Remote Sensing of Water Quality Index and Connectivity in Florida Bay and Florida Keys: Some Recent Advances

Chuanmin Hu[1] (hu@marine.usf.edu, http://imars.usf.edu), Frank E. Muller-Karger[1], Zhongping Lee[2], Elizabeth Johns[3], James C. Hendee[3], and Thomas N. Lee[4]

[1]Institute for Marine Remote Sensing, USF/CMS, [2]Naval Research Lab at Stennis, [3]NOAA/AOML, [4]Univ. Miami/RSMAS

Summary

The Institute for Marine Remote Sensing (IMaRS) at USF/CMS is teamed up with NOAA/AOML and NRL at Stennis to study water quality and connectivity in the SW Florida coastal areas, including the FKNMS, Florida Bay, and Biscayne Bay. Our goal is to monitor several key environmental variables and document their relationship with coastal habitat (e.g., coral reef) health. Data have been and will continue to be collected by a variety of platforms, including satellite remote sensors (CZCS, SeaWiFS, MODIS, MERIS, AVHRR, Landsat, QuikSCAT, EPTOMS), marine stations, and ship surveys. The integration of these data provides unprecedented capability to study ecosystem connectivity, water quality trends, and bio-physical processes that are important to this region. Here we show several case studies to demonstrate how these data are used, and outline future efforts for improvement.

Data Collection

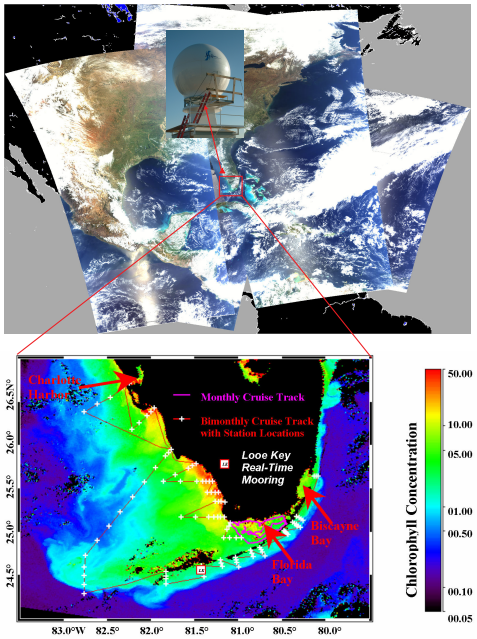


Figure 1. Data collection platforms, coverage, and frequency.

Top: Daily satellite coverage. Data products include: surface reflectance, water clarity/turbidity, chlorophyll concentration, surface temperature, chlorophyll fluorescence, true-color images, and others;

Bottom: Monthly and bi-monthly cruise surveys (AOML/RSMAS) of physical and biogeochemical parameters and hourly data from moored buoys.

Case studies

1. The 2002 "black water" event

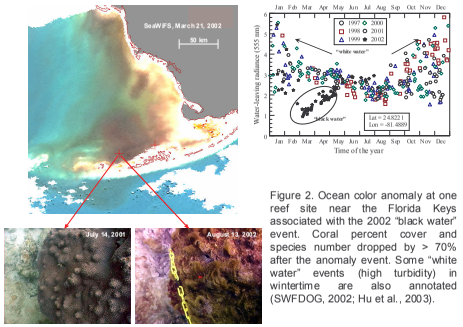


Figure 2. Ocean color anomaly at one reef site near the Florida Keys associated with the 2002 "black water" event. Coral percent cover and species number dropped by > 70% after the anomaly event. Some "white water" events (high turbidity) in wintertime are also annotated (SWFDOG, 2002; Hu et al., 2003).

2. The 2003 dark plume

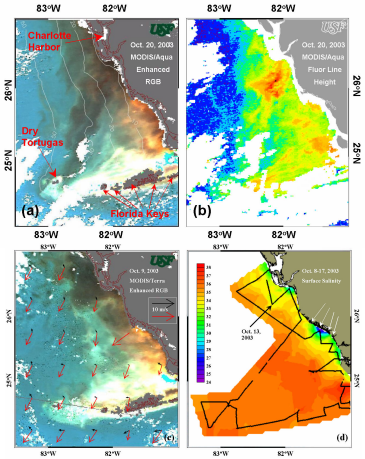


Figure 3. (a) A dark plume showing connectivity between FKNMS and coastal waters near Charlotte Harbor; (b) MODIS fluorescence line height (FLH) image shows phytoplankton patches within the dark plume; (c) Wind patterns before 9 October (black arrows) and after 9 October 2003 (red arrows), after which the coastal dark water was "flushed" towards the Florida Keys; (d) Concurrent salinity map showing the freshwater along the coast. (Hu et al., 2004)

3. The 2004 Mississippi River plume

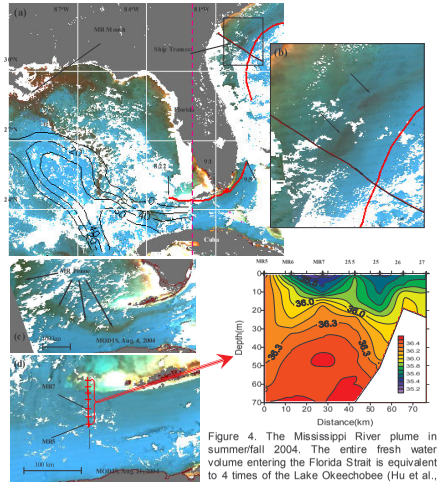


Figure 4. The Mississippi River plume in summer/fall 2004. The entire fresh water volume entering the Florida Strait is equivalent to 4 times of the Lake Okeechobee (Hu et al., 2005a).

4. The 2004 red tide event

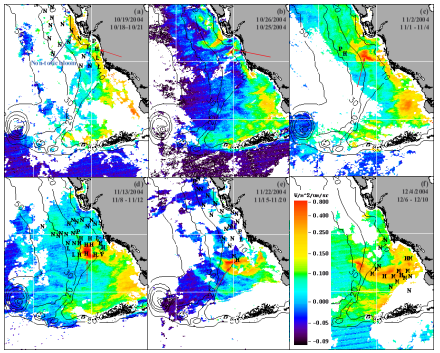


Figure 5. MODIS FLH data showing unprecedented capability to detect blooms in complex coastal environment. The data were validated with AOML/RSMAS field surveys, and they detected and traced the *Karenia brevis* bloom (red tide) in late 2004. The letters represent concentrations of *K. brevis*, from not present (N), low (L), medium (M), to high (H) and very high (V) (Hu et al., 2005b).

5. Zoom in the picture

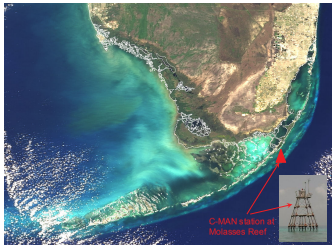
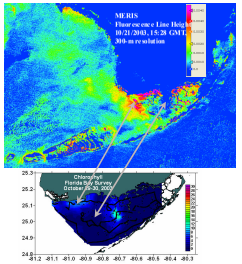


Figure 6.
Top: MODIS 250-m resolution image showing details in Florida Bay and Florida Keys;
Middle: MERIS 300-m resolution fluorescence image showing localized blooms;
Bottom: Map of chl. concentration from field survey by NOAA/AOML.



6. Near real-time data merging

USF satellite data were operationally pulled, merged with those from marine stations, and displayed/analyzed at NOAA/AOML every day. Below is the content of a sample file after merging of MODIS, AVHRR, and Molasses CMAN station data (location shown in Fig. 6)

```
—— Molasses Reef Upwelling Report for 08/02/2005 ——
tmodis4 satellite period: local midnight (0412 hrs GMT)
tmodis4 satellite SST: 28.94
amodis-c satellite period: local mid-day (1749 hrs GMT)
amodis-c satellite chlor: 0.692
amodis satellite SST: 29.45
noaa15 satellite period: local sunset (2348 hrs GMT)
noaa15 satellite SST: 27.78
noaa17 satellite period: local evening (0243 hrs GMT)
noaa17 satellite SST: 29.772
MLRF1 in situ period: mid-day
MLRF1 in situ SST: 32.0 (drastic-high)
MLRF1 in situ Wind Direc 207 (SSW-WSW)
```

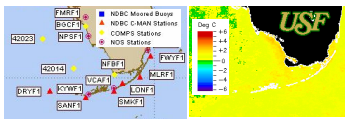


Figure 7. The finite number of buoys and stations (left) is not sufficient to resolve the fine structure of SST anomaly (right) in the complex region. The SST anomaly image is the difference between 2-8 July 2005 and a 11-year weekly climatology (1994-2004).

Future efforts

- Data quality control and cross-validation
- More tailored data products for local needs
- Inter-disciplinary collaboration to address environmental issues

Acknowledgements:

NASA Biogeochemical Program
NOAA Coastal Ocean Program
Office of Naval Research
Florida Fish and Wildlife Research Institute
SeaWiFS, MODIS, and MERIS science teams
Financial and technical support at USF/IMaRS, NOAA/AOML, UM/RSMAS, and NRL/Stennis.

References:

SWFDOG (2002), Satellite images track 'black water' event off Florida coast. EOS Trans.83(26), 281, 285.

Hu, C., K. E. Hackett, M. K. Callahan, S. Andréfouët, J. L. Wheaton, J. W. Porter, F. E. Muller-Karger (2003), The 2002 ocean color anomaly in the Florida Bight : a cause of local coral reef decline? GRL, 30, L1151, doi:10.1029/2002GL016479.

Hu, C., F. E. Muller-Karger, G. A. Vargo, M. B. Neely, and E. Johns (2004), Linkages between coastal runoff and the Florida Keys ecosystem: A study of a dark plume event. GRL, 31, L15307, doi:10.1029/2004GL020382.

Hu, C., J. Nelson, E. Johns, Z. Chen, R. Weisberg, and F. E. Muller-Karger (2005a), Mississippi River water in the Florida Straits and in the Gulf Stream off Georgia in summer 2004. GRL, 32, L14606, doi:10.1029/2005GL022942.

Hu, C., F. E. Muller-Karger, C. Taylor, K. L. Carder, C. Kelble, E. Johns, and C. Heil , (2005b), Red tide detection and tracing using MODIS fluorescence data: A regional example in SW Florida coastal waters. RSE, 97:311-321.