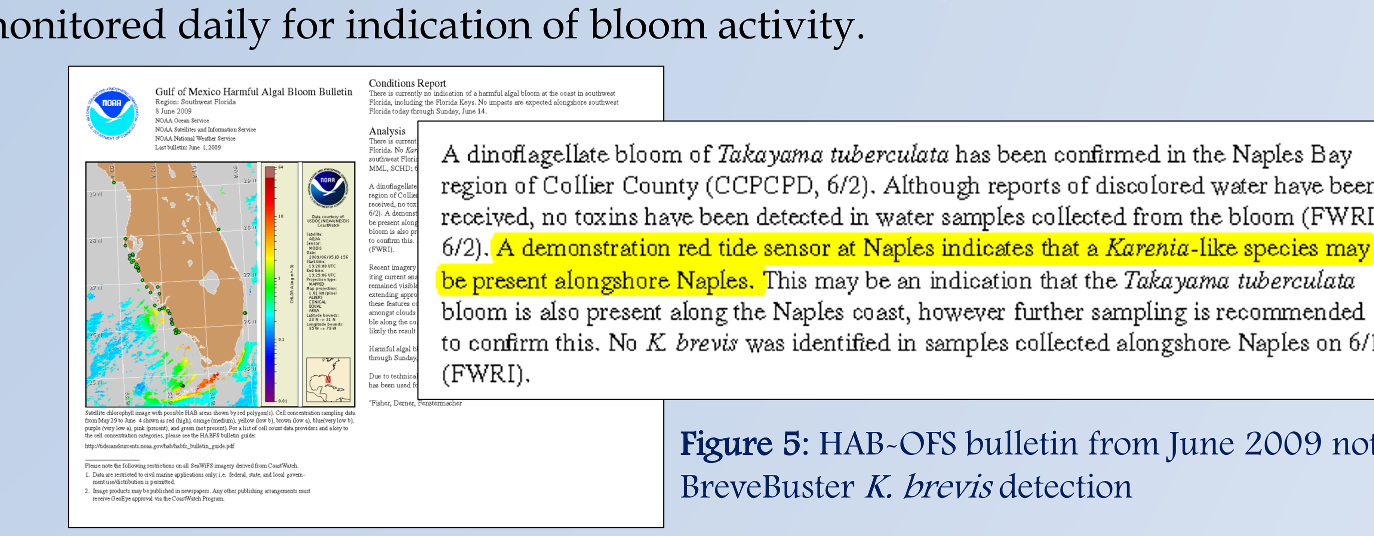
As with any demonstration project, many challenges were encountered during the deployment of the HAB sensor . The key lessons learned included the revelation of significant maintenance requirements and several opportunities for system deployment improvements.

- **Maintenance** – *cable damage, blown fuses, biofouling, etc.*
- **Sensor failure** – *various reasons; frequent maintenance is required due to the proximity of sensor to shoreline which causes sediment buildup*
- **Communications failures** – *sensor clock drift relative to DCP clock results in polling outside of the sample time window*
- **Data path losses** – *despite successful GOES transmission, some data did not make it from the DCP to the publicly available FTP site. More work is needed to integrate new technologies with existing operational IT systems.*
- **Marginal phone line capability** – *unreliable phone line at the site added to remote maintenance challenges*

Figure 4: Sensor biofouling and cable damage from wind/water action

5 Project Summary

One project goal was to assimilate data collected from the sensor with existing resources and tools to provide a better understanding of the initiation and distribution of harmful algal blooms and to establish more accurate early-warning forecasts for coastal resource managers and fisheries. The project complemented the NOAA HAB Operational Forecast System (HAB-OFS) bulletins, which use satellite imagery analysis, water samples, meteorological data, respiratory irritation/impact reports, and other sources to forecast HABs. Although no significant bloom events occurred in the Naples area during the deployment timeframe, data from the BreveBuster provided an additional resource for the HAB eco-forecasters when preparing bulletins and was monitored daily for indication of bloom activity.


Gulf of Mexico Harmful Algal Bloom Bulletin
Region: Southwest Florida
8 June 2009
NOAA Ocean Service
NOAA Satellites and Information Service
NOAA National Weather Service
Last bulletin: June 1, 2009

Conditions Report
There is currently no indication of a harmful algal bloom at the coast in southwest Florida, including the Florida Keys. No impacts are expected alongshore southwest Florida today through Sunday, June 14.

Analysis

A dinoflagellate bloom of *Takayama tuberculata* has been confirmed in the Naples Bay region of Collier County (CCPCPD, 6/2). Although reports of discolored water have been received, no toxins have been detected in water samples collected from the bloom (FWRI, 6/2). A demonstration red tide sensor at Naples indicates that a *Karenia*-like species may be present alongshore Naples. This may be an indication that the *Takayama tuberculata* bloom is also present along the Naples coast, however further sampling is recommended to confirm this. No *K. brevis* was identified in samples collected alongshore Naples on 6/1 (FWRI).

Figure 5: HAB-OFS bulletin from June 2009 noting BreveBuster *K. brevis* detection

A major achievement of the HAB project was to **demonstrate that the Breve-Buster can be interfaced with the existing CO-OPS data collection platform**, in the process showing that biological and physical sensors can be successfully integrated into the NWLON system.

Almost two years of field testing also **provided several recommendations for ways to reduce the number of maintenance visits required**, including a redesign of the sensor to fit into a protective well, similar to a conductivity/temperature sensor or on an aid-to-navigation buoy, packaged similarly to a current meter.

The lessons learned from the BreveBuster demonstration project may also **assist future efforts to obtain meaningful data** for Florida and other regions that experience harmful algal blooms.

References

Kirkpatrick, G J., Millie, D F., Lohrenz, S E., Moline, M A. and Schofield, O M. 2011. Automated, in-water determination of colored dissolved organic material and phytoplankton community structure using the optical phytoplankton discriminator. Proc. SPIE 8030, 803002

Mote Marine Laboratory, 2007. Optical Phytoplankton Discriminator User Guide, Low Pressure Unit, Version 1.1. Sarasota, FL.

Acknowledgements

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Other GLIMO Partners: NOS Office of Coast Survey, Coastal Services Center, Office of Response and Restoration; NWS Data Buoy Center; Naval Research Laboratory; University of South Florida