Observations 1: Overview
The Global Ocean Observing System

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NOAA Pacific Marine Environmental Laboratory

ECCO Summer School 2019 * Friday Harbor Laboratories

What are Observations used for?

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- **Observations for mapping fields, initiating or nudging models**
- **Observations for validation**
- **Observations for improving model physics, parameterizations and understanding of processes**

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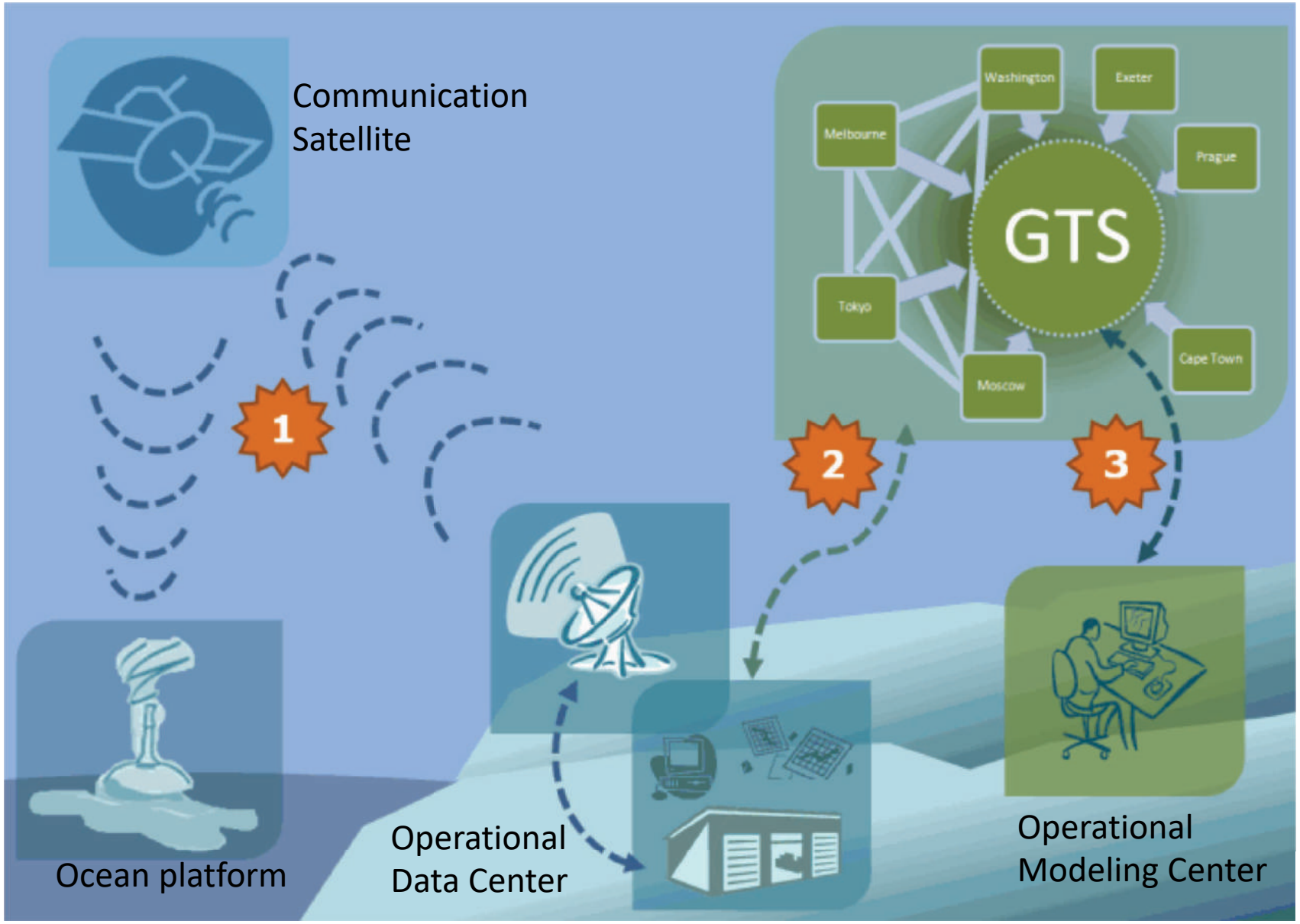
  - Timely (available through the Global Telecommunication System (GTS) in near realtime)
  - Geographically distributed in coherent array, with known uncertainty and quality

What is the Global Telecommunication System (GTS)?



The 3 parts of the WMO telecommunications systems used for sharing real time ocean and weather data:

1. From ocean platform (e.g. buoy, drifter, float) to Satellite (e.g. Iridium), to National Data Centers.
2. From Data Centers to the GTS of WMO (WMO #, GTS bulletin format,…)
3. From the GTS to a downlink node and the data user (e.g. modeling center).

from www.jcommops.org/dbcp/platforms/telecomms.html

WORLD METEOROLOGICAL ORGANIZATION

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How many errors can I have?

- Mistakes and Miscalculations
- Mean bias errors & Random uncertainty due to noise
- Systematic biases due to sampling issues
- Systematic biases due to field errors
- Systematic biases dues to calibration errors, model physics errors, etc.

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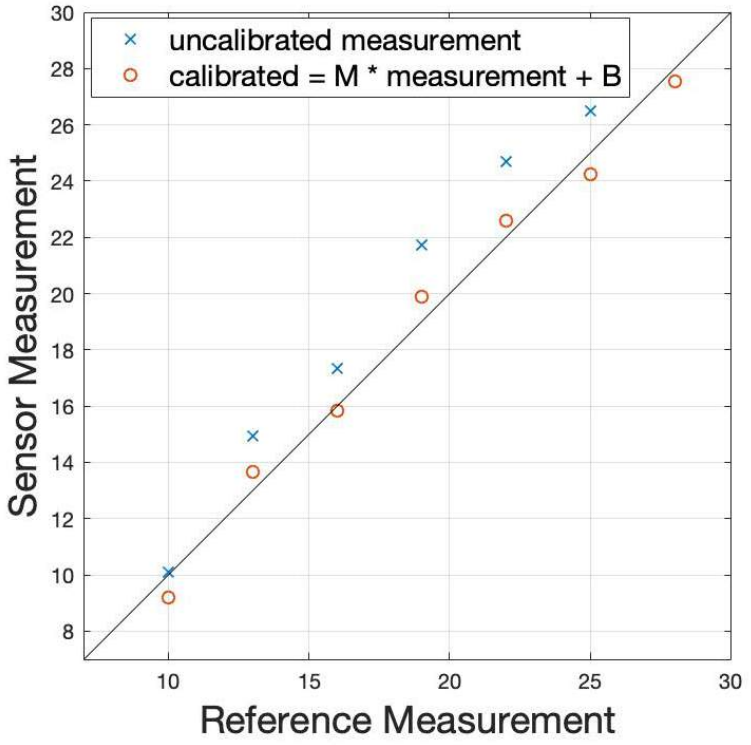

Bias error and scaling error can be minimized by calibrating (i.e. regressing) against a reference.

Sensor will still have an error due to random uncertainty.

Standard Deviation = $\langle (y - y_{ref})^2 \rangle^{0.5}$

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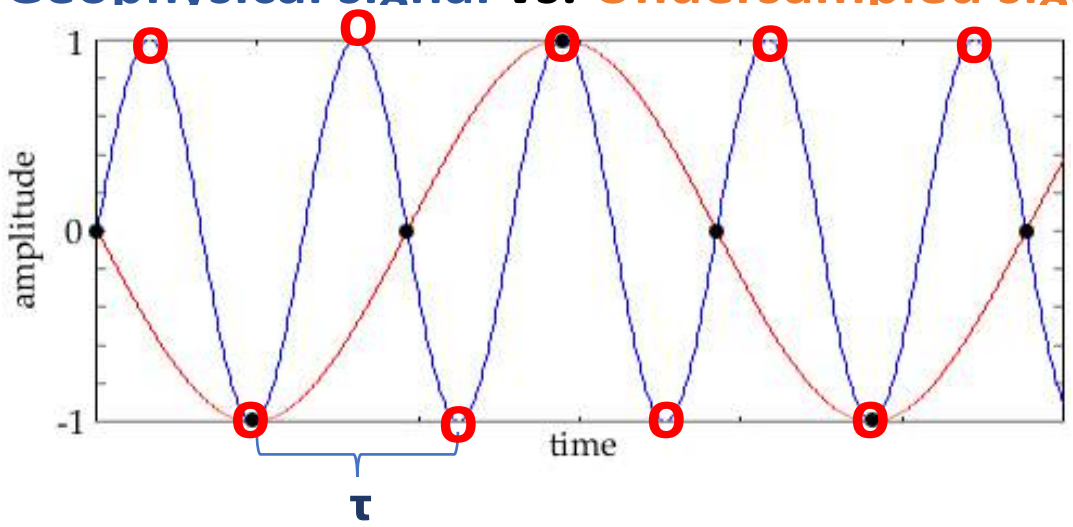
Geophysical signal vs. Undersampled signal

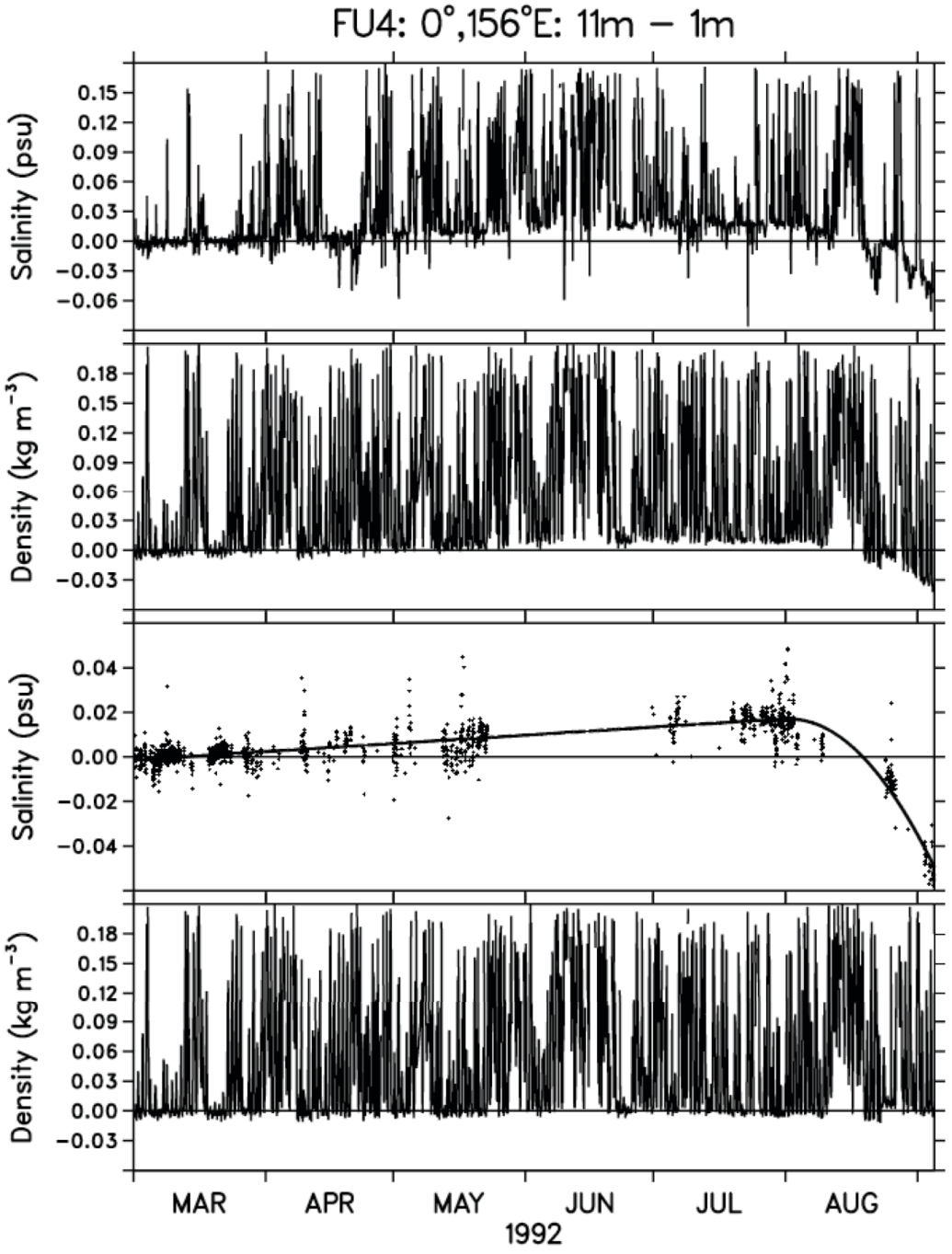


o samples at the Nyquist Frequency

If a signal has a frequency f_0 (= $1/\tau$), then must sample at a rate more frequent than $2f_0$ = "Nyquist Frequency". Otherwise, will introduce lower-frequency aliasing.

How many errors can I have?

- Mistakes and Miscalculations
- Mean bias errors & Random uncertainty due to noise
- Systematic biases due to sampling issues
- Systematic biases due to field errors (e.g. sensor drift, biofouling, bird poop, radiative heating of sensor, clock errors, …). Quality Control: Flag if not in expected range. Some biases can be corrected in postprocessing.



Salinity is subject to both a drift due to "scouring" of conductivity cell (will make salinity appear to be too fresh) and biofouling (will make salinity appear to be too salty).

Assume these effects are reduced as go deeper in water column. **Good Assumption.**

Assume that any apparent longterm density "inversion" is due to biofouling of shallower sensor. **Excellent Assumption! Gravity works.**

Assume that any apparent nighttime stratification in the mixed layer is due to scouring of the shallow sensor. **Good Assumption is know how deep mixed layer is.**

Remove piece-wise fit to salinity differences.

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Global Ocean Observing System (GOOS)

Sponsored by:

Overlapping global satellite and in situ networks

vs.

A set of regional integrated observing systems that are each “Fit for Purpose”

Use http://www.jcommops.org/ to help explore the GOOS

JCOMMOPS = WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology in situ Observations Programme Support Centre.

http://www.jcommops.org/

Quick search | Select | Submit | Charts | Maps | Metrics | Log In

Check out the brand-new menu with improved search engine.

These shortcuts have been redesigned too. A new section for charts enters the stage.

Want to share something? Get a permalink to this dashboard here.

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Maps menu has two choices: “static” gives maps for different networks “interactive” allows you to click on the dot on the map to get more info

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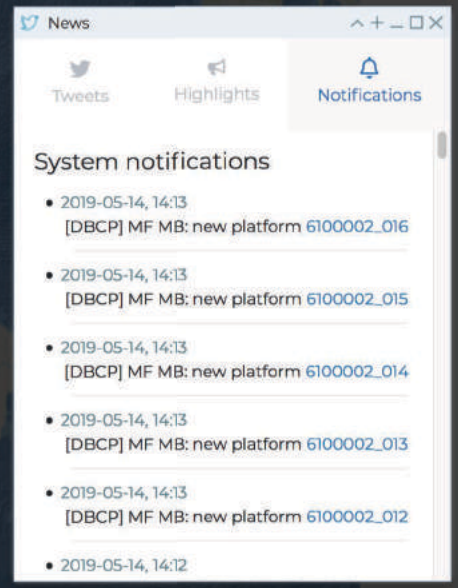

Click anywhere on the map to activate it

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Esri, GEBCO, DeLorme, NaturalVue | JCOMMOPS

Powered by Esri

https://www.jcommops.org

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In pulldown menu Select:
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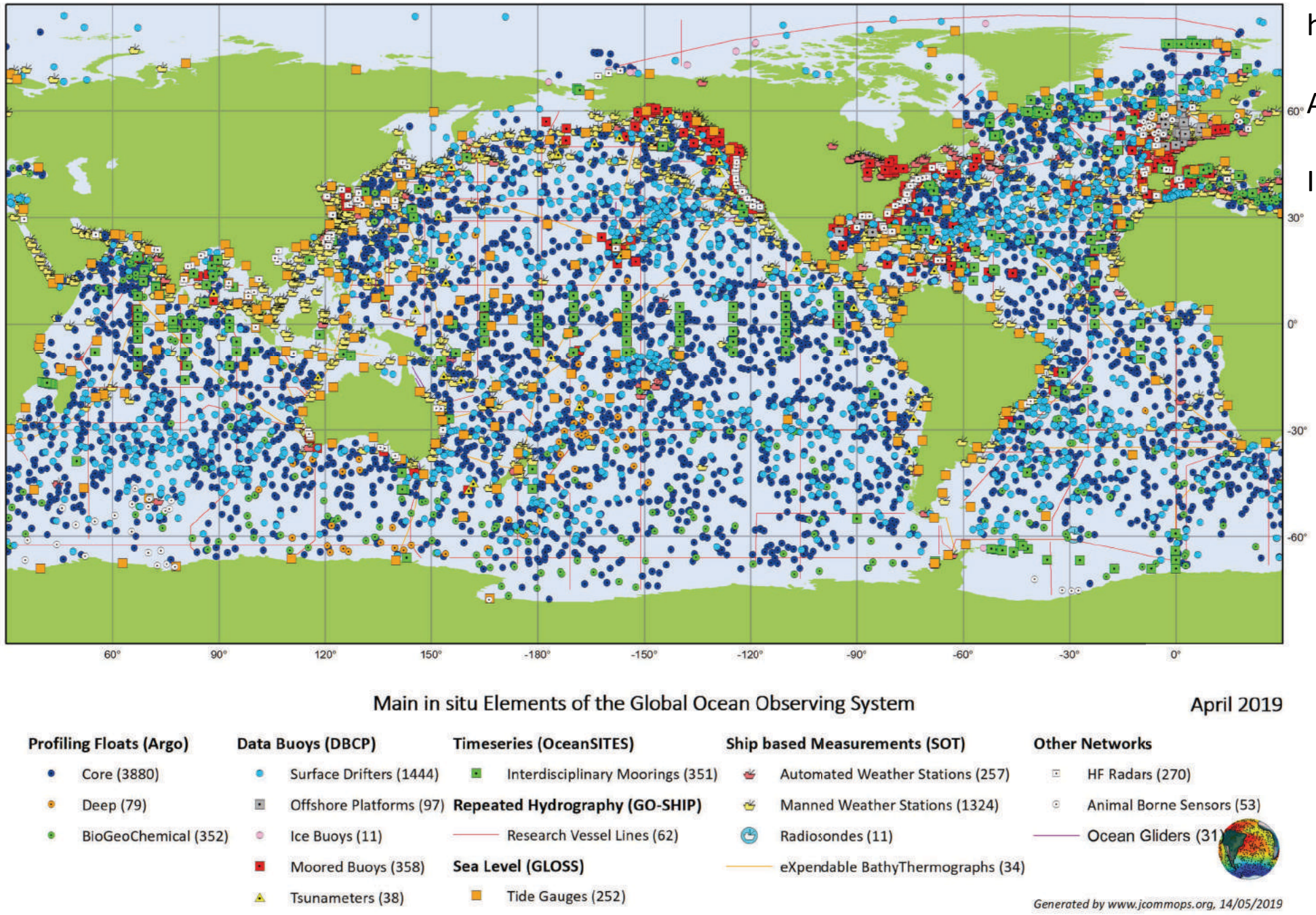

Main in situ Elements of the Global Ocean Observing System

April 2019

Profiling Floats (Argo)
- Core (3880)
- Deep (79)
- BioGeoChemical (352)

Data Buoys (DBCP)
- Surface Drifters (1444)
- Offshore Platforms (97)
- Ice Buoys (11)
- Moored Buoys (358)
- Tsunameters (38)

Timeseries (OceanSITES)
- Interdisciplinary Moorings (351)

Repeated Hydrography (GO-SHIP)
- Research Vessel Lines (62)

Sea Level (GLOSS)
- Tide Gauges (252)

Ship based Measurements (SOT)
- Automated Weather Stations (257)
- Manned Weather Stations (1324)
- Radiosondes (11)
- eXpendable BathyThermographs (34)

Other Networks
- HF Radars (270)
- Animal Borne Sensors (53)
- Ocean Gliders (31)

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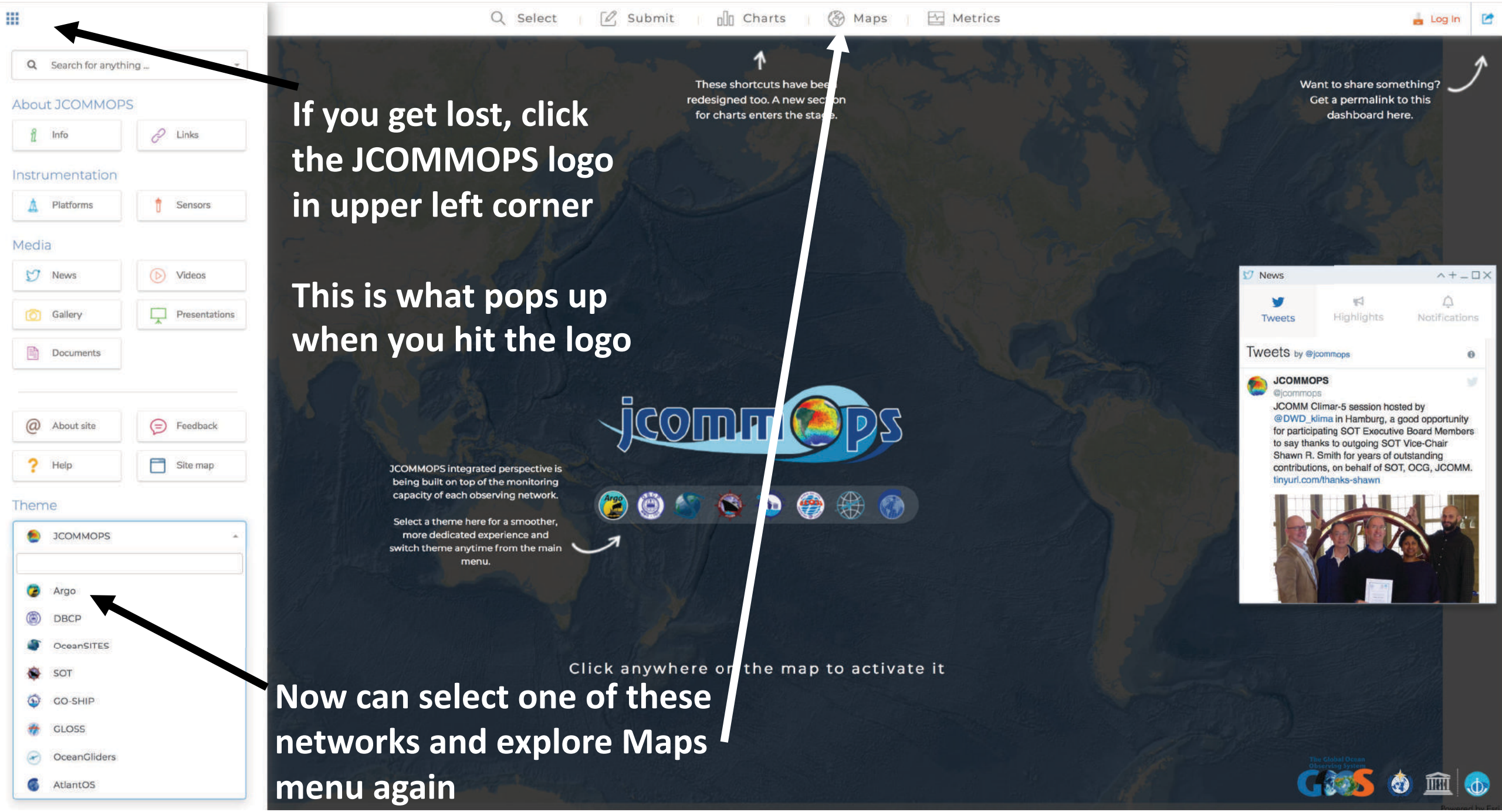
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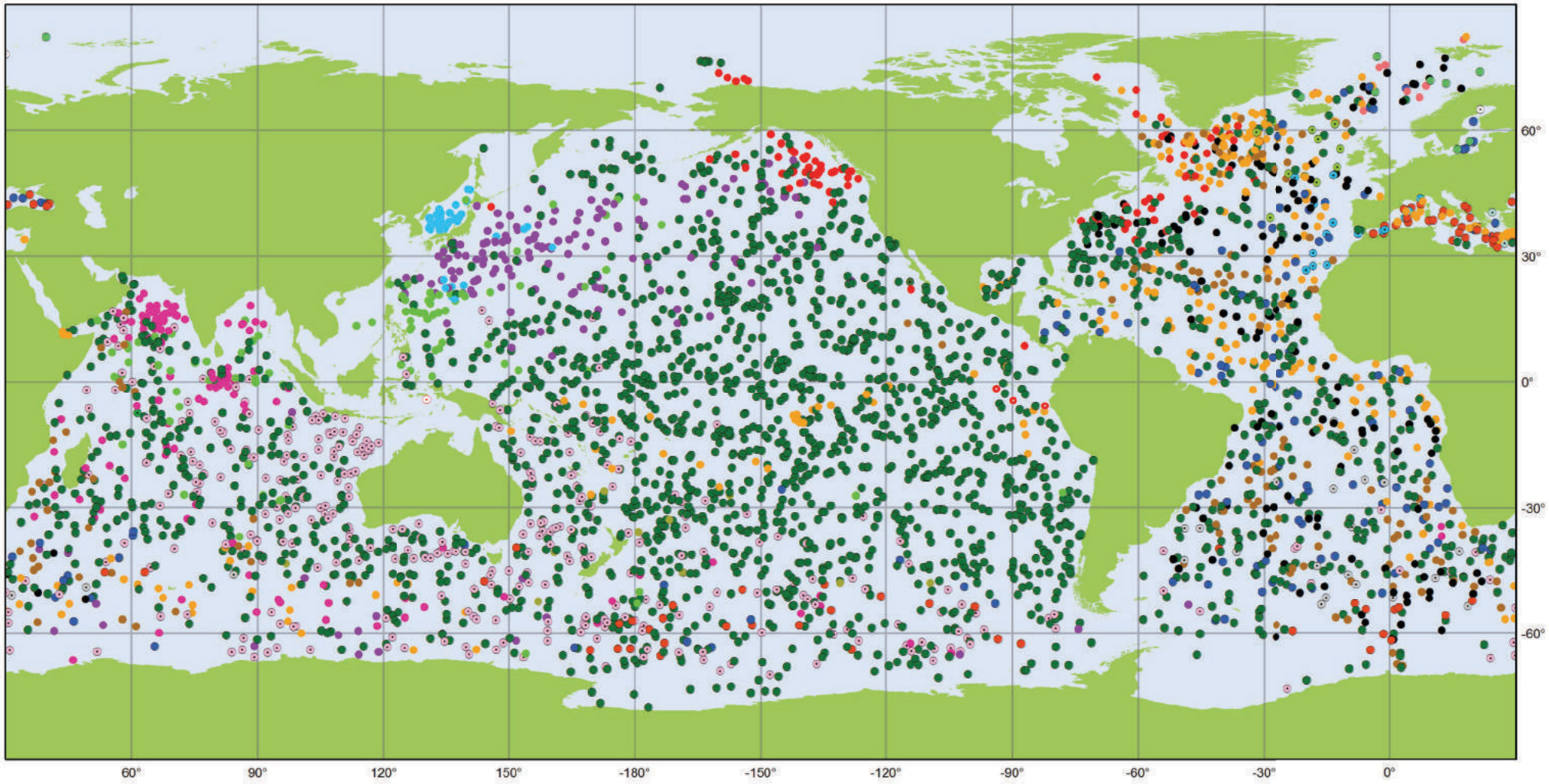

Argo

National contributions - 3884 Operational Floats

April 2019

Latest location of operational floats (data distributed within the last 30 days)

- AUSTRALIA (353)
- BRAZIL (1)
- CANADA (92)
- CHINA (93)
- EUROPE (125)
- FINLAND (3)
- FRANCE (284)
- GERMANY (150)
- GREECE (3)
- INDIA (121)
- INDONESIA (1)
- IRELAND (11)
- ITALY (76)
- JAPAN (157)
- KENYA (1)
- MEXICO (1)
- NETHERLANDS (23)
- NEW ZEALAND (11)
- NORWAY (9)
- PERU (3)
- POLAND (9)
- KOREA, REPUBLIC OF (42)
- SPAIN (16)
- UK (142)
- USA (2157)

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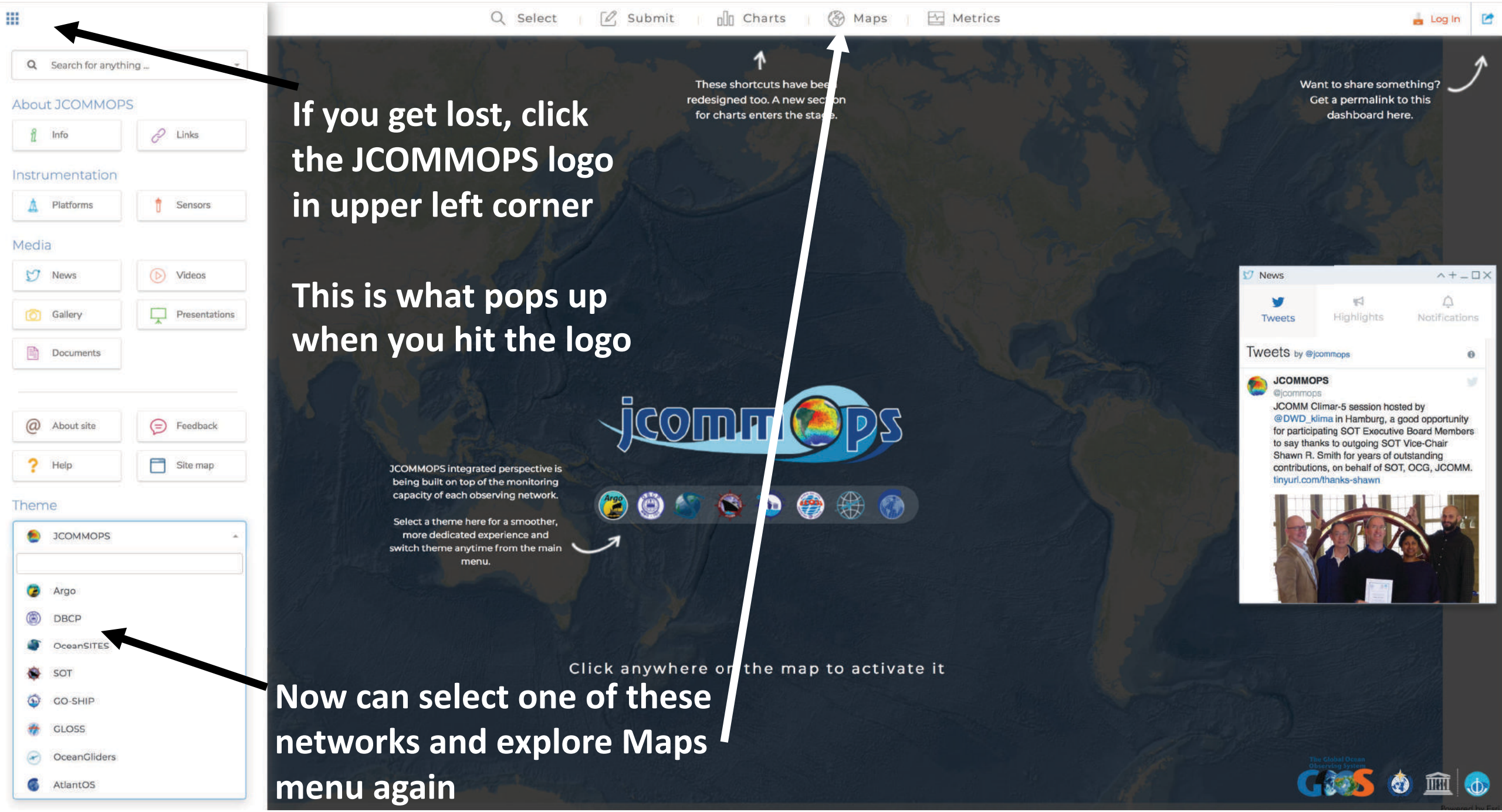
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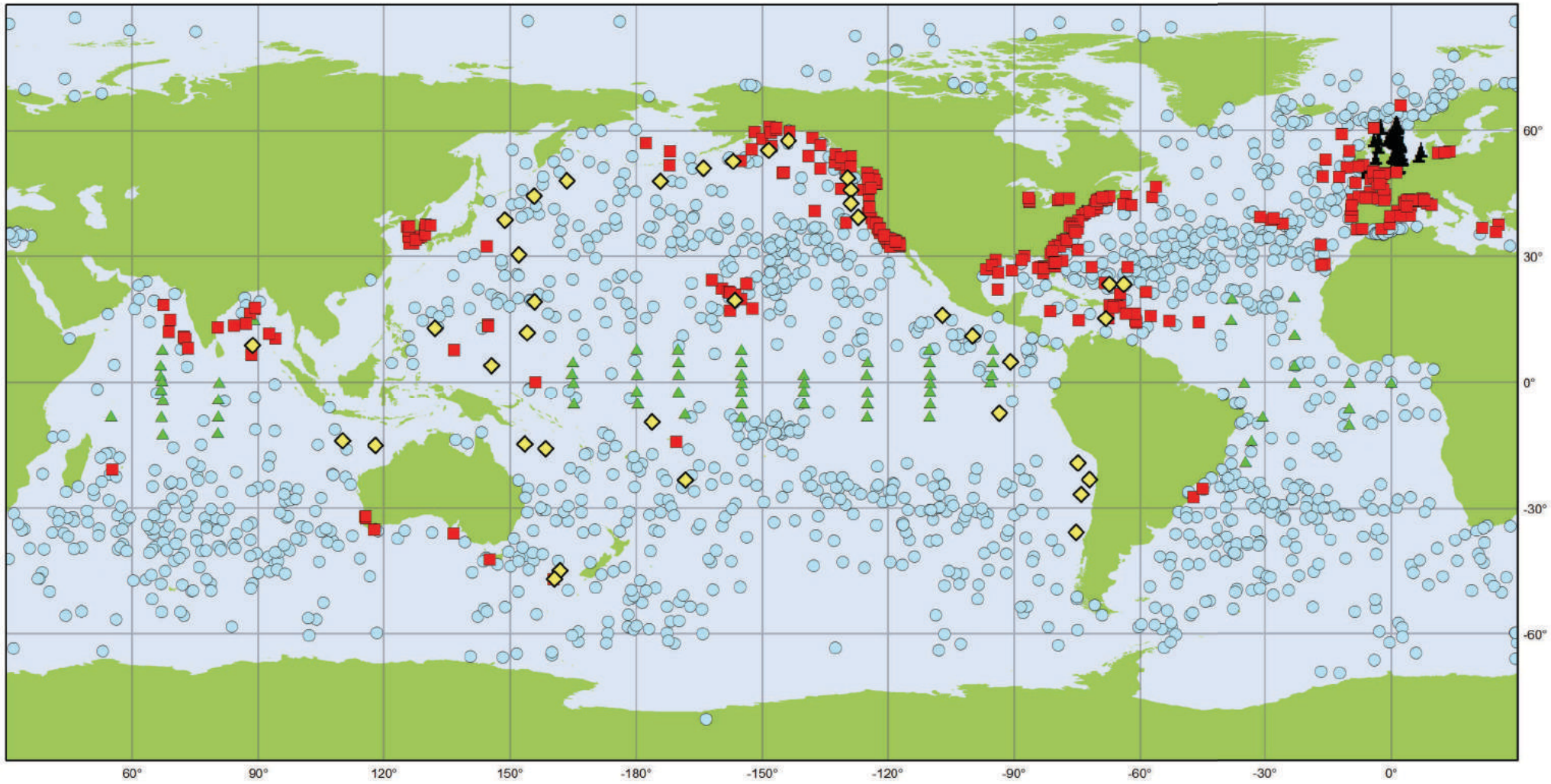

Data Buoy Cooperation Panel

Operational Platforms

April 2019

Platforms operational during the month. GTS data as received by Meteo France.

- Tsunameters (38)
- Coastal/National MB (297)
- Tropical MB (68)
- Fixed Platforms (93)
- Drifting Buoys (1 505)

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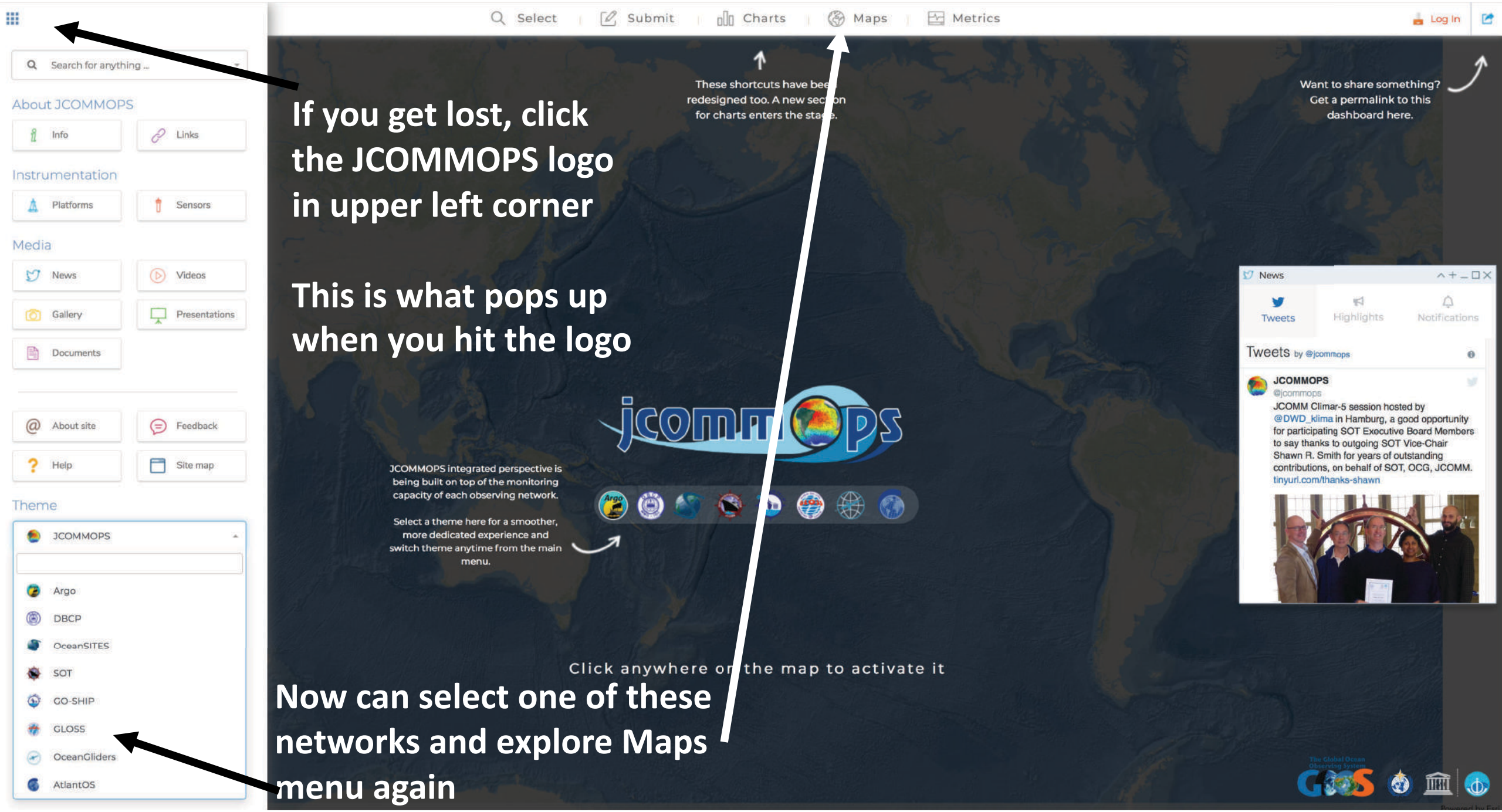
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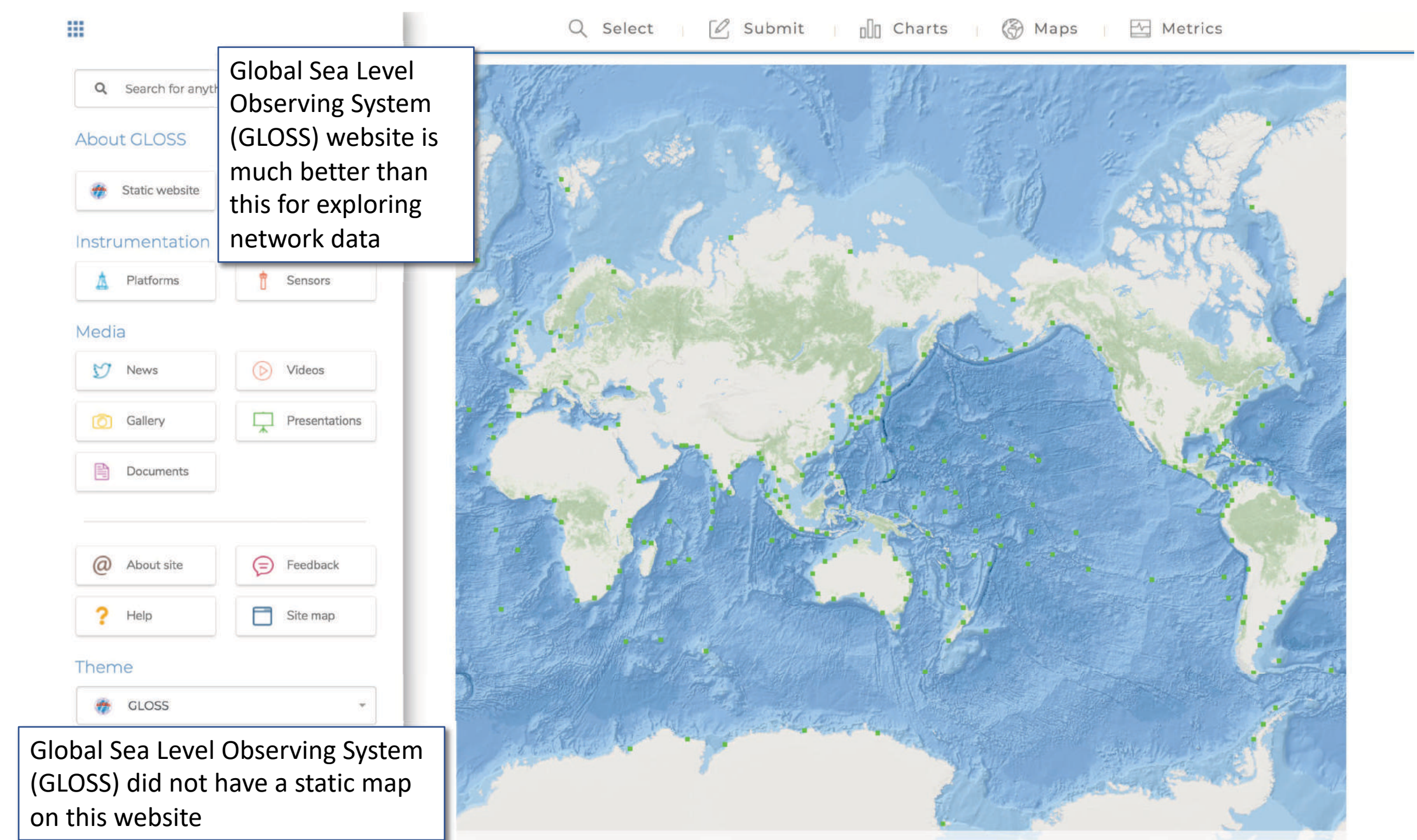
Global Sea Level Observing System (GLOSS) website is much better than this for exploring network data



Global Sea Level Observing System (GLOSS) did not have a static map on this website

https://www.gloss-sealevel.org/

Global Sea Level Observing System

Home About Data Library Station Handbook

The Global Sea Level Observing System (GLOSS), a component of the Global Ocean Observing System (GOOS), is establishing a well-designed, high-quality sea level observing network to support a broad research and operational user base.

Sea level data are vital for

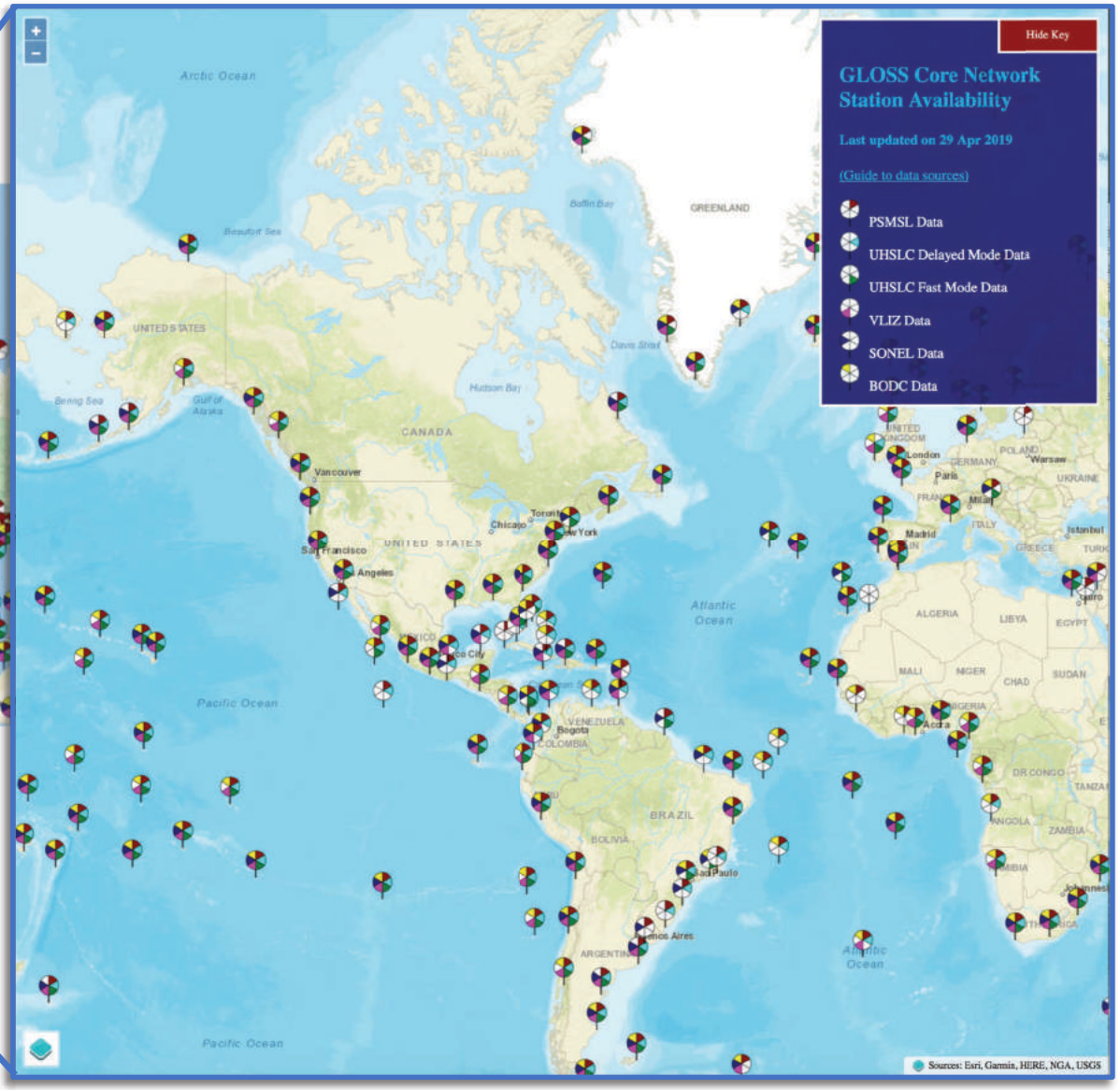
Research into sea level change and ocean circulation

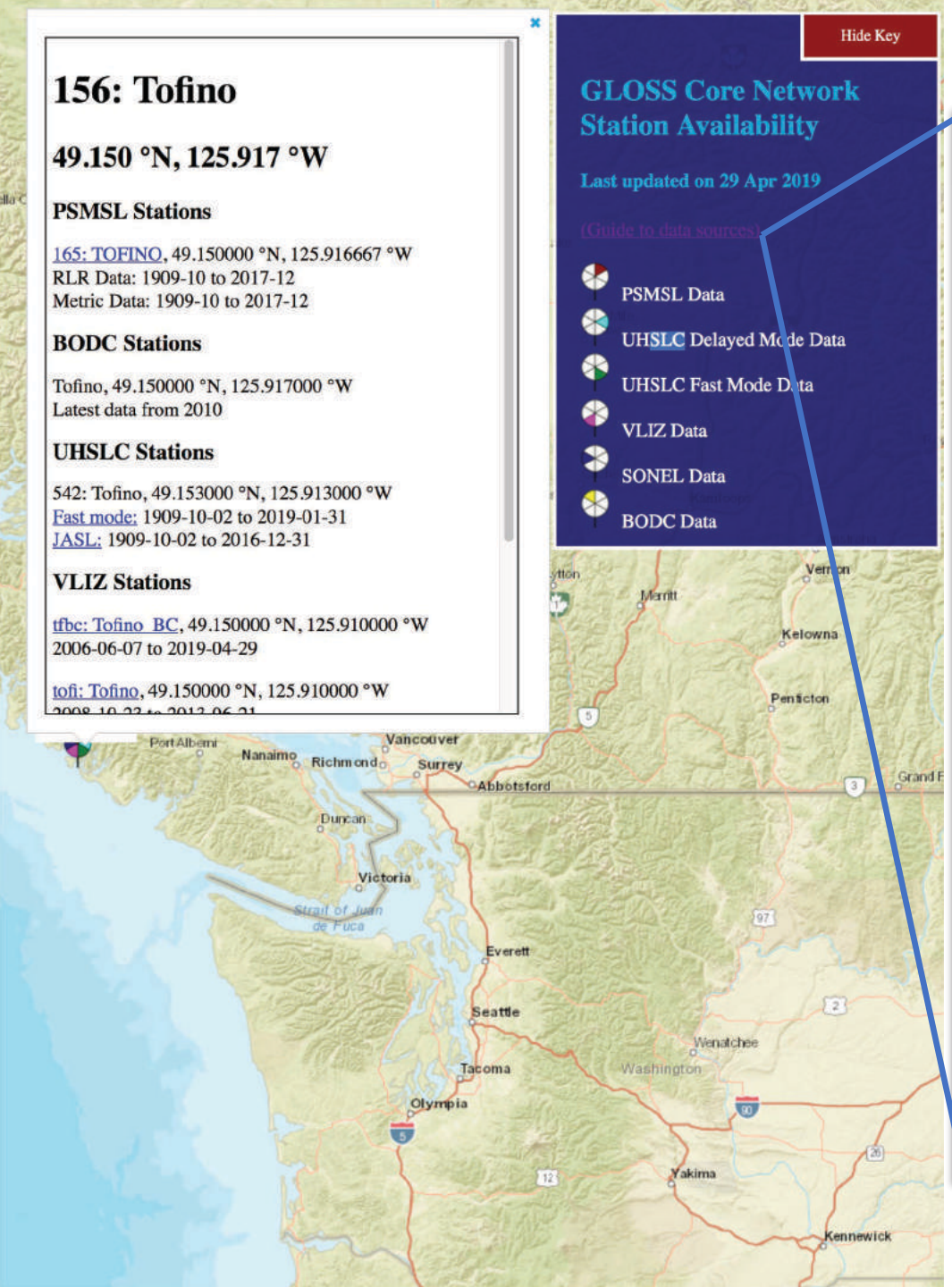
Coastal protection during events such as storm surges

Providing flood warning and monitoring tsunamis

Tide tables for port operations, fishermen, and recreation

Defining datums for national or state boundaries





PSMSL Permanent Service for Mean Sea Level

About Us | Data | Products | GLOSS | Training | Links

You are here: home > data > obtaining > stations >

Data

- Obtaining
- Supplying
- High-Frequency
- Bottom Pressure Records
- Other Long Records
- GLOSS/ODINAFRICA Calibration Data

Guide to Other Data Sources

We have provided links to other sources of data that may be helpful. The criterion for choosing these links is that they are within 10 kilometres of our listed location.

The links are to a variety of different data types. Thus, one should be aware of differences in the data from these sources prior to using them. An extended description of the different data types can be found in the Global Sea Level Observing System (GLOSS) Implementation Plan 2012, Chapter 6.2.

- **GNSS Stations from SONEL:** These links go to GNSS station pages at Système d'Observation du Niveau des Eaux Littorales (SONEL). The information can be useful to assess the vertical land motion at or near the tide gauge. In addition, if the GNSS receiver is co-located, the data can be used to find the time-mean geocentric height.
- **Real Time Stations from VLIZ:** These links are to the Sea Level Station Monitoring Facility hosted by Flanders Marine Institute (VLIZ). This is a real time sea level site that is useful for determining the current status of a station. While data is archived at the facility, it is not quality controlled. Thus, in general it should not be used in scientific analysis.
- **Fast Delivery Data from UHSLC:** The GLOSS Fast Delivery Center is operated by the University of Hawaii Sea Level Center (UHSLC), which has the responsibility for assembling and distributing a version of GLOSS sea level data sets that has undergone preliminary quality control by the data originators. "Fast delivery" implies posting of the data within 4-6 weeks. Note that this service includes some stations that are not part of the GLOSS network.
- **Research Quality Data from UHSLC/NOAA:** The Joint Archive for Sea Level (JASL) acquires hourly datasets that have received a final quality assessment from the data originators, and provides an independent check of the data. JASL then assembles a single hourly time series for each station, or a series of sub-records if datum changes occur over time. The JASL dataset therefore represents a "data product", as changes to the data are implemented by JASL analysts (e.g., level adjustments, timing shifts, outlier removal). These changes are documented in the metadata information. The data product is archived at UHSLC with the support of National Oceanic and Atmospheric Administration (NOAA) Ocean Data Center (NODC).

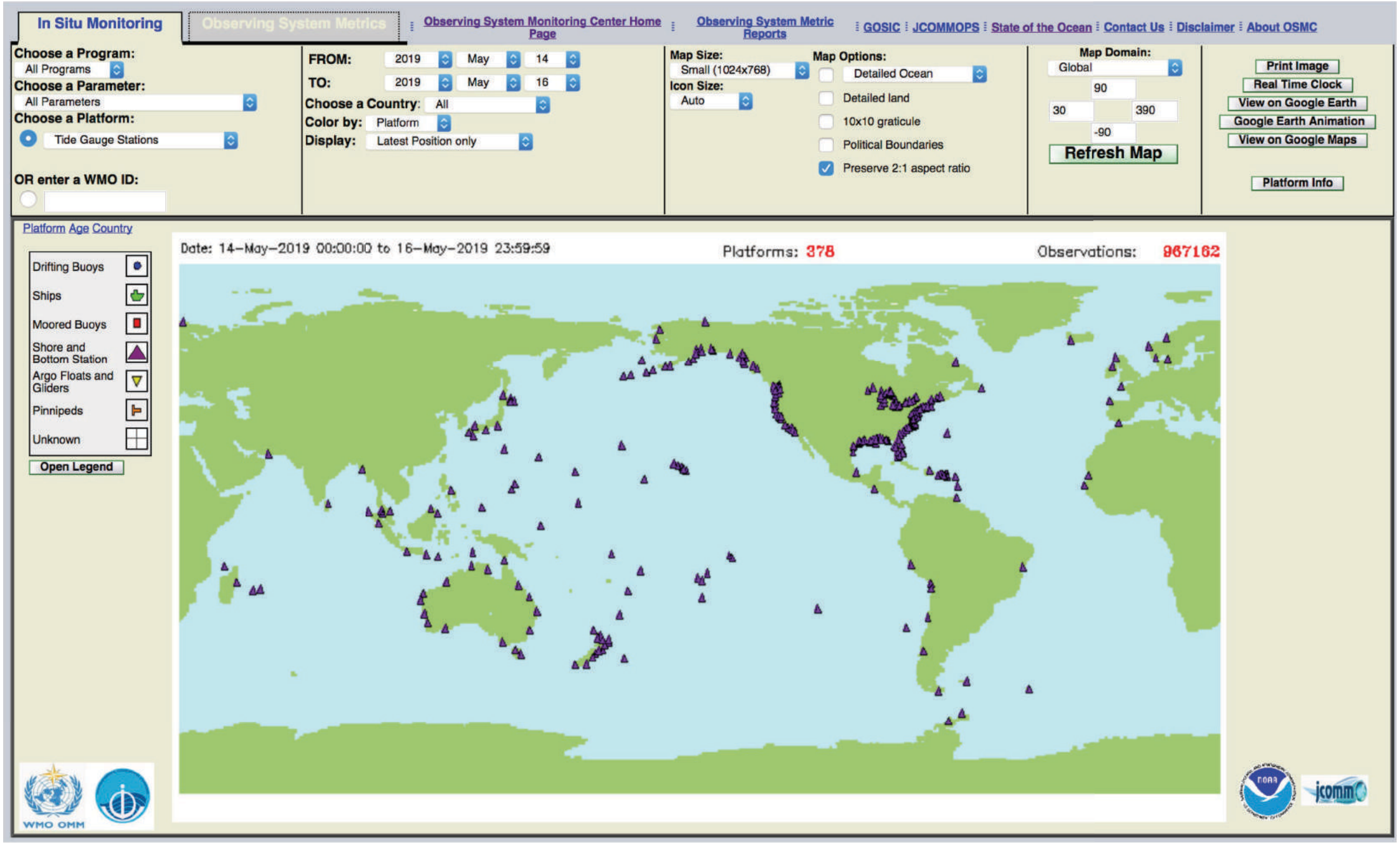
IOC | ICSU WORLD DATA SYSTEM | IAG GGOS | IAG

National Oceanography Centre — NATURAL ENVIRONMENT RESEARCH COUNCIL

BODC British Oceanographic Data Centre — NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT

Another way to see what is on GTS: http://osmc.noaa.gov/Monitor/OSMC/OSMC.html



https://tidesandcurrents.noaa.gov/sltrends/

For Friday Harbor, WA, Check out: https://tidesandcurrents.noaa.gov/map/index.html?id=9449880

TIDES & CURRENTS

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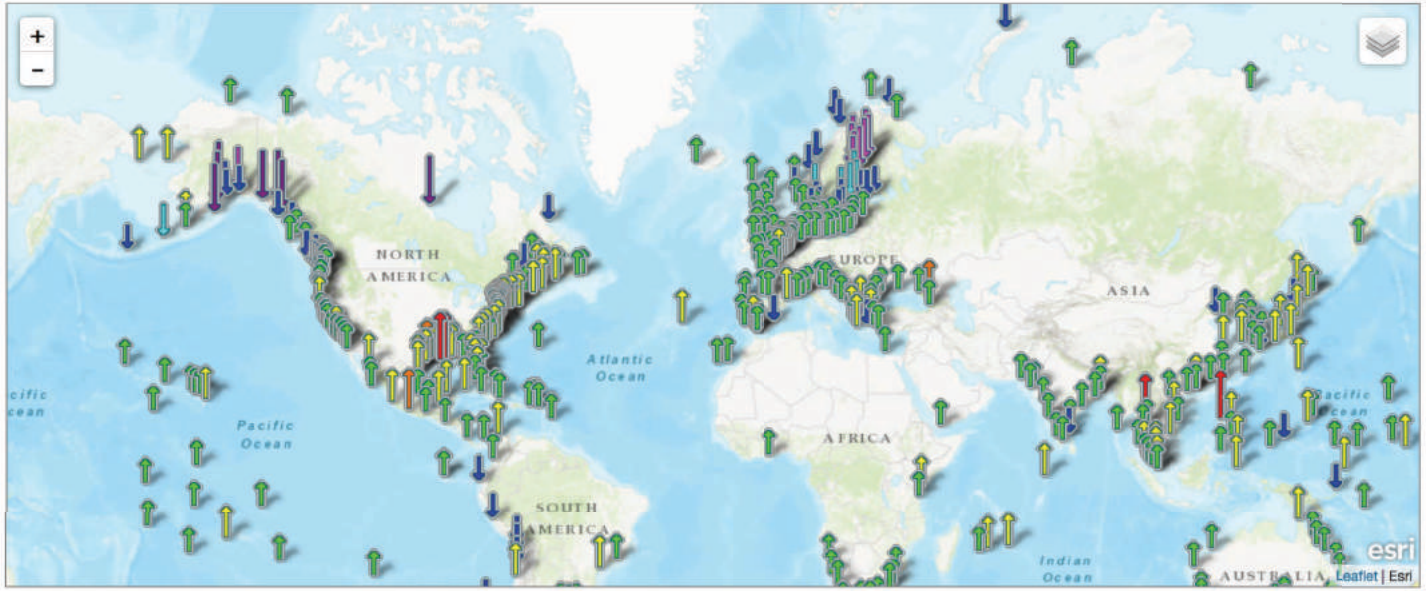
Sea Level Trends

The sea level trends measured by tide gauges that are presented here are local relative sea level (RSL) trends as opposed to the global sea level trend. Tide gauge measurements are made with respect to a local fixed reference on land. RSL is a combination of the sea level rise and the local vertical land motion. The global sea level trend has been recorded by satellite altimeters since 1992 and the latest global trend can be obtained from NOAA's Laboratory for Satellite Altimetry, with maps of the regional variation in the trend. The University of Colorado's Sea Level Research Group compares global sea level rates calculated by different research organizations and discusses some of the issues involved.

East Coast | West Coast | Gulf Coast | Alaska | Hawaii | Global

View in Google Earth



The map above illustrates relative sea level trends , with arrows representing the direction and magnitude of change. Click on an arrow to access additional information about that station.

Relative Sea Level Trends
mm/yr (feet/century)

Above 9 (Above 3)	6 to 9 (2 to 3)	3 to 6 (1 to 2)	>0 to 3 (0 to 1)	-3 to 0 (-1 to 0)	-6 to -3 (-2 to -1)	-9 to -6 (-3 to -2)	Below -9 (Below -3)

The Center for Operational Oceanographic Products and Services has been measuring sea level for over 150 years, with tide stations of the National Water Level Observation Network operating on all U.S. coasts. Changes in RSL, either a rise or fall, have been computed at 142 long-term water level stations using a minimum span of 30 years of observations at each location. These measurements have been averaged by month which removes the effect of higher frequency phenomena in order to compute an accurate linear sea level trend. The trend analysis has also been extended to 240 global tide stations using data from the Permanent Service for Mean Sea Level (PSMSL). This work is funded in partnership with the NOAA OAR Climate Observation Division.

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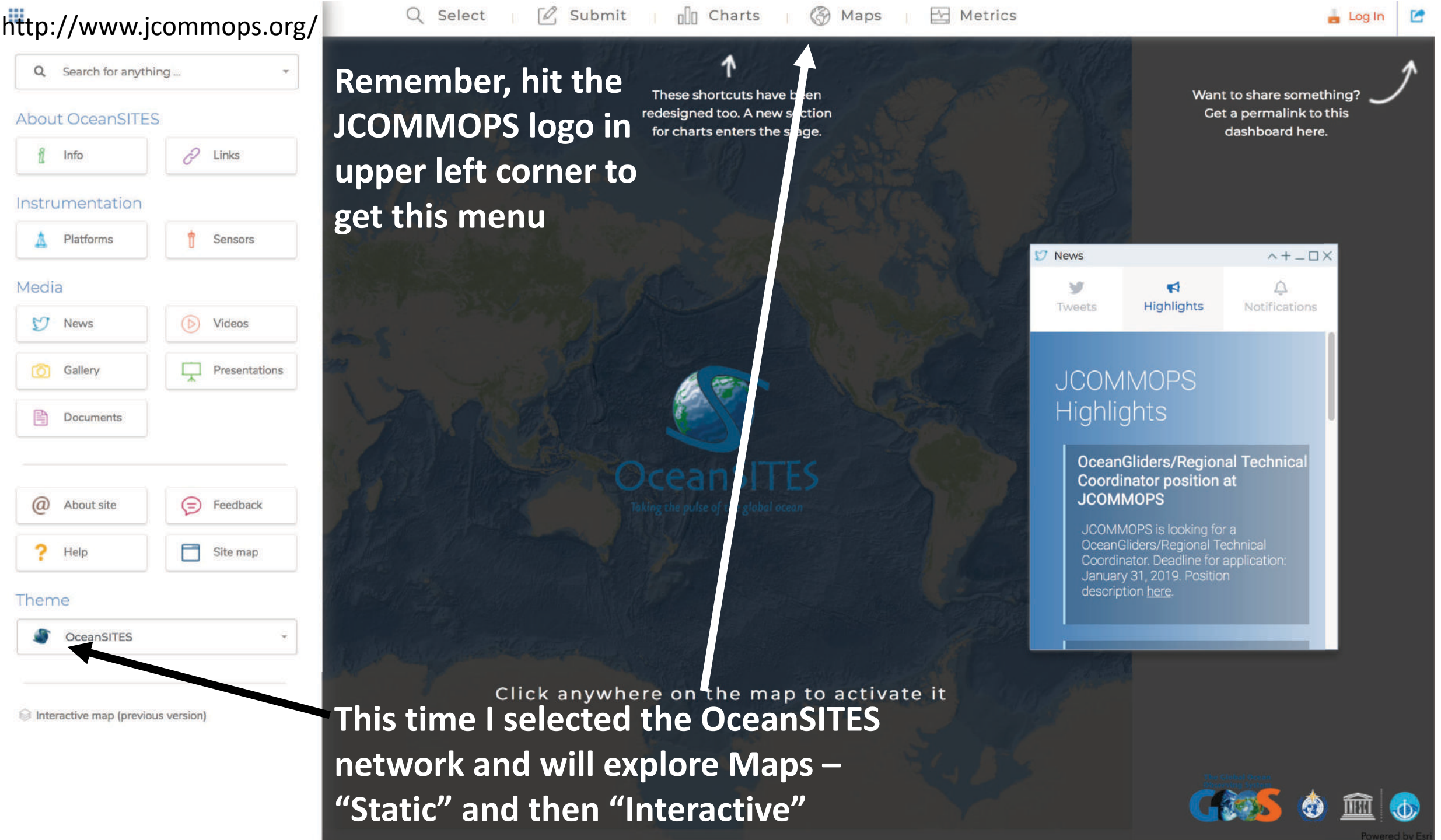

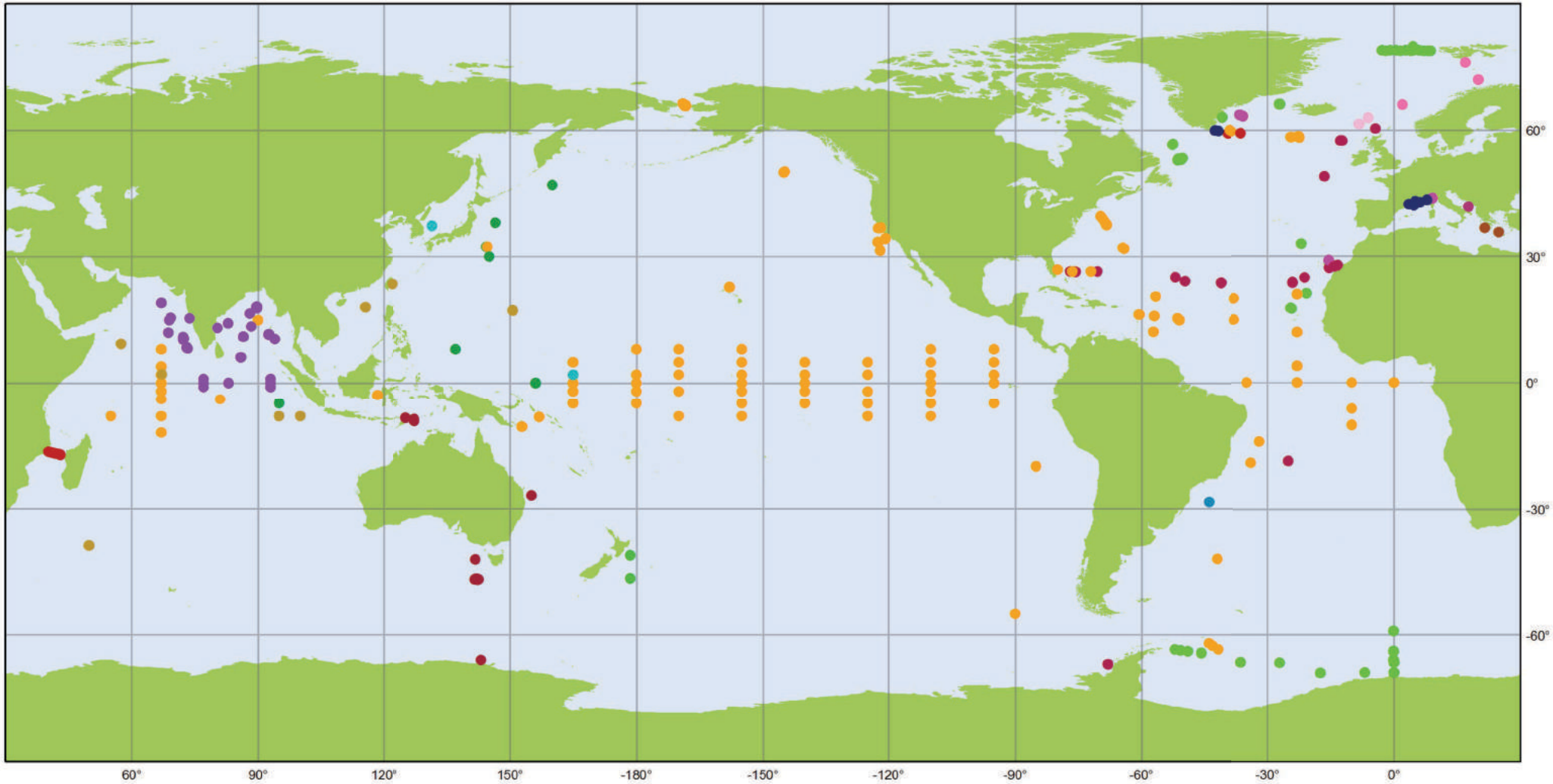

OceanSITES

Platforms by country

April 2019

Information received from the platform operators

- AUSTRALIA (11)
- BRAZIL (1)
- CANADA (1)
- CHINA (8)
- DENMARK (4)
- EUROPE (4)
- FRANCE (10)
- GERMANY (56)
- GREECE (3)
- INDIA (37)
- ITALY (1)
- JAPAN (8)
- KOREA, REPUBLIC OF (3)
- NETHERLANDS (9)
- NEW ZEALAND (2)
- NORWAY (3)
- UK (46)
- USA (138)

OceanSITES
Taking the pulse of the global ocean

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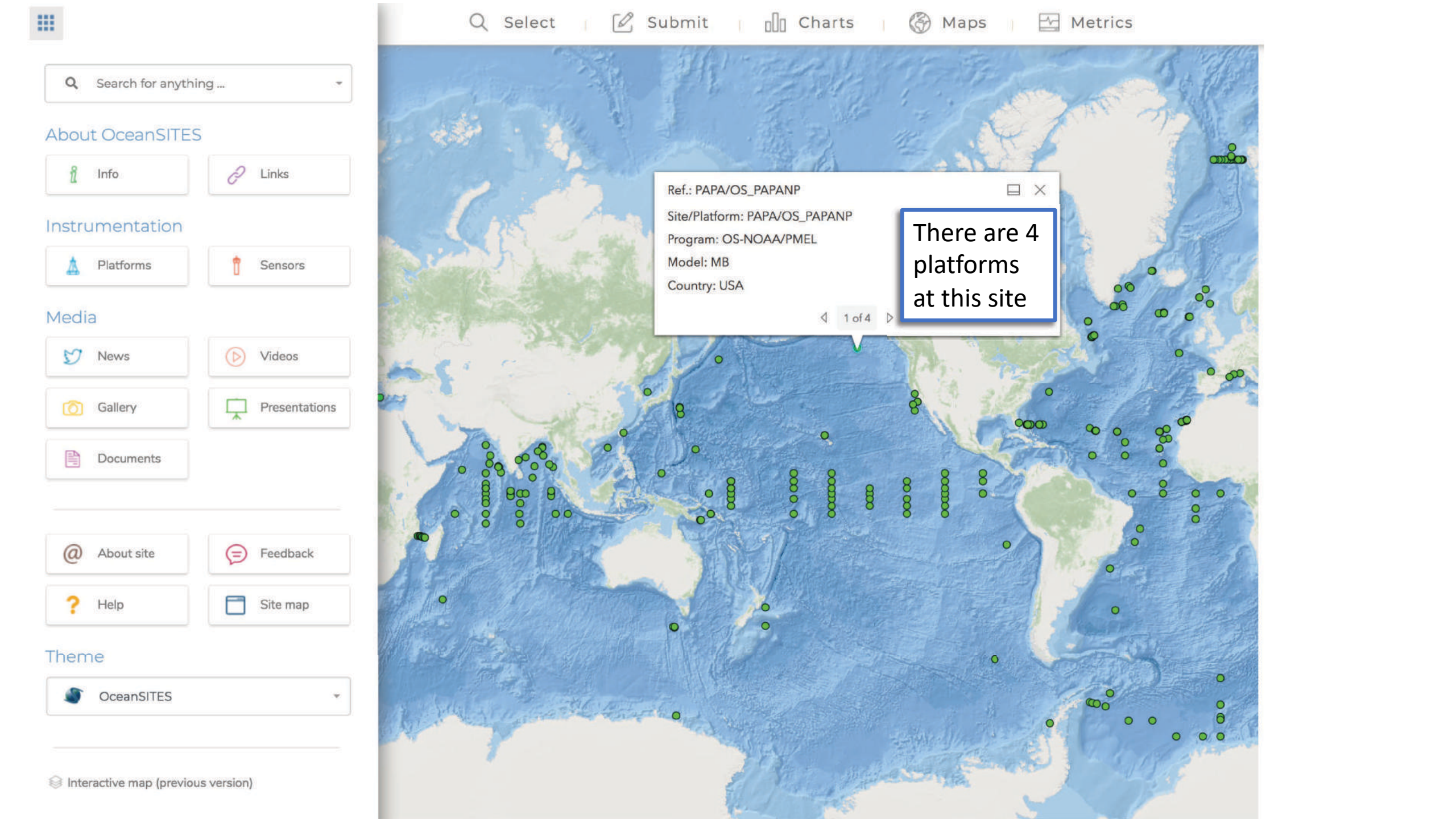
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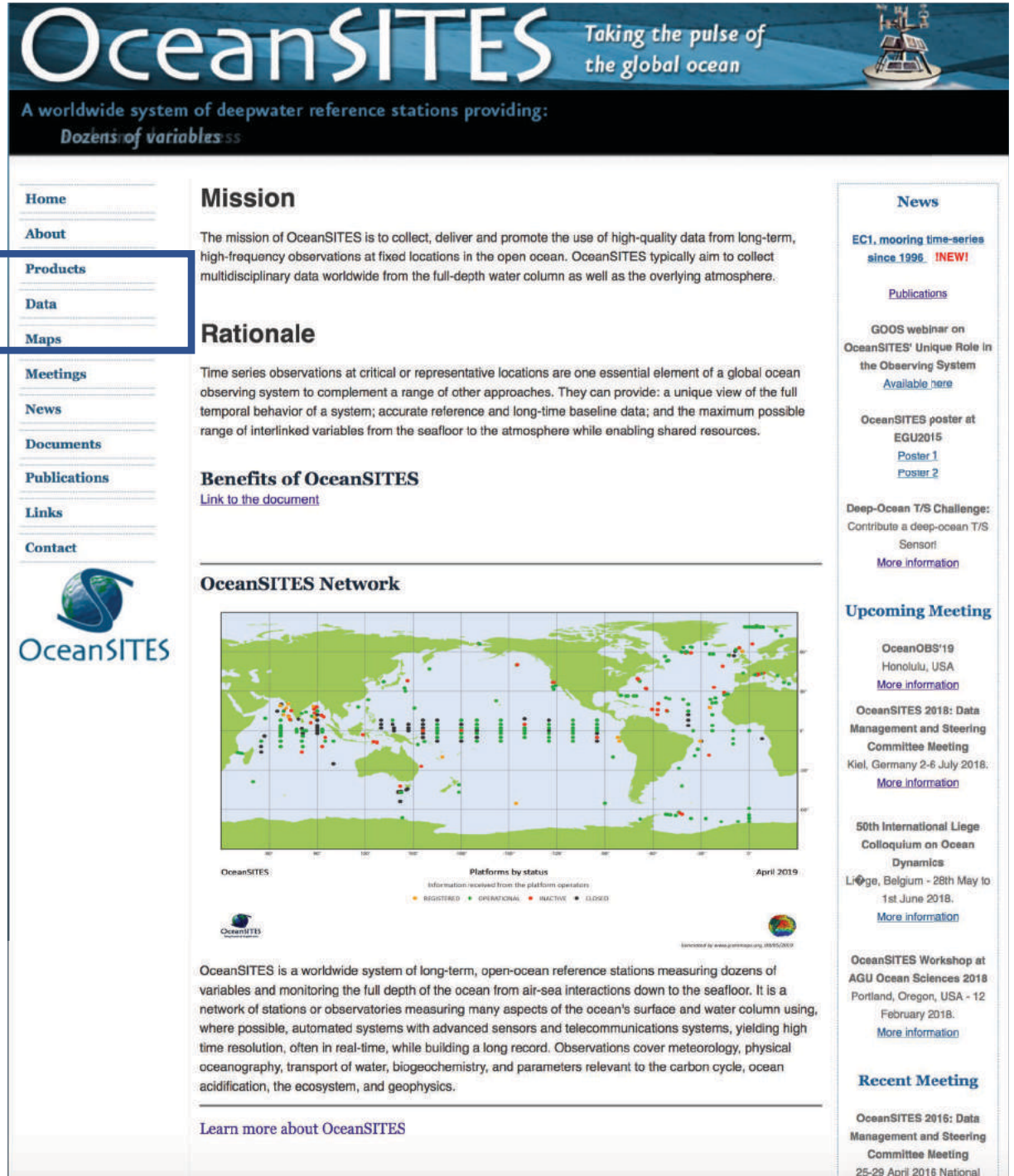
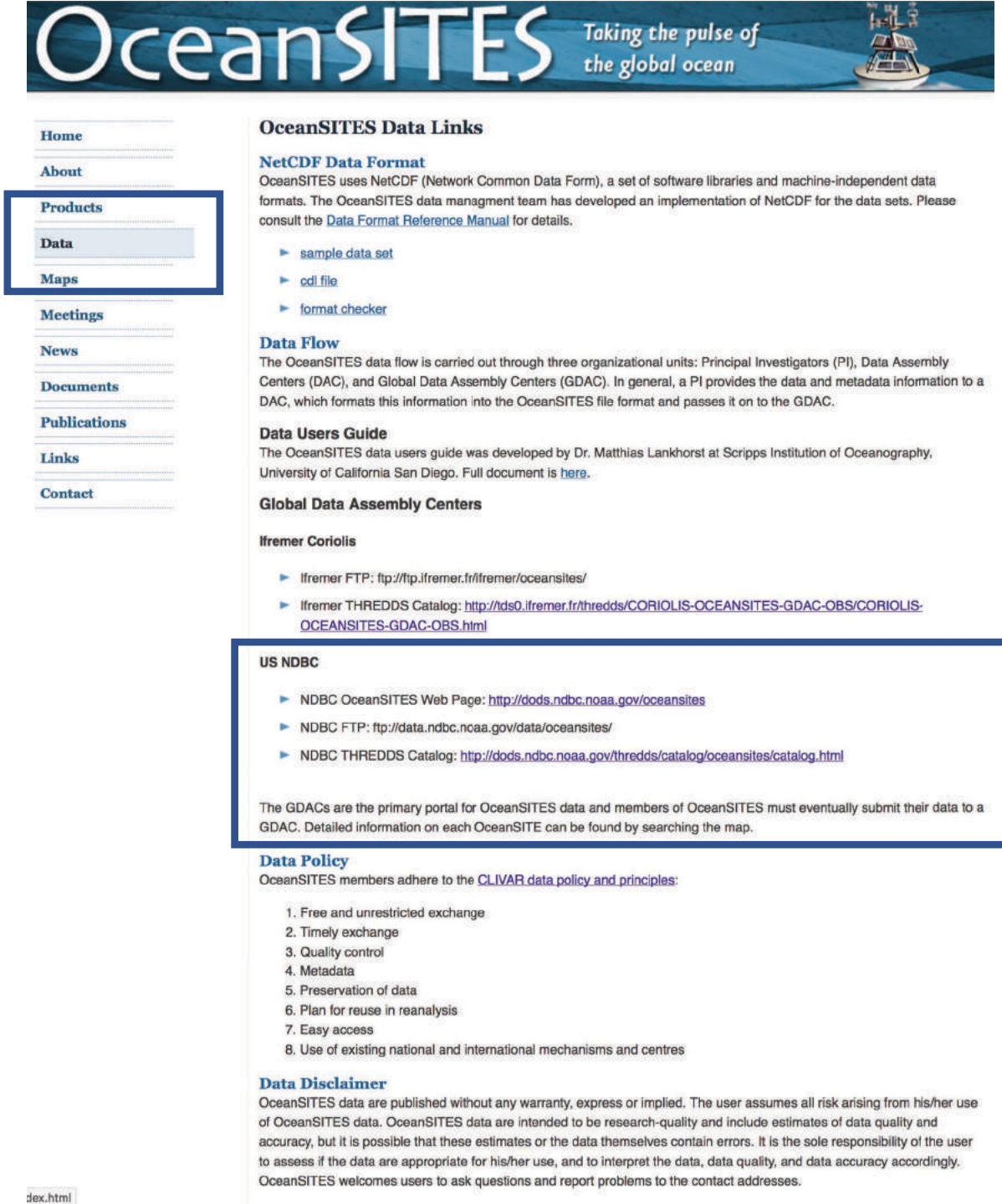
Documents
About site
Feedback
Help
Site map
Theme
OceanSITES
Interactive map (previous version)
Ref.: PAPA/OS_PAPANP
Site/Platform: PAPA/OS_PAPANP
Program: OS-NOAA/PMEL
Model: MB
Country: USA
1 of 4
There are 4 platforms at this site



The JCOMMOPS website is intended to be used for data exploration.

For accessing the data, it is best to go to the network's website, e.g. www.oceansites.org
or even the PI's project page, e.g. www.pmel.noaa.gov/OCS/

PI customer service is easier at the project level.



The JCOMMOPS website is intended to be used for data exploration.

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National Data Buoy Center

Center of Excellence in Marine Technology

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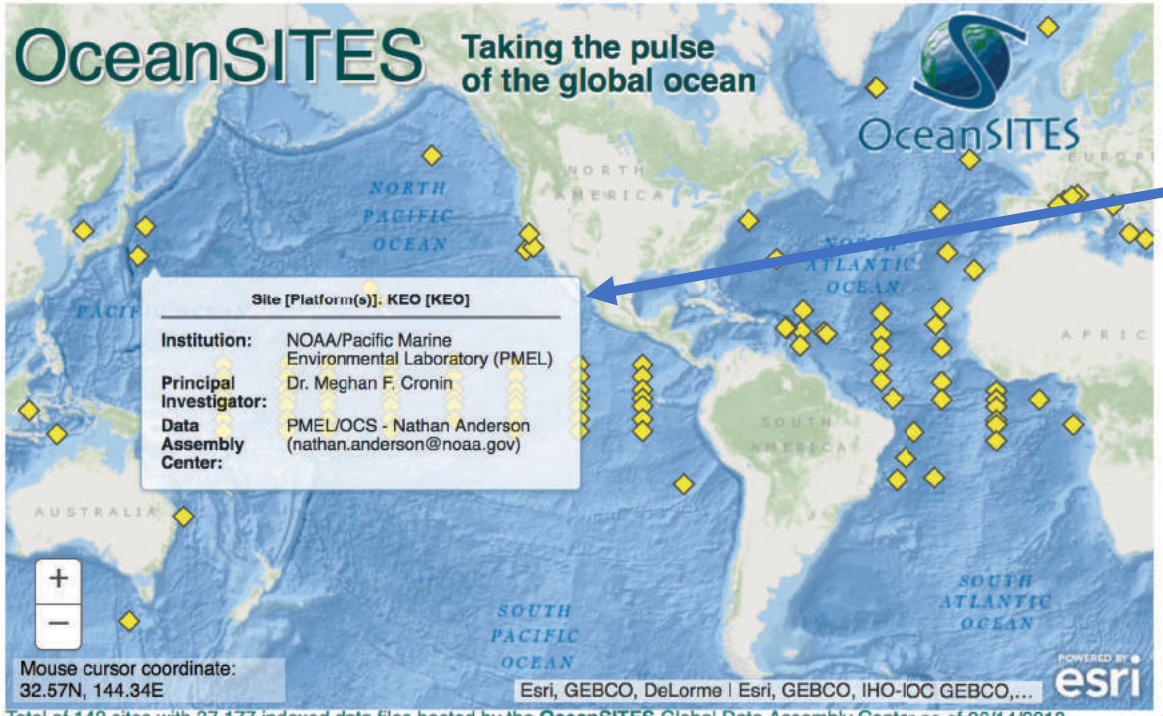
The DODS site is now available only via HTTPS. Please update your bookmarks and/or links to use https://dods.ndbc.noaa.gov/.



Total of 142 sites with 37,177 indexed data files hosted by the **OceanSITES** Global Data Assembly Center as of 06/14/2018.
Mouse over a site icon ◆ on the map to show data information and a single left click to show the site's datasets.

OceanSITES is an international system of long-term, open-ocean reference stations measuring dozens of variables and monitoring the full depth of the ocean from air-sea interactions down to the seafloor. It is a network of timeseries observations that fill a unique role by measuring many aspects of the ocean's surface and water column, and where possible, through advanced sensors and telecommunications systems, yield a long-term record of high resolution data, often in real-time.

Observations cover meteorology, physical oceanography, transport of water, biogeochemistry, and parameters relevant to the carbon cycle, ocean acidification, the ecosystem, and geophysics. Operational applications include the detection of events, initialization and validation of assimilation products, and reference data for forecasts. **OceanSITES** is an integral part of the Global Ocean Observing System. The network complements satellite imagery and other in-situ observation data by extending the dimensions of time and depth.

For more information visit OceanSITES Project Office or access the NetCDF Data Files at its Global Data Assembly Center (GDAC). Also see the THREDDS statistics and FTP statistics at NDBC.

This work is funded by the Climate Observations and Monitoring Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Use the DODs link to get to interactive map.

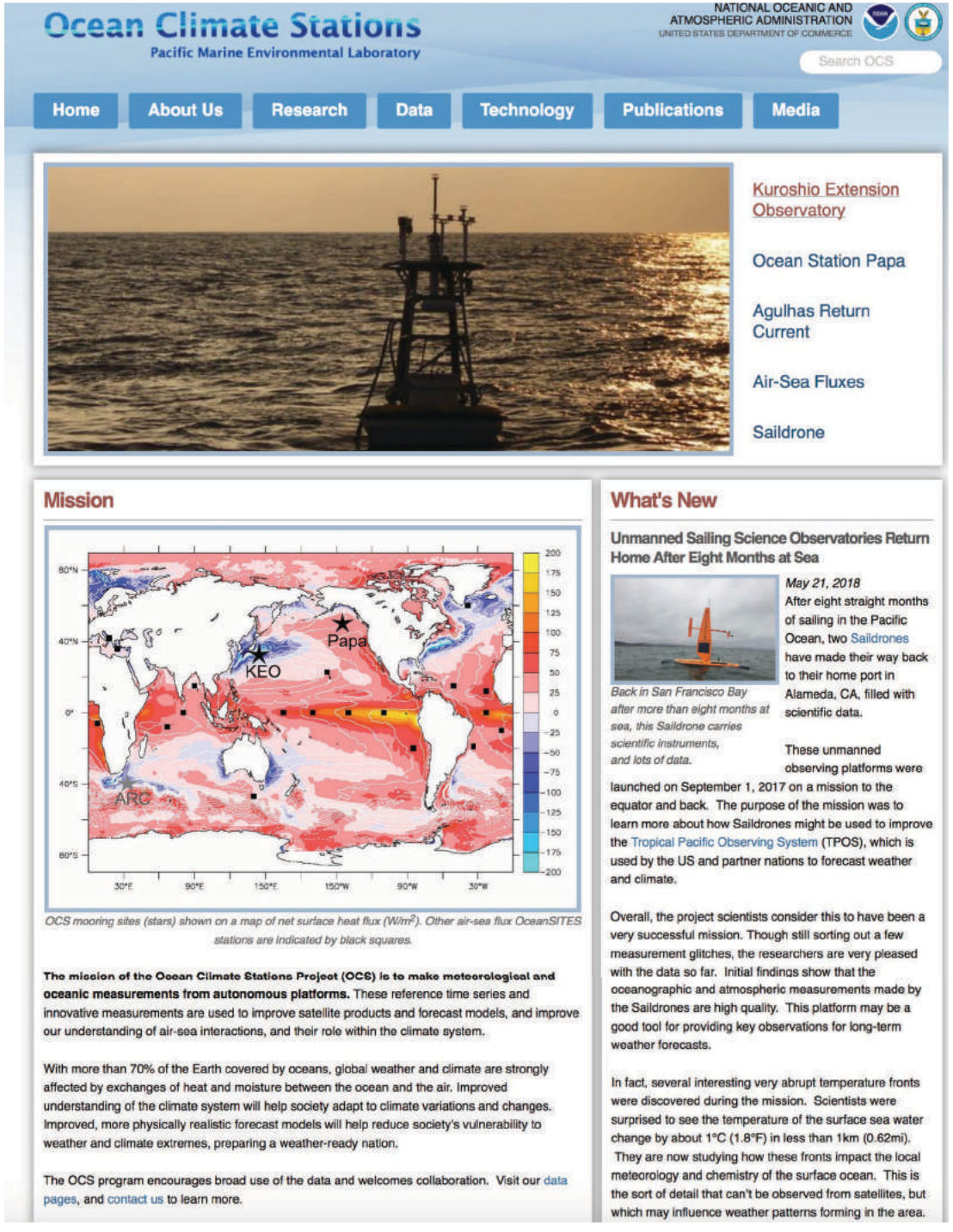
Hovering cursor over site gives pop-up info

Clicking on site brings you to DODS thredds catalog for accessing data

Catalog https://dods.ndbc.noaa.gov/thredds/catalog/data/oceansites/DATA_GRIDDED/KEO/catalog.html

Dataset	Size	Last Modified
KEO		--
OS_KEOK7_200406_D_ADCP-1day.nc	573.8 Kbytes	2016-02-13T01:10:39Z
OS_KEOK7_200406_D_ADCP-1hr.nc	11.79 Mbytes	2016-02-13T01:10:43Z
OS_KEOK7_200406_D_ADCP-30m.nc	40.98 Mbytes	2016-02-13T01:10:53Z
OS_KEO_200406_D_SW_LW_32N145E_2m.nc	94.91 Mbytes	2019-05-15T02:04:12Z
OS_KEO_200406_D_TVMBP_32N145E_10m.nc	460.9 Mbytes	2019-05-15T02:07:18Z
OS_KEO_200406_M_TSVMBP_32N145E_dy.nc	5.390 Mbytes	2019-05-15T02:07:19Z
OS_KEO_200406_M_TSVMBP_32N145E_hr.nc	107.1 Mbytes	2019-05-15T02:07:42Z
OS_KEO_200709_D_V_32N145E_20m.nc	35.13 Mbytes	2019-05-15T02:07:52Z
OS_KEO_200909_D_SW_LW_32N145E_1m.nc	167.1 Mbytes	2019-05-15T02:09:23Z

National Data Buoy Center THREDDS Server at National Data Buoy Center see Info
THREDDS Data Server [Version 4.6.10 - 2017-04-19T16:32:55-0600] Documentation



https://www.pmel.noaa.gov/ocs/

NOAA PMEL Ocean Climate Stations contribute to the OceanSITES network of time series reference stations

PI: Meghan Cronin

All data are freely available. Collaborative research is appreciated and welcomed.

Ocean Climate Stations

Pacific Marine Environmental Laboratory

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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Data

- Data Overview
- Mooring Data
- Computed Fluxes
- Partners Data
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Related

Sensor Specifica...
Sensors used on OCS moorings are listed in the following table, along with th

Sampling Rates
Data from OCS moorings are obtained from three different data collection syst

Measurement Heig...
The tables below describe the nominal heights of meteorological measurements,

Flux Documentati...
Documentation for Calculations of Air-Sea Flux

Mooring Data

KEO (32.3°N, 144.6°E) | Papa (50.1°N, 144.9°W) | ARC (38.5°S, 30°E)

Time Series | Profiles | Separate Plots | Overlay | De-Select Variables

☑ Shortwave Radiation	☑ Wind Speed	☑ Sea Surface Temperature	☐ Zonal Current	☐ Heat Content
☑ Longwave Radiation	☐ Scalar Wind Speed	☑ Temperature Profile	☐ Meridional Current	☐ Longitude
☑ Rain Rate	☐ Wind Direction	☐ Sea Surface Salinity	☑ Current Vectors	☐ Latitude
☑ Air Temperature	☐ Zonal Wind	☐ Salinity Profile	☐ Zonal ADCP	
☑ Relative Humidity	☐ Meridional Wind	☐ Sea Surface Density	☐ Meridional ADCP	
☑ Barometric Pressure	☐ Wind Vectors	☐ Density Profile	☐ Deep TSP	

2004 JUN 16 — 2019 MAY 15 — Daily

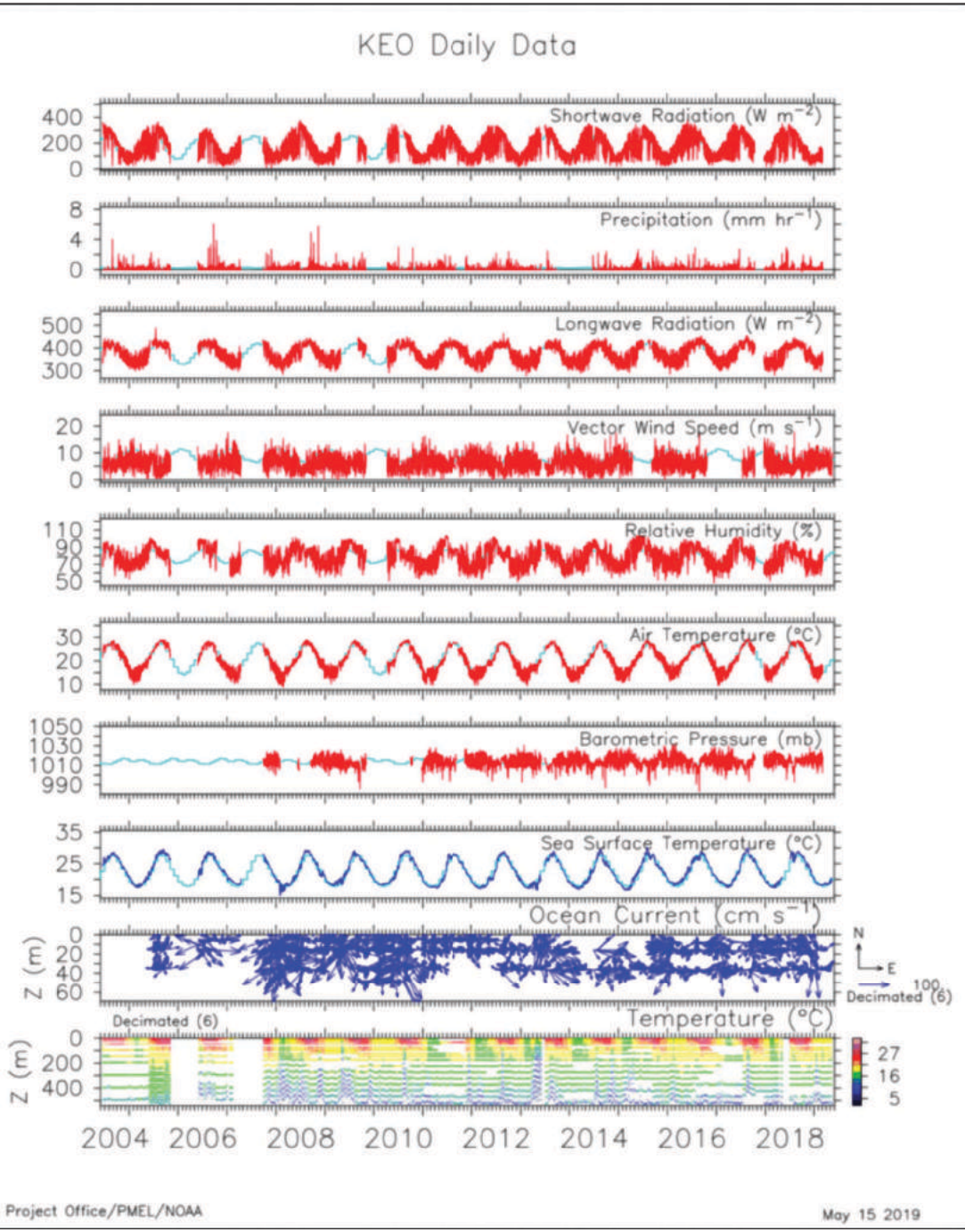
ASCII — Compression

Clear | Deliver | Display

Instructions

To view plots or download data from the KEO, Papa and ARC moorings: Click a blue site button to select the mooring, and use the menus to define the time period of interest, and sample rate. Choose observations to display by clicking checkboxes. A gray box indicates that data are unavailable. Availability of observations changes as you change the time range and data frequency. Click the purple **Display** button to view plots. To deliver data, choose the file type (ASCII or NetCDF) and the compression, and then click the red **Deliver** button. Light blue lines on plots are climatological averages.

Note: Please do not use your browsers 'Back' button. To clear selections click the orange **Clear** button.



What are Observations used for?

- **Observations for mapping fields, initiating or nudging models**
  - Timely (available through the Global Telecommunication System (GTS) in near realtime)
  - Geographically distributed in coherent array, with known uncertainty and quality **(Satellite, Argo, DBCP drifters, GLOSS)**
- **Observations for validation**
  - Independent obs (e.g. not assimilated) **(OceanSITES)**
  - High quality, of known uncertainty that is smaller than error of model.
- **Observations for improving model physics, parameterizations and understanding of processes**
  - Oversampled observations **(OceanSITES, Process Studies)**

Global Ocean Observing System (GOOS)

Sponsored by:

Overlapping global satellite and in situ networks

vs.

A set of regional integrated observing systems that are each “Fit for Purpose”

Use http://www.jcommops.org/ to help explore the GOOS

JCOMMOPS = WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology in situ Observations Programme Support Centre.

TPOS 2020 update

Meghan Cronin (NOAA PMEL)

Co-chair TPOS 2020 Planetary Boundary Layer Task Team

Contributing author to First and Second TPOS 2020 Reports

Science Steering Committee Meetings

2018 Backbone Task Team Face-to-Face Meeting

Others involved in TPOS2020 who are here: **Yolande Serra, Carol Anne Clayson,…**

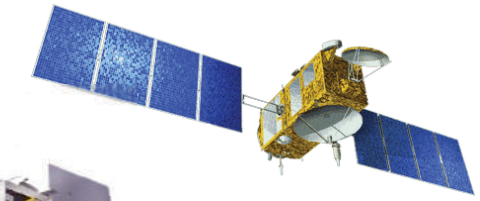
US CLIVAR Workshop on Air-sea Interaction and Convection over the Tropics * Boulder CO USA * 7 May 2019

tpos2020.org

An integrated vision

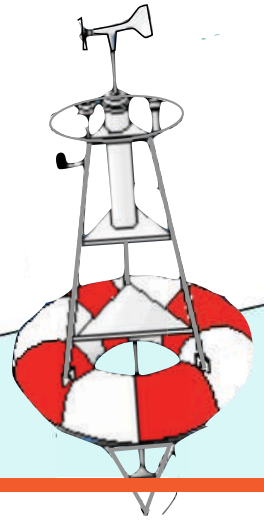
Complementary "backbone" technologies:

- Satellites give global coverage, horizontal detail
- Moorings sample across timescales, allow co-located ocean-atmosphere observations, velocity sampling
- Argo resolves fine vertical structure, adds salinity, maps subsurface T and S, connects to subtropics



Assimilating models integrate diverse observations

TPOS data reaches our stakeholders primarily as the output of an assimilation



Global Tropical Moored Buoy Array
Pacific Marine Environmental Laboratory

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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Data

- Data Display and Delivery
  - Animations
  - Assorted Plots
  - Gridding Methods
- Oceansites Flux Data
- PIRATA Station Plots
- RAMA Station Plots
- Data Quality Control
- Data Telemetry
  - GTS Data Distribution
    - WMO Numbers
  - GTS Data Transmissions
- Historic TAO Data Return
- Mooring Status Summary
  - Historical PIRATA Mooring Status

Related


Indian Ocean - R...
Research Moored Array for African-Asian-*Australian Monsoon* Analysis

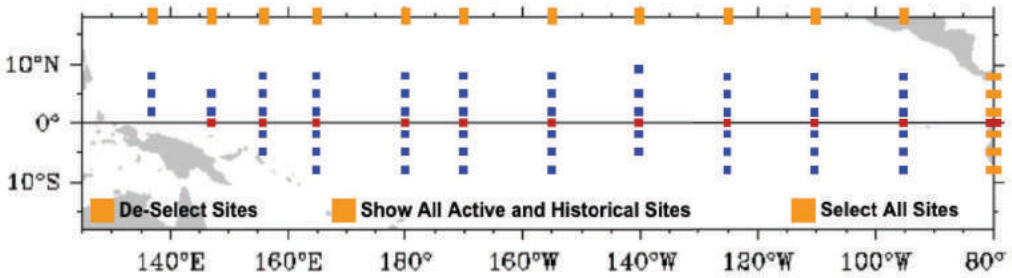

Atlantic Ocean -...
Prediction and Researched Moored Array in the Atlantic (PIRATA)


Pacific Ocean -...
Tropical Atmosphere Ocean (TAO)

Data Display and Delivery

Show Instructions

TAO/TRITON (Pacific) | PIRATA (Atlantic) | RAMA (Indian)



Time Series | Profiles | Time Section | Lat Lon Map | Depth Section

One Variable | One Site | Separate Plots | Overlay | Subsurface Area | Subsurface Lines

SW Rad | LW Rad | Rain | Wspd | Uwnd | Vwnd | Wdir | Wind Vec | RH
Air T | SLP | SST | T(z) | SSS | S(z) | SSD | D(z) | Heat
Dyn Ht | 20C | Ucur | Vcur | Cur Vec | Uadcp | Vadcp | Long | Lat

1979 | JAN | 20 | 2019 | MAY | 19 | 5-Day

files by site | ASCII | Compression

Definitions | Availability | Clear | Deliver | Display

FTP Access | Acknowledgment for use of data | Realtime High Resolution Data

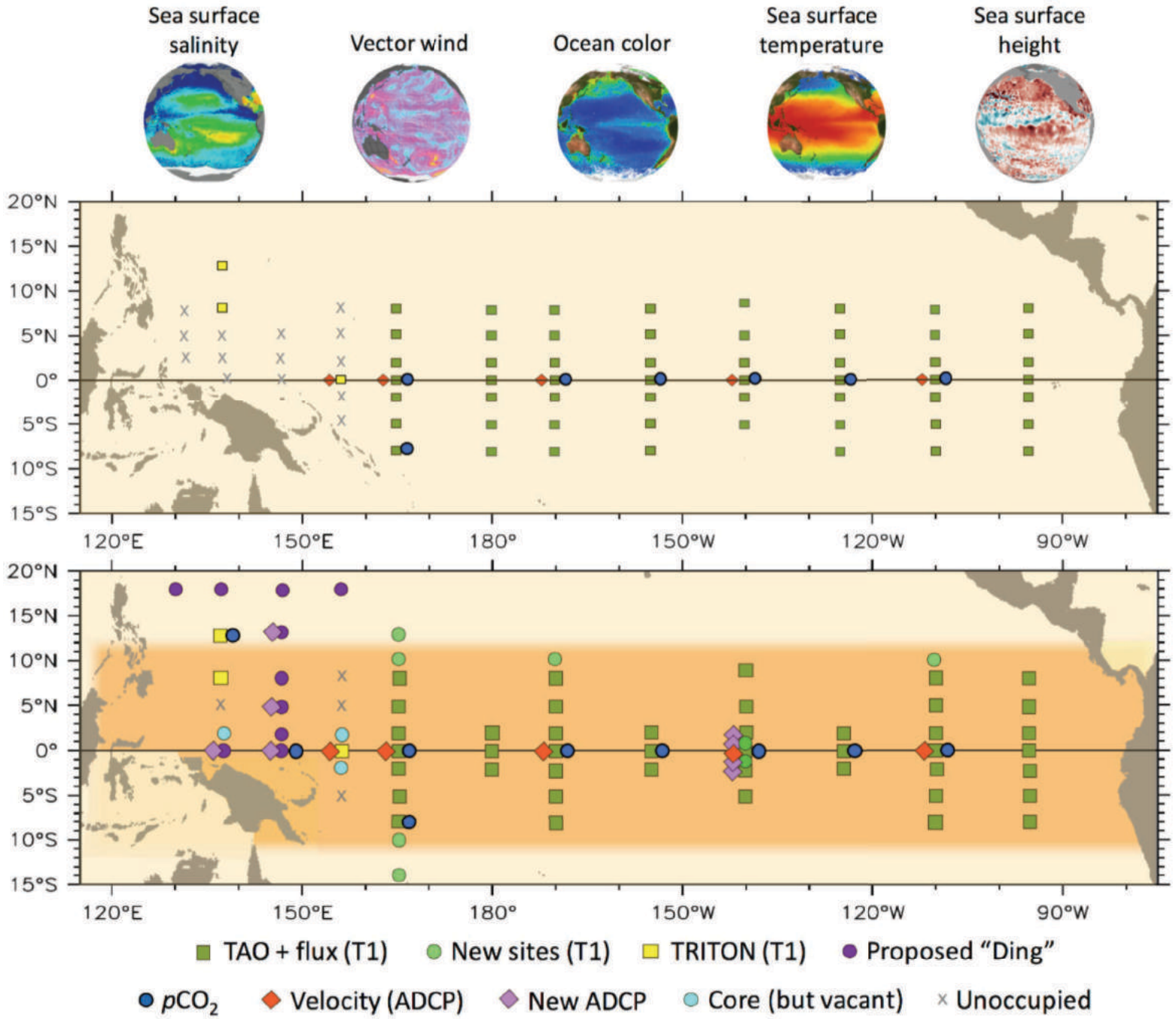
Send Questions to oar.pmel.taotech@noaa.gov

https://www.pmel.noaa.gov/tao/drupal/disdel/

Present Tropical Moored Array (TMA)

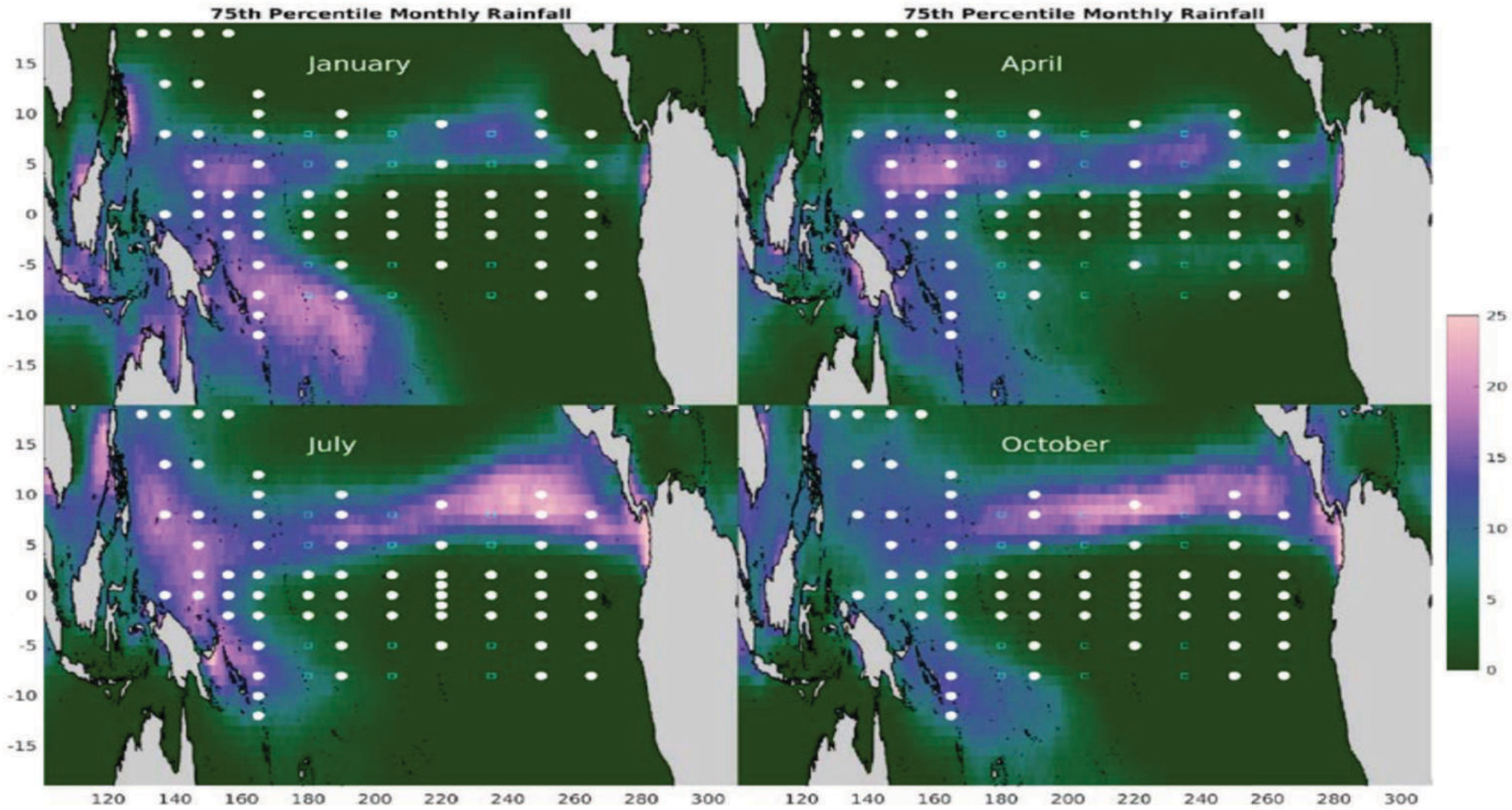
https://www.pmel.noaa.gov/tao/

Proposed TPOS TMA high priority sites and double Argo region (dark orange)



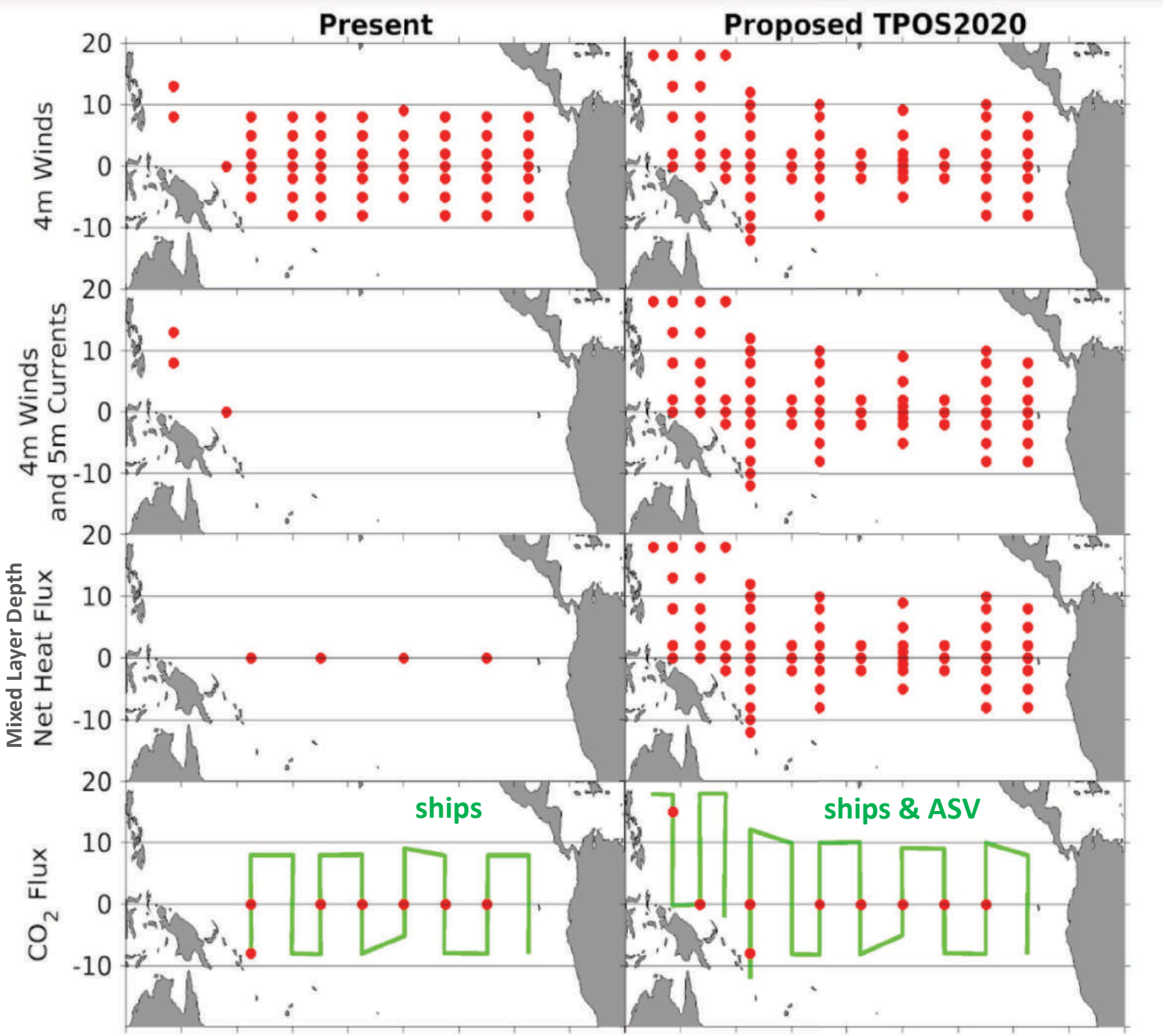
Better support the satellite products

---- better coverage for high rain regions



What are the differences?

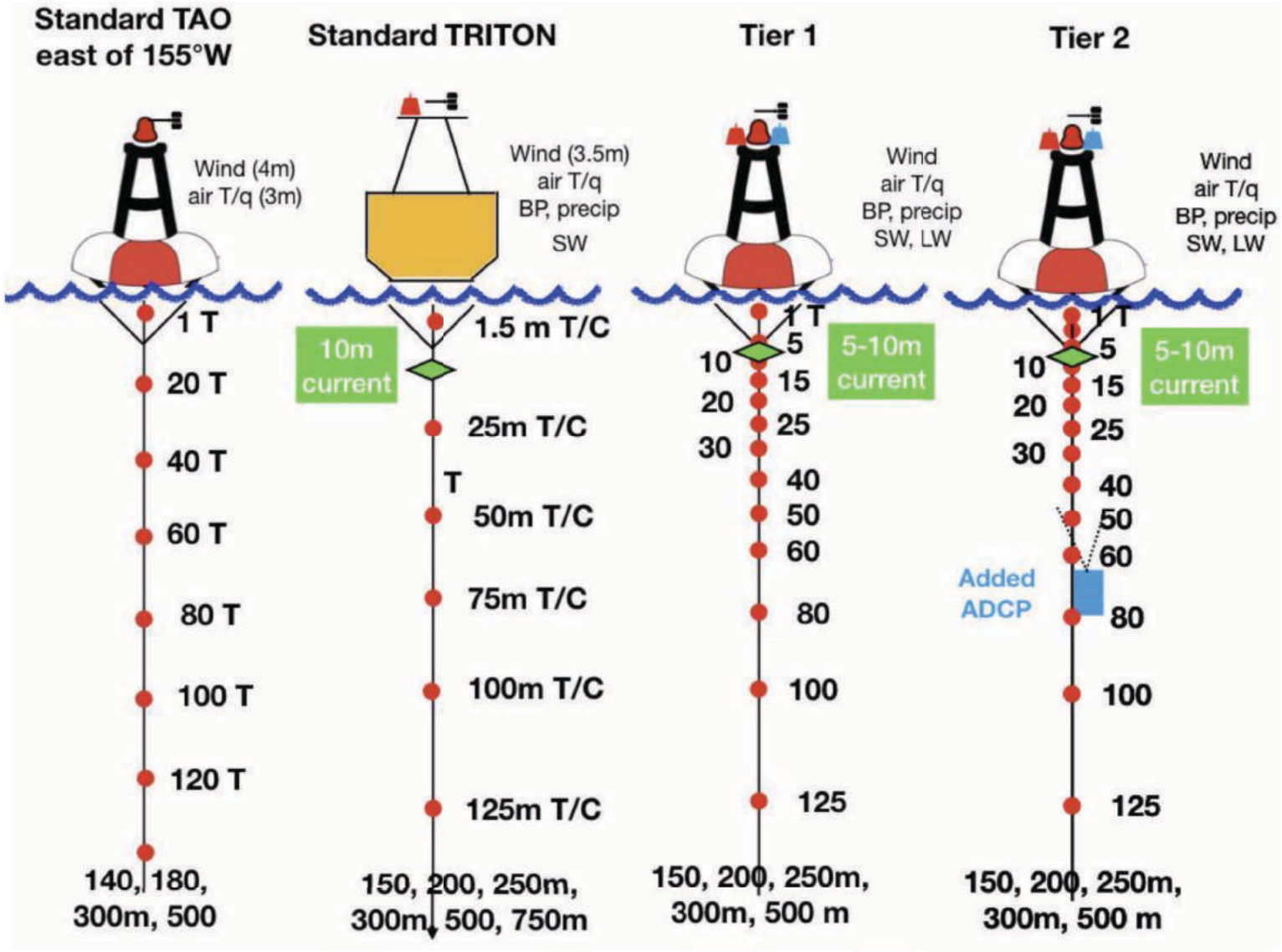
--Better air-sea interaction



What are the differences?

--Better air-sea interaction

How will it be done?



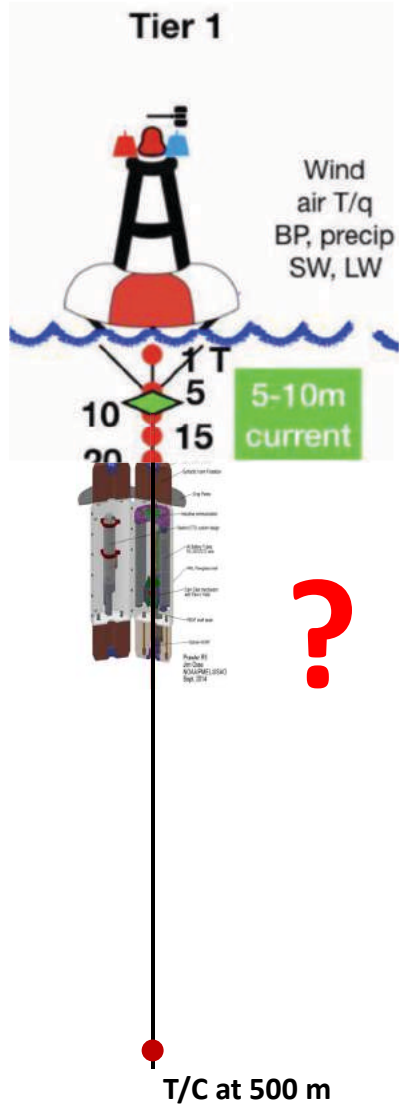
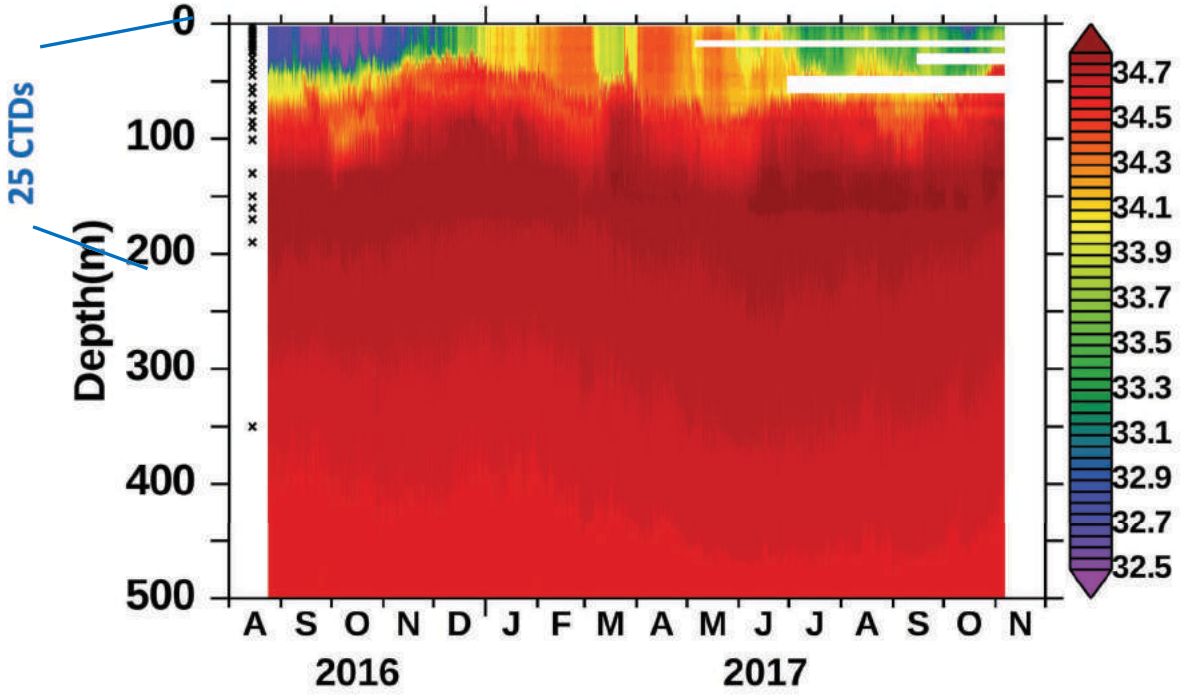


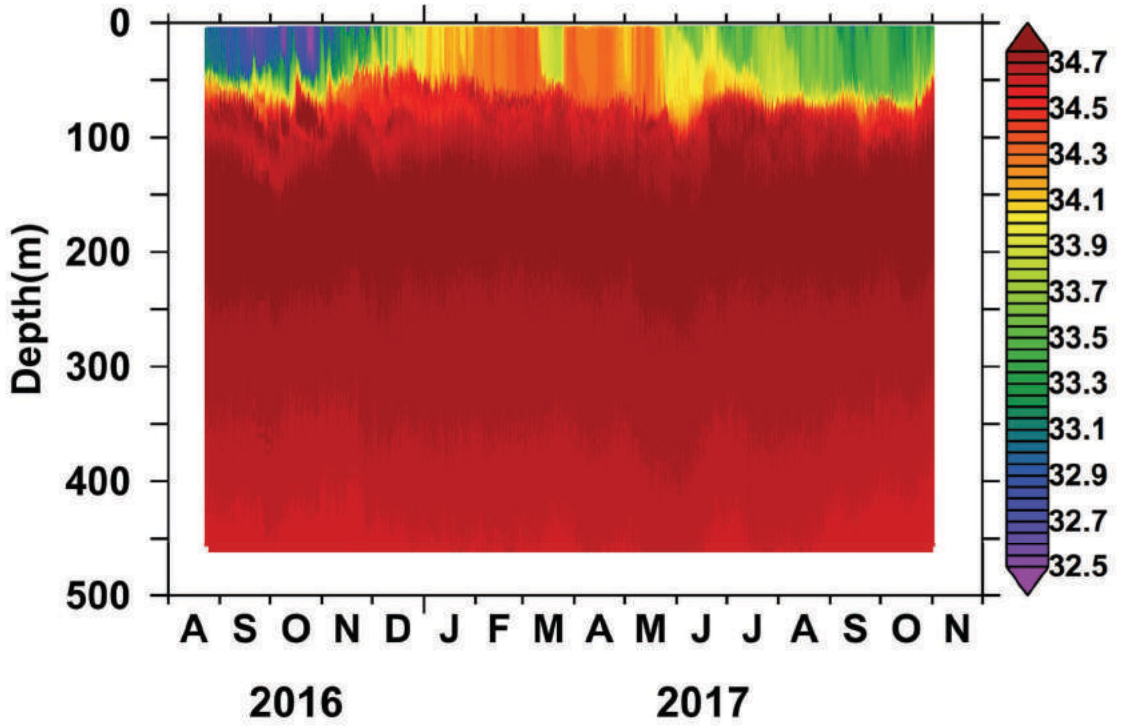
Figure 7.3: Schematics comparing the instrumentation of the current TAO and TRITON moorings- on the left, with those of the new enhanced TMA Tier 1 and Tier 2 - on the right. In the subsurface red dots and black text indicate the depths of temperature and salinity measurements, and green diamonds velocity measurements. Tier 2 moorings will have an upward looking current profiler (blue rectangle). Above the surface, parameters are noted as: Wind = wind speed, air T/q = air temperature and specific humidity, BP = barometric pressure, precip = rainfall, downwelling SW and LW = shortwave and longwave radiation respectively.

PMEL PRAWLER 14-month High Quality Measurements During SPURS-2

Salinity by 25+ WHOI CTDs 10°N, 125°N



Salinity by 1 PRAWLER CTD 9°N , 125°N



- High temporal resolution, every 5 minutes
- Available commercially
- **Lower Risk (failure → data gap at single depth), higher cost**

- Near-realtime telemetry, 2-way communication
- High vertical resolution; Settable 8-24 profiles/day, 20-30 minutes/profile (limited by battery: 8 profiles/day lasts ~ 14+ months)
- Available commercially
- **Higher risk (failure → loss of profile), lower cost**

NOAA OOMD funded 4 pilot studies of emerging technologies that may eventually be used in TPOS.

Saildrone TPOS pilot study will have another mission to equator this summer.

Links discussed here

- http://www.jcommops.org/ -- JCOMMOPS is good place to explore Global Ocean Observing system
- http://osmc.noaa.gov/Monitor/OSMC/OSMC.html -- NOAA Observing System Monitoring Center is good place to see what is on the GTS
- https://www.gloss-sealevel.org/ -- Global Sea Level Observing System
- https://tidesandcurrents.noaa.gov/sltrends/ -- interactive tide website
- https://tidesandcurrents.noaa.gov/map/index.html?id=9449880 – FHL tide station
- www.oceansites.org – OceanSITES time series reference stations
- https://www.pmel.noaa.gov/OCS -- PMEL Ocean Climate Stations
- http://tpos2020.org – Tropical Pacific Observing System -2020 homepage
- https://www.pmel.noaa.gov/tao/