Coastal and Regional Environments

Background:

Coastal and regional environmental problems have been a focus of AOML activities for more than two decades. Prior major interdisciplinary, multi-institutional efforts have included the Nutrient Enhanced Coastal Ocean Productivity (NECOP) program, study of the New York Bight, and a series of fisheries oceanography-related studies (Fisheries Oceanography Cooperative Investigations, South Atlantic Bight Recruitment Experiment, and Southeast Florida and Caribbean Recruitment). At present, our interdisciplinary field efforts include physical, biological, and chemical studies supporting the South Florida Ecosystem Restoration (SFER) effort and the underlying health of this ecosystem to the regional Intra-Americas Sea program and the status and health of coral reef ecosystems worldwide. We have also begun a new cooperative effort with the National Marine Fisheries Service/ Southeast Fisheries Science Center in marine mammal acoustic studies and a collaborative ship-of-opportunity coastal observations effort with the University of Miami's Rosenstiel School of Marine and Atmospheric Science, the Royal Caribbean Cruise Lines, and the National Science Foundation. At the same time, we are seeking to develop the next generation of instrumentation and data assimilation tools necessary to provide the nowcast and forecast products required by the coastal ocean resource management community.

Florida mangrove.

Challenges:

AOML's role in coastal and regional environmental research will expand in the coming years, both in regard to basic research and integrated operational monitoring/modeling. There is no question that the problems coastal managers and planners face require information on processes at both shorter time and space scales than previously studied, but over longer periods than previously available. In our view, progress requires time series Eulerian data sets best and most cost effectively obtained from fixed platforms, moorings, or buoys nested within remotely-sensed wider fields. Ship-based process studies have a role but will, in the future, no longer be exploratory in nature. Much greater use will be made of ships-of-opportunity and unmanned platforms. Recent advances have been made and will continue to be made both in regard to *in-situ* sensor technology and in adapting and integrating commercially-available sensors into instrument packages tailored to our questions of interest. Real-time data assimilation and creative analysis are now possible and will become practical due to advances in both computer hardware and software. All of these information sources will have to be integrated into end-to-end information systems to deliver the products relevant to our future.

Scuba diver explores coral reef environment.

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Priorities:

In coastal and regional research, AOML's efforts should be approximately equally divided between basic research, applied research, and quasi-operational programs. We are seeking to reach a programmatic balance. In regard to quasi-operational activities, we see our role as inherently transitional. We believe this transition period is critical and requires commitment for periods considerably longer than traditionally allotted to research projects. Our goal is to provide the intellectual and physical tools necessary for the NOAA line organizations with operational missions

Florida Bay, looking east from Route 1, south of Key Largo.

to accomplish their mandated objectives. We are intimately connected with our user community through a built-in feedback loop that we must make every effort to strengthen. AOML has substantially invested in measurement, analysis of measurement, and long-term environmental monitoring. These efforts must continue to receive much of our time and attention. In addition, as a government laboratory with a core of base funding, some part of our efforts must be directed towards high risk/high return applied research, *e.g.,* the prototype development of measurement platforms to be deployed in remote regions worldwide, coupled with decision support systems that may lead to better understanding of factors critical to harmful algal blooms. Last, we must continue to take advantage of a unique aspect of AOML. We are a meteorological laboratory as well as an oceanographic laboratory. We intend to more diligently and creatively capitalize upon and exploit the unique possibilities open to us due to this inherent interdisciplinary character. Within this context, the following research topics are projected to be the foci of our efforts in the coming years.

Research Goals and Actions for 2002-2007:

Goal:

Improve understanding of the impact of the Comprehensive Everglades Restoration Plan and other restoration actions upon the south Florida coastal marine ecosystem including Florida Bay and the Florida Keys National Marine Sanctuary (FKNMS)

Actions:

- Provide the physical, water quality, and biological data required to verify models and analyze alternative water management and restoration scenarios

- Define the degree to which restoration actions threaten the FKNMS and its living marine resources

- Fully implement a real time interdisciplinary regional monitoring network utilizing state-of-the-art data assimilation, computational, and information dissemination methodologies

Deployment of shallow-water drifters into Florida Bay.

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Goal:

Predict the effects on coral reef ecosystems of global climate change and local anthropogenic stresses
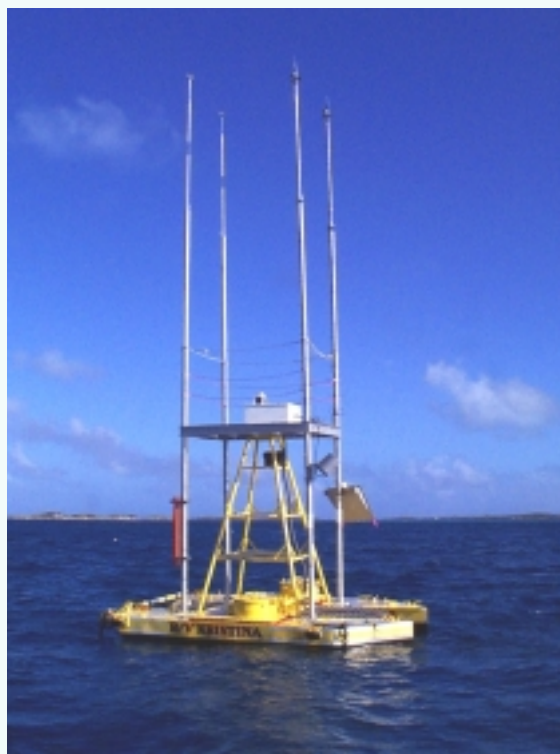
Actions:

- Incorporate additional biological and chemical parameters into the Coral Reef Early Warning System (CREWS) neural-net based analysis and automated information dissemination system

- Determine the relationships between reef calcification, photosynthesis, and environmental stress by enhancing CREWS sites with continuous pCO_2 sensors

- Utilize advanced acoustic and optical methods to define the interdependence of coral reef and planktonic tropical marine ecosystems
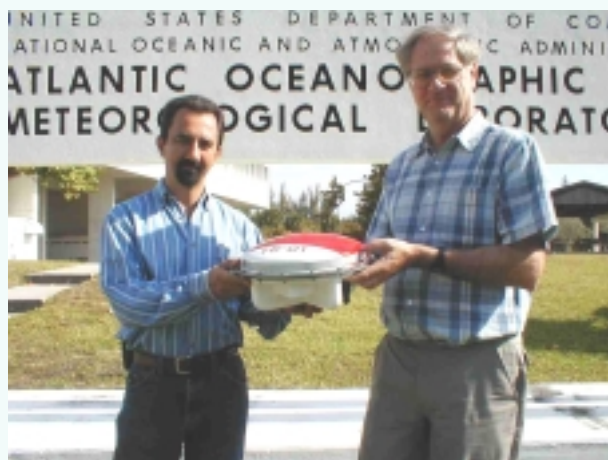
Goal:

Develop the next generation of sensors and integrated environmental monitoring systems required to monitor ecological and chemical processes in the coastal marine ecosystem

The R/V Kristina, currently moored at Lee Stocking Island, Bahamas, gathers atmospheric and oceanic data that assist researchers in monitoring coral reef environments.

Actions:

- Develop remote sensor systems based upon molecular quantification of planktonic organisms and microbial contaminant abundance

- Extend the concentration range over which we can measure atmospheric ammonia in the marine boundary layer and develop an *in-situ* dissolved ammonia sensor sufficient to assess air-sea fluxes in coastal environments

- Distribute near-real-time value-added integrated analysis products based upon coastal ocean measurements to coastal managers, emergency service managers, and environmental regulators

- Adapt present and next generation sensors to a range of platforms, *e.g.*, research ships, moorings, towers, airplanes, ships-of-opportunity, and/or automated underwater vehicles

*Electronic engineers Nelson Melo and David Bitterman display shallow-water drifter designed at AOML.*

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Goal:

Improve understanding of marine mammal distribution, abundance and migration patterns, and possible deleterious interactions with human activities or man-made marine structures

Actions:

- Design, develop, and construct passive acoustic sensor arrays to monitor sperm whale abundance and possibly vertical distribution in the northern Gulf of Mexico

- Conduct passive acoustic surveys of baleen whale distribution throughout the Caribbean

- Implement a data processing center to process National Marine Fisheries Service/Southeast Fisheries Science Center marine mammal data utilizing AOML's parallel processing computation system
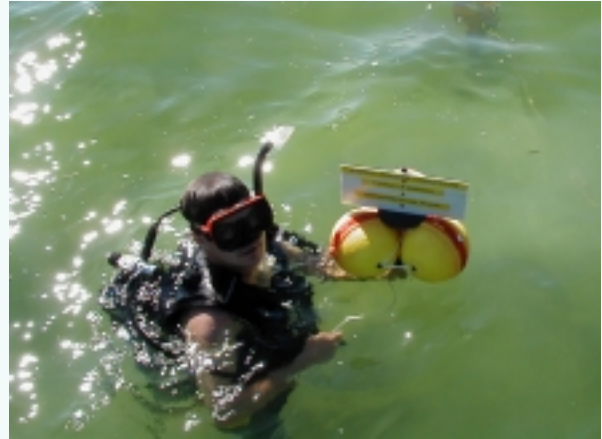
Retrieval of a float from Florida Bay.

Goal:

Evaluate quantitatively the coastal air-sea flux of carbon dioxide

Action:

- Conduct collaborative shipboard process studies using dual deliberate inert gas tracers to estimate gas transfer rates and the effect of coastal wave environments and surfactant properties

Goal:

Determine if Langmuir cells and larger scale mesoscale features regulate the distribution of harmful algal blooms

Actions:

- Conduct collaborative interdisciplinary process studies in water parcels tagged with deliberate inert gas tracers

- Document algal bloom dynamics using molecular-based, species-specific sensors

The R/V Virginia Key is used for research in the south Florida area.

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Goal:

Determine the degree to which the coastal ecosystems of the Intra-Americas Sea are interconnected and affected by remote oceanographic and meteorological forcing

Actions:

• Conduct interdisciplinary studies of the impact of Brazil Current eddies upon coastal ecosystems in the lower Caribbean basin

• Document the inherent variability of the Gulf Stream using ship-of-opportunity and remote sensing data

Goal:

Determine the degree to which the south Florida coastal ecosystem is affected by the landfall of hurricanes and tropical storms
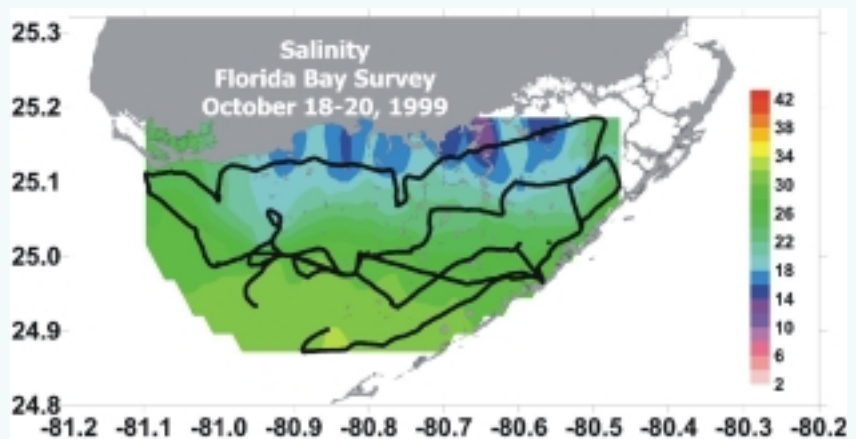
Action:

• Conduct biological and chemical studies of the coastal ecosystem before and after tropical storm landfall in conjunction with appropriately scaled wind field, tidal surge, and wave height studies

Depending upon their exact path, intensity, and size, tropical storms and hurricanes may substantially affect the distributions of salinity and other ecologically significant water properties in Florida Bay. A shipboard survey of Florida Bay in the wake of Hurricane Irene (1999) indicated not only considerable discharge into the Bay through channels in the Buttonwood Embankment well to the west of the typical center of discharge but a consequent, if comparatively shortlived, phytoplankton bloom.

Anticipated Impacts:

This research will lead to more informed management of coastal marine resources and better prediction of the consequences of continuing coastal development and global climate change. It will permit rational, science-based decisions regarding NOAA coastal stewardship obligations and interagency ecosystem and habitat restoration efforts. The information generated is essential if we are to mitigate or avoid unintended deleterious effects upon coastal environments.

Beyond 2007:

As our measurement and analytical capacities improve, our research is expected to contribute to progressively more quantitative predictions of environmental change and to truly adaptive management of coastal resources. Moreover, with continued evolution in computing resources and data assimilation strategies, we will be providing progressively more real-time information to our user community. Rather than real-time raw data, or even quality-controlled data, this information will consist of value-added products tailored to the information needs of our user community.