David Legler

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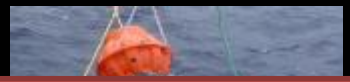
Ocean Observing and Monitoring Division (OOMD)

Climate Program Office

Mission

To provide high-quality long-term global observations, climate information, and products to researchers, forecasters, and other users to inform and prepare society for environmental challenges



Key Activities

- Sustained Ocean Observing
- Arctic Research Program
- Climate Monitoring/Products

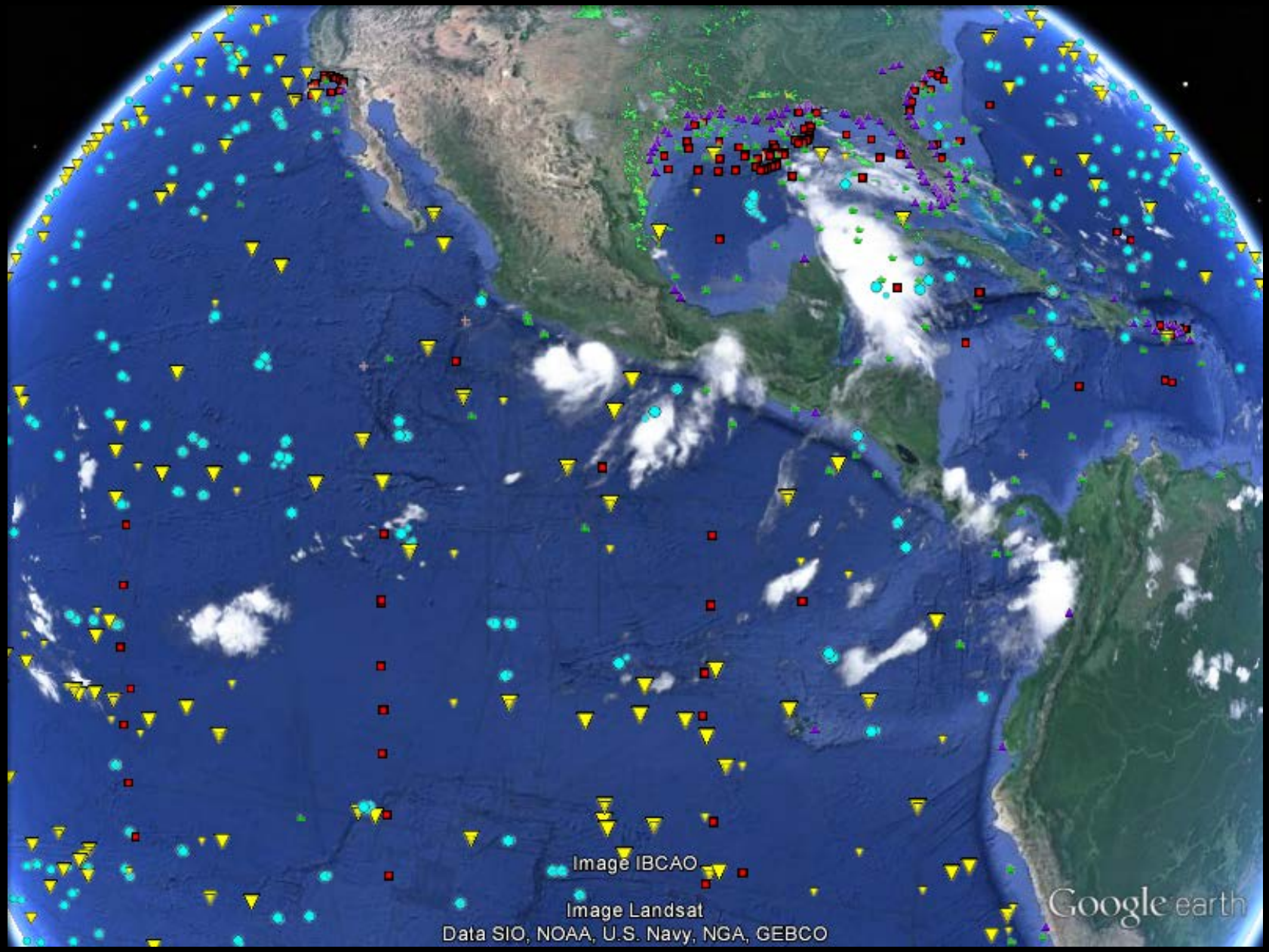
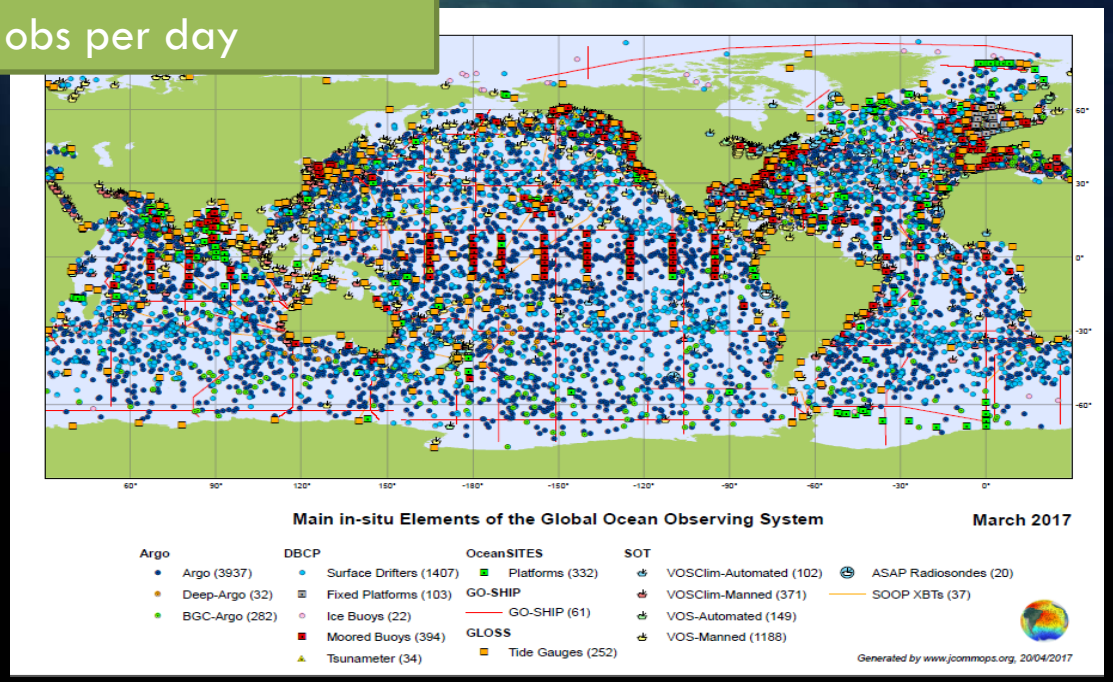


Image IBCAO
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth

Global In-Situ Sustained Ocean Observing

NOAA Leverages 50% of the Global Ocean Observing System

1M obs per day



Essential ocean variables: temperature, salinity, currents/circulation, carbon/Ph, sea-level, sea-ice, air-sea fluxes, waves, ocean acoustics, and surface meteorology

OOMD Sponsored Observing Networks

- Argo, surface drifters, RAMA, PIRATA, Oceansites, GLOSS Tide gauges (int'l and US), SOOP/XBT, gliders, pCO2, GO-SHIP, etc

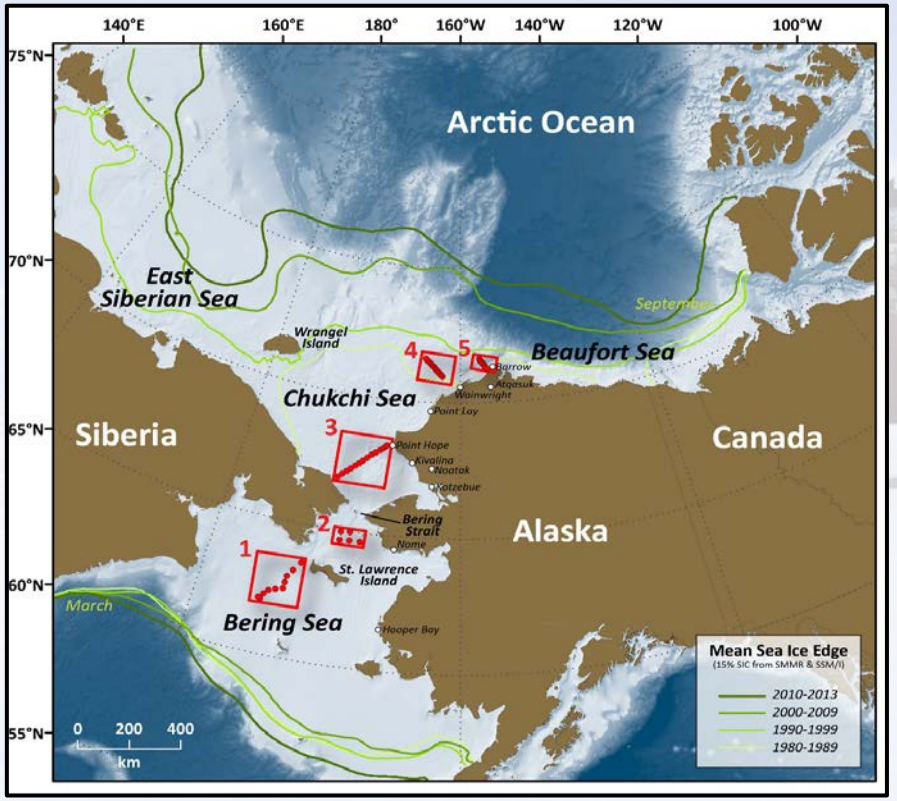
Key Attributes

- Global in coverage, fixed and Lagrangian/autonomous platform strategy
- International effort (dozens of countries contribute)
- Data reported in real-time (over 5000 platforms)

Arctic Research Program
Line of Effort - 1

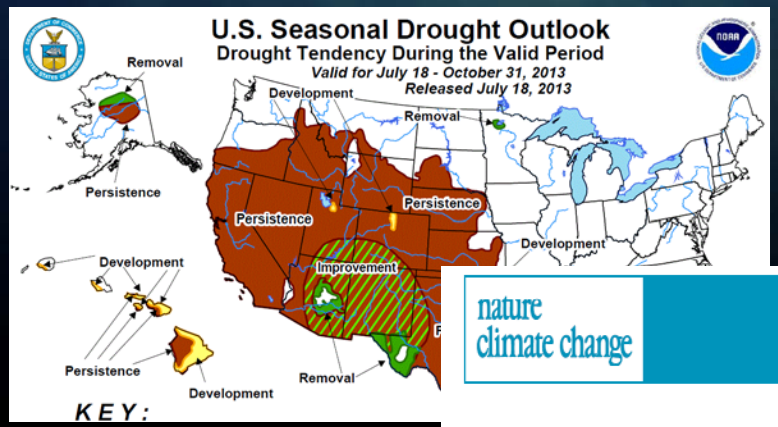
An element of the Arctic Observing Network (AON)

Distributed Biological Observatory (DBO)

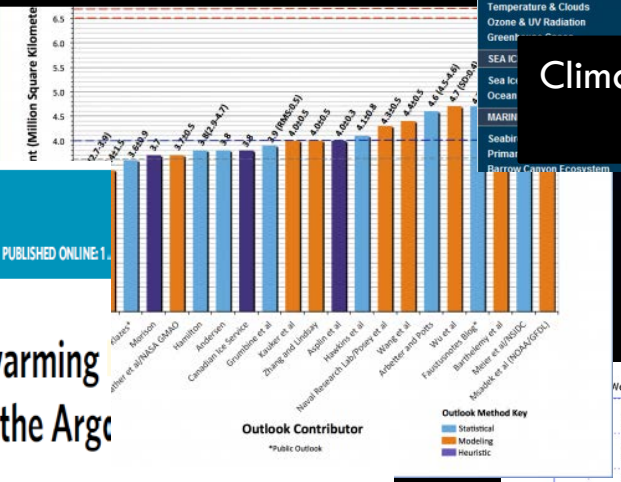


- **DBO regions are centered on "hotspots" located along a latitudinal gradient**
- **The DBO serves as a *change detection array*, via standardized sampling of biophysical processes**
- **Building *links* to coastal ecosystem health *via* Community Observations**

From NOAA's most comprehensive sustained global ocean observing program (and soon for the Arctic!): Weather, Marine, Arctic, and Climate Research, Products, and Services



SEA ICE OUTLOOK

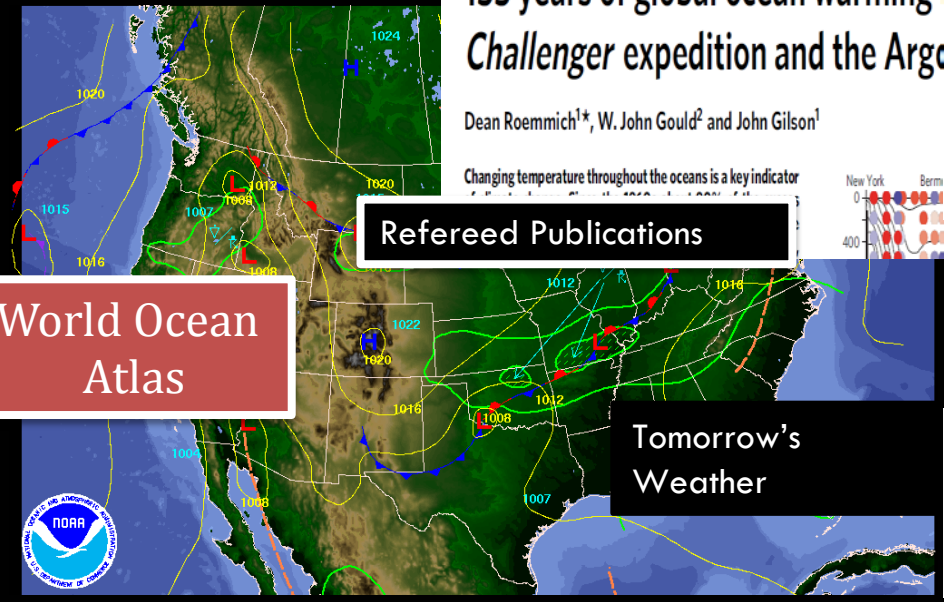


Climate Assessments

Refereed Publications

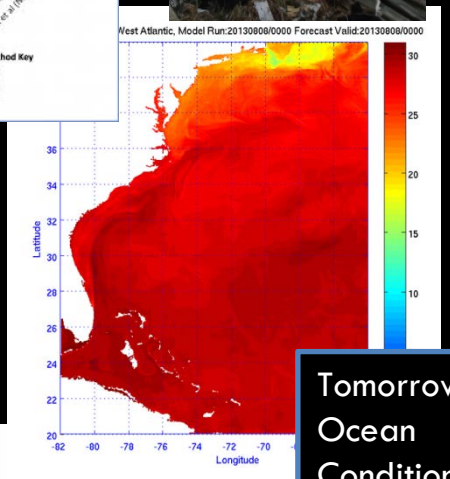
ICOADS

SOCAT
SURFACE OCEAN CO2 ATLAS

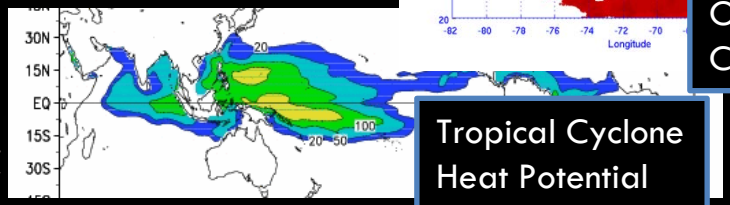


World Ocean Atlas

Tomorrow's Weather



Tomorrow's Ocean Conditions

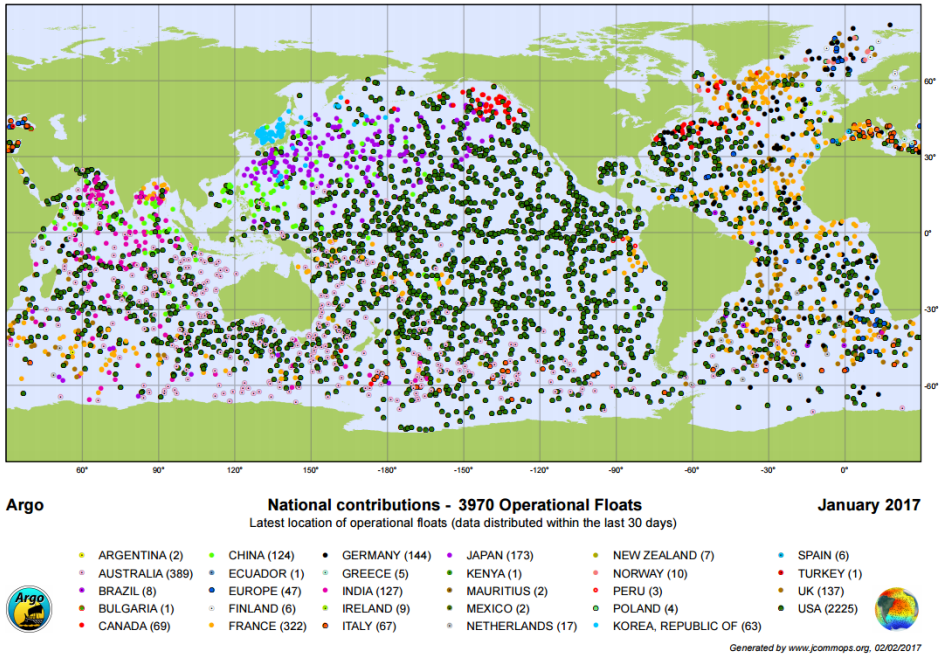


Tropical Cyclone Heat Potential

Highlights

- Charting new territory (deep ocean)
- Arctic (building a sustained system)
- Enabling new discoveries (carbon)
- Demonstrating impacts (forecasts)
- Products & info to stakeholders (sea level)

Argo



Status (January 2017)

- 3970 Operational Floats
- 29 active countries
- Some flat/declining national contributions
- Core Argo 23% underfunded
- Extra contributions 15% (BGC, research)
- Progress for Europe
- 10000 obs/month (70% of highest quality)
- 85% obs. within 24h

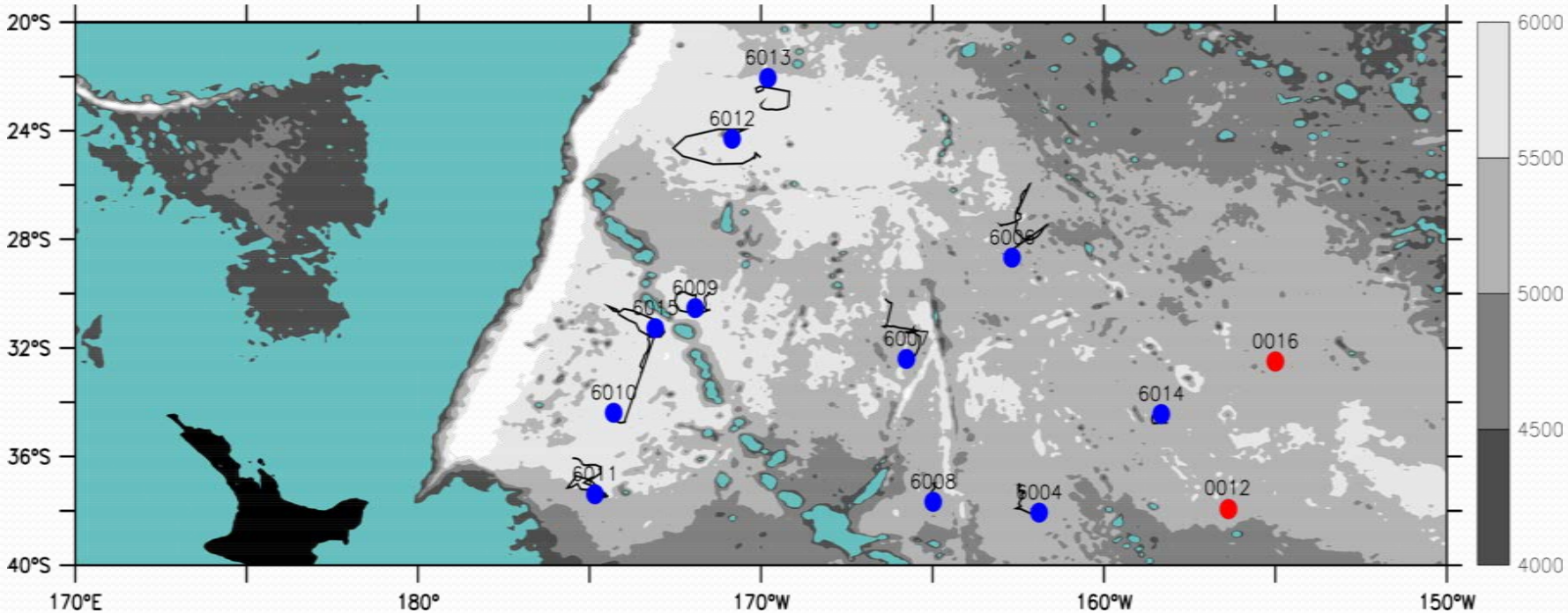
Recent Achievements

- Design reviewed (initial 3200 to global 3800) (+Polar/Marginal)
- Good coverage (~70%) P.O. getting old, and on decrease.
- 1+ paper per day logged
- Global ocean heat gain observed with unprecedented accuracy

Foci for the Next Year

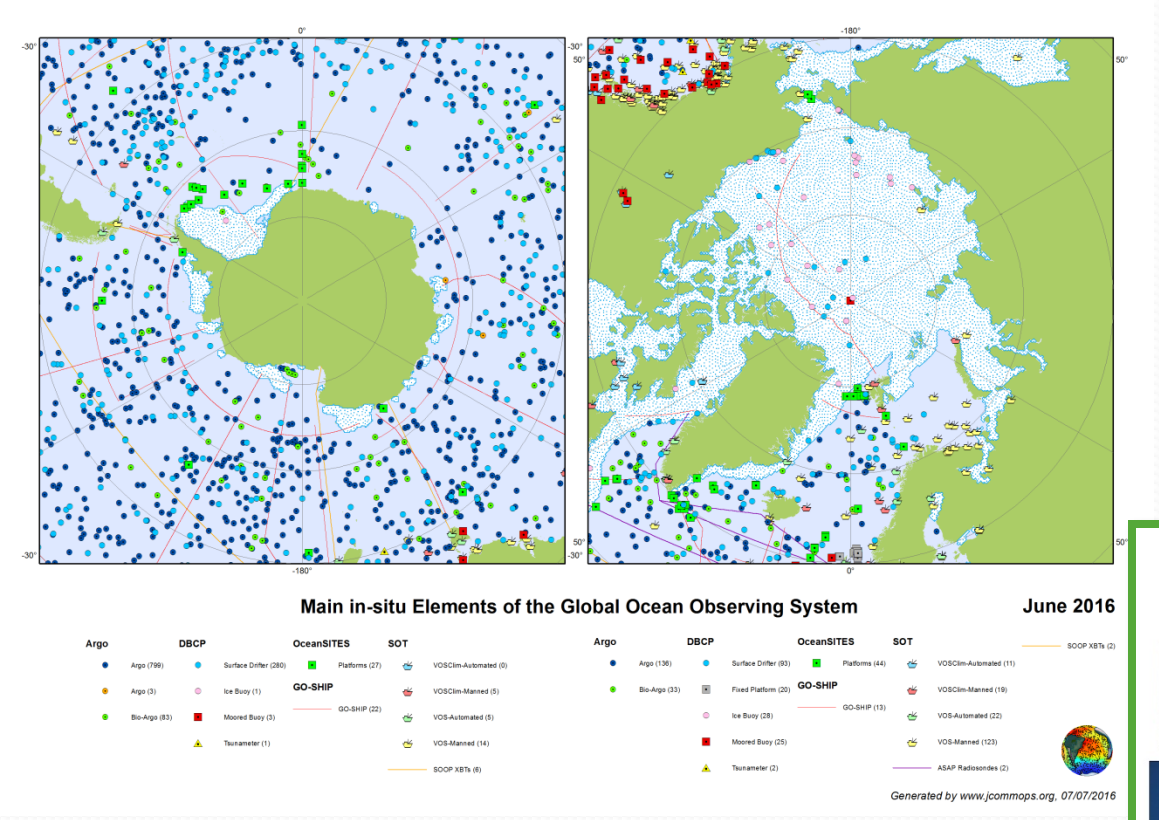
- Proj: max to 4000 then degradation
- BGC (900) Argo planning
- Deep Array and regional enhancements piloted
- Technology progressing
- Charters crucial for sustained coverage

Deep Argo



Locations of active Deep SOLO (blue dots) and Deep APEX (red dots) floats in the SW Pacific Basin regional pilot array.

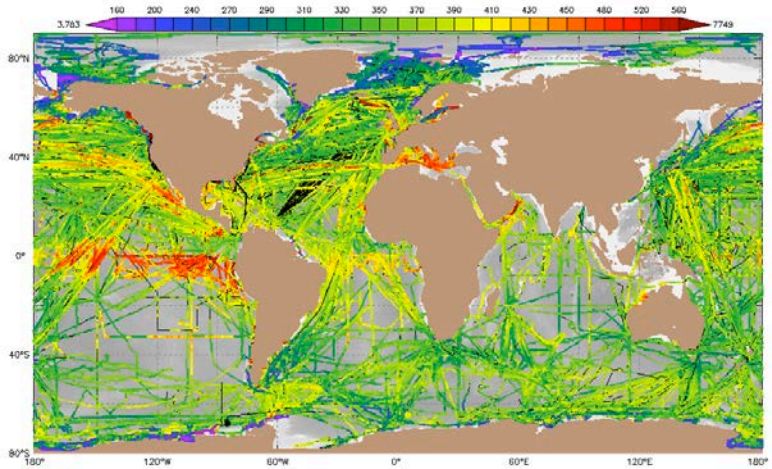
Arctic Observing Network (AON)

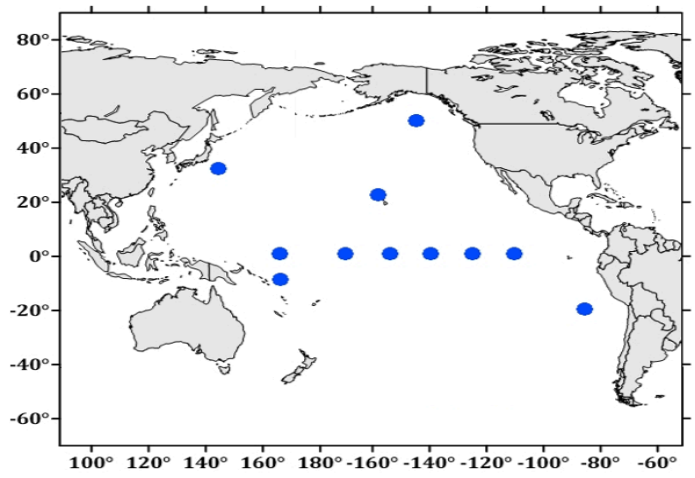


International Arctic Systems for Observing the Atmosphere (IASOA)

Establishing US Arctic Observing Network (AON) Office

Surface Water CO_2





Recent achievements

- Surface Ocean CO_2 Atlas (SOCAT) released on an annual basis
- Include float and mooring pCO_2 data in the SOCAT database
- Contribute to Annual Assessments of the Global Carbon Project, and BAMS State of the Ocean
- Data used to provide seasonal global air-sea CO_2 flux estimates

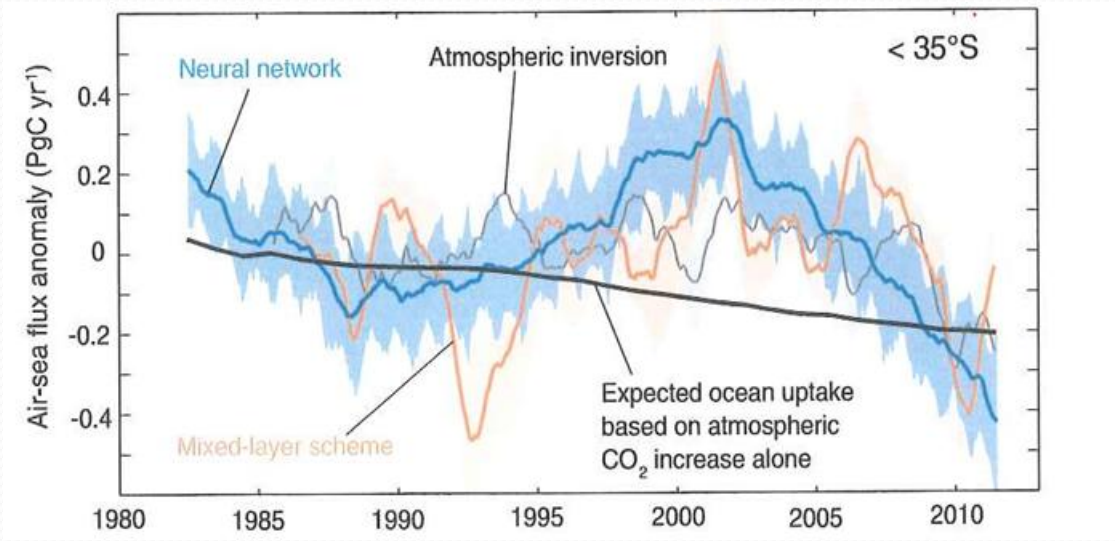
Status

- ≈50 ships contribute to the SOCAT data holdings
- 17 moorings provide high-resolution temporal data
- Network Provides ≈> 2 Million new data points per year to assess ocean acidification and flux variability and change

Foci for the next year(s)

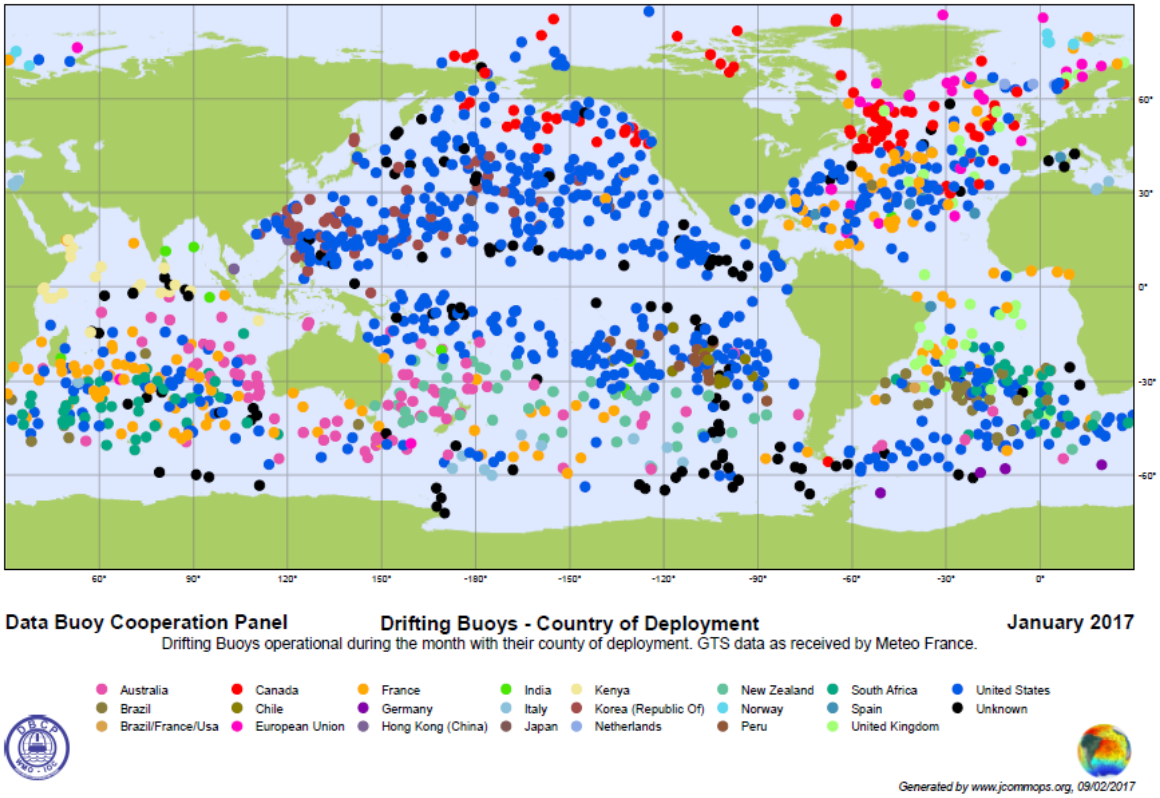
- Increase international coordination, including with ICOS-ocean and JCOMM/SOT
- Document Best practices
- Specification sheets for EOVs on surface carbon and CO_2 fluxes
- Develop optimal network design
- Real time data and position transmission
- Include other biogeochemical (BGC) parameters, including air CO_2, pH and O_2 and develop a surface BGC network
- Utilize data to calibrate and validate BGC Argo (surface)
- Incorporate OOI CO_2 observations in data holdings

The Southern Ocean: an Increasing CO_2 Sink



- **3 independent analyses are consistent, Southern Ocean uptake of atmospheric carbon increased (more negative) after 2002**
- **Recent provocative results based on calculated pCO_2 derived from SOCOM floats suggest the area is a CO_2 <u>source</u> in 2014-2016. (Gray et al., Nature, under review)**

DBCP (Drifting Buoy Network)



Status (January 2017)

- 1444 drifting buoys providing data to the GTS
- 20 countries contributing
- 63% of drifters report data to the GTS in less than 60min

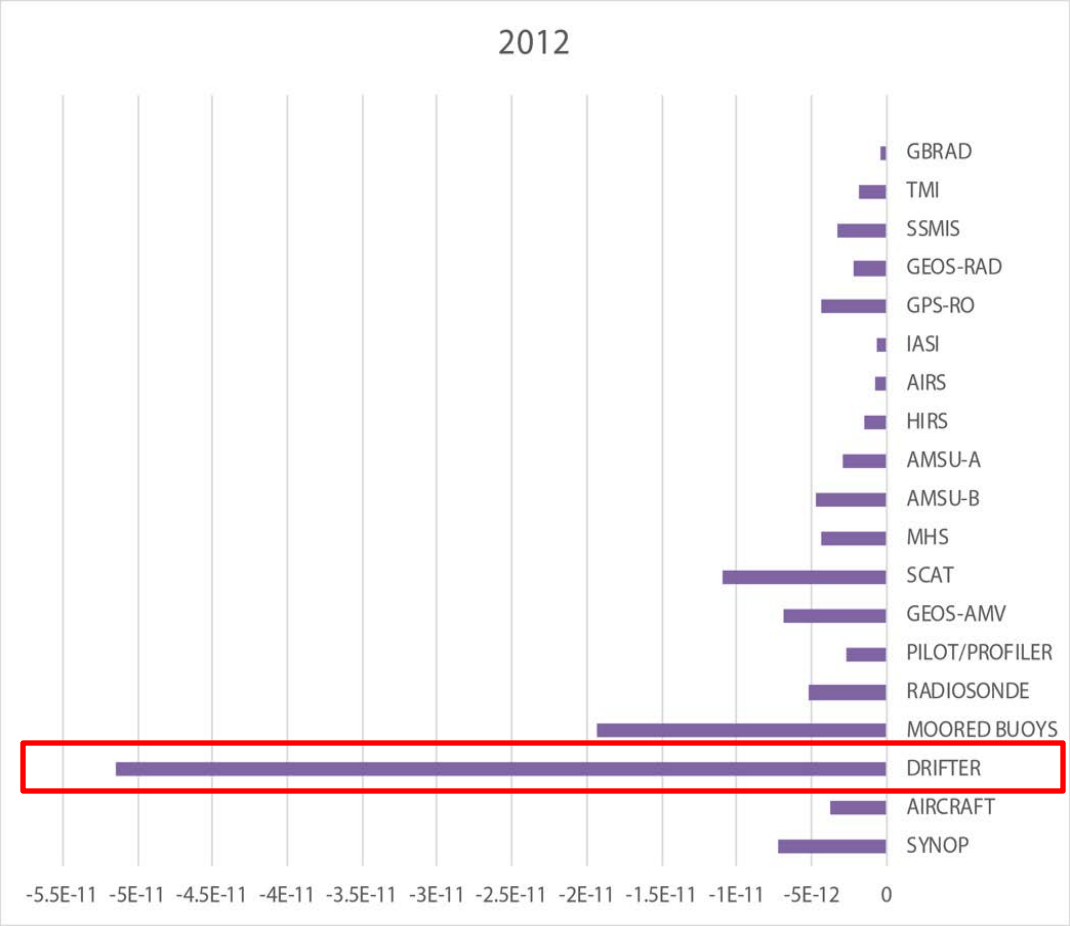
Foci for the Next Year

- Improve the data timeliness of drifting buoys to the GTS, particularly by increased use of Iridium
- DBCP/GHRSST project on high resolution drifter SST measurements for improved satellite SST validation
- Increase the number of drifters with sea level pressure measurement for improved weather forecasting
- Improve the drifter density distribution coverage

Recent Achievements

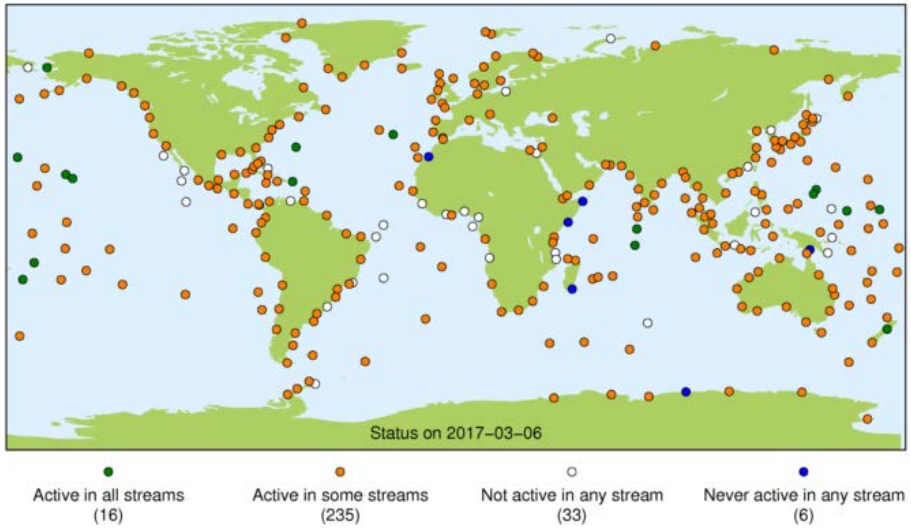
- 48% of the drifting buoys use the Iridium satellite system
- 56% of the drifters are providing Barometric Pressure data to the GTS
- KPIs for drifting buoy network are finalized and are reported monthly

Drifter Barometer Impacts



Forecast Sensitivity Observation Impact study at ECMWF (for 2012): Adding barometers to surface drifters most cost-efficient and impactful on a per-observation basis for forecasts.

GLOSS



Status (March 2017)

- Map shows stations reporting via at least one GLOSS data pathway
- 251 stations yes, 39 stations no
- This map is now part of the JCOMM-OPS status map, and additional content is in progress

Recent Achievements

- As noted above, now reporting via JCOMM-OPS
- Major revamp of the GLOSS web pages has been undertaken and will be brought online very soon
- GLOSS/SONEL data center has data or information from about 1000 GPS sites within 10-15 km of a tide gauge!

Foci for the Next Year

- GLOSS Meeting, July 2017
- Review of procedures for data acquisition and distribution
- Discuss a new "vision" of GLOSS focused on science missions rather than data streams
- Develop an update to the GLOSS implementation plan that takes the above into account

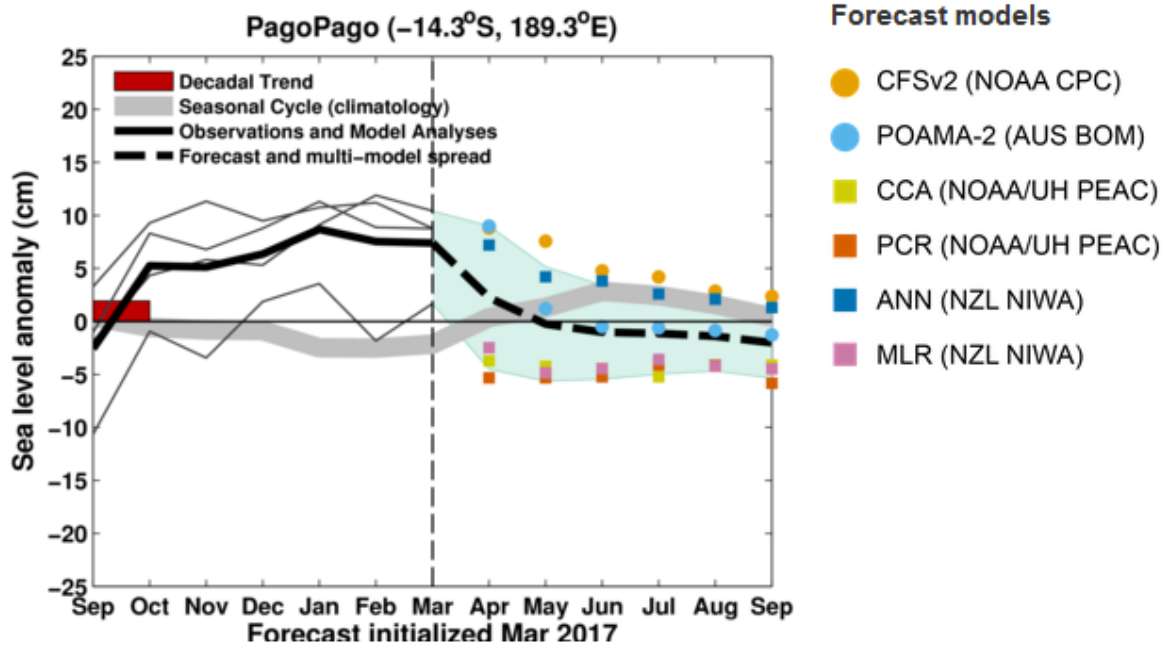
Seasonal

UNIVERSITY OF
SEA LEVEL CE

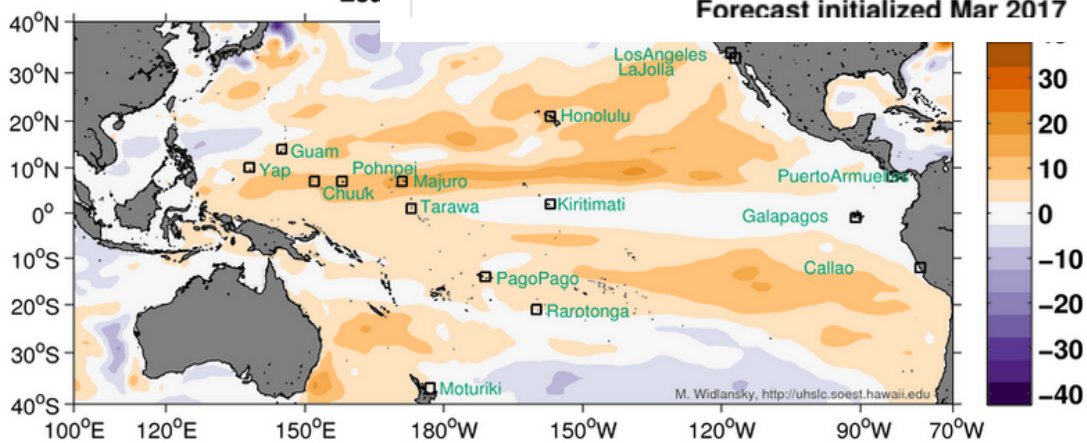
Sea Level Forecasts

This product provides an outlook of mc
anomalies for the next one to two
combine sea level forecasts with astror
more accurate predictions of coastal wate
alone.

Discussion | **Forecasts** | Tides | Impacts



Model forecast (C
Lea



-6 -5 -4 -3 -2 -1 0 0 1 2 3 4 5 6

- from satellites (past 6 months) and predictions from one model (next 6 months) by moving the mouse over the row of numbers below the map.
- View multi-model forecasts for many islands in the tropical Pacific by clicking tide gauge station labels on the map.
- Click on the "Tides" or "Impacts" tabs to see how the predicted relative sea level anomaly is likely to alter the astronomical tide cycle and affect the coastline.

Program Updates

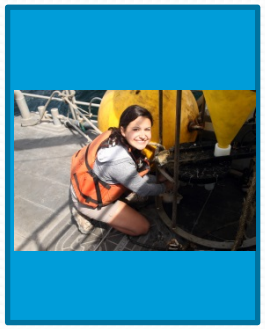
Changes at OOMD

Jennifer Saleem-Arrigo

Transitioned from OOMD

Shelby Brunner
Sea Grant Fellow

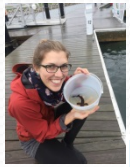
Monique Baskin

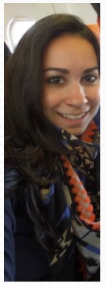
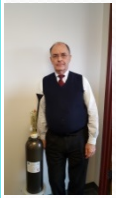


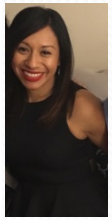
Emily Osborne
Sea Grant Fellow

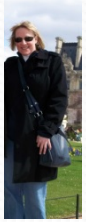
New Team Members

Staffing



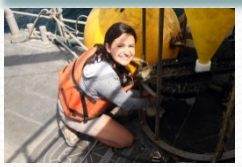
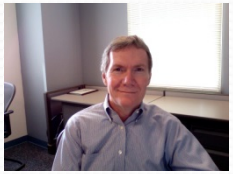


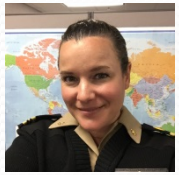


Ocean Climate Observations	Arctic	Climate Monitoring	Administration and Budget
Steve Piotrowicz Emily Smith Kathy Tedesco Sidney Thurston Jim Todd Shelby Brunner	Jeremy Mathis Monique Baskin Emily Osborne	TBD	Monica Morales Claudia Perez

LCDR Megan Raymond

Additional hires anticipated to support Climate Monitoring



Budget

Division Allocation FY16 (FY15)

Climate Observation Division $43.7M ($44.1M)

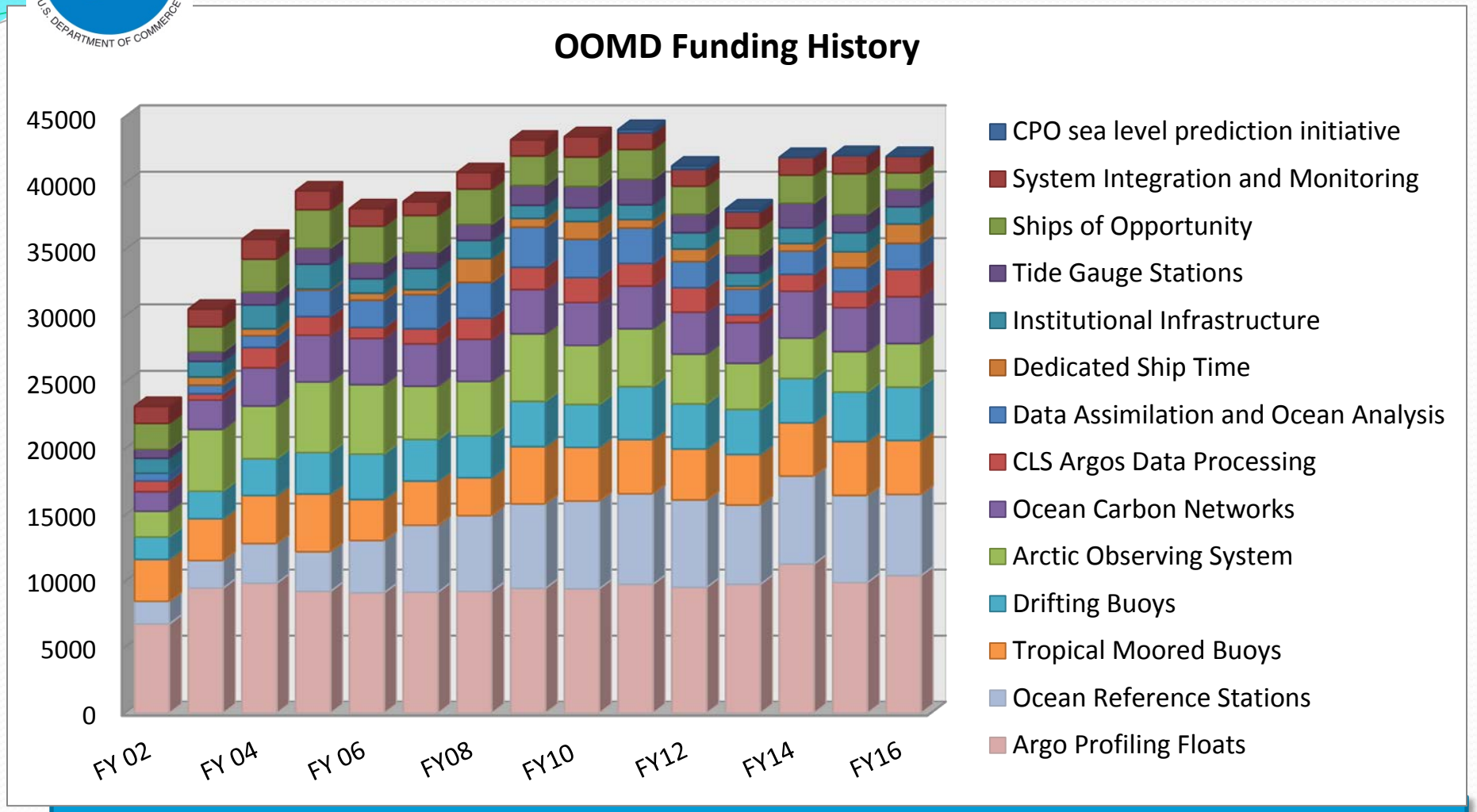
Ocean Climate Observations $37.7M ($37.7M)	Climate Monitoring $2.9M ($2.9M)	Arctic Program $3.1M ($3.1M)

Sustained Ocean Observations and Monitoring (SOOM)	Sustained Ocean Observations and Monitoring (SOOM)	Regional Climate Data and Information

NOAA Budget Lines

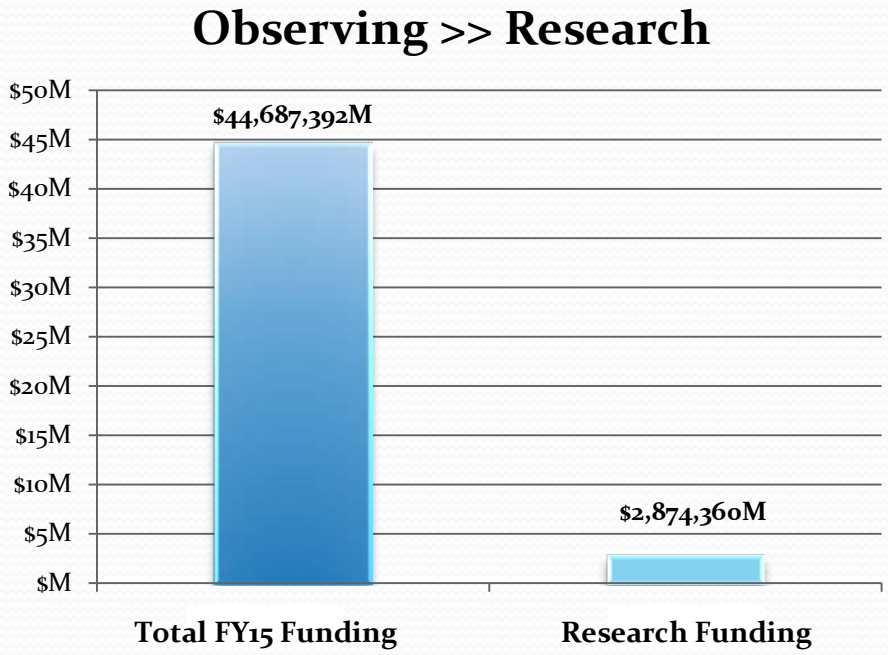
FY17: Congressional appropriations comparable to FY16
FY17: Increased allocation towards Argo
FY17: Expecting substantial increase of CPO and OAR *taxes*

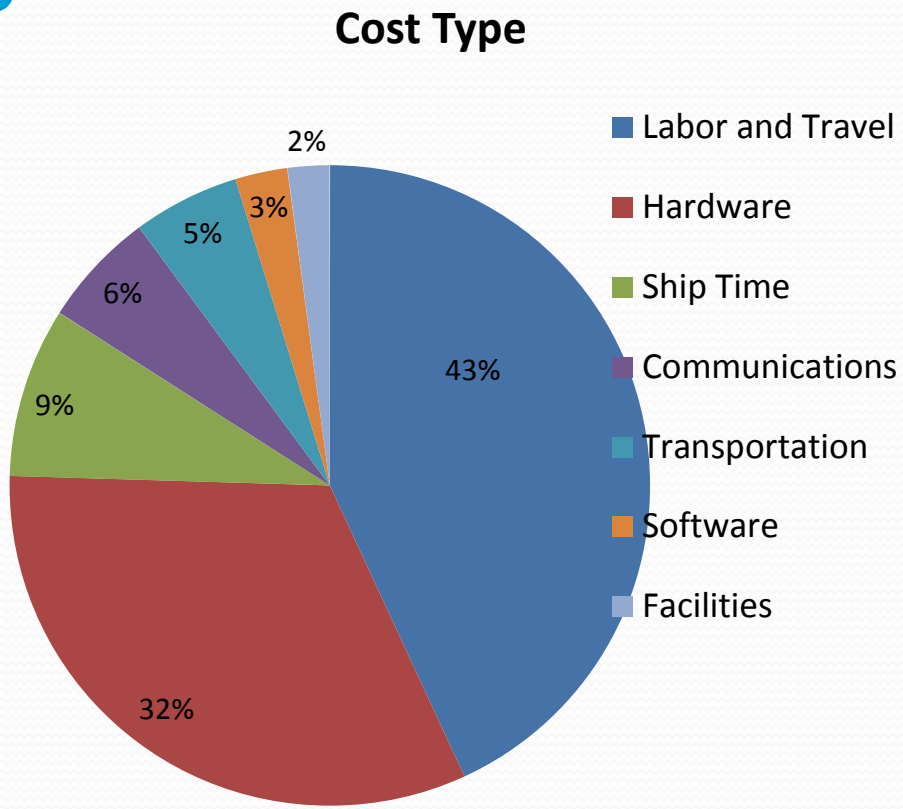
Budget



- Some recovery since Sequestration enacted, but largely flat for over a decade
- Unsustainable future

Funding Facts





- Research is defined as activities associated with hypothesis-driven, and/or interpretation/analysis of data leading to a published paper
- Climate Monitoring Program : 80% of "research" funding

Program has sacrificed research to sustain observing activities

Costs are primarily labor and hardware

OOMD Opportunities

Opportunities/Needs

- Build on: NOAA's most comprehensive sustained global ocean observing program(Arctic soon!)
- New scientific and services frontiers and requirements
  - Biogeochemical, Biological
  - Deep Ocean, Arctic and Antarctic Oceans
  - Debris, etc
- Technology testing and transition
- Studies to ease transition to new observing strategies
- Observing system design
- Enhanced interaction: modeling and satellite communities
- Data use/impact valuation (e.g. modeling/forecast systems)
- Expanded product suite
- Increase interaction with other parts of NOAA
- Enhanced international relations/contributions

OOMD Response

Raise Visibility , Seek new funding (2015+)

Raise awareness within NOAA and Externally (NOAA, IOC, GOOS, IARPC, AESC, SAON, JCOMM, TPOS)

Arctic, TPOS, Deep Argo, Bio Argo funding requests

Program Assessment/Review (2016+)

Portfolio Analysis

Program Reviews

Engagement with stakeholder/users

Improved performance metrics (value chain)

Develop tools /approaches to prioritize our activities

Assess Program structure

Revise Program (2018+)

Determine scope, priorities, and program balance

Identify new areas of investment

Communicate proposed changes to international community

Oceanobs 19

OOMD of the Future

- Scope, practices, and organization of OOMD will change.
- Tenets of changes:
  - Prioritize to sustain the most critical activities
  - Utilize Framework for Ocean Observing (FOO)
  - Develop balance across research/pilot observing, sustained observing, and product development
  - Telling our story better!
  - Value chain and performance metrics. And getting others to advertise our program ‘s importance
  - Invest in new strategic areas (TBD), even if amounts are small
  - Seek financial partnerships and joint sponsorships, especially where we can address additional requirements

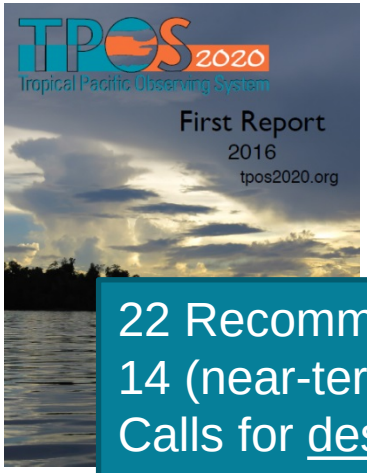
OOMD Ocean Program Reviews

- OOMD undertaking series of program reviews
- Strategic aims, performance, assess requirements and outcomes, forward looking:
  - Solomon Sea Glider (2015), Antarctic Moorings (2015)
  - Global Drifter Program (Oct 2016 – nearly Final)
  - pCO2 (November 2016 – nearly final)
  - XBT/SOOP (Spring 2017 - nearly final)
  - OceanSites (Fall 2017)
  - Products (Fall 2017)
  - Others (e.g. GLOSS/SL, to be scheduled)

Tropical Pacific Observing System-2020 Project

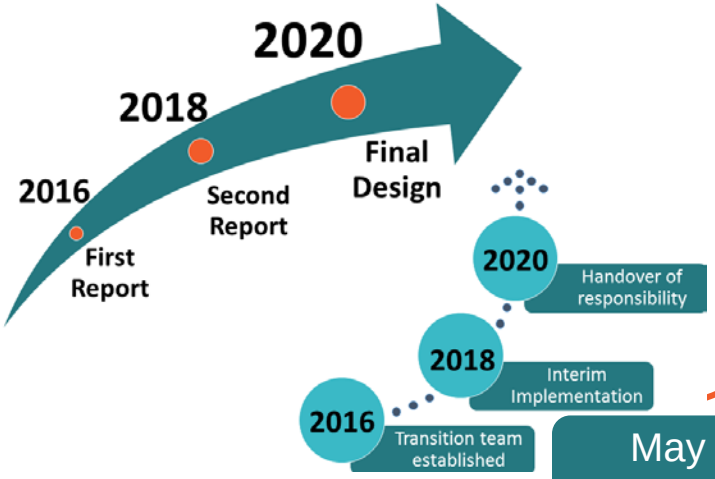
Example of the FOO in action

- To redesign and refine the TPOS to observe ENSO and advance scientific understanding of its causes,
- To determine the most efficient and effective observational solutions to support prediction systems for ocean, weather and climate services, and
- To advance understanding of tropical Pacific physical and biogeochemical variability and predictability.



Special Technology Pilot Awards
$4.5M, 4 years

22 Recommendations,
14 (near-term) Actions
Calls for design, modeling, pilot and process studies and several observing changes

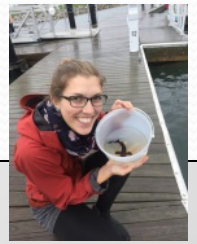


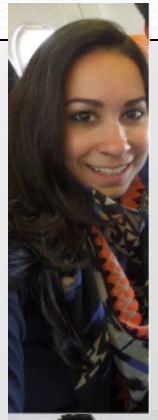
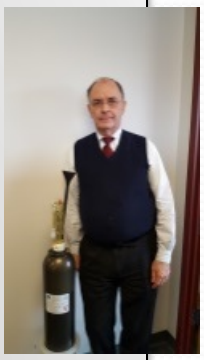
May 2017
Resources Forum

www.tpos2020.org

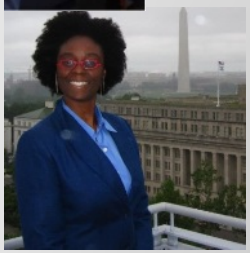
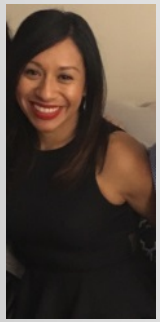
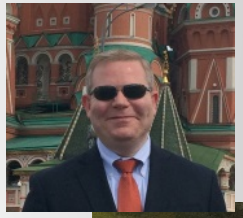
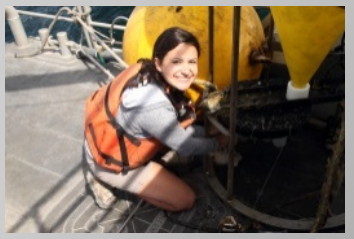
Summary

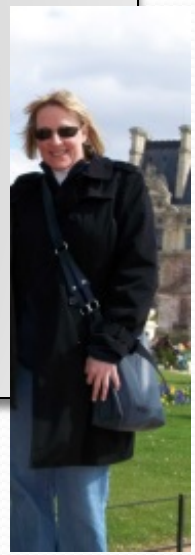
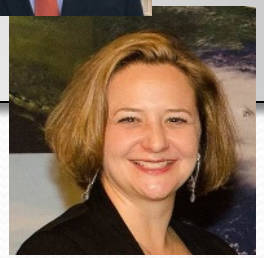
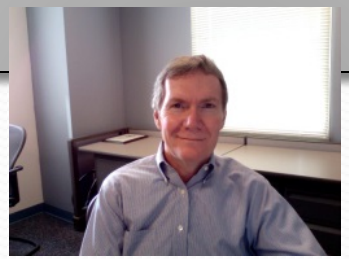
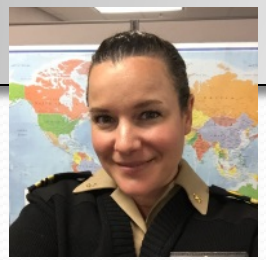
- Global ocean observing: remarkable progress
- Arctic observing: compelling motivation; positioned for success with AON
- Program is successful, though we are largely unrecognized amongst NOAA senior officials and on Capitol Hill (not unique within NOAA)
- Stagnant resources, but plenty of new opportunities: catalyst for change
- Change planning under way
- Always prepare for the opportunities!
- Community workshop: addressing many of the topics I've raised



Thanks all and the OOMD Team

Prioritization/Performance for Observing Activities

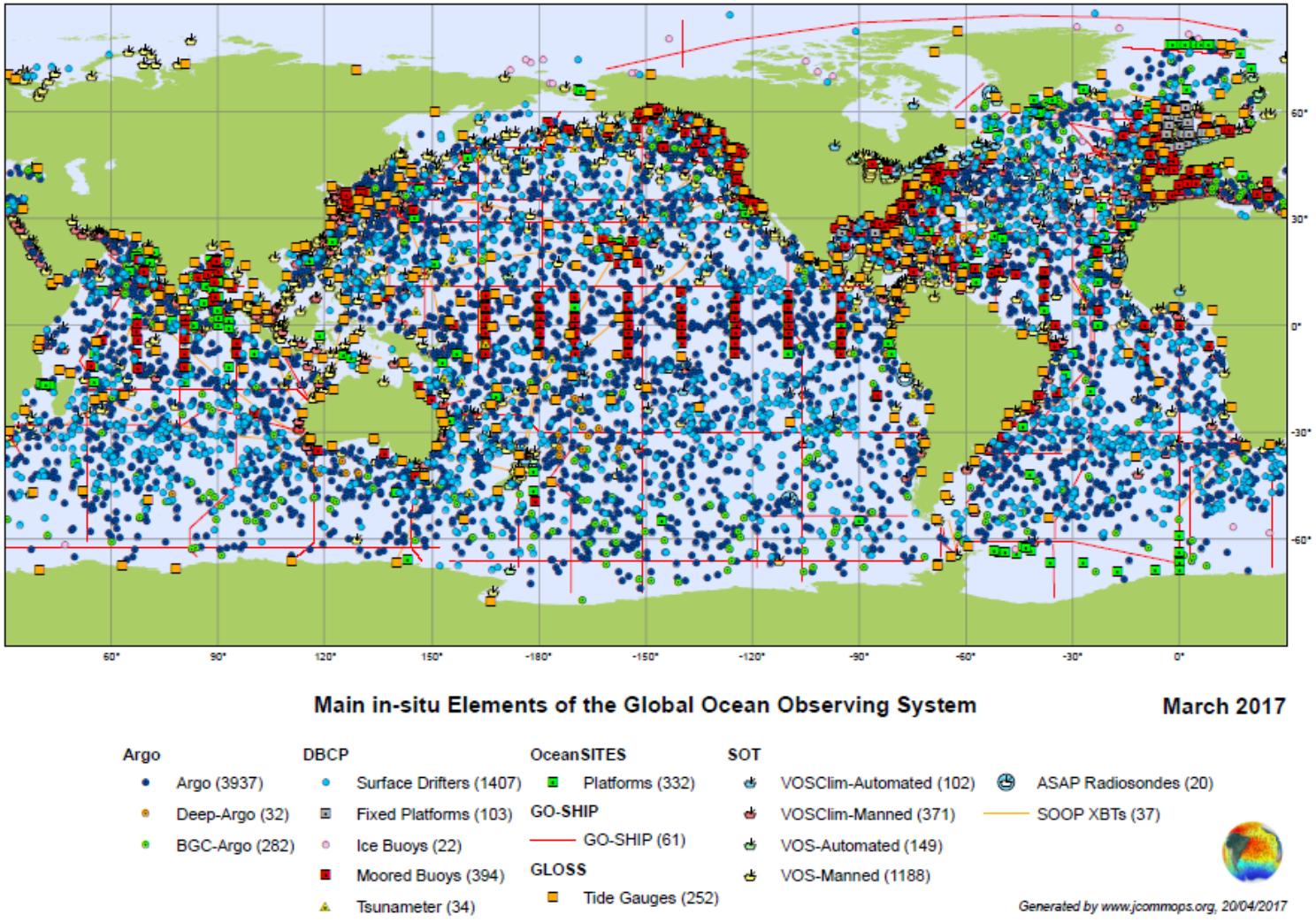
- Relevance to COD Strategic Plan (and its Guiding Questions), NOAA, and evolving Observing Systems (e.g. GOOS, SAON, GAON, etc)
- Focus on mature observing (see Framework for Ocean Observing) and targeted pilot activities
- Integration within national and/or international programs and partnerships central to its function
- Need for *sustained* observations is clear (other programs support process studies)

Measures of Performance

- Information routinely available, accessible, and discoverable
- Strong and broad citation record (of data/information use) demonstrating ongoing advances
- Information improves analysis & forecast systems (within NOAA and elsewhere)
- Information calibrates/validates satellites and/or other systems
- Data, products, & info central to assessments such as the State of the Climate report, IPCC, Arctic, Carbon, etc
- Data and information directly support decision and/or policy-making
- Data/Information is the authoritative record and cited as such
- Extent and nature of partnerships
- Sustained observing, and progress in increased maturity of observing system

How will these be used? How will programs be evaluated? When?

JCOMMOPS


60°
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Main in-situ Elements of the Global Ocean Observing System
March 2017
Argo
Argo (3937)
Deep-Argo (32)
BGC-Argo (282)
DBCP
Surface Drifters (1407)
Fixed Platforms (103)
Ice Buoys (22)
Moored Buoys (394)
Tsunameter (34)
OceanSITES
Platforms (332)
GO-SHIP
GO-SHIP (61)
GLOSS
Tide Gauges (252)
SOT
VOSClim-Automated (102)
VOSClim-Manned (371)
VOS-Automated (149)
VOS-Manned (1188)
ASAP Radiosondes (20)
SOOP XBTs (37)
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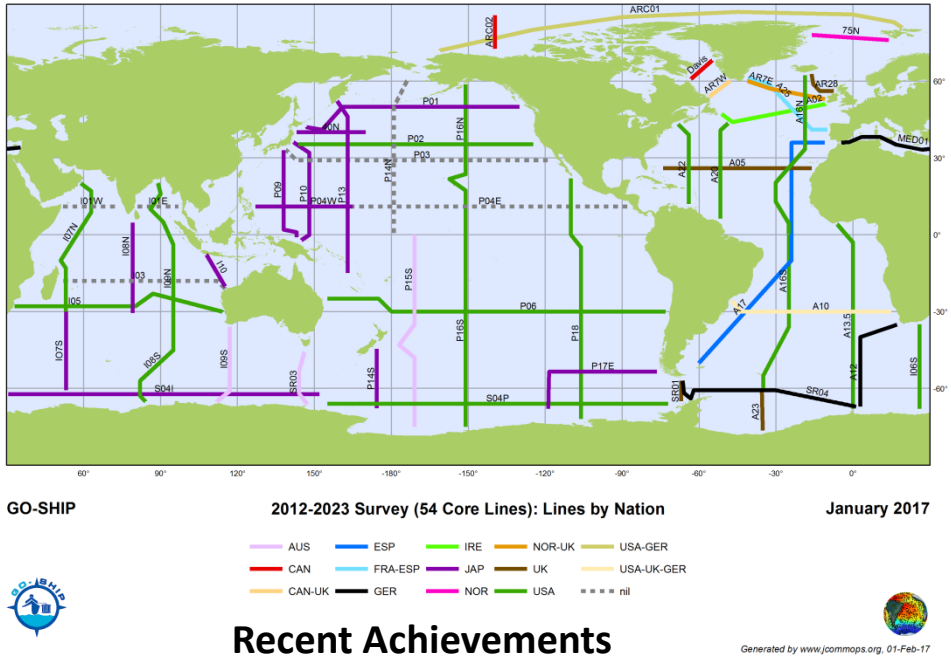
GO-SHIP



Status (January 2017)

- 54 core reference lines in 2012-2023 survey
- Completed/funded/planned lines: 89%
- Lines not planned yet: 11%
- 2017 means 45% through decadal period
- 16 countries in GO-SHIP Committee

Recent Achievements

- Community paper in 2016 ARMS:
  Talley *et al.*, 2016 "Change in Ocean Heat, Carbon Content, and Ventilation: A Review of the First Decade of GO-SHIP Global Repeat Hydrography"
- Almost 20 GO-SHIP cruises in last 12 months
- Plans to re-occupy line I7N (last occupied in 1995)
- Progress with data-archives, in particular ADCP

Foci for the Next Year

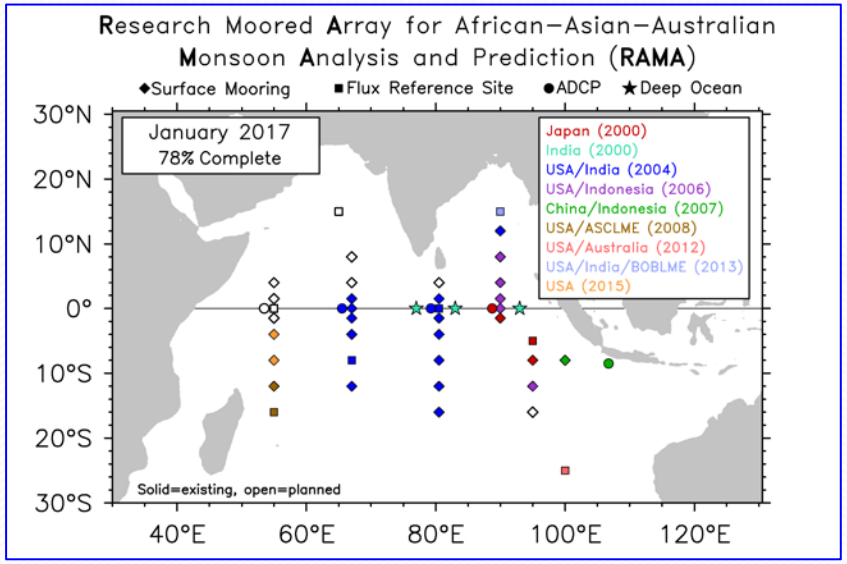
- Complete planning of current survey
- Finish review of manual on best practices
- Involve further countries in GO-SHIP
- Track data-flow into CCHDO data archive
- Develop KPIs

New RAMA Research Partnership

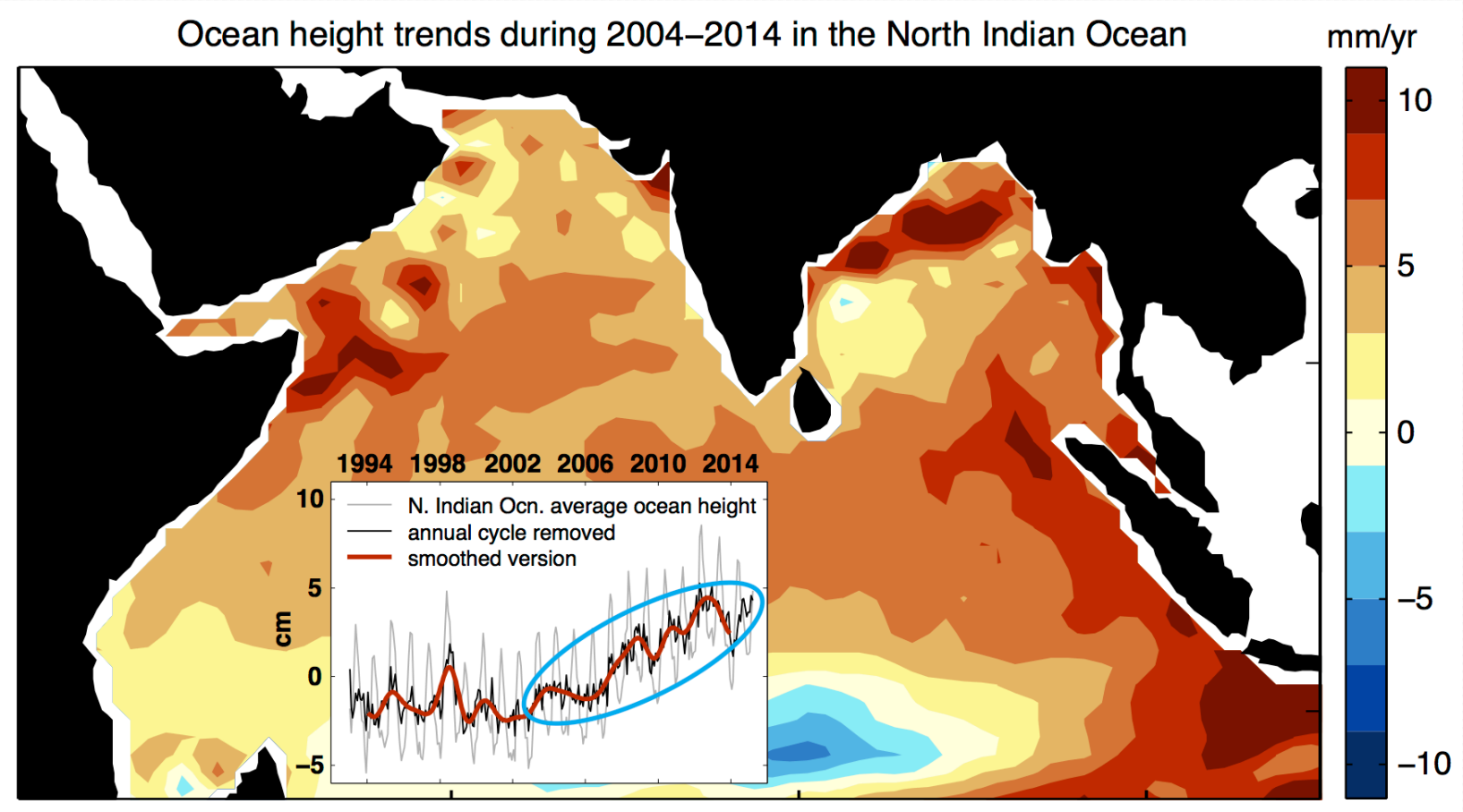
NOAA-KIOST Cooperative Project For Indian Ocean Studies

Planned activities in 2017:

- Pilot cruise on new KIOST *RV Isabu* to service 3 RAMA moorings along 67°E (May-June 2017)
- Workshop in Korea to design a multi-year joint Korea-U.S. Indian Ocean contribution to IIOE-2 (29 Nov-1 Dec 2017)



Decadal Change in Indian Ocean Sea Level



Thompson: JGR-doi:10.1002/2016JC012132

Program Measures of Performance (Presentations this week)

- PI publications that utilize observations
- Publications by others that utilize our observations
- Models that utilize observations – new dialogue with NCEP
- Impacts on model analyses and forecasts (e.g. OSEs)
- Model improvement (how do we document this?)
- Highly cited products and authoritative assessment
- International engagement and leveraging of resources
- Others…