Oceans and Climate Research

Physical Oceanography Division (PHOD)

Gustavo Jorge Goni, Division Director

www.aoml.noaa.gov/phod

Division Goal: To strengthen our scientific understanding of the role of the ocean in climate, extreme weather events, and ecosystems, by enhancing our **observational work, research, technological development, and science communications.**






PHOD Major Science Objectives

• Assessment of the state of the ocean, with emphasis on the Atlantic Meridional Overturning Circulation and variability of key ocean currents;

• Evaluation of processes that drive Tropical Atlantic climate variability;

• Use of data and analysis to assess uncertainties of climate models and what cause them, with the goal to improve predictability;

• Evaluation of the effect of the ocean on extreme weather events (tornados, hurricanes, droughts, etc);

• Evaluation and design of ocean observing systems (OSE and OSSE);

• Assessment of the link between climate signals and changes in ecosystems;

• Development of new technology in support of climate, extreme weather, and ecosystem studies.

Main Scientific Questions

• What drives the variability of key ocean currents; how do numerical models reproduce their observed variability; and what are the main links to large scale/ long period changes ?

• What is the spatial and temporal variability of the Atlantic Meridional Overturning Circulation and regional ocean/climate patterns, and what are the processes driving them ?

• What is the role of the ocean in driving extreme weather events and climate ?

• How are climate models reproducing the state of the ocean ?

• What are the optimal ocean observing systems and strategies that will improve ocean state estimates and forecasts for a broad range of applications ?

• How are physical oceanography parameters linked to ecosystem variability ?

PHOD and NOAA's Objectives

Climate Adaptation and Mitigation:

- *What is the state of the climate and how is it evolving?*
- *What causes climate variability and change on global to regional scales?*
- *What improvements in global and regional climate predictions are possible?*

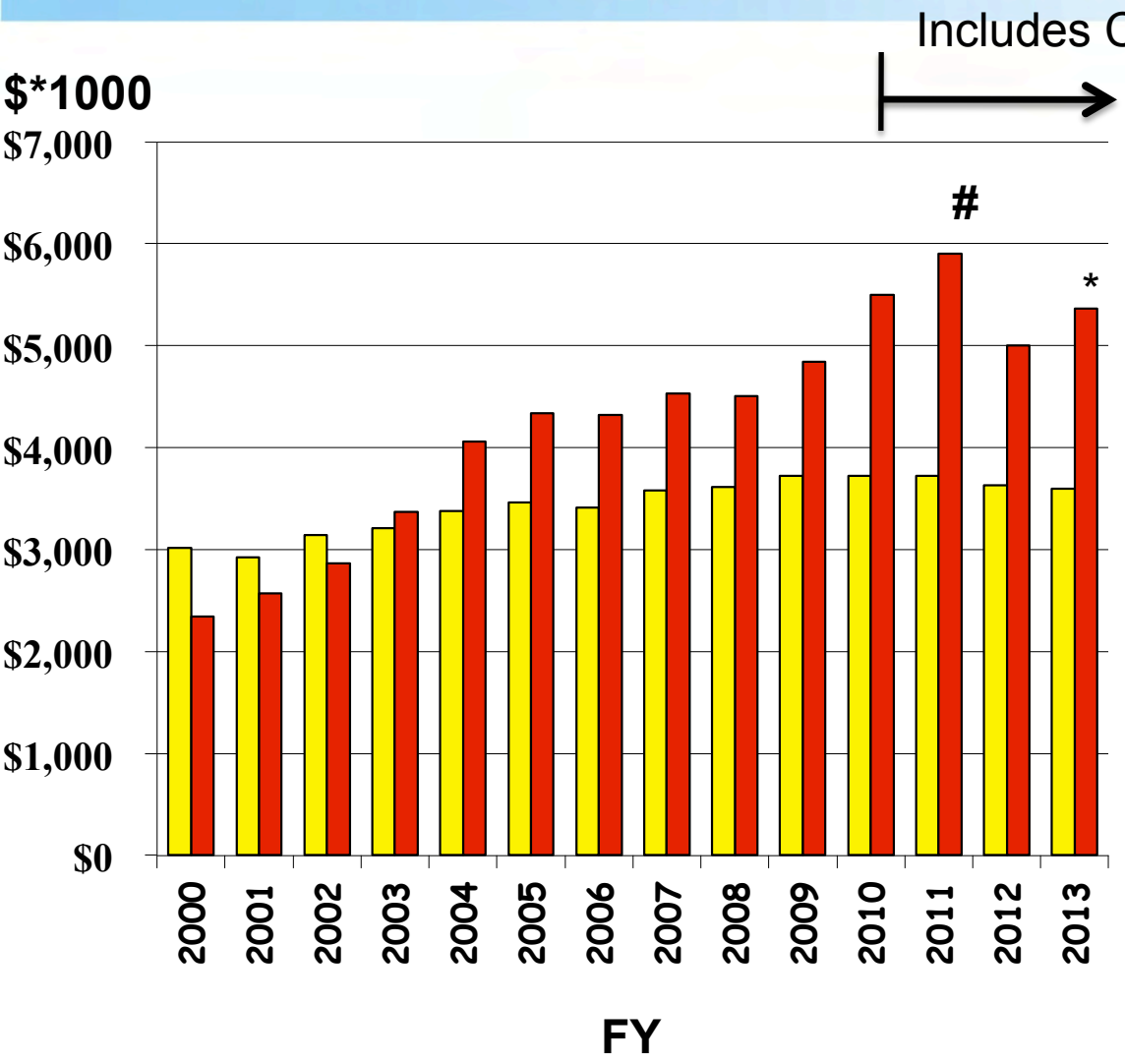
Weather-Ready Nation:

- *How does climate affect seasonal weather and extreme weather events?*

Cross-Cuts: Observing, Modeling, and Engaging.

- *What is the best observing system to meet NOAA's mission?*
- *How can emerging technologies improve ecosystem-based management?*

PHOD Budget



#= Deepwater Horizon
*= Sandy Supplemental

Divisional budget: approximately $8.3M

- **Base: $3.6M**
- **Proposals: $4.7M**

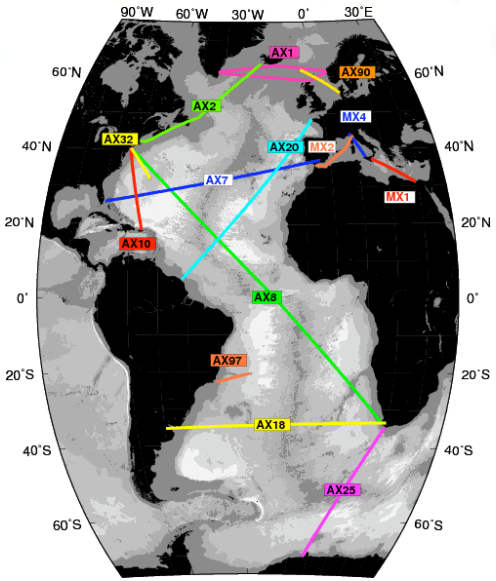
Increased proposal funding by 50% ($3M) since 2000

Number of proposals: 34

PHOD Personnel

	Research Scientists	Research and Operation Support	Instrumentation	Administrative	TOTAL
Feds	9	6	3	2	20
CIMAS	8	14	3	1	26
Total	**17**	**20**	**6**	**3**	**46**

Major Observational Projects

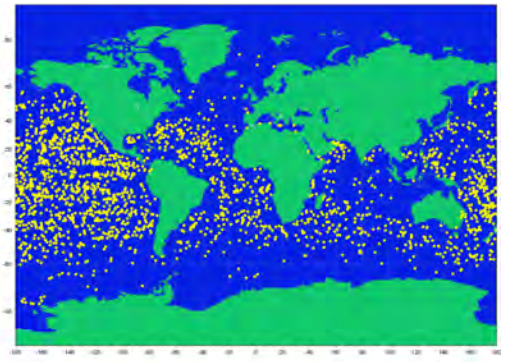


XBT Network

• Approximately 8,000 deployments per year along 15 fixed repeat transects, within an international effort of 10 countries, since 1983.

• Sustained observations of the Meridional Overturning Circulation (MOC) and variability of major surface and near surface currents.

• First time series of Meridional Heat Transport and heat fluxes in the Atlantic Ocean.



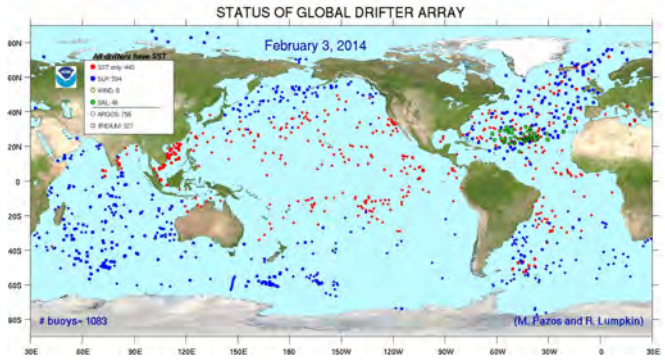
Argo Program

• US Data Assembly Center. Collect and distribute ~70,000 profiles data annually from ~1900 floats.

• Coordinate deployment of approximately 100 Argo floats per year in the Atlantic Ocean, within an international effort of 30 countries, since 2000.

• Assessment of upper ocean heat content, salinity, dynamics, and atmosphere-ocean interactions.

Major Observational Projects

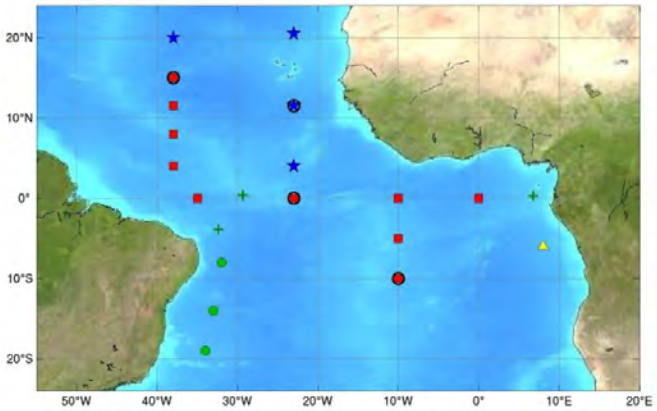


Global Drifter Program

• Maintenance of approximately 1200 drifter array, and coordination of around 1100 annual deployments within an international effort , since 2001. Data assembly, quality control, and distribution since mid 1980's.

• Comprehensive understanding of global ocean circulation and variability.

• Validation and calibration of satellite-derived SSTs.



PIRATA Array

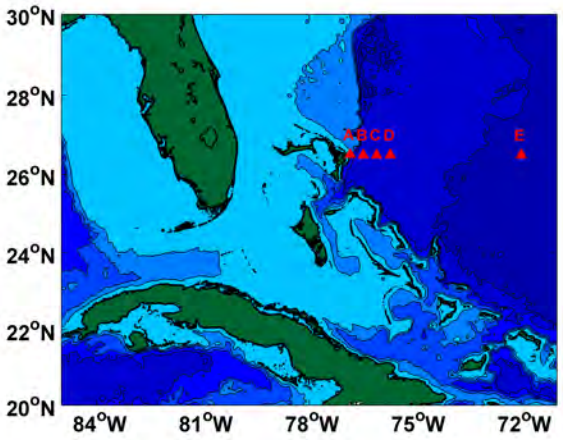
• AOML Partnership with PMEL, Brazil, and France to maintain 18 moorings in the tropical Atlantic Ocean, since 2006; Annual hydrographic cruises during maintenance of four PIRATA Northeast Extension moorings.

• Understanding tropical Atlantic climate variability.

• Link of spatial and temporal variability of zonal current system with two climate modes of variability.

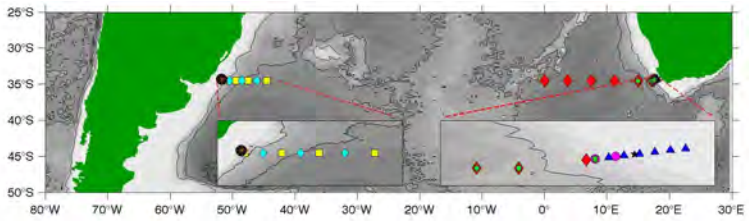
Please see poster by Schmid and Garzoli

Major Observational Projects



Western Boundary Time Series

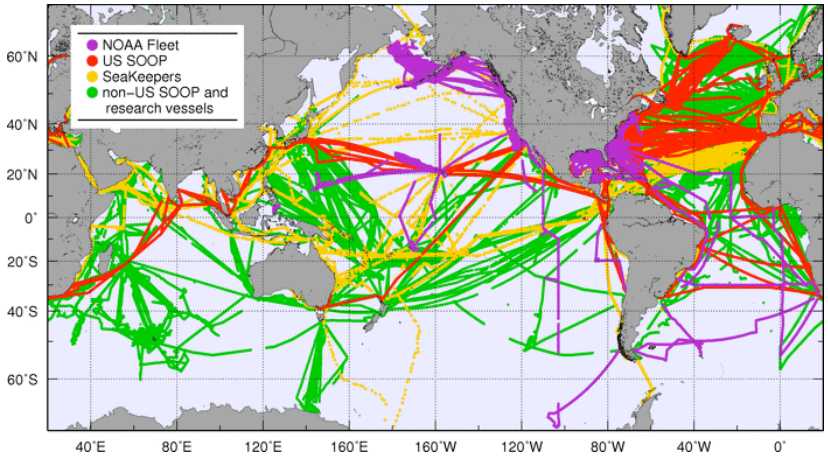
- Partner in RAPID-MOCHA-WBTS array, since 2004; Sustained observations of Florida Current since 1982.
- Monitoring upper and deep limbs of the MOC near the western boundary.
- Longest open ocean time series of transport of GS/ DWBC system



Southwestern Atlantic MOC

- Maintenance of 4 moorings, of a larger array along 35°S, since 2009. Building towards a larger array with international partners.
- Sustained observations of the water column in the SW Atlantic Ocean to understand the contribution of the SA to the MOC.
- DWBC variability in the South Atlantic.

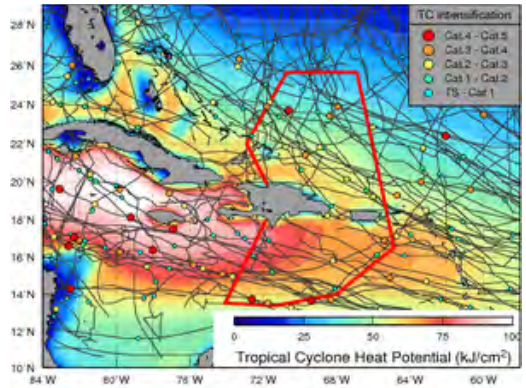
Major Observational Projects



Thermosalinographs

• Maintain equipment and transmission in approximately 20 ships.

• Repeat transects are carried out in support of pCO2 assessments, Aquarius SSS data, and process experiments (SPURS)



Gliders

• 2 gliders in the tropical Atlantic and Caribbean Sea, by July 2014; to provide ~5,000 T-S-O2 profiles per year.

• Improving TC seasonal and intensification forecasts, by gaining a better understanding of air-sea processes during extreme weather events.

Major Observational Projects

- **Number of cruises** (includes XBT transects)

2009	2010	2011	2012	2013
69	66	75	60	55

- **Days at sea**

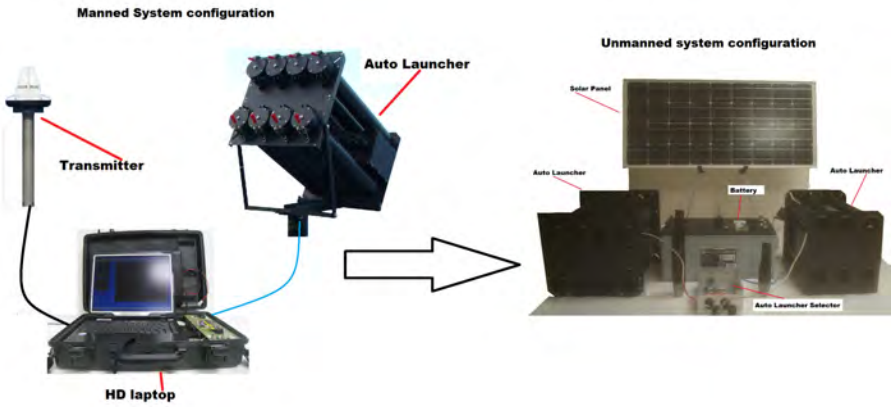
2009	2010	2011	2012	2013
464	561	479	420	422

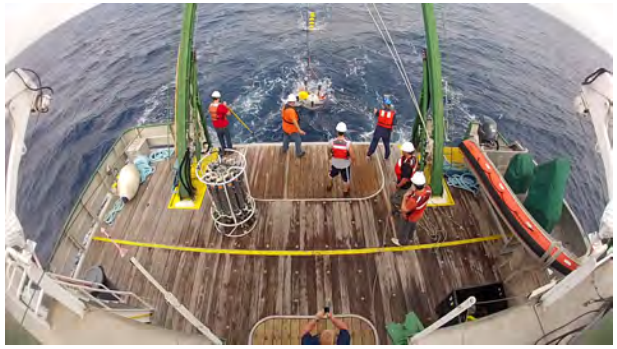
Major Technological Developments

Data Pods

XBT Climate Quality Probes

Autonomous XBT Autolauncher



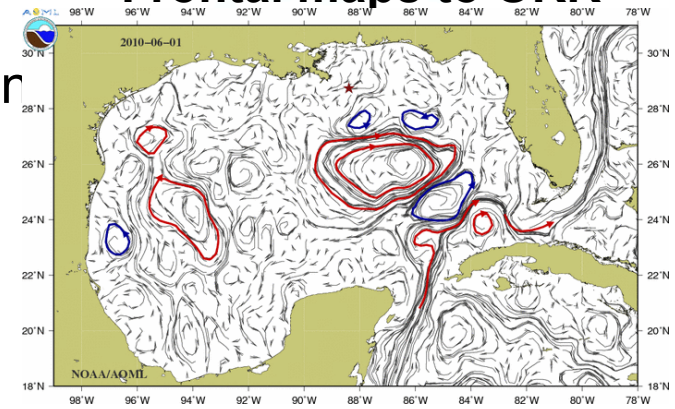


PNE Radiometer

Please see technological work in poster area

Science Support to other Programs and Operations

Frontal maps to ORR



• **Deepwater Horizon:** NOS/Office of Response ar
•Restoration. Please see Poster by R. Smith and E. Johns.

• **OAR:** Sandy-Related support.

• **NESDIS:** Validation of satellite-derived sea surface temperature observations.

• **NWS:** Marine Meteorological Observations.

• **NASA SPURS (Salinity Processes Upper Ocean Regional Studies)** geared towards understanding salinity maximum in the North Atlantic Ocean.

• **NMFS: Mandatory Ship Reporting (MSR)** geared to reduce the number of collisions with North Atlantic right whales.

Stakeholders

NOAA:
OAR, Ocean Observation Programs
NESDIS, Climate Prediction Center for improving forecast models
NWS, marine meteorological observations
NOS/ORR, emergency response for oil and debris
NOAA/EMC, for operational forecast improvements
NMFS (Mandatory Ship Reporting)

Government:
US Coast Guard, Amver SEAS for Search and Rescue

Non-NOAA Operational:
Operational Ocean Forecast and Monitoring Centers (NRL, Coriolis)
Worldwide weather services: Australian BOM, ECMWF, Meteo France, South African Weather Svc., etc.

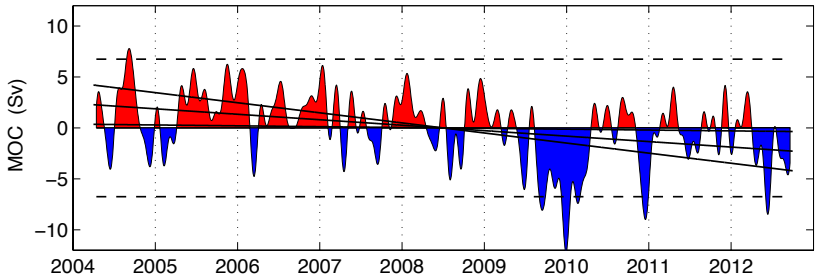
Scientific Community, Researchers world-wide for Argo, XBT, drifters, PIRATA, WBTS, SAM, TSG data

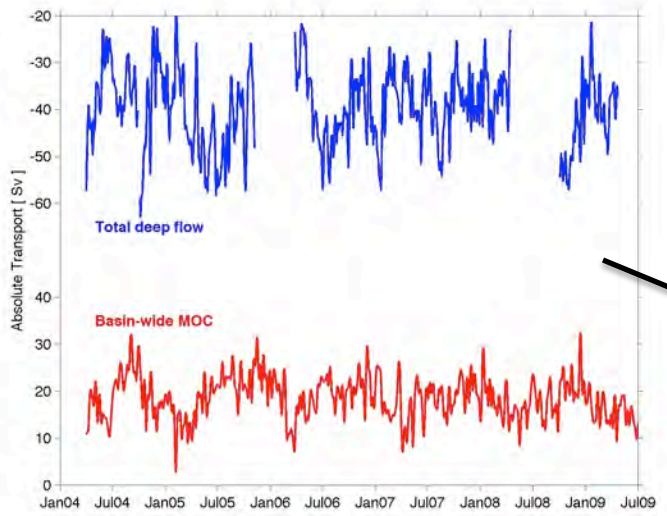
Private:
Major shipping companies, for ocean currents and marine weather forecasts
Fisheries, for ocean currents and ocean fronts monitoring
Oil industry, for surface currents and eddy monitoring

Partners and Collaborators

Educational
Research
Operational
Shipping Companies
Fishing Companies

Major Science Accomplishments: MOC in the North Atlantic Ocean





- During the first 8.5 years of the MOCHA-RAPID-WBTS array, a small, but statistically significant (at the 95% confidence limit) decline in the MOC volume transport was observed.

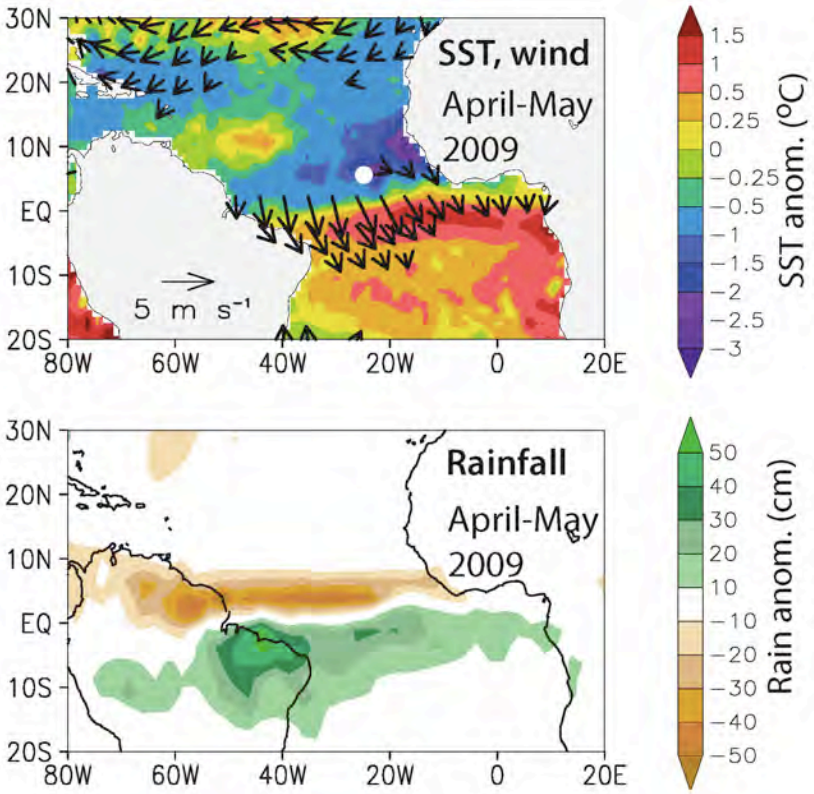
- The decrease is due to the upper-ocean interior flow.

- This trend clearly highlights the importance of maintaining long-term, continuous, time series of observations to understand these questions.

- Recent results show that the DWBC variability is much larger than the MOC variability.

Smeed et al., 2014; Meinen et al., 2013.

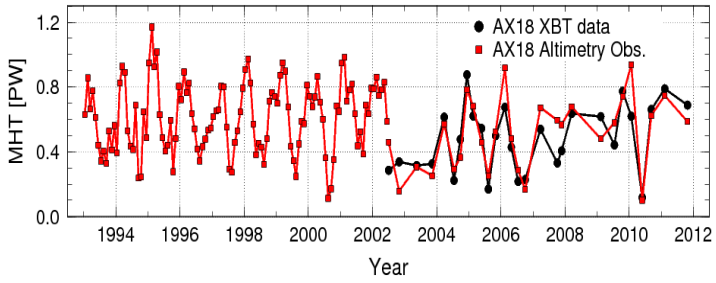
Major Science Accomplishments: Tropical Atlantic Variability

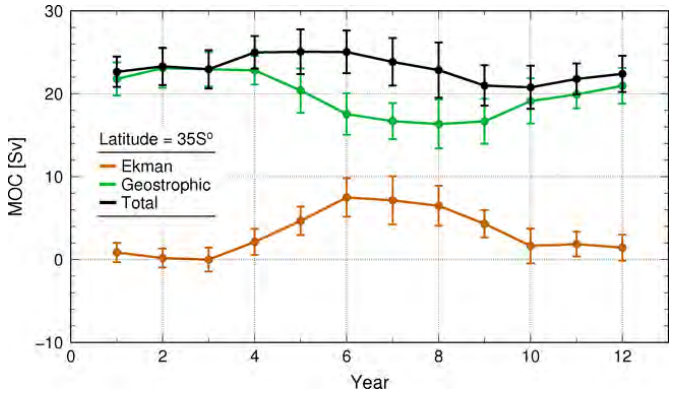


- A strong anomalous dipole of SST developed in the tropical Atlantic during the first half of 2009, peaking in April-May (top panel).
- The ITCZ was displaced southward, resulting in extreme flooding in Northeast Brazil during April and May (middle panel).
- Displacements of warm waters to the south coincide with a very weak Atlantic hurricane season.

Please see poster by Foltz and Wang

Major Science Accomplishments
MOC in the South Atlantic Ocean





Please see poster by Perez and Dong.

- Combined analysis of a suite of in situ, satellite, and numerical models outputs for South Atlantic MOC/MHT/Mov studies.

- Identify and assess contributions from ocean interior and boundary currents and their temporal variations.

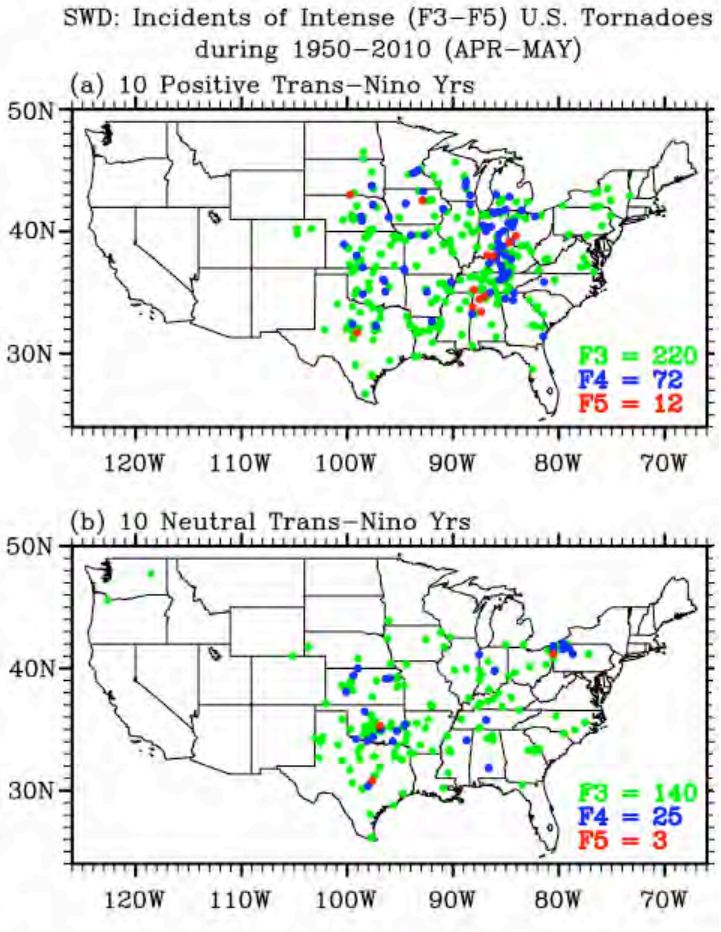
- Significant seasonal cycles were identified from in situ observations, in which geostrophic and Ekman components are not in phase.

- Before 2006 geostrophic transport controlled interannual variability. After 2006, Ekman transport controlled this variability.

- Assess if climate models reproduce observational results.

Dong et al, 2009; Dong et al, 2014

Major Science Accomplishments
US Tornado Activity



- Of the top ten extreme outbreak years during 1950-2010, seven years including the top three are identified with a strongly positive phase Trans-Niño (top figure)

- The number of intense tornadoes in April - May is nearly doubled during the top ten positive Trans-Niño years compared to those during ten neutral years (top, increased tornado activity during positive Trans-Nino years; bottom, normal tornado activity during neutral Trans-Nino years).

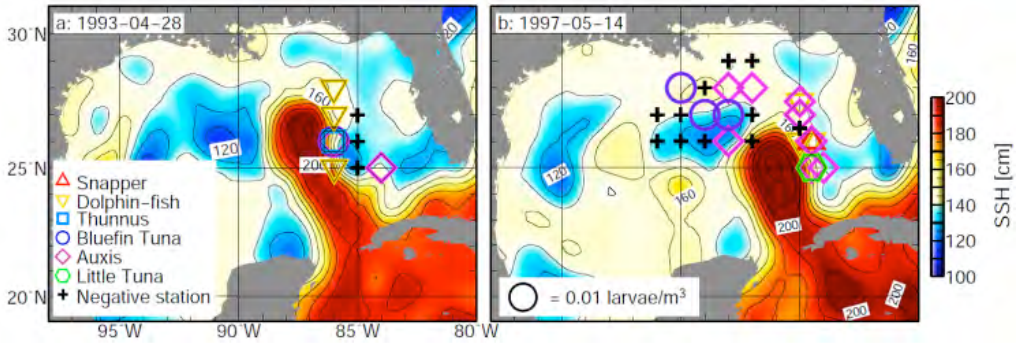
Trans-Niño represents the evolution of tropical Pacific sea surface temperatures (SSTs) during the onset or decay phase of the El Niño-Southern Oscillation.

Major Science Accomplishments: Fisheries Oceanography

Fisheries and mesoscale features

Real-time remote sensing methods to estimate environmental parameters linked to density of larvae of highly commercial species in the Gulf of Mexico.

Frontal regions and anticyclonic rings were identified as regions were larvae density is higher.

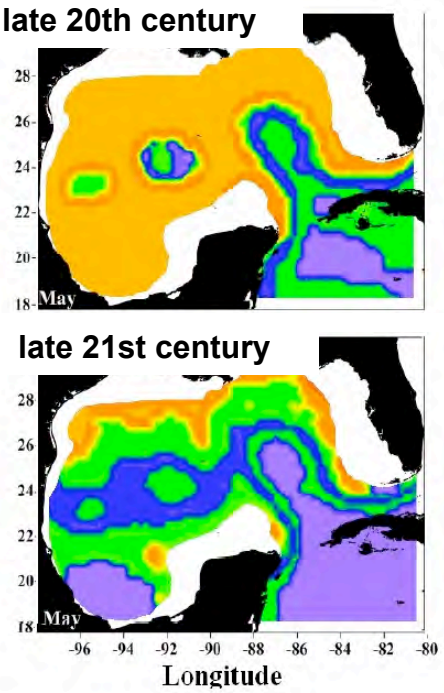


(IPCC) Projected changes of bluefin tuna spawning habitat in the Gulf of Mexico due to anthropogenic global warming.

Assessment of preferred spawning habitat, with yellow/orange (two panels on right) for favored locations and blue/purple for non-ideal regions.

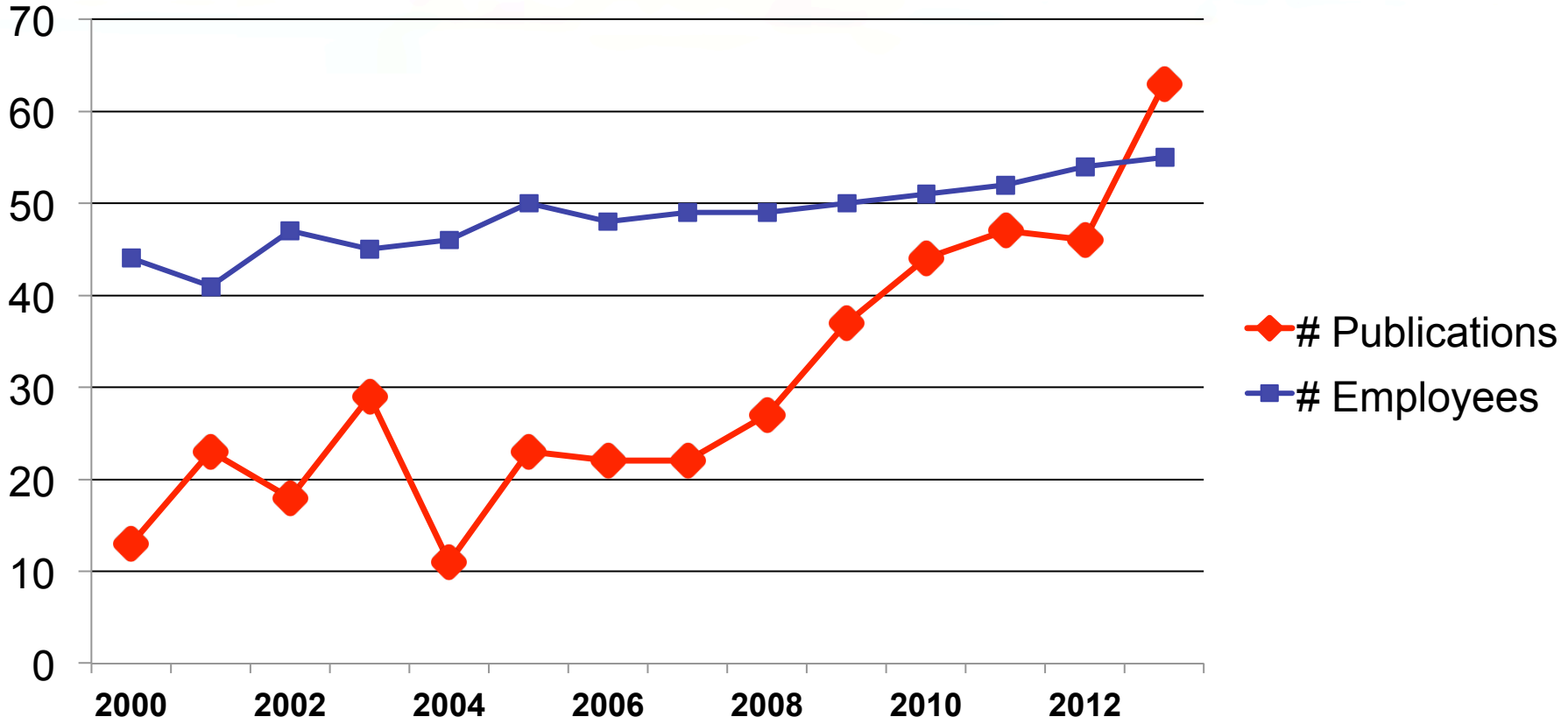
IPCC results suggest that the area of bluefin tuna habitat may be drastically reduced in the future (figures). However, due to the changes in the ocean circulation pattern, the rate of the habitat loss will be much slower than the IPCC projection.

Please see poster by Johns and Lee



Liu et al, 2012; Muhling et al., 2011; Lindo et al., 2013

Scientific Publications



Increase of more than 100% in peer-reviewed scientific publications during the last ten years.
Total number of refereed publication during last 5 years: 237
Average H-Index of divisional scientist: 13

Panel Memberships

Participation in 60 panels, including:

- International Clivar panels
- US Clivar panels
- IAPSO panel
- MPOWIR
- JCOMM Obs panels
- Argo Science Steering Team
- Argo Data Management
- XBT Science Steering Team
- NASA Ocean Surface Topography

Science Team

- Editorial, Journal of Geophysical Research
- South Atlantic MOC (SAMOC)
- PIRATA Steering Team
- Repeat Hydrography Steering Team
- NASA SPURS Steering Team
- …

Organization of Scientific Meetings:

2013 NASA SPURS Meeting
2011 and 2013 XBT Science Workshops
2010 PIRATA Steering Team and Tropical Atlantic Climate Experiment
2010, 2011, and 2013 SAMOC Meetings
…

Retreats, Divisional Meetings

2009 PHOD-SEFSC Meeting
June 1, 2009
Theme: Finding Opportunities for New Collaborative Research

2011 PHOD Retreat
February 15-16, 2011
Theme: Integrating Observations for Multidisciplinary Research

2012 PHOD Retreat
February 29 and March 1, 2012
Theme: Synergy between Observations and Numerical Models for Weather, Climate, and Ecosystem Research

2014 AOML-SEFSC Meeting
May 2014
Theme: Continued Collaborative Success: Now and in the Future.

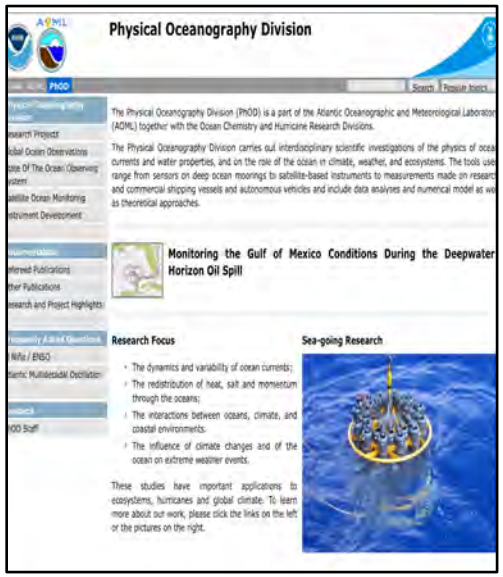
Visitors, Scientific Exchanges

Dr. Monika Rhein, U. Bremen, Germany
Dr. Sabrina Speich, U. Brest, France
Dr. Mauricio Mata, FURG, Brazil
Dr. Rym Msadek, GFDL
Dr. Ricardo Matano, Oregon State University
Dr. Anne Thresher, CSIRO, Australia
Dr. Janet Sprintall, Scripps Inst. Oceanogr.
Dr. I-I Lin, U. Taiwan
Dr. Frank Muller-Karger, USF
Dr. Semyon Grodsky, U. Maryland
Dr. Xidong Wang, S. China Sea Inst. Ocean.
Dr. Susan Wijffjels, CSIRO, Australia
Dr. Josh Willis, NASA/JPL
Dr. Sybren Drifjhout, Netherlands
Dr. Edmo Campos, USP, Brazil
Lt. Cdr. Ariel Troisi, SHN, Argentina
Dr. Janice Trotte, Brazilian Ministry of Science
Dr. Ivan Perez Santos, U. Concepcion, Chile
Dr. Michael Roberts, University of Cape Town
Dr. Randy Watts, U. of Rhode Island
Dr. Sybren Drijfhout, KNMI, Netherlands
ANAMAR, Dominican Republic Ministry of Science
……..

Dillon Amaya (TAMU) and Alexandra Ramos (UPR), 2013 summer interns.

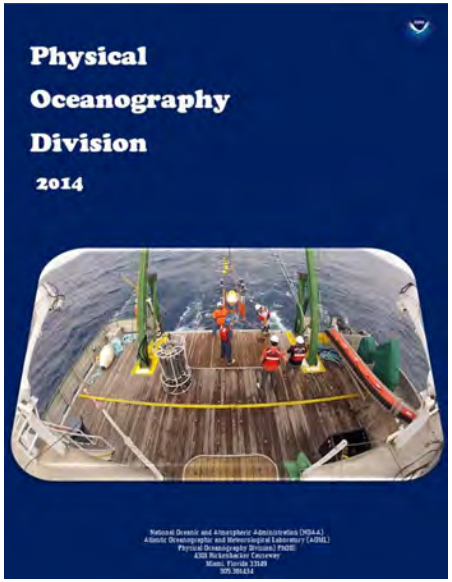
Lt. Cdr. Camila Cariccio (SHN, Brazil)

Communications



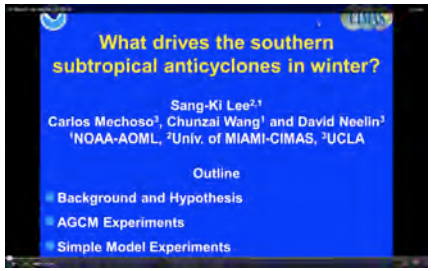
aoml.noaa.gov/phod

Comprehensive divisional **web page** with detailed and updated description of each project, data, and product distribution



Up-to-date PHOD Project report: Annual update of projects, including technological developments

- **Videos (including YouTube) of main PHOD projects.**



- **Live video streaming and recording of PHOD seminars through Gotomeeting.**

PHOD Outreach Highlights

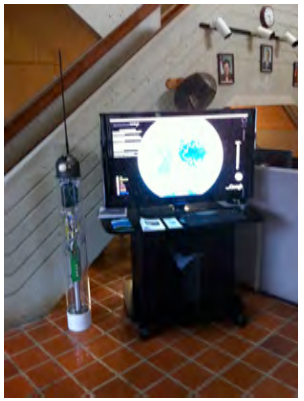
U. Va. Semester At Sea

Adopt a drifter program

Teachers at Sea

University of Miami, Annual undergraduate student visit

Annual AOML Open House and high school student tours and presentations



Global Ocean Observation Google display

Looking Ahead

1. Continue as a premier science group for designing, implementing, and maintaining sustained ocean observations (some with time series longer than 30 years) for oceans and climate research;
2. Continue emphasis of synergy between observations (in situ and satellite), numerical modeling, and theoretical studies;
3. Continue leading studies of Ocean Observing System Simulation Experiments (OSSE) geared towards improving tropical cyclone intensity forecasts and improving ocean observing networks for climate studies;
4. Continue work on cutting edge scientific research to understand ocean-weather-climate system and impacts;
5. Continue strengthening partnerships benefiting and leading to operations and applications;
6. Continue strong partnership with other AOML divisions in support of ecosystems and hurricane studies; and
7. Continue partnership and collaboration with scientists from other NOAA LOs and national and international university and government laboratories.

Thank you very much

www.aoml.noaa.gov/phod