NOAA Coral Reef Conservation Program Final Report

Establish baseline optical conditions in the Florida Keys coral reefs, and quantify spatial and temporal variability

Project ID: 454
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Line Office: OAR
Office: Atlantic Oceanographic Meteorological Laboratory
Division: Physical Oceanography Division

This document reports the results for the characterization of the underwater optical properties over the Florida Keys reef tract in space and time during the interdisciplinary bimonthly shipboard cruises of the South Florida Monitoring Program (SFP).

The purpose of the bio-optical profiling and optical measurements are to:

- Quantify the 3-D light environment over the coral reef.
- Assess the baseline and time-varying water quality attributes (spectral light attenuation, chlorophyll_a, CDOM, turbidity).
- Provide valuable in situ data to improve satellite algorithms for ocean color products in the region.

The optical data acquisition was collected during 11 SFP cruises from January 2009 to February 2012 for a total of 126 stations and 332 optical observations (Fig. 1).

Instrumentation used and optical measurements conducted during the SFP cruises

PRR2600 Profiling Reflectance Radiometer System
Instantaneous multi-wavelength profiles of down-welling irradiance (PAR Photo-synthetically Active Radiation -- 400-700 nm) and up-welling radiance over the visible channels 412, 443, 490, 510, 555, 565, and 665 nm.

PUV2500 Profiling Ultraviolet Radiometer
Instantaneous multi-wavelength profiles of up-welling irradiance over the ultraviolet channels 305, 340, and 380 nm.

Hyper-Profiler Hyperspectral Ocean Colour Radiometer (HyperProOCR)
Instantaneous multi-wavelength profiles of down-welling and up-welling radiance-irradiance (provides 136 channels of calibrated optical data from 350 to 800 nm).

GER1500 Field portable spectro-radiometer covering the UV, Visible, and NIR wavelengths from 350 nm to 1050 nm. Includes an underwater enclosure to measure bottom and benthos.

C6 Multi-Sensor Platform (flow-through system) Integrates 4 Cyclops-7 fluorometers (Chl, CDOM, Turbidity and Crude Oil) and the onboard thermosalinograph (TSG) flow-through system (Temperature, Salinity, CDOM, and Chl).

Total optical profiles done: PRR2600: 121; PUV2500: 45; HyperPro: 43; GER1500: 91

Total CTD profiles done: 582 profiles; includes Chl fluorometer and Transmissometer.

C6 Multi-Sensor Platform (flow-through system): 11 cruises with spatial optical characterization of the surface water in the South Florida coral reef tract and the southwest coastal waters of Florida (Chl, CDOM, Turbidity and Crude Oil fluorometry).

Data Processing and Results to Date:

The "in situ" diffuse attenuation coefficient K_d(PAR) for the photo-synthetically active radiation and the spectral diffuse attenuation coefficient $K_d(\lambda)$ were calculated from the optical data to describe the different spatiotemporal patterns seen in Florida Keys visible and UV water clarity (Fig 2). Diffuse attenuation of solar light (K_d, m^{-1}) determines the percentage of light penetrating the water column and available for benthic organisms. Therefore, K_d can be used as an index of water quality for coastal ecosystems that are dependent on photosynthesis, such as the coral environments of the Florida Reef Tract.

Remote-sensing reflectance is easier to interpret for the open ocean than for coastal regions because the optical signals are highly coupled to the phytoplankton (e.g., chlorophyll) concentrations in the coastal regions. For the estuarine and coastal waters of South Florida, variable terrigenous colored dissolved organic matter (CDOM), suspended sediments, and bottom reflectance, all factors that do not covary with the pigment concentration, confound data interpretation and satellite algorithms to characterize the coastal waters. To resolve this problem, the GER1500 spectro-radiometer data were used to calculate the remote-sensing reflectance (R_{rs}), in order to characterize the optically distinctive water masses in the Florida Reef Track and the southwest Florida shallow water coastal region.

The optical data collected during this project have been used on 4 published papers and 3 in preparation:

Published:

Zhao, J., C. Hu, B. Lapointe, N. Melo, E. M. Johns, and R. H. Smith (2013). Satellite-Observed Black Water Events off Southwest Florida: Implications for Coral Reef Health in the Florida Keys National Marine Sanctuary. *Remote Sensing 5, 415-431; doi:10.3390/rs5010415.*

Cannizzaro, J. P., C. Hu, K. L. Carder, C. R. Kelble, **N. Melo**, E. M. Johns, G. A. Vargo, and C. A. Heil (2013). On the accuracy of SeaWiFS ocean color data products on the west Florida shelf. *Ref.: Ms. No. J. COASTAL RESEARCH - D-12-00223*.

Zhao, J., B. Barnes, **N. Melo**, D. English, B. Lapointe, F. Muller-Karger, B. Schaeffer, and C. Hu (2012). Assessment of satellite-derived diffuse attenuation coefficients and euphotic depths in south Florida coastal waters. *Remote Sensing of Environment 131, 38–50.*

Barnes, B. B., C. Hu, J. P. Cannizzaro, S. E. Craig, P. Muller, D. Jones, J. C. Lehrter, **N. Melo**, B. A. Schaeffer, and R. Zepp. Estimation of diffuse attenuation of ultraviolet light in optically shallow Florida Keys waters from MODIS measurements. *Accepted in Remote Sensing of Environment (Jun. 2013).*

In Preparation:

Melo, N., G. Toro, F. Muller-Karger, M. Vega-Rodriguez, B. B. Barnes, and E. M. Johns. On the colors of coastal waters of South Florida: An index for ecosystem health.

Toro-Farmer, G., F. Muller-Karger, **N. Melo**, M. Vega-Rodriguez, E. Johns, and S. Cerdeira. Connectivity of optically shallow water masses between a seagrass and coral reef ecosystem in the Lower Keys, Florida.

Turk, D., W. McGillis, **N. Melo**, F. Muller-Karger, M. Vega-Rodriguez, G. Toro, and K. Yates. Ocean chemistry changes and calcification on coral reefs and seagrass beds in a shallow reef system at Sugarloaf Key, Florida.

Data access

All the data collected as part of this project were shared (via FTP) with Dr. Chuanmin Hu and his colleagues at USF's Optical Oceanography Laboratory and Dr. Frank Muller-Karger and his colleagues at USF's Institute for Marine Remote Sensing (IMaRS), for the interpretation of satellite sea surface, temperature and ocean color.

All required data and metadata have been delivered to CORIS as specified in the project work plan.

All shipboard data can be accessed on the AOML South Florida Program (SFP) web site at http://www.aoml.noaa.gov/sfp

All optics data collected and processed can be accessed (on request) on the AOML server at\\phodnet\data\cruisedat\Florida_Coastal_Oceanography\SFER\Cruise_data\regional_surveys\Optic

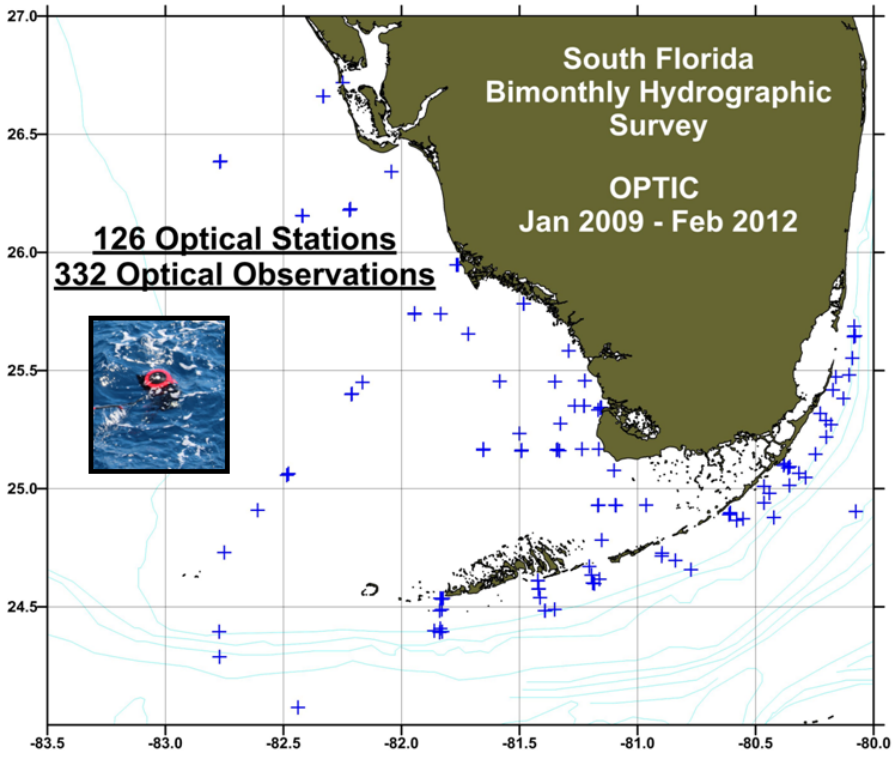

Fig.1 Optical stations occupied during the interdisciplinary bimonthly shipboard cruises of the South Florida Program.

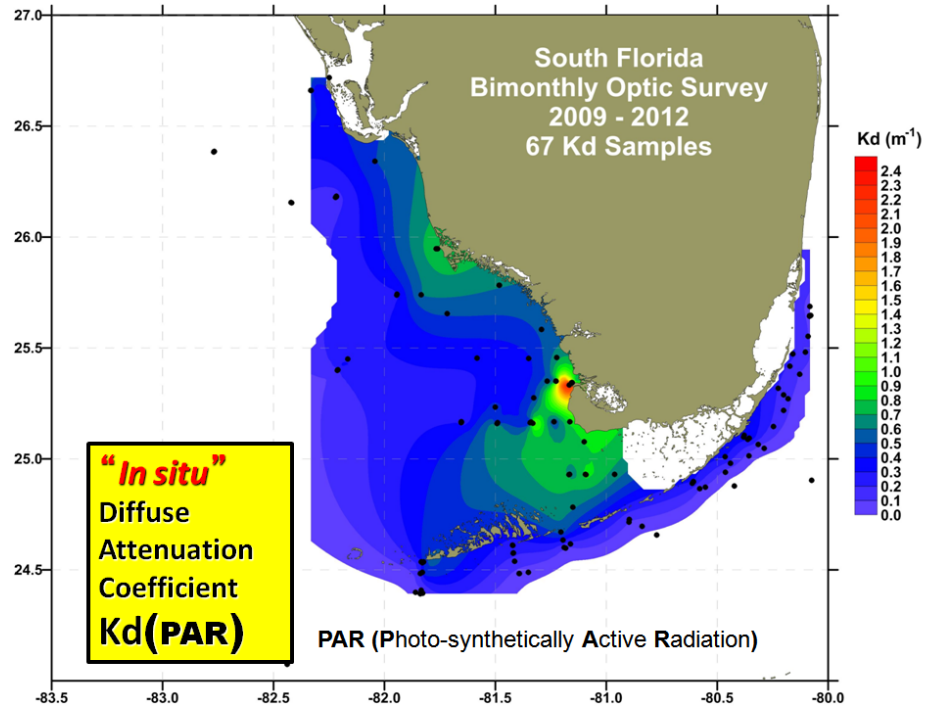

Fig 2. Spatial characterization of the diffuse attenuation coefficient for the photo-synthetic active radiation in the South Florida region.