COOPERATIVE INSTITUTE FOR MARINE AND ATMOSPHERIC STUDIES

CIMAS

Second Year Annual Report

NOAA Cooperative Agreement NA17RJ1226

2002 - 2003

Joseph M. Prospero, Director
Claes Rooth, Associate Director

UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL OF MARINE
AND ATMOSPHERIC SCIENCE

Table of Contents

CIMAS MISSION

Above, a view of Virginia Key showing the Rosenstiel School, forground, NOAA Atlantic Oceanographic and Meteorological Laboratory, center, and the Southeast Fisheries Science Center of the National Marine Fisheries Service. Virginia Key is about 3 mile east of downtown Miami, Florida.

CIMAS, the University, and NOAA

The Cooperative Institute of Marine and Atmospheric Studies (CIMAS) is a research institute at the University of Miami located in the Rosenstiel School of Marine and Atmospheric Science (RSMAS). CIMAS is sponsored jointly by the University of Miami and the National Oceanic and Atmospheric Administration (NOAA) through NOAA's Office of Oceanic and Atmospheric Research (OAR), a line office in NOAA also known as "NOAA Research". CIMAS was established in 1977 through a Memorandum of Understanding between NOAA and the University of Miami. It is one of eleven such Institutes nationwide. As an Institute of the University, CIMAS operates under the same policies and procedures as those that apply to the other units of the University.

The CIMAS Vision:

- *To serve as a center of excellence in Earth Systems Science and the human interactions with the Earth System;*
- *To serve as a means of using this knowledge to improve and protect our environment and to use it more effectively and benevolently;*
- *To convey this knowledge to the public through education and outreach.*

The CIMAS Mission:

- *To conduct research in the terrestrial, ocean, and atmospheric environment within the general context of the NOAA's mission;*
- *To focus on the physical, chemical, and biological interactions between and among these environments;*
- *To understand the role of humans in affecting these environments and the impact of the changes in the environment on humans;*
- *To facilitate and participate-in education programs that are grounded in advanced Earth System Science.*

How CIMAS Carries Out Its Mission

CIMAS serves as a mechanism to promote synergisms between University scientists and those in NOAA so as to develop a center of excellence in research that is relevant to understanding the dynamics of the Earth's ocean-atmosphere-land system. Most of our research is related to programs in OAR and in the National Marine Fisheries Service (NMFS). Over recent years we have had increasing interactions with NOAA's National Environmental Satellite Data and Information Service (NESDIS). Most activities

in CIMAS are associated with research programs at the local NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) and the Southeast Fisheries Science Center (SEFSC) both of which are located on Virginia Key in close proximity to the CIMAS/RSMAS campus.

CIMAS addresses issues of national interest within the context of NOAA's missions of environmental prediction and stewardship. CIMAS accomplishes this:

- *By fostering joint projects between University of Miami scientists and those employed at the NOAA laboratories;*
- *By providing a mechanism for engaging graduate students and post-doctoral fellows in the research at these laboratories;*
- *By arranging for short-term visiting specialists to enhance the general effort in relevant research areas through short term consultations and seminars or by arranging for their involvement in ongoing projects for longer time periods;*
- *By providing training for personnel in various areas of research in marine and atmospheric science.*

CIMAS enhances NOAA-University cooperation and thus promotes both the quality and attractiveness of the local NOAA laboratories as a scientific working environment, and it increases the breadth of University activities in research areas that are complementary to NOAA's mission.

CIMAS research and its scientific objectives are guided by the general objectives of NOAA's Strategic Plan for FY 2003-2008. NOAA identifies four mission goals:

1. *Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management.*

2. *Understand climate variability and change to enhance society's ability to plan and respond.*

3. *Serve society's needs for weather and water information.*

4. *Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation*.

Each of the mission goals is organized according to *five types of mission strategies and measures of success* that reflect NOAA's general, daily activities that are common across almost every NOAA office:

1. *Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.*

2. *Understand and describe how natural systems work together through investigation and interpretation of information.*

3. *Assess and predict the changes of natural systems, and provide information about the future.*

4. *Engage, advise, and inform individuals, partners, communities, and industries to facilitate information flow, assure coordination and cooperation, and provide assistance in the use, evaluation, and application of information.*

5. *Manage coastal and ocean resources to optimize benefits to the environment, the economy, and public safety.*

Each research project in CIMAS is associated with a specific NOAA mission goal and a specific mission strategy. These are identified in the Research Reports section of this document.

CIMAS activities during FY 2002-2003 involved 116 persons in various capacities. The distribution of personnel is shown in Table 1.

The Research Associates are those employees under Task 2 who work closely with the local NOAA laboratories. There has been a steady growth in Task 2 personnel in the middle and late 1990s. This appears to have leveled off. The total personnel count in Year 1 and Year 2 of the Agreement is essentially unchanged.

Post Doctoral Fellows play an important role in our research activities. In Year 2 the number is substantially reduced from Year 1 when we had a total of 9.

Part-Time Researchers are senior personnel working on projects.

The distribution of degrees amongst the research personnel is as follows:

BS: 15
MS: 9
PhD: 15

It should be noted that although CIMAS has the status of a division in the School it has no faculty. School faculty participate in CIMAS activities in many ways, but they hold their primary appointment in one of the aforementioned academic divisions. Similarly, graduate students who work on CIMAS programs have their primary affiliation with an academic division which has the ultimate responsibility for overseeing the students' academic performance and the degree-granting degrees.

Many faculty participate in CIMAS as Fellows who play a role in the governance of the Institute. The Fellows act much like a Board of Directors. At present there are 22 CIMAS Fellows. Fellows are scientists of established national or international standing who either hold regular teaching or research faculty appointments or who are staff members of NOAA. Approximately half of the Fellows are University faculty and half are NOAA employees. Fellows who are NOAA staff members also serve as adjunct faculty in the various academic divisions of the School in accordance with standard University procedure. A list of the CIMAS Fellows membership is shown in the *CIMAS Fellows* section, page 77, along with their affiliation.

Table 1 includes part-time students (Temp Pool Staff) who are hired as part of outreach activities in cooperation with the local NOAA laboratories. The Outreach Programs are described in a separate section of this report.

CIMAS staff consists of the Director and Associate Director, who hold their primary appointments in School academic divisions, and three administrative personnel.

Table 1:	AOML	SEFSC	TOTALS
Research Associates	23	9	32
Post Doctoral	2	3	5
Part-Time Researchers	4		4
Graduate Students	4	4	8
Undergraduates	4	2	6
Temp Pool Staff	17	17	34
Fellows			22
Staff			5
TOTALS	54	16	116

Administratively, CIMAS activities are grouped under four distinct Tasks that are related to different aspects of the CIMAS mission.

- Task 1 provides the administrative structure for the Institute and includes support for limited-term postdoctoral research associates, graduate students and limited-term collaborating research scientists from outside Miami. The University contributes to the administrative support of CIMAS in its role as a Division in the School. Task 1 also provides travel expenses and honoraria for short-term visits by scientists. CIMAS has an active Visiting Scientist program. During a typical year, CIMAS hosts about 10 scientists who resided in CIMAS for periods of a week to several months.

- Task 2 provides support for highly specialized research scientists who are employed by CIMAS to complement existing expertise at NOAA and the University in the collaborative research themes of the Institute. The University of Miami employment policy incorporates a well-delineated series of employment categories that allow for professional advancement in the research ranks.

- Task 3 and Task 4 encompass the directed research programs of CIMAS. These provide support for research in CIMAS themes by University faculty, scientists and students. Support for specific projects under these tasks is largely based on competitive proposals that are submitted to specific NOAA units or to programs such as the Office of Global Programs. Task 3 encompasses activities of CIMAS scientists that are carried out in cooperation with the personnel at the local NOAA laboratories in Miami. Under Task 4 are projects that support or complement activities at NOAA laboratories other than those located in Miami. The indirect cost rates for these two tasks differs in recognition to the direct funding support that CIMAS receives under Task 1 from the local NOAA laboratories.

A summary of CIMAS funding in Fiscal Year 2 of the Cooperative Agreement through the local NOAA laboratories, AOML and SEFSC, is shown in Table 2. The table also shows the contribution from the University in support of CIMAS administration.

Table 2: TOTAL CIMAS FUNDING BY FY YEAR AND TASKS (millions of dollars)

	Task I		Task II		Task I	Task II	Task III	Task IV			Task 3&4	All Tasks
FY	T1 AOML	T1 SEFSC	T2 AOML	T2 SEFSC	Tot T1	Tot T2	Tot T3	Tot T4	UM Admin	Total	T3&4	
2001-02	0.77	0.85	1.11	0.33	1.62	1.43	2.60	0.32	0.20	6.18	2.92	5.979
2002-03	0.59	0.79	1.78	0.28	1.38	2.06	1.44	0.63	0.19	5.70	2.07	5.509

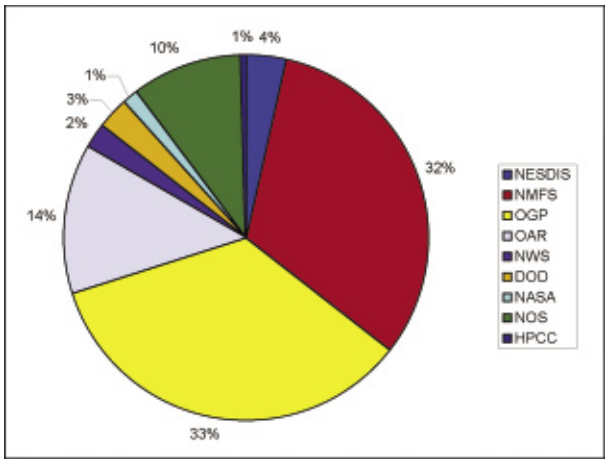


Figure 1- NOAA Agency Sources of Funding in Year 2.

The agency sources of funding in Year 2 (as a percentage of total funding) are shown in Figure 1. The Office of Global Programs and the National Marine Fisheries Service are the dominant sources, each providing about a third of the total funding. NOAA sources account for 96% of total funding.

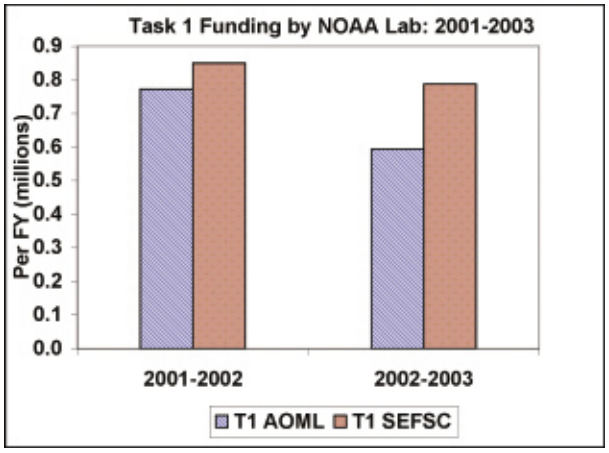


Figure 2- Task 1 Funding by AOML and SEFSC: 2001-2003

The history of Task 1 funding from AOML and SEFSC over the first two years of the Cooperative Agreement is shown in Figure 2. There is a slight decrease in second year of the Agreement. This is due to some extent to the long delays in the federal funding process under continuing resolutions. This has impacted our funding in a number of ways as noted below.

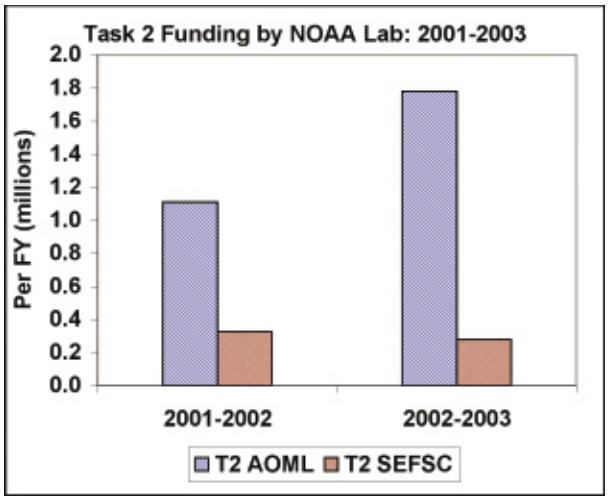


Figure 3- Task 2 Funding by AOML and SEFSC: 2001-2003.

The history of funding for the Research Associate program (Task 2) is shown by source (i.e., AOML and SEFSC) in Figure 3. The past year saw a substantial increase in Task 2 funding through AOML. This continues a trend seen over the past several years.

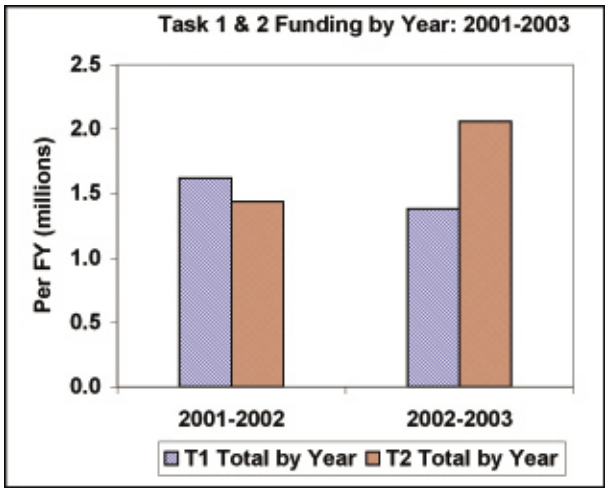


Figure 4- Task 1 and Task 2 Funding by Year: 2001-2003.

Total funding for Task 1 and Task 2 by year over the current Agreement period is shown in Figure 4. The increase in total Task 2 is due to the sharp increase in Task 2 through AOML.

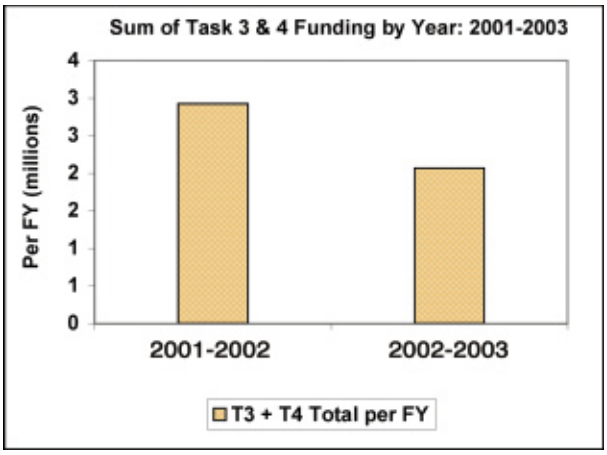


Figure 5- Sum of Task 3 and Task 4 Funding by Year: 2001-2003.

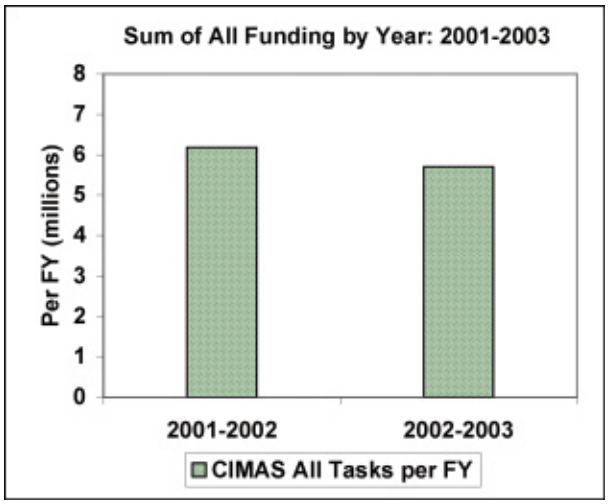


Figure 6- Sum of all funding by year: 2001-2003..

The history of research funding (Task 3 and Task 4 combined) is shown in Figure 5. There was a substantial drop in funding from FY 2001-2002 to FY 2002-2003. This is attributed largely to deferred programs because of the delayed funding cycle in the Federal Government.

Finally, Figure 6 shows the total funding by year for all Tasks. There is little difference between the first and second years of the Agreement. The substantial drop-off in research funding seen in Figure 5 was largely offset by a large increase in Task 2 funding in Year 2.

The scientific activities in CIMAS are organized under broad Research Themes. The selection of Theme topics is guided by the major environmental issues that confront our nation today. Scientific objectives are defined so as to complement and integrate with those in NOAA's Strategic Plan. Specific goals are set in the context of the research activities and expertise resident in the University and the local Miami laboratories of NOAA. Under the new Cooperative Agreement, scientific activities in CIMAS are carried out under six themes.

Theme 1: Climate Variability
Theme 2: Fisheries Dynamics
Theme 3: Regional Coastal Ecosystem Processes
Theme 4: Human Interactions with the Environment
Theme 5: Air-Sea Interactions and Exchanges
Theme 6: Integrated Ocean Observations

Theme 1: Climate Variability

- ***Investigate the dynamics of the ocean and the atmosphere and the ways in which they interact on interannual and longer-scales and the link to climate variations.***

One of the major problems in climate change research is to accurately characterize climate variability on time scales ranging from weeks to centuries, to detect trends in climate, and to identify the factors causing those changes, especially those deriving from human activities. In Theme 1 research focuses on climate variations that occur on an interannual-to-longer time-scale. The objective is to understand the dynamics of oceanic and atmospheric processes that affect climate variations. The ultimate goal is to increase our capability to predict climate through the use of models.

The CIMAS program places emphasis on systematic analysis of environmental data sets. These tend to be very large and require special processing techniques. These consist of specific diagnostic studies as well as fundamental research into the principles of analysis. The CIMAS effort, combined with a continuing commitment to climate-oriented long-term observations of oceanic transport processes, contribute to the development of climate-prediction capabilities and to the assessment of climate change.

RSMAS pursues a vigorous program in atmospheric and ocean chemistry as related to climate processes and their variability. Research is underway with regards to the role of chemistry in radiative energy transfer processes by direct effects as well as indirect effects that involve the modification of oceanic cloudiness. Recently RSMAS has expanded its research capability in tropical meteorology; this will enhance the CIMAS mission in aspects of tropical atmospheric processes that relate to climate variability and to activities in the AOML Hurricane Research Division.

Because climate and climate variability are fundamentally global-scale phenomena, CIMAS research activities often involves strong interactions with the national and international research communities. To this end, CIMAS plays a role in fostering international cooperation. The major focus is with individuals and institutions in Latin America in the area of tropical air-sea interaction and in Europe with regard to research into the climatic role of the subtropical and tropical Atlantic circulation.

Theme 1 activities contribute to NOAA Mission Goal 2: Understand climate variability

and change to enhance society's ability to plan and respond.

Research in this theme is consistent with three Mission Strategies:

- *Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.*
- *Understand and describe how natural systems work together through investigation and interpretation of information.*
- *Assess and predict the changes of natural systems, and provide information about the future.*

Forest Fires in Portugal - A huge plume of smoke drifts westward over the Atlantic Ocean from a massive forest fire in southwestern Portugal

Theme 2: Fisheries Dynamics

- ***Enhance our understanding of fisheries and ecosystem dynamics so as to improve the management of fisheries and marine protected species.***

Many ocean fisheries are undergoing rapid change, some due to natural variability and others due to human activities – overfishing, destruction and polluting of coastal habitats, climate changes resulting from greenhouse gases. While these issues are complex, in many cases it is clear that heavy fishing pressures are the primary cause. The main objectives of Theme 2 are to enhance our understanding of fisheries dynamics so as to foster better fisheries management, and to provide educational opportunities in this area of research.

CIMAS has a long history of research that focuses on applications of prediction models to specific fisheries. Recently emphasis has shifted to the development and use of risk assessment methods that take into account the role of uncertainty in our understanding of ecosystem and fishery dynamics and the impact of uncertainty in the management process.

The current emphasis on rational management of fishery resources is coincident with an increasing demand for these resources, often in the face of declining fish catches. Emphasis is also placed on proper management of marine protected species. Analysis has shown that there are fundamental constraints on our knowledge of fisheries systems in the context of marine ecosystems. In particular, theoretical models are mostly based on hypothesized relationships among the various components of marine ecosystems, including exploitation by humans. Most models are still in the development stage and they have limited ability as forecasting tools.

Many activities related to this theme are carried out in a sub-unit in CIMAS, the Cooperative Unit for Fisheries Education and Research (CUFER). CUFER was established in 1992 in response to a need for the development of methods for improved quantitative assessment of fish populations and as a source of advice for resource sustainability. CUFER offers the opportunity to work on research issues with long-time horizons, an advantage afforded by academic research. An important ancillary component of CUFER is to develop the human resources and expertise needed for the future research and management of Florida and Caribbean fishery resources. However, the program is broadly applicable to tropical and subtropical fisheries.

Another fisheries-related unit housed in CIMAS is the Center for Independent Experts (CIE) established in 1998. The primary function of CIE is to organize and facilitate independent

peer reviews of stock assessments carried out by the National Marine Fisheries Service (NMFS). Under this program, CIE arranges for the solicitation and selection of qualified scientists who carry out reviews of ongoing and completed assessments and who serve as independent experts on advisory panels and working groups.

Theme 2 activities contribute to NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management.

Research in this theme is consistent with three Mission Strategies as related to fisheries research:

- *Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.*

- *Understand and describe how natural systems work together through investigation and interpretation of information.*

- *Assess and predict the changes of natural systems, and provide information about the future.*

- *Manage coastal and ocean resources to optimize benefits to the environment, the economy, and public safety.*

Theme 3: Regional Coastal Ecosystem Processes

- ***Carry out research on the ecological health of coastal ocean ecosystems in the Southeast U.S so as to lead to better management strategies.***

South Florida is beset with a broad range of environmental problems that are the result of many decades of intense development in this fragile subtropical environment, unique in the continental United States. Because of the unique character of the region and the widely-diverse and closely-linked terrestrial and aquatic ecosystems, new strategies are required to address these issues. To this end Theme 3 focuses on the development of a scientific framework that links the multitude of special problems and scientific studies across the region.

A major part of the research in Theme 3 is carried out in the context of the South Florida Ecosystem Restoration initiative, a program that seeks to reverse the damage caused by the rapid growth in this region. Legislation recently passed by Congress allocates 7.8 billion dollars over the next several decades for this effort. CIMAS and NOAA's Miami laboratories are playing a central role in this program. Research activities under Theme 3 include:

- *Observations and analyses of atmospheric and ocean chemical and physical variability and their impact upon the health of the regional coastal ocean.*

- *Observations and modeling to elucidate how indigenous biological populations and communities respond to the unique physical and chemical environment of South Florida***.** How does variability in the environment influence the viability and distribution of biological populations? How is the system changing? What changes (and what consequences) might we expect in the future as the restoration program is implemented?

- *Special integrated studies of critically-stressed or keystone components of the South Florida coastal ecosystem.* These include studies that characterize natural and anthropogenic stressors, that identify causal mechanisms, and that establish ecological endpoints as well as the measurable indicators of progress towards achieving regional coastal ecosystem health.

- *Development of theories and methodologies necessary to understand the biological, ecological and oceanic variables controlling and regulating South Florida coastal fisheries populations, their food sources and their habitat.* We need such knowledge in order to predict variability in space and time with an accuracy useful for management purposes. Fishery problems are an important subset of the coastal ocean

ecosystem processes because of their large economic significance both commercially and recreationally in South Florida.

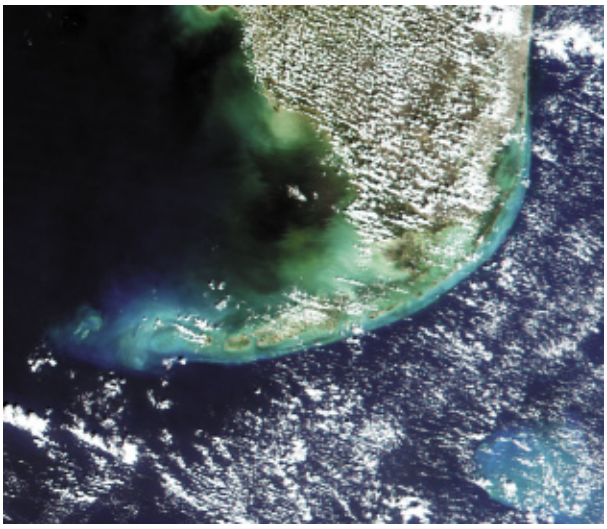
The activities under Theme 3 bring together local management expertise and experience so as to provide analytical tools - models and techniques - for making timely and informed assessments of the combined effects of natural processes and restoration-related actions upon the regional coastal ecosystem. Such tools are essential for the informed management of regional coastal ecosystem resources.

Theme 3 activities contribute to NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. They also contribute to Mission Goal 3: Serve society's needs for ... water information.

Research in this theme is consistent with three Mission Strategies as related to coastal ocean processes and their impact on fisheries and other aspects of the coastal environment.

- *Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.*

- *Understand and describe how natural systems work together through investigation and interpretation of information.*



This image from the Moderate-Resolution Imaging Spectroradiometer (MODIS) shows black water off the coast of Florida on January 30, 2002. In late March 2002 a diver investigating the water discovered dead and dying sponges and coral—an indication that the discoloration may be the result of a toxic phytoplankton bloom, which sometimes kill sponges before other marine species. (NASA)

- *Assess and predict the changes of natural systems, and provide information about the future.*

- *Manage coastal and ocean resources to optimize benefits to the environment, the economy, and public safety.*

- *Study how humans interact with the environment so as to lead to better policy making.*

Theme 4: Human Interactions with the Environment

- ***Study how humans interact with the environment so as to lead to better policy making.***

Theme 4 highlights the role of human systems in environmental decision making. Humans interact with the environment in many ways. Studies of these interactions range from assessing societal risks from natural hazards to considering how population growth and land use changes may affect the health of ecosystems. Humans shape natural systems and are shaped by them. Examples are climate change, the utilization of marine resources, and the urbanization of coastal regions. The inter-dependence of humans and ecosystems makes human interactions a topic of interest to environmental managers as well as to stakeholders and the scientific community.

Researchers use ***integrated assessments*** to study and resolve the complex dynamics of overlapping human and natural systems. This approach goes beyond synthesizing and advancing what is known about a problem; it also ensures that the results are relevant to society. Estuaries, to take one example, are considered as integrated systems. While often thought of as natural systems in terms of their rates of soil and water movement and rich habitats, estuaries are also appropriately

regarded as socio-economic systems in terms of the size and distribution of costs and the benefits they help create. It is the interplay of natural and human systems that creates problems for resource managers and opportunities for stakeholders.

There are three distinct foci in Theme 4:

• ***Human dimensions of climate change and variability.***
Researchers seek to improve our understanding of how social and economic systems are currently influenced by climatic fluctuations, and how human behavior can be affected by using our gained knowledge about variability in the climate system, for example, by using El Niño forecasts in agriculture.

• ***Sustainable use of the world's fisheries.***
Researchers emphasize the role of human behavior in the fisheries and marine ecosystems to be managed. The study of marine reserve networks, for example, has explored their optimal design in terms of biological and physical connections and the socio-economic consequences of implementation within fishing communities.

• ***Urbanization of the Coastal Zone.***
Half the nation's population lives on coastal lands which comprise only 17% of the total land area. Recent assessments of coastal zone impacts identify the dominant ecological risks as habitat alteration, hydrological alteration, and the over-exploitation of natural resources. Moreover, the steadily increasing population within the coastal environment increases the potential for exposure to environmental risks such as storms and hurricanes.

Integrated assessments of human/environmental interactions can only be as good as the cooperation between social scientists, natural scientists, economists, and stakeholders. Social scientists assess societal goals and policy options through a process of inclusion and consultation while economists assess the monetary consequences. Natural scientists assess changes in the natural world that may affect human well being. Stakeholders provide critical local knowledge. To have a shared vision of sustainable use, a multi-disciplinary, multi-institutional dialog is needed. Research under Theme 4 facilitates this dialog and leads to the development of new analytical tools with which to identify problems, to characterize sources of environmental degradation, and to monitor progress towards restoration.

Theme 4 activities contribute to NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Also, Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond.

Research in this theme is consistent with all five Mission Strategies as related to the human dimensions of environmental change:

• *Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.*

• *Understand and describe how natural systems work together through investigation* and *interpretation of information.*

• *Assess and predict the changes of natural systems, and provide information about the future.*

• *Engage, advise, and inform individuals, partners, communities, and industries to facilitate information flow, assure coordination and cooperation, and provide assistance in the use, evaluation, and application of information.*

• *Manage coastal and ocean resources to optimize benefits to the environment, the economy, and public safety.*

Theme 5: Air-Sea Interactions and Exchanges

- ***Understand the energy exchanges and interactions between the atmosphere and the oceans and the consequent effects on atmospheric and ocean mixing and circulation.***

The oceans are an important source of the energy that drives large-scale atmospheric circulations; conversely, the wind systems drive oceanic mixing and circulation. The interplay between the ocean and the atmosphere can result in large variations in global weather patterns as demonstrated by the impact of el Niño events. These interactions involve a wide range of properties such as the air and sea-surface temperatures, humidity, wind speed, rainfall, salinity, mixed-layer depth and heat content. These properties vary on scales from a millimeters to 1000 km; they underlie the variability of oceanic and atmospheric circulations from the scale of a single ocean wave to tropical cyclones. The ocean plays a major role in the biogeochemical cycles of many important species that can have an important role in climate forcing: e.g., CO_2, halocarbons, aerosols. Air-sea exchange processes control the amount of these materials that remain in the atmosphere and thus the degree to which these species, both natural and pollutant, can affect radiative processes and climate.

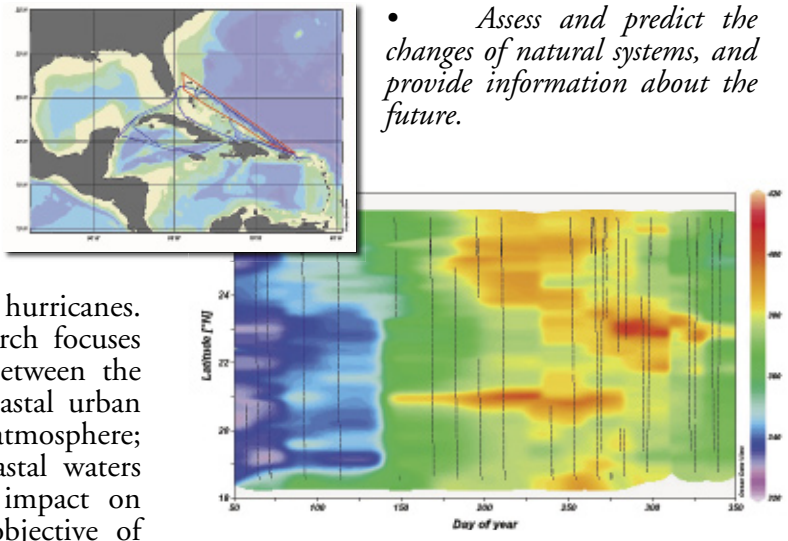
Research on air-sea interactions largely focuses on processes in the marine atmospheric boundary layer and the surface waters of the ocean including the oceanic mixed layer and the top of the seasonal thermocline. It also extends into maritime cloud climatology and to maritime weather system prediction - from coastal fog and stratus clouds to tropical waves, squall lines and hurricanes. An equally important area of research focuses on the exchange and interaction between the atmospheric environment of the coastal urban complex and the coastal marine atmosphere; the deposition of pollutants to coastal waters are known to have a substantial impact on coastal ecosystems. The ultimate objective of these various programs is to develop and verify physical-chemical models of the atmosphere and the ocean and the processes that couple them. Another critical area of research is to understand the role of the upper ocean on hurricane intensity changes.

RSMAS has developed a strong program in air-sea interaction studies. University scientists work closely with AOML in research on in situ exchange processes and in the development of new instrumentation such as airborne oceanography. Remote sensing techniques are playing an increasing role in studies of the marine boundary layer and the upper ocean including the interface. Both RSMAS and AOML have strong programs in this area as well and these two groups work closely together in these areas.

Theme 5 activities contribute to NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond.

Research in this theme is consistent with two Mission Strategies:

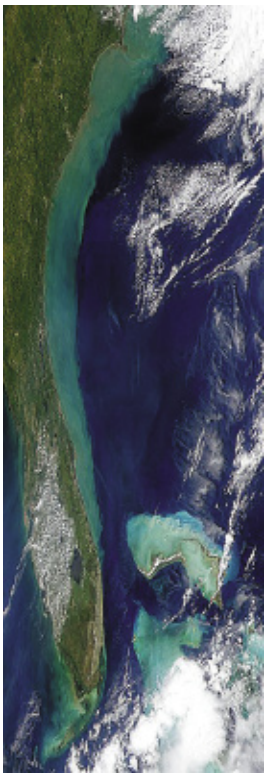
- *Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.*
- *Assess and predict the changes of natural systems, and provide information about the future.*



Trend of pCO_2 with time along the ship's Eastern track (left). The red colors on the figure at left indicate that the region is releasing CO_2 to the atmosphere, blue that it is absorbing CO_2. In general, the Caribbean Sea releases CO_2 to the atmosphere during the summer and fall and takes up CO_2 in the spring. This data was compiled in the research labs aboard the cruise ship, ***Explorer of the Seas.***

Theme 6: Integrated Ocean Observations

- ***Study the integration of modeling and physical measurements in the ocean and the atmosphere so as to achieve optimal designs of observing systems.***



Observing systems are costly to design, to deploy, and to maintain. To design an efficient system it is necessary to first identify the critical variables to be measured, the spatial configuration of sensors, and the frequency of measurements necessary to identify and characterize temporal and spatial trends. Consequently the development of integrated observing systems requires the interplay of numerical models and observing system networks so as to accurately and efficiently estimate the optimal fields of essential oceanic variables. Another objective of this research is to develop the criteria for the acquisition of oceanic data needed to determine and document the role of the ocean in long-term climate change and to monitor these changes.

The optimal system must accomplish several objectives. It must efficiently characterize climate variability and change in the presence of geophysical noise; it must provide a product that can support marine ecosystem management with physical transport estimates; and it must provide initialization, validation, and verification data for climate forecast models. The design of ocean observing systems depends on the scale of the domain, the processes of interest, and the application of the data that is to be obtained. For example, on global scales systems must be designed to observe climate variability and dynamics. Regional scales must be observed for marine resource management, waterborne pollution mitigation, and efficient navigation. Coastal scales must be observed to support marine ecosystem management, pollution response, safe navigation, and coastal flooding.

Careful design studies are needed to determine the optimal mix of in situ (Eulerian and Lagrangian) sensors, satellites, and other remote sensing observations. Observational evidence indicates that the coupled air-sea system is undergoing dramatic changes on long time scales - for example, the melting of the Arctic and Greenland ice caps, the increasing surface temperatures. These changes will have a great impact on transport and mixing in the Atlantic. CIMAS investigators have a long history of tracking Atlantic thermohaline circulation, a major factor in climate variability over longer periods. We currently lack a good understanding of the time-scales of the factors that control Atlantic circulation. This will require continued observations in the Atlantic coupled with numerical modeling.

Theme 6 activities contribute to NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Also, Mission Goal 4: Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation.

Research in this theme is consistent with three Mission Strategies:

- *Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.*

- *Understand and describe how natural systems work together through investigation and interpretation of information.*

- *Assess and predict the changes of natural systems, and provide information about the future.*

Theme 1: Climate Variability

The Impact of the Saharan Air Layer on Atlantic Tropical Cyclone Activity

J. Dunion and J. Prospero (UM); W. Barry, M. Black, N. Dorst, S. Feuer, J. Kaplan, C. Landsea, P. Leighton, F. Marks, M. Powell, and R. Rogers (NOAA)

Tropical cyclones (TCs) usually develop from easterly waves which emerge from the west coast of North Africa. TCs often interact with the Saharan Air Layer (SAL), a hot, dry, dust-laden layer of air often found over the tropical Atlantic during the summer and fall. We have developed a technique that allows us to follow the interaction of TCs with the SAL in real time using GOES-8 split window imagery techniques. This technique has been used to retroactively study past TCs including major hurricanes such as Cindy in 1999, Joyce in 2000, and Chantal, Erin, and Felix in 2001. Our studies suggest that the SAL seems to inhibit the development of TCs; in many cases when it overtakes storms the SAL actually seems to weaken them. The GOES technique is being used to increase our understanding of the interaction of TCs and the SAL and it should lead to more accurate hurricane forecasts.

North Brazil Current Retroflection and Transports

A. Ffield, W. E. Johns, and Q. Yao (UM); S. L. Garzoli (NOAA)

We seek to understand the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change. This work focuses on the North Brazil Current which has been shown to play a large role in energy transport and, hence, climate in the Atlantic. Data collected as part of the North Brazil Current Rings Experiment shows that there is a direct relation between the latitude of penetration, the number of rings shed and the intensity of the North Brazil Current. These studies will contribute to our understanding of climate variability over the Atlantic.

Studies of Pacific and Atlantic Climate Variability

C. Shaji (UM); C. Wang and D. B. Enfield (NOAA)

Our work concentrates on understanding the variability of the El Niño-Southern Oscillation (ENSO) and Atlantic climate and to assess the linkage between the Pacific ENSO and tropical Atlantic variability. We find that the Walker and Hadley circulations are closely related to ENSO, the tropical Atlantic meridional gradient variability, the Atlantic Niño, the North Atlantic Oscillation, and the Western Hemisphere warm pool. The Pacific ENSO can affect tropical Atlantic climate variability through the Walker and Hadley circulation cells. We developed a new version of HYCOM model to simulate the tropical Pacific and Atlantic Oceans. The model is able to simulate major features of ocean circulation and temperature in the tropical Pacific and Atlantic.

Western Boundary Current Time Series

C. S. Meinen (UM)

We want to understand the movement of water and heat around the global ocean and to determine ways in which these transports affect climate. We use a wide variety of observations ranging from satellite measurements to direct ocean measurements of heat and current. Climate models have shown that variations of the transport of the Deep Western Boundary Current in the Atlantic Ocean (DWBC) have significant impacts on the climate at both the national and global level. We developed a low cost method for monitoring the DWBC in the Atlantic Ocean east of Florida where it brings dense water formed in the northern North Atlantic southward along the east coast of the Americas. Through collaborations with German scientists we are extending the study of the DWBC further south off the coast of Brazil.

Initial Steps Towards a Global Surface Water pCo_2 Observing System

F. J. Millero (UM)

Our work focuses on the ocean-atmosphere carbon cycle and the role of the oceans in CO_2 exchanges. In this initial phase we have concentrated on measuring pCO_2 in the North Atlantic. We have designed and constructed a pCO_2 system that will be placed on a Volunteer Observing Ship (VOS) that travels from New York to Iceland. This system will later be adapted to other VOS ships. This research study is the first step to developing a global network that can be used to monitor the flux of CO_2 into and out of the oceans.

Moisture Budget in the Intra-Americas Sea, its Transport into North America and their Roles in Warm-Season Precipitation

A. M. Mestas-Nuñez, C. Zhang, and B. Albrecht (UM); D. B. Enfield (NOAA)

We explore the connection among the warm pool of the Intra-Americas Sea (IAS), its moisture budget, moisture transport from the IAS into North America, and warm-season precipitation over North America. We use observations from a sounding network around the IAS, the Eta regional model analysis, the NCEP/NCAR global model reanalysis, and other datasets. We find good agreement between vertically integrated vapor fluxes estimated from soundings around the IAS and simulated soundings from the Eta regional analyses. This shows that the Eta analyses can be used to estimate the moisture fluxes in the IAS but the sounding network is inadequate for estimating the regional moisture flux divergence.

North Atlantic Decadal Variability and the Formation of Tropical Storms and Hurricanes

A. M. Mestas-Nuñez (UM); R. L. Molinari (NOAA)

To understand the association between Atlantic climate variability and tropical storm activity we carried out statistical analysis of historical observations of tropical storm frequency and of oceanic and atmospheric variables. We find that the annual number of Atlantic tropical storms increased between the 1970's/1980's and 1995-2000 along with the frequency of major hurricanes. These increases were coincident with a general multi-decadal warming trend in North Atlantic sea-surface temperatures (SST). This long-term SST trend suggests that the high activity over 1995-2000 may persist for the next ~10 to 40 years. However, the association of hurricanes with SST trends is complicated by the observation that during 1950-2000 there were strong decadal SST oscillations superimposed on the multi-decadal changes in both SST and tropical storms. The current trend in SST suggests that tropical storm activity may actually decrease over the next several years rather than remain at the very high 1995-2000 level when both the long-term and the decadal SST signals were in their positive phase.

Tropical/Subtropical Interactions

C. F. Lumpkin (UM)

We seek to describe and understand ocean circulation and its variability working primarily with data from an array of surface drifting buoys. Initial research has focused on drifter observations in the tropical Atlantic. Analytical tools were developed which have yielded significantly improved estimates of surface circulation using these data. These data are available to the public via a web site which shows the monthly large-scale temperature and current anomalies in the Atlantic Ocean. As this product evolves, it will include other basins and regional monthly current maps.

Theme 2: Fisheries Dynamics

Modeling Pink Shrimp Recruitment from Florida Bay

M. M. Criales and J. Wang (UM); J. A. Browder, S. Wong and T. Jackson (NOAA); M. Robblee and C. Hittle (USGS)

We developed a pink shrimp simulation model and performance measures to evaluate the impact on Florida Bay of upstream water management changes resulting from efforts to restore the Greater Everglades ecosystem. This model will help us to understand the ecology of fishery species in relation to the processes influencing transport, settlement, survival, and recruitment.

By means of channel net collections of post larvae, the most important path connecting spawning and nursery grounds was from the west, across the northwestern border of Florida Bay. A new potential larval transport mechanism for pink shrimp larvae across the SW Florida shelf was identified by simulations of transport and analysis of hydrographical data. The proposed mechanism is strongly dependent on seasonal winds and the capability of larvae to select the appropriate tidal current during their journey to Florida Bay.

Upstream Larval Supply to Florida Bay – the Dry Tortugas Connection

C. Yeung, D. L. Jones, M. M. Criales (UM); W. J. Richards (NOAA)

We seek to understand recruitment processes and larval ecology of marine fishes and crustaceans in South Florida's marine ecosystems using a combination of field studies and modeling. We focus on the role of the Dry Tortugas in the Florida Bay nursery system. High rates of larval influx are associated with eddy-induced increases in larval retention and onshore transport. This suggests that spawning areas in the Dry Tortugas supply the nursery grounds in Florida Bay.

Use of Geochemical Tracers to Elucidate Life History Trajectories of Gray Snapper in South Florida's Marine Ecosystems

M. R. Lara and D. L. Jones (UM); J. T. Lamkin (NOAA)

We want to characterize the life history and habitat requirements of gray snapper within Florida Bay and the Florida Reef Tract. We use the chemical composition of otoliths (earbones) as natural tags to determine the juvenile nursery habitat used by adult snappers inhabiting the reef tract. These data will improve the fisheries management of snapper, a commercially and ecologically important fish community

Monitoring Coral Reef Fish Populations in the Florida Keys

J. S. Ault and S G. Smith (UM); J A. Bohnsack (NOAA)

This project augments the South Florida Ecosystem Restoration Program to provide a comprehensive 5-yr evaluation of trends in FKNMS no-take zones (Sanctuary Preservation Areas - SPAS), Ecological Reserves, and Research Areas. We carried out a comprehensive survey of coral reefs along the Florida reef tract using state-of-the-art sampling strategies. It included fishes, corals, conch, spiny lobster, and other reef species. Results will be used to define current conditions and monitor future changes as the result of management actions in Biscayne National Park, the Florida Keys National Marine Sanctuary, and Dry Tortugas National Park.

Photo-Identification of Bottlenose Dolphins in Biscayne Bay, Florida

J. A. Wicker (UM); S L. Swartz and J. P. Contillo (NOAA)

We are developing a long-term database on bottlenose dolphin population parameters using photographic identification techniques that can be used to monitor the overall health of the Biscayne Bay ecosystem. The main goals of this monitoring are the detection of large-scale changes in bottlenose dolphin abundance and the establishment of archival databases for long-term trend detection. Biscayne Bay has been greatly influenced by development of the Miami area in the past 75 years. We developed a web-based system for the sharing of photo-ID data and images between adjacent photo-ID projects in south Florida.

Abundance and Diel Migrations Of Demersal Mesozooplankton And Small Reef Fishes And Their Trophodynamic Contribution to the Coral Reef Ecosystem

S. Smith, J. Luo, P. Lane, and D. Pilz (UM); P. B. Ortner, J. C. Hendee, S. Cummings, J. Stamates, J. Lamkin and D. Jones (NOAA)

Our objective is to describe and quantify the functional bio-physical relationships and processes that control and impact planktonic processes associated with coral reef ecosystems as a first step in formulating future recommendations for fisheries management in coral reef ecosystems and for evaluating potential regulatory options. Sampling strategies employed during the past year included in situ multi-frequency acoustic and optical packages, acoustic Doppler current profilers (ADCPs) and traditional net tows near a coral reef in St. Croix, USVI. It seems clear that the local current regime and the migratory behavior of some zooplankton species interact to modify the plankton community over the reef on a daily basis.

Theme 3: Regional Coastal Ecosystem Processes

Faunal Density and Community Composition of the Nearshore Zone Biscayne Bay Biological Community Performance Measures

J. Hall (UM); J. Browder (NOAA); M. Robblee and D. Moore (USGS)

In order to evaluate and guide restoration efforts in southern Biscayne Bay, we need to develop monitoring capabilities for the environmental characteristics in Biscayne Bay and to relate these to the distribution and abundance of various target species, for example fish and macro-invertebrates in seagrass habitats and the variations in shrimp distribution and abundance. The salinity, geographic, and depth zonations used in our sampling design help to explain the variation in faunal density in the western near-shore South Biscayne Bay area. For example vegetation cover is an important covariate and adds substantially to the explanation of shrimp density variation. Our research suggests that, in general, faunal densities are low compared to historical data.

Real-Time Oceanographic Observations in the FKNMS

T. N. Lee, V. H. Kourafalou (UM); E. Johns, P. B. Ortner, J. C. Hendee (NOAA)

The current system in the Florida Keys, especially currents through the passages between Florida Bay to the reef tract, are known to have a strong impact on the reef environment. We make targeted real-time observations of important oceanographic parameters at various sites throughout the Florida Keys National Marine Sanctuary (FKNMS). The objective is to develop an understanding of the forces driving the currents, and to efficiently communicate relevant information to resource managers and the general public via the internet. We use a combination of a deployed sensor network (e.g., bottom-mounted acoustic Doppler current profilers) and targeted cruises. Our measurements show that currents through inter-island passages in the Florida Keys are strongly influenced by local wind forcing and by gravity driven transports produced by cross-key sea level differences on time scales of several days to weeks.

Reef Fish Community Dynamics and Linkages with Florida Bay

J. S. Ault and S. G. Smith (UM); J. A. Bohnsack (NOAA)

The goal of this research is to quantify community and reef fish population changes in management zones under different levels of protective management. It provides data needed to model the effects of the Everglades Restoration on coral reef fishes and to assess the effectiveness of restoration in terms of ecological recovery. A study of 35 important fisheries species in Biscayne National Park shows the effects of widespread overfishing. The average fish size during the last 25 years has remained relatively constant and is very close to minimum size of capture, not to historical unfished population size. For example, the average size of black grouper is now 40% of what it was in 1940. Overall, of the 35 stocks analyzed 77% were overfished by federal standards, including 13 of 16 grouper species, 11 of 13 snapper and barracuda, and 2 of 5 grunt. Stock biomass was critically low for most of the key targeted species within the recreational fishery. These data suggest that fishing has been a dominant factor influencing reef fish community structure. Baseline data collected from recently established no-take reserves will eventually enable managers to distinguish between impacts from fishing and those from changes in water quality from Florida Bay.

Florida Bay Inner Basins Circulation and Exchange Study: Northeast and Western Basins

N. Melo (UM); T. N. Lee, V. Kourafalou and E. Williams (UM.); E. Johns and R. Smith (NOAA)

We study the circulation and exchange rates influencing salinity variability in the eastern and western regions of Florida Bay so as to better understand and predict the future effects of proposed changes to water delivery to the bay as part of Everglades restoration plans. Of particular concern are the periodic occurrences of hypersaline conditions in some parts of the Bay. Local wind forcing was found to be the dominant mechanism driving inner basin exchange and sea level variability in Florida Bay. Average flushing rates are low, suggesting s residence time of about 2 months. Changes in regional hydrology could impact these flushing rates considerably.

Studying Early Life History Processes in Corals to Develop Better Management Protocols in the Florida Keys

M. J. A Vermeij and M. W. Miller (UM)

In order to better understand the dominant structuring processes in coral communities we investigated the influence of variable environmental conditions on larval behavior and survival. Planktonic stress is an important factor affecting both pre- and post-settlement behavior and survival. Our studies of larval stages suggest that reef management strategies should include the factors that affect early life stages in corals, and not focus solely on factors shaping adult populations. Incorporation of these findings in new management protocols will improve the protection of Florida Keys reefs in the future.

Status of *Acropora* spp. Populations in South Florida: Proximal Causes of Mortality

D. E. Williams and C. Fasano (UM); M. W. Miller (NOAA)

We characterize the various sources of mortality affecting juvenile and remnant *Acropora palmata* and *A. cervicornis* populations and establish their relative importance to the population. Our strategy is to document the status and distribution of *Acropora* spp. in the upper Florida Keys and to observe mortality rates in relation to environmental variables. A disease outbreak that impacted 60% of the tagged colonies occurred shortly after the start of this study. By following the course of this outbreak, we are developing a better understanding of the factors affecting mortality and the manner in which diseases spread through colonies.

Coral Health and Monitoring Program Data and Information Products

L. Florit and M. Gurnée (UM); J. C. Hendee (NOAA)

The Coral Health and Monitoring Program (CHAMP) aims to improve and sustain coral reef health by providing services to the research community as well as the general public. To this end we have developed a coral reef monitoring capability at reef station sites using cameras which broadcast live via the CHAMP website. These data are made available over a website interface along with other reef information products. As a part of outreach we provide an online email list server for coral research topics and for discussion groups.

Theme 4: Human Interactions with the Environment

Use of Climate Prediction to Support Decision-Making in Argentine Agriculture

G. Podestá, D. Letson, and K. Broad (UM)

The goals of this project are: to carry out a multidisciplinary assessment of the consequences of seasonal-to-interannual climate variability linked to the El Niño-Southern Oscillation (ENSO) phenomenon on Argentine agriculture; and to develop a set of tools and methodologies for the effective use of ENSO-related climate forecasts in agriculture. Our study reveals a widespread interest in climate information, but also pervasive lack of knowledge and, thus, mistrust about the current capabilities and limitations of climate forecasting techniques. We are using these results to develop a knowledge-support tool that will enable farmers to explore the outcomes of different management alternatives under various climate scenarios (e.g., a wet spring). These climate tools will eventually developed for use by farmers in the US.

Simulation of Management Strategies

D. J. Die and K. Kleisner (UM.); G. Scott and J. Powers (NOAA)

This project has developed an analysis framework for statistical evaluation of fishery management strategies. It is linked to an international project funded by the European Union and involving fishery institutions in France, the United Kingdom, Spain, Portugal, and two international fishery commissions, the International Council for the Exploration of the Sea (ICES) and the International Commission for the Conservation of Atlantic Tunas (ICCAT). The framework has been used to evaluate both theoretical and real fisheries including those for Atlantic Yellowfin tuna and Atlantic marlins as part of the work of ICCAT. We are working to expand the simulation framework so that it can incorporate state-of-the-art operating and assessment models that can be applied to the study of management strategies for highly migratory species.

Theme 5: Air-Sea Interactions and Exchanges

Interpretation of SAR-Observed Boundary Layer Structures

W. Drennan (UM)

The development of tropical storms and hurricanes is strongly controlled by sea-air energy fluxes. Our program focuses on boundary layer processes that affect these fluxes. Measurements of turbulence fluxes made from the NOAA P3 aircraft during hurricanes Isidore and Lili show the presence of roll cells. The generation of roll cells has implications for the air-sea exchanges that impact on hurricane modeling and predictability.

Hurricane Heat Content Estimates For Intensity Forecasting Using SHIPS in Support of the Joint Hurricane Testbed

L. K. Shay (UM); M. DeMaria (NOAA); M. Mainelli (NOAA)

Hurricanes derive their energy from the ocean. The exchanges of heat and momentum at the air-sea interface plays a critical role in hurricane development. We use radar altimeter data to estimate oceanic heat content coupled with the seasonal climatology in the Atlantic Ocean Basin. These were used each day in intensity forecasts using SHIPS model at NHC/TPC. This procedure lead to improved intensity forecasts by over 5%. These oceanic heat content data are now a viable parameter in the data stream for hurricane forecasts.

Assay and Sensor Development to Identify, Detect, and Quantify Microbial Contaminants

K. Goodwin, S. Cotton and J. Fell (UM); P. Ortner (NOAA)

This project aims to apply advances in biotechnology to water quality monitoring. We are developing improved methods of monitoring for harmful algal blooms and bacterial contamination. We designed and developed a microplate assay to detect the toxic dinoflagellate Karenia brevis. The technique was successfully used in seawater samples where sensitivity was sufficient to detect “low” and “very low” amounts of K. brevis. We have also developed probes for the toxic dinoflagellate K. mikimotoi, and a series of bacteria that are used for indicators of sewage contamination in coastal waters.

Evaluating Microphysical Parameterization Schemes for Use in Hurricane Environments

R. Rogers (UM); R. Black (NOAA)

The development of tropical cyclones is strongly influenced by cloud microphysical processes. In order to improve predictions, we need to model microphysical processes. In this study we evaluate the performance of a commonly-used, yet relatively sophisticated, microphysical parameterization scheme used in high-resolution simulations. These comparisons show that the scheme leads to large errors in some model fields. The production of snow and graupel is too large in the model, the fallout speeds are too small, and the conversion of snow and graupel to rain is too slow, producing reflectivities and hydrometeor concentrations higher than what are typically observed in tropical cyclones. These deficiencies can seriously impact on model performance and they clearly need improvement.

Real-Time Hurricane Wind Analysis

N. Carrasco, N. Morisseau-Leroy, S. Otero and R. St. Fleur (UM); Mark Powell (NOAA)

To improve our understanding of tropical cyclones and to disseminate data rapidly to users and the public we need to develop advanced computing technology tools. To this end we developed a series of applications for the efficient collection of near-real-time meteorological observations and a robust java application for viewing and working with these observations and performing the analyses of hurricane winds. The HRD Real-time Hurricane Wind Analysis System (H*Wind) is a distributed system that ingests real-time global tropical cyclone observations measured by land-, sea-, space-, and air-borne platforms. These data and a variety of graphical hurricane-related products are available via automated web posting. Over the past 12 months much effort has been dedicated to transition H*Wind for operational use at the National Hurricane Center.

Air-Sea Interactions in Tropical Cyclones

E. W. Uhlhorn (UM); P. Black (NOAA)

The prediction of hurricane intensity remains a major issue because of the considerable uncertainty in many of the physical processes that control hurricanes especially the exchanges of heat, momentum and moisture at the air-sea interface. We find that the decrease of hurricane inner-core sea-surface temperatures (SST) below the ambient unforced environment is significantly less than that observed in the cold-wake region days after the storm's passage. Although the change in SST is small, the differences in heat fluxes associated with this change can be dramatic in regions where the highest winds occur. Hurricane models must be able to capture this variability if they are to yield accurate predictions. In one test of parameterization schemes, the radial distribution of the azimuthal average surface momentum, heat, and moisture fluxes in a hurricane were examined based on a set of co-located observations. The variability of the computed maximum surface fluxes based on the choice of parameterization scheme is extremely large. This uncertainty represents a severe flaw in models of hurricanes, and is one major reason that numerical models are unable to accurately predict changes in intensity.

Theme 6: Integrated Ocean Observations

US Argo Project: Global Ocean Observations for Understanding and Prediction of Climate Variability

X. Xia and E. Forteza (UM); R. L. Molinari, C. Schmid, R. Sabina and Y.-H. Chong Daneshzadeh (NOAA)

The Argo Project involves observational studies designed to improve our understanding of interannual to multidecadal ocean variability. The strategy is to deploy 1000 profiling floats within 5 years. These will be part of a global array of 3000 floats. The system runs in a 24/7 mode. The initial focus is in the North Atlantic were the data are used to study the spreading of Antarctic Intermediate Water (AIW) in the tropical Atlantic. The variability of the AIW flow on annual and smaller time scales was resolved in the Argo data and the dynamic characteristics were analyzed in the framework of the linear wave theory. The major modes of the variability can be described by planetary waves with periods of one year, 66 days and 45 days.

Sustained XBT Observations for North Atlantic Climate Variability Studies

Q. Yao (UM); M. Baringer, S. Garzoli, and G. Goni (NOAA)

Our objective is to study the upper-ocean thermal structure of the North Atlantic which plays a large role in climate. Our strategy is to carry out an extensive array of XBT monitoring programs aboard Volunteer Observing Ships (VOS) following routes across the major Atlantic current systems. Ships currently follow four lines. Measurements have recently been extended to the South Atlantic by deploying XBTs on a line that links South Africa with Buenos Aires, Argentina, and crosses two important current systems, the Brazil Current and the Benguela Current. These data are available on a web site.

The Impact of the Saharan Air Layer on Atlantic Tropical Cyclone Activity

Project Personnel: Jason Dunion and Joseph Prospero (UM/CIMAS); William Barry, Michael Black, Neal Dorst, Steve Feuer, John Kaplan, Christopher Landsea, Paul Leighton, Frank Marks, Mark Powell, and Robert Rogers (NOAA/AOML)

Long Term Research Objectives And Strategy:
To understand the affects of the Saharan Air Layer (SAL) on the intensity of Atlantic tropical cyclones. These objectives include improving our understanding how the SAL's strong winds, dry air, and embedded mineral dust affect tropical cyclone intensity change.

Link To NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy I: Increase understanding of the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change. Strategy II: Improve intraseasonal and interannual climate forecasts.

Tropical storms and hurricanes often develop from easterly waves which emerge from the west coast of North Africa every 4-5 days during the summer and early fall. The cyclones often interact with the Saharan Air Layer (SAL), a hot, dry, dust-laden layer of air often found over the tropical Atlantic.

The SAL is a prominent meteorological feature over the tropical Atlantic during the summer. We are interested in the SAL because of its possible impact on the development of easterly waves, tropical storms and hurricanes. The SAL has its origins over North Africa where a well-mixed, dry adiabatic layer forms over the Sahara Desert and Sahel regions of North Africa during the late spring, summer, and early fall. As this air mass emerges from the northwest African coast, it is undercut by cool, moist low-level air and forms the Saharan Air Layer. The SAL is often associated with a mid-level easterly jet and contains very dry air and substantial mineral dust lifted from the arid desert surface over North Africa. A temperature inversion occurs at the base of the SAL where very warm Saharan air overlies relatively cooler air above the ocean surface.

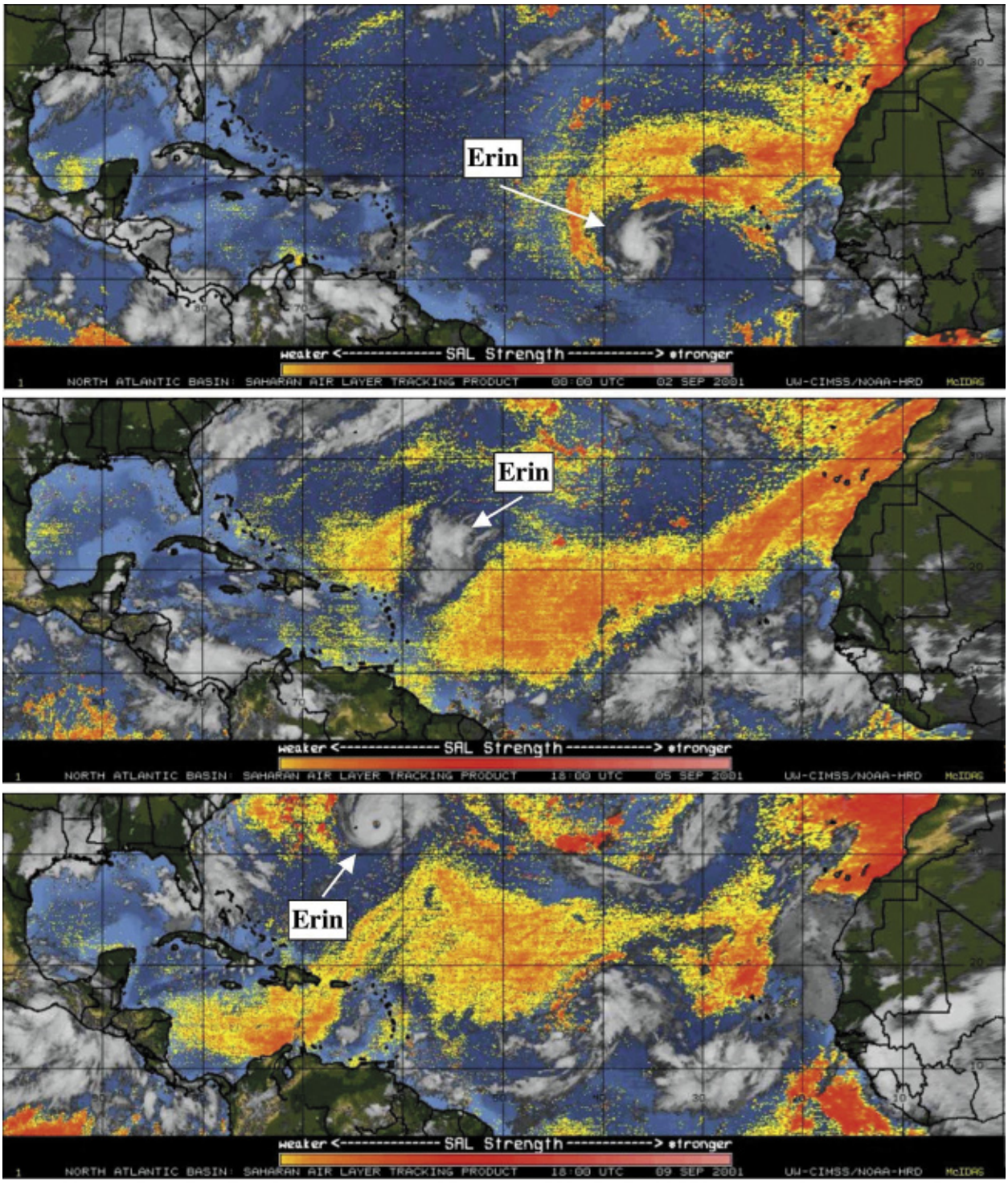


Fig. 1: Recently developed GOES SAL tracking satellite imagery showing Hurricane Erin's interaction with the SAL from 2-9 September 2001. The yellow and red shading indicates likely SAL regions with increasing amounts of dust content and dry lower tropospheric air. Erin struggled to maintain its intensity while it was embedded in the SAL and rapidly intensified to major hurricane strength after it emerged from the SAL's influence.

We developed a multi-spectral GOES infrared satellite product that enables us to follow the SAL as it moves westward over the tropical Atlantic. Our observations suggest that when the SAL engulfs tropical waves, disturbances, or pre-existing tropical cyclones it tends to inhibit their intensification possibly because of the effects of the extremely dry air, the strong temperature inversion, or the mid-level easterly jet which increases wind shear. The SAL's influence on tropical cyclones may be an important factor in the tropical cyclone intensity forecast and it may act to inhibit tropical cyclone activity in the Atlantic which is markedly less than in the Pacific. The GOES technique is being used to increase our understanding of the interaction of tropical cyclones and the SAL and it should lead to more accurate forecasts.

Characterization of Tropical Atlantic Shallow Meridional Overturning Cells and Their Interaction with the Atmosphere

Project Personnel: Rana A. Fine (UM/RSMAS); Robert L. Molinari (NOAA/AOML)

Long Term Research Objectives and Strategy:
To characterize the mean and time dependent properties of the Subtropical and Tropical Cells of the North and South Atlantic oceans and their interaction with the atmosphere.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To increase understanding of the dynamics and impacts of coupled atmosphere/ ocean/ land systems through research on climate variability and change.

Our work has concentrated on shallow meridional overturning cells (STCs) in the North Atlantic. Through the effect of these circulations on SST distributions described previously, the cells have been proposed as the oceanic component of coupled modes of air-sea variability that influence atmospheric climate on decadal time scales.

Three areas of research related to STCs were pursued. (1) The first subduction and formation rates of STUW in the North and South Pacific oceans were estimated. The work used tracers, drifters, and satellite data to estimate subduction rates, and look at their interannual variability. A major conclusion is that gyre intensity and wobble need to be considered in evaluating temporal changes in subduction rates. (2) A global comparison of the subduction rates of STUW show differences in wind and buoyancy forcing between the oceans, which effect the subduction rates, and lateral induction and vertical pumping. A major conclusion is that the subduction process depends implicitly on the large scale circulation, and the combination of the outcrop pattern of the winter mixed layer depth and the air-sea fluxes. (3) We look at interannual variability of the rate of subduction of STUW in the North Atlantic, and its pathways and fate. The largest affect of using XBT data as compared to climatology for mixed layer depths and gradients in the North Atlantic is on both the lateral induction and vertical pumping terms, which can each increase by 10 m/y over a decade. As a consequence, subduction rates can be nearly double those from climatology. The data suggest that the subduction rate increases in the North Atlantic during low North Atlantic Oscillation years. In addition, a review on STCs in the Atlantic Ocean was prepared and delivered at the CLIVAR conference on STCs in Venice. The main conclusion of the review of modeling and observational studies was that we can quantify the mean state of the South Atlantic's STC but not the variability. For the North Atlantic STC, it is not yet clear if a "canonical" STC (i.e., one closed in the tropics by equatorial upwelling) is present.

Western Boundary Current Time Series

Project Personnel: Christopher S. Meinen (UM/CIMAS)

Long Term Research Objectives and Strategy:
To understand the movement of water and heat around the global ocean and to determine ways in which these transports affect climate. This will be studied using a wide range of observations ranging from satellite measurements to direct ocean measurements of heat and current.

Link to NOAA Strategic Plan:
This research will contribute to NOAA Mission Goal 2 by improving the understanding of the strong year-to-year changes in ocean heat content and ocean transport, which will lead to better understanding of the physical processes driving these year-to-year changes.

Climate models have shown that variations of the transport of the Deep Western Boundary Current in the Atlantic Ocean have significant impacts on the climate at both the national and global level. Long term observations of the DWBC will be required in order to quantify the natural scales of variability of the current, however because the DWBC has no surface expression it is necessary to make direct measurements of the current using instruments directly moored in the current's path. Such moorings are expensive, so all effort must be expended to seek the most inexpensive but accurate method for monitoring the current variations.

In the less-than one year I have been working at CIMAS, I have made comparisons between indirect observations made by moored inverted echo sounders and direct measurements made by moored current meters. The former, in combination with historical data on the temperature and salinity of seawater as well as with measurements of bottom pressure, have been shown to accurately reproduce the measurements of the current meters. The combined cost of the inverted echo sounders and bottom pressure gauges are a fraction of the cost of the moorings with current meters on them, and this combination of instruments represents a much more cost effective method for monitoring DWBC changes over time.

Initial Steps Towards a Global Surface Water pCo_2 Observing System

Project Personnel: Frank J. Millero (UM/RSMAS)

Long Term Research Objectives and Strategy:
Determine the changes in the pCO_2 in the Atlantic and Pacific Ocean waters in order to examine the uptake of fossil fuel CO_2 by the oceans over time. This is being done by using volunteer observing ships (VOS) in the Atlantic and Pacific oceans.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond.

The oceans are thought to take up 40% of the CO_2 produced from the burning of fossil fuels. Much of this CO_2 is taken up by the oceans in cold waters that have partial pressures of CO2 that are lower than the values in the atmosphere. The driving force for the flux of the gas into the ocean is the difference in the partial pressure of CO_2 (pCO_2) in the oceans and atmosphere. When the pCO2 in the atmosphere is higher in the atmosphere than in the ocean, the CO_2 will dissolve in the ocean waters. When the cold and salty ocean waters of the North Atlantic sink they carry this CO2 into the deep oceans. At the present time few continuous measurements of pCO_2 are available in the major oceans as a function of time. This makes it difficult to determine the variability of the uptake of CO_2 as a function of time. This research study is the first step to developing a global network that can be used to monitor the flux of CO_2 into and out of the oceans.

Tropical/Subtropical Interactions

Project Personnel: Claude Frederick Lumpkin (UM/CIMAS)

Long Term Research Objectives and Strategy:
To describe and understand ocean circulation and its variability, and analyze and assist in maintaining the array of surface drifting buoys. Studies of circulation, isopycnal and diapycnal mixing, and near-surface heat budgets will involve analysis of in-situ and remote observations, and water transformation rates will be derived from a synthesis of these observations and estimates of air-sea heat and freshwater fluxes.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Relevant research addresses seasonal to interannual variability in near-surface circulation and heat budgets, which directly impacts air-sea exchanges. NOAA Mission Goal 3: Serve society's needs for weather and water information.

The tropical Atlantic array of surface drifters was virtually nonexistent a few years ago. Since 1997, it has grown dramatically and offers observations of near-surface circulation at unprecedented resolution. In concert with other observations, these data help us understand how the ocean transports properties, why variations have their observed structure, and what the implications are for air-sea exchanges.

Lumpkin has developed tools for examining these observations (Lumpkin, 2003), has presented results at several meetings, and is currently preparing a manuscript in collaboration with Silvia Garzoli (NOAA/AOML) describing

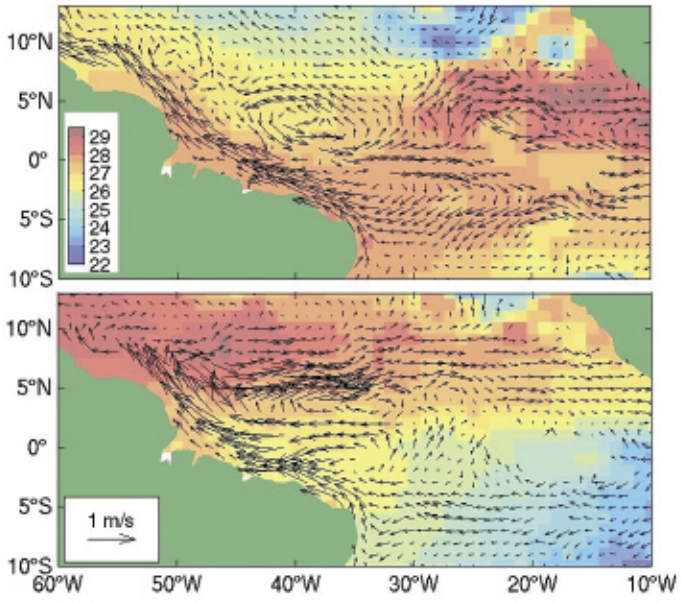


Figure 1- sea surface currents (arrows) and temperature (shading, °C) in the tropical Atlantic Ocean, during early May (top panel) and early October (bottom panel). These climatological fields were calculated from satellite-tracked surface drifting buoy observations, and reveal strong seasonal variations at unprecedented spatial resolution. By combining currents and temperature, heat transports can be estimated. These transports supply or remove heat for downward mixing and exchange with the atmosphere, and may have profound impacts upon regional climates. Ongoing maintenance of the tropical Atlantic drifting buoy array is supported by NOAA/OGP, and will – as temporal coverage is extended – provide direct measurements of interannual variability throughout this crucial basin.

Western Boundary Current Climate Time Series

Project Personnel: Carlos A. Fonseca (UM/CIMAS); Molly Baringer (NOAA/AOML)

Long Term Research Objectives and Strategy:
To understand Atlantic Ocean's role in decadal and longer time scale climate variability through the continued time series at Abaco.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: Monitoring of the Deep Western Boundary Current for watermass and transport signatures to track decadal changes in large-scale watermass properties.

Heat fluxes over the Atlantic play an important role in climate. Because the western boundary current is the endpoint of a subtropical Meridional Overturning Circulation (MOC), heat flux can be monitored by measuring the interior dynamic height difference across the Atlantic basin and the associated baroclinic heat transport. Also, by monitoring the intensity of the Antilles current as an index (together with the Florida Current) of inter-annual variability in the strength of the subtropical gyre, we can evaluate its relationship with the North Atlantic Oscillation (NAO), an important mechanism in the atmosphere-ocean feedback proposed in coupled models.

In this program a total of 54 stations were occupied during the 2003 cruise. At each station profiles of velocity, pressure, salinity (conductivity), temperature, and dissolved oxygen concentration were measured. Water samples were collected at various depths and analyzed for salinity and oxygen concentration to aid with CTD calibration. Underway thermosalinograph data and bathymetry data were also collected. A survey of the bathymetry in the Florida Straits near 27_N was also conducted, using the Seabeam 2112 (12 kHz) swath bathymetric sonar system, to aid in the analysis of ocean transport measurements made by a submarine cable in that area.

We are developing the methods, algorithms and software to calibrate CTD data using two parameters provided by water samples: conductivity of seawater and dissolved oxygen. We are following the specifications of the sensors as well the standards of the WOCE program.

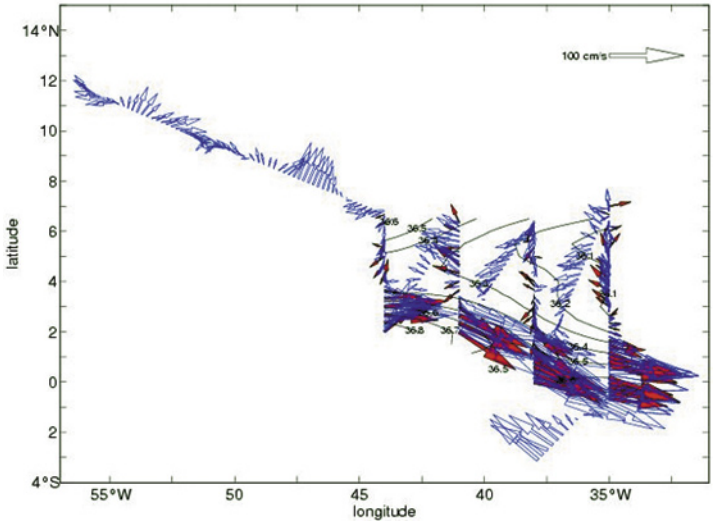


Figure 1: Salinity and velocity vectors (red: LADCP, blue: ADCP) in the salinty maximum of the Subtropical Underwater.

Development of a Hybrid Coordinate Ocean Model with Data Assimilation Capabilities

Project Personnel: Sang-Ki Lee (UM/CIMAS) George H. Halliwell, Jr. (UM/RSMAS); William C. Thacker (NOAA/AOML)

Long Term Research Objectives And Strategy:
To develop data-assimilating capability for HYCOM, which provides the framework for an ocean climate change forecasting system.

Link To NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To increase understanding of the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change.

Atlantic XBT data for 1972-1991 have been assimilated into the model. This has yielded a significant correction. Assimilation brings the simulation into much closer agreement with the climatology. Between monthly assimilations, there is little tendency for the model to regress toward the uncorrected mean conditions. Currently, twin experiments are being carried out to refine the assimilation scheme. These include a study of the optimal period of data assimilation and the error covariance model.

Repeat Hydrography Surveys in Support of CLIVAR and Carbon Cycle Science Programs

Project Personnel: Kevin Sullivan (UM/CIMAS); Rik Wanninkhof (NOAA/AOML)

Long Term Research Objectives and Strategy:
To update the inventory of dissolved inorganic carbon in the oceans by carrying out repeat hydrography cruises. These data are necessary to improve the forecasting skill for the oceans and global climate and are important benchmarks for more autonomous monitoring instruments.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: carry out sustained physical, chemical, and biological observing components, including carbon dioxide, as part of a comprehensive system in support of climate assessments and forecasts.

Monitoring the changing patterns of carbon dioxide (CO_2) in the ocean yields data that will improve forecasting skill for oceans and global climate. The recent WOCE/JGOFS global carbon survey program yielded the first comprehensive inventory of anthropogenic CO_2 in the ocean. The total anthropogenic inventory of dissolved inorganic carbon (DIC) into the ocean can be determined using concurrent hydrographic, alkalinity, oxygen, nutrient and tracer measurements. We initiated a series of cruises reoccupying the WOCE/JGOFS transects so as to characterize the long-term changes in DIC and related biogeochemical parameters.

An important component of DIC is the partial pressure of dissolved CO_2 (pCO_2). The pCO_2 is a sensitive indicator of biological activity throughout the water column and a critical component in the surface water in assessing the air-sea CO_2 flux. An instrument to measure pCO_2 in discrete samples was refurbished prior to the first of the repeat hydrographic cruises. In addition to replacing and reconfiguring components,

tests were done to ensure accurate and precise analyses. The discrete pCO2 instrument was installed in a mobile laboratory van that was also outfitted with two instruments to measure DIC and with the necessary ancillary equipment.

The laboratory van was installed on the R/V Ron Brown in Charleston, South Carolina, along with two other laboratory vans and equipment from 14 research institutions. The initial leg of the cruise transited to Iceland. During the transit the performance of the pCO_2 and DIC instruments were optimized and were used to analyze samples collected underway. The transit leg was successful as well as the following two legs of the cruise that extended south through the equator

Studies of Pacific and Atlantic Climate Variability

Project Personnel: Chunzai Wang, David B. Enfield (NOAA/AOML), Chithrabhanu Shaji (UM/CIMAS).

Long Term Research Objectives and Strategy:
To understand variability of the El Niño-Southern Oscillation (ENSO) and Atlantic climate and to assess the linkage between the Pacific ENSO and tropical Atlantic variability.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To increase understanding of the dynamics and impacts of coupled atmosphere-ocean system through research on climate variability and change, and to improve seasonal-to-interannual climate forecasts.

Analyzing observational data, we found that the Walker and Hadley circulations are closely related to ENSO, the tropical Atlantic meridional gradient variability, the Atlantic Niño, the North Atlantic Oscillation, the Western Hemisphere warm pool. Data analyses showed that the Pa-

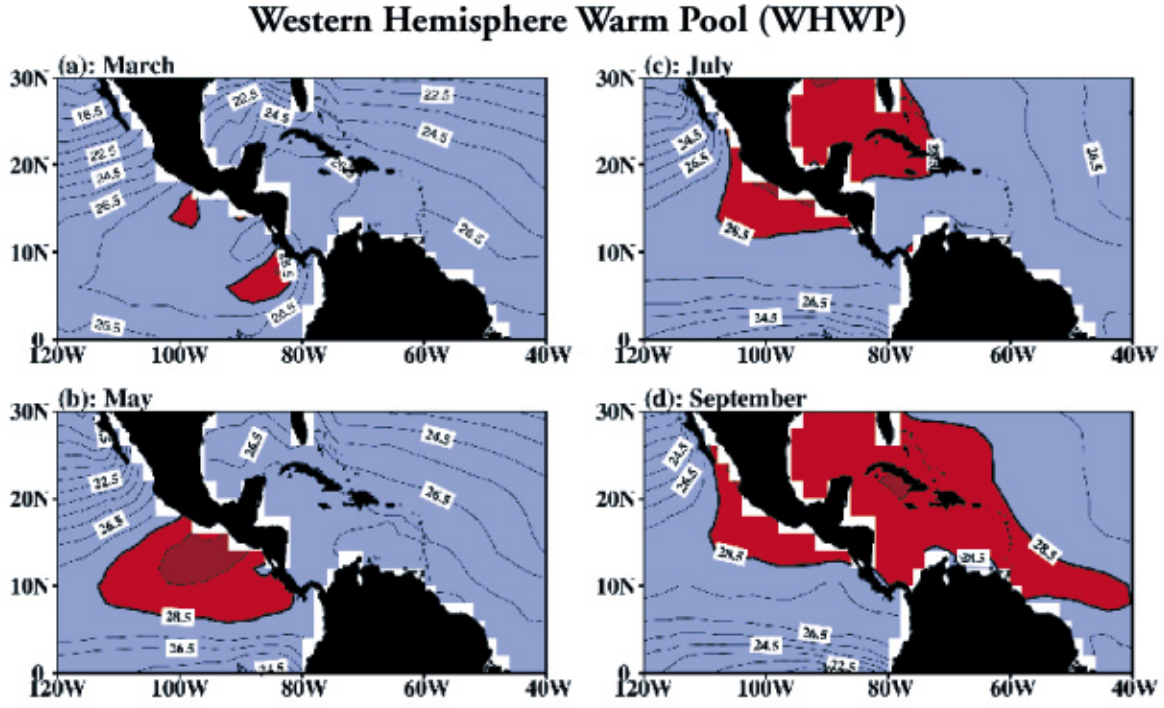


Figure 1- The tropical western warm pool (WHWP) as defined by sea surface temperature in excess of 28.5° for the months of (a) March, (b) May, (c) July, and (d) September.

cific ENSO can affect tropical Atlantic climate variability through the Walker and Hadley circulation cells.

The tropical Western Hemisphere warm pool (WHWP), defined as having sea surface temperature (SST) in excess of 28.5°C, extends from the eastern North Pacific to the Gulf of Mexico and the Caribbean, and the western tropical North Atlantic. Surface heat fluxes warm the WHWP through the boreal spring to an annual maximum of SST and areal extent in the late summer/early fall. Interannually, we found that a positive ocean-atmosphere feedback operating through longwave radiation and associated cloudiness seems to be responsible for the WHWP SST anomalies. The WHWP is related to climate over North and South Americas and Atlantic hurricane.

We developed a new version of HYCOM model to simulate the tropical Pacific and Atlantic Oceans. The model is able to simulate major features of ocean circulation and temperature in the tropical Pacific and Atlantic. The model will be used to study seasonal-to-interannual climate variability in the tropical Pacific and Atlantic.

North Brazil Current Retroflection and Transports

Project Personnel: Amy Field and Williams E. Johns (UM/RSMAS); Qi Yao (UM/CIMAS); Silvia L. Garzoli (NOAA/AOML)

Long Term Research Objectives and Strategy:
To understand the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change.

Link to NOAA Strategic Plan:
Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond.

We participated in a large program, the North Brazil Current Rings Experiment, to study the transport of the North Brazil Current before it retroflects towards the interior of the tropical Atlantic. Results of the analysis indicate that the excess in the return flow is due to North Atlantic water joining the reflected flow from South Atlantic. The combination of both flows constitutes the North Equatorial Counter Current. Also the time series of the NBC transport are compared with the westward penetration of the NBC.

It is concluded that there is a direct relation between the latitude of penetration, the number of rings shed and the intensity of the NBC. This relation cannot be simply explained by the potential vorticity argument relating the latitude of separation of the current to the volume transport. These currents play an important role in energy transports which have a role in climate.

A Study on the MJO-ENSO Problem

Project Personnel: Javier Zavla and Chidong Zhang (UM/RSMAS)

Long Term Research Objectives and Strategy:
To understand how the MJO would affect the evolution and prediction of ENSO by using coupled atmosphere-ocean models of different complexity

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To increase understanding of the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change.

The objective of this research is to describe and quantify the Madden-Julian Oscillation (MJO) effect on the ENSO variability. We have isolated the uncoupled variability from observations, characterized the MJO of this uncoupled variability and studied the effect of these estimates on a hierarchy of numerical models. The results indicate that it is the low-frequency component of the MJO that can be important to ENSO. The low-frequency component comes from the irregularity of the MJO on the interannual timescales. The nonlinear rectification of the high-frequency component of the MJO suggested by some previous studies is not reproduced. During a warm event under development, however, oceanic Kelvin waves forcing by the MJO during boreal winter can be important to the evolution of that event.

Application of a Hybrid Coordinate Ocean Model for Simulating the Tropical Pacific and Atlantic Oceans

Project Personnel: Chithrabhanu Shaji (UM/CIMAS); Chunzai Wang (NOAA/AOML)

Long Term Research Objectives and Strategy:
To Study the large-scale ocean-atmosphere interactions in the Tropical Pacific and Atlantic Oceans using observed and model simulated results.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To increase understanding of the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change.

The Hybrid Coordinate Ocean Model named HYCOM is an emerging ocean tool. The advantage of this model is that it is well suited for studying the space and time variability of circulation and hydrographic properties in the upper as well as the deep ocean. We have used HYCOM configured in a non-uniform horizontal grid for studying the upper ocean dynamics in the tropical Pacific and Atlantic Oceans. Initially several test experiments were performed for the model calibration. Then a monthly ocean climatological simulation was successfully performed, wherein the climatic surface wind stress and the thermal forcing acted as the main model forcing fields. The model simulated the general features and the seasonal changes of the equatorial current system in the upper ocean in both the tropical Atlantic and Pacific basins quite satisfactorily. The upper ocean currents, temperature and many features of the thermocline are realistically modeled. In both the tropical oceans, the simulated major surface zonal flows, with its location and seasonality, can be compared with the currents from the satellite-tracked drifters. It is found that in general, the simulated currents are slightly weak compared to the observation. In addition to the comparison of model currents with the observed currents, the model fields are also being compared with the observed sea surface height, and the currents and temperature obtained from the Tropical Atmosphere Ocean (TAO) array region in the Pacific. The model thermocline generated the observed slopes, ridges and troughs very reasonably.

Another high-resolution model was also developed in which the model domain is further extended to the high latitude regions. This high resolution model yields a better mean ocean state compared to the present model simulation. After a successful simulation of the climatic mean state the model will be used for interannual simulations to study (1) the ENSO mechanism, (2) the tropical warm pool in the Atlantic Ocean and (3) the meridional overturning circulation. Work in that direction is currently in progress.

Moisture Budget in the Intra-Americas Sea, its Transport into North America and their Roles in Warm-Season Precipitation

Project Personnel: Alberto M. Mestas-Nuñez (UM/CIMAS) Chidong Zhang and Bruce Albrecht (UM/RSMAS); David B. Enfield (NOAA/AOML)

Long Term Research Objectives and Strategy:
To explore the connection among the warm pool of the Intra-Americas Sea (IAS), its moisture budget, moisture transport from the IAS into North America, and warm-season precipitation over North America. These quantities will be diagnosed using observations from a sounding network around the IAS, the Eta regional model analysis, the NCEP/NCAR global model reanalysis, and other datasets.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To increase understanding of the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change.

We are archiving Eta regional analyses that includes the 2002 and the on-going 2003 warm seasons. We have also archived NCEP/NCAR global re-analyses, and twice-daily atmospheric sounding data around the IAS. We have estimated the water vapor fluxes for July 2002 using sounding stations with available Eta Model Output Location Time Series (MOLTS). For July 2002, the vertically integrated moisture fluxes from soundings and Eta MOLTS agree very well. This indicates that the Eta analyses can be used to estimate the moisture fluxes in the IAS. The net moisture flux divergence (evaporation minus precipitation) over the IAS region estimated from the soundings is 2.4 mm/day, which agrees very well with estimates from the Eta MOLTS (2.7 mm/day). This means that during this period, neglecting the local storage of moisture, evaporation in the IAS exceeded precipitation by that amount.

Uncertainties in the flux estimates due to the crude representation of the IAS boundary by the polygon joining sounding sites, which includes inland stations, and to the assumption of linearly varying fluxes between sites are estimated using the full resolution Eta regional analysis fields. We found that a larger error is introduced by assuming a linearly varying flux field between stations than by the rough approximation of the IAS boundary by the polygon of sounding sites. These two errors combine to give a very large underestimation of the moisture flux divergence when compared to estimates using the full resolution Eta analyses with a more realistic boundary (about 7 mm/day for July 2002). We therefore conclude that the sounding data is not adequate for estimating the IAS moisture flux divergence.

We have verified our moisture flux divergence estimates by applying the Gauss theorem (using an area integral of the divergence of the flux in the interior of the IAS instead of a line integral of the flux along the boundaries of the IAS) to the Eta moisture flux fields and obtained very similar results. We have also investigated uncertainties in the moisture flux divergence estimates associated with different spatial and temporal resolution of the atmospheric analyses. The flux divergence estimates do not change much when using 2-time or 4-time daily temporal sampling or when using 32-km (grid size of the Eta model) or 2.5° (grid size of the NCEP/NCAR global re-analyses) horizontal spatial sampling. In conclusion, estimates of the IAS moisture flux divergence are not very sensitive to the method, horizontal resolution or daily sampling frequency.

Using the full resolution Eta analysis fields for July 2002 we also estimated the moisture flux divergences in the Gulf of Mexico and the Caribbean Sea with boundaries similar to Hastenrath [J. Appl. Meteor., 1966]. Our estimates of the Gulf of Mexico and Caribbean moisture flux divergences are about 6 and 10 mm/day, respectively. Therefore, evaporation exceeds precipitation in both regions by these amounts. These estimates of moisture flux divergence are much larger than those of Hastenrath who used sounding data for July 1960 and obtained 1 mm/day for both the Gulf of Mexico and the Caribbean Sea.

North Atlantic Decadal Variability and the Formation of Tropical Storms and Hurricanes

Project Personnel: Alberto M. Mestas-Nuñez (UM/CIMAS); Robert L. Molinari (NOAA/AOML)

Long Term Research Objectives and Strategy:
To understand the association between Atlantic climatic variability and Atlantic tropical storm activity. This objective is accomplished through statistical analysis of historical observations of tropical storm frequency and of oceanic and atmospheric variables.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To increase understanding of the dynamics and impacts of coupled atmosphere/ocean/land systems through research on climate variability and change.

Atlantic tropical storm activity shows trends over time, sometimes increasing and sometimes decreasing. By studying these trends and their relationship to climatic variables we hope to gain an understanding of the causes behind these trends. With such knowledge we could improve our ability to predict future hurricane activity and thereby to perhaps mitigate societal impacts.

We have observed that the annual number of Atlantic tropical storms forming south of 23.5°N increased between the 1970's/1980's and 1995-2000 along with the frequency of major hurricanes. These increases were coincident with a general multi-decadal warming trend in North Atlantic sea-surface temperatures (SST). This long-term SST trend suggests that the high activity over 1995-2000 may persist for the next ~10 to 40 years.

However, the association of hurricanes with SST trends is complicated by the observation that during 1950-2000 there were strong decadal SST oscillations superimposed on the multi-decadal changes in both SST and tropical storms. These shorter-term oscillations modulated the occurrence of storms with positive SST anomalies being associated with increased storm activity. The decadal SST signal now appears to be entering a negative phase. This suggests that tropical storm activity, and most likely the occurrence of major hurricanes, may decrease over the next several years rather than remain at the very high 1995-2000 level when both the long-term and the decadal SST signals were in their positive phase. Tropical storm activity during 2001 and 2002 was indeed less than the expected from the multi-decadal signal but for 2002 El Niño rather than the decadal signal may be to blame for the decrease.

Abundance and Diel Migrations Of Demersal Mesozooplankton And Small Reef Fishes And Their Trophodynamic Contribution to the Coral Reef Ecosystem

Project Personnel: Sharon Smith, Jiangang Luo, Peter Lane, and Dora Pilz (UM/RSMAS); Peter B. Ortner, James C. Hendee, Shailer Cummings and Jack Stamates (NOAA/AOML); John Lamkin (NOAA/SEFC); Dave Jones (UM/CIMAS)

Long Term Research Objectives and Strategy:
To describe and quantify the functional bio-physical relationships and processes that control and impact planktonic processes associated with coral reef ecosystems. The study of these relationships is the first step in formulating future recommendations for fisheries management in coral reef ecosystems and for evaluating potential regulatory options. Sampling strategies employed during the past year included in situ multi-frequency acoustic and optical packages, acoustic Doppler current profilers (ADCPs) and traditional net tows near a coral reef in St. Croix, USVI.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: To specifically to monitor and observe the coral reef associated plankton community to provide basic information on habitat and community dynamics, with particular emphasis on biological responses to physical processes.

A variety of autonomous sensors were deployed in the Salt River Natural Historical Park and Ecological Preserve on the north shore of St. Croix, USVI. This location was selected because of the proximity to a NOAA Coral Reef Early Warning System (CREWS) station. The study site includes a relatively vibrant coral community in approximately 20-70 feet of water with nearby sandy bottom allowing non-invasive deployment of bottom moored instrumentation. The research reported here was conducted during two field studies, each lasting about 25 days, during October 2002 and May 2003. The primary instrumentation consisted of an optical plankton counter (OPC), a multi-frequency Tracor Acoustical Profiling System (TAPS) and a 300 kHz RDI acoustic Doppler current profiler (ADCP). A 1200 kHz ADCP was added during the May sampling period.

Preliminary analyses of acoustic data showed distinct daily cycles of biomass change over the reef. Further analysis is needed to resolve biomass fluxuations related to tidal cycles and fluxuations related to night-time migrations of zooplankton out of the reef and into the water column. Data from the 1200 kHz ADCP, which have yet to be analyzed, may yield further insight into the community biomass cycles over longer time scales and with greater spatial resolution. At the conclusion of the May study period, both the 300 kHz and the 1200 kHz ADCPs were re-deployed and will continue to collect data at the study site through the summer.

Laboratory analyses of net samples collected during day and night in late October yielded some preliminary information on the plankton community dynamics over the reef. When compared with ADCP current measurement data for the period during the collections (27-28 October), some observations can be made regarding the influence of the currents on mesozooplankton species composition. Three species of copepod (*Undinula vulgaris*, *Clausocalanus* sp. and *Oncaea* sp.) were found to be much more abundant in the morning sample than in the afternoon or evening samples. This observation suggest that these species were associated with a westerly flowing current, and coincidentally with the incoming tide. The copepod *Temora turbinata* was more abundant in the night sample than in the day samples, suggesting this species may migrate upward from depth at night. Ostracods were also more abundant in the night sample, again suggesting that this group may migrate upward from near-bottom daytime depths. Although these data are preliminary, it seems clear that the local current regime and the migratory behavior of some zooplankton species interact to modify the plankton community over the reef on a daily basis.

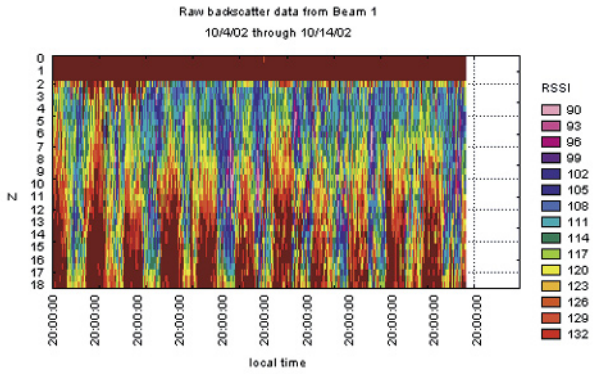


Figure 2- Acoustic backscatter from the bottom moored 300 kHz ADCP for the 10 day period in October corresponding to TAPS data shown in figure 3. Diel periodicity suggests substantial cycles in planktonic biomass in the water column each day. Note that on the Y axis bin 18 is surface and bin 0 is the bottom (i.e., figure is inverted).

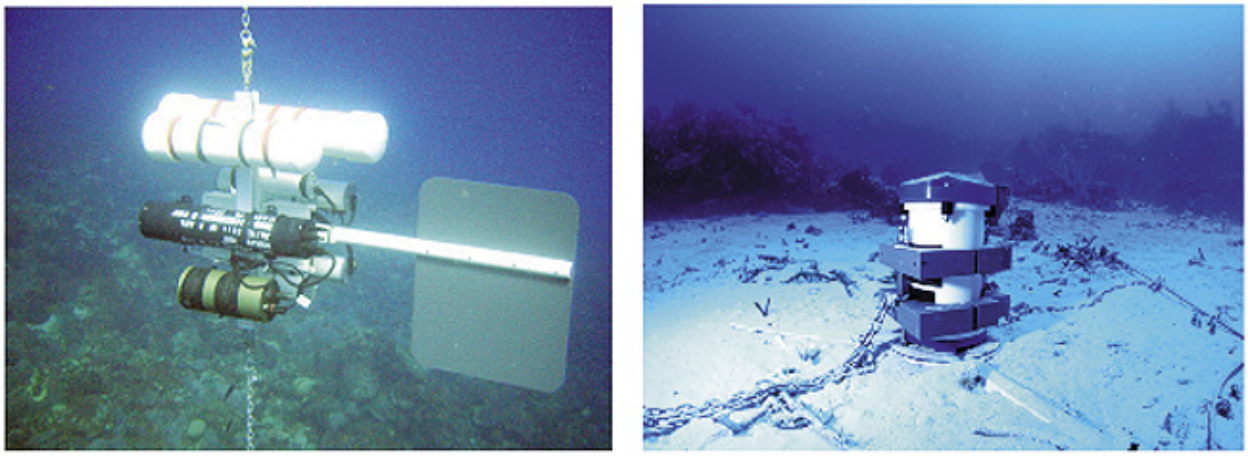


Figure 1- Autonomous instruments for measuring water column plankton and currents. The photo on left shows the multi-frequency Tracor Acoustical Profiling System (TAPS) and the optical plankton counter (OPC) on a mooring with battery packs, buoyancy canisters and current vain. Photo on right shows 300 kHz acoustic Doppler current profiler (ADCP) mounted on sandy bottom adjacent to coral reef. Photos by P. Lane and J. Luo.

Use of Geochemical Tracers to Elucidate Life History Trajectories of Gray Snapper in South Florida's Marine Ecosystems

Project Personnel: Monica R. Lara and David L. Jones (UM/CIMAS); John T. Lamkin (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
To understand life history and habitat requirements of gray snapper within Florida Bay and the Florida Reef Tract. The chemical composition of otoliths (earbones) are used as natural tags to determine which juvenile nursery habitat was used by adult snappers inhabiting the reef tract.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: To observe aspects of habitat associated communities and provide basic information on habitats and resources and understand and describe linkages among the resource components and processes. Monitor and observe all aspects of fish species to provide basic information on fish species and their habitats.

In the Florida Bay–Coral Reef ecosystem, commercially and ecologically important snapper communities are believed to migrate to the reef from other areas, such as seagrass and mangrove habitats of Florida Bay, where they may spend their juvenile phase before migrating to the coral reefs as young adults. The source of recruits is of particular importance given the recent efforts to restore Florida Bay and the establishment of Sanctuary Preservation Areas (SPA's) and the Tortugas Ecological Reserve. These protected coral reef areas need an established and protected source of recruits if they are to function as a reef fish sanctuary.

We have now defined a unique chemical signature for fishes that have resided in Florida Bay. This Florida Bay signature is a complex composite of elements including a number of rare earth elements. This study is the first in which rare earth elements have been included in an otolith chemical signature. The presence of this particular chemical composition (signature) in the otolith of a fish identifies it, with a high degree of confidence, as a fish that has resided in Florida Bay. We now have a chemical signature that can be tested for in fish that have an unknown past history of residence.

Trace elements incorporated into the otoliths (earbones) of a fish during growth will vary in composition and proportion depending on the environmental conditions to which the fish was previously exposed. Analysis of the otolith material using inductively coupled plasma mass spectrometry (ICP-MS) can separate these elements and their composition and proportions define a distinct "chemical signature". These signatures can differ among stocks exposed to different water masses and environmental conditions which allows them to serve as natural tags for tracking fishes. The ability to reconstruct the environmental history of individual fish is a significant advancement in our ability to describe life histories and habitat requirements and offers an indispensable tool for fisheries management.

Upstream Larval Supply to Florida Bay – the Dry Tortugas Connection

Project Personnel: Cynthia Yeung, David L. Jones (UM/CIMAS); Maria M. Criales (UM/RSMAS); William J. Richards (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
To understand recruitment processes and larval ecology of marine fishes and crustaceans in South Florida's marine ecosystems. To elucidate the major processes and pathways influencing the transport of pre-settlement stage larvae from spawning sites in the Dry Tortugas to nursery grounds in Florida Bay by monitoring and modeling the association between larval influx and coastal eddies.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Characterize coastal and ocean resources and conduct research to understand and describe the linkages among resource components and processes. Conduct research to understand and describe the ecological and biological aspects of fish species.

Variability in oceanographic features on regional (i.e., South Florida) and local (e.g., the Middle Florida Keys) scales has an immediate and direct effect on the influx of larval stages to Florida Bay by influencing transport pathways and offshore retention times. Our previous work brought into focus eddy processes as a key component in the recruitment model of South Florida. Our main goal now is to specifically test the hypothesis that the presence of a coastal eddy significantly enhances the influx of pre-settlement stage larvae to Florida Bay.

Influx rates of pre-settlement stage larvae of fish, lobster, and shrimp entering Florida Bay were monitored at sampling sites within the Middle Florida Keys before, during, and after the passage of coastal eddies using plankton nets moored in inter-island tidal channels. Coastal eddies were tracked on a regional scale using satellite SST imagery and SSH altimetry; eddies in the vicinity of biological collection sites were tracked at higher resolutions using a Doppler-based ocean surface current radar. In addition, the radar-derived ocean current data were used to model larval transport trajectories during the presence and absence of coastal eddies.

This work is aimed at providing direct evidence that eddies offshore of the Florida Keys enhance the transport of larval recruits from spawning areas in the Dry Tortugas to nursery grounds in Florida Bay.

Two complete experiments testing our eddy hypothesis have thus far been conducted. The strength of the eddy captured in the first experiment, as well as the magnitude of its corresponding effect on the physical and biological systems of the study area, was significantly weaker than in the second experiment. A simulation model was constructed incorporating virtual larval trajectories with the radar-derived current data. Results of this model indicate that offshore flow was conducive to larval dispersal during the absence of offshore eddies, while eddy presence was associated with eddy-enhanced onshore larval transport and increased larval retention potential.

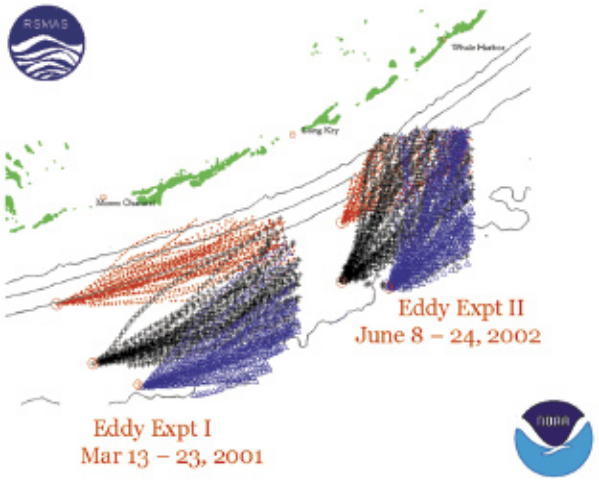


Figure 1- Simulated trajectories of drifters initiated at three positions at the upstream end of the OSCR domain during Expt I and II. Time step of the simulation was 20 minutes using averaged real-time OSCR surface current vectors. Every 6 hours, another simulated drifter particle was launched from the starting position. Simulation was stopped when the particle exited the domain.

Photo-Identification of Bottlenose Dolphins in Biscayne Bay, Florida

Project Personnel: Jesse A. Wicker (UM/CIMAS); Steven L. Swartz and Joseph P. Contillo (NOAA/SEFSC);

Long Term Research Objectives and Strategy:
Develop and maintain a long-term database on bottlenose dolphin population parameters using photographic identification techniques which can be used to monitor the overall health of the Biscayne Bay ecosystem. Facilitate sharing of bottlenose dolphin photo-ID information and images among research groups in adjacent study areas in south Florida via the Internet.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Conduct research to understand and describe the parameters of bottlenose dolphin populations in Biscayne Bay and to monitor and observe their role in the south Florida ecosystem and the impacts of human activities on them. Advise and inform decision-makers and the general public on the condition of the bottlenose dolphin population in Biscayne Bay and the affects of human interactions on them.

The National Marine Fisheries Service (NMFS) is responsible for monitoring the populations of bottlenose dolphins (*Tursiops truncatus*) in the southeastern United States waters. The main goals of this monitoring are detection of large-scale changes in bottlenose dolphin abundance and establishment of archival databases for long-term trend detection. Biscayne Bay has been greatly influenced by development of the Miami area in the past 75 years. Information from 12 years of photo-ID surveys have confirmed the presence of a relatively large, long-term resident, core population of bottlenose dolphins in the Bay. Their role as apex predators characterizes these animals as excellent indicators of the overall health of Biscayne Bay.

Aside from 20 aerial surveys (40 survey hours) conducted by Odell in the mid-1970's, very little formal research had been conducted on the abundance and distribution of bottlenose dolphins in Biscayne Bay prior to 1990. From 1990-2002, a total of 269 photo-ID surveys comprising 1335 hours of sampling effort were conducted in Biscayne Bay. Sampling has continued uninterrupted into 2003. These surveys have defined the basic parameters of the Biscayne Bay bottlenose dolphin population, including abundance, distribution, natality and mortality. To improve data management of photo-ID information in the SEFSC, and to facilitate efficient data sharing among other photo-ID research groups in south Florida, an Oracle database application was developed. This database enables "Internet web-based" online data entry, update, categorization, search, and download capabilities. The data resident on the system include scanned digital photos, associated collection information and meta-data, and allows viewing and sharing of this information between researchers and the general public via web browsers. In May 2002, a genetics-based stock-structure program was initiated, and involves a remote biopsy-sampling program to collect skin and blubber samples from dolphins that reside in Biscayne Bay. The principal aims of this program are to; (1) integrate genetic data from skin samples with photo-ID sighting data to give a clearer picture of the overall stock structure of the Biscayne Bay community and, (2) conduct contaminant analysis of the blubber samples to determine the range and degree of toxins contained within these tissues. To date, a total of 63 skin and 44 blubber samples from 45 known individuals have been collected and are currently being processed and analyzed. Additional biopsy sampling is planned.

Continuation of the established photo-ID sampling regimen and integration of photo-ID and genetic data will provide the framework for defining biologically based management units and ultimately, understanding the consequences of anthropogenic influences on the bottlenose dolphin population in Biscayne Bay.

Enhancing Competency and Metamorphosis of Laboratory Reared *Diadema antillarum* for Ecologically Based Coral-Diadema Restoration Research

Project Personnel: Thomas R. Capo and Nadiera C. Sukhraj (UM/RSMAS); Margaret W. Miller (NOAA/SEFSC); Alina M. Szmant (UNC, Wilmington)

Long Term Research Objectives and Strategy:
To develop techniques for the rearing of larval long-spined black sea urchin, *Diadema antillarum,* which plays a vital role in the ecology of coral reefs in Florida. To rear larval *Diadema* with the intent of restocking critial reef areas.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Characterize coastal and ocean resources and conduct research to understand and describe the linkages among resource components and processes.

The long spined black sea urchin, *Diadema antillarum*, plays a pivotal role in the recruitment and ecological health of the south Florida coral reef tract. Recent field studies confirm their lack of recovery since the massive 1983 die-off. The *Diadema* population collapse in 1983 triggered a drastic increase in the areal coverage of macroalgal species on south Florida coral reefs. The ensuing "phase shift" from a coral- to an algae-dominated state has been implicated in recent coral mortality. Because organisms inhabiting the coral reef are strongly interlinked, the loss of one or more key community components can result in long-term habitat degradation and possibly to irrevocable ecosystem changes. Restoration of a keystone species such as *D. antillarum* may have a positive ecological impact to coral recruitment and growth, as well as contribute to overall ecosystem health by enhancing essential fish habitat for declining and overfished stocks.

The early life history of *D. antillarum* is poorly described due to difficulty in rearing their planktotrophic larval stages and the lack of information concerning their subsequent metamorphic phase. Characterizing and enhancing metamorphosis in the laboratory has elucidated some of the basic biological questions concerning chemical cues that may contribute to survival and recovery of this species in the wild. As a result of this study there is potential for limited stock enhancement trials in order to monitor and assess the biological implications of long spined urchin reintroduction on the south Florida reef tract.

In this project, we successfully reared numerous larval cohorts in the laboratory and consistently induced metamorphosis on natural as well as chemically-defined substrates. Our laboratory-based studies describe baseline information covering the initial critical life stages for this keystone species. Over the past year, *Diadema* collected in the Florida Keys and held at the UM experimental hatchery spawned and provided a constant supply of viable gametes. Both non-invasive photo-thermal conditioning and injection of potassium chloride resulted in over 10 million fertilized eggs from which 81 culture trials were initiated. Larval trials designed to test the effects of temperature, algal diet, salinity and water-changing regime resulted in late stage larvae for competency and settlement assays. Previous field as well as laboratory studies utilizing other sea urchin species suggested primary algal/bacterial colonizers as the potential metamorphic substrate. We evaluated several unialgal diatoms, an unidentified mixture of primary algal/bacterial colonizers, acid washed silica, and the corresponding negative (filtered seawater) and positive (KCl) controls.

Modeling Pink Shrimp Recruitment from Florida Bay

Project Personnel: Maria M. Criales and John Wang (UM/RSMAS); Joan A. Browder, Steve Wong and Thomas Jackson (NOAA/SESFC); Michael Robblee and Clinton Hittle (USGS/CWRS)

Long Term Research Objectives and Strategy:
To develop a pink shrimp simulation model and performance measures to evaluate the impact on Florida Bay of upstream water management changes resulting from efforts to restore the Greater Everglades ecosystem. Our contribution will be to the ecology of fishery species in relation to the processes influencing transport, settlement, survival, and recruitment.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Measure of success is the future use of the model to predict ecological effects of planned changes in water management and to interpret results of follow-up monitoring.

This project is a component of NOAA-South Florida Ecosystem Restoration Prediction and Modeling (SFERPM) that addresses scientific questions about pink shrimp (Farfantepenaeus duorarum), an ecologically and economically important species in south Florida. The project is developing a pink shrimp simulation model and performance measures to evaluate the impact on Florida Bay of upstream water management changes resulting from efforts to restore the Greater Everglades ecosystem. With this study we are also contributing substantially to the population dynamics and ecology of this species in relation to the processes influencing transport, settlement, survival, and recruitment.

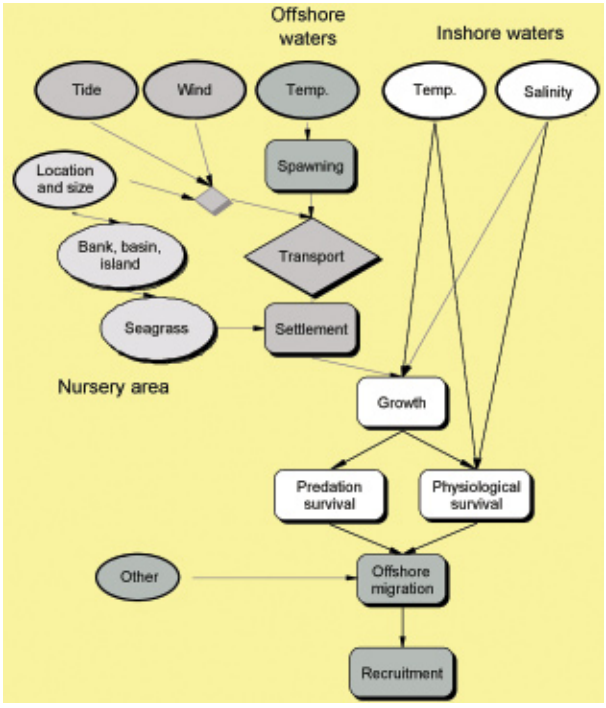


Figure 1- Simulated trajectories of drifters initiated at three positions at the upstream end of the OSCR domain during Expt I and II. Time step of the simulation was 20 minutes using averaged real-time OSCR surface current vectors. Every 6 hours, another simulated drifter particle was launched from the starting position. Simulation was stopped when the particle exited the domain.

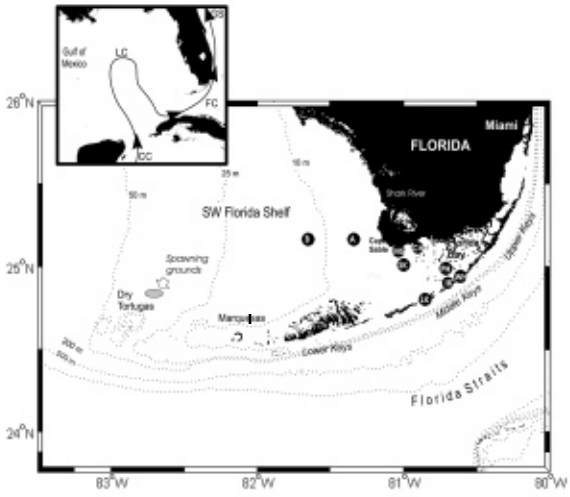


Figure 2- Map of study area showing sampling stations. MG- Middle Ground, SK- Sandy Key, CH- Conchie Channel. Florida Keys stations: PH- Panhandle, IK- Indian Key. A, B- ADCP stations fom Lee et al. (Florida Circulation Project). CC- Caribbean Current; LC- Loop Current; FC- Florida Current.

Progress has been made in relating upstream water management and freshwater flow to Florida Bay to the valuable commercial pink shrimp fishery. Potential recruitment and harvest from different regions of the Bay were simulated based on local observed temperatures and salinity. The simulations predict that potential harvests might differ among years, seasons, and regions of the Bay solely on the basis of observed temperature and salinity. Regional differences in other

characteristics, such as seagrass cover and tidal transport, may magnify regional differences in potential harvests.

This project is clarifying important aspects of the population dynamics of the pink shrimp. To help determine recruitment pathways, pink shrimp postlarvae entering Florida Bay have been collected monthly in new moon periods since January 2000. Sampling takes place in the wide western channels that connect Florida Bay with the Florida shelf of the Gulf of Mexico, and in more confined channels of the Middle Florida Keys that connect the southeastern margin of the Bay with the Atlantic Ocean. Acoustic Doppler Velocity Meters (ADVM's) were installed in each channel as part of an USGS cooperative agreement.

Results indicate that temporal patterns and magnitude of postlarval influxes differed substantially between the two borders. The influx of postlarvae at the Florida Keys passes was lower in magnitude but more frequent and more variable in comparison to the northwestern stations. The greatest postlarval influx (>70%) occurred at the northwestern border of the Bay, where there was a strong seasonal pattern with maxima from July through September each year. Postlarval densities at the northwestern stations were correlated with the alongshore winds and surface temperature but did not correlate with the cross-shelf winds. However, postlarvae need to move 150 km across the shelf in less than 30 days to reach the nursery grounds. Transport mechanisms were explored with larval transport simulations. Results of simulations indicated that the only feasible hydrodynamic transport mechanisms for pink shrimp postlarvae to travel 150 km in 30 days required that they have an active behavioral component. Thus, postlarvae moving only at night and only with the eastward current (flood tide) can travel 100 - 200 km in 30 days on a consistent basis and 94% can make it this far.

The ability of decapod postlarvae to sense and respond to the tidal effect at the entrance of the nursery grounds is well known and this particular behavior has been confirmed for pink shrimp postlarvae in this study. Postlarvae ascend in the water column during the flood and sit in the bottom during the ebb. Density of postlarvae showed clearly that dark-ebb catches were negligible (<10%) by comparison with dark-flood catches (>90%). This particular behavior has not been confirmed for the early stages near the spawning grounds. Further research will be needed to test the hypothesis of tidal behavior for early larval stages near the spawning grounds and to link the behavioral pattern(s) to specific environmental cues. With this information, more realistic simulations of transport of sequential early life stages of pink shrimp can be made using a hydrodynamic model.

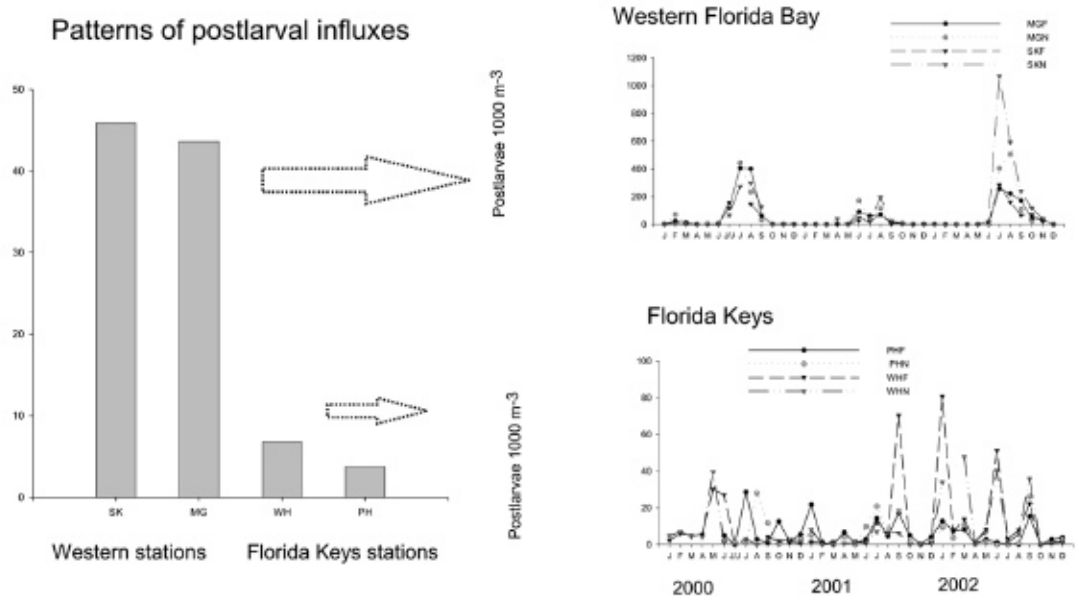


Figure 3- Monthly patterns of pink shrimp postlarval influxes through the western and Florida Keys stations (right) and percentages of occurence at the two sites.

Monitoring Coral Reef Fish Populations in the Florida Keys

Project Personnel: Jerald S. Ault and Steven G. Smith (UM/RSMAS); James A. Bohnsack (NOAA/SEFSC)

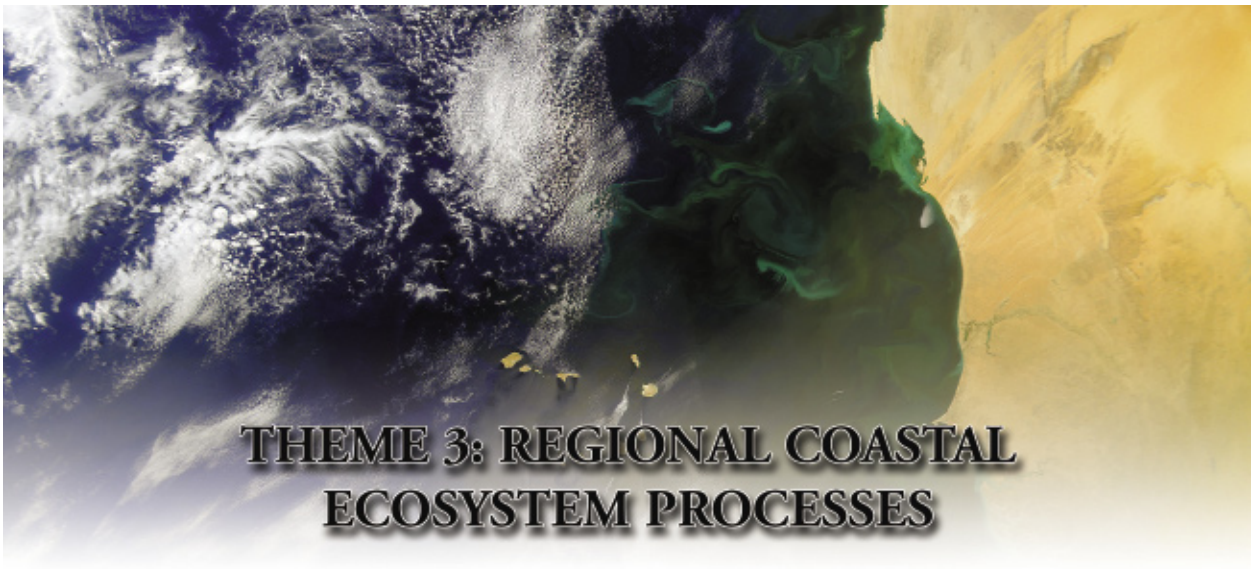
Long Term Research Objectives and Strategy:
This project augments the South Florida Ecosystem Restoration Program research to provide a comprehensive 5-yr evaluation of trends in Florida Keys National Marine Sanctuary (FKNMS) no-take zones [Sanctuary Preservation Areas (SPAS), Ecological Reserves (ERs), and Research Areas] to provide a state-of-the-art multispecies assessment and habitat summary report for the evaluation of the FKNMS efficacy towards meeting marine ecosystem management goals.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect and Manage Use of Ocean Resources and Rebuild and Maintain Sustainable Fisheries. Strategy: Monitor and observe all aspects of reef fish species to provide basic spatial abundance distribution information on the multispecies community in the Florida Keys, their essential habitats, and human activities that affect them.

The main objective was to provide a comprehensive survey of coral reefs along the Florida reef tract. Simultaneous surveys were conducted of fishes, corals, conch, spiny lobster, and other reef species using state-of-the-art sampling strategies Results will be used to define current conditions and monitor future changes as the result of management actions in Biscayne National Park, the FKNMS, and Dry Tortugas National Park. The expedition, led by Drs. Ault and Bohnsack, included scientists from many state and federal agencies, several universities, and a volunteer non-profit organization. This research represents an excellent example of coordination, cooperation, and participation by different government agencies, universities, and private organizations to achieve a common goal. The research was documented in a number of media pieces including National Geographic, BBC (British Broadcasting Company), NBC, Chicago Tribune, Miami Herald, Associated Press, Christian Science Monitor, etc.

No-take reserves (NTRs) in the Florida Keys National Marine Sanctuary (FKNMS) are a joint effort between the NOAA National Marine Sanctuary Program, National Park Service and the State of Florida. The FKNMS has implemented three types of no-take areas: (1) 16 small Sanctuary Preservation Areas (SPAs) totaling ~ 46 km2 that protected high relief coral reef; (2) one large (30 km2) ecological reserve (ER) that includes several different habitats; and, (3) 4 special use SPAs designed for research purposes. Four SPAs that allow rod-and-reel trolling by recreational anglers are not considered NTRs for this review. Two large Ecological Reserves (ERs), 206 and 312 km2, are were added in 2001 west of the Tortugas, Florida.

The NOAA/NMFS Southeast Fisheries Science Center Coral Reef Initiative is supporting University of Miami RSMAS scientists in implementing interdisciplinary research on multispecies fisheries dynamics in the Florida Keys and wider Caribbean coral reef ecosystems. Quantitative evaluations were done on data collected from Biscayne National Park and Dry Tortugas National Park for design and analysis of their coral reef monitoring plans.



Coral Health and Monitoring Program Data and Information Products

Project Personnel: Louis Florit and Monika Gurnée (UM/CIMAS); James C. Hendee (NOAA/AOML)

Long Term Research Objectives and Strategy:
To provide near real-time data and information products from coral reef monitoring stations, archives of historical data from these stations. To enhance information exchange of coral reef researchers through the development and implementation of web and database information systems.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management, Objective A: Protect, Restore and Manage Use of Ocean, and Coastal Resources via "Monitor and Observe", "Understand and Describe" and "Asses and Predict" strategies and measures of success.

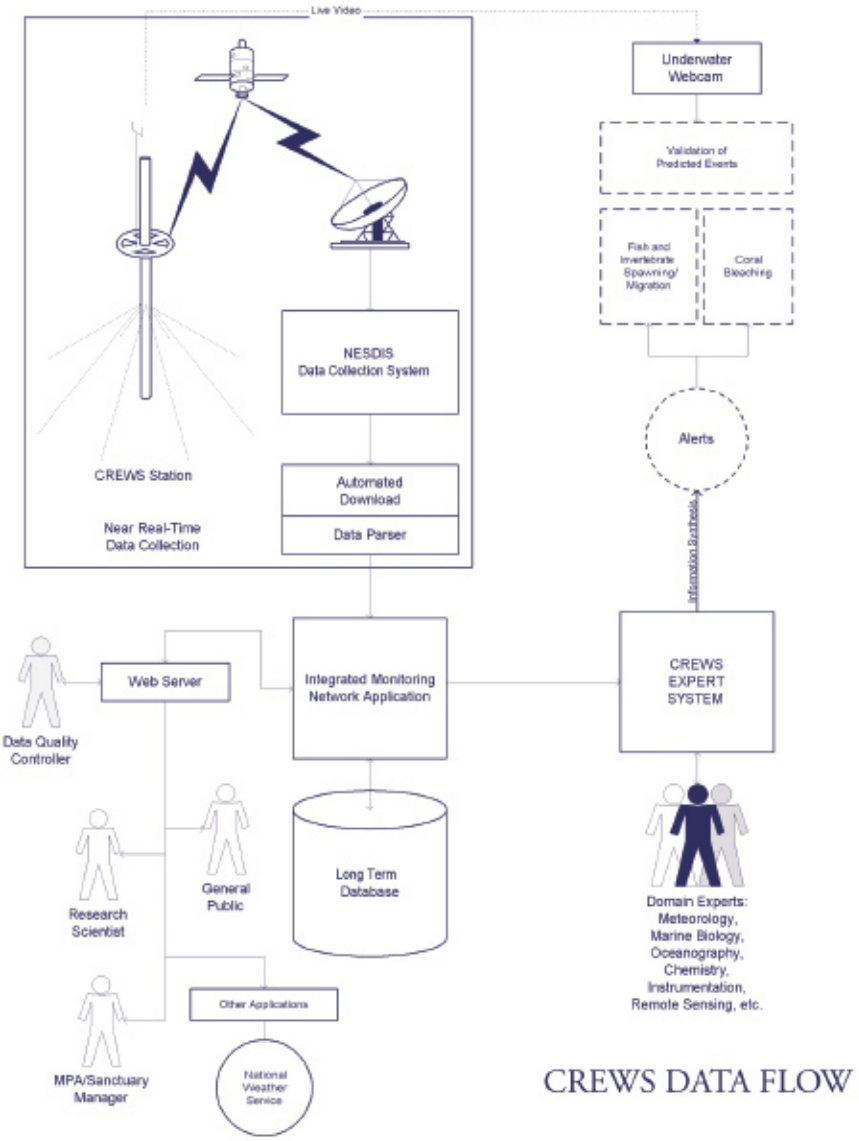
The Coral Health and Monitoring Program (CHAMP) aims to improve and sustain coral reef health by providing services to the research community as well as the general public. Some of these services include near-real-time data and information products, coral monitoring station web cameras, and an online email list server for coral research topics and discussion.

The data used for the near real-time data and information products is derived from coral reef environmental monitoring stations (SEAKEYS/CREWS) that provide hourly measurements for many meteorological and oceanographic pa-

Figure 1- (Right) CREWS Station near St. Croix, US Virgin Islands

rameters. An information system examines these data by a suite of expert systems to support data quality review, and place this data into a web accessible database application. This data is used to model and predict biological events in coral reef areas (i.e. coral bleaching) in the form of expert systems reports delivered via the CHAMP website.

In order to confirm the expert system predictions, real time visual monitoring is accomplished via web cameras monitoring the station and selected coral reef subjects. The first installation has been successfully implemented, transmitting video from the cameras to the onsite station encoder in the form of microwave signal, this encoded video is then sent over a DSL line to a VPN connection to a server located at AOML, where it is broadcasted via the CHAMP website. These web cameras provide researchers and the public with the opportunity to remotely observe coral events such as bleaching and spawning first hand, as well as allow for the development of new research techniques to gain further understanding of these events.



CREWS DATA FLOW

Determination of Genetically Distinct Subgroups and Contaminant Body Burdens of Resident bottlenose dolphin (*tursiops truncatus*) within Biscayne Bay, FL

Project Personnel: Jenny Litz and Jesse Wicker (UM/CIMAS); Lynne Fieber, Colin Hughes and Gregory Bossart (UM/RSMAS); Steven Swartz, John Kucklick, Anthony Martinez and Joseph Contillo (NOAA/SEFSC).

Long Term Research Objectives and Strategy:
Objectives are to define the genetic structure of resident bottlenose dolphin within Biscayne Bay using molecular genetic techniques and to evaluate the current levels of contaminate load in a model organism, the bottlenose dolphin. Our strategy is to pinpoint specific compounds of concern by testing the blubber of resident dolphin for bioaccumulated compounds and to compare the identified compounds to those found in dolphin of other Florida embayments, available in published reports.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, Restore, and Manage the use of Coastal and Ocean Resources Through Ecosystem-Based Management. Strategic Objectives: A: Protect, Restore and Manage Use of Ocean, Coastal, and Great Lakes Resources. B: Recover Protected Species.

The NOAA Fisheries, Southeast Fisheries Science Center (SEFSC) has been conducting a low-level monitoring project of bottlenose dolphin in Biscayne Bay, Florida for more than ten years. Through photo-identification techniques, the SEFSC has been able to identify individual dolphins that inhabit the Bay year round and appear to be long-term residents. In this new project we will first determine if the resident bottlenose dolphin population within Biscayne Bay consists of one breeding stock or several distinct breeding stocks of dolphins. Integrating these genetic data with the ten years of sighting data, will give a clearer picture of the overall social and stock structure of this dolphin community. Dolphins have previously been shown to bioaccumulate environmental toxins, such as organochlorine compounds, in their blubber layer. Because of these characteristics, bottlenose dolphin can be used as biological indicators of the health of their habitat and can even be used to compare contaminant levels from different geographical areas. This project will collect baseline data on the types of compounds stored in the blubber of resident dolphin and compare the results to those found in dolphin in other areas of Florida. Likewise, if it is determined that there are different breeding stocks within the bay, their contaminants will be compared to determine if any one community of dolphin in Biscayne Bay is at higher risk of anthropogenic impacts than the others.

A remote biopsy sampling procedure is used to obtain skin and blubber samples. This procedure consists of firing specially designed darts with biopsy sampling heads from a modified rifle. The samples obtained generally consist of a layer of skin and core of blubber that are roughly 1 cm in diameter and weigh between 0.5 and 1 gram. The samples are collected under MMPA Permit No. 779-1633-00, Biscayne National Park Permit Nos. BISC-2003-SCI-0021 and BISC-02-004, as well as, approval from the University of Miami's Institutional Animal Care and Use Committee. Photographs are taken of the dorsal fin of each animal sampled to match to the photo-identification catalogue. This allows sighting histories of individuals to be linked with the tissue samples. The dolphins' reactions to biopsy sampling are carefully observed and recorded as required by the Marine Mammal Protection Act. Although we do not expect any long-term effects on the animals caused by the sampling, observations of the biopsy wound and behavior are recorded when previously sampled animals are sighted in subsequent surveys. The GIS software ArcView will be used to spatially analyze sighting data from the photo-identification study. Genetic analyses will be conducted at the University of Miami and the contaminant analysis will be conducted at the NOAA, NIST laboratory in Charleston, SC.

Biscayne Bay has been greatly influenced by the increase in development of the Miami area in the past 75 years. Before researchers can attempt to

quantify the effects of these anthropogenic influences on the local bottlenose dolphin population, the structure of this dolphin community must be defined. The genetic analyses from this proposed study combined with long-term photo-identification data will define management units for the conservation of resident bottlenose dolphins within Biscayne Bay. This study will also measure baseline contaminant levels in the Biscayne Bay dolphins and provide the framework for monitoring the consequences of anthropogenic stressors on the Biscayne Bay ecosystem.

Faunal Density and Community Composition of the Nearshore Zone Biscayne Bay Biological Community Performance Measures

Project Personnel: Jeremy Hall (UM/CIMAS); Joan Browder (NOAA/SEFSC); Mike Robblee and David Moore (USGS).

Long Term Research Objectives and Strategy:
The purpose of this study is to acquire the data necessary for developing performance measures for use in guiding and evaluating restoration activities in southern Biscayne Bay

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.

The study has five broad objectives: (1) characterization of the spatial and temporal patterns of density and diversity of fish and macroinvertebrates (emphasis on *caridean* and *penaeid* shrimps including the pink shrimp, *Farfantepenaeus duorarum*) in seagrass habitats of the mainland nearshore zone of southern Biscayne Bay (south of Chicken Key) as well as in the adjacent deeper water commercial fishing zone, (2) evaluation of the relationship of variability in shrimp catch rates of commercial vessels operating in the commercial fishing zone with shrimp densities in fished versus unfished seagrass habitats, (3) examination of trends in commercial pink shrimp fisheries in relation to freshwater inflow and salinity, (4) evaluation of relationships between fishes utilizing mangrove fringe habitats and the abundance and diversity of fish and macroinvertebrates in adjacent seagrass habitats (in collaboration with a separate study), and (5) examination of fish abundance and aggregation in coastal creek/wetland flats habitat.

Two gear types, the commercial roller frame trawl and the 1m2 throw-trap, are being used to maximize the effectiveness of sampling and for purposes of comparison. The roller frame trawl is the same used by the bait shrimp fishery in Biscayne Bay except that it is equipped with an outer fine-mesh "sock" to retain animals that pass through the 25.4 cm stretch mesh of the commercial bait trawl. The throw-trap samples 1 square meter of bottom and can be used in water depths from a few centimeters to more than 3 meters; all depths occurring in the study area are accessible to the throw-trap. A stratified random sampling method is being used to characterize the mainland nearshore zone of southern Biscayne Bay between Shoal Point and Turkey Point. The strata are distinguished by geographic zone (Geozone), salinity zone Salzone), and depth zone (Depthzone).

In summary, vegetation cover is an important covariate and adds substantially to the explanation of shrimp density variation. Thus vegetation cover should be included in analyses where possible (i.e., in throw trap sampling). A cursory examination of trawl data in relation to throw trap data for pink shrimp suggests that the trawl is roughly one tenth as efficient as the throw trap in catching. Nevertheless, the trawl provides many more specimens for use in determining size distributions and the ratio of the sexes. Our research suggests that, in general, that faunal densities are low. Cursory comparisons with published or available unpublished data from previous studies in Biscayne Bay and nearby areas are planned. Statistical comparisons of sampling results from two gear types are also planned.

Florida Bay Inner Basins Circulation and Exchange Study: Northeast and Western Basins.

Project Personnel: Nelson Melo (UM/CIMAS); Thomas N. Lee, Villy Kourafalou and Elizabeth Williams (UM/RSMAS); Elizabeth Johns and Ryan Smith (NOAA/AOML)

Long Term Research Objectives and Strategy:
The primary objectives are to quantify the circulation and exchange rates influencing salinity variability in the eastern and western regions of Florida Bay so as to better understand and predict the future effects of proposed changes to water delivery to the bay as part of Everglades restoration plans. This will be accomplished through direct measurement of salinity variability and water exchange with surrounding basins.

Link to NOAA Strategic Plan:
NOAA's Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems. Assess and predict the changes of natural systems, and provide information about the future.

The primary objectives of this project are to quantify the circulation and exchange rates influencing salinity variability in the eastern and western regions of Florida Bay; to determine their interactions with connecting regions; and to identify the controlling physical processes. This information is needed to aid evolution and evaluation of hydrodynamic models for prediction of future water deliveries. This effort is a continuation of our study of inner basin processes initiated as part of SFERPM 2000 with investigation of Whipray basin in the central bay. We have employed similar measurement strategies as were developed for Whipray. Observational methods consisted of a combination of Eulerian and Lagragian measurements, rapid shipboard surveying and ADCP transects to directly measure the volume and salt transports and changes of basin average salinity needed for salt balance estimates and exchange rates. Thus the measurement program is designed for determination of seasonal changes in basin salt balance and exchange patterns. This effort is highly coordinated with ongoing and planned projects that will place the local basin dynamics in the context of the larger Bay-wide processes, as well as the entire south Florida coastal system to better understand the linkages over different scales, which are important to management and restoration of the south Florida coupled ecosystems.

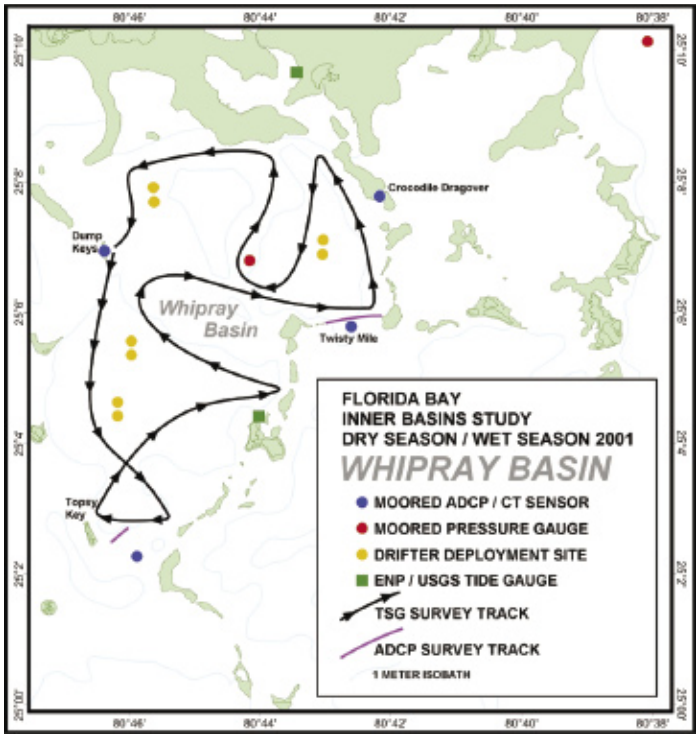


Figure 1- Measurement strategy for the circulation and exchange study of central Florida Bay during dry and wet seasons of 2001. Whipray Basin is the site of maximum salinity development. Shown are vessel tracks for continuous salinity surveys, ADCP transects across exchange routes, and moored current, salinity, sea level time series sites and drifter releases.

Field Application of the SWAPS System

Project Personnel: Diego Lirman (UM/RSMAS); Gregory DeAngelo (NOAA/National Geodetic Survey); Carlos Rivero (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
Our objective is to test the practical application of the SWAPS system (shallow water positioning system) in shallow coastal habitats. The main goal of these activities is to provide an accurate, spatially-explicit, permanent visual record of benthic habitats of the nearshore environment of Biscayne Bay, Florida.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: To protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategies: To monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems. To assess and predict the changes of natural systems, and provide information about the future.

Continuous video surveys were performed with the SWAPS system in very shallow (< 1 m), nearshore benthic environments of Biscayne Bay, Florida. The digital video images obtained are being analyzed to develop seagrass abundance and distribution contours for this previously undescribed habitat. These data will provide for the first time an accurate, spatially-explicit, permanent visual record of benthic habitats of the nearshore environment of Biscayne Bay, Florida.

Studying Early Life History Processes in Corals to Develop Better Management Protocols in the Florida Keys

Project Personnel: M. J. A Vermeij and M. W. Miller (UM/CIMAS)

Long Term Research Objectives and Strategy:
To reveal the dominant structuring processes in coral communities. Incorporation of these findings in new management protocols will improve the protection of Florida Keys reefs in the future.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems Understand and describe how natural systems work together through investigation and interpretation of information

In order to better understand the dominant structuring processes in coral communities we investigate the influence of variable environmental conditions on larval behaviour and survival. Larvae of various corals are reared under various conditions. Pre- and post settlement behavior and survival rates are compared. 4500 Coral juveniles (<0.2cm2) are monitored at three month intervals in various environmental settings at a small spatial scale (mm2). Data are used to develop and ground truth a model of coral community development.

In addition, the fate of early benthic growth stages of corals is monitored at a high spatial and temporal scale to reveal important structuring processes after corals settled. Planktonic stress is an important factor affecting both pre- and postsettlement behavior and survival. The fate of settlers is dependent on their preceding history. Density dependence and the distribution of habitat types determine the structure of coral populations after recruits successfully settled. Our results indicate that management strategies should include the factors that affect early life stages in corals, and not focus solely on factors shaping adult populations.

Field Application of the SWAPS System

Project Personnel: Diego Lirman (UM/RSMAS); Gregory DeAngelo (NOAA/National Geodetic Survey); Carlos Rivero (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
Our objective is to test the practical application of the SWaPS system (shallow water positioning system) in shallow coastal habitats. The main goal of these activities is to provide an accurate, spatially-explicit, permanent visual record of benthic habitats of the nearshore environment of Biscayne Bay, Florida.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: To protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategies: To monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems. To assess and predict the changes of natural systems, and provide information about the future.

Continuous video surveys were performed with the SWAPS system in very shallow (< 1 m), nearshore benthic environments of Biscayne Bay, Florida. The digital video images obtained are being analyzed to develop seagrass abundance and distribution contours for this previously undescribed habitat. These data will provide for the first time an accurate, spatially-explicit, permanent visual record of benthic habitats of the nearshore environment of Biscayne Bay, Florida.

Studying Early Life History Processes in Corals to Develop Better Management Protocols in the Florida Keys

Project Personnel: M. J. A Vermeij and M. W. Miller (UM/CIMAS)

Long Term Research Objectives and Strategy:
To reveal the dominant structuring processes in coral communities. Incorporation of these findings in new management protocols will improve the protection of Florida Keys reefs in the future.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems Understand and describe how natural systems work together through investigation and interpretation of information

In order to better understand the dominant structuring processes in coral communities we investigate the influence of variable environmental conditions on larval behaviour and survival. Larvae of various corals are reared under various conditions. Pre- and post settlement behavior and survival rates are compared. 4500 Coral juveniles (<0.2cm2) are monitored at three month intervals in various environmental settings at a small spatial scale (mm2). Data are used to develop and ground truth a model of coral community development.

In addition, the fate of early benthic growth stages of corals is monitored at a high spatial and temporal scale to reveal important structuring processes after corals settled. Planktonic stress is an important factor affecting both pre- and postsettlement behavior and survival. The fate of settlers is dependent on their preceding history. Density dependence and the distribution of habitat types determine the structure of coral populations after recruits successfully settled. Our results indicate that management strategies should include the factors that affect early life stages in corals, and not focus solely on factors shaping adult populations.

Interdisciplinary Surveys of Western Florida Bay and Connecting Waters of the Gulf and Atlantic for FY2003

Project Personnel: Thomas N. Lee, Villy Kourafalou, Chris Kelble, Nelson Melo, Grant Rawson, and Benjamnin Kates (UM/RSMAS); Peter B. Ortner, Elizabeth Johns, and Ryan Smith (NOAA/AOML)

Long Term Research Objectives and Strategy:
The objective of this program is to develop a better understanding of the factors that control the circulation and water properties in Florida Bay and adjacent coastal waters on time scales ranging from "events" to the interannual. Our strategy is to monitor the Bay and adjacent waters with a moored instrument arrays and targeted drifter releases; these are supplemented by monthly cruises and special cruises that focus on special events (i.e., storms, temperature anomalies, etc.).

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.

Water properties in Florida Bay and Biscayne Bay can change dramatically depending on a wide range of factors including weather (e.g., storms or the absence of them), runoff from land, and variations in currents in adjacent coastal waters. To better understand these factors we carry out high resolution surveys of both Florida and Biscayne Bay on a monthly basis, recording salinity, temperature, chlorophyll, percent transmittance, and CDOM utilizing a flow-through water system. Discrete sampling stations are made for additional chemical, biological and physical parameters. Contour maps are created from this data and posted on the web permitting timely access and application by the SFER scientific and management communities. In addition, bi-monthly surveys are conducted on the R/V Walton Smith measuring similar parameters in the near shore waters of South Florida from Fort Myers to the Dry Tortugas and along the FKNMS reef tract up to Miami. Cruises were made on: 6-14 Aug 02, 2-10 Oct 02, 1-10 Dec 02, 10-18 Feb 03, 17-25 Apr 03, and 4-13 Jun 03. ADCP current measurements are made during the large vessel cruises to document eddy development and the interaction of the Gulf Stream with FKNMS coastal waters. Bi-monthly releases of surface drifters are made both in the Dry Tortugas and at the mouth of the Shark River to document current trajectories in these areas. These data are also made available on the project website in near realtime. Furthermore, a mooring array is maintained to continuously measure current trajectories, temperature, and salinity along the southern SW Florida Shelf and along the perimeter of Florida Bay. Project data can be accessed at http://www.aoml.noaa.gov/sfp/data.shtml

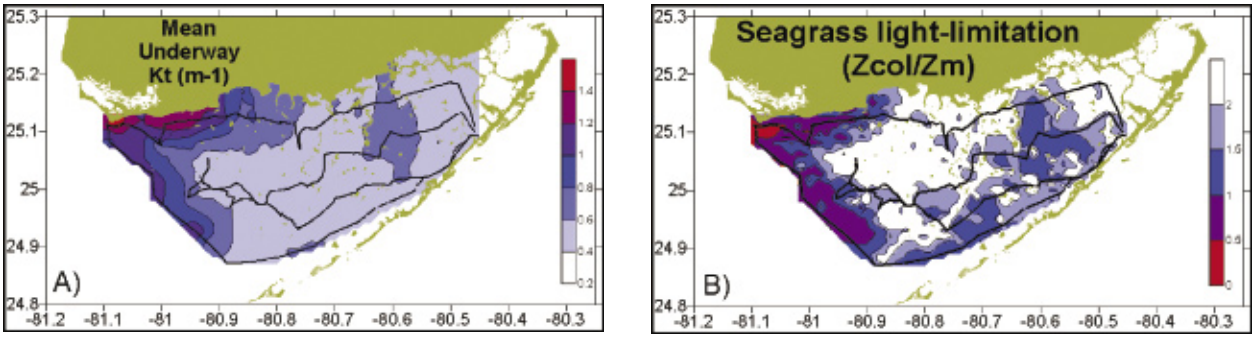


Figure 1- A) Plot of the average light attenuation coefficient, Kt, throughout Florida Bay from July 2001 until March 2002 and B) the average potential for seagrass light limitation for the same period. Light-limitation is thought to prohibit seagrass growth when the Zcol/Zm ratio is consistently below one.

Status of *Acropora* spp. Populations in South Florida: Proximal Causes of Mortality

Project Personnel: Dana E. Williams and Charles Fasano (UM/CIMAS); Margaret W. Miller (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
Our objective is to characterize the various sources of mortality affecting juvenile and remnant *Acropora palmata* and *A. cervicornis* populations and establish their relative importance to the population. Our strategy is to document the status and distribution of *Acropora* spp. in the upper Florida Keys and to observe mortality rates in relation to environmental variables.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, Restore and Manage Use of Ocean, Coastal, and Great Lakes Resources. Strategy: Monitor and Observe: "…monitor and observe aspects of ocean, coastal …areas and associated communities to provide basic information on habitats, resources, human activities, and uses that may impact coastal ecosystems." Understand and Describe: "…characterize coastal… resources and conduct research to understand and describe the linkages among the resource components and processes and human impacts on them, and will develop new tools and techniques to facilitate sound management decisions.

Acropora palmata and *A. cervicornis* colonies tagged in May-June 2002 were monitored every 4-5 months at 8 sites in Biscayne National Park and the Florida Keys National Marine Sanctuary to assess the relative importance of different sources of mortality. During this monitoring a disease outbreak was discovered and reported to managers. The disease outbreak was then followed through time and experiments to characterize the disease were undertaken. Ultimately, 60% of tagged colonies were affected by this disease by early June. Sampling of diseased colonies was swiftly coordinated with the Coral Disease and Health Consortium and FKNMS and NPS managers. Additionally visual surveys at other sites in the Florida Keys for active signs of disease were conducted to assess the extent of this outbreak. Disease signs were found affecting *A. cervicornis* to varying degrees at all 3 sites surveyed in Biscayne National Park, 4 out of 7 sites in the upper Florida Keys and 2 out of 3 sites in the Dry Tortugas National Park indicating that this outbreak is a relatively widespread phenomenon.

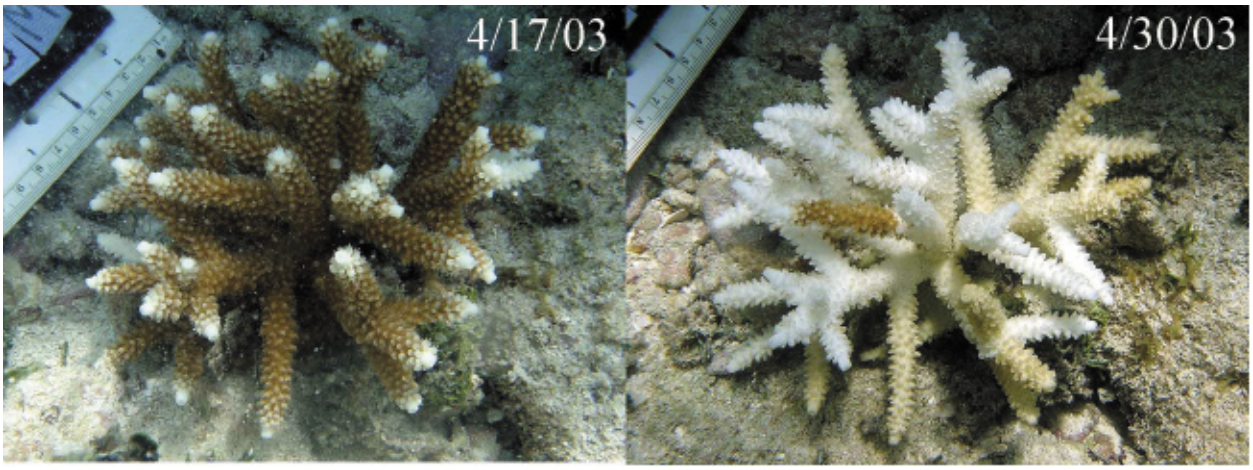


Figure 1- *Acropora cervicornis* colony tagged for monitoring, healthy on 4/17/03 and 99% dead from disease 13 days later.

Reef Fish Community Dynamics and Linkages with Florida Bay

Project Personnel: Jerald S. Ault and Steven G. Smith (UM/RSMAS); James A. Bohnsack (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
The goal of this research is to quantify community and reef fish population changes in management zones under different levels of protective management.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect and Manage Use of Ocean Resources and Rebuild and Maintain Sustainable Fisheries. Strategy: To understand and describe the ecological and biological aspects of fish species and economic impacts as a basis for sound management decisions. It is also implementing models and integrated data sets to assess fish populations and predict their future abundance.

This research provided critical data needed to model the effects of the Everglades Restoration on coral reef fishes and to assess the effectiveness of restoration in terms of ecological recovery. Many exploited reef fish species use Florida Bay as a settlement and nursery habitat. Thus, any changes in Florida Bay will result in changes in recruitment, growth, and mortality and will be reflected in reef fish species abundance, size, and distribution. This research established baselines data for the Florida Keys using a state-of-the-art sampling strategy. The research monitored reef fish community trends by habitat type at sites with different exposure to Florida Bay and under different levels of management protection along the inshore and offshore reef track from Miami through the Lower Keys. Study sites included areas managed by the Florida Fish and Wildlife Conservation Commission (FFWCC), Biscayne National Park (BNP), Everglades National Park (ENP) in Florida Bay (FB), the South Atlantic Fishery Management Council (SAFMC), and the Florida Keys National Marine Sanctuary (FKNMS).

No-take marine reserves were established in 19 zones in the FKNMS in 1997. This research was designed to directly test specific hypothesis involving these zones after 5 years. Specifically, this project collected data from years 3 and 4 following reserve establishment. Elucidating the importance of fishing is essential for determining the causes of ecosystem change and to measure the success of the southern Florida Ecosystem restoration effort. The establishment of one large (79 km2) Ecological Reserve and 18 smaller (0.16-4 km2) no-take Sanctuary Preservation Areas (SPAs) in the FKNMS provided a unique opportunity to address the influence of fishing. Fishing and other human extractions are recognized as a major disturbance to coral reefs. The establishment of no-take zones provide a control to allow scientists to distinguish between changes caused by natural versus anthropogenic disturbances. Determining the response of reef fish populations to no-take protection also provides a potential estimate of rates of change that could occur following Everglades restoration.

Stratified random sampling was used to collect reef fish and habitat monitoring data for reef habitats from Miami through Key West Florida during FY 2001 and 2002. Major objectives were to provide a baseline for assessing any future changes associated with the southern Florida Everglades restoration efforts, to assess changes in no-take zones established in 1997 in the Florida Keys National Marine Sanctuary, and to support fishery and habitat assessments and management of the Florida reef tract including Biscayne National Park (BNP) and the FKNMS. The studies quantify specific habitat uses and changes by different life history stages of different reef fish species. A focus on 35 important fishery species in BNP showed that the average size fish within the exploited phase for the last 25 years has remained relatively constant and is very close to minimum size of capture, not to historical unfished population size. The average size of black grouper, for example, is now 40% of what it was in 1940 and the spawning stock is now less than 5% of its historical unfished maximum. Overall, 77% of the 35 stocks that could be analyzed were overfished by federal standards, including 13 of 16 grouper species, 11 of 13 snapper, barracuda, and 2 of 5 grunt. Stock biomass was critically low for most

of the key targeted species within the recreational fishery. The current level of fishing mortality for grouper stocks, for example, was 3 to 10 times the exploitation level of fishing mortality that would achieve maximum sustainable yield (MSY). Some stocks appear to have been chronically overfished since at least the late 1970's and high sustained exploitation pressures have precipitated serial overfishing of key resources. These data suggest that fishing has been a dominate factor influencing reef fish community structure. Baseline data collected from recently established no-take reserves will eventually permit managers to distinguish between possible impacts of changes in water quality from Florida Bay and fishing.

Real-Time Oceanographic Observations in the FKNMS

Project Personnel: Thomas N. Lee and Vassiliki H. Kourafalou (UM/RSMAS); Elizabeth Johns, Peter B. Ortner and James C. Hendee (NOAA/AOML)

Long Term Research Objectives and Strategy:
The objective of this program is to develop a better understanding of the current system in the Florida Keys. Currents through the passages from Florida Bay to the reef tract have a strong impact on the reef environment. Our strategy is to make targeted real-time observations of important oceanographic parameters at various sites throughout the Florida Keys National Marine Sanctuary (FKNMS), to develop an understanding of the forces driving the currents, and to efficiently communicate relevant information to resource managers and the general public via the internet.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, Restore, and Manage the use of Coastal and Ocean Resources Through Ecosystem-Based Management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems

The initial phase of this project focused on the construction, deployment, and testing of the necessary instrumentation needed for real-time data collection. Real-Time current velocity measurements (via bottom-mounted ADCP) were added to the instrument suite at Looe Key (www.LooeKeyData.net). While this phase is essentially complete, we continue to improve our existing designs. We are experimenting with cheaper, faster, and more reliable ways of telemetering data back to our laboratory.

The second phase of the project focuses on continuing the real-time data collection and the incorporation of other data into the analysis. This includes shipboard transport calibrations in Long Key and Seven-Mile Bridge channels, and the analysis of moored current and pressure time series data. Once collected, these data are statistically correlated with the real-time sea level height differences between the Long Key and Sombrero Key CMAN stations, and an analysis strategy is implemented to produce real-time transport values. The real-time transports, combined with data from real-time moored conductivity-temperature sensors, will be used to direct event-response small boat cruises to map plumes of Florida Bay water as they impinge onto the coral reefs of the FKNMS. Additionally, bimonthly one-day interdisciplinary surveys of the Tortugas Ecological Reserve were begun in Year 1 and continue through Year 2 in conjunction with the bimonthly monitoring cruises described in a separate proposal by Dr. Peter B. Ortner.

Florida Bay Inner Basins Circulation and Exchange Study: Northeast and Western Basins.

Project Personnel: Nelson Melo (UM/CIMAS); Thomas N. Lee, Villy Kourafalou and Elizabeth Williams (UM/RSMAS); Elizabeth Johns and Ryan Smith (NOAA/AOML)

Long Term Research Objectives and Strategy:
The primary objectives are to quantify the circulation and exchange rates influencing salinity variability in the eastern and western regions of Florida Bay so as to better understand and predict the future effects of proposed changes to water delivery to the bay as part of Everglades restoration plans. This will be accomplished through direct measurement of salinity variability and water exchange with surrounding basins.

Link to NOAA Strategic Plan:
NOAA's Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems. Assess and predict the changes of natural systems, and provide information about the future.

The primary objectives of this project are to quantify the circulation and exchange rates influencing salinity variability in the eastern and western regions of Florida Bay; to determine their interactions with connecting regions; and to identify the controlling physical processes. This information is needed to aid evolution and evaluation of hydrodynamic models for prediction of future water deliveries. This effort is a continuation of our study of inner basin processes initiated as part of SFERPM 2000 with investigation of Whipray basin in the central bay. We have employed similar measurement strategies as were developed for Whipray. Observational methods consisted of a combination of Eulerian and Lagragian measurements, rapid shipboard surveying and ADCP transects to directly measure the volume and salt transports and changes of basin average salinity needed for salt balance estimates and exchange rates. Thus the measurement program is designed for determination of seasonal changes in basin salt balance and exchange patterns. This effort is highly coordinated with ongoing and planned projects that will place the local basin dynamics in the context of the larger Bay-wide processes, as well as the entire south Florida coastal system to better understand the linkages over different scales, which are important to management and restoration of the south Florida coupled ecosystems.

Studying Early Life History Processes in Corals to Develop Better Management Protocols in the Florida Keys

Project Personnel: M. J. A Vermeij (UM/CIMAS); M. W. Miller (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
To reveal the dominant structuring processes in coral communities. Incorporation of these findings in new management protocols will improve the protection of Florida Keys reefs in the future.

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems Understand and describe how natural systems work together through investigation and interpretation of information

In order to better understand the dominant structuring processes in coral communities we investigate the influence of variable environmental conditions on larval behaviour and survival. Larvae of various corals are reared under various conditions. Pre- and post settlement behavior and survival rates are compared. 4500 Coral juveniles (<0.2cm2) are monitored at three month intervals in various environmental settings at a small spatial scale (mm2). Data are used to develop and ground truth a model of coral community development.

In addition, the fate of early benthic growth stages of corals is monitored at a high spatial and temporal scale to reveal important structuring processes after corals settled. Planktonic stress is an important factor affecting both pre- and postsettlement behavior and survival. The fate of settlers is dependent on their preceding history. Density dependence and the distribution of habitat types determine the structure of coral populations after recruits successfully settled. Our results indicate that management strategies should include the factors that affect early life stages in corals, and not focus solely on factors shaping adult populations.

Use of Climate Prediction to Support Decision-Making in Argentine Agriculture

Project Personnel: G. Podestá, D. Letson, and K. Broad (UM/RSMAS)

Long Term Research Objectives and Strategy:
The goals of this project are: (a) to carry out a multidisciplinary assessment of the consequences of seasonal-to-interannual climate variability linked to the El Niño-Southern Oscillation (ENSO) phenomenon on Argentine agriculture; and (b) to develop a set of tools and methodologies for the effective use of ENSO-related climate forecasts in agriculture.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. NOAA Mission Goal 3: Serve society's needs for weather and water information. Strategy: To develop generic tools for the production and dissemination of relevant climate information (diagnostic and forecasts); to strengthen decision making in agriculture. Although the project focuses on Argentina, tools developed by this project have been successfully transferred to applications in the southeastern United States.

Statistical analyses of historical data showed ENSO impacts on crop yields in the Pampas. These analyses were complemented by modeling to quantify the range of outcomes (yields and economic returns) and their likelihood under different ENSO phase and current management practices.

We built a pilot "decision map" of a maize production system that was enhanced during workshops with technical advisors from the study region. The map listed climate-sensitive decisions, their timing, and a viable range of options of r each decision, that were used in subsequent modeling.

Together with Argentine colleagues participating in this proposal, we conducted two sets of focus groups (each replicated with three groups of farmers). The first group involved an open-ended exploration of farmers' perceptions of regional climate and their current use of climate information. In the second group, farmers completed a decision experiment targeting specific management decisions under two scenarios (with and without a climate forecast). A hypothetical forecast of a dry spring was presented in a variety of formats consistent with products publicly available, such as those produced by NOAA/NCEP or the IRI.

Simulation of Management Strategies (FEMS)

Project Personnel: David J. Die and Kristin Kleisner (UM/RSMAS); Gerry Scott and Joseph Powers (NOAA/SEFSC)

Long Term Research Objectives and Strategy:
To develop and test assessment methods to be incorporated into a simulation framework for the evaluation of management strategies

Link to NOAA Strategic Plan:
NOAA Mission Goal 1: Protect, restore and manage the use of coastal and ocean resources through ecosystem management. Strategy: Develop and implement models and integrate data sets to assess current state and predict future condition of ecosystems, and protected and fished species.

This project has developed an analysis framework for statistical evaluation of fishery management strategies. We have used this framework to evaluate both theoretical and real fisheries. The evaluation of hypothetical fisheries aims to help understand which processes within a fisheries system are the most critical in affecting the success of management strategies. In this respect we have compared the performance of tuna management on three theoretical stocks that differed in their life history and fishery characteristics. This project is linked to an international project funded by the European Union and involving fishery institutions in France (IFREMER), United Kingdom (CEFAS), Spain (Instituto Espanol de Oceanografia), Portugal (Universidade dos Açores), and two international fishery commissions, the International Council for the Exploration of the Sea (ICES) and the International Commission for the Conservation of Atlantic Tunas (ICCAT). This large international project just started in late 2002 partially as a result of the work conducted in this NOAA project.

The international FEMS project has now developed base-case data and models for all case studies proposed. The UM team has lead the development of the Skipjack tuna base case. The UM team also participated in the international FEMS workshop were the new simulation framework is been implemented.

In developing this framework we have helped fishery scientists to conduct stock assessments and perform evaluation of management strategies. This has been achieved because the framework's architecture is designed to facilitate access to its analytical methods to fishery scientists with limited modeling capabilities. The framework has now been introduced to International working groups in charge of assessment of large pelagic fisheries in the Atlantic and to scientists at the SEFC and the University of Miami.

The project will now expand the methods included in the framework to other models being developed by other research groups working on Atlantic Bluefin tuna and swordfish resources. The group at the Imperial College of London has been developing new spatial Bayesian models that use tagging data and that can complement the classical (non-spatial) models incorporated so far in the simulation framework. In addition the University of New Hampshire is leading a program that provides additional information on movement patterns for bluefin tuna and will be integrating this new knowledge into operational movement models for this species.

Ultimately, the aim of this project is to expand the simulation framework so that it can incorporate state-of-the-art operating and assessment models that can be applied to the study of management strategies for highly migratory species.

Assay and Sensor Development to Identify, Detect, and Quantify Microbial Contaminants

Project Personnel: Kelly Goodwin, Sara Cotton (UM/CIMAS); Jack Fell (UM/RSMAS); Peter Ortner (NOAA/AOML)

Long Term Research Objectives and Strategy:
The objective of this research is to improve coastal water quality monitoring by harnessing advances in biotechnology to develop new assay systems.

Link to NOAA Strategic Plan:
Mission Goal 1: Protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.

Coastal water quality is important for human and ecosystem health and has economic repercussions at the local, regional, and national levels. Decisions to close fisheries and beaches in order to protect human health are based on traditional, culture-based assays. However, traditional microbiological assays suffer from serious drawbacks, and improved assays are needed to better protect human health and economic interests. This project aims to apply advances in biotechnology to water quality monitoring. We are developing improved methods of monitoring for harmful algal blooms and bacterial contamination which is consistent with NOAA goal to monitor, observe, understand, and describe how coastal environments work naturally and to detect when such environments are impacted by human activities. Such research helps NOAA engage, advise, and inform partners and the public about the health of its ocean resources so that these resources can be managed for the benefit to the environment, economy, and public safety. This research represents the type of sound, state-of-the art research supported by NOAA in order to bring new approaches and products to ecosystem management.

This research develops DNA probes for common microbial contaminants in the coastal environment (e.g., red tide, bacterial indicators of sewage). The probes are immobilized onto the surface of microtiter plates. DNA is extracted from environmental samples and amplified using universal PCR primers. The use of universal primers (versus a series of species-specific primers) simplifies the assay and allows for the detection of multiple species while using a limited amount of genomic DNA. In our initial effort we designed and developed a microplate assay to detect the common toxic dinoflagellate Karenia brevis. The method was successfully tested in seawater samples. The sensitivity of the method was sufficient to detect "low" and "very low" amounts of *K. brevis*.

We also developed probes for the toxic dinoflagellate *K. mikimotoi* and a series of bacteria that are used for indicators of sewage contamination in coastal waters. These probes are currently being tested in typical coastal environments.

Air-Sea Interactions in Tropical Cyclones

Project Personnel: Eric W. Uhlhorn (UM/CIMAS); Peter black (NOAA/AOML)

Long Term Research Objectives and Strategy:
To improve the prediction of hurricane intensity and intensity change. Specifically, to better understand the relationship between the intensity of hurricanes and the sea-surface fluxes of momentum, heat, and moisture.

Link to NOAA Strategic Plan:
NOAA Mission Goal 3: Serve society's needs for weather and water information. Strategy: Improve forecast warning capabilities to reduce uncertainty and increase economic benefits.

The prediction of hurricane intensity remains a major issue confronting meteorologists. This is due to the considerable uncertainty in many of the physical processes that control hurricanes. One such aspect concerns the exchanges of heat and momentum at the air-sea interface. Hurricanes derive their energy from the ocean; thus understanding these processes is crucial to accurately predicting a cyclone's intensity. Due to a lack of data at the sea surface in high-wind conditions, these exchanges are currently not well understood.

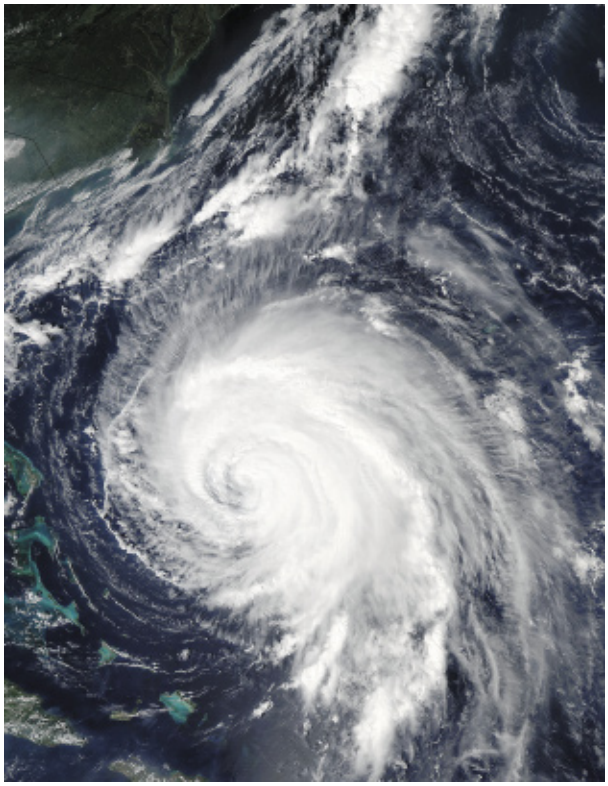
NOAA's Hurricane Research Division (HRD), in collaboration with several agencies and institutions, is supporting the ONR CBLAST experiment, which is designed to improve the understanding of the exchanges of energy at the air-sea interface in hurricanes through an observational effort. Specific activities include coordinating an airborne field program, processing and providing data from several instrument platforms to collaborators, and validating measurements to support a modeling effort designed to test these new parameterizations of surface fluxes.

Recent research activities include an investigation of the quality of surface wind measurements (upon which fluxes depend) from NOAA's Stepped-Frequency Microwave Radiometer (SFMR). These remotely sensed wind speed estimates were independently verified from winds measured by Global Positioning System (GPS) dropwindsondes, which are the current standard for estimating the maximum wind in hurricanes. The SFMR provides an unprecedented view of the distribution of tropical cyclone surface winds, both in magnitude and resolution.

The fluxes of heat and moisture are sensitive to he sea surface temperature (SST), especially in the high-wind inner-core of hurricanes. Scientists at HRD have recently completed a study to document the variability of SST within hurricanes. It is found that the decrease of inner-core SST below the ambient unforced environment is significantly less than that observed in the cold-wake region days after the storm's passage. Although the change in SST is small, the differences in heat fluxes associated with this change can be dramatic in regions where the highest winds occur. It is crucial that models of hurricanes are able to capture this variability, since a hurricane's intensity is known to depend upon SST.

Finally, the radial distribution of the azimuthal average surface momentum, heat, and moisture fluxes in a hurricane were examined based on a set of collocated observations. A number of flux parameterization schemes currently employed by mesoscale numerical models are tested. It is found that the variability of the computed maximum surface fluxes based on the choice of parameterization scheme is extremely large. This uncertainty represents a severe flaw in models of hurricanes, and is one major reason that numerical models are unable to predict changes in intensity.

In conclusion, observations of the atmosphere and ocean at the air-sea interface in hurricane conditions are now becoming increasingly available. With this new data, scientists should be able to begin to understand the exchange processes that ultimately fuel tropical cyclones.



(Above) Hurricane Isabel approaches the North Carolina coast, September 17, 2003.

Instrumentation for Humidity Flux Measurements in Hurricanes

Project Personnel: William Drennan (UM/RSMAS)

Long Term Research Objectives and Strategy:
This objective of this project is to design and built fast-response humidity sensors to extend the turbulent flux package on the NOAA P3 aircraft. The sensors allow for the routine measurement of latent heat fluxes, a key air-sea interaction parameter, one that is particularly important with respect to the development of tropical storms.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.

A prototype sensor has been designed, built and delivered to NOAA-AOC for testing. Flight testing commenced during August 2003, and is ongoing. The instrument passed the preliminary tests. Comparisons of the humidity data with those from other sensors will be made. The instrument will be deployed during the 2003 CBLAST-hurricane experiment.

Hurricane Heat Content Estimates For Intensity Forecasting Using SHIPS In Support of the Joint Hurricane Testbed

Project Personnel: Lynn K. Shay (UM/RSMAS); Mark DeMaria (NOAA/NESDIS/ORA); Michelle Mainelli (NOAA/TPC)

Long Term Research Objectives and Strategy:
To understand the importance of oceanic heat content on hurricane intensity forecasts using the Statistical Hurricane Intensity Prediction Scheme and satellite radar altimetric measurements from TOPEX, JASON-1, European Research Satellite-2, and Geosat Follow On Missions.

Link to NOAA Strategic Plan:
NOAA Mission Goal 3: Serve society's needs for weather and water information Monitor and Observe: ...use cost-effective observation systems that meet diverse and expanding societal needs for accuracy, parameters observed, and temporal and geographic coverage. Understand and Describe: ... invest in new technologies, techniques, and weather and water forecast modeling. Assess and Predict: ... improve forecast and warning capabilities to reduce uncertainty and increase economic benefits.. Strategy: ... to understand and describe the role of the upper ocean on strong weather events through air-sea interactions, and provide such data to the forecast model to assess and to improve hurricane intensity forecasts aimed at saving lives and property.

Hurricanes derive their energy from the ocean. The exchanges of heat and momentum at the air-sea interface plays a critical role in hurricane development. In order to improve predictions, we must have a better understanding of these exchanges which are not currently well understood. In our study we developed improved estimates of ocean heat content which were then used in various hurricane forecast models.

To this end we combined several radar altimeters for a surface height anomaly field from TOPEX and JASON, European Research Satellite-2, and the Geosat-Follow-On Missions which have repeat cycles of 10, 17 and 35 days, respectively. Surface height anomalies from each altimeter were carefully weighted and blended prior to objectively analyzing the data over the basin. The resultant field was combined with a seasonal climatology developed by Mainelli (2000) to map the depth of the 20°C and 26°C isotherms using a crude two-layer model.

Oceanic heat content was then estimated from different sets of two radar altimeters and a blended 7-day Reynolds SST field over the basin as shown on the web page: http://storm.rsmas.miami.edu/~nick/heat. These fields were checked against in situ data to insure that the inferred satellite fields were consistent with profiler data. In addition, ocean heat content differences along the altimeter track as well as at cross-over points were assessed for data quality and consistency. If ocean heat content changed by more than the threshold of 10 KJ cm-2, we looked at the estimates more carefully prior to inputting the data into the experimental version of SHIPS at TPC/NHC for intensity forecasts.

These procedures leads to a 5% improvement of intensity forecasts.

Real-Time Hurricane Wind Analysis

Project Personnel: Nicholas Carrasco, Nirva Morisseau-Leroy, Sonia Otero and Russell St. Fleur (UM/CIMAS); Mark Powell (NOAA/AOML)

Long Term Research Objectives and Strategy:
To improve our understanding of tropical cyclones through advances in computing technology.

Link to NOAA Strategic Plan:
NOAA Mission Goal 3: Serve society's needs for weather and water information Monitor and Observe: ...use cost-effective observation systems that meet diverse and expanding societal needs for accuracy, parameters observed, and temporal and geographic coverage. Understand and Describe: ... invest in new technologies, techniques, and weather and water forecast modeling. Assess and Predict: ... improve forecast and warning capabilities to reduce uncertainty and increase economic benefits. Strategy: Understand tropical cyclones winds at the surface and during landfall to enhance emergency managers ability to plan, prepare, respond and recover in the event of a tropical cyclones. Advance the understanding of tropical cyclones though the aid of new computing technology.

The HRD Real-time Hurricane Wind Analysis System (H*Wind) is a distributed system that ingests real-time global tropical cyclone observations measured by land-, sea-, space-, and air-borne platforms adjusted them to a common framework, 10m marine exposure. These observations are stored in an object-relational database, and then graphically displayed via an interactive java application where scientists can quality control, objectively analyze, and visualize the information. The H*Wind system consists of five sub-components: data collection, the database, the quality control interface, the analysis package, and the product generation package.

Data collection is accomplished through a series of Unix scripts and C programs. The current platforms being ingested include Air Force and NOAA reconnaissance, Dropwindsondes: GOES, SSM/I, TM/I and QSCAT satellites; METAR, C_MAN, Buoys and Ship observations. All observations are stored in an object-relational database consisting of several schemas and a series of PL/SQL and SQLJ components.

The H*Wind Quality Control (QC) Client is the focal point of the H*Wind system. The QC Client allows scientist to interact with the data stored in the database. QC graphically displays the data and allows close inspection, editing or removal of data from the analysis, by the scientist. The QC Client can be launched over the web from any workstation and schedule analyses over the Internet.

The analysis algorithm consists of a process of estimating the continuous spatial field of a physical variable from a set of discrete observational data. For our purposes, the physical variables of concern are wind, pressure (or geopotential height above surface), temperature and relative humidity. Analyses are customizable via filter wavelength and mesh sizes. The product of this analysis is a colored and annotated wind contour plot.

Over the past 12 months much effort has been dedicated to transition H*Wind for operational use at the National Hurricane Center.

Evaluating Microphysical Parameterization Schemes for Use in Hurricane Environments

Project Personnel: Robert Rogers (UM/RSMAS); Robert Black (NOAA/AOML)

Long Term Research Objectives and Strategy:
To improve the representation of latent heating in numerical models by comparing the performance of microphysical parameterization schemes in high-resolution simulations with a variety of airborne radar and microphysical data sets.

Link to NOAA Strategic Plan:
NOAA Mission Goal 3: Serve society's needs for weather and water information Monitor and Observe: ...use cost-effective observation systems that meet diverse and expanding societal needs for accuracy, parameters observed, and temporal and geographic coverage. Understand and Describe: ... invest in new technologies, techniques, and weather and water forecast modeling. Assess and Predict: ... improve forecast and warning capabilities to reduce uncertainty and increase economic benefits. Strategy: To evaluate and improve the parameterization of the conversion and transport of water (in all its forms) in numerical models, thereby improving the representation of latent in these models and, ultimately, improving tropical cyclone intensity forecasts.

The development of tropical cyclones is strongly influenced by cloud microphysical processes. In order ot improve predictions, we need to model microphysical processes. In this study we evaluate the performance of a commonly-used, yet relatively sophisticated, microphysical parameterization scheme used in high-resolution simulations. Simulations of two tropical cyclones are compared to airborne radar and PMS probe data collected from many storms over many years, including as a part of the CAMEX III field program in 1998. Statistics of vertical motion, reflectivity, and hydrometeor concentrations are compared for the two datasets (observed vs. simulated) to identify potential deficiencies in the microphysical scheme and areas for improvement.

Comparisons show that the model reproduces many of the gross features seen in the observations, though notable differences are evident. The majority of simulated updrafts and downdrafts are weak, and the strongest updrafts comprise less than 2% of the population, similar to observations. The simulations show a larger spread in the distribution of vertical motion for the eyewall regions and a contraction toward weaker vertical motion for the stratiform regions, again similar to observed storms. However, the simulations tend to produce vertical motions that are overall weaker than the observations. The model produces reflectivities that are much higher than observed, both above and below the melting level. Comparisons of simulated hydrometeor concentrations with probe data from Hurricane Bonnie show that the model produces comparable vertical motion distributions for the levels chosen, but produce mixing ratios much larger than those observed by the probe data. Correlations between vertical motion and hydrometeor concentration and reflectivity show a much stronger relationship in the model than what is observed.

These comparisons show that there are several likely areas of deficiency in the parameterization scheme: the production of snow and graupel is too large in the model, the fallout speeds are too small for these species, and the conversion of snow and graupel to rain is too slow, producing reflectivities and hydrometeor concentrations higher than what are typically observed in tropical cyclones. Future investigations will test proposed changes in improving the statistics in the simulations. The comparison technique presented here provides a reliable method for testing simulations against observations, and it provides a framework for conducting comparisons using other observational platforms.

Interpretation of SAR-Observed Boundary Layer Structures

Project Personnel: William Drennan (UM/RSMAS)

Long Term Research Objectives and Strategy:
The objectives are to understand the role of secondary circulations (roll vortices) on air-sea fluxes in relation to hurricane dynamics and evolution.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems.

The development of tropical storms and hurricanes is strongly controlled by sea-air energy fluxes. Thus we are interested in boudary layer processes that affect these fluxes. Our program focuses on measurements of turbulences fluxes made from aircraft. In 2002 we obtained flight level data in the atmospheric boundary layer (ABL) in four cases where we expected secondary flows to be present. One such case is from the flight of 43RF into Hurricane Isidore on 22 September. At this time the hurricane eye was situated at the northern edge of the Yucatan Peninsula. The flight included a low-level pattern designed to investigate ABL turbulence. The low level flight path can be divided into two segments: one (I) in the northwest quadrant approaching the eye, heading roughly perpendicular to the wind, and another (II) heading roughly into the wind, north of the hurricane eye.

In order to study the structure of the wind field, a wavelet transform was applied to the 1 Hz vertical velocity data. The wavelet transform allows for a decomposition of a signal in both frequency and time, hence can be used to study the evolution of features (e.g., Farge, 1990). We detect evidence that supports the existence of secondary circulation in the hurricane wind field. Based on the flight speed and direction relative to the wind, this would correspond to roll features with a ~3 km wavelength. The cells are lines up roughly in the wind direction (i.e., Young et al., 2002), hence, would not likely be observed in a flight in the wind direction. Later in the flight there was evidence of energy at low frequencies (long wavelengths) – consistent with crossing the rolls at a considerable angle. Unfortunately, a RADARSAT SAR image coincident with the P3 flight is not available. A high resolution image taken roughly 24 hours after the P3 flight is currently under analysis by the PIs. Such an analysis will yield information on roll cells (if any) present, and allow for confirmation of the P3 turbulence analysis.

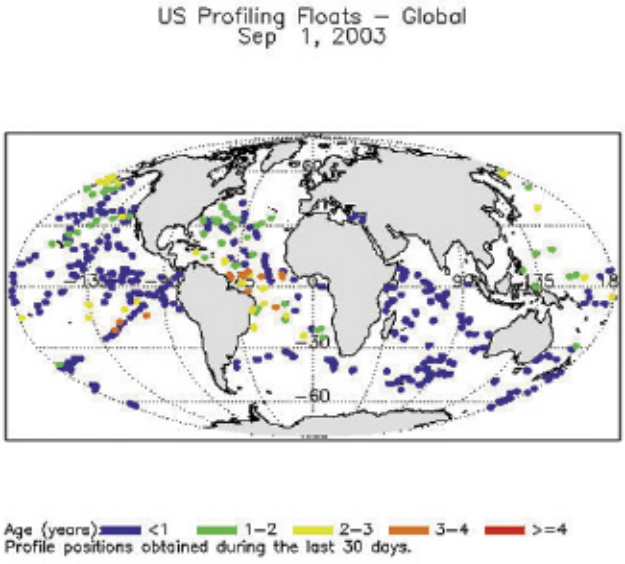
During the 2002 field season, only a few coincident RADARSAT/aircraft data are available, and those are for aircraft 49RF which did not carry turbulence instrumentation. In several cases, the P3 data are available within 12 hours of a RADARSAT image. The lack of coincident data was due in part to the limited number of storms. During the upcoming 2003 field season, ABL turbulence data are a major priority, and emphasis will be placed on obtaining data coincident with RADARSAT images.

US Argo Project: Global Ocean Observations for Understanding and Prediction of Climate Variability

Project Personnel: Xiangdong Xia and Elizabeth Forteza (UM/CIMAS); Robert L. Molinari, Claudia Schmid, Reyna Sabina and Yeun-Ho Chong Daneshzadeh (NOAA/AOML)

Long Term Research Objectives and Strategy:
The project involves observational studies designed to improve our understanding of interannual to multidecadal ocean variability. The strategy is to deploy 1000 profiling floats within 5 years. These will be part of a global array of 3000 floats.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems. Strategy: To invest in high quality observations and to provide a comprehensive observing system in support of climate assessments and forecasts.



Data from ARGO floats were used to study the spreading of Antarctic Intermediate Water in the tropical Atlantic. The variability of the flow on annual and smaller time scales was resolved and the dynamic characteristics were analyzed in the framework of the linear wave theory. The major modes of the variability can be described by planetary waves with periods of one year, 66 days and 45 days.

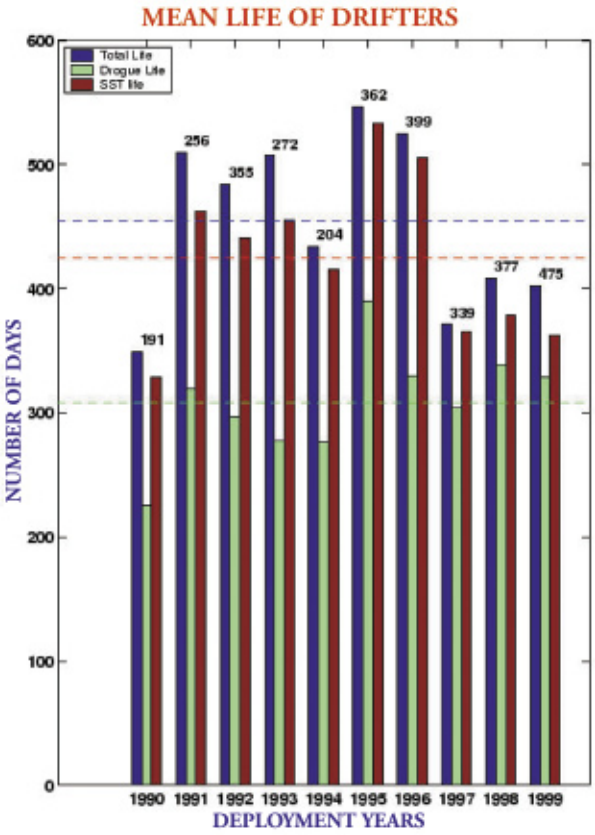
Global Drifter Data Assembly Center (DAC)

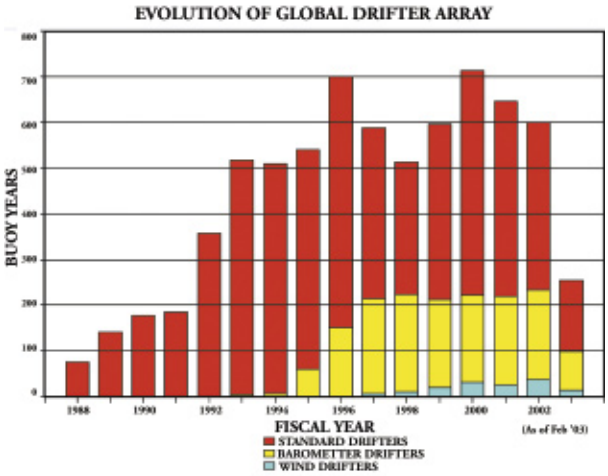
Project Personnel: Jessica Redman (UM/CIMAS); Mayra Pazos (NOAA/AOML)

Long Term Research Objectives and Strategy:
The DAC receives, processes, and sends data to the Marine Environmental Data Service (MEDS) for archiving and makes data and related products available through the WEB in near-real-time. The DAC objective for real time data is to arrange for the distribution of Global Telecommunications System (GTS) data and to ensure their accuracy by closely monitoring for sensor failures and immediately taking such data out of the system. The objective for the historical data set is to provide uniform quality-controlled data for sea surface temperature (SST) and surface velocity measurements.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond. Strategy: To invest in needed climate quality observations and ... to provide a comprehensive observing system in support of climate assessments and forecasts.

The DAC works closely with researchers to provide high-quality drifter data in a rapid and accessible manner. The DAC has four primary objectives: GTS distribution, quality control, web access, and performance evaluation. The DAC inserts and deletes drifters onto the GTS. The accuracy of data is monitored and drifters are removed once sensors fail. The DAC also notifies Argos of drifters that have lost their drogue





so that this information can be noted in the GTS message.

The DAC decodes raw data that is received from Argos and applied calibrations. New drifters are identified and deployment times and positions are determined. Drifters that have stopped transmitting are identified and last good time and position is determined. Drogue off day is determined. The DAC then compares the drifter's SST with Reynolds' climatology to determine last good day for the SST sensor. Bad SST's and positions are removed and data is interpolated to six-hour interval using Kriging method.

Web Access: The DAC inserts interpolated data in the NOAA/AOML database for web access. Web products are maintained and updated. Database updates are periodically sent to MEDS for archiving and distribution.

Coastal Storms initiative Project Number 5: Data Access and Standards

Project Personnel: Miguel Izaguirre (UM/CIMAS); Judy Gray (NOAA/AOML)

Long Term Research Objectives and Strategy:
Increase the amount of data available to forecasters and community decision makers to support accurate forecasts and response scenarios. Better utilize existing observations and fill observational gaps. Make a wide range of coastal data and information easily accessible to the user community in a timely, user friendly, and understandable way. Populate a metadata catalog to improve understanding of the data being served.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Engage, advise, and inform individuals, partners, communities, and industries to facilitate information flow, assure coordination and cooperation, and provide assistance in the use, evaluation, and application of information.

The project works closely with data providers to ensure quality control and develops the databases, metadata, and catalogs of the information collected. In order for the NOAA/AWIPS to accept and make available to forecasters weather observation collected from nontraditional sources, it requires that the information be properly coded. The weather observations arrive via email contained in different file formats or embedded into email messages, with the help of computer programs, or manually, the relevant information is extracted, codified and transfer to the AWIPS server. The arrival of new sources represents an increase in the diversity in the formatting of the information. With this in mind, distribution software has been generated. This program captures the observation, codes it, and sends an email directly to a NOAA server which, after authenticating the source, transfers the information to the AWIPS system. The intention is to minimize the time delay between data collection and data transfer.

Two input forms allow the user(s) to input meteorological information. One has been customized for Crowley Maritime Co. and allows for multiple vessels observations. The second application has been customized for single vessel input and internally translates the information according to the MAROB protocol. Both forms have an internal mailer that automatically emails the collected information as an attached file back to CSI-NOAA. In order to generate a MAROB report from Crowley's information, an Excel routine has been implemented, this routine processes the file and sends the resulting MAROB report to the CSI ftp site, from where it is ingested into AWIPS.
A third application has been designed to extract information embedded in an email message and to form a MAROB report which in turn gets transfer to the CSI ftp site.
These applications are executable programs that operate under the windows operating system, which is the most common platform, and can be easily recompiled for UNIX and Linux operating systems.The project worked closely with data providers on data processing and data documentation to ensure quality control and that Federal Geographic Data Committee (FGDC) and other applicable standards are maintained for all data delivered. Long-term storage and archival of CSI data is being coordinated with other NESDIS Data Centers and the OAR laboratories. The project develops the databases, metadata, and catalog for the pilot areas to provide "first-stop shopping" for CSI related data and information.

Sustained XBT Observations for North Atlantic Climate Variability Studies

Project Personnel: Qi Yao (UM/CIMAS); Molly Baringer, Silvia Garzoli, and Gustavo Goni (NOAA/AOML)

Long Term Research Objectives and Strategy:
Our objective is to study the upper-ocean thermal structure of the subtropical North Atlantic which plays a large role in climate. Our strategy is to carry out an extensive array of XBT monitoring programs aboard Volunteer Observing Ships (VOS) following routes across the major Atlantic current systems.

Link to NOAA Strategic Plan:
NOAA Mission Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond. Monitor and observe the land, sea, atmosphere, and space and create a data collection network to track Earth's changing systems. Strategy: To invest in high quality observations and to provide a comprehensive observing system in support of climate assessments and forecasts.

The heat flux variability in the Atlantic plays a major role in climate. These XBT lines require the aid of Volunteer Observing Ships (VOS) willing to have a scientist aboard to deploy XBTs. These lines (designated AX7, AX8, AX10, and AX18) meet WOCE criteria for high resolution deployment providing temperature profiles every 50 km in the open ocean and between 10-30 km near boundary currents down to a depth of about 800 meters.

The line of AX7, nominally at 30°N, is ideal for monitoring the Atlantic heat flux because it lies near the center of the subtropical gyre which has been shown to be the latitude of the maximum heat flux in the ocean. The high resolution line from New York to Puerto Rico, designed AX10, began in 1997. Together with ongoing measurements of the Florida Current transport and temperature (Babymax), these two lines from a closed box off the eastern United States and thus is ideal for studying the heat flux variability and the effect of atmospheric weather patterns. AX8 is designed to characterize both the mean and the time-dependent upper ocean properties of the tropical portion of the Meridian Overturning Circulation and the shallow Subtropical Cell in the Tropical Atlantic. AX18 line has been operating since July 2002. The object of this work is to improve the existing climate observing system in the South Atlantic by deploy XBTs, a line which links South Africa with Buenos Aires, Argentina, and crosses the important current system of Brazil Current and Benguela Current. AX18 line will provide heat transport estimates, important for monitoring abrupt climate change. High Density XBT Lines are updated and shown on the web at http://www.aoml.noaa.gov/phod/hdenxbt/

The Rosenstiel School and CIMAS are active in education and outreach at the undergraduate and high school level. Many of these activities take place in cooperation with the local NOAA laboratories. Here we present a brief overview of outreach activities at the School in which CIMAS in involved.

The MAST Academy

Starting in 1984 CIMAS has participated in a high school apprenticeship program that is made possible through NOAA funding. Students participate in a summer internship program at AOML and SEFSC. The program began as an "inner city" program. More recently the program is carried out through a Miami-Dade County "magnet" school, the MAST Academy (Maritime and Science Technology High School) which is located on Virginia Key, only a few hundred meters from CIMAS and the NOAA laboratories. http://mast.dade.k12.fl.us/

The MAST Academy curriculum is organized around a marine theme. The school has been recognized by the U. S. Department of Education with a Blue Ribbon School of Excellence (1994-96) and by Business Week magazine (1993) as one of seven most innovative schools of choice in the nation. The total enrollment is 550. The school has a broad cultural-ethnic mix of students: 36% Caucasian; 32% African American; 29% Hispanic; 3% Asian. Approximately 94% of the students eventually enroll in college. MAST students excel according to traditional measures of student performance, exceeding national averages on the PSAT, SAT, and ACT. In 1998-99, MAST had one National Merit Scholar, two National Merit Finalists, two National Merit Hispanic Scholars, two National Achievement Scholars, one Intel Science Talent Search (formerly Westinghouse) semifinalist, and fourteen Advanced Placement Scholars.

RSMAS participates in education-related activities at MAST by providing faculty and graduate students to teach courses. Every summer, 12-18 students are selected to participate in the summer program supported through CIMAS. The students assist in programs at AOML and SEFSC as well as at RSMAS. In addition to the summer program, CIMAS hires MAST students during the course of the year. As a result of these activities MAST students have co-authored

papers with RSMAS and NOAA scientists; students have attended national conferences and presented the findings of their research. They have participated in field programs, for example in a comprehensive study of Biscayne Bay. In this way, we have developed a solid working and teaching relationship with the MAST Academy

In February 2003, the MAST Academy from Miami won the Florida Regional Competition of the National Ocean Sciences Bowl (NOSB - see below) held at Mast Academy.

RSMAS and the National Ocean Science Bowl.
In February 2003, the Rosenstiel School and Harbor Branch Oceanographic Institution hosted the National Ocean Science Bowl (NOSB). The NOSB was developed to stimulate interest among high school students in the ocean sciences, encourage the incorporation of oceanography in high school science curricula and demonstrate to the public the importance of the oceans in our daily lives. In addition, the NOSB aims to foster the next generation of marine scientists, educators and policy makers for the ocean sciences. The Program is managed by the Consortium for Oceanographic Research and Education. The NOSB receives financial support from nine federal agencies, including NOAA, via the National Oceanographic Partnership Program.

University of Miami, a Minority Serving Institution
The National Oceanic and Atmospheric Administration (NOAA) has established a set of research and education centers to advance the community of under-represented minority scientists in the US and, especially, in the NOAA workforce. The four centers address different thematic areas of research in support to NOAA: environmental sciences, marine sciences, remote sensing, and atmospheric sciences. The Rosenstiel School is partner with two of these centers, led by Florida A&M University (FAMU) and the University of Maryland Eastern Shore (UMES).

The FAMU-led center is called the Environmental Cooperative Science Center (ECSC), and consists of partner institutions FAMU, Delaware State University, Jackson State University, Morgan State University, South Carolina State University, and UM-Rosenstiel. The central research themes of ECSC focus on the human-environment interactions involving the coastal environment and the development of conceptual models of those interactions.

The objectives of the ECSC are:
- to develop the next generation of MS and PhD-level scientists in the environmental sciences from under-represented minorities, especially African-Americans, Hispanic-Americans, and American Indians;
- to develop research activities on coastal environmental issues, focused on a set of NOAA National Estuarine Research Reserve (NERR) sites, plus the Florida Keys National Marine Sanctuary (FKNMS); and
- to conduct institutional capability building in the partner Historically Black Colleges and University (HBCU) institutions (e.g., graduate degree programs).

The Rosenstiel School's roles are:
- to provide two full fellowships for minority students for MS and PhD studies at RSMAS in environmental science and policy fields;
- to provide ship and other field experiences for undergraduate students;
- to assist in developing distance-learning classes in environmental sciences;
- to assist in the capacity building at partner institutions; and,
- to serve as the linkage to Florida Keys Sanctuary.

The UMES-led center is the Living Marine Resources Cooperative Science Center (LMRCSC). Partner institutions include Hampton University, Savannah State University, Delaware State University, and UM-Rosenstiel. The mission is similar to the ECSC, but the focus is on marine sciences, including fisheries and aquaculture. There are an additional two minority graduate fellowships under the funding from LMRCSC to RSMAS.

An important outcome of the association of RSMAS with the network of minority serving institutions is that it will greatly improve our ability to recruit minority graduate students.

GLOBE (Global Learning and Observations to Benefit the Environment) http://www.globe.gov/ is a worldwide network of students, teachers, and scientists who work together to investigate and understand the global environment. Students and teachers from over 7,000 schools and 83 countries are working with research scientists around the world to learn more about our planet. The School and NOAA AOML actively participate in GLOBE as a part of Florida GLOBE International (FGI) http://www.rsmas.miami.edu/support/outreach/fla-globe.html. Within the tri-county area of Miami-Dade, Broward, and Monroe Counties in South Florida (which together have a population of over 3 million) there are currently 44 registered GLOBE schools. The Florida franchise began in January 1998 and the first GLOBE training activity was held May 1998. The short-term objectives are to train teachers in the tri-county area and to develop a Mentor Program involving electronic and school-site visits to support teachers after training. The long term goal is to increase GLOBE Franchise partners to cover central and northern Florida and Caribbean.

Florida GLOBE International activities focus on four research themes: atmosphere, hydrology, soil analysis, land cover analysis. Research programs include measurements of: cloud cover, temperature, precipitation; water transparency, water temperature, pH; soil characterization, bulk density, pH, temperature, infiltration, gravimetric moisture; qualitative land cover sampling, manual mapping.

Trained GLOBE teachers at K-12 schools set up environmental monitoring sites at or near their schools. Students measure environmental parameters within strict sets of data protocols, and enter their data into the international GLOBE database through the Internet. Students can manipulate data through visualization exercises based upon Geographic Information System (GIS) and remote sensing applications so as to compare their data with that of other schools in the GLOBE network.

RSMAS and the NOAA laboratories in Miami are playing an important role in GLOBE. The School has a faculty member who acts as a coordinator for GLOBE activities.

Project INSTAR

INSTAR (Investigating Nature Through Science Teacher Active Research) http://mgg.rsmas.miami.edu/groups/instar/index.htm is an Earth Systems Science Teacher Institute focused on marine science education and technology training. INSTAR provides an innovative approach to teacher professional development. The Institute, developed by a team of scientists and educators, began in 1998 at RSMAS. The INSTAR mission is to enhance the geoscience knowledge of middle school and high school teachers by offering laboratory, field, and technology training in coastal marine science themes. Teachers can directly use a majority of these activities and lessons in their classrooms. Training takes place during an 8-day summer program. Two more follow-up days are schedule during the following academic year. The program is built around four themes:

- ***Coral Reefs and Nearshore Ecosystems***
- ***South Florida Hydrogeology***
- ***Marine Microorganisms***
- ***Quantifying Marine Animals and the Ecosystems Around Us***

CIMAS participates in this program by providing opportunities through the many research programs in these study areas.

Undergraduate Employee Program

CIMAS hires undergraduate students from the University who work part time on projects at AOML and SEFSC. This program has been effective in exposing bright students to the scientific working environment. Some of these students have subsequently gone on to graduate school at RSMAS and other institutions and some have been hired as full time employees.

Bronze Medal, Department of Commerce - 2002.
NOAA Development Team to Implement Marine Protected Areas Executive Order.
Jerald S. Ault

HPCC NOAA Tech 2002 Award for "Best Technology Transfer to Operation".
To Sonia Otero, Nick Carrasco, Nirva Morriseau-Leroy and Russell St. Fleur for the best presentation for "H Wind".

Bulletin of the American Meteorological Society "Papers of Note".
To Eric Uhlhorn for his paper in the Journal of Atmospheric and Oceanographic Technology:
Uhlhorn, E. W., and P. G. Black, Verification of remotely sea sensed surface winds in hurricanes, J. Atmos. Ocean. Tech., 20, 99-116, 2003.

The paper was spotlighted in the February 2003 issue. Paper was also highlighted on NOAA's web page.

Annual Best Paper Award for Fishery Bulletin.
To Jerald S. Ault:
Ault, J. S., J. A. Bohnsack, and G. A. Meester, A retrospective (1979-1996) multispecies assessment of coral reef fish stocks in the Florida Keys, Fishery Bull., 96(3), 395-414, 1998. (Awarded in 2002)

NOAA-OAR Outstanding Scientific Paper Award – 2002 (2-3 authors).
To Christopher S. Meinen:
Meinen, C. S., and M. J. McPhaden, Observations of warm water volume changes in the equatorial Pacific and their relationship to El Niño and La Niña, J. Clim., 13, 3551-3559, 2000.

NOAA Outstanding Scientific Paper Award (4 or more authors).
To Alberto M. Mestas-Nuñez:
Goldenberg, S.B., C.W. Landsea, A.M. Mestas-Nuñez, and W.M. Gray, The recent increase in Atlantic hurricane activity: Causes and implications. Science, 293, 474-479, 2001.

NOAA Research Team Member of the Month, February 2003.
Alberto M. Mestas-Nuñez

Carnegie Mellon University.
Frank J. Millero selected for "Outstanding Alumnae" award.

Oracle Corp. "Most Innovative Application Developer of the Year 2002".
Nirva Morisseau-Leroy

"Woman of Achievement".
USBE & Information Technology magazine, Hispanic Engineer I Information Technology magazine, and Women of Color Conference magazine.
Nirva Mourisseau and Leroy and Shirley T. Murillo were recognized by the USBE & Information Technology magazine, Hispanic Engineer I Information Technology magazine, and Women of Color Conference Magazine. Nirva was recognized as a "Woman of Achievement" for her research on advanced methods for distributed scientific analysis and the use of cutting-edge technologies to address hurricane research challenges.

"Young Scientist/Rising Star" Award.
Women of Color Research Sciences and Technology Awards Conference, Nashville, TN.
Shirley T. Murillo was recognized for her outstanding contributions to hurricane research, her leadership in science education outreach, and her indomitable spirit. The award is given to persons who have influenced the community either an engineer, researcher, scientist, or technologist whose contributions continue to advance technical career opportunities for other women of color.

NOAA/AOML Certificate of Appreciation Award.
To Jessica Redman in recognition of excellent work in the Physical Oceanography Division's Drifter Data Assembly Center.

NOAA/AOML Certificate of Appreciation Award.
To Qi Yao for "extraordinary effort in the completion of the XBT high density line program and web display".

Berberian, George	Research Associate, Part-Time
Carrasco, Hector	Research Associate I
Cotton, Sara	Research Associate II
Die, David	Scientist
Dunion, Jason	Sr. Research Associate II
Fasano, Charles	Research Associate I
Florit, Louis	Research Associate II
Fonseca, Carlos	Research Associate I
Forteza, Elizabeth	Research Associate I
Goodwin, Kelly	Associate Scientist
Gurnee, Monika	Research Associate II
Hall, Jeremy	Research Associate I
Hansen, Don	Research Associate, Part-Time
Izaguirre, Miguel	Research Associate II
Jones, Robert	Research Associate, Part-Time
Kates, Benjamin	Research Associate I
Kelble, Chris	Research Associate I
Lara, Monica	Assistant Scientist
Lee, Sang-Ki	Post-Doctoral Associate
Litz, Jenny	Research Associate I
Lumpkin, Rick	Assistant Scientist
Meinen, Christopher	Assistant Scientist
Melo, Nelson	Research Associate I
Mestas-Nunez, Alberto	Assistant Scientist
Morisseau-Leroy, Nirva	Assistant Scientist
Otero, Sonia	Research Associate II
Perruso, Lary	Post-Doctoral Associate
Redman, Jessica	Research Associate I
Rogers, Robert	Assistant Scientist
Rooth, Claes	Professor and Associate Director
Shaji, C.B.	Post-Doctoral Associate
Sullivan, Kevin	Sr. Research Associate II
Uhlhorn, Eric	Sr. Research Associate II
Vermeij, Mark	Post-Doctoral Associate
Wicker, Jesse	Research Associate I
Williams, Dana	Post-Doctoral Associate
Willis, Paul	Research Associate, Part-Time
Xia, Xiangdong	Research Associate II
Yao, Qi	Research Associate II

CIMAS FELLOWS	AFFILIATION
Dr. Bruce Albrecht	UM/Meteorology and Physical Oceanography
Dr. James Bohnsack	NOAA/Southeast Fisheries Science Center
Dr. Otis B. Brown (ex-officio)	UM/Dean
Dr. David J. Die	CIMAS/Marine Biology and Fisheries
Dr. Nelson Ehrhardt	UM/Marine Biology and Fisheries
Dr. David Enfield	AOML/Physical Oceanography
Dr. Rana A. Fine	UM/Marine and Atmospheric Chemistry
Dr. Silvia Garzoli	AOML/Physical Oceanography
Dr. Mark A. Harwell	Florida A&M University/Environmental Sciences Institute
Dr. Kevin D. Leaman	UM/Meteorology and Physical Oceanography
Dr. Frank Marks	AOML/Hurricane Research Division
Dr. Robert L. Molinari	AOML/Physical Oceanography
Dr. Christopher N.K. Mooers	UM/Applied Marine Physics
Dr. Donald B. Olson	UM/Meteorology and Physical Oceanography
Dr. Peter B. Ortner	AOML/Ocean Chemistry Division
Dr. Joseph E. Powers	NOAA/Southeast Fisheries Science Center
Dr. William J. Richards	NOAA/Southeast Fisheries Science Center
Dr. Claes G.H. Rooth	CIMAS/ Meteorology and Physical Oceanography
Dr. Sharon S. Smith	UM/Marine Biology and Fisheries
Dr. Nancy Thompson	NOAA/Southeast Fisheries Science Center
Dr. Rik Wanninkhof	AOML/Ocean Chemistry Division
Dr. Hugh Willoughby	FIU/International Hurricane Center
Dr. Rod G. Zika	UM/Marine and Atmospheric Chemistry

VISITING SCIENTISTS -1 JULY 2002 – 30 JUNE 2003

2002

Dr. Pierre F.J. Lermusiaux
Harvard University
Division of Engineering and Applied Sciences
Data Assimilation in Ocean Sciences: Research and Applications
July 9, 2002
Ecosystems Dynamics in Massachusetts Bay and Physical-Acoustical Interactions over the New England Shelfbreak: Interdisciplinary Error Subspace Statistical Estimation
July 10, 2002

Dr. William Frank
Department of Meteorology
Penn State University
Hurricanes In Shear
September 10, 2002
Waves and Weather in the Tropical Atmosphere
September 12, 2002

Dr. James J. Sloan
NSERC/OPG Chair
Atmospheric Sciences
University of Waterloo, Ontario, Canada
Complete Characterization of Atmospheric Aerosols by Remote Sensing
December 13, 2002

2003

Dr. Friedrich Schott
Professor
Institut für Meereskunde an der Universität Kiel
Kiel, Germany
The Circulation and Deep Water Outflow at the Exit of the Subpolar North Atlantic
February 26, 2003
The Meridional Overturning Circulation in the Tropical Atlantic
March 17, 2003

Dr. Paul G. Falkowski
Institute of Marine and Coastal Sciences
Department of Geology
Rutgers University
The Evolution of Martine Phytoplankton in the Phanaerozoic Oceans: From Dinosaurs to Diatoms
April 14, 2003

Dr. Detlef Stammer
Associate Professor
Scripps Institution of Oceanography
What We Learned from Altimetry about the Ocean April 28, 2003

We list all publications in 2002-2003 according to category: Publications in Refereed Journals (published and accepted/in-press listed separately); Chapters in Books; Conference Proceedings; Technical Reports; Theses and Dissertations. CIMAS scientists continue to have a strong record of publication. The record over the first two years of the Cooperative Agreement are shown in the table below. This listing does not include conference proceedings.

Publication Count

	CIMAS Lead Author					NOAA Lead Author				
	FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05
Peer-reviewed	54	60				0	7			
Non-Peer reviewed	7	8				0	3			

Refereed Journal Articles

Published

Browder, J.A., Z. Zein-Eldin, Z., M.M. Criales, M.B. Robblee, S. Wong, T.L. Jackson, and D. Johnson, Dynamics of pink shrimp (*Farfantepenaeus duorarum)* recruitment potential in relation to salinity and temperature in Florida Bay, *Estuaries*, 25(6B), 1355-1371, 2002.

Chiappone, M., D.W. Swanson, S.L. Miller, and S.G. Smith, Large-scale surveys on the Florida reef tract indicate poor recovery of the long-spined sea urchin *Diadema antillarum*, *Coral Reefs*, *21*, 155-159, 2002.

Cione, J.J., and E.W. Uhlhorn, Sea surface temperature variability in hurricanes: implications with respect to intensity change, Mon. Wea. Rev., 131, 1783-1796, 2003.

Criales, M.M., C. Yeung, D. Jones, T.L. Jackson, and W.J. Richards, Variation of oceanographic processes affecting the size of pink shrimp (*Farfantepenaeus duorarum*) postlarvae and their supply to Florida Bay, *Est. Coast. Shelf Sci.*, *57*(3), 457-468, 2003.

Dunion, J.P., and C.S. Velden, Application of surface adjusted GOES low-level cloud-drift winds in the environment of tropical cyclones. Part I: Methodology and Validation, *Mon. Wea. Rev.*, *130*, 1333-1346, 2002.

Dunion, J.P., S.H. Houston, C.S. Velden, and M.P. Powell, Application of surface adjusted GOES low-level cloud-drift winds in the environment of tropical cyclones. Part II: Integration into surface wind analyses, *Mon. Wea. Rev.*, *130*, 1347-1355, 2002.

Feely, R.A., C.L. Sabine, K. Lee, F.J. Millero, M.F. Lamb, D. Greeley, J.L. Bullister, R.M. Key, T.-H. Peng, A. Kozyr, T. Ono, and C.S. Wong, *In-situ* Calcium Carbonate Dissolution in the Pacific Ocean, *Global Biogeochem. Cycles, 16*(4) 1144, doi:10.1029/2002GB001866, 2002.

Franklin, E.C., J.S. Ault, S.G. Smith, J. Luo, G.A. Meester, G.A. Diaz, M. Chiappone, D. W. Swanson, and S.L. Miller, Benthic habitat mapping in the Tortugas region, Florida, *Mar. Geodesy*, *26*(1-2), 19-34, 2003.

Gedzelman, S., J. Lawrence, J. Gamache, M. Black, E. Hindman, R. Black, J. Dunion, H. Willoughby, and X. Zhang, Probing hurricanes with stable isotopes of rain and water vapor, *Mon. Wea. Rev.*, *131*, 1112–1127, 2003.

Idrisi, N., T. Capo, and J. Serafy, Postmetamorphic growth and metabolism of long-spined black sea urchin (*Diadema antillarum*) reared in the laboratory, *Mar.Fresh.Behav.Physiol.*, *36*, 87-95, 2003.

Kell L.T., D.J. Die, V.R. Restrepo, J.M. Fromentin, V. Ortiz de Zarate, and P. Pallares, An Evaluation Of Management Strategies For Atlantic Tuna Stocks, *Scientia Marina*, *67*, 353-370, 2003.

Kiesling, T.L., E. Wilkinson, J. Rabalais, P. Ortner, M. McCabe, and J. Fell, Rapid identification of adult and naupliar stages of copepods using DNA hybridization methodology, *Mar. Biotech., 4*, 2002.

Lamb, M.F., C.L. Sabine, R.A. Feely, R. Wanninkhof, R.M. Key, G.C. Johnson, F.J. Millero, K. Lee, T.-H Peng, A. Kozyr, J.L. Bullister, D. Greeley, R.H. Byrne, D.W. Chipman, A.G. Dickson, B. Tilbrook, T. Takahashi, D.W.R. Wallace, Y. Watanabe, S. Winn, and C.S. Wong, Internal consistency and synthesis of Pacific Ocean CO_2 data, *Deep-Sea Res. II, 49*, 21-58, 2002.

Lee, T.N., and N. Smith, Volume transport variability through the Florida Keys tidal channels, *Cont. Shelf Res., 22*, 1361-1377, 2002.

Liu, X., and F.J. Millero, The solubility of iron in seawater, *Mar. Chem., 77*, 43-54, 2002.

Lumpkin, R., Decomposition of surface drifter observations in the Atlantic Ocean, *Geophys. Res. Lett., 30*(14), 1753, 10.1029/2003GL017519, 2003.

Luo, Y., and F.J. Millero, Solubility of Rhodochrosite ($MnCO_3$) in NaCl Solutions*, J. Solution Chem., 32*(5) 405-416, 2003.

Millero, F.J., F. Huang, and A.L. Laferriere, The solubility of oxygen in the major sea salts and their mixtures, *Geochim. Cosmochim. Acta., 66*(13), 2349-2359, 2002.

Millero, F.J., F. Huang, and A.L. Laferriere, Solubility of oxygen in the major sea salts as a function of temperature and concentration, *Mar. Chem., 78*(4), 217-230, 2002.

Millero, F.J., D. Pierrot, K. Lee, R. Wanninkhof, R. Feely, C.L. Sabine, and R.M. Key, Dissociation constants for carbonic acid determined from field measurements, *Deep-Sea Res., 49*(10), 1705-1723, 2002.

Millero, F.J., F. Huang, and T.B. Graham, Solubility of oxygen in some 1-1, 2-1, 1-2, and 2-2 electrolytes as a function of concentration at 25°C, *J. Solution Chem., 32*(6), 473-487, 2003.

Mojica Prieto, F.J., and F. J. Millero, The values of $pK_1 + pK_2$ for the dissociation of carbonic acid in seawater, *Geochim. Cosmochim. Acta, 66*(14), 2529-2540, 2002.

Molinari, R.L., and A.M. Mestas-Nuñez, North Atlantic decadal variability and the formation of tropical storms and hurricanes, *Geophys. Res. Lett., 30*(10), 1541, doi:10.1029/2002GL016462, 2003.

O'Connor, B.M., R.A. Fine, K.A. Maillet and D.B. Olson, Formation rates of subtropical underwater in the Pacific Ocean, *Deep-Sea Res. I*, *49*(9), 1571-1590, 2002.

Pettine, M., L. Campanella, and F.J. Millero, The reduction of hexavalent chromium by H_2O_2 in acidic solutions, *Environ. Sci. Technol., 36*, 901-907, 2002.

Podestá, G.P., D. Letson, C. Messina, F. Royce, R.A. Ferreyra, J.W. Jones, J.W. Hansen, I. Llovet, M. Grondona, and J.J. O'Brien, Use of ENSO related climate information in agricultural decision making in Argentina: a pilot experience, *Agricultural Systems*, *74*, 371-392, 2002.

Sabine, C.L., R.A. Feely, R.M. Key, J.L. Bullister, F.J. Millero, K. Lee, T.-H Peng, B. Tilbrook, T. Ono, and C.S. Wong, Distribution of anthropogenic CO_2 in the Pacific Global, *Global Biogeochem. Cycles, 16*(4), 1083, doi:10.1029/2001GB001639, 2002.

Sharma, V.K., F. Casteran, and F.J. Millero, and C. De Stefano, Dissociation Constants of Protonated Cysteine Species in NaCl Media, *J. Solution Chem., 10*, 783-792, 2002.

Silva, C.A.R., X. Liu and F.J. Millero, Solubility of Siderite ($FeCO_3$) in NaCl Solutions, *J. Solution Chem., 31*(2), 97-108, 2002.

Smith, N., and T.N. Lee, Volume transport through tidal channels in the middle Florida Keys, *J. Coastal Res.*, *19*, 254-260, 2003.

Uhlhorn, E.W., and P.G. Black, Verification of remotely sea sensed surface winds in hurricanes, J. Atmos. Ocean. Tech., 20, 99-116, 2003.

Vermeij, M.J.A., K. Broker, E. Sampayo, and R.P.M. Bak, Planulae release in the Caribbean genus *Madracis*, *Mar. Ecol. Prog. Ser.*, *247*, 75-84, 2003.

Vermeij, M.J.A., A.E. Engelen, R.P.M. Bak, Deep formations (50 –80 m) of the solitary coral *Phacelocyanthus flos* on southern Caribbean reefs, *Coral Reefs*, *22*, 107-108, 2003.

Vermeij M.J.A., and R.P.M. Bak, Inferring demographic processes from population size structure in corals, *Proc. 9th Int. Coral Reef Symp. I*, 589-593, 2003.

Wang, C., and D. B. Enfield, A further study of the tropical Western Hemisphere warm pool, *J. Climate*, *16*, 1476-1493, 2003.

Wang, J.D., J. Luo, and J. S. Ault, Flows, salinity, and some implications for larval transport in south Biscayne Bay, Florida, *Bull. Mar. Sci.*, *72*(3), 311-329, 2003.

Zhang, J.-Z., and F.J. Millero, Comment on "A Kinetic Study of the Oxidation of S(IV) in Seawater", *Environ. Sci. Technol, 36*(4), 817-817, 2002.

Accepted and In Press

Chung, S., K. Lee, R.A. Feely, C.L. Sabine, F.J. Millero, R. Wanninkhof, J.L. Bullister, R.M. Key, and T.-H. Peng, Calcium carbonate budget in the Atlantic Ocean based on water-column inorganic carbon chemistry, *Biogeochem. Cycles*, in press, 2003.

Clark, C.D., W.T. Hiscock, F.J. Millero, G. Hitchcock, L. Brand, W.L. Miller, L. Ziolkowski, R.F. Chen, and R.G. Zika, CDOM distribution and CO_2 production on the Southwest Florida Shelf, *Mar. Chem*., in press, 2003.

Dunion, J.P., C.W. Landsea, S.H. Houston, and M.D. Powell, A Re-Analysis of the surface winds for Hurricane Donna of 1960, *Mon. Wea. Rev.*, in press, 2003.

Gonzalez-Caccia, V., F. J. Millero, and A. Palanques, The distribution of trace metals in Florida Bay sediments, *Mar. Poll. Bull.*, in press, 2003.

Kaandorp, J.A., E.A. Koopman, P.M.A. Sloot, R.P.M. Bak, L.E.H. Lampmann, and M.J.A. Vermeij, Simulation and analysis of flow patterns around CT-scans of the scleractinian coral *Madracis mirabilis* (Duchassaing and Michelotti), *Proc. Roy. Acad. Sc*. (UK), in press, 2003.

Lawrence, D.J., M. Dagg, H. Liu, S. Cummings, P. Ortner, and C. Kelble, Wind events and benthic-pelagic coupling in a shallow subtropical bay in Florida, USA, *Mar. Ecol. Prog. Ser.,* accepted, 2003.

Lee, K., S.-D. Choi, G.-H Park, R. Wanninkhof, T.-H. Peng, R. M. Key, C. L. Sabine, R. A. Feely, J. L. Bullister, and F. J. Millero, An updated anthropogenic CO_2 inventory in the Atlantic Ocean, *Global Biogeochem. Cycles*, in press, 2003.

Millero, F.J., and F. Huang, Solubility of oxygen in aqueous solutions of KCl, K_2SO_4 and $CaCl_2$ as a function of concentration and temperature, *Chem. Eng. Data*, in press, 2003.

Millero, F.J., and D. Pierrot, The thermochemical properties of seawater fit to the Pitzer equations, *Mar. Chem*., in press, 2003.

Millero, F.J., L.A. Gordon, L.A. Codispoti, and J.M. Morrison, The chemistry of the Ross Sea in the Austral Spring, *Antarctic J.,* in press, 2003.

Morse, J.W., D.K. Gledhill, and F.J. Millero, $CaCO_3$ precipitation kinetics in waters from the Great Bahama Bank: Implications for the relationship between bank hydrochemistry and whitings, *Geochim. Cosmochim. Acta, 67*(11) 000-000, in press, 2003.

Schmid, C., E. Johns, R. L. Molinari and S. L. Garzoli, Pathways and Variability of the Intermediate Water Flow in the Tropical Atlantic, *Elsevier Oceanographic Series*, in press, 2003.

Sharma, V.K., A. Zinger, F.J. Millero, and C. De Stefano, Dissociation constants of protonated Methionine species in NaCl media, *Biophys. Chem. J*., in press, 2003.

Tokarczyk, R., K.D. Goodwin, E.S. Saltzman, Methyl bromide and methyl chloride degradation in the Southern Ocean, *Geophys. Res. Letts.*, in press, 2003.

Vermeij, M.J.A., K. Broker, E. Sampayo, and R.P.M. Bak, Gametogenesis in the Caribbean genus *Madracis*, *Coral Reefs*, in press, 2003.

Vermeij, M.J.A., O.E. Diekmann, and R.P.M. Bak, A new species of Scleractinian coral (Cnidaria, Anthozoa), *Madracis carmabi* n.sp. from the Southern Caribbean, *Bull. Mar. Sci.*, in press, 2003.

Yvon-Lewis, S.A., D.B. King, R. Tokarczyk, K.D. Goodwin, E.S. Saltzman, and J.H. Butler, Methyl bromide and methyl chloride in the Southern Ocean, *J. Geophys. Res.*, in press, 2003.

Chapters-in-Books

Ault, J. S., J. Luo, and J. D. Wang, A spatial ecosystem model to assess spotted seatrout population risks from exploitation and environmental changes, in *Biology of Spotted Seatrout*, edited by S. Bortone, Chapter 15, pp. 267-296, CRC Press, Boca Raton, Florida, 2003.

Bohnsack, J. A., J. S. Ault, D. B. McClellan, D. E. Harper, S. G. Smith, and B. Causey, Effects of no-take zones on reef fish populations in the Florida Keys National Marine Sanctuary, in *Aquatic Protected Areas as Fisheries Management Tools*, 133rd American Fisheries Society, Quebec, Canada, 2003.

Dickson, A., R. Bidigare, J. Hedges, K. Johnson, D. Leblanc, C. Lee, A. McNichol, F. Millero, J. Moffett, W. Moore, E. Peltzer, and S. van den Berg, Ocean Studies Board, National Research Council, *Chemical Reference Materials. Setting the Standards for Ocean Science*, 130 pp., The National Academies Press, Washington, D.C., 2002.

Franklin, E. C., J. S. Ault, S. G. Smith, J. Luo, G. A. Meester, G.A. Diaz, M. Chiappone, D. W. Swanson, S. L. Miller, and J.A. Bohnsack, Utilization of GIS in a fisheries assessment and management system, Chapter 5, pp. 49-54, in *Marine Geography: GIS for the Oceans and Seas*, edited by J. Breman, ESRI Press. Redlands, CA., 204 pp., 2002.

Franklin, E. C., J. S. Ault, S. G. Smith, and J. Luo, Utilization of GIS in a fisheries assessment and management system, Chapter 5, pp. 49-54, in *Marine Geography: GIS for the Oceans and Seas*, edited by J. Breman, ESRI Press, Redlands, CA., 204 pp., 2002.

Goodwin, K.D., Bacterial degradation of trihalomethanes, in *Processes Affecting the Ttrihalomethane Concentrations Associated with the Subsurface Injection, Storage, and Recovery Program in Lancaster, Antelope Valley, California*, edited by M.S. Fram, B.A. Bergamaschi, K.D. Goodwin, R. Fujii, J.F. Clark, U.S. Geological Survey Water-Resources Investigations Report, 03-4062, http://water.usgs.gov/pubs/wri/wri034062/, 2003.

Lee, T.N., E. Johns, D. Wilson, E. Williams, and N. Smith, Transport processes linking south Florida coastal ecosystems, in *The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Source Book,* pp. 309-342, CRC Press, 2001.

Miller, M. W., M. Vermeij, D. E. Williams, D. McClellan, B. Yoshioka, Chapter III: Benthic Habitats and Community Structure, in *Status of Reef Rresources of Navassa Island: Cruise Report Nov. 2002*, edited by M.W. Miller, NOAA Technical Memorandum NMFS-SEFSC-501, 115 pp., 2003.

Millero, F.J., Seawater as an Electrolyte, in *Chemistry of Marine Water and Sediments*, edited by A. Gianguzza, E. Pellizzetti, and S. Sammartano, pp. 1-34, Springer-Verlag, Berlin, 2002.

Millero, F.J., and D. Pierrot, Speciation of Metals in Natural Waters, in *Chemistry of Marine Water and Sediments*, edited by A. Gianguzza, E. Pellizzetti, and S. Sammartano, pp. 193-220, Springer-Verlag, Berlin, 2002.

Millero, F.J., Physico-Chemical Controls On Seawater, *Treatise on Geochemistry*, Vol. 6., edited by K.K. Tarekian and H.A. Holland, *The Oceans and Marine Geochemistry*, in press, 2003.

Morisseau-Leroy, N., *Oracle 9iAS: Building J2EE Applications*, Oracle Press, New York. 2002.

Williams, D. E., and M. W. Miller, Chapter VIII: Population demographics of the corallivorous snail *Coralliophila abbreviata* from Navassa Island, in *Status of Reef Resources of Navassa Island: Cruise Report Nov. 2002*, edited by M. W. Miller, NOAA Technical Memorandum NMFS-SEFSC-501, 115 pp., 2003.

Williams, D. E., Chapter IX: Symbiont-bearing Foraminifera of Navassa Island, in *Status of Reef Resources of Navassa Island: Cruise Rreport Nov. 2002*, edited by M.W. Miller, NOAA Technical Memorandum NMFS-SEFSC-501, 115 pp., 2003.

Conference Proceedings

Capo, T., A. Boyd, J. Bauer, D. Cole, M. Miller, and A. Szmant, Spontaneous Spawning of *Diadema antillarum* Under Photo-Thermal Control: An Essential Step For Year-round Laboratory Culture, Aquaculture 2001: Book of Abstracts, 868 pp., Lake Buena Vista, FL, 21-25 January 2001.

Capo, T., N. Sukhraj, A. Boyd, M. Miller, and A. Szmant, Non-invasive spawning of captive *Diadema antillarum* (Philippi) under photo-thermal control, CRC Proceeding of the International Conference on Sea Urchin Fisheries and Aquaculture, Puenta Monte, Chile. March 24-27, 2003.

Criales, M. M., J. Wang, J. Browder, M.B. Robblee, T. L. Jackson and C. Hittle, Postlarval transport of pink shrimp into Florida Bay. Abstract. Joint conference on the Science and Restoration of the Greater Everglades and Florida Bay, April 2003.

Foti, C., A. Gianguzza, D. Milea, F.J. Millero, D. Piazzese, and S. Sammartano, Chemical speciation of organometallic compounds in seawater, Abstract, 5th Congresso Nazionale del Consorzio Interuniversitario Nazionale "La Chimica per l'Ambiente", Tunisia, June, 26-28, 2002.

Foti, C., A. Gianguzza, D. Milea, F.J. Millero, and S. Sammartano, Speciation of tri-alkyltin (IV) cations in natural fluids, Abstract, XXX Annual Italian Spanish Congress on Thermodynamics of Metal Complexes, Capri, Italy, June 2003.

Gianguzza, A., D. Milea, F.J. Millero, and S. Sammartano, Speciation of dioxouranium(VI) in natural fluids, Abstract, XXX Annual Italian Spanish Congress on Thermodynamics of Metal Complexes, Capri, Italy, June 2003.

Gonzalez-Cassia, V., F.J. Millero, and A. Palanques, The distribution of trace metals in Florida Bay sediments, Abstract, Everglades and Florida Bay Ecosystem Restoration Conference, Tampa Bay, FL, April 2003.

Hiscock, W.T., F.J. Millero, X. Zhu, A.M. Cabrera, and V. Koehler, Measurements of nutrients and carbon system parameters during the southern ocean Iron experiment (SOFEX), Abstract, EOS, AGU Meeting, San Francisco, Calif., December, 2002.

Johns, E., P. Ortner, R.H. Smith, C. Kelble, S. Cummings, J. Hendee, N. Melo, T. N. Lee, and E. Williams, New interdisciplinary oceanographic observations in the coastal waters adjacent to Florida Bay, Proceedings, 2003 Joint Conference on the Science and Restoration of the Greater Everglades and Florida Bay Ecosystem, pp. 45-47, Palm Harbor, FL, University of Florida, April 13-18, 2003.

Jones, D. L., M. R. Lara and J. T. Lamkin, Use of geochemical tracers to elucidate life history trajectories of gray snapper within South Florida's marine ecosystems, Joint conference on the science and restoration of the greater Everglades and Florida Bay ecosystem, Florida Bay and Adjacent Marine Ecosystems Program Management Committee, Palm Harbor, Florida, 2003.

Lee, T. N., E. Williams, E. Johns, R. H. Smith and N. Melo, Circulation and exchange processes within Florida Bay interior basins, Florida Bay Science Conference, pp. 26-28, April, 2003.

Mainelli, M., M. DeMaria, and L.K. Shay, Impact of oceanic heat content on hurricane intensity forecasts using SHIPS model, in *25th Conference Hurricanes and Tropical Meteorology*, American Meteorological Society, p. 627-628, 29 April – 3 May 2002, San Diego, CA, 2002.

Melo, N., T.N. Lee, E. Williams, D. Smith, M. Framinan, R.H. Smith, and E. Johns, A movie of Florida Bay sea level response to local wind forcing, Florida Bay Science Conference, p. 59, April 2003.

Millero, F.J., Carbon Dioxide System in Natural Waters, Abstract, 223rd ACS National Meeting, Orlando, FL, April 2002.

Millero, F.J., The speciation of metals in natural waters, Abstract, XXX Annual Italian Spanish Congress on Thermodynamics of Metal Complexes, Capri, Italy, Abstract, June, 2003.

Rogers, R.F., and R.A. Black, Evaluating Microphysical Parameterization Schemes for Use in Hurricane Environments, 57th Interdepartmental Hurricane Conference, Office of the Federal Coordinator for Meteorology, Miami, FL, March 2003.

Sabine, C.L., R.A. Feeley, R.M. Key, J.L. Bullister, F.J. Millero, K. Lee, T. Peng, B. Tilbrook, T. Ono, and C. Wong, Distribution of anthropogenic CO_2 in the Pacific Ocean, Abstract, ASLO/AGU Ocean Science Meeting, Hawaii, February 2002.

Williams, D. E., and M. W. Miller, Photo-monitoring of *Acropora cervicornis* & *Acropora palmata* on Florida reefs: importance of predation to growth & survivorship, presented at 59th Annual Meeting, Marine Benthic Ecology Meeting, March 28-30, 2003.

Wong, S., J. Contillo, J. Tobias, B. Mase, J. Litz, and J. Wicker, Creating High Resolution Still Images of Bottlenose Dolphins from Video Clips, Poster/ Presentation Seventh Annual International Conference on Remote Sensing for Marine and Coastal Environments, Miami, FL, 2002.

Wong, S., J. Contillo, S. Molina, J. Wicker, B. Mase, and J. Litz, Web-based Data Management and Sharing of Bottlenose Dolphin Photo-ID Information, Oral Presentation, Oceans 2002 Conference and Exhibition, Biloxi, MS, 2002.

Yeung, C., D. L. Jones, M. M. Criales, M. R. Lara, T. L. Jackson, J. T. Lamkin, and W. J. Richards, Large Eddy, Small Eddy - Suppling recruits to the South Florida Ecosystem, Proc. 55th Annual Gulf and Caribbean Fisheries Institute Meeting, Xel Ha, Mexico, November 2002.

Yeung, C., D. L. Jones, M. M. Criales, M. R. Lara, T. L. Jackson, J. T. Lamkin and W.R. Richards, Influence of eddies on the transport of pre-settlement stages into Florida Bay, Joint conference on the science and restoration of the greater Everglades and Florida Bay ecosystem, Florida Bay and Adjacent Marine Ecosystems Program Management Committee, Palm Harbor, Florida, April 2003.

Technical Reports

Ault, J.S., S.G. Smith, G.A. Diaz, and E. Franklin, Florida hogfish fishery stock assessment. Final Report to the Florida Fish and Wildlife Conservation Commission, 46 pages + Tables and Figures, 2003.

Ault, J.S., S.G. Smith, E. Franklin, J. Luo, and J.A. Bohnsack, Sampling design analysis for coral reef fish stock assessment in Dry Tortugas National Park, Final Report to NPS ENP/DTNP, 105 pp., 2003.

Ault, J.S., and N.M. Ehrhardt, Ault and Ehrhardt method to estimate total mortality in fish stocks. FiSAT II Software FAO-ICLARM Stock Assessment tools VER 1.00 from 1 June 2003. http://www.fao.org/fi/statist/fisoft/fisat/index.htm.

Baringer, M., and Yao, Q., Cruise Report: Atlantic Climate Change Program: Volunteer Observing Ship High Resolution XBT line AX7 and Direct Observations in Support of Operational Monitoring in the Straits of Florida, August, 2002.

Bohnsack, J.A., Coral Reefs and Fisheries: Past, Present and Future, Proceedings of Capitol Hill Oceans Week 2002, Coral Reefs at Risk: Challenges and Solutions, National Marine Sanctuary Foundation, McLean, VA, 2002.

Capo, T. R., K. Gracie, and A. T. Bardales, Fisheries Habitat: Restoration of coral reef fisheries habitat by enhancement of coral recruitment via improved substrate quality, larval seeding and sea urchin re-introduction. Final Report to Sea Grant, University of Miami, Rosenstiel School of Marine and Atmospheric Sciences, 2003.

Fram, M.S., J.K. Berghouse, B.A. Bergamaschi, R. Fuji, K.D. Goodwin, and, J.F. Clark. Water-Quality Monitoring and Studies of the Formation and Fate of Trihalomethanes during the Third Injection, Storage, and Recovery Test at Lancaster, Antelope Valley, California, March 1998 through April 1999. *U.S. Geological Survey Open File Report* 02-102, http://water.usgs.gov/pubs/of/ofr02102/, 2002.

Johns, E., T.N. Lee, and P.B. Ortner, Surface currents connect south Florida and the Keys. Sounding Line, a publication of the FKNMS, 2 pp., Winter issue, 2002.

Johns, E., and T.N. Lee, Red tides on the southwest Florida shelf: The effect of physical oceanographic and meteorological forcing on the onset, severity and persistence of Karenia brevis blooms, Preliminary summary report submitted to the Florida Fish and Wildlife Conservation Commission's Florida Marine Research Institute (FMRI), 4 pp., June 13, 2003.

Johnson, K.M., A.G. Dickson, G. Eischeid, C. Goyet, P.R. Guenther, R.M. Key, K. Lee, E.R. Lewis, F.J. Millero, D. Purkerson, C. L. Sabine, R.G. Schottle, D.W.R. Wallace, R.J. Wilke, and C. D. Winn, Carbon dioxide hydrographic, and chemical data obtained during the nine R/V Knorr Cruises comprising the Indian Ocean CO_2 survey (WOCE Sections I8SI9S, 19N, I8N15E, I3, I5W14, 17N, I1, I10, and I2; December 1, 1994-January 19, 1996) *Environ. Sci. Div. Pub. No. 4988*, US Dept. of Energy, CDIAC, Oak Ridge Tenn., June, 2002.

Lee, T. N., and E. Johns, South Florida's "current" concerns require a global view, Florida Bay Watch Report, A publication of the Nature Conservancy of the Florida Keys, pp. 1-6, 2001.

Wanninkhof, R. T-H. Peng, B. Huss, C.L. Sabine, K. Lee, K.Azetsu-Scott, J.L Bullister, R.A. Feely, M. Hoppema, R.M. Key, A. Kozyr, F.J. Millero, and A.F. Rios, Comparison of inorganic carbon system parameters measured in the Atlantic Ocean from 1990 to 1998, *Environ. Sci. Div. Pub. No. 4988*, US Dept. of Energy, CDIAC, Oak Ridge Tenn., ORNL/CDIAC-116, 41 pp., Carbon Dioxide Inf. Anal. Cent. Oak Ridge Natl. Lab., U.S. Dept. Of Energy, Oak Ridge Tenn, 2003.

Theses and Dissertations

González Caccia, V., Distribución de Metales Traza en el Aqua de Mar y Sedimentos de la Bahia de Florida, Ph.D. Dissertation, Universitat Politecnica de Catalunya, 2002.

Jurado, J.L., The dynamics of diatom blooms and silicon cycling in coastal waters of the southwestern Florida Shelf and northwestern Florida Bay, Ph.D. Dissertation, 268 pp. University of Miami/RSMAS/MBF, Miami, FL, 2003.

Kelble, C.K., Attenuation of photosynthetically active radiation (PAR) in Florida Bay, USA, M.S. Thesis, 98 pp., University of Miami/RSMAS/MBF, Miami, FL, 2003.

Otero, S., A Real-time Distributed Analysis Automation for Hurricane Surface Wind Observations, M.S. Thesis, School of Computer Science, Florida Intl. Univ., Miami, FL, 2002.

Pierrot, D., Thermodynamic Investigations Using the Pitzer Formalism: Extension of the Model and Its Applications, Ph.D. Dissertation, University of Miami, FL, 2002.

Voss, D., Sea-Salt Aerosol and Bioaerosol Production from an Artificial Sea-Salt Aerosol Generator, M.S. Thesis, University of Miami, FL, 2002.

The Cooperative Institute of Marine and Atmospheric Studies
University of Miami Rosenstiel School of Marine and Atmospheric Science
4600 Rickenbacker Causeway
Miami, Florida 33149
http://cimas.rsmas.miami.edu