Observing the Changing Ocean






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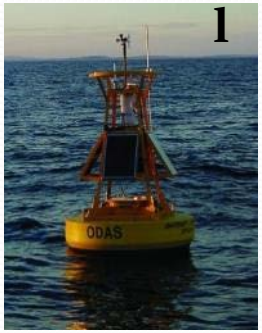
Climate Program Office

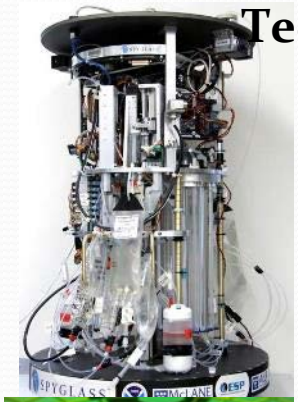
Contributions from IOOS, Dean Roemmich, and others

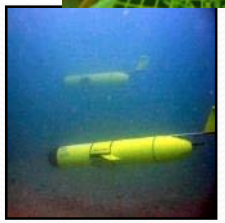
In Situ Platforms – Many Types

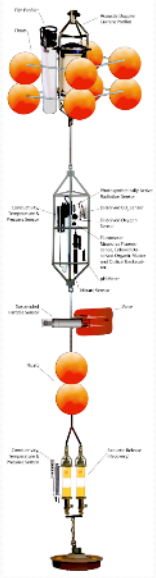
Traditiona l



New Technologies



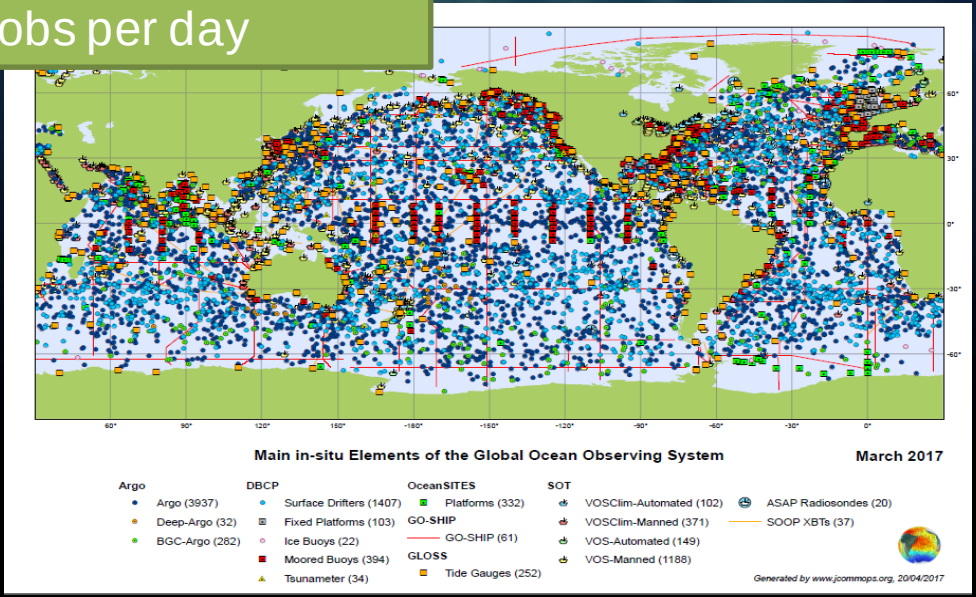




Global In-Situ Sustained Ocean Observing

U.S. Leverages 50% of the Global Ocean Observing System

1M obs per day



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

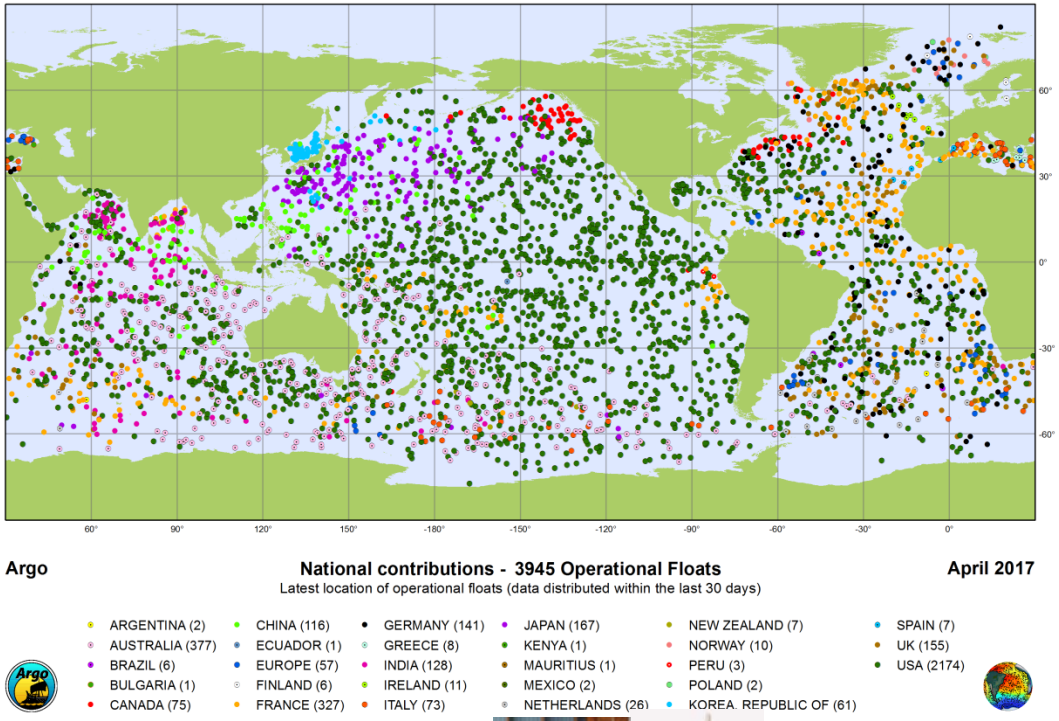
Globally Sponsored Observing Networks

- Argo, surface drifters, RAMA, PIRATA, Oceansites, GLOSS Tide gauges (int'l and US), VOS, SOOP/XBT, OceanGliders, pCO2, GO-SHIP, Animal Tags/profiling, Tsunami

Key Attributes

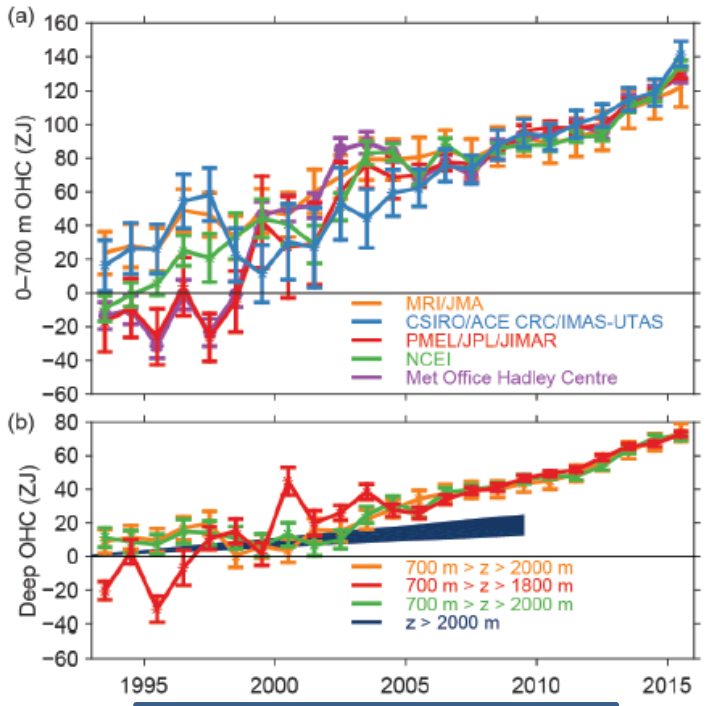
- Global in coverage, fixed and Lagrangian/autonomous platform strategy
- International effort (dozens of countries contribute)
- Data reported in real-time (over 5000 platforms)

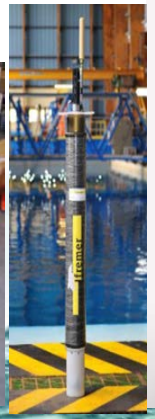
Argo



Status (May 2017)

- 3970 Operational Floats
- 10000 obs/month (70% of highest quality)
- 85% obs. Available within 24h
- 29 active countries
- 1+ paper per day logged
- 295 BGC floats
- 29 deep floats (75 by end of 2017)





Deep Argo Floats

Ocean Heat Content

New Missions: BGC-Argo

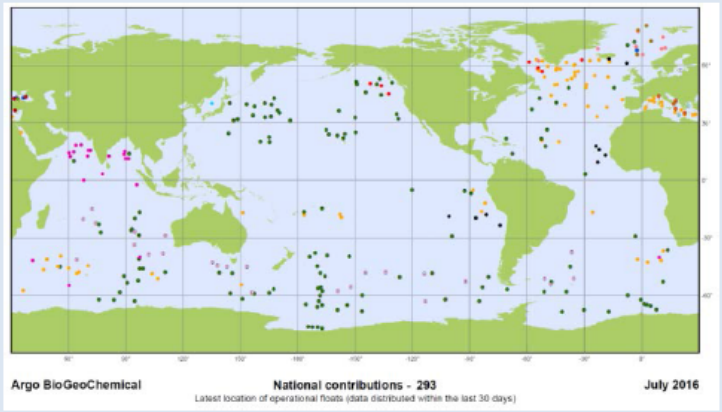
Why

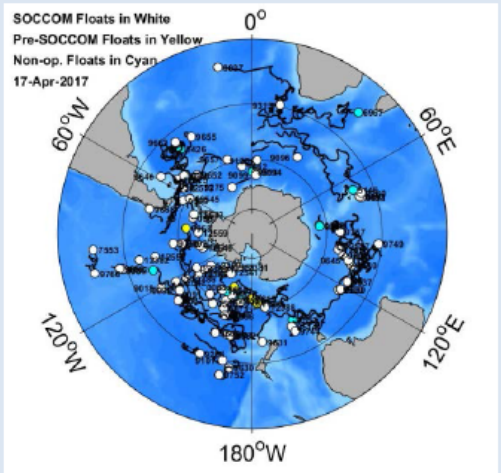
- Understand the fundamental bio-geochemical cycling in the oceans, and thus the foundation of biological productivity patterns and carbon uptake
- To track any long term trends – e.g there is already evidence of significant ocean oxygen changes

Status

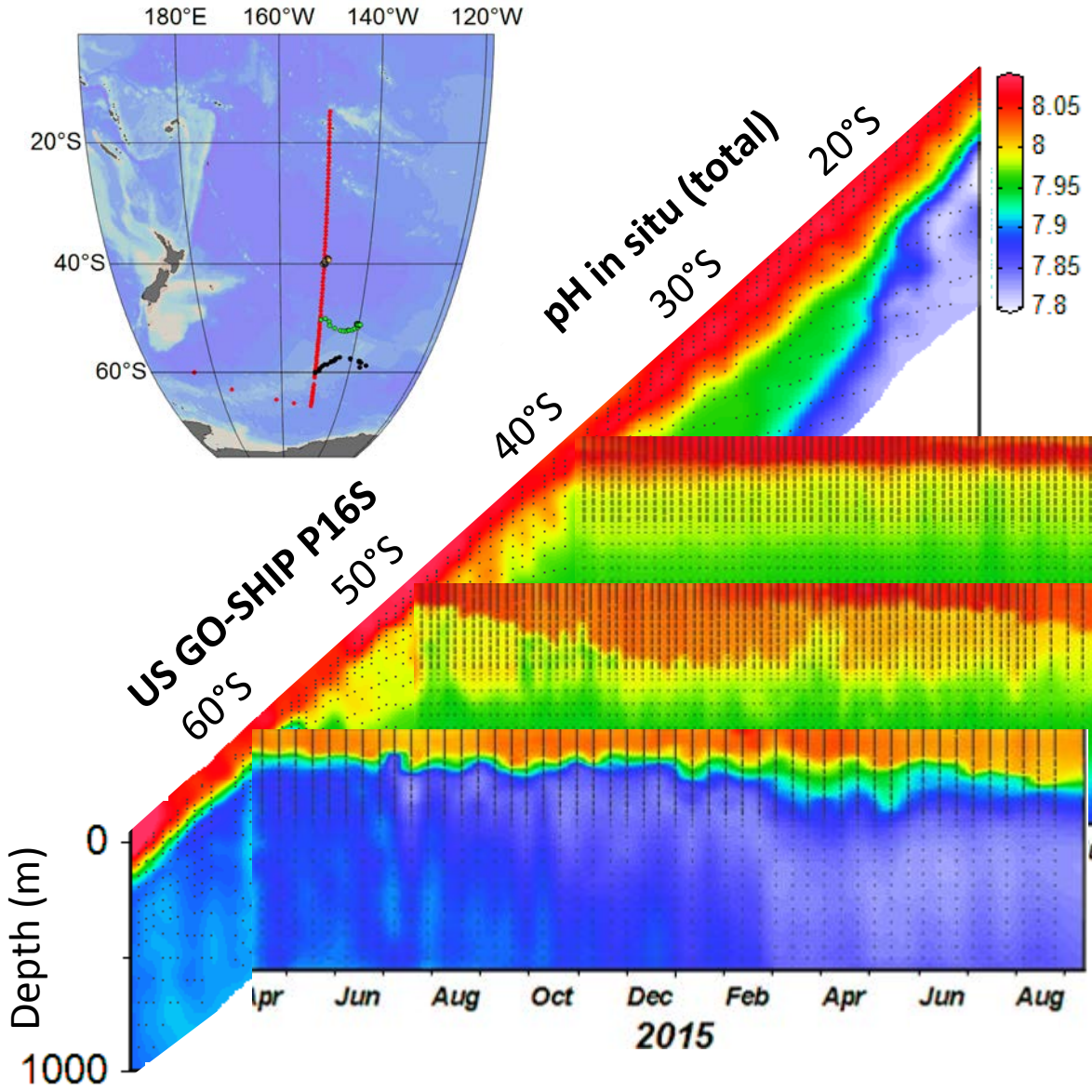
- > 200 floats already carry oxygen – QC and sensor stability work is progressing well
- Nitrate, pH (acidity), and bio-optical sensors have been developed and now deployed on a subset of Argo floats
- Regional pilot arrays (Atlantic, Southern Ocean, Med Sea) are rolling out, including SOCCOM
- Major progress on data handling and QC – partnership with the Argo Data System
- Strong links to **GOSHIP/IOCCP/GOOS.**

Location of 293 active floats carrying one or more Bio-Geochemical sensors.





SOCCOM float locations: 69 active (JCOMMOPS)



Extend decadal-scale GO-SHIP carbon observations into the seasonal and interannual domain with BGC floats. Link the data to high res. models.

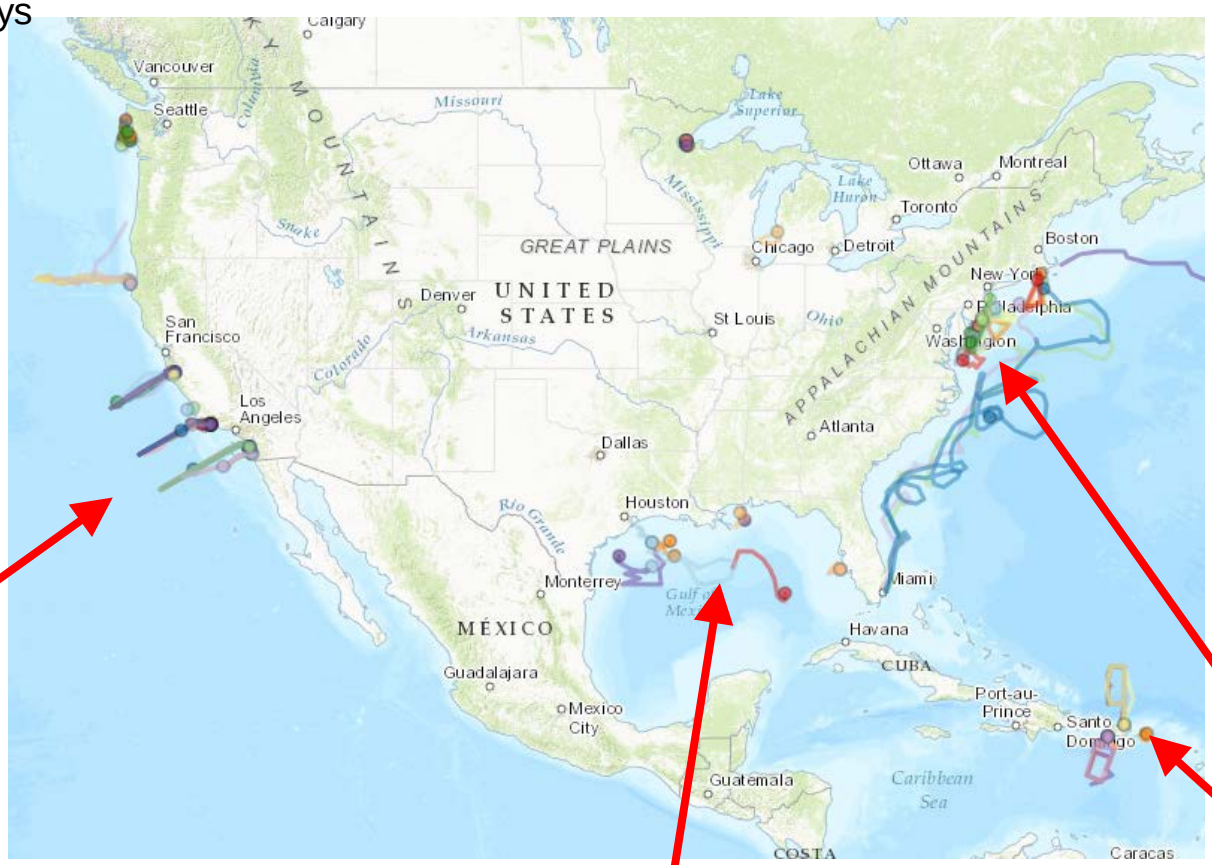
SOCCOM Float 9254

SOCCOM Float 9095

SOCCOM Float 9092

Underwater Gliders – A flexible platform; multiple mission capabilities; U.S. national DAC; international Ocean Gliders project

> 45000 glider days

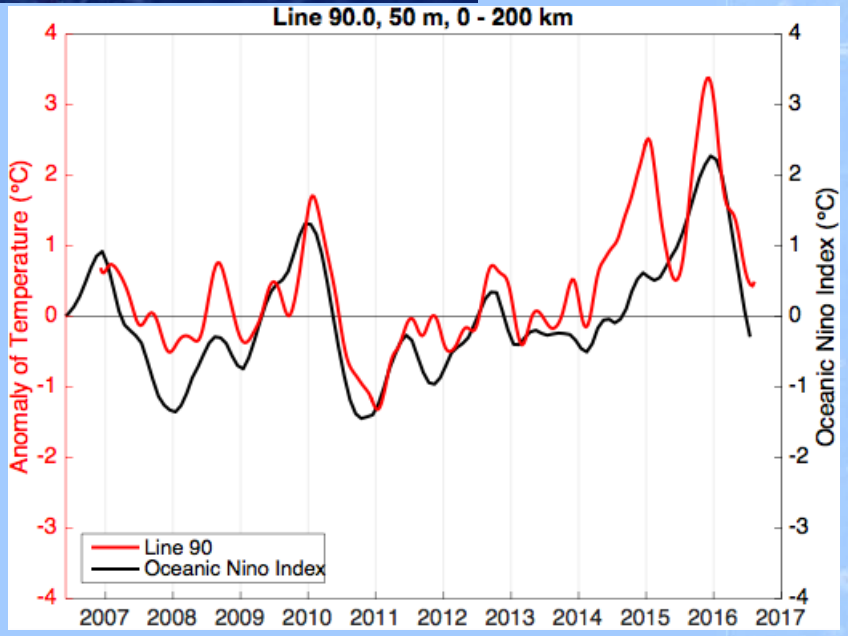


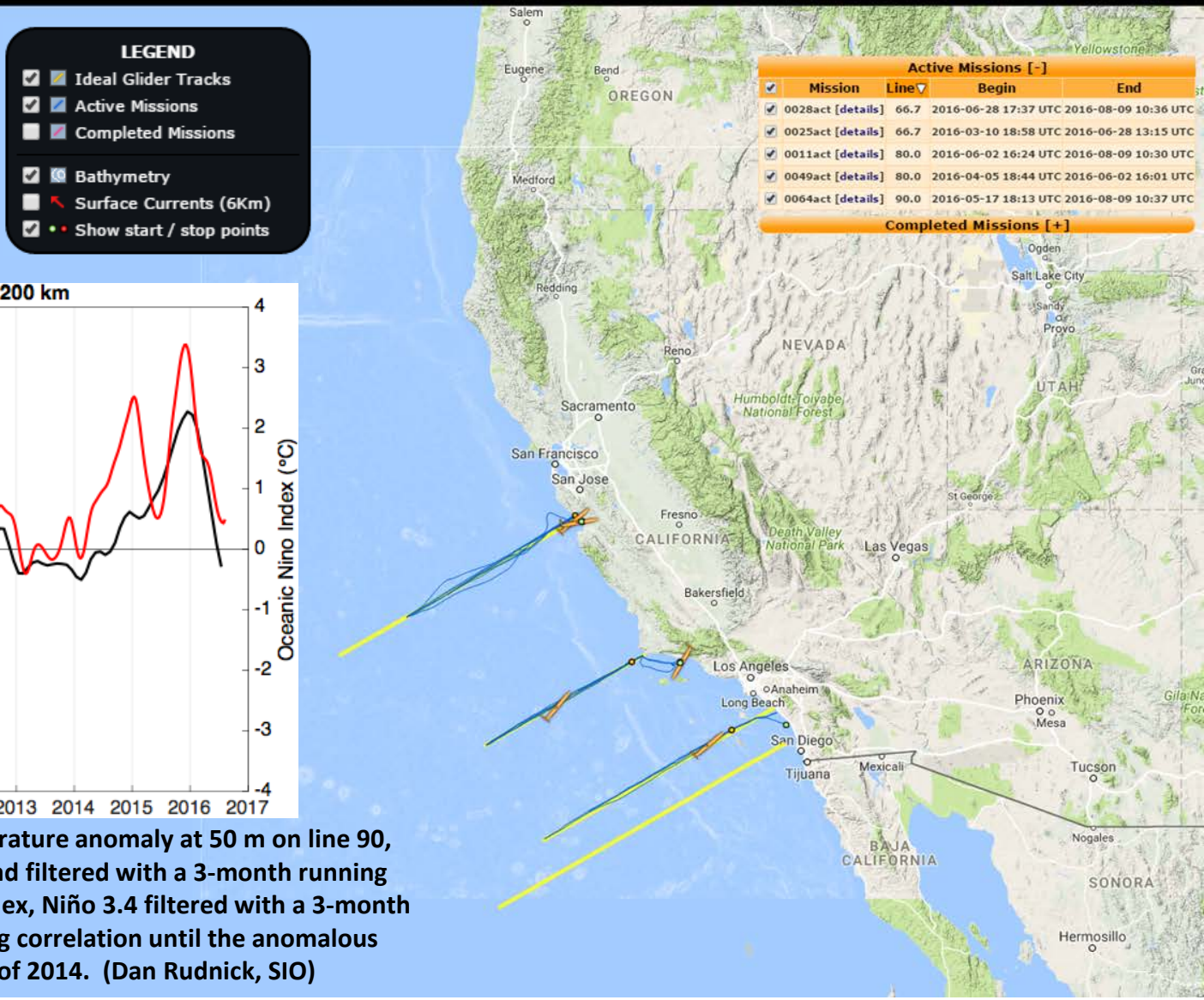
Sustained ocean and ecosystem monitoring

Fast response to crisis: Deepwater Horizon

Understanding the ocean's role in hurricane intensification

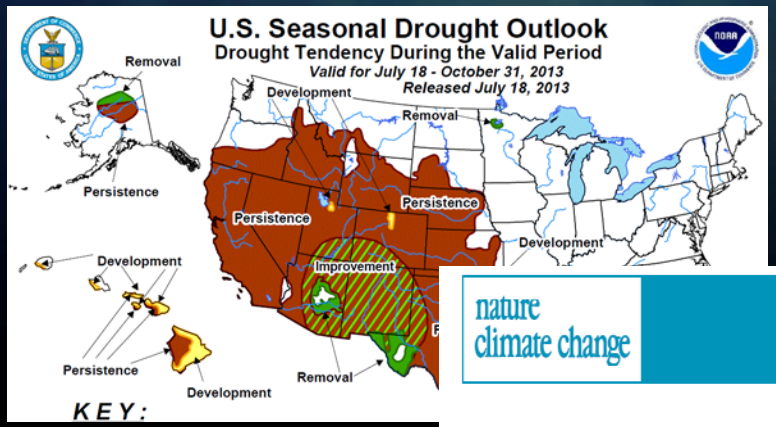
Network

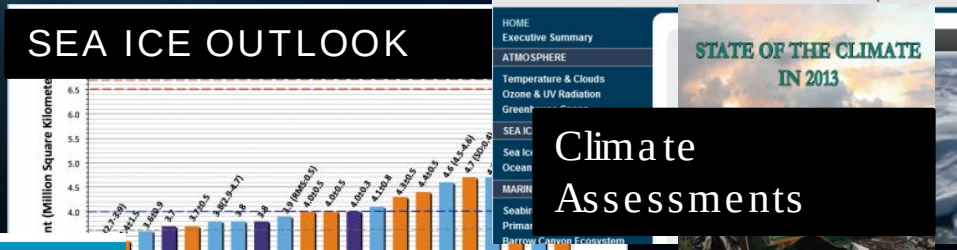




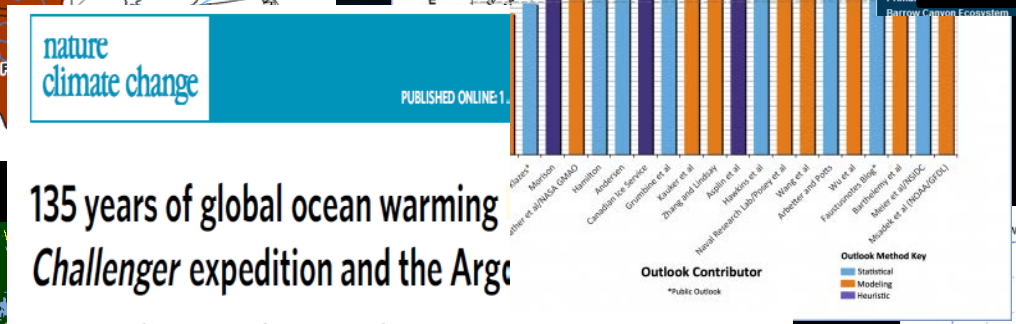
The SoCal Temperature Index, temperature anomaly at 50 m on line 90, averaged over the inshore 200 km, and filtered with a 3-month running mean (red), and the Oceanic Niño Index, Niño 3.4 filtered with a 3-month running mean (black). Note the strong correlation until the anomalous warming starting near the beginning of 2014. (Dan Rudnick, SIO)

Weather, Marine, Arctic, and Climate Research, Products, and Services



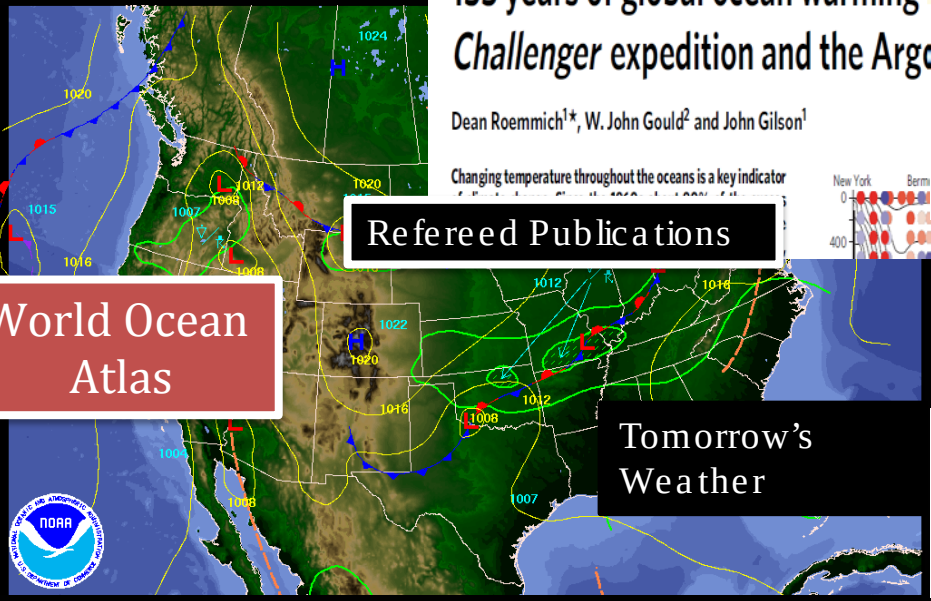


Climate Assessments

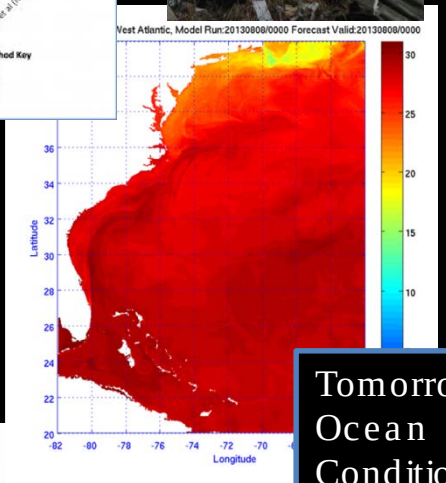


Refereed Publications

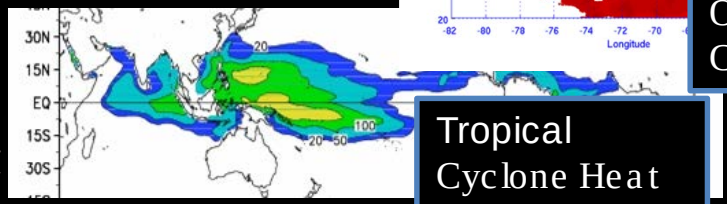
World Ocean Atlas



Tomorrow's Weather



Tomorrow's Ocean Conditions

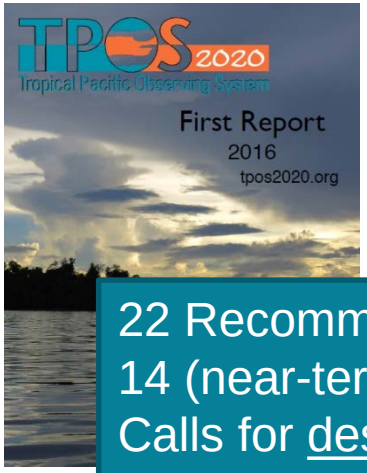


Tropical Cyclone Heat Potential

Example of the FOO in action

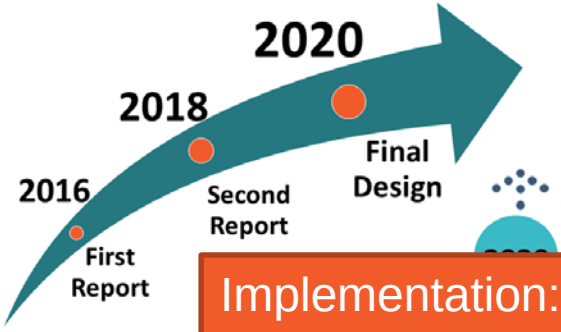
Tropical Pacific Observing System-2020 Project

- 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

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



Implementation:
- In-situ and satellite
- Observers and modelers
- Operational and research

www.tpos2020.org

Summary

- 20 years of effort have lead to an initial sustained global ocean observing system for the upper ocean
- New technologies (platforms, sensors, data comm, etc) are rapidly expanding capabilities and efficiencies
- Observational-based products and predictions are extremely helpful in engaging users/stakeholders
  - How do we encourage development of additional targeted products?
- Projects like TPOS-2020 are bringing together observationalists, researchers, modelers, stakeholders, and othes to deliver improved information

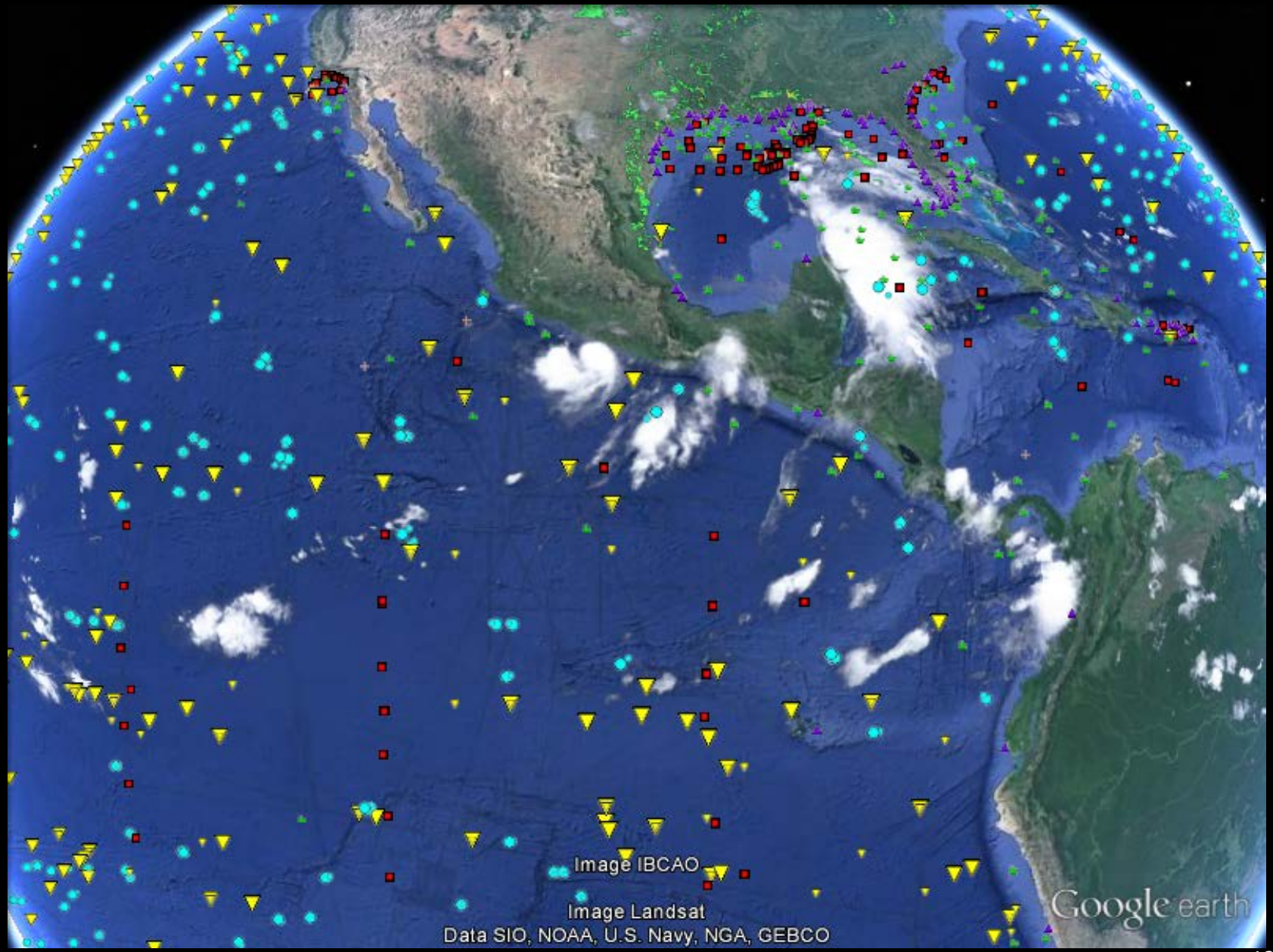
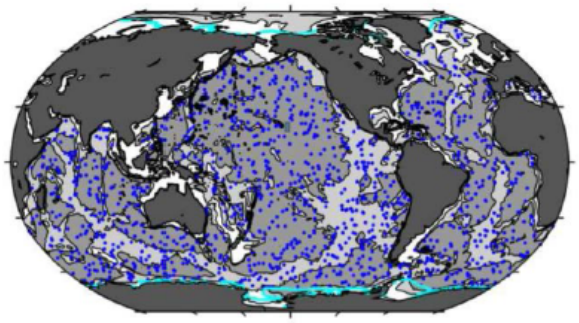


Image IBCAO
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth

Deep Argo

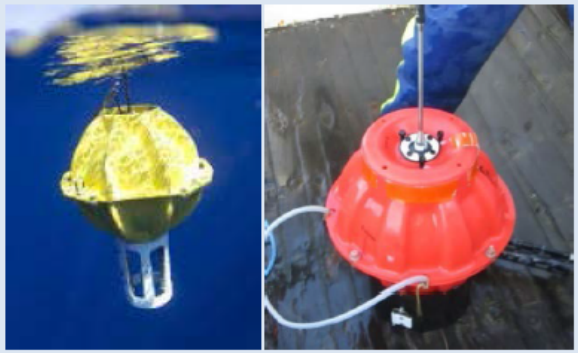


Left: Strawplan for 1228 Deep Argo floats at nominal 5° x 5° spacing (Johnson et al, JAOT, 2015) over the global ocean where depth exceeds 2000 m. (Based on decorrelation statistics from GO-SHIP decadal repeat hydrography.

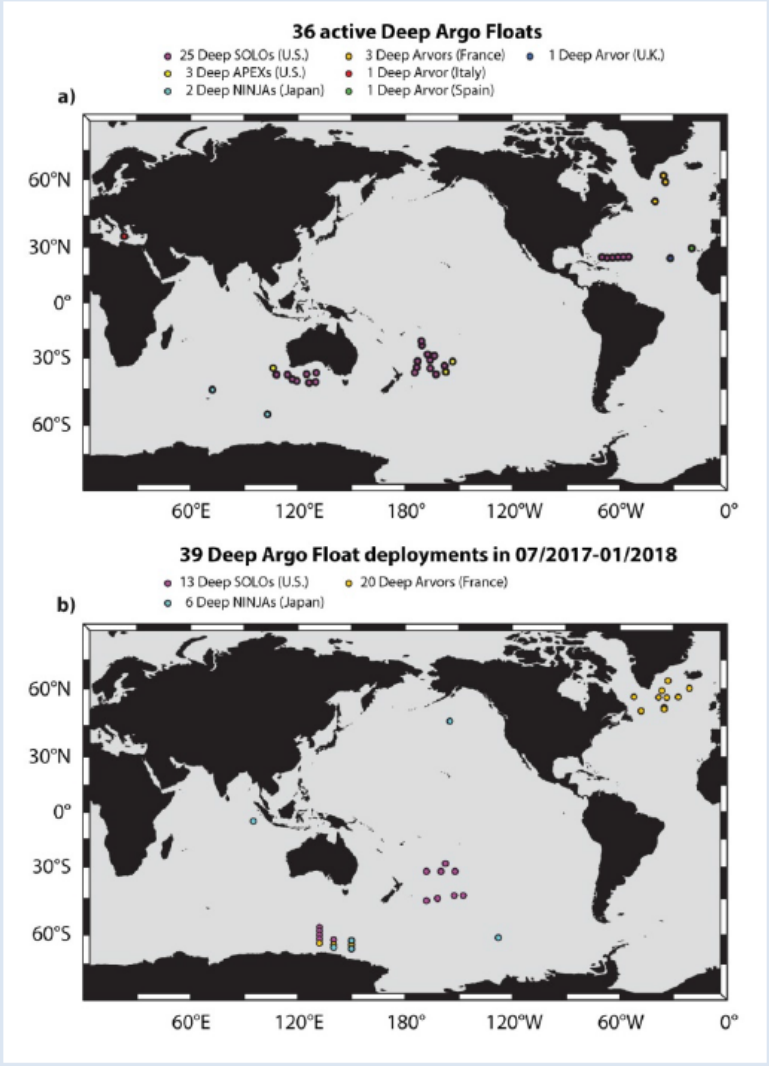
Status

- Four Deep Argo float models have been developed and tested.
- A new CTD sensor (SBE-61) is under parallel development with improved stability and accuracy.
- Coordinated regional Deep Argo pilots are being deployed in the N. and S. Atlantic, S. Pacific, and Southern Ocean

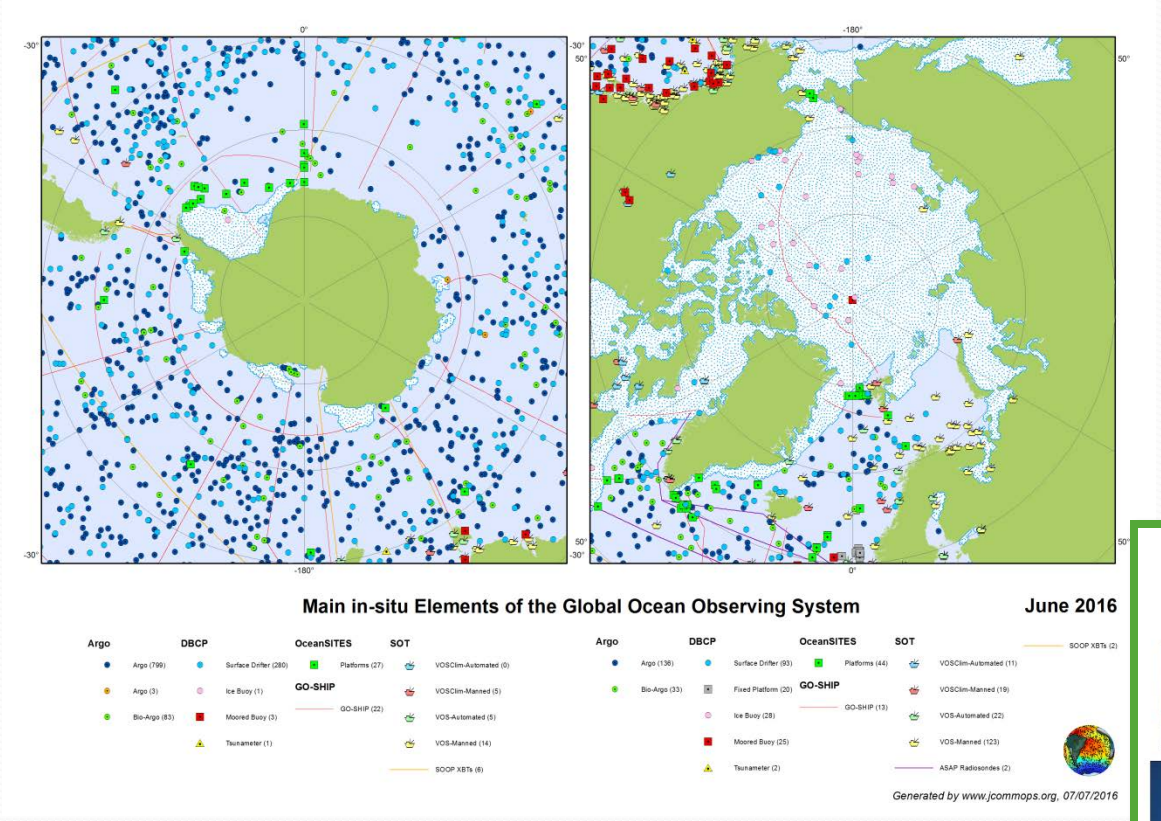
Deep NINJA (left) and Deep PROVOR (below) 4000 m floats.



Deep APEX (above left) and Deep SOLO (above right) 6000 m floats.



Arctic Observing Network (AON)



International Arctic Systems for Observing the Atmosphere (IASOA)

Establishing US Arctic Observing Network (AON) Office