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AOML Keynotes

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

AOML is an environmental laboratory of NOAA's Office of Oceanic and Atmospheric Research on Virginia Key in Miami, Florida

Connectivity of the Florida Keys Coral Reef Ecosystem with Upstream Waters of the Mesoamerican Barrier Reef System

The Mesoamerican Barrier Reef System (MBRS) is the second longest barrier reef system in the world, extending more than 1,000 km along the eastern coast of the Yucatan Peninsula. The MBRS is of high ecological and economic importance to the western Caribbean region and contains essential habitat and spawning sites for a number of reef fish species such as groupers and snappers. Despite this, little is known of the distribution and transport of pelagic fish larvae in the area.

Two research cruises were conducted in the winter-spring of 2006 and 2007 as part of a collaborative effort between scientists with AOML's Physical Oceanography Division, NOAA's Southeast Fisheries Science Center, the University of Miami, and El Colegio de la Frontera Sur, focusing on the link between the region's physical oceanography and larval reef fish distributions. Results from this study have been reported in Muhling *et al.** Herein, we provide highlights from the physical oceanography portion of this paper.

Regional environment and oceanographic circulation

The Caribbean Current/Yucatan Current system is the dominant oceanographic feature observed in the study region (Figure 1). During the 2006 and 2007 surveys, this circulation was confirmed by satellite-tracked surface drifter trajectories (Figure 2). These trajectories showed, in general, that the westward-flowing Caribbean Current impinged upon the Yucatan Peninsula at a latitude of approximately 18°N, east of Banco Chinchorro, before flowing northward along the coast and passing through the Yucatan Channel into the Gulf of Mexico. This resulted in strong northward flow close to the northern Yucatan coast, including along both the eastern and western coastlines of Cozumel.

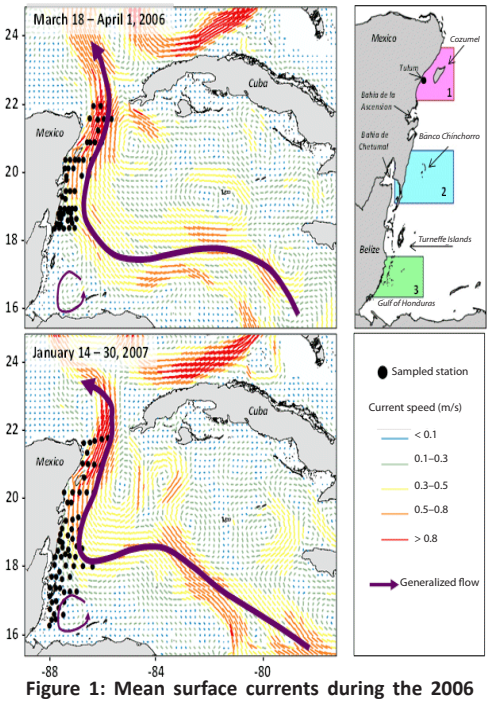


Figure 1: Mean surface currents during the 2006 (top) and 2007 (bottom) cruises from the HYCOM (HYbrid Coordinate Ocean Model) 1/12° global analysis, with sampled stations also shown. Three areas of interest around Cozumel (1), Banco Chinchorro (2), and the Gulf of Honduras (3) used in later analysis are shown in the upper right panel. Current speeds are indicated in the lower right panel.

Of the nine drifters released during the 2006 cruise and the seven drifters released during the 2007 cruise (Figure 2), most eventually became entrained into the Loop Current and exited the region east of the south Florida peninsula. One exception, however, was a deployment made in 2007 in the Gulf of Honduras at the southernmost extent of the survey track. This drifter remained in the Honduran Gyre south of the latitude of impingement, executing one complete cyclonic rotation around the gyre before it died 27 days after its deployment (Figure 2, bottom of right panel).

In order to understand more about possible larval dispersion versus retention in the study area, the trajectories of all drifters that had ever passed through the three labeled boxes in Figure 1 were obtained from AOML's Global Drifter Program, and their paths over one-week and two-week periods were examined.

This analysis showed that historically, the 54 drifters that passed through the Cozumel area of interest (*cont. page 2*)

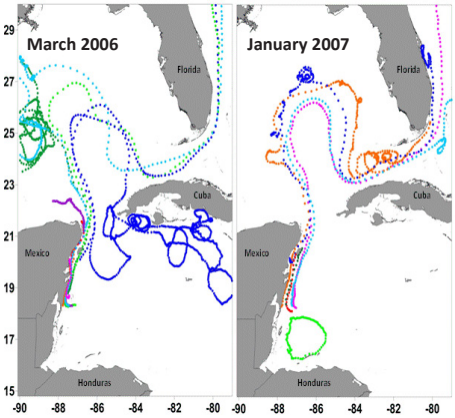


Figure 2: Trajectories of satellite-tracked surface drifters released during March 2006 (left panel) and January 2007 (right panel). Dots represent 6-hourly position fixes.

*Muhling, B.A., R.H. Smith, L. Vásquez-Yeomans, J.T. Lamkin, E.M. Johns, L. Carrillo, E. Sosa-Cordero, and E. Malca. Larval fish assemblages and mesoscale oceanographic structure along the Mesoamerican Barrier Reef system. *Fisheries Oceanography,* Accepted for publication, November 2012.

(Figure 3, upper panels) tended to continue northwards. After one week, most were dispersed throughout the southeastern Gulf of Mexico within the Loop Current with some remaining in the vicinity of Cozumel. After two weeks, 15 were retained south of 21°N (27.8%), 34 were in the Gulf of Mexico (63%), and five had exited through the Straits of Florida (9.3%).

The 56 drifters that passed through the Banco Chinchorro area of interest (Figure 3, middle panels) also tended to continue northwards. After one week the drifters were widely distributed along the northern Yucatan coast, with some entering the Gulf of Mexico and some remaining to the south. After two weeks, 24 of the 56 drifters were retained south of 21°N (42.9%), 30 drifters (53.6%) were located within the Gulf of Mexico, and two drifters (3.6%) had continued into the Gulf Stream.

Few drifters have historically passed through the Gulf of Honduras/Honduras Gyre area of interest (only five in total, Figure 3, lower panels), one of which was the southernmost drifter deployed during the 2007 cruise. By the end of two weeks, all five drifters were still retained south of 21°N, although four of the five had moved some distance northwards along the MBRS. None of these drifters had reached the Gulf of Mexico after a period of two weeks.

Implications for connectivity

The analysis of the cruise data, including synoptic drifter deployments in conjunction with historical drifter tracks obtained from AOML's Global Drifter Program, documented (1) the strong northwards flow and high dispersion conditions typically present along the northern MBRS and (2) the role of the Honduras Gyre in creating a region of lower dispersion/high larval retention in the Gulf of Honduras.

In summary, the Gulf of Honduras/Honduras Gyre region may act as an important retention area for larval reef fish, while conditions further to the north may favor dispersion to the Florida Keys and beyond, demonstrating the potential for rapid connectivity (on the order of one to two weeks) between the western Caribbean Sea, Gulf of Mexico, and the Atlantic Ocean. However, it should be noted that despite the probable dispersal of reef fish larvae from the MBRS to the Florida Keys region and beyond, the biological literature shows little evidence of strong genetic connectivity between the two regions, and it remains unclear how many of these larvae may survive to recruit to distant reefs.

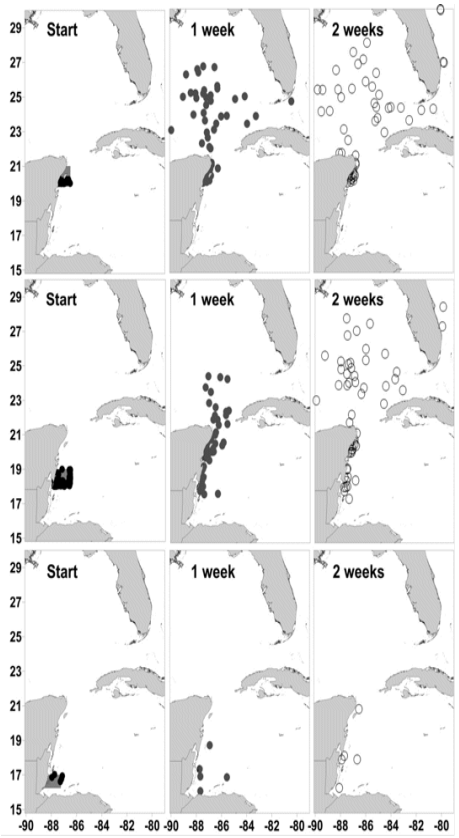
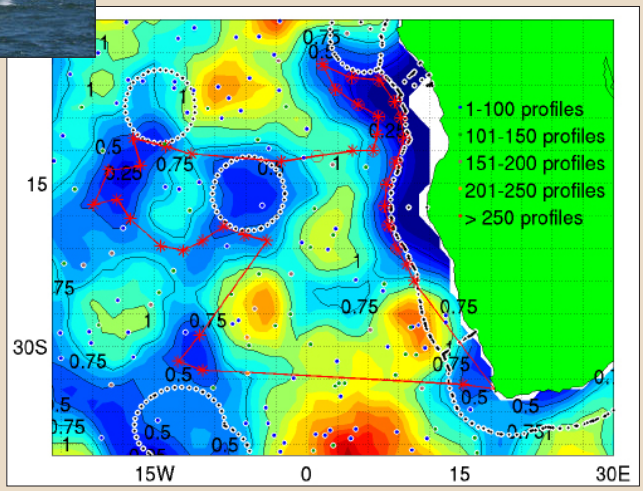


Figure 3: Position of all drifters passing through the three areas of interest (see Figure 1) between February 15, 1979 and September 30, 2011, obtained from AOML's Global Drifter Program. Positions are shown when a drifter first entered the area of interest (left panels), one week after entering the area of interest (center panels), and two weeks after entering the area of interest (right panels).

In early December, researchers with the South Atlantic Argo Regional Center at AOML finalized plans for a float and drifter deployment cruise aboard the sailing ship *Lady Amber*, a privately owned and operated South African schooner. The *Lady Amber* will deploy 38 Argo profiling floats and 16 satellite-tracked drifting buoys into data-sparse regions of the South Atlantic Ocean not easily accessed by ships of opportunity.

Left: The *Lady Amber* is a 38 tonne, 20-meter schooner owned by Captain Peter Flanagan and operated by a crew of four. Captain Flanagan offered the *Lady Amber* to assist the international oceanographic community in its efforts to deploy ocean-observing instruments.

Below: Planned track of the *Lady Amber* cruise. Dark blue areas indicate a very low density of profiles obtained from Argos floats (based on analysis of data coverage for November 2012). Five such areas are targeted during the *Lady Amber* cruise. Red stars indicate the location of the planned float deployments, and red circles mark the location of planned satellite-tracked drifter deployments.



Shortly before Christmas, the *Lady Amber* departed Cape Town, South Africa to begin the two-month long deployment cruise, which will cover an estimated 8,980 miles. Sailing northward along the west coast of Africa (see graphic at right) the *Lady Amber* will deploy floats and drifters offshore of coastal upwelling regions before journeying westward into the central Atlantic Ocean. Turning south at 32°S, the *Lady Amber* will deploy additional floats and drifters to help fill two large data-poor areas before returning to Cape Town near the end of February 2013.

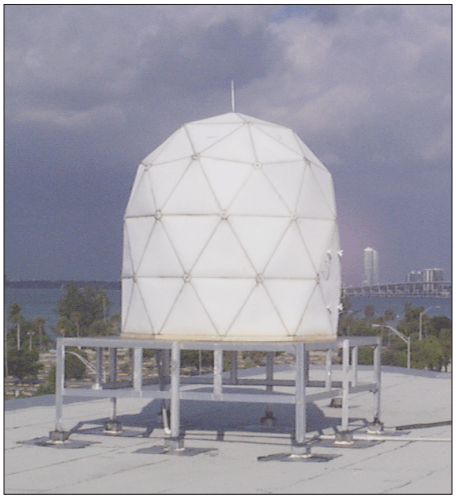
Argo profiling floats measure the temperature and salinity of the ocean from the surface to depths as great as 2000 m, while satellite-tracked drifting buoys measure sea surface temperatures and near surface currents. The data generated from these ocean-observing instruments are used in weather forecasts, seasonal to interannual climate predictions, and climate research.

Satellite Receiving Station at AOML Upgraded to Receive SARAL Data

A new data acquisition system and demodulator were installed on the satellite receiving station at AOML during the week of December 3rd. Laure Boutemy and Patrick Groussin from the Centre National d'Etudes Spatiales (CNES), the French Space Agency, performed the installation. They were assisted by Joaquin Triñanes of AOML with support from AOML's Physical Oceanography Division.

This equipment upgrade will enable the AOML station to receive telemetry from the SARAL (Satellite with Argos and AltiKa) satellite scheduled for launch in February 2013. The SARAL satellite mission is a joint endeavor of the Indian and French space agencies to study ocean currents and global sea surface heights.

The L-band, multi-mission satellite receiving station at AOML was established in 1999. It works on a 24×7 basis to provide near-real-time High Resolution Picture Transmission (HRPT) data to NOAA's National Environmental Satellite, Data and Information Service.



The radome housing the 1.7 m satellite receiving antenna.

Joaquin Triñanes of AOML's Physical Oceanography Division, operational manager of the CoastWatch regional node at AOML, with Laure Boutemy and Patrick Groussin from the Centre National d'Etudes Spatiales.

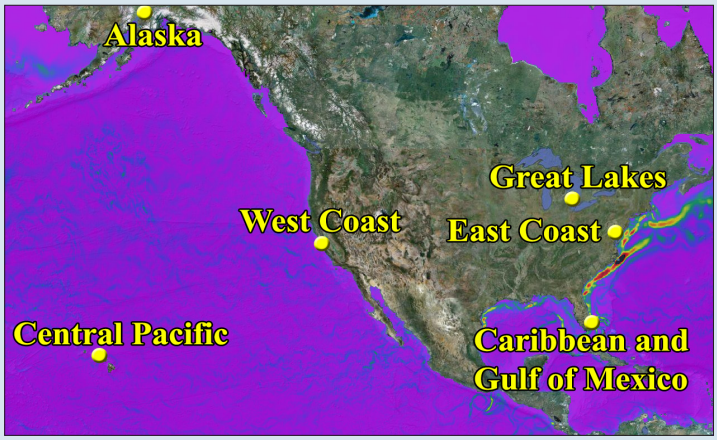
The station's antenna enables it to receive telemetry from a number of satellites (NOAA-15, 16, 17, 18, and 19, MetOp-A, and MetOp-B) that provide high quality environmental data used for climate research and weather forecasts. The telemetry also provides data from the Argos Data Collection System (DCS), which is operated by CNES and NOAA through a cooperative agreement. The Argos DCS gathers environmental data from more than 21,000 fixed and moving platforms that are sent to Argos data processing and distribution centers in the U.S. and France.

Serving as the regional node for NOAA's CoastWatch Program, the receiving station at AOML is the main NOAA provider of HRPT data for the Gulf of Mexico and Caribbean. The CoastWatch program focuses on the rapid distribution of high quality satellite products. It distributes numerous operational environmental data sets, such as sea surface temperatures, surface winds, and ocean color, and covers all U.S. coastal waters, including Hawaii and Alaska.

The upgrade to the AOML station will enable it to receive data from the Argos DCS-3 sensor aboard the SARAL satellite and serves as a testbed to evaluate its implementation and compatibility with current infrastructure. Results from the AOML upgrade will determine whether upgrades are made to other NOAA stations in Monterey and Hawaii.

Monitoring U.S. Coastal Waters

NOAA's CoastWatch program freely provides remotely-sensed satellite and other environmental data to the government, academic, commercial, and public sectors. The Caribbean/Gulf of Mexico regional node at AOML is one of six sites located throughout the United States that processes and distributes information in near-real-time. CoastWatch data are used to monitor sea-surface temperature and algal blooms, study fish and marine mammal distributions, and to aid in atmospheric forecasting. The primary data source for CoastWatch is the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA series polar-orbiting weather satellites. For more information about the CoastWatch program, visit http://coastwatch.noaa.gov/ and http://cwcaribbean.aoml.noaa.gov.



Map depicting all six regional nodes of the CoastWatch program. The background shows the frontal boundaries derived from the sea surface temperature field.

Hurricane Science Pioneer Dr. Robert Simpson Celebrates 100 Years

Dr. Robert Homer Simpson, a tropical meteorology pioneer who had much to do with the formation of AOML and its Hurricane Research Division, turned 100 years old on November 19th. His life has been as remarkable as it has been long.

Growing up on the Texas Gulf coast, tropical storms were always a backdrop to his life. When Simpson was six years old, a major hurricane struck his hometown of Corpus Christi. He and his family survived the storm by swimming through rapidly rising flood waters to reach the city courthouse located on a bluff several blocks from their home. The experience, while frightening, left Simspon with an enduring fascination for hurricanes.

His early interest in an architectural career ended with the stock market crash of 1929. Simpson's skill as a trumpeter, however, provided the opportunity for him to attend Southwestern University in Georgetown, Texas, and graduate school at Emory University in Atlanta, Georgia. Although he attended on music scholarships, Simpson majored in mathematics rather than music.

He obtained a master's degree in physics in 1935 and wanted to study sonar, but financial considerations prevailed. To earn a living, he became a music teacher and taught at various Texas high schools, including his alma mater in Corpus Christi.

In 1940, Simpson obtained a job as an apprentice observer with the U.S. Weather Bureau. This meant a serious pay cut, and by now Simpson had a wife and daughter. He was, however, offered a path to promotion if he served six months on the isolated Weather Bureau station on Swan Island in the Caribbean. It meant isolation from his family and the creature comforts of the mainland, but he used the time to study meteorology texts and familiarize himself with tropical weather first-hand.

Practicing the trumpet as a boy, Bob Simpson later won first place in the Texas state trumpet solo contest for two consecutive years. He was subsequently invited to attend Southwestern University on a music scholarship, where he was the first chair trumpet player in the university's orchestra and concert band.

Dr. Bob Simpson at the American Meteorological Society's 2012 Conference on Hurricanes and Tropical Meteorology in Jacksonville, Florida.

The attack on Pearl Harbor in 1941 threatened to strand him on the tiny island for the duration of the war, but Simpson stood on the principal of the agreement he'd made with the Weather Bureau. The Bureau finally relented, and he was transferred to the Hurricane Warning Center in New Orleans, Louisiana.

Simpson's principled stand caught the attention of Weather Bureau director, Francis Reichelderfer. Soon the Chief sent Simpson to the University of Chicago to begin doctoral studies, but these were interrupted to work at the Miami Hurricane Warning Center and to study under the renowned forecaster Grady Norton.

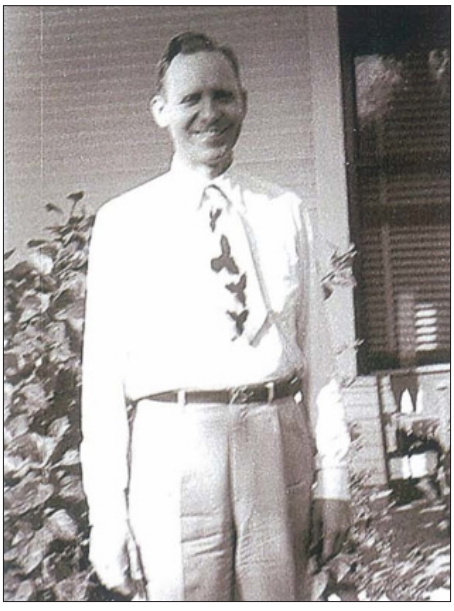
When the Army Air Force wanted to set up a tropical forecast school in Panama, the Weather Bureau lent them Bob Simpson. The school had a radar equipped C-47 aircraft to allow the students to "fly the weather" they had forecast. In August 1945, he used the aircraft to fly into a minimal hurricane south of Hispañola. This would be the first of many flights to study hurricanes from aboard aircraft.

After the War, Simpson was called to Weather Bureau headquarters to work on special projects directly under the tutelage of Reichelderfer. During the summer months, with the Chief's blessing, he would use his annual leave to fly "piggy back" science missions on Air Force hurricane reconnaissance flights. On these, he could request the pilots to fly into various parts of the storm during the time between required "fixes." He was able to use this borrowed time to explore the upper reaches of tropical cyclones, as well as their structure.

In 1948, Reichelderfer asked him to move to Hawaii to oversee the Weather Bureau's Pacific operations, especially the transfer of Army and Navy resources in that theater to the civilian agency. The nomadic lifestyle required by his employment with the Weather Bureau strained his marriage and family life. Simpson and his wife divorced, and Mrs. Simpson returned to Texas with their two daughters.

Being bereft of family life and social obligations, Simpson threw himself into his work. While in Hawaii, he traveled to typhoon conferences, studied "Kona lows," and created a weather observatory on the summit of Mauna Loa. He even managed to arrange a special research flight aboard an Air Force B-29 into Typhoon Marge, where he explored the eye and eyewall in detail.

Simpson returned to Weather Bureau headquarters in 1952 to assist with the Bureau's research efforts and battled not only stagnant budgets but also a recalcitrant attitude in Washington, where many saw the Weather Bureau as strictly an operational organization and resisted any attempts to engage in research. That all changed after the 1954 hurricane season when the heavily-populated northeast corridor came under fire from three



Bob Simpson in the 1940s.

Bob Simpson with Cecil Gentry at the National Hurricane Research Project facility in south Florida during the late 1950s.

damaging storms in the matter of a little over a month (Carol, Edna, and Hazel). The Weather Bureau brass suddenly appreciated the wisdom of research when Congress allocated funds to upgrade the Bureau's radar network and inaugurate the National Hurricane Research Project (NHRP), which would later become AOML's Hurricane Research Division.

Although Simpson hadn't yet completed his doctoral degree, Reichelderfer selected him to head NHRP through its critical first three years. Bob kept NHRP going even through a couple of lean years of hurricane activity and when others within the Bureau hungrily eyed the project's funds. Simpson began annual reviews of NHRP's accomplishments, which eventually morphed into the American Meteorological Society's biennial Hurricane and Tropical Meteorology conference starting in 1958.

Once the permanence of NHRP was assured, Simpson turned it over to his friend Cecil Gentry and returned to the University of Chicago to finish his doctorate under Herbert Riehl. After Simpson's dissertation was accepted, he was called to Washington to become the Deputy Director of Research in charge of severe storm studies.

In this position, Simpson not only oversaw NHRP but restructured what would later become NOAA's National Severe Storms Laboratory (NSSL). He also inaugurated Project STORMFURY, the Weather Bureau's decades-long experiment to test the hypothesis that seeding hurricanes with silver iodide would reduce their maximum winds.

With the formation of the Environmental Science Services Administration (ESSA, the forerunner of NOAA) in 1964, the operational components of the Weather Bureau and the Coast and Geodetic Survey were separated from the research components, which contained NHRP, NSSL, and the newly formed AOML.

In 1965, Simpson married Dr. Joanne Malkus, a fellow atmospheric scientist. Since Joanne had already agreed to lead the Experimental Meteorology Laboratory at AOML, Bob switched over to ESSA's-operational component (to avoid nepotism conflicts). Joanne took over directing Project STORMFURY, and Bob transferred to the National Hurricane Center (NHC). As NHC's deputy director, Bob worked to expand the authority and abilities of NHC and to separate it from the local Weather Bureau office.

Simpson became the director of NHC in 1967 following the retirement of Gordon Dunn. During his tenure, Bob created the position of hurricane specialist (as opposed to hurricane forecaster), fascilitated the use of computers and satellites that would revolutionize hurricane forecasting, and expanded NHC's presence on television.

After reviewing the damage caused by Hurricane Camille in 1969, he briefed Vice President Spiro Agnew on NHC's role and the inadequacies of the aircraft reconnaissance fleet. This caused a furor within the bureaucracies of the Defense and Commerce departments, but led to improvements in the Air Force and Navy Hurricane Hunter airplanes, as well as to NOAA's eventual acquisition of two P-3 research aircraft.

Drs. Joanne and Bob Simpson.

Bob and Joanne left government service in 1974 to pursue careers at the University of Virginia. In their academic positions, they participated in international experiments such as GATE and MONEX, as well as several other projects involving weather modification and tropical meteorology. They also formed a private consulting firm, Simpson Weather Associates. Joanne returned to government service in the 1980s and had a distinguished 24-year career at NASA leading the Tropical Rainfall Measuring Mission.

Even in semi-retirement, the Simpsons remained active in science, attending the AMS' biennial Hurricane and Tropical Meteorology conferences and mentoring young scientists. Joanne died in 2010, but Bob, despite his advanced age, was able to attend the 2012 AMS conference and present a paper about the Saffir-Simpson hurricane scale, which he codeveloped in 1971 with civil engineer Herbert Saffir.

We all wish Bob well on his centenary and thank him for his many valuable contributions that have advanced the field of tropical meteorology, as well as his role in fostering an appreciation for research that led to the creation of AOML.

Directors of the National Hurricane Center circa 2003 (from left to right): Max Mayfield, Jerry Jarrell, Bob Burpee, Bob Sheets, Neil Frank, and Bob Simpson. Missing from the photo are Gordon Dunn and Grady Norton (both deceased by 2003).

AOML Scientists Participate in International South Atlantic Research Cruise

AOML scientists joined with partners from Brazil and Argentina in December to collect crucial new data on the Meridional Overturning Circulation (MOC) in the South Atlantic. The expedition along 34.5°S represented the inaugural cruise of the *N. Oc. Alpha-Crucis,* the new research vessel of the Brazilian Sao Paulo Research Foundation.

The MOC is a vertical circulation cell that exchanges surface and deep waters via poleward surface transports, sinking at high latitudes and upwelling elsewhere. The variability of the Atlantic MOC has been shown in numerical models to impact global climate, including surface air temperatures, precipitation, and hurricane intensity over large portions of the Earth.

Cruise participants included scientists with the Universidade de Sao Paulo, the Instituto Nacional de Pesquisas Espaciais, Universidade Federal do Rio Grande, and the Universidade de Buenos Aires. AOML/Physical Oceanography Division participants included Drs. Christopher Meinen and Silvia Garzoli and Mr. Ulises Rivero.

The cruise supported several programs that address a broad international initiative to improve understanding of the South Atlantic MOC. These initiatives include, among others, the Brazilian funded SAMOC-Br program, the NOAA funded Southwest Atlantic MOC project (SAM), and the South Atlantic Climate Change effort of the Inter-American Institute for Global Change Research.

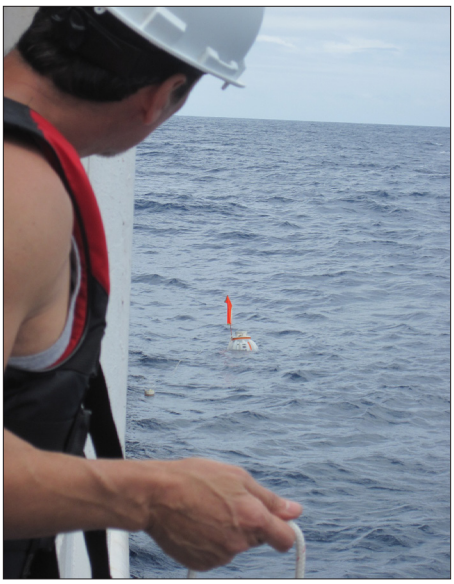
With its partners, NOAA-AOML is taking a leading role in collecting observations of the southern portion of the MOC to gain a more complete picture of this complex ocean circulation system. A complete trans-basin array to measure the MOC at 34.5°S is planned, and the NOAA and Brazilian instruments near the western boundary are the first component of the full array. Major French and South African components near the eastern boundary are planned for deployment in late 2013.

The new Brazilian vessel *N. Oc. Alpha-Crucis* at port before its first research expedition.

Crew and scientists from Brazil, Argentina, and AOML aboard the Brazilian research vessel *N. Oc. Alpha-Crucis*.

During the *N. Oc. Alpha-Crucis* expedition, three pressure-equipped inverted echo sounders (PIES) from the SAM array were recovered, fitted with new batteries, and redeployed at the same sites, while data from a fourth SAM PIES were acoustically downloaded. Additionally, three new current-and-pressure equipped inverted echo sounder (CPIES) instruments funded by the Brazilian SAMOC-Br program were deployed. Researchers collected new hydrographic observations on the continental shelf and across the Brazil and Deep Western Boundary currents.

The NOAA SAM PIES array, first deployed in March 2009, and the newly deployed Brazilian SAMOC-Br CPIES instruments are anchored on the ocean floor at depths ranging from 1300-4800 m. These instruments send sound pulses to the sea surface and listen for the return of the reflected sound waves. The round-trip travel time of the acoustic pulses are then combined with historical hydrographic data to obtain daily estimates of the temperature, salinity, and density for the full water column. The current meters on the CPIES measure near-bottom currents, while the pressure gauges provide information on the variability of deep water flows.



Preparing for the recovery of one of the NOAA SAM PIES moorings after it surfaced.

The combination of acoustic Doppler current profiler, conductivity-temperature-depth (CTD)/oxygen, PIES, and CPIES data will provide long-term observations of the western boundary currents and water masses at 34.5°S and will help to quantify the interaction between the shelf and deep ocean at this latitude. Future instrument deployments from SAMOC partners and observations obtained from various components of the Global Ocean Observing System will enable basinwide monitoring of meridional heat and volume transport associated with the MOC in the South Atlantic along the developing trans-basin array.

The existing boundary array is planned to continue through at least 2016, with cruises planned to acoustically download PIES/CPIES data and to collect new hydrographic observations annually or bi-annually. NOAA's contribution to this effort is funded by the Climate Program Office/Climate Observations Division.

AOML hosted its annual holiday dessert contest and lobby decorating event on Friday, December 7th. Staff gathered to dress the lobby for the season, trim a tree, play music, and sample a delicious assortment of dessert contest entries. Congratulations to Shirley Murillo of AOML's Hurricane Research Division (top photo, holding certificate), who won first place in the dessert contest for her scrumptious chocolate cheesecake.

Happy Holidays 2012

The annual Holiday Party at AOML was held on Friday, December 14th. Friends, family, and coworkers gathered in the lobby to share a turkey dinner and other seasonal festivities. Thanks to Lindsey Visser of AOML's Ocean Chemistry Division for leading the effort to organize the event and to the Buoys and Gulls group for their added support.

Welcome Aboard

Dr. Xidong Wang joined the staff of AOML's Physical Oceanography Division in December 2012 as a visiting scientist of the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. During his time at AOML, he will work with Chunzai Wang and scientists with the Climate and Hurricane Group to perform research in the areas of ocean-atmosphere interaction, climate and ocean variability, and their relationships with typhoon activity in the western North Pacific Ocean. Xidong obtained his Ph.D. in 2011 from the South China Sea Institute of Oceanology, Chinese Academy of Sciences, in Guangzhou, China. Since 2006, he has worked as a research assistant with the National Marine Data and Information Service in Tianjin, China.

AOML coral researcher Derek Manzello (pictured above) participated in the Tuamotu Archipelago Leg of the Global Reef Expedition from November 15 through December 11th. The five-year effort to study coral reefs throughout the Atlantic, Pacific, and Indian oceans is sponsored by the Khaled bin Sultan Living Oceans Foundation. Derek collected 200 coral cores samples from four species of reef-building coral coincident with baseline carbonate chemistry data from the Rangiroa, Aratika, Raraka, and Fakarava Atolls in French Polynesia.

Congratulations

Dr. Robert Detrick, Administrator of NOAA's Office of Oceanic and Atmospheric Research, with Kelly Goodwin and Chris Sinigalliano of AOML's Environmental Microbiology Program.

Drs. Kelly Goodwin and Chris Sinigalliano with AOML's Environmental Microbiology Program attended NOAA's annual Awards Ceremony in Silver Spring, Maryland on November 16th as invited guests of the Office of Oceanic and Atmospheric Research. Kelly and Chris were presented with a 2012 NOAA Technology Transfer Award for their work in developing microbial source tracking diagnostic tools. These tools enable the quantification and identification of fecal contaminants in coastal waters and are now being used by city and county managers to devise mitigation strategies for restoring water quality, thus decreasing the risks to human health and preserving coastal economies.

Paul Chinn, a computer specialist with AOML's Physical Oceanography Division, retired on December 29th after 41 years of federal service. During his years with NOAA-AOML, Paul led the effort to create and maintain the Shipboard Environmental data Acquisition System (SEAS) software used to transmit marine meteorological and oceanographic observations. This software is currently installed on numerous cargo ships and research vessels that traverse the world's oceans. SEAS data provide the largest source of marine meteorological observations, approximately 1.2 million per year, used by the National Weather Service for its weather forecasts. Additionally, Paul created the software and operated the servers that receive and process SEAS and other Voluntary Observing Ship Program observations for delivery to the Global Telecommunications System for model ingest. Paul's work highlights the importance of collaboration across NOAA line offices. Although retired from federal service, Paul will continue to work with NOAA-AOML as a contractor employee.

Dr. Silvia Garzoli, AOML's Chief Scientist, retired from the federal government on December 31st after 16 years of service. Silvia began her federal career in 1996 as an oceanographer with AOML's Physical Oceanography Division with research focused on studying ocean circulation and its relationship to climate. While at AOML, she conducted and directed national and international research programs in several regions of the world ocean, including the tropical Atlantic, Brazil Malvinas Confluence in the southwestern Atlantic, the Indonesian throughflow in the Makassar Strait, the Benguela Current system south of South Africa, and the North Brazil Current north of Brazil. In 1998, Silvia became the director of AOML's Physical Oceanography Division, a position she held for 12 years. She became AOML's Chief Scientist in 2009 to work closely with the AOML director on climate-related issues. Although officially retired, Silvia will continue her research activities at AOML as an affiliate of the University of Miami's Cooperative Institute for Marine and Atmospheric Studies.

NOAA Corps officer Stephen Meador, AOML's Associate Director, was promoted to the rank of Commander in November. Steve has served with the NOAA Corps for the past 17 years and has supported research missions across the globe, including the Arctic and Antarctic and the Atlantic, Pacific, and Indian oceans. As Associate Director, he oversees facility operations and safety issues at AOML and coordinates ship time aboard NOAA research vessels. Steve holds a bachelor's degree in mechanical engineering from Oklahoma State University and a master's degree in environmental health engineering from the University of Kansas.

Recent Publications *(AOML authors are denoted by bolded capital letters)*

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