

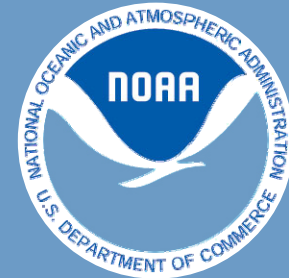
# NOAA'S Climate Monitoring Ocean Climate Indicators Efforts

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Climate Observation Division

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



<http://cpo.noaa.gov/ClimatePrograms/ClimateObservation.aspx>

GSOP-9 and ODMP Joint session  
September 18, 2016

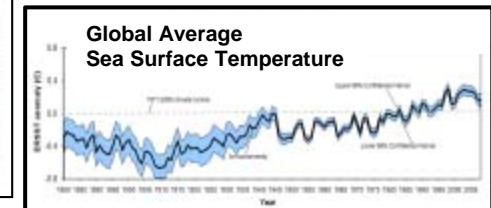
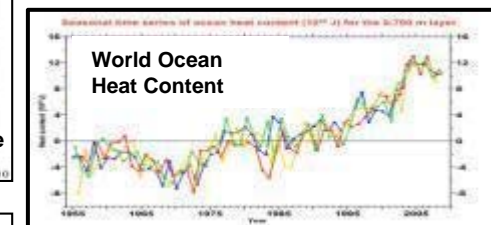
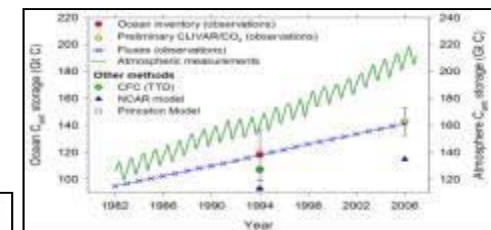
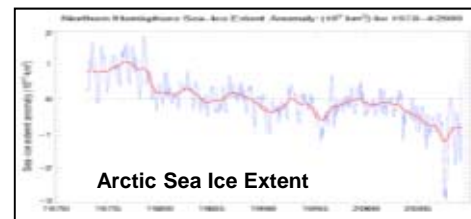
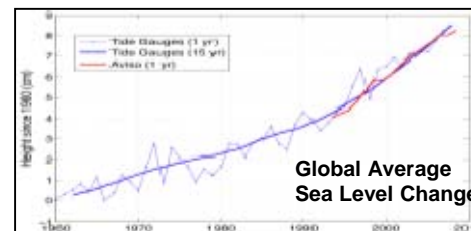
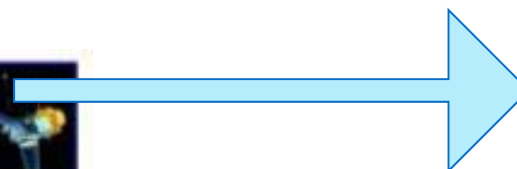


# NOAA's Climate Program Office Climate Observation Division

## Mission

To develop and sustain, with national & international partners, an in situ global observing system to monitor, understand, & support prediction of the coupled ocean, arctic, & atmosphere systems;

To provide long-term, high quality, timely global observational data, information, and products in support of communities of researchers, forecasters, service providers, and end-users, for the benefit of society





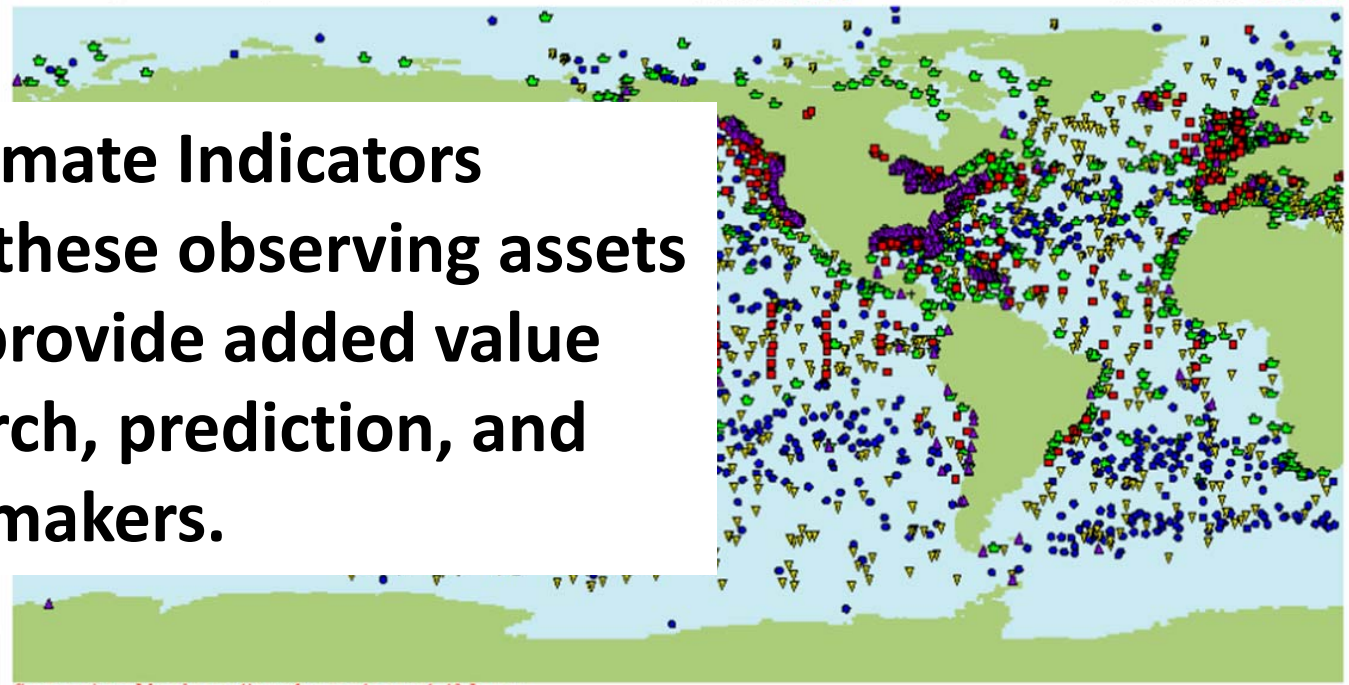
# Ocean Climate Observation Program

## Global In-Situ Ocean Observing

### Observing System Monitoring Center



Date: 05-Sep-2016 to 08-Sep-2016 Platforms: 5329 Observations: 3314940



Suppressing ship observations for most recent 48 hours

**Ocean Climate Indicators leverage these observing assets and can provide added value for research, prediction, and decision makers.**

Argo: 34 countries  
OceanSITES: 20 countries  
Global Sea-Level System: 57 countries

Surface Drifters: 14 countries  
Tropical Moored Buoy Arrays:  
RAMA (15) and PIRATA (3)  
GO-SHIP (11) +pCO2 (17)



# Climate Monitoring

## Strategic Goal: Information and Products

COD Strategic Plan (Aug 2014)

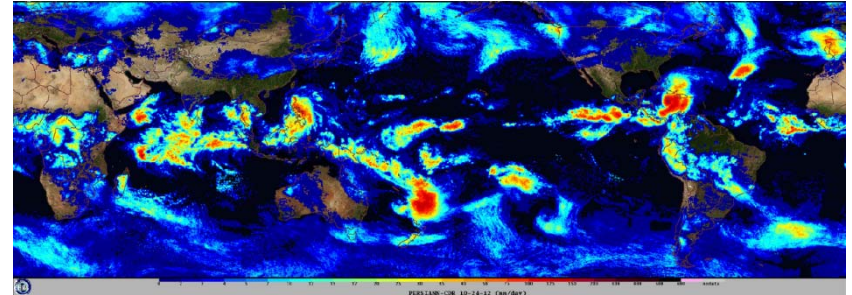
### Information and Products

Provide a broad and expanding range of observation-based products and analyses that describe global and regional patterns of climate variability and change that address the needs of our broad range of customers.

A competitive research program that leverages and enhances observation and data collection efforts to supportive innovative research that:

- **Develops, synthesizes, and analyzes climate data sets**
- **Develops key indicators and diagnostics to monitor and detect changes in the climate system**
- **Documents historical and projected variability and changes in phenomena that impact society**

By the numbers....



**Current Research Portfolio of \$2.3 million funding an active focused on developing products addressing two main themes**

**Extreme Events  
Ocean Indicators**





# Climate Monitoring Ocean Climate Indicators Portfolio



## Ocean Climate Indicators

***Air Sea Fluxes at the NOAA Ocean  
Climate Station Reference Sites***

***Continuous Records of the Mixed Layer  
Heat Budget in the Tropical Atlantic  
Ocean***

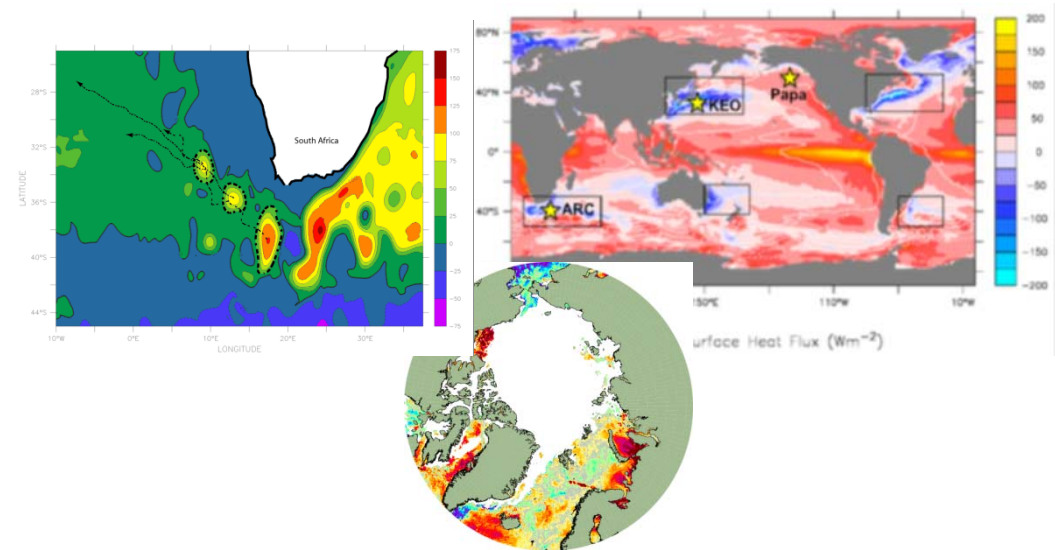
***Ocean Indicators in the Tropical and  
South Atlantic Ocean***

***Tropical Pacific and Indian Ocean***

***Climate Indicators: warm water volume,  
subtropical cells, Indonesian throughflow  
indices***

***Development of satellite-based surface  
fluxes of heat and moisture in the Arctic  
Ocean for understanding impacts of  
changing Arctic environments***

***Transport in the upper branch of the South  
Atlantic Meridional Overturning Circulation***



***Western Boundary Currents as a Climate Index***

***Ocean Climate Indicators for the Trade Winds  
Region***

***Dynamics and seasonal predictability of extreme  
sea level rise in the tropical western Pacific***

<http://cpo.noaa.gov/ClimatePrograms/ClimateObservation/ClimateMonitoring/Fundedprojects.aspx>

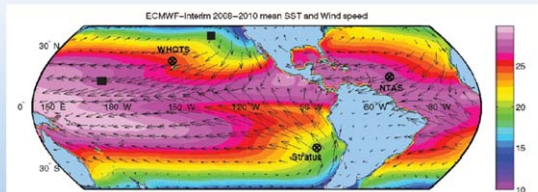


# Climate Monitoring Ocean Climate Indicators

## Successful Themes and Approaches

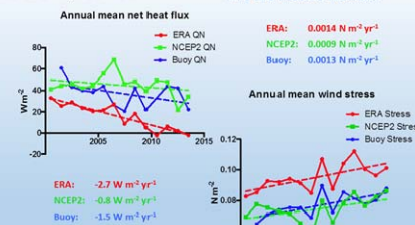
- Leveraging/demonstrating value of long time-series
- Utilize ocean observing assets from NOAA and partners
- Addressing model biases
- Comprehensive, systematic regional approaches
- Combining data resources, both cross platform and cross-method
- Focus on prediction and actionable information

### Ocean Reference Stations



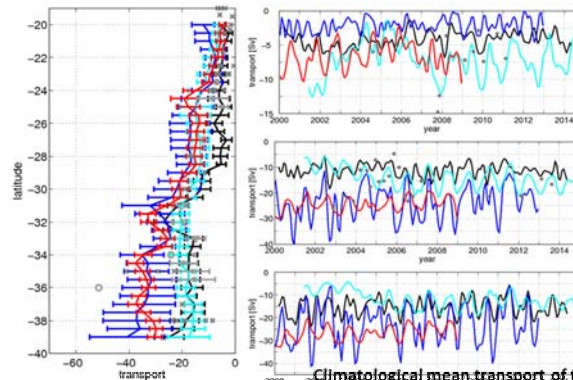
The three WHOI ORS, Stratus, NTAS, and WHOTS form an array sampling the critical trade wind region. This figure shows SST (colors) and surface wind vectors from the ECMWF-Interim reanalysis for the period 2008-2010. The positions of the Stratus, NTAS and WHOTS ocean reference station buoys are indicated. The corresponding virtual positions of the Stratus, NTAS and WHOTS buoys, relative to the North Pacific Hadley circulation and SST, are indicated by black squares, showing how the descending, ascending branches are sampled as well in between. From Dr. Roger Lukas, Univ. of Hawaii, partner at WHOTS.

### Stratus 20°S, 85°W



Courtesy B. Weller (WHOI)

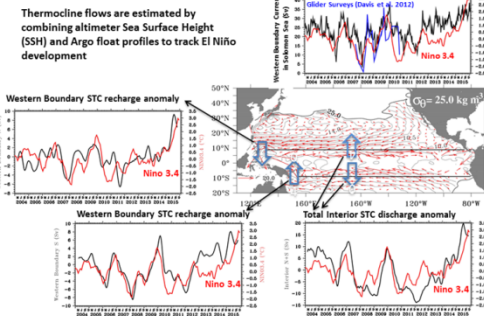
Recently published work from "Transport in the upper branch of the South Atlantic Meridional Overturning Circulation" (Claudia Schmid and George Hallwax (NOAA/OML)) Computes transports of the Atlantic Meridional Overturning Circulation (AMOC) at selected latitudes from Argo and satellite observations as well as model fields



Climatological mean transport of the Brazil Current; right: temporal variability of the meridional transport in the Brazil Current at 24°S, 35°S and 38°S (from top to bottom). Black: observations, blue: HYCOM, cyan: NCEP, red: SODA.

### Tropical Pacific Ocean Climate Indicators

Subtropical Cells and Warm Water Discharge and Recharge of El Niño



Courtesy T. Lee (JIFRESSE, UCLA)



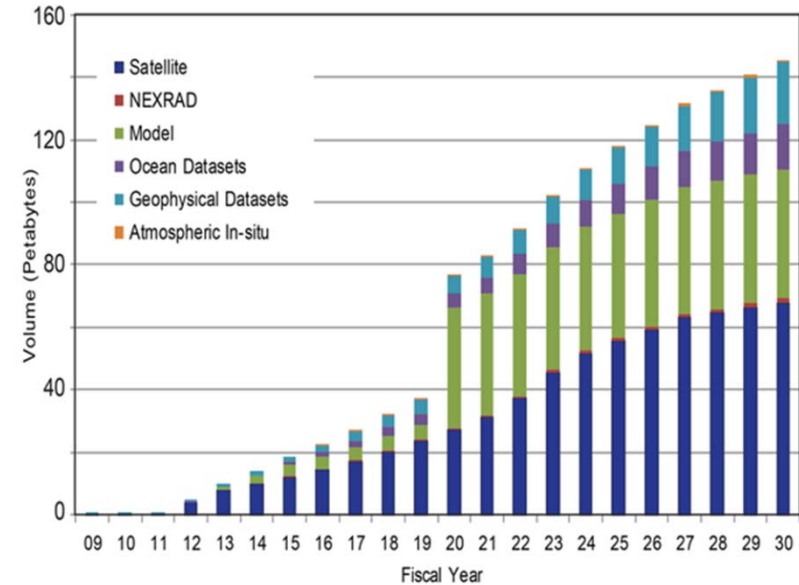
# How does NOAA COD support innovative Ocean Climate Indicators Research?

## DATA

### Global Observing Systems

In FY15, the Ocean Climate Observations program sustained NOAA's contributions towards several global ocean observing systems with more than 8,000 platforms—including Argo, the Global Drifter Program, GLOSS, OceanSites, GO-SHIP, RAMA, PIRATA, and SOOP—in support of NOAA's research and operational requirements.

Growth of NOAA's Archive



▲ The deployment of an Argo float into the ocean. Credit: CSIRO.

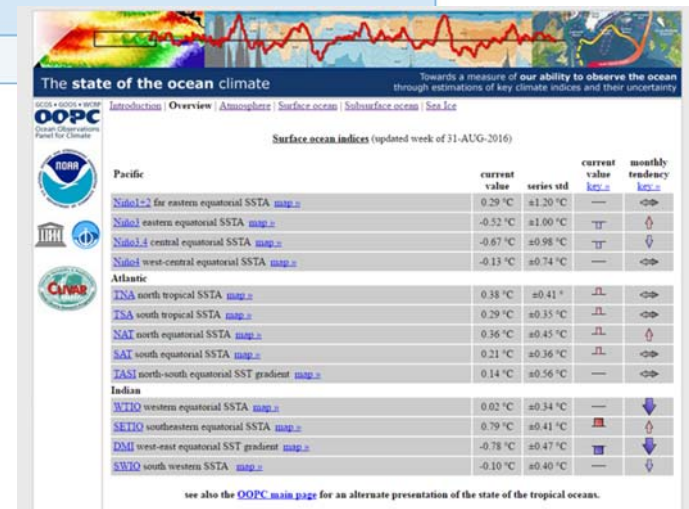


# How does NOAA COD support innovative Ocean Climate Indicators Research?

## International efforts and frameworks

Readiness level: **CONCEPT** | **PILOT** | **MATURE** [Click on each EOVI for their respective spec sheets]

PHYSICS	BIOGEOCHEMISTRY	BIOLOGY AND ECOSYSTEMS
Sea state	Dissolved Oxygen	Phytoplankton biomass and productivity
Ocean surface vector stress	Inorganic macro nutrients	Harmful Algal Bloom (HAB) incidence
Sea ice	Carbonate System	Zooplankton diversity
Sea surface height	Transient tracers	Fish abundance and distribution
Sea surface temperature	Suspended particulates	Apex predator abundance and distribution
Subsurface temperature	Nitrous oxide	Live coral cover
Surface currents	Carbon isotope ( <sup>13</sup> C)	Sea grass cover
Subsurface currents	Dissolved organic carbon	Mangrove cover
Sea surface salinity		Macroalgal canopy cover
Subsurface salinity		
Heat flux / radiation		



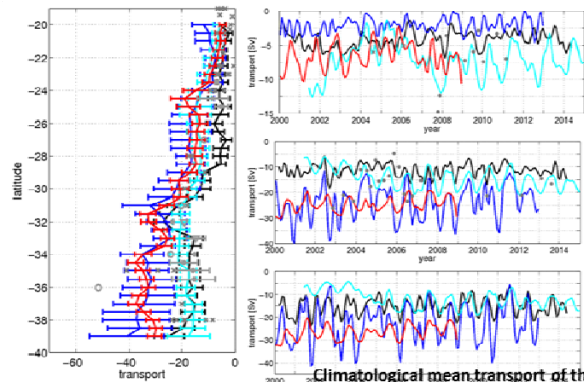




# Moving Forward: The Vision for Indicators Research?

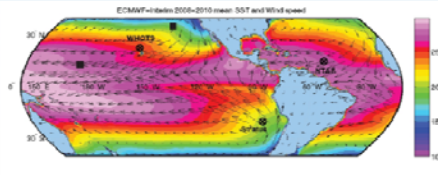
- Innovative development of “Indices” and products to scientific stakeholders
- Focus on systematic, comprehensive monitoring of regional systems
- Foster collaborations between observational and modeling community

Recently published work from “Transport in the upper branch of the South Atlantic Meridional Overturning Circulation” (Claudia Schmid and George Halliwell) (NOAA/AOML) Computes transports of the Atlantic Meridional Overturning Circulation (AMOC) at selected latitudes from Argo and satellite observations as well as model fields



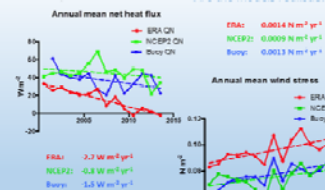
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## Ocean Reference Stations



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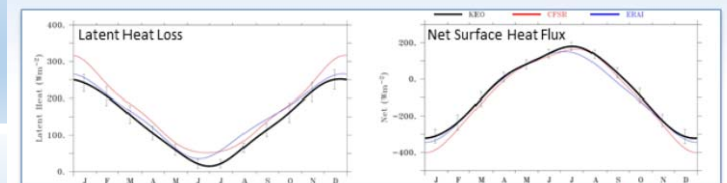
## Stratus 20°S, 85°W



Are the models realistic?

**Computed Fluxes**

<input type="checkbox"/> Sensible	<input type="checkbox"/> Net Shortwave	<input type="checkbox"/> Evaporation	<input type="checkbox"/> Zonal Wind Stress	<input checked="" type="checkbox"/> 10m Zonal Wind
<input type="checkbox"/> Sensible (Rain)	<input type="checkbox"/> Net Longwave	<input type="checkbox"/> Precipitation	<input type="checkbox"/> Meridional Wind Stress	<input checked="" type="checkbox"/> 10m Merid Wind
<input type="checkbox"/> Latent	<input type="checkbox"/> Net Heat Flux	<input type="checkbox"/> Evap - Precip	<input type="checkbox"/> Wind Speed Magnitude	<input checked="" type="checkbox"/> 10m Wind Speed
<input type="checkbox"/> Skin Temperature	<input type="checkbox"/> Warm Layer Cor	<input type="checkbox"/> Cool Skin Cor	<input type="checkbox"/> Stress Vectors	
<input checked="" type="checkbox"/> 2m Specific Humidity	<input checked="" type="checkbox"/> 2m Air Temperature	<input type="checkbox"/> Buoyancy		



Seasonal Cycles and Standard Errors determined by 10-year KEO observations compared with CFSR and ERA-I

paper submitted to JGR-Oceans -- Zhang et al. "Assessing surface heat fluxes in atmospheric reanalyses with a decade of data from the NOAA Kuroshio Extension Observatory".



## Building On Success

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- New solicitation out now for Ocean Climate Products for the Scientific community:  
<http://cpo.noaa.gov/GrantsandProjects/ClimateProgramOfficeFFO.aspx>
  - Add value and context to the wide range of observations supported by the Division.
  - Utilize ocean observing assets from NOAA and others to create global or regional ocean indices or products that provide information on essential ocean variables (e.g. <http://ioc-goos-oopc.org/obs/ecv.php>) tailored to research investigations and scientific monitoring.
  - Identify a scientific stakeholder community or research partner that will form a base user community for the data and a pilot project to demonstrate use.
  - New indices that use long term ocean records and/or synthesize these with new and multiple data sources are encouraged.
  - Oct 24 deadline
- Seeking closer collaboration between in-situ, satellite, and modeling communities
- Exploring how to transition projects and contribute to national and international efforts

# Thank You

Further Information:

<http://cpo.noaa.gov/>

*Jennifer.saleemarrigo@noaa.gov*





# Climate Monitoring Ocean Climate Indicators

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In FY14 (and FY15), 7 projects funded under the OCI element

**“Air-Sea Fluxes at NOAA Ocean Climate Station Reference Sites”**

Meghan F. Cronin, PI (NOAA/PMEL), Dongxiao Zhang, co-PI (NOAA/PMEL and JISAO/U Washington)

**“Continuous Records of the Mixed Layer Heat Budget in the Tropical Atlantic Ocean”** Gregory Foltz, Claudia Schmid, and Rick Lumpkin (NOAA AOML)

**“Ocean Indicators in the Tropical and South Atlantic Ocean”** Gustavo Jorge Goni (NOAA AOML), Shenfu Dong (CIMAS), Marlos Goes (CIMAS) Francisco J. BeronVera (University of Miami)

**“Tropical Pacific and Indian Ocean Climate Indicators: Warm Water Volume, Subtropical Cells, Indonesian Throughflow Indices”** Tong Lee (Joint Institute for Regional Earth System Science and Engineering at UCLA), Michael McPhaden (NOAA PMEL), Dongxiao Zhang (NOAA PMEL), Xiaochun Wang (UCLA)

**“Transport in the Upper Branch of the South Atlantic Meridional Overturning Circulation”** Claudia Schmid and George Halliwell (NOAA AOML)

**“Western Boundary Currents as a Climate Index”** Nathalie Zilberman, Dean Roemmich, Sarah Gille (SIO)

**“Ocean Climate Indicators for the Trade Winds Region,”** Dr. Robert Weller and Dr. Albert Plueddemann (Woods Hole Oceanographic Institute)

**“Dynamics and seasonal predictability of extreme seas level variability in the tropical western Pacific,”** Dr. Axel Timmermann and Dr. Matthew Widlansky (University of Hawai’i)