The Ocean Observations Physics and Climate panel

A panel of the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), and the World Climate Research Programme (WCRP)

Provides scientific advice to the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)*

Chairs: Bernadette Sloyan, John Wilkin
Secretariat: Katy Hill (GCOS/GOOS)

With input from GOOS Biogeochemistry and Biology Panels and JCOMM Observations Coordination Group

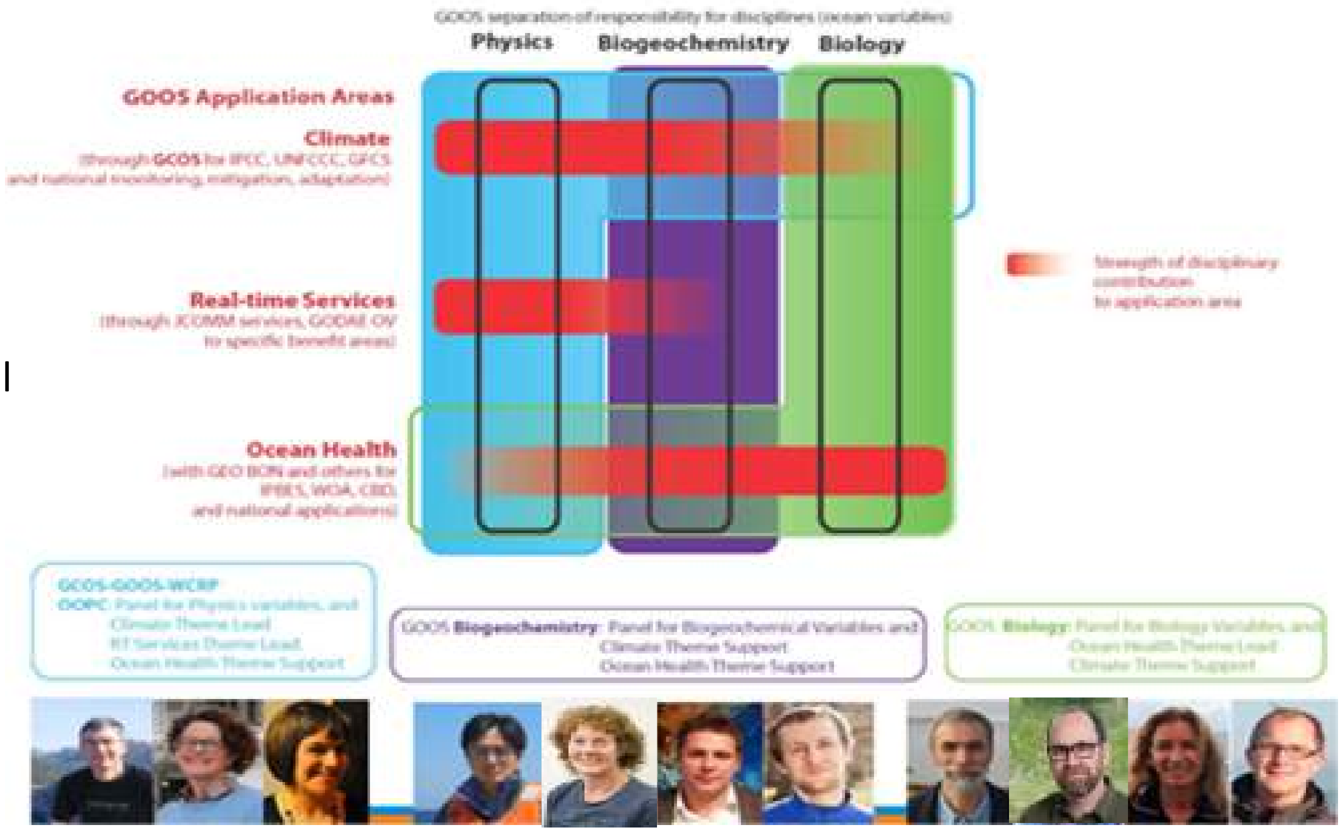
*– World Meteorological Organisation - Intergovernmental Oceanographic Commission

GCOS • GOOS • WCRP
OOPC Ocean Observations Physics and Climate panel

GCOS The Global Ocean Observing System GOOS WCRP jcomm

GOOS Panels

- From GOOS Perspective, OOPC has a large and important role to play, responsible for leading on
  - Physics Essential Ocean Variables
  - Leads on Climate applications (Ocean Essential Climate Variables)
  - Leads on Operational applications
  - Supporting Ocean Health applications.



Introducing

THE PANELS: OOPC, MARCH 2018
IOCCP OCTOBER 2018, BIO/ECO NOVEMBER 2019

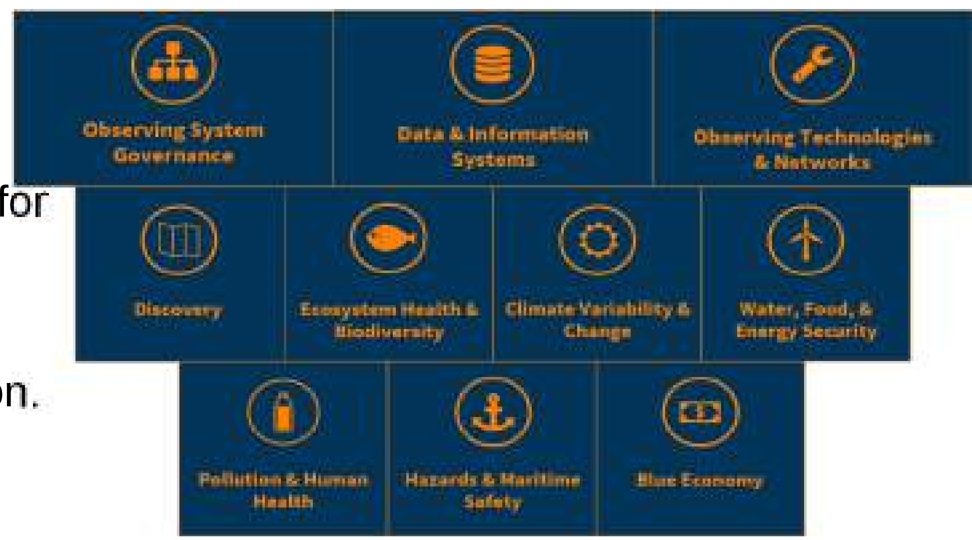
Outline

- Major initiatives and opportunities.
- Requirements:
  - New perspectives and challenges
  - Observing system reviews evaluations to inform observing system development
- Observing network coordination and performance tracking
- Challenges and opportunities:
  - GCOS cross panel meeting – expectations and outcomes.

Major Initiatives, Drivers

OOPC Engagement in OceanObs'19

- Major decadal planning exercise. OOPC was instrumental in organising previous 2 OceanObs conferences.
  - 2 panel members are co-chairs of the Programme Committee.
  - 1 panel member co-chair of the sponsors committee.
- OOPC Secretariat supported establishing committees, project office, and coordinated initial sponsorship engagement.
- 140 Whitepapers under development aligned with themes:
  - OOPC members leading on key papers which align with OOPC Work Plan priorities.
  - OOPC Overarching paper on ocean observations for physics/climate
- Programme focussed on
  - Innovation, Integration, Interopperability Information.



UN Decade of Ocean Science for Sustainable Development

- Considered an 'Innovation Incubator' for the Ocean Observing System.
- Aim to position outcomes of OceanObs to be taken up by the Decade.
  - Aim: bloster Ocean Observations
- (See more in IOC, GOOS talks)

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

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IPCC Special Report 1.5 degrees C.
Are we in a position to track these changes?

- **Oceans**. Limiting warming to 1.5°C compared to 2°C: substantially reduce risks to marine biodiversity, ecosystems and their ecological functions and services to humans in ocean and coastal areas, especially Arctic sea-ice ecosystems and warm water coral reefs.
- a. With 2°C of global warming, it is very likely that there will be at least one **sea ice-free Arctic summer** per decade. This is reduced to one per century with 1.5°C global warming.
- b. **Ocean ecosystems** are experiencing large-scale changes with critical thresholds being exceeded at 1.5°C and above. Crossing these thresholds may have irreversible effects.
- c. The majority of **warm water coral reefs** are already experiencing the large-scale loss of coral abundance (cover) today and would lose a further 70-90% of cover at 1.5°C.
- d. **Ocean acidification** at 1.5°C is expected to amplify the adverse effects of warming, impacting the survival, calcification, growth, development, and abundance of a broad range of taxonomic groups (i.e. from algae to fish)
- e. The risk of **declining ocean productivity**, distributional shifts (to higher latitudes), damage to ecosystems (e.g. coral reefs, wetlands), loss of fisheries productivity (at low latitudes), and changing ocean chemistry (e.g., acidification, hypoxia) are projected to be substantially lower at 1.5°C compared to 2°C

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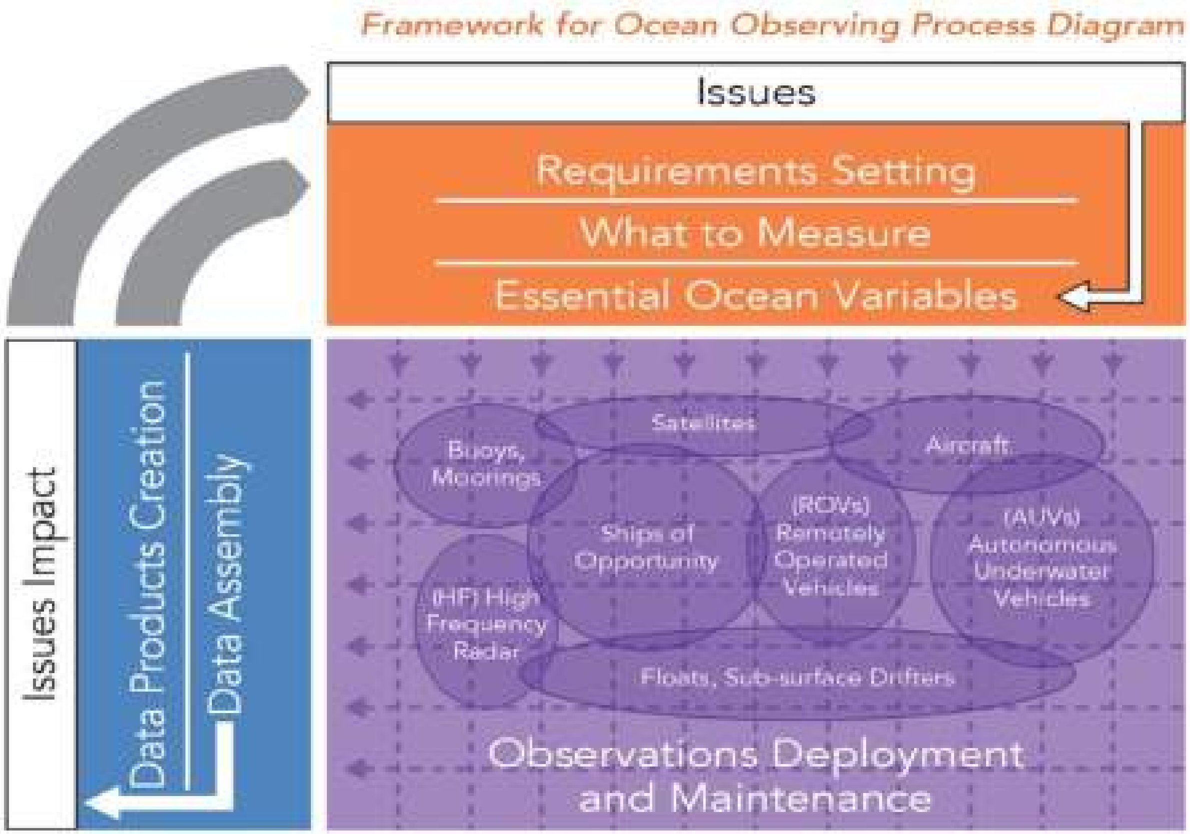
OOPC Ocean Observations Physics and Climate panel

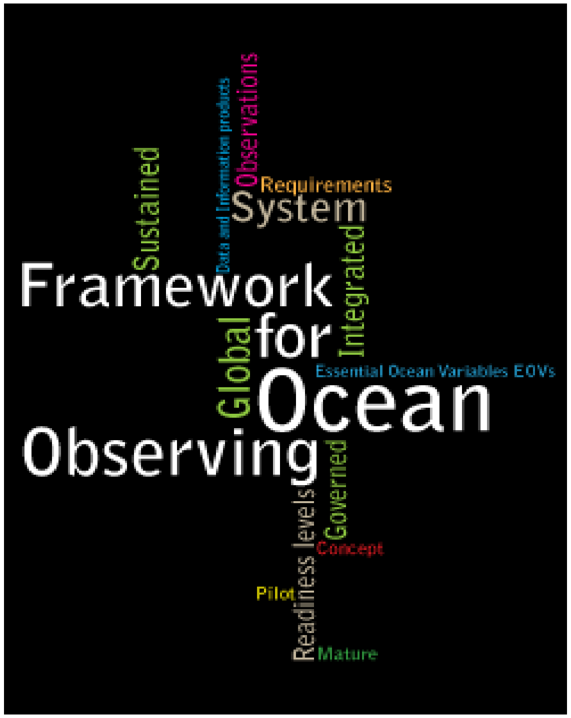
ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

OOPC Focus

- **Assess, review and prioritize requirements** for Essential Ocean Variables, **EOVs** and Essential Climate Variables, **ECVs**
- Work with JCOMM OCG and regional bodies to **coordinate observing networks**
- **Review** the status of and **requirements** for **data and information management**
- Develop a **process for ongoing evaluation** of the observing system
- **Liaison and advocacy** for agreed plans
- Report to sponsors, partners.

Framework for Ocean Observing (FOO)





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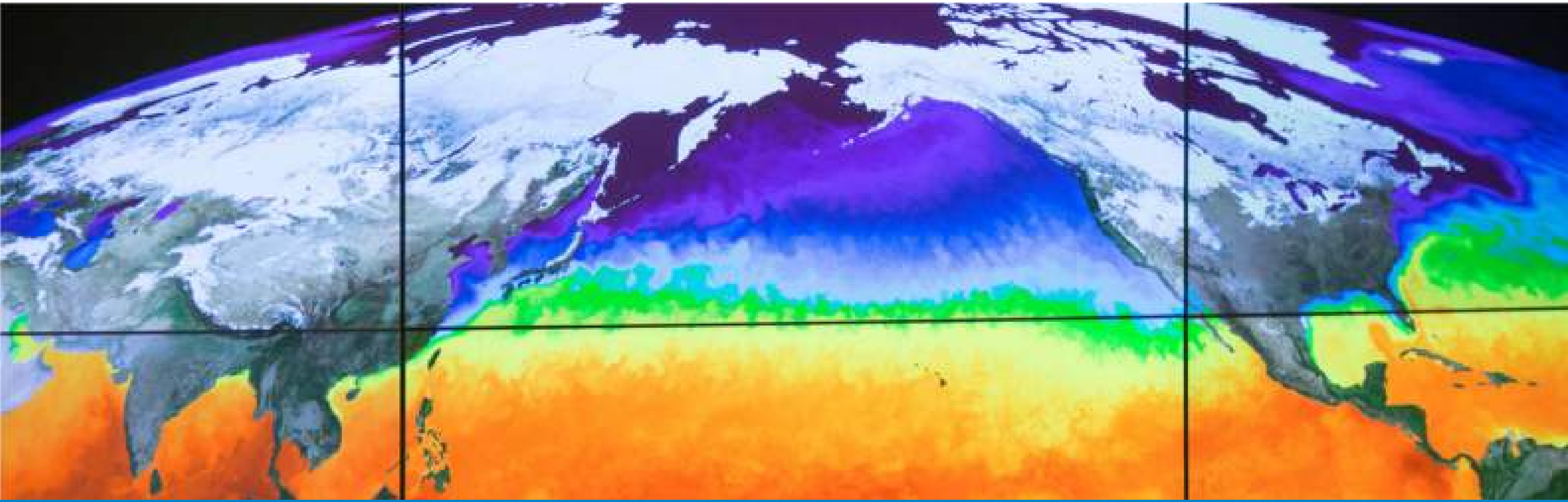


Developing Requirements and Observing System Design for

ESSENTIAL CLIMATE VARIABLES

EOVs and Essential Climate Variables (ECVs)

Physics

- Sea State
- Ocean surface stress
- Ocean Heat Fluxes
- Sea Ice
- Sea level
- SST
- Subsurface temperature
- Surface currents
- Subsurface currents
- Sea Surface Salinity
- Subsurface salinity

Biogeochemistry

- Oxygen
- Nutrients
- Inorganic Carbon
- Transient tracers
- Particulate matter
- Nitrous oxide
- Stable carbon isotopes
- Dissolved organic carbon
- Ocean colour

www.goosocean.org/eov

Biology and Ecosystems

Plankton

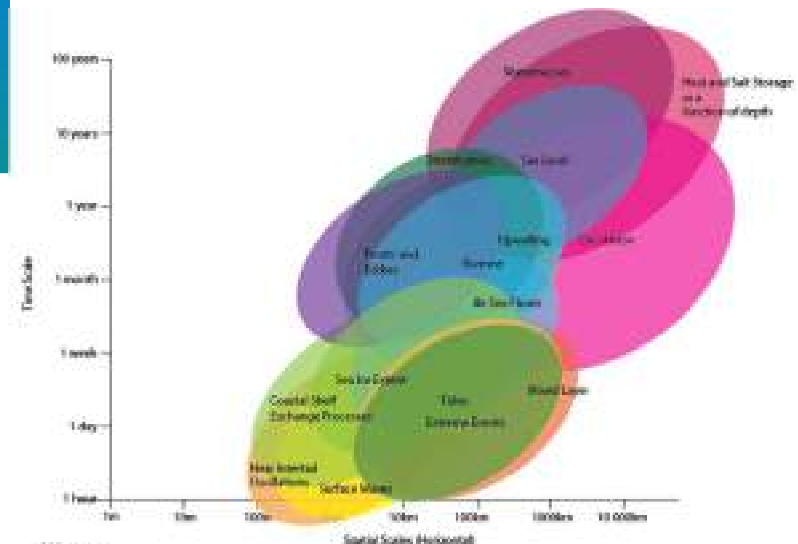
- Phytoplankton biomass and diversity
- Zooplankton biomass and diversity
- Fish abundance and distribution
- Marine turtles birds and mammals abundance and distribution

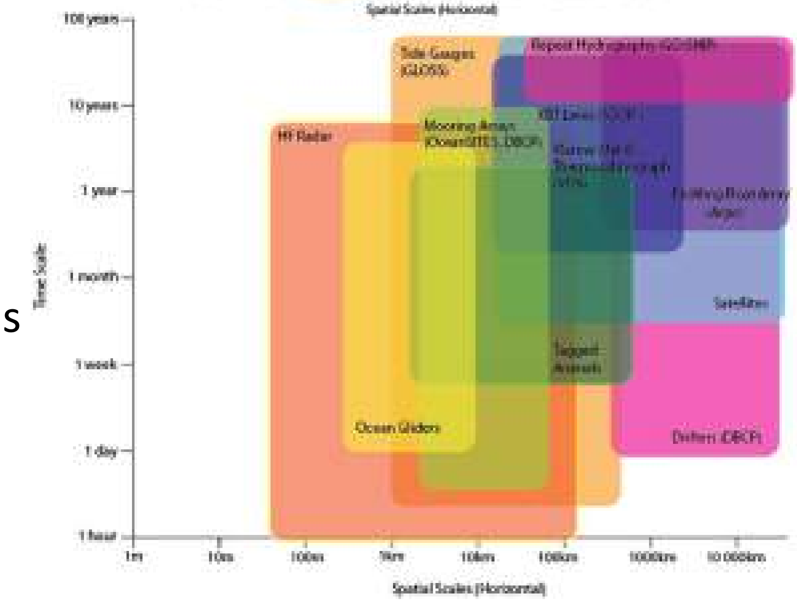
Marine Habitat Properties

- Hard coral cover and composition
- Seagrass cover and composition
- Mangrove cover and composition
- Macroalgal cover and composition
- Microbe biomass and diversity (*emerging)
- Benthic invertebrate abundance and distribution (*emerging)
- Ocean sound

Developing requirements for Essential Ocean Variables

- EOV Specifications
  - Mapping of societal drivers, applications, phenomena, EOV requirements, observing components, data streams.
  - Phenomena approach; easy to draw out requirements for different applications (e.g. climate relevant phenomena)
  - Seeking clarification, agreement between GCOS/GOOS on requirements setting, terms, etc before updating (see GCOS-GOOS paper).
    - Important to ensure that Panel efforts meet needs of both GCOS, GOOS
    - Clarity on terminology, how one maps to other particularly important for users.





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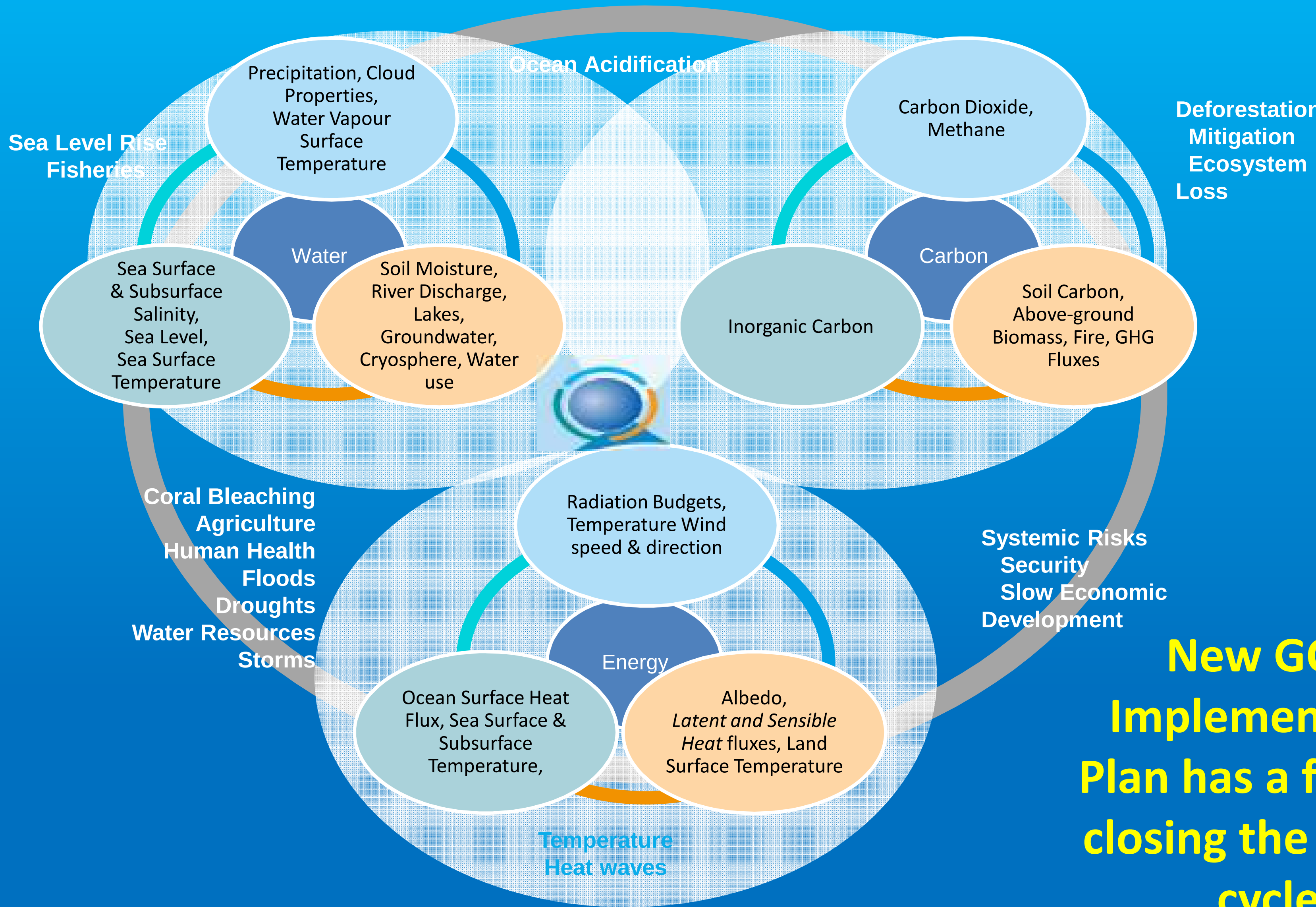
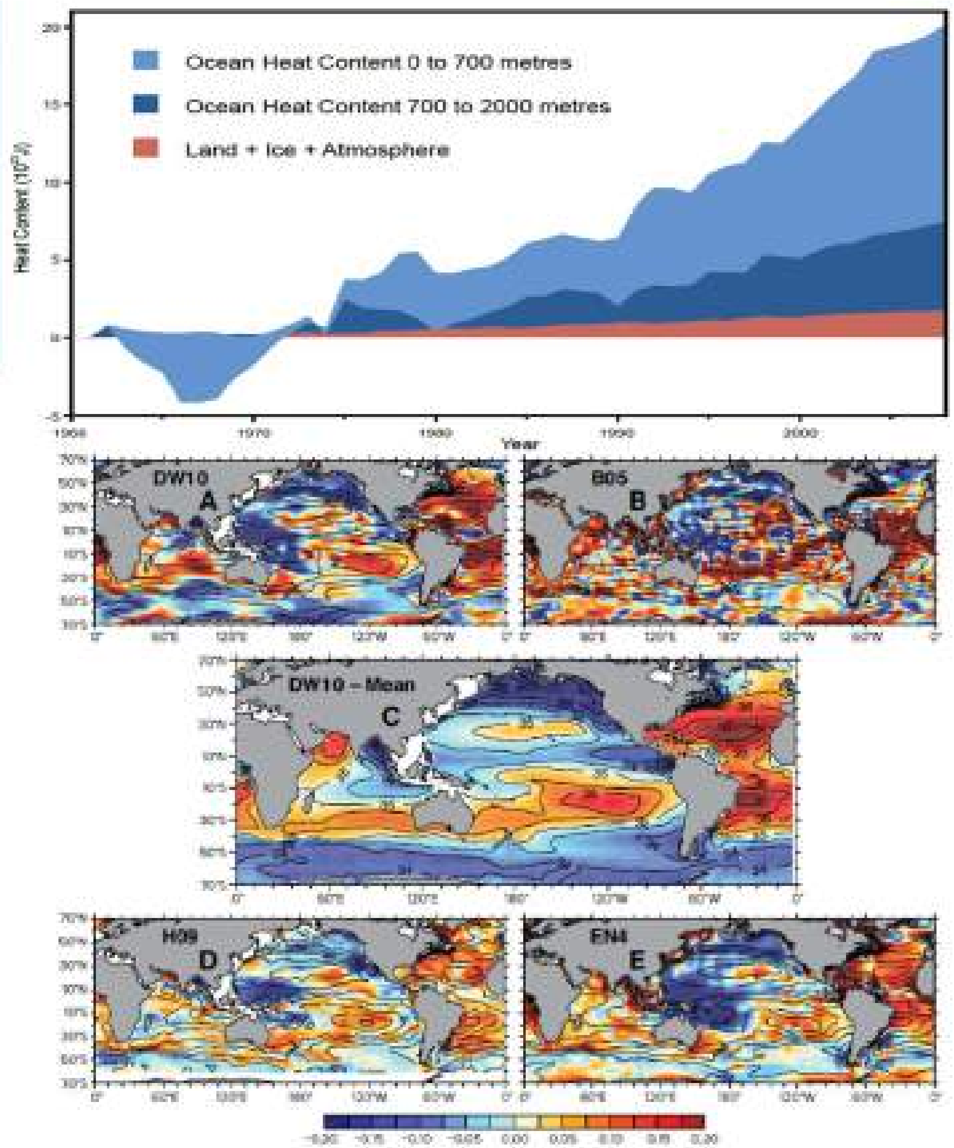


New GCOS Implementation Plan has a focus on closing the climate cycles

Review: Ocean Heat and Freshwater Storage

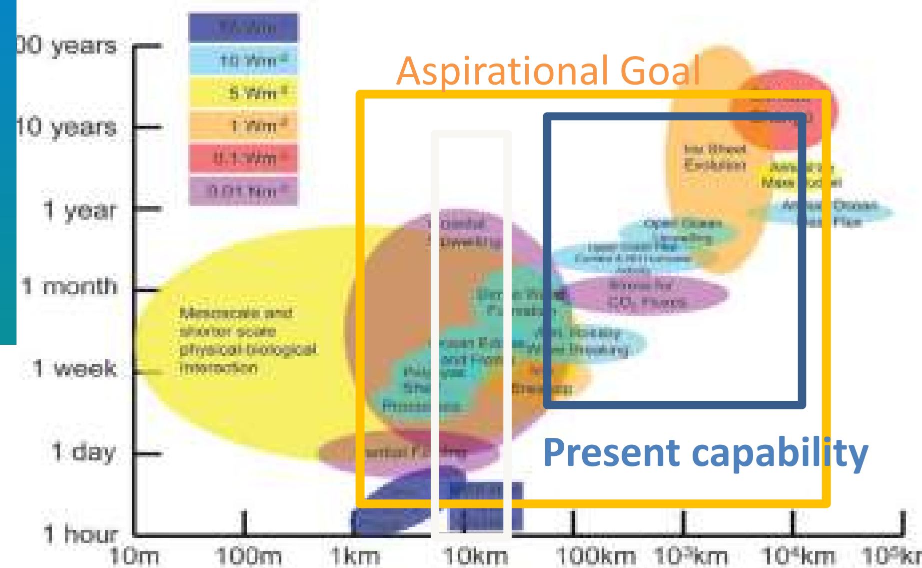
(Leads: Matt Palmer, Paul Durack).

- Around 20 Experts invited to engage.
- Aim: undertake a review of the observing system for capturing changes in Heat and Freshwater Storage:
  - Review drivers, requirements (space/time scales.
  - Agree on set of global/regional analyses.
  - Workshop to review analyses, agree on drafting of review paper.
- Outcomes: recommendations on observing system gaps, adjustments; improve integration, products.
- Proposed workshop: late 2018 or early 2019, UK Met Office.
- OO’19 Community Whitepaper outlining approach



Strategy: Air-Sea Heat Fluxes

Meghan Cronin Bob Weller, (OOPC)
Marjolaine Krug (OOPC - link to boundary currents), Liz Kent (AOPC).



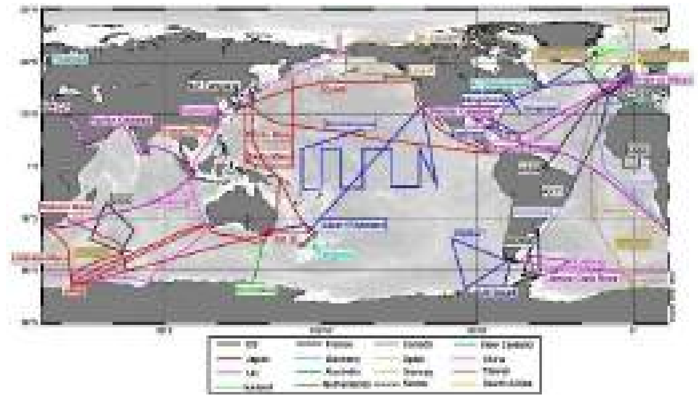
Aspirational Goal:
Random regional uncertainty <10W/m2
Bias error < 1 W/m2, Error in basin average < 1 W/m2

- Motivation:
  - Air Sea Fluxes key to understanding and predicting climate from days to decades.
  - Large uncertainties in flux products
  - New techniques and technologies mean opportunity to make progress. .
- AIM: outline ambitious forward strategy for improving estimates of air-sea fluxes
  - Drivers for improved flux estimates, need to engage modelling groups.
  - Coordinated requirements, observing system design (atm, ocean, land)
  - Satellite-In Situ integration
  - Data curation (historical ship, next gen direct flux data).
- Future: include fluxes of properties, gases (engage GOOS BGC Panel).

OO'19 Community Whitepaper

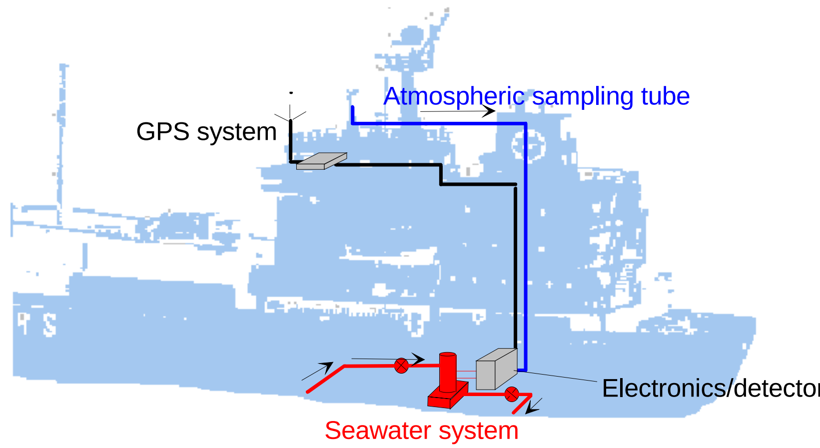
Surface ocean CO_2 observations

soconet
· SURFACE OCEAN CO_2 OBSERVING NETWORK ·



Objectives:

- To provide a coordinated framework of surface water CO_2 data of known high-quality following established principles and best practices to determine accuracy in order to:
  - Provide annual estimates of **global air-sea CO_2 fluxes** to within 0.2 Pg/yr.
  - Determine **trends of surface water pCO_2** to within 0.2 µatm/yr
- To provide reference data of known quality for validation and intercomparison with other data



Note:

- **Atmospheric CO_2** from some data originators (discussions with GAW)
- **Need to connect to AOPC re. surface ocean/atm. Observing requirements, targets**

Global Atmospheric Watch (GAW)

WMO has recognized the first marine vessel as a regional station in the GAW network.

GAW seeks to understand the short-term variability and long-term trends in the composition of the atmosphere.

The instruments for dedicated atmospheric composition and meteorological sensors are onboard the vessel on a permanent basis, which together with the underway ocean surface sensors provide a perfect platform for monitoring the ocean—atmosphere boundary layer.

Requirements for Ocean Acidification

SDG Indicator 14.3.1 Methodology accepted by the IOC-UNESCO Executive Council

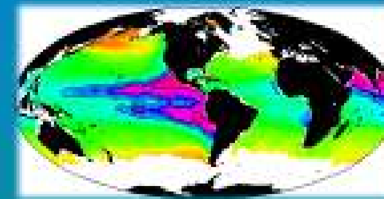
Ocean Acidifcation becomes one of GCOS WMO's Global Climate Indicators

Working towards time series based synthesis products

Global Ocean Acidification Observing Network

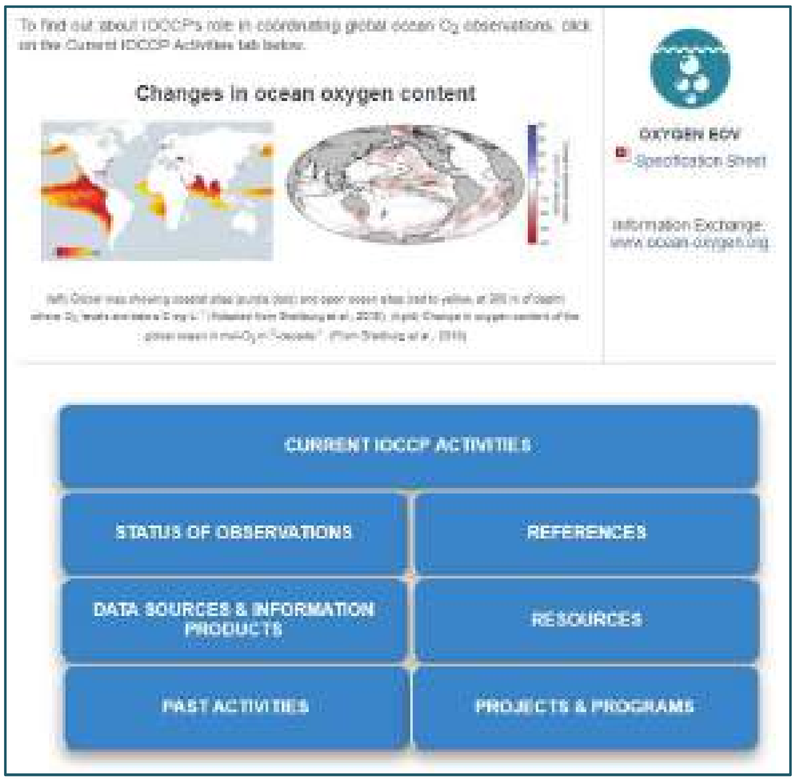
GOA-ON Data Portal Explorer:
http://portal.goa-on.org/Explorer

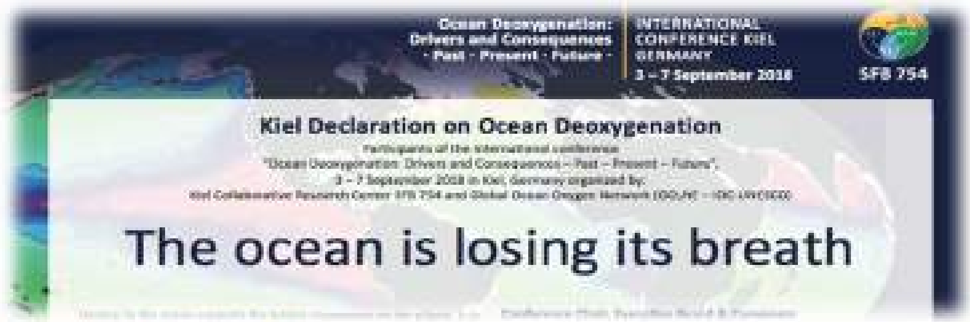
Setting requirements for Oxygen EOV/ECV & ocean deoxygenation phenomenon

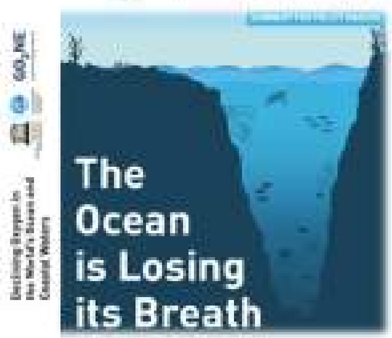


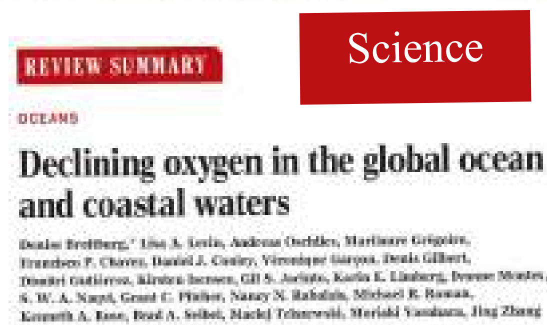
www.sfb754.org

www.ioccp.org/oxygen









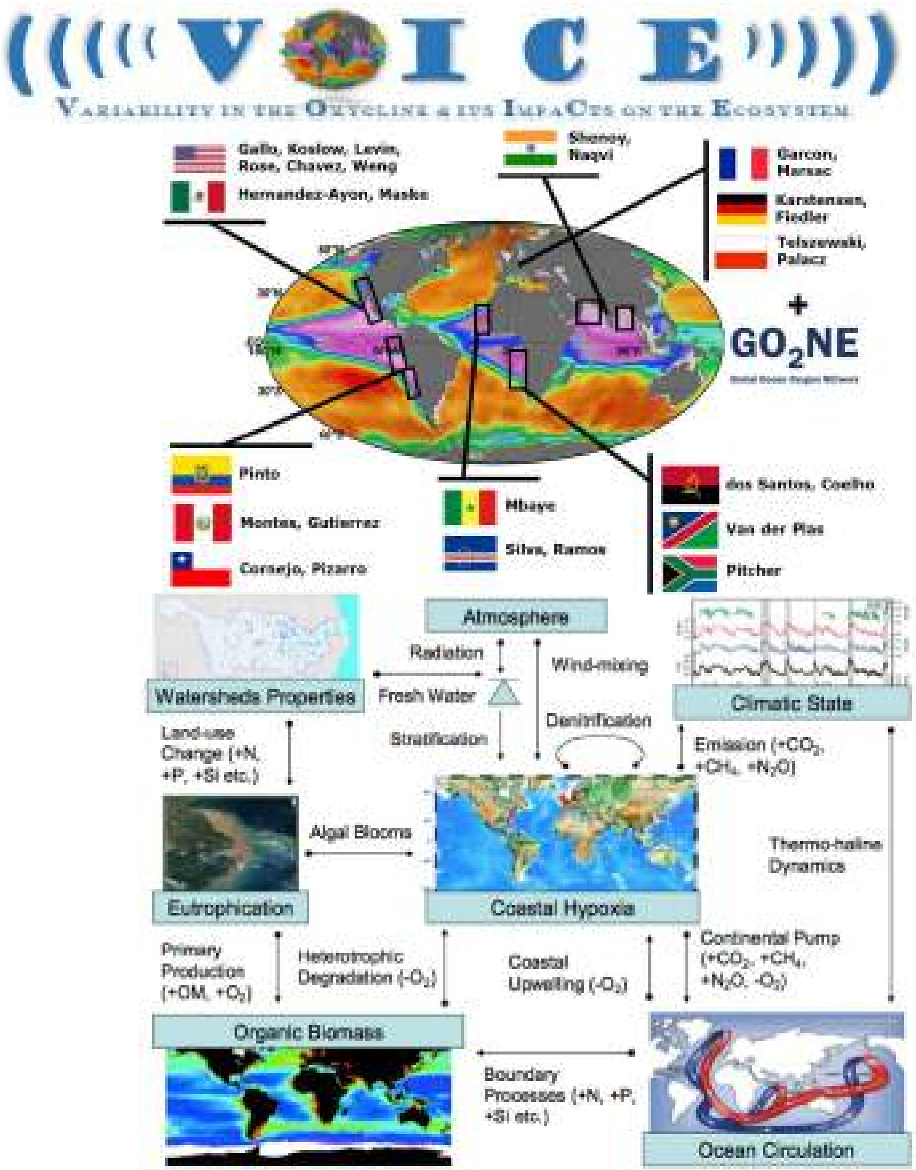
Oxygen Minimum Zone (OMZ) observing system: general requirements

o Climate Drivers:

(e.g. OMZ expansion, deoxygenation, N_2O greenhouse gas release)

- Many OMZ observing targets are truly multidisciplinary require simultaneous Physics, Biogeochemistry, Biology/Ecosystems observations,
- Multiplatform approach needed to capture all relevant scales and timescales.
- GO_2NE Observing network for Oxygen
- VOICE Project: to advance development of observing system design for Oxygen Minimum Zones, building on existing networks.

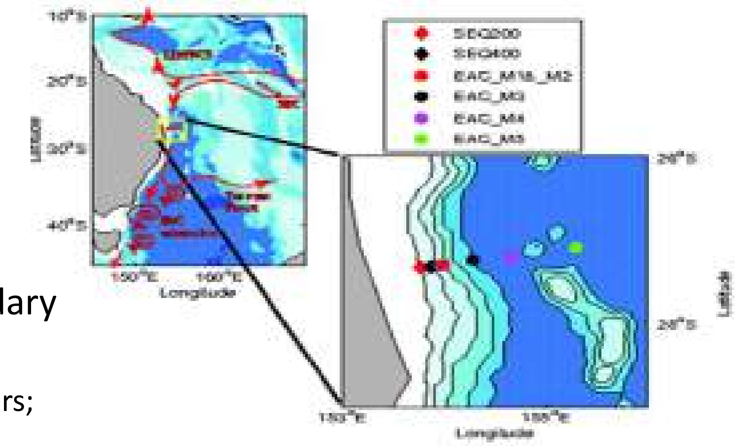
OceanObs'19 Community White Paper: Multidisciplinary ocean observing in the world ocean's OMZ regions: from climate to fish – the VOICE initiative

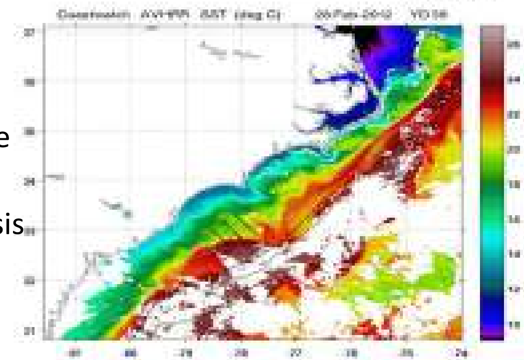


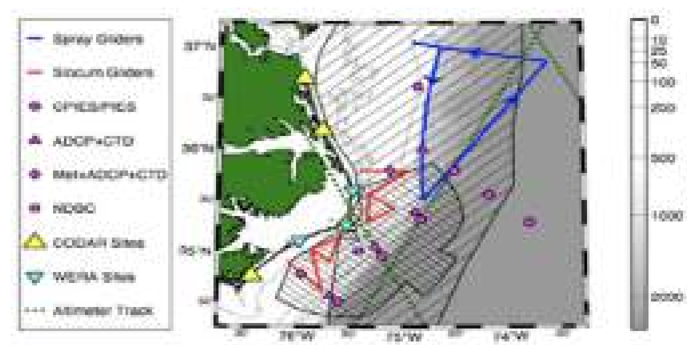
Project: Boundary Currents

Leads: John Wilkin, Maria Paz Chidichimo, Marjolaine Krug

- AIM: Establish an ongoing project to guide, support the development of boundary current observing systems
  - Leveraging OO'19 Whitepapers (Boundary Currents 'super' paper; Coastal BGC/Eco papers; Network based papers; New technologies)
  - Reviews of mature BC obs. systems and process studies.
  - Collaboration with OceanPredict through OSSEs etc.
  - Engage GRAs on capacity development, open data, collaboration/access to coasts; articulate societal impacts
  - Work with observing networks to coordinate multi-platform approaches and model synthesis
- Progress:
  - Sent out communique, seeking input and interest from broader community.
- Next Steps:
  - Developing prospectus for project
  - Establish Steering Committee (12-15 people)
  - Work toward a community workshop around pilot project themes: WBC fluxes; EBC OMZ; OSSEs to design multi-platform sustained systems







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Biological EOVs Implementation Plans

Biology and Ecosystems Panel

IMPLEMENTATION OF BIOLOGICAL EOVS		*TO BE CONTRIBUTED BY OOPC*
Hard Coral	ICRI (International Coral Reef Initiative), GCRMN (Global Coral Reef Monitoring Network) *November 2017* *Dar es Salaam, Tanzania*	• Sea surface height • Sea surface temperature • Surface currents • Sea surface salinity • Ocean surface heat flux
Phytoplankton Zooplankton	Ocean RCN, SCOR, GACS *June 2018* *Santa Cruz, CA, USA*	• Sea surface height • Sea surface and subsurface temperature • Surface and subsurface currents • Sea surface and subsurface salinity • Ocean surface heat flux
Macroalgal Canopy	pogo *September 2018* *Hobart, Australia*	• Sea surface height • Sea surface temperature • Surface currents • Sea surface salinity • Ocean surface heat flux

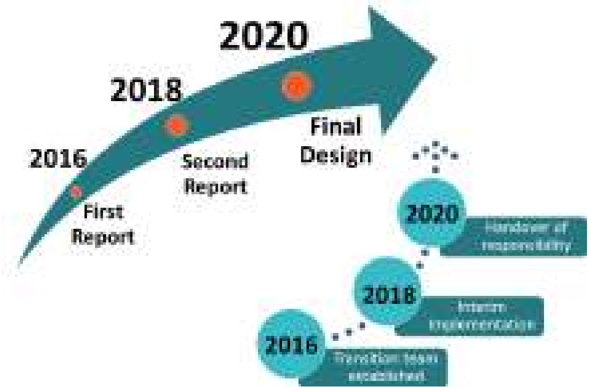
...and for the rest of the EOVs as they develop...

Working with regional projects and reviews:

- OOPC provides support and guidance on conducting reviews to ensure they help in advancing the global effort.
- Identifies synergies and opportunities to connect regional reviews and efforts.
- Considers recommendations, challenges and advances in requirements/approaches and recommendations in global context.
- Assists in connecting projects into higher level science and coordination bodies

DEEP OCEAN OBSERVING STRATEGY

TPOS 2020
Tropical Pacific Observing System



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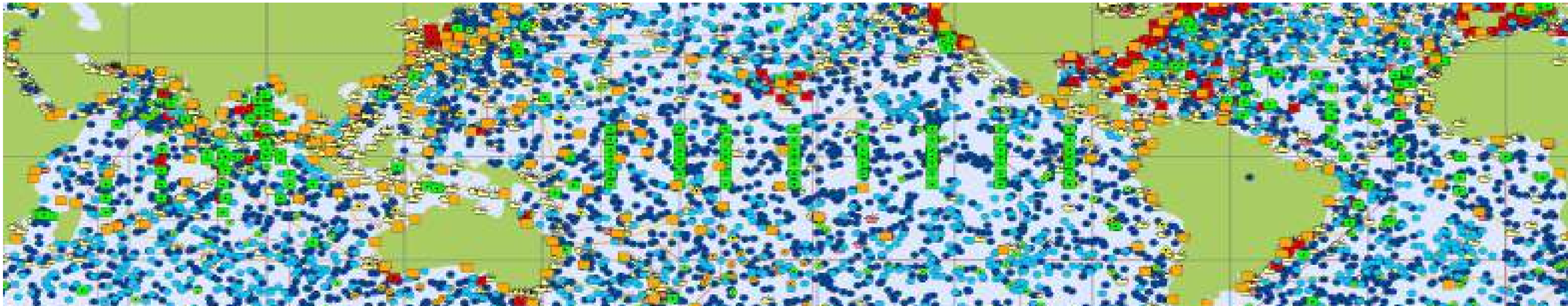
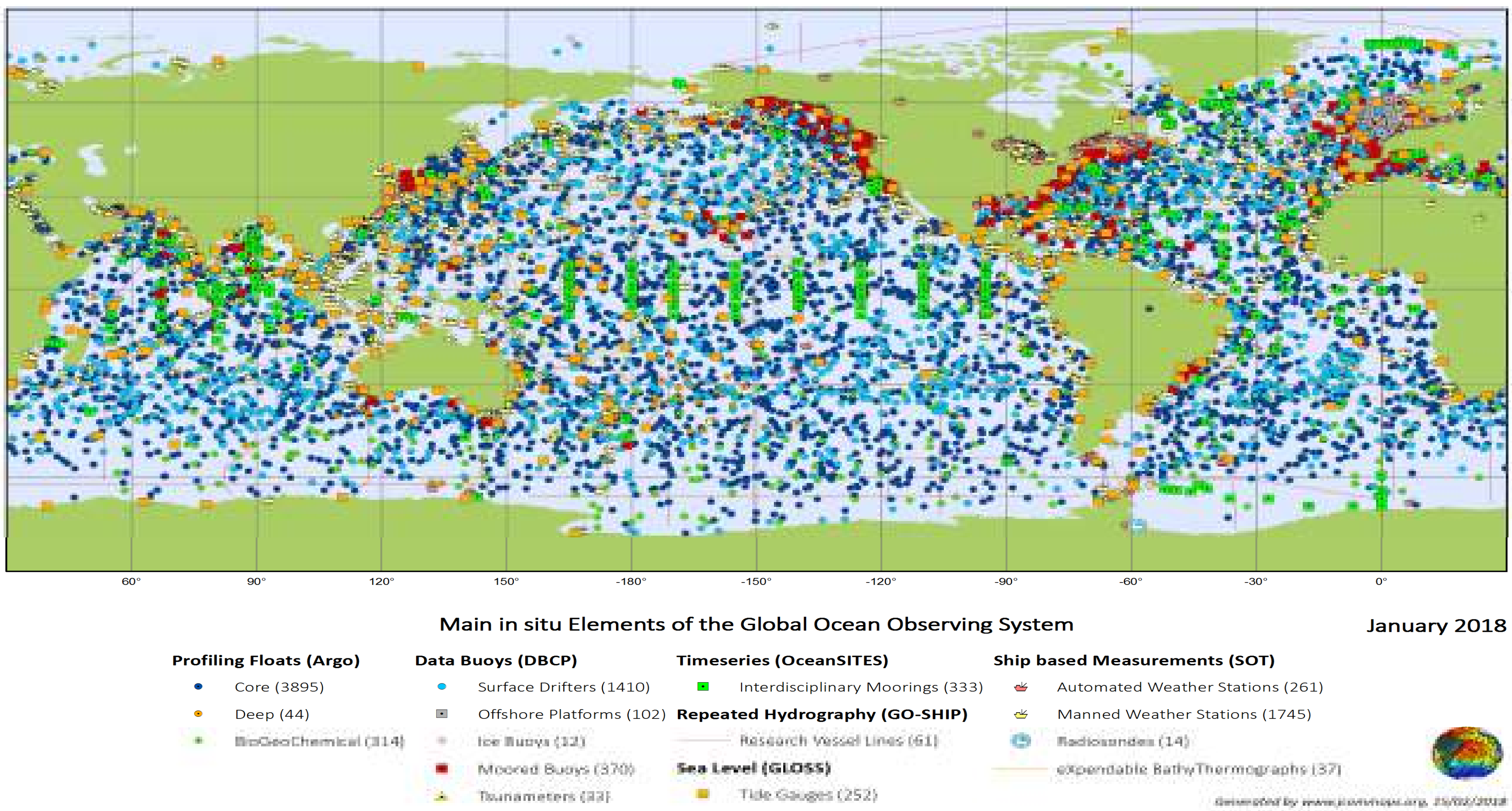


Working with JCOMM Observations Coordination Group

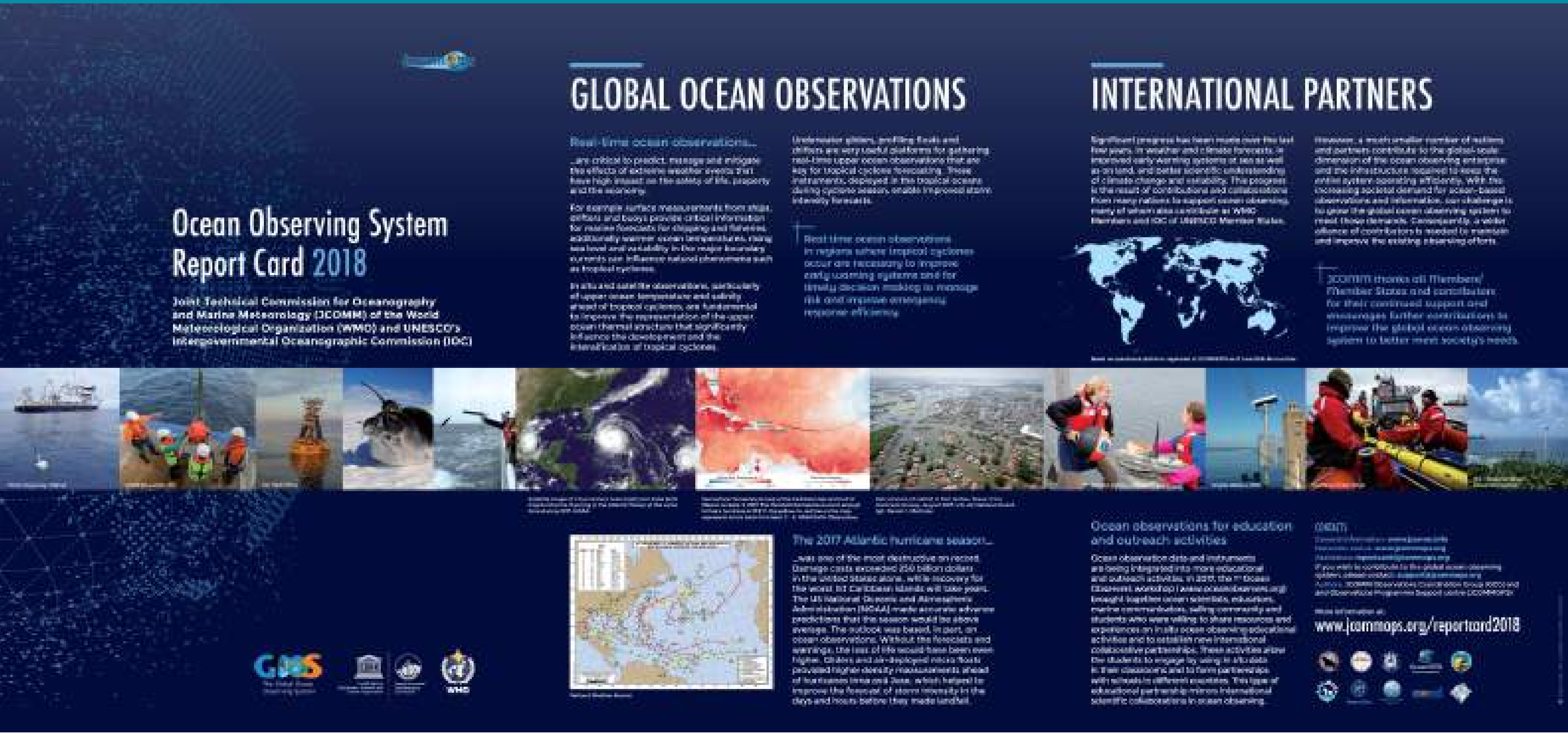
THE OBSERVING NETWORKS.

JCOMMOPS



60°
90°
120°
150°
-180°
-150°
-120°
-90°
-60°
-30°
0°
Main in situ Elements of the Global Ocean Observing System
January 2018
Profiling Floats (Argo)
Core (3895)
Deep (44)
BioGeoChemical (314)
Data Buoys (DBCP)
Surface Drifters (1410)
Offshore Platforms (102)
Ice Buoys (12)
Moored Buoys (370)
Tsunameters (33)
Timeseries (OceanSITES)
Interdisciplinary Moorings (333)
Repeated Hydrography (GO-SHIP)
Research Vessel Lines (61)
Sea Level (GLOSS)
Tide Gauges (252)
Ship based Measurements (SOT)
Automated Weather Stations (261)
Manned Weather Stations (1745)
Radiosondes (14)
eXpendable BathyThermographs (37)
Generated by www.jcommops.org, 15/02/2018

Monitoring status and Impact of the Observing System



Monitoring status and Impact of the Observing System

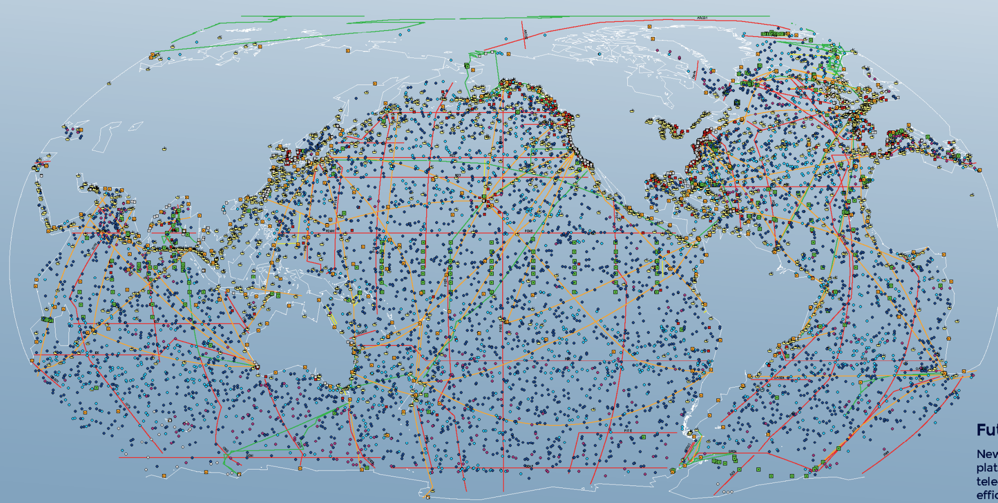
IN SITU AND SATELLITE OBSERVING SYSTEM STATUS

In situ and satellite observations are fundamental for delivering marine weather and ocean services (*e.g.* forecasts) to support safety of life and property at sea, maritime commerce and the well-being of coastal communities. Not only they underpin scientific knowledge and the intricate relationship between the ocean, the atmosphere and the ice, but they also provide insights into the global weather and climate system and the impacts of long-term climate change. These ocean observations also provide information on the occurrence of marine natural hazards and increasing stress on the ocean from human activities; both posing challenges to sustainable development.

The **Ocean Observing System Report Card 2018** seeks to inform ocean observing stakeholders, society and decision-makers about the status of the global ocean observing system coordinated by the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM).

The global ocean observing system has developed significantly over the last few years, with emerging networks and sensors helping to meet new requirements and to deliver critical data at different time and space scales. For instance, global ocean heat content, increasing ocean acidification and sea level rise can now be observed with unprecedented accuracy. Continued availability and expansion of *in situ* observations are vital to maintaining, and improving upon, that success.

For many years, the satellite network has enabled us to accurately measure fundamental variables such as: ocean surface temperature and salinity, ice coverage, ocean color (an indication of ocean productivity), sea level and sea surface winds. The satellite network relies upon and complements the *in situ* observations. Together they provide foundational knowledge about the ocean environment and enable a wide range of forecasts and services.



Map legend: see in situ and emerging networks tables. Symbols size in the map are exaggerated in the order of hundreds kilometres for readability.

The *in situ* global ocean observing system is composed of multiple platforms, including ship-based weather stations, moored and drifting buoys, autonomous profiling floats, dedicated research vessels and tide gauges, which observe a range of essential environmental variables.

Although the *in situ* ocean observation system provides many fundamental observations, it remains vulnerable, as many of its components are reliant on short-term commitments through research programmes.

JCOMM *in situ* networks	Implementation: Status	Implementation: Trend	Data & metadata: Real-time	Data & metadata: Archived high quality	Data & metadata: Metadata	Comments
Ship based meteorological measurements – SOT/VOS	★★☆	⇨	★★☆	★★★	★★☆	Increasing number of Automatic Weather Stations installed globally.
Ship based oceanographic measurements – SOT/SOOP	★★★	⇨	★★★	★★☆	★★☆	More than 95% of data transmitted in real-time.
Ship based aerological [illegible]	★★☆	⇨	★★☆	☆☆☆	★☆☆	European E-ASAP programme is providing the only steady and stable real-time radiosonde [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Profiling floats – Argo	★★★	⇨	★★★	★★★	★★★	More than 1 scientific paper per day logged.
Repeated transects – GO-SHIP	★★★	⇨	☆☆☆	★★★	★★☆	Increased international participation: Ireland leads its 1st cruise.

Emerging networks and extending capabilities	Highlights	Readiness level
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Animal borne sensors	Regional pilots, polar ocean observations.	PILOT

More information on Global Ocean Observing System readiness level at: www.goosocean.org

Challenges

Today, one of the greatest challenges facing the global ocean observing system is in securing the sustained resources needed to meet the expanding societal demands. This includes filling observation gaps such as in the Arctic, the Southern Ocean, regional basins and the deep ocean below 2,000 meters; and to expand our capability to measure more biogeochemical and ecosystem variables. Other specific challenges include the increasing costs to maintain moorings and deploy instruments in remote areas, in a context of decreasing access to academic and commercial ship time, and the communication to coastal communities to avoid vandalism to the existing moored buoys.

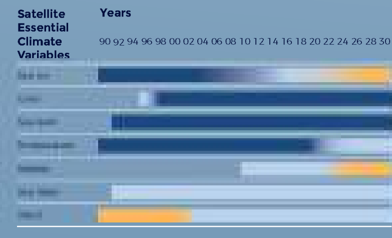
Optimization of resources, technology development and coordination with partner countries to share best practices and transfer expertise can enhance and enable expansion of the system. Developing global initiatives in these areas is an ongoing challenge that carry many benefits. Only by having a fully integrated and rigorously monitored ocean observing system will we be able to respond to the many scientific and societal needs to ensure a healthy ocean and a healthy planet.

We need to strengthen international cooperation to maintain and improve the system, and to increase the levels of long-term funding needed to sustain an efficient, integrated, innovative and fit for purpose global ocean observing network.

Future

New technologies based on autonomous platforms, smart sensors and improved telecommunications can offer more cost-efficient solutions towards improving the global observing system. Using these technologies helps to improve the multidisciplinary ocean observing system as well as responding to new requirements. It is important to introduce gradually technological and scientific innovations alongside the existing observing networks while preserving some stability. The diversity and complementary nature of the systems should ultimately lead to better quality observations both spatially and temporally and better measurement accuracy.

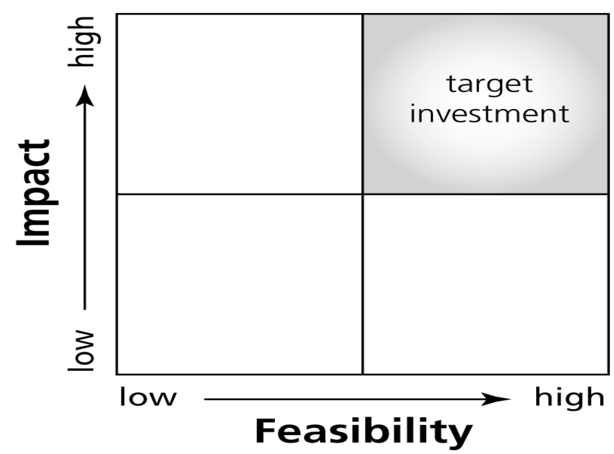
The observing system also needs to develop stronger links with the downstream users of the observations, in order to increase system responsiveness and to ensure that it is fit for purpose. Developing these vital end-to-end links is both a current and future challenge.



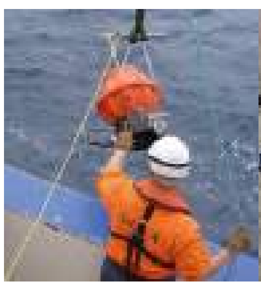
More information on satellite status at www.jcommops.org/reportcard2018

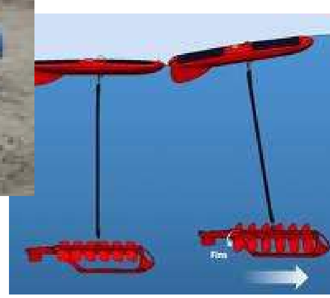
Key Messages

Essential Climate Variables: Emerging Technologies



- Advances in understanding combined with technology development (explosion!).
- Period of significant growth.
- Guidance and oversight needed to evolve O.S. in coordinated way.

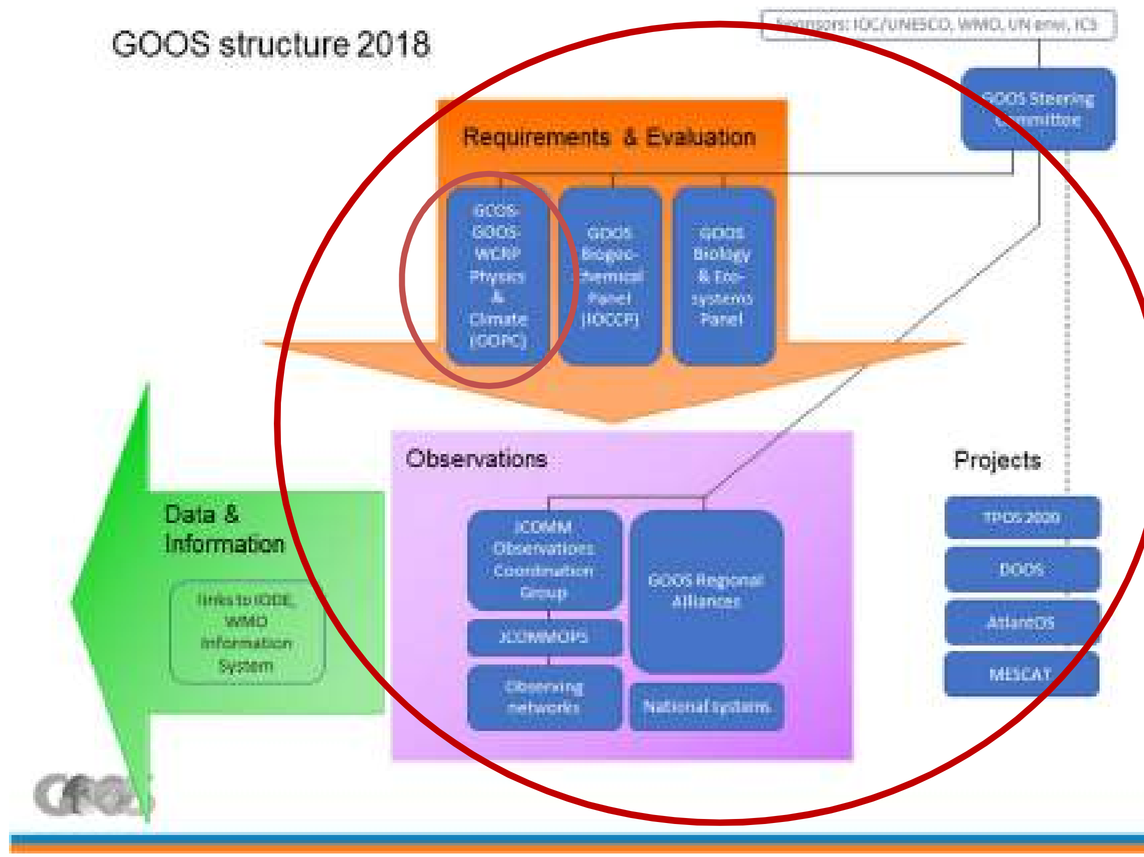





GOOS · GOOS · WCRP
OOPC Ocean Observations Physics and Climate panel

Key Messages

- OOPC has a complex, multifaceted mandate, with large engagement overhead.
  - GCOS Ocean ECVs, GOOS Physics EOVs (and delivering to climate applications, operational services)
  - OOPC draws on other GOOS panels, JCOMM OCG, GRAs in order to deliver to GCOS.
  - Challenging for one panel, with one staffer! GCOS-GOOS relationship paper to be presented during the meeting



GCOS All Panel Meeting - Expectations

- OOPC will include reps from other GOOS panels, JCOMM OCG,
  - Covers full set of ECVs and how they are implemented.
- Key thematic areas of interest:
  - Connecting the Energy, Hydrological Cycle:
    - Heat and Freshwater Storage – (Review underway by OOPC, engaging WCRP colleagues)
    - Air Sea Fluxes (heat and momentum) - (discussion commenced with AOPC) .
  - Connecting the Carbon Cycle: To be discussed with TOPC Potential focii.
    - Land-sea fluxes
    - Biosphere observations for climate
- Preparation needed for meeting
  - Chairs/Vice Chairs form Organising Committee: Teleconference to discuss/agree on focii, priorities.
  - Arrange Thematic calls for key focii with key panel experts to discuss/agree on focus/aims of discussions in Marakech, preparations, experts to engage.
- Planning timeline?

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