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A call for revolution –
Better partnerships to coordinate observing and modelling system evolution

John Wilkin*

and Bernadette Sloyan

GOOS Ocean Observations Physics and Climate panel (OOPC)

**Rutgers, The State University of New Jersey, USA*

OceanPredict '19

GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada

Advancing the science and application of ocean predictions

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GOOS
The Global Ocean Observing System

Home

Why A GOOS

How We Work

GOOS Framework

Who We Are

Steering Committee

Panels

Physics & Climate Panel

Biogeochemistry Panel

Biology & Ecosystems Panel

Physics and Climate panel

Chair: **Bernadette Sloyan**
CSIRO Ocean and Atmosphere, Australia

Katy HILL (Scientific Officer)

Panel members:

John WILKIN, USA
Karina VON SCHUCKMANN, France
Johannes KARSTENSEN, Germany
Marjolaine KRUG, South Africa
Benjamin RABE, Germany
Maria Paz CHIDICHIMO, Argentina
Matt PALMER, UK

Eitarou OKA, Japan
Weidong YU, China
Tony LEE, USA
Robert WELLER, USA
Meghan CRONIN, USA
Sabrina SPEICH, France

GOOS GCOS GLOBAL CLIMATE OBSERVING SYSTEM WCRP World Climate Research Programme jcomm OCEANOGRAPHY & MARINE METEOROLOGY

OOPC Key Task Areas

Physics panel of GOOS – with companion *Biogeochemistry* and *Biology* panels

Ocean panel of GCOS – with companion *Atmosphere* and *Terrestrial* panels

Assess, review and prioritize requirements for observing **EOVs*** and **ECVs**

Reviews and ongoing evaluation of the observing system

- *Ocean heat and freshwater storage*
- *Air-sea fluxes*
- *Tropical Pacific Observing System* (TPOS2020) review
- *Boundary System Task Team* – with initial emphasis on shelf-sea interactions
- *Status of and requirements for data and information management*

Work with JCOMM Operations Coordination Group (OCG) and regional bodies to **coordinate observing networks**

Liaison and advocacy for agreed plans

*Essential Ocean Variables www.goosocean.org/eov and Essential Climate Variables of GCOS from Framework for Ocean Observing (FOO)

Essential Ocean Variables

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Requirements Settings				
Responsible GCOS/GOOS Panel Reporting Mechanism	OOPC GCOS Implementation Plan/Status Reporting to UNFCCC JCOMM Observations Coordination Group, WCRP			
Readiness Level [5]	Mature to pilot			
Phenomena to capture.	Circulation	Fronts and Eddies	Coastal shelf exchange processes	Tides
Temporal Scales of the Phenomena	Weekly	< daily to decadal	hourly	Hourly
Spatial Scales of the Phenomena (Horizontal and Vertical - O)	H 50 km V 10 m	H 10km V 10 m	H 1km V 10 m	H 10km V 10 m
Magnitudes/range of the signal, thresholds to capture for the processes				

[5] See FOO readiness table on last page

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	Observation Deployment & Maintenance						
Observing Elements [7]	Moorings (DBCP, OceanSITES)	Profiling Floats (Argo)	Ocean Gliders	Repeat Hydrography (GO-SHIP)			
Relevant measured parameters	Vector current	1000m Vector current (Drift)	Vector current	Vector Current	Vector current	T, S.	
Sensor(s)/ Technique	Acoustic travel time, Mechanical current meters	Float trajectory, hydrography	Doppler shift, hydrography, Dead-reckoning	LADPC Doppler shift	SADCP Doppler Shift	Hydrography (relative velocity – Geostrophic currents)	
Phenomena addressed	Boundary currents	Gyre scale circulation	Ocean boundary currents	Major currents, gyre circulatio n (full depth)	Upper ocean Major currents, gyre circulatio n	Major currents, gyre circulation	
Readiness Level [5]	Mature 8	Mature 8	Pilot 6	Mature 8	Mature 8	Mature 8	
Spatial sampling	Full depth, O(1-5km)	Upper 2000m, O(global to basin scale)	Upper 1000m, O(1-100km)	Full depth, O(50km)	Upper 1500m, O(<2km)	Full depth, 100km	O(1 -100kms)
Temporal sampling	Hourly	10 day	< hourly	7-10 yrs	7-10 years	7-10 years	Dependant on sampling
Special Characteristics/ Contributions	High to medium vertical resolution Delayed mode data retrieval	Global resolution of velocity of ocean at drift depth of float. Autonomous Platform, real time	Spatial and temporal range set by specifics of glider mission	Full depth sampling at horizontal resolution of voyage.	High temporal resolutio n, but limited vertical resolutio n (2-800 m)	Full depth sampling at horizontal resolution of voyage.	Fixed long-term timeseries (cabled arrays). Varying vertical resolution depending on float design
Supporting Variable(s)	T , S and P at varying vertical resolution	T, S and P	T, S and P	T, S and P. Full depth	Underwa y ocean observati ons	T, S, P full depth	EM-floats: u, v, T, S, P to depth of float EM-cable: u, v, full depth integral
Random Uncertainty estimate (units, one standard	0.02m/s	Km/day	0.02m/s (ADCP)	0.02m/s	0.02m/s		0.05m/s
Uncertainty in the bias Units, one standard deviation)							

[7] Identify existing observing network programmes (as reference if not unique), not simply a platform type. A control list of networks will be compiled. Attributes of networks are relative to this EOV. If applicable, in a separate paragraph please describe how the networks interact with each other. For example, one network might be very sparse but it provides the most accurate data which are used to improve the calibration in other networks.

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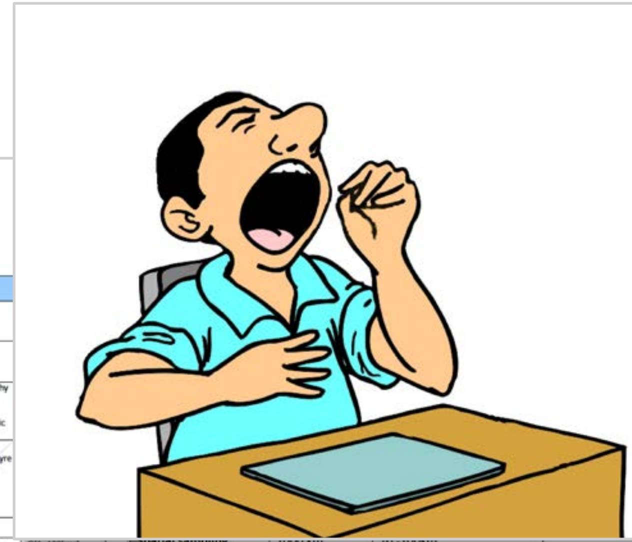

Spatial sampling	1000 km	10 -100km
Temporal sampling	monthly	Semi-annually
Special Characteristics or Contribution	Autonomous sampling of deep ocean	Upper ocean
Estimated time when part of the observing system	>5 -10 years	> 5 years
Relevant measured parameter(s)	u,v, T, S and P	u,v, T, S , P
Sensor(s)/Technique	Float drift	ADCP, hydrography
Random Uncertainty estimate (units, 1 standard deviation).	10 m/s	

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Essential Ocean Variables criteria

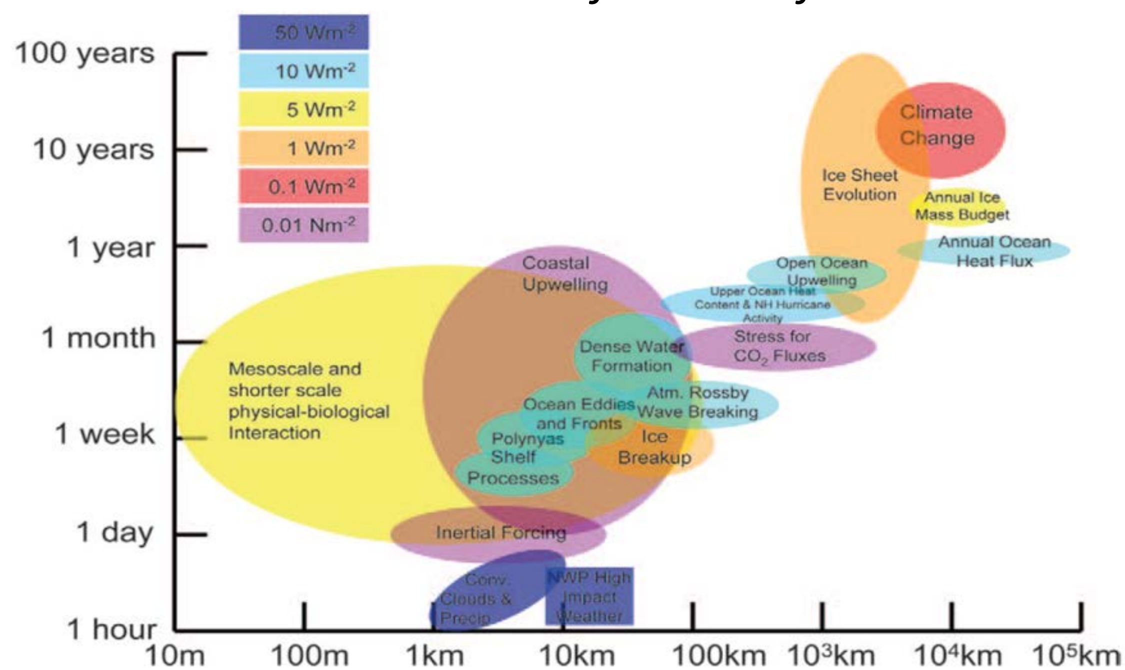
Relevance: GOOS Themes – Climate, Operational Ocean Services, and Ocean Health

Feasibility: Observing on a global scale is technically feasible using established methods

Cost effectiveness: Affordable through coordinated observing using proven technology

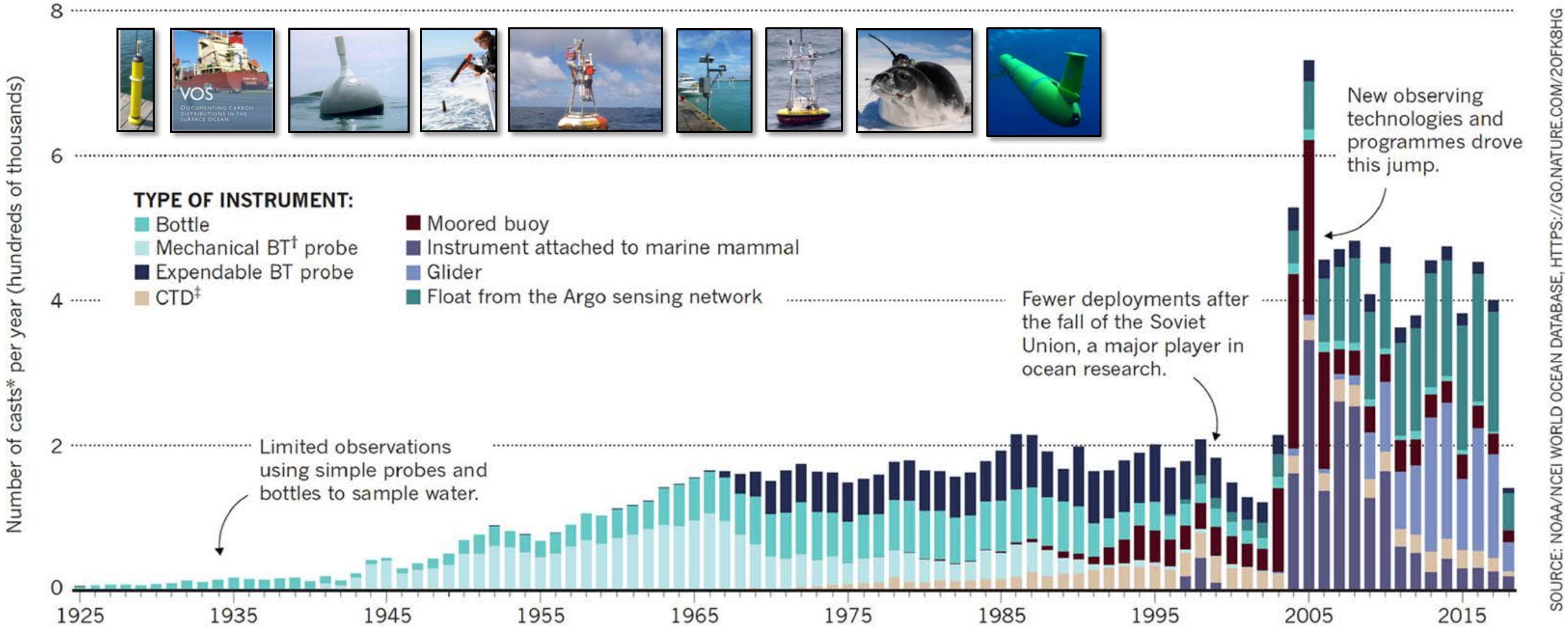
Requirements: Time and space scales of sampling to deliver useful knowledge on key ocean phenomena

Ocean surface heat flux



*Essential Ocean Variables www.goosocean.org/eov and Essential Climate Variables of GCOS from Framework for Ocean Observing (FOO)

EOV process is platform agnostic – requirements relate to system as a whole

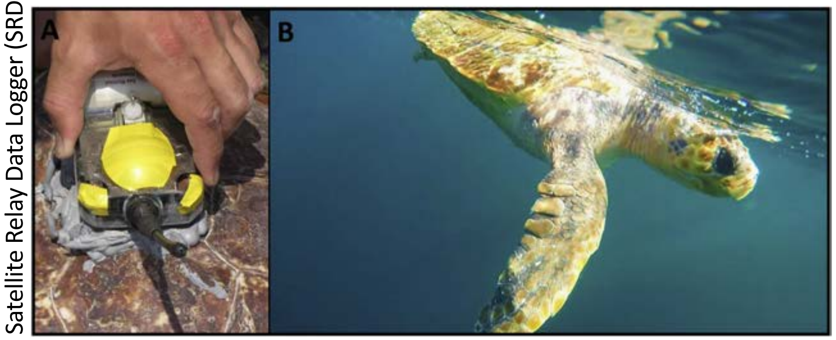


*A cast is a set of measurements for a single variable such as temperature or salinity at different depths; †BT, bathythermograph; ‡CTD, high-resolution sensor of conductivity, temperature and depth.

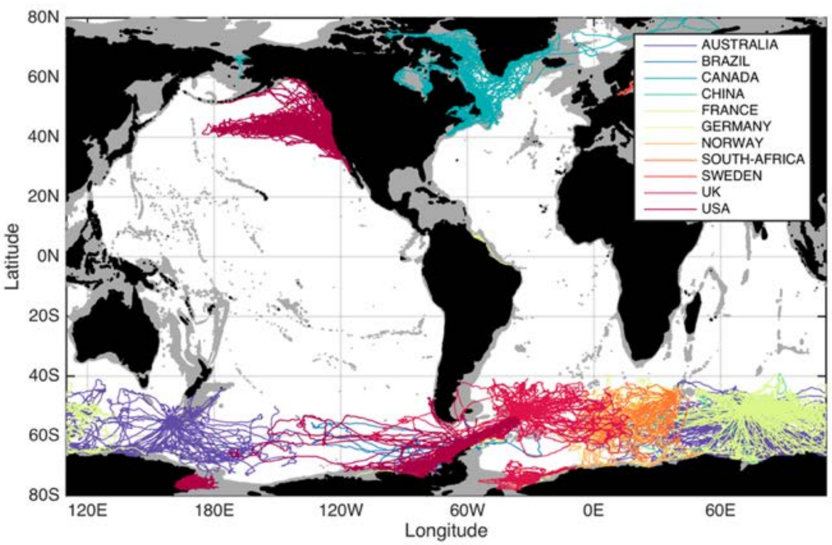
Marine Mammals

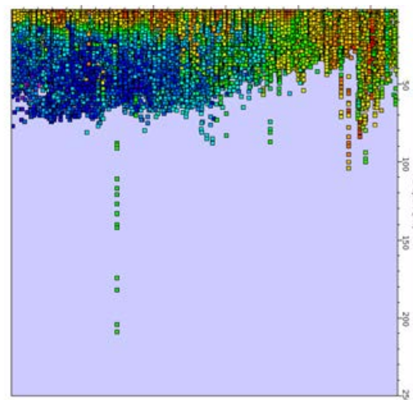
Loggerhead turtles

Sea Mammal Research Unit
Satellite Relay Data Logger (SRDL)

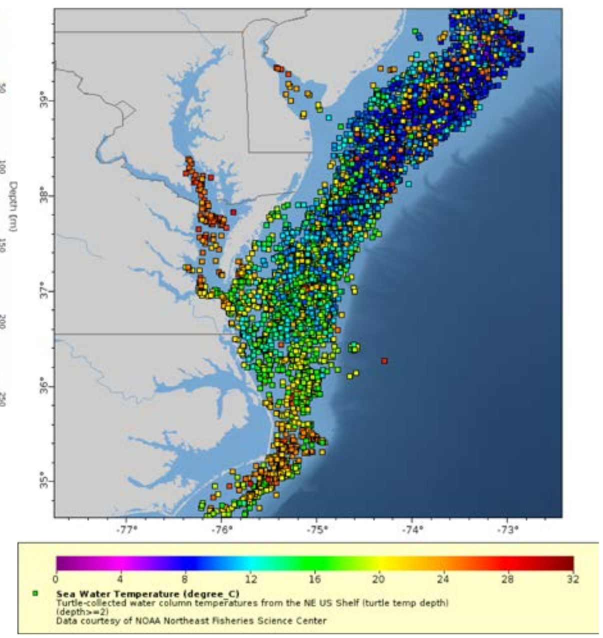


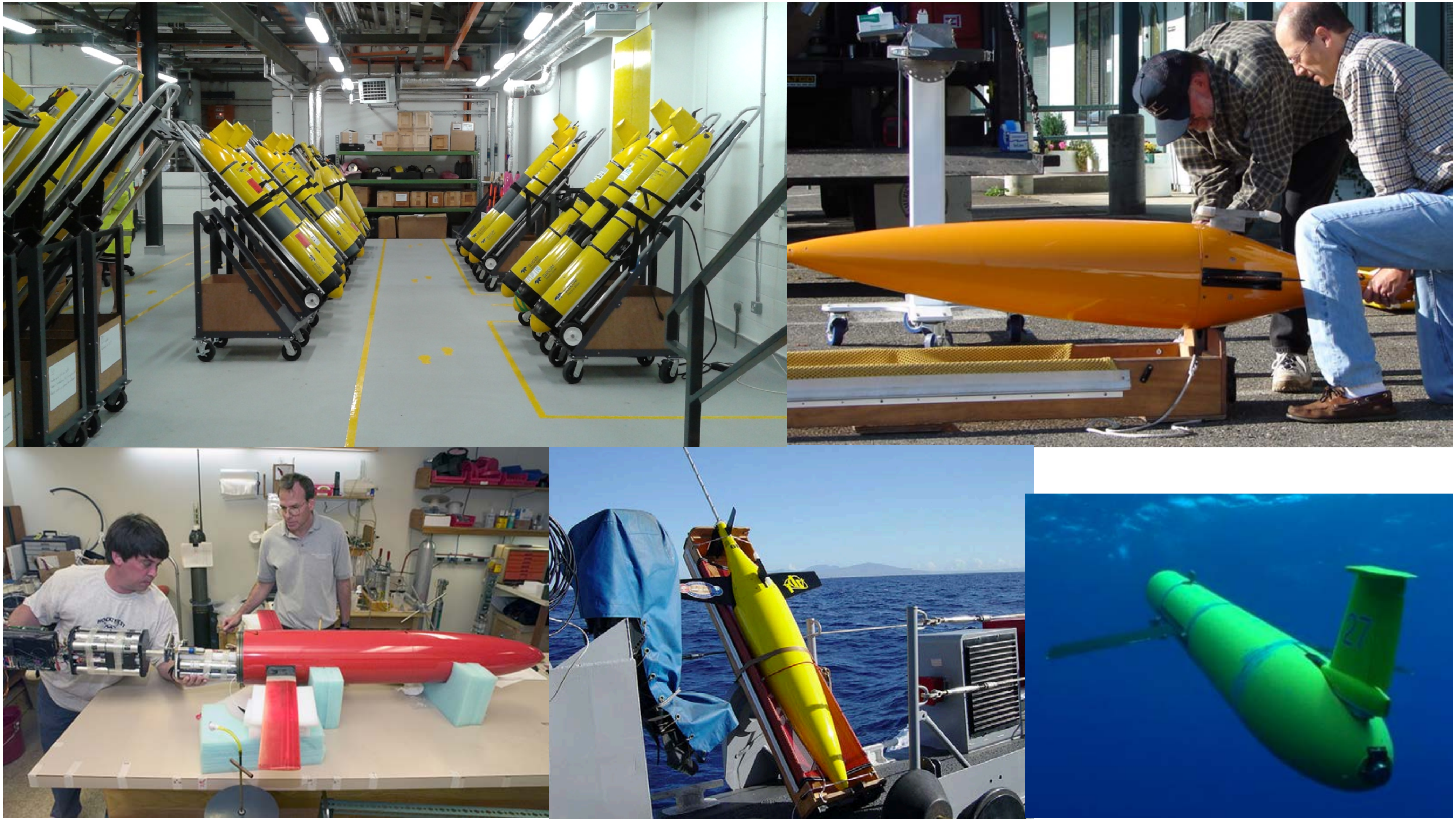
MEOP (Marine Mammals Exploring the Oceans Pole to Pole)
435628 CTD profiles, 143 deployments, 1021 tags

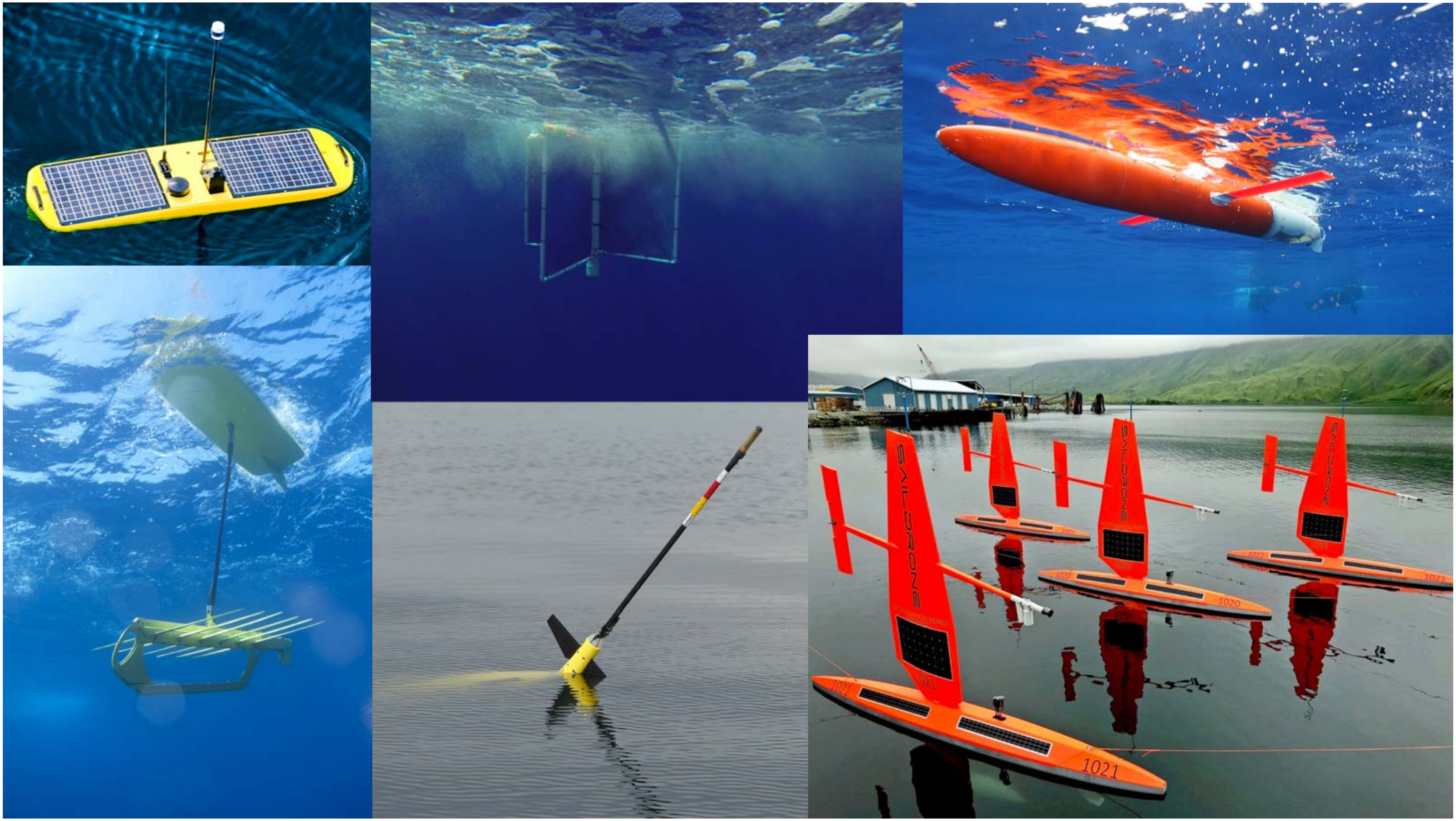




Patel, S. H., et al. (2018). Loggerhead turtles are good ocean-observers in stratified mid-latitude regions. *Est., Coastal & Shelf Sci.*, *213*, 128-136.



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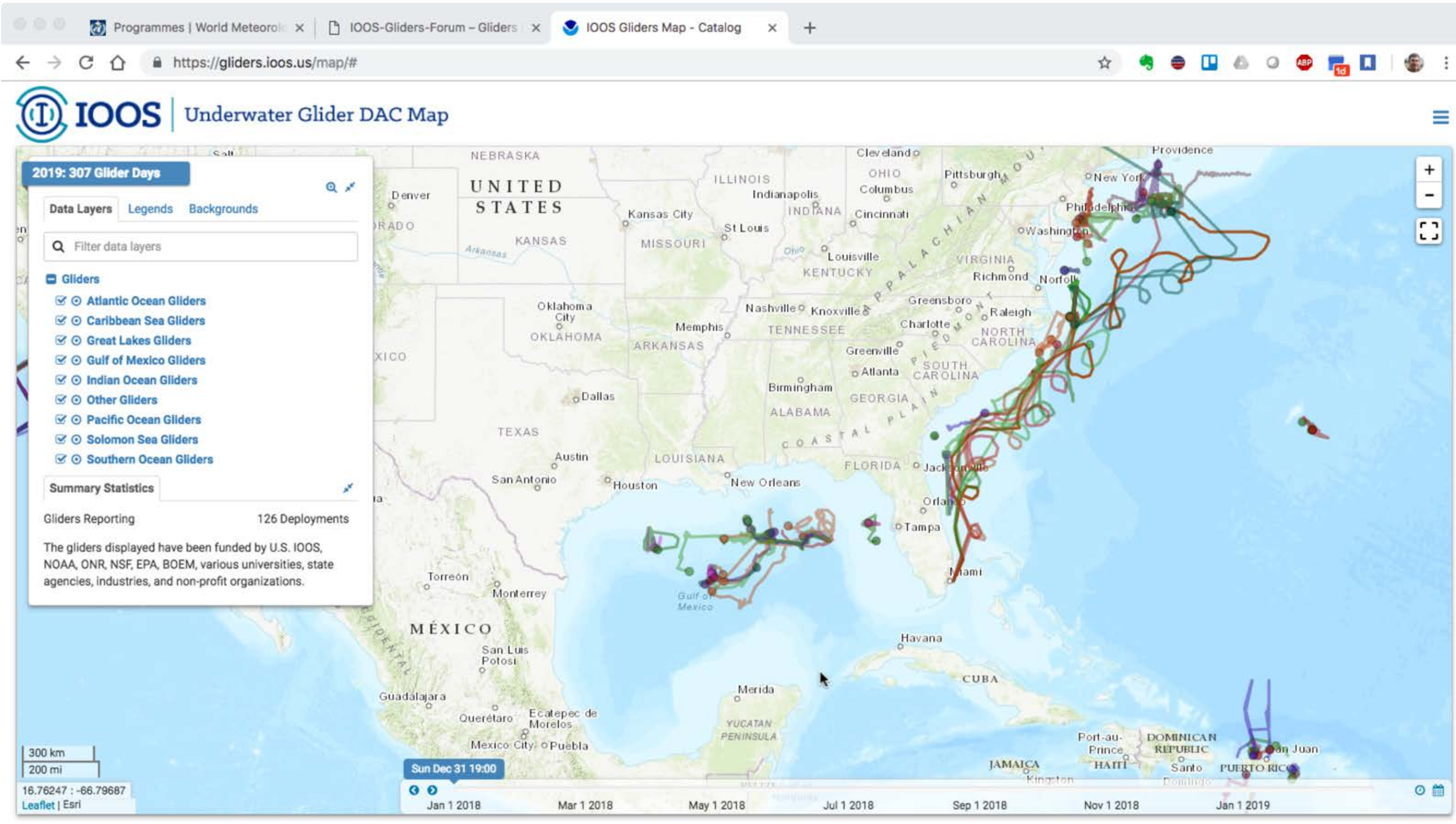
Programmes | World Meteorolo
IOOS-Gliders-Forum – Gliders
IOOS Gliders Map - Catalog
https://gliders.ioos.us/map/#
IOOS
Underwater Glider DAC Map
2019: 307 Glider Days
Data Layers
Legends
Backgrounds
Filter data layers
Gliders
Atlantic Ocean Gliders
Caribbean Sea Gliders
Great Lakes Gliders
Gulf of Mexico Gliders
Indian Ocean Gliders
Other Gliders
Pacific Ocean Gliders
Solomon Sea Gliders
Southern Ocean Gliders
Summary Statistics
Gliders Reporting
126 Deployments
The gliders displayed have been funded by U.S. IOOS, NOAA, ONR, NSF, EPA, BOEM, various universities, state agencies, industries, and non-profit organizations.
UNITED STATES
MÉXICO
CUBA
Gulf of Mexico
300 km
200 mi
16.76247 : -66.79687
Leaflet | Esri
Sun Dec 31 19:00
Jan 1 2018
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May 1 2018
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Nov 1 2018
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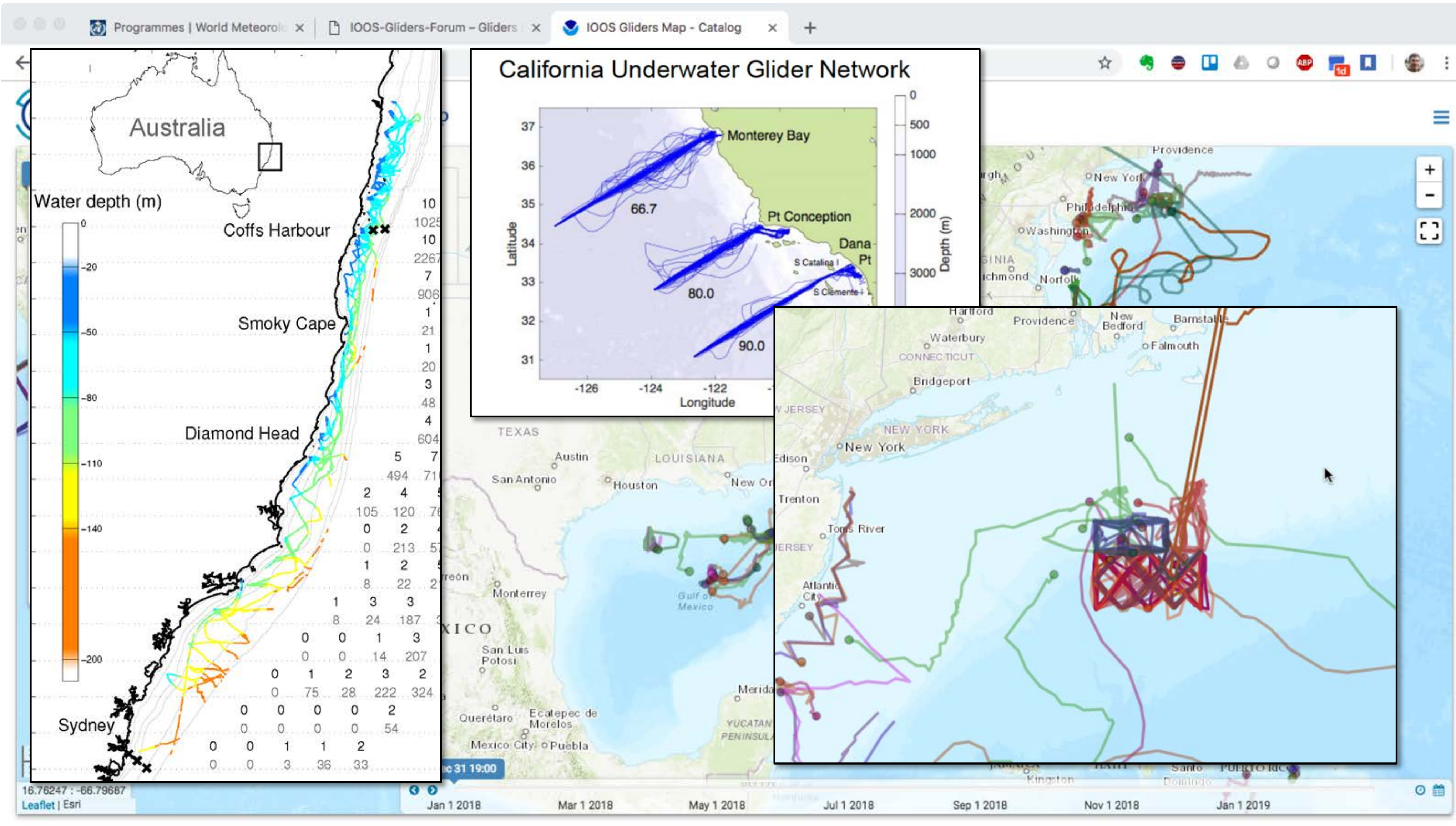

Programmes | World Meteorolo
IOOS-Gliders-Forum – Gliders
IOOS Gliders Map - Catalog
Australia
Water depth (m)
Coffs Harbour
Smoky Cape
Diamond Head
Sydney
California Underwater Glider Network
Monterey Bay
Pt Conception
Dana Pt
S Catalina I
S Clemente I
66.7
80.0
90.0
Latitude
Longitude
Depth (m)
TEXAS
LOUISIANA
Austin
San Antonio
Houston
Monterrey
MEXICO
San Luis Potosi
Querétaro
Mexico City
Puebla
Merida
Gulf of Mexico
YUCATAN PENINSULA
Providence
New York
Philadelphia
Washington
Norfolk
Hartford
Waterbury
CONNECTICUT
Bridgeport
New Bedford
Barnstable
Falmouth
NEW YORK
Edison
Trenton
Toms River
Atlantic City
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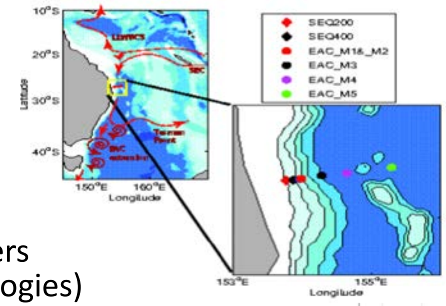
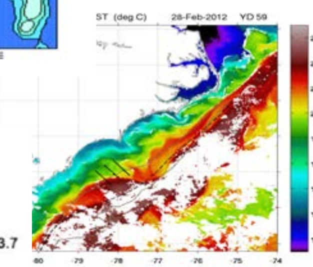
PUERTO RICO
16.76247 : -66.79687
Leaflet | Esri
Jan 1 2018
Mar 1 2018
May 1 2018
Jul 1 2018
Sep 1 2018
Nov 1 2018
Jan 1 2019

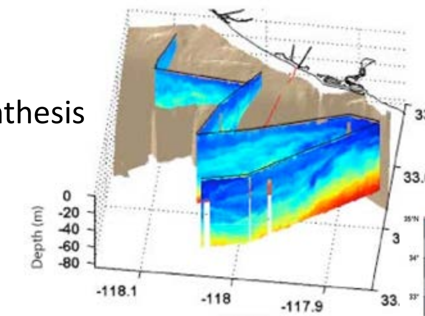
Boundary Systems Task Team

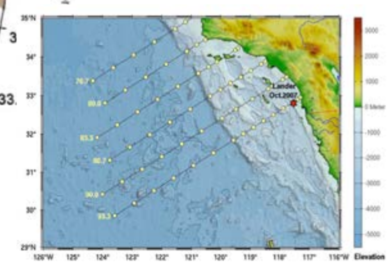
Leads: Maria Paz Chidichimo, Marjolaine Krug, John Wilkin, Robert Todd

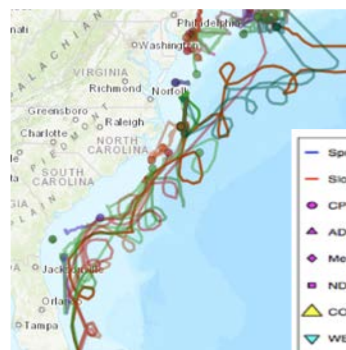
- Guide, support and develop boundary current observing systems
  - Reviews mature BC obs. systems and process studies, leveraging OO’19 Whitepapers (Boundary Currents; Coastal BGC/Eco papers; Network based papers; New technologies)
  - Engage GOOS Regional Alliances on capacity development, open data, collaboration/access to coasts; articulate societal impacts
  - **Collaboration with OceanPredict through OSSEs etc.**
  - With observing networks, coordinate multi-platform approaches and model synthesis
- Steps:
  - Communiqué in 2018 gathered input on framing the priorities and objectives
  - Boundary Systems Task Team of 11 international researchers has been formed
  - Complete Task Team membership with expertise in satellite observing, BGC/Eco, **and representation from OceanPredict**
  - Developing expanded prospectus for project
  - Possible initial priorities and pilot project themes
    - WBC air-sea fluxes
    - EBC Oxygen Minimum Zones (OMZ)
    - Boundary currents as drivers of deep-ocean/shelf-sea exchange
    - OSSEs to design multi-platform sustained systems
  - Community workshop in 2020 around pilot project themes

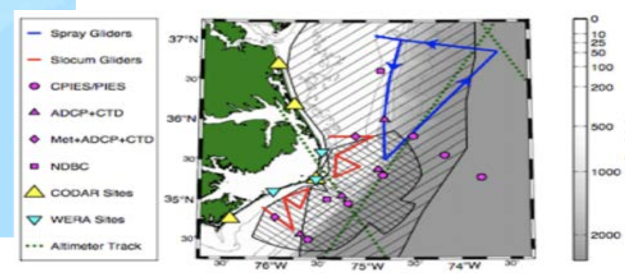












OceanPredict and GOOS

Back in January …

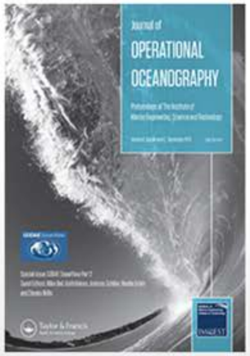
OceanPredict19 is structured around themes (operations, observations, models, users, etc.) that ***perpetuate siloed approaches to advancing observing and modeling separately*.**

Observing networks are ***reluctant to radically redesign or reallocate deployments or resources***, preferring to sustain present activities and grow principally by addition.

The FOO requires a ***partnership between research and operational observing and modeling communities*** to assess observation elements for ***every EOV***, and to expand the quality, scope and relevance of products.

The adequate ocean observing system of today need not, and should not, be the sustained system of tomorrow.

It is hard to argue that the global observing and modelling communities have achieved the level of coordination and synergy that the FOO aspires to.



Journal of Operational Oceanography

Official Journal of the Institute of Marine Engineering, Science & Technology (IMarEST)

Vol 10, 2017 | Vol 9, 2016 | **Volume 8, 2015** | Vol 7, 2014 | See all volumes and issues

Supplement 2 | Issue 2 | **Supplement 1** | Issue 1

GODAE OceanView Part 1

Article
Coastal Ocean Forecasting: system integration and evaluation
V.H. Kourafalou, P. De Mey, M. Le Hénaff, G. Charria, C.A. Edwards, R. He, M. Herzfeld, A. Pascual, E.V. Stanev, J. Tintoré, N. Usui, A.J. van der Westhuysen, J. Wilkin & X. Zhu
Pages: s127-s146
Published online: 09 Jun 2015
Abstract | Full Text | References | PDF (1704 KB)
1214 Views · 7 CrossRef citations · 0 Altmetric

Article
Coastal Ocean Forecasting: science foundation and user benefits
V.H. Kourafalou, P. De Mey, J. Staneva, N. Ayoub, A. Barth, Y. Chao, M. Cirano, J. Fiechter, M. Herzfeld, A. Kurapov, A.M. Moore, P. Oddo, J. Pullen, A. van der Westhuysen & R.H. Weisberg
Pages: s147-s167
Published online: 09 Jun 2015
Abstract | Full Text | References | PDF (1488 KB)
1353 Views · 9 CrossRef citations · 1 Altmetric

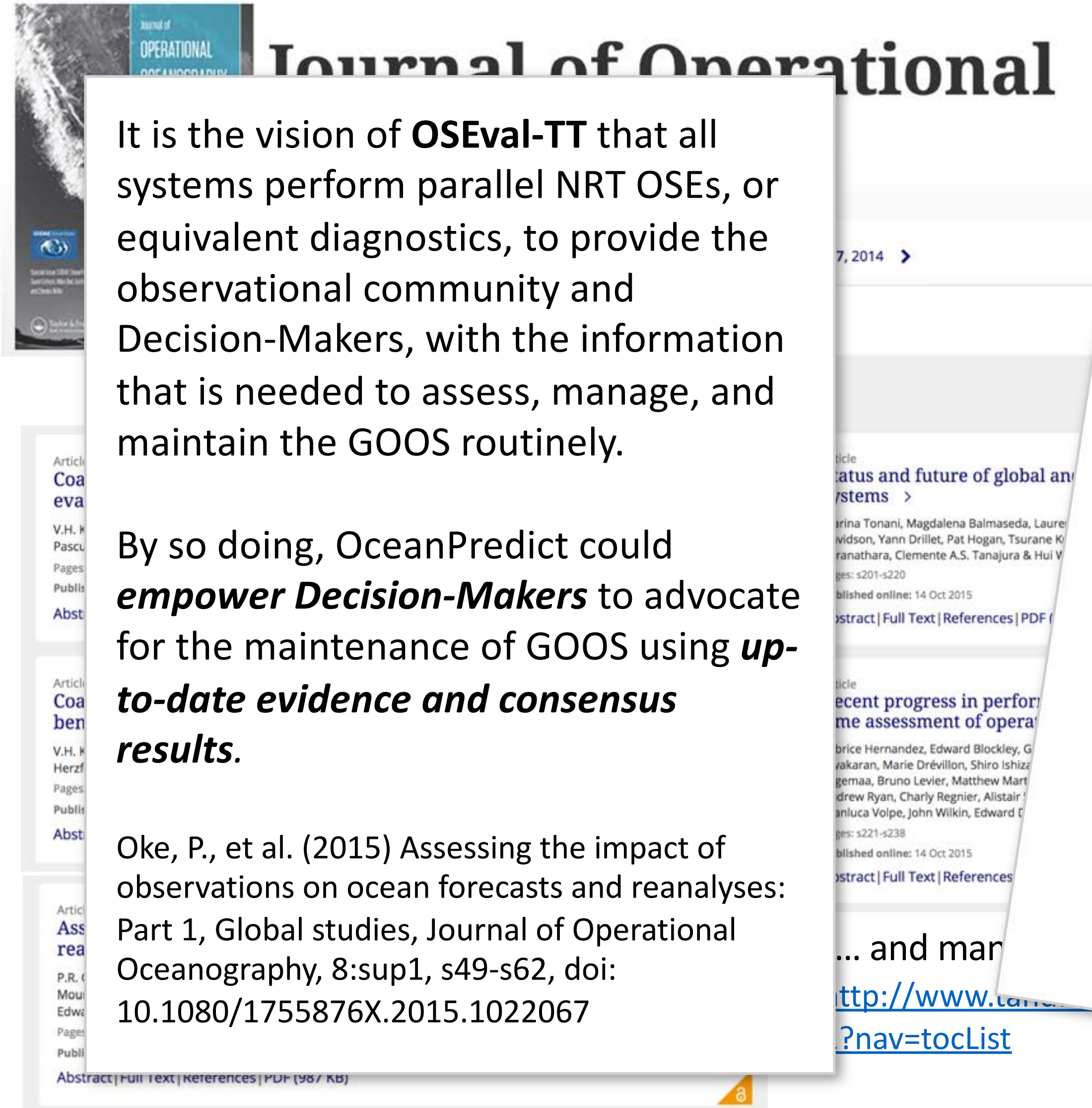
Article
Assessing the impact of observations on ocean forecasts and reanalyses: Part 2, Regional applications
P.R. Oke, G. Larnicol, E.M. Jones, V. Kourafalou, A.K. Sperrevik, F. Carse, C.A.S. Tanajura, B. Mourre, M. Tonani, G.B. Brassington, M. Le Henaff, G.R. Halliwell Jr., R. Atlas, A.M. Moore, C.A. Edwards, M.J. Martin, A.A. Sellar, A. Alvarez, P. De Mey & M. Iskandarani
Pages: s63-s79
Published online: 09 Jun 2015
Abstract | Full Text | References | PDF (987 KB)
579 Views · 12 CrossRef citations · 0 Altmetric

Article
Status and future of global and regional ocean prediction systems
Marina Tonani, Magdalena Balmaseda, Laurent Bertino, Ed Blockley, Gary Brassington, Fraser Davidson, Yann Drillet, Pat Hogan, Tsurane Kuragano, Tong Lee, Avichal Mehra, Francis Paranathara, Clemente A.S. Tanajura & Hui Wang
Pages: s201-s220
Published online: 14 Oct 2015
Abstract | Full Text | References | PDF (1330 KB)
703 Views · 9 CrossRef citations · 0 Altmetric

Article
Recent progress in performance evaluations and near real-time assessment of operational ocean products
Fabrice Hernandez, Edward Blockley, Gary B. Brassington, Fraser Davidson, Prasanth Divakaran, Marie Drévillon, Shiro Ishizaki, Marcos Garcia-Sotillo, Patrick J. Hogan, Priidik Lagemaa, Bruno Levier, Matthew Martin, Avichal Mehra, Christopher Mooers, Nicolas Ferry, Andrew Ryan, Charly Regnier, Alistair Sellar, Gregory C. Smith, Sarantis Sofianos, Todd Spindler, Gianluca Volpe, John Wilkin, Edward D. Zaron & Aijun Zhang
Pages: s221-s238
Published online: 14 Oct 2015
Abstract | Full Text | References | PDF (3650 KB)
505 Views · 6 CrossRef citations · 0 Altmetric

… and many more articles

http://www.tandfonline.com/toc/tjoo20/8/sup1?nav=tocList



It is the vision of **OSEval-TT** that all systems perform parallel NRT OSEs, or equivalent diagnostics, to provide the observational community and Decision-Makers, with the information that is needed to assess, manage, and maintain the GOOS routinely.

By so doing, OceanPredict could ***empower Decision-Makers*** to advocate for the maintenance of GOOS using ***up-to-date evidence and consensus results***.

Oke, P., et al. (2015) Assessing the impact of observations on ocean forecasts and reanalyses: Part 1, Global studies, Journal of Operational Oceanography, 8:sup1, s49-s62, doi: 10.1080/1755876X.2015.1022067

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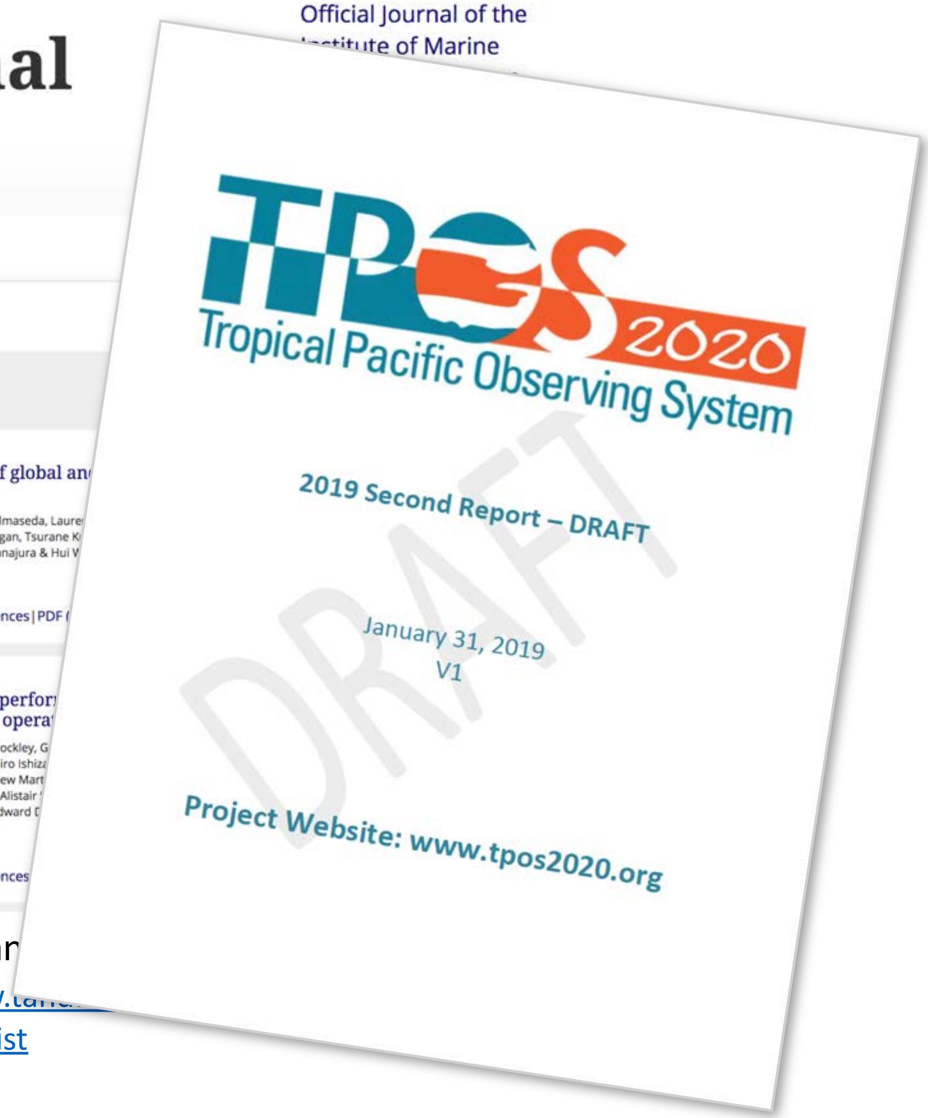

Recommendation 2.2.

Increase support for ***observing system sensitivity and simulation experiments*** to identify observations that constrain models most effectively and have ***high impact on forecasts***. …

3.3.3.2 Sensitivity to Initial conditions

Marshall et al. (2016) showed that the record March 2015 MJO event was promoted by the unusual SST anomaly at the edge of the western Pacific warm pool, and ***without this anomaly*** in the initial condition the amplitude of the ***MJO was underpredicted by ~25%.*** Hence, ***accurate initialization was critical*** for accurate prediction …

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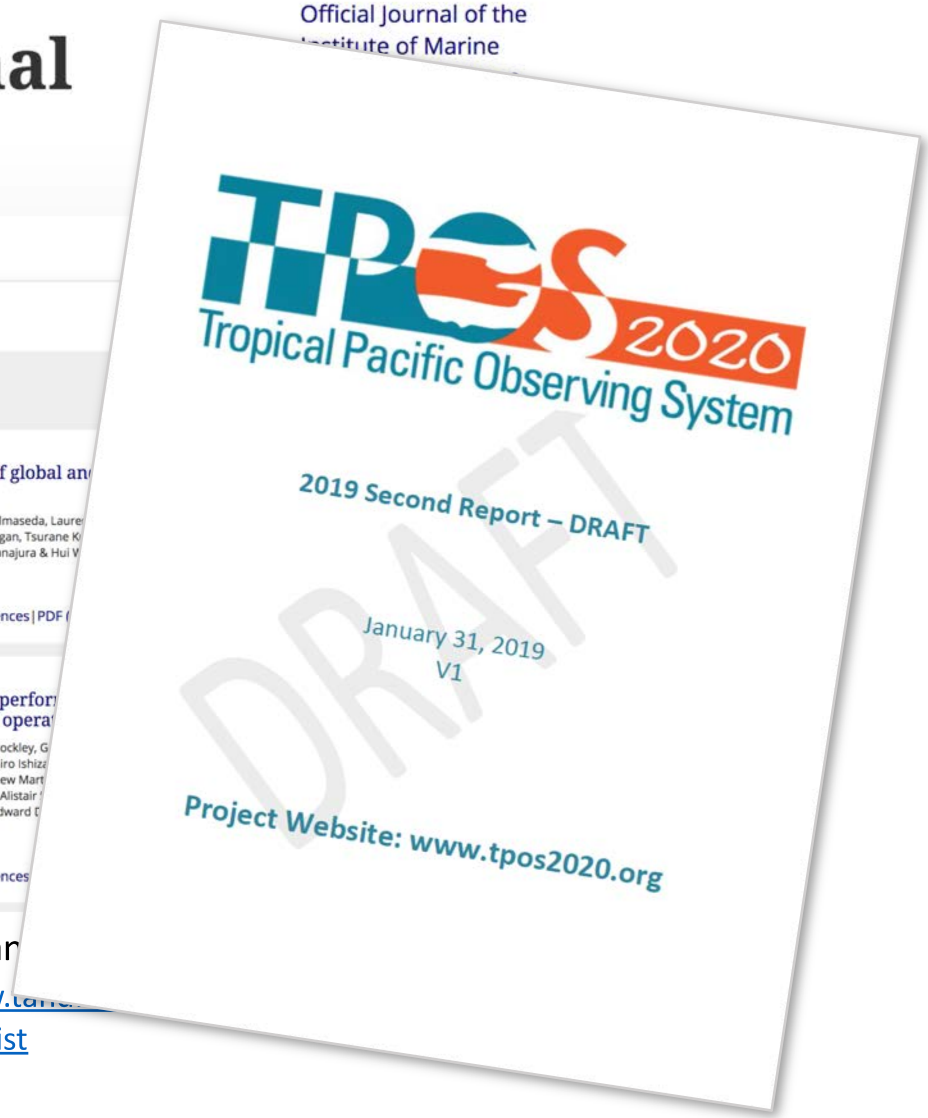

OceanPredict and GOOS

And yesterday …

- Require strengthened cooperation between GOOS and OceanPredict
- Alignment of work plans
- Co-development and co-evolution of respective systems

– Pierre-Yves Le Traon

The adequate ocean observing system of today need not, and should not, be the sustained system of tomorrow.

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- Require
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- Alignm
- Co-dev
  of respective sys
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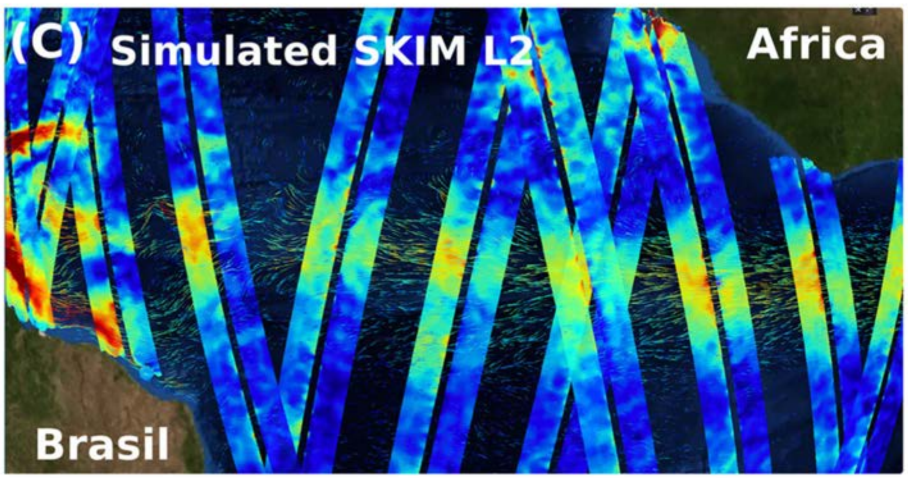
What if you had 1000 autonomous vehicles?

- Where would you deploy them?
- Can your model help these “be in the right place at the right time”

The adequate ocean observing system of today need not, and should not, be the sustained system of tomorrow.

OceanPredict and GOOS



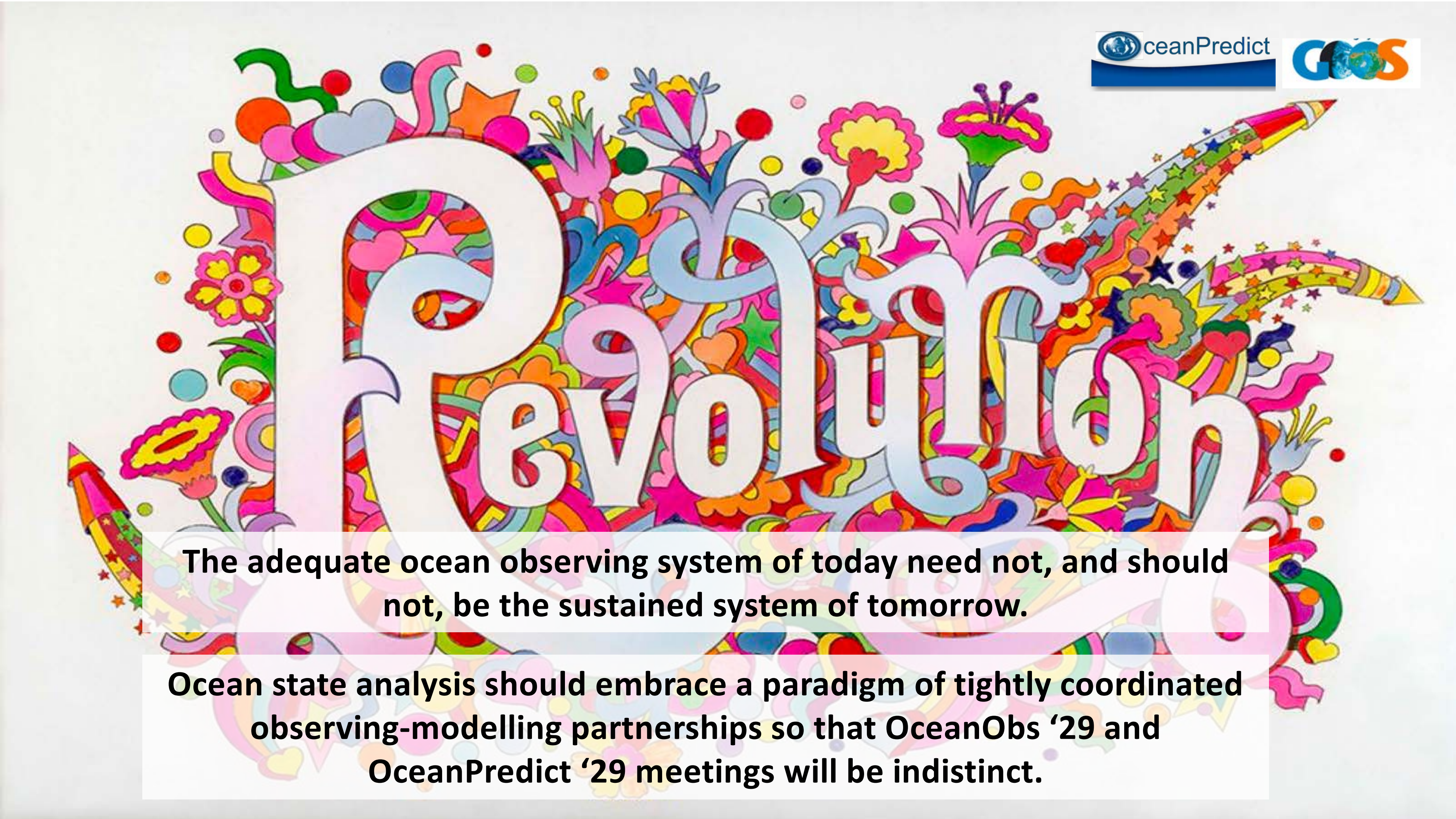
What if you had 1000 autonomous vehicles?

- Where would you deploy them?
- Can your model help these "be in the right place at the right time"

What if you had

- Global surface currents from SKIM?
- Operational satellite surface salinity?
- Global geostationary ocean colour?

Ocean state analysis should embrace a paradigm of tightly coordinated observing-modelling partnerships so that OceanObs '29 and OceanPredict '29 meetings will be indistinct.



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