



IOCCP

International
Ocean Carbon
Coordination Project

Towards a sustained
global observation network
for marine biogeochemistry



Biogeochemistry Panel

Biogeochemical Essential Ocean Variables Review and Update EU BioGeoSea and Global Ocean Observing System

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GOOS Regional Alliance Forum XII
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Why observe the ocean?

Forecasts & Early warning systems



Climate action



Ocean economy

Community adaptation



Carbon strategies

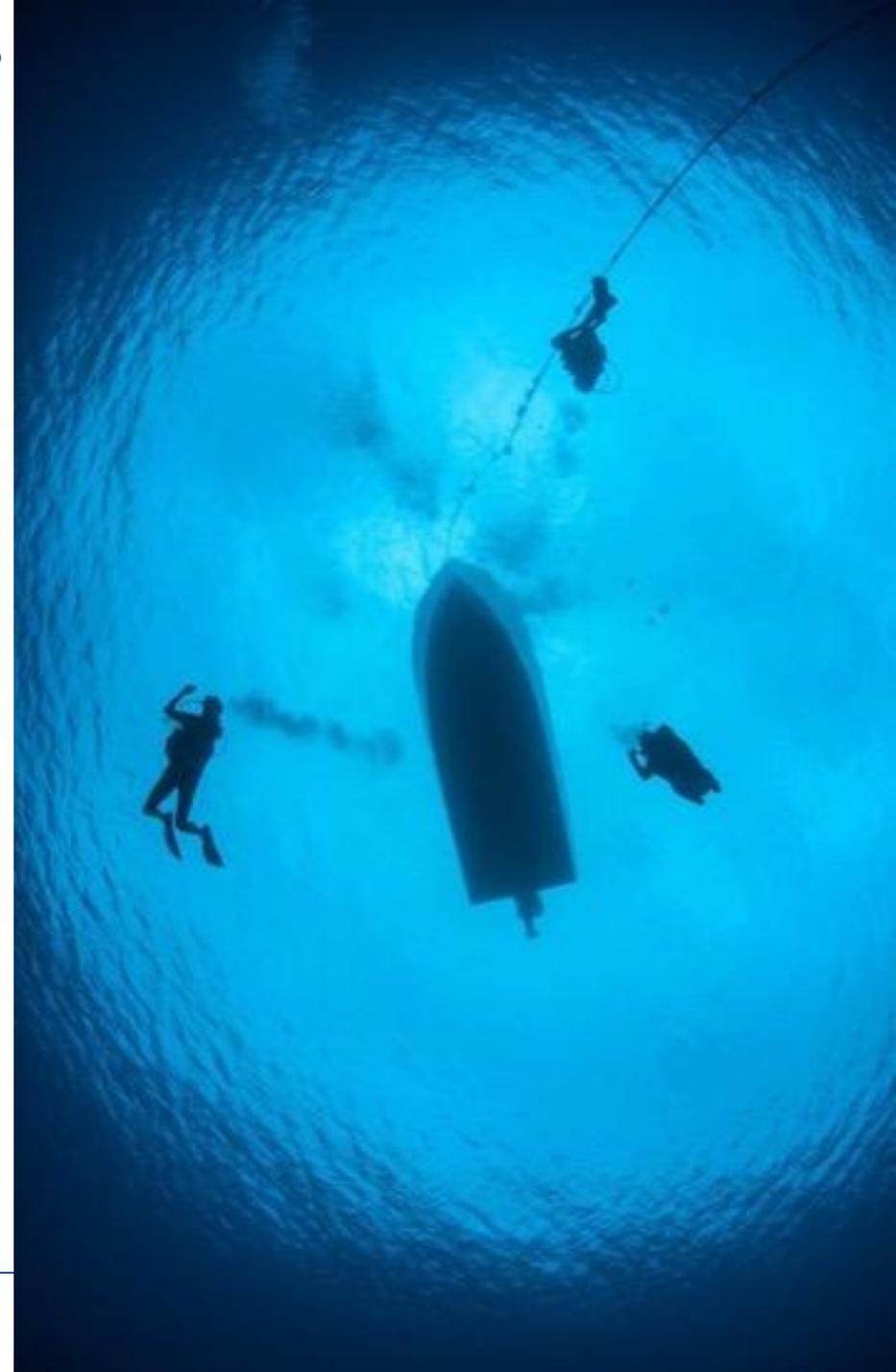


Ocean health

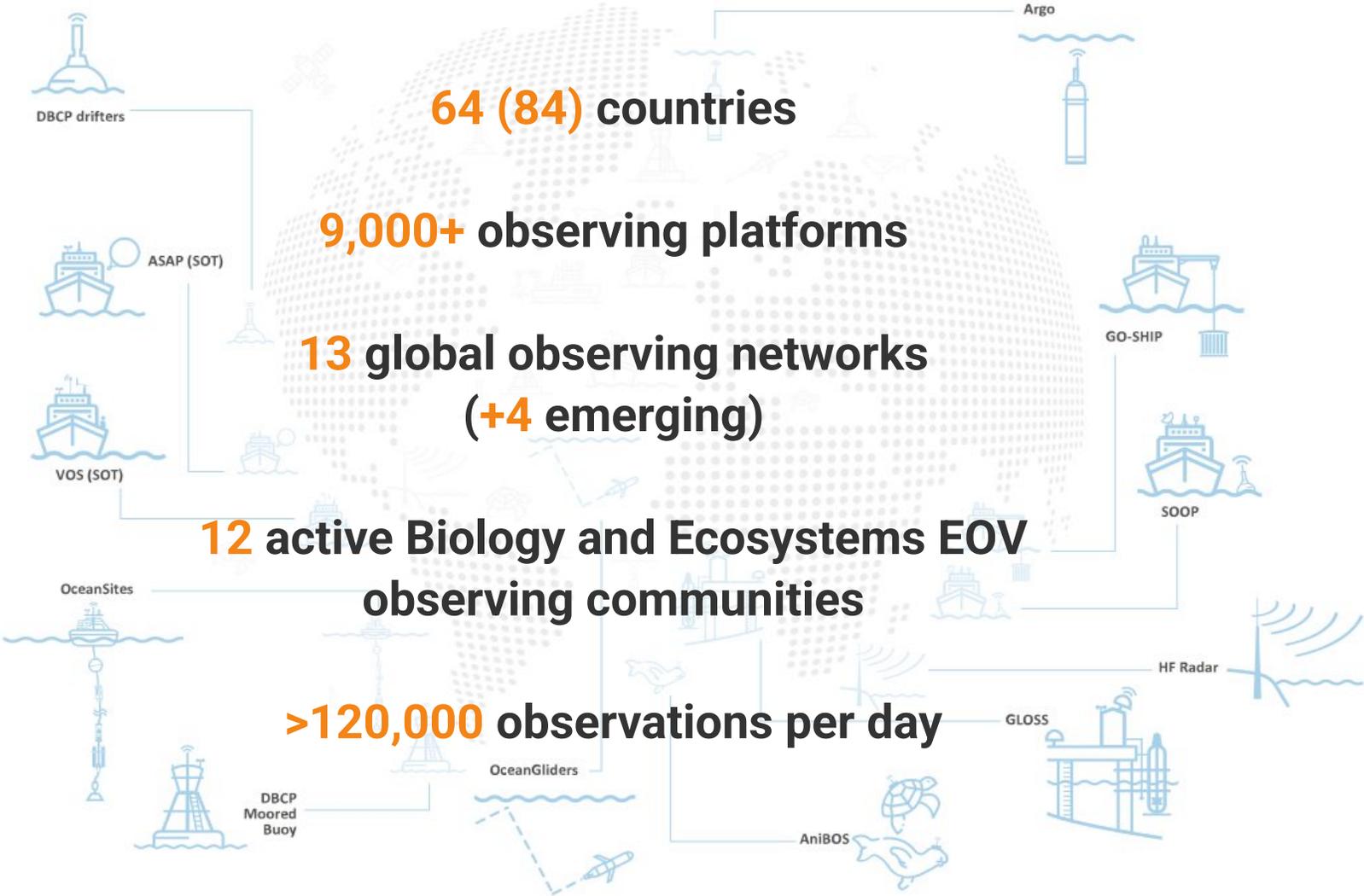
What are our motivations for monitoring the Ocean?

Societal Needs - Applications

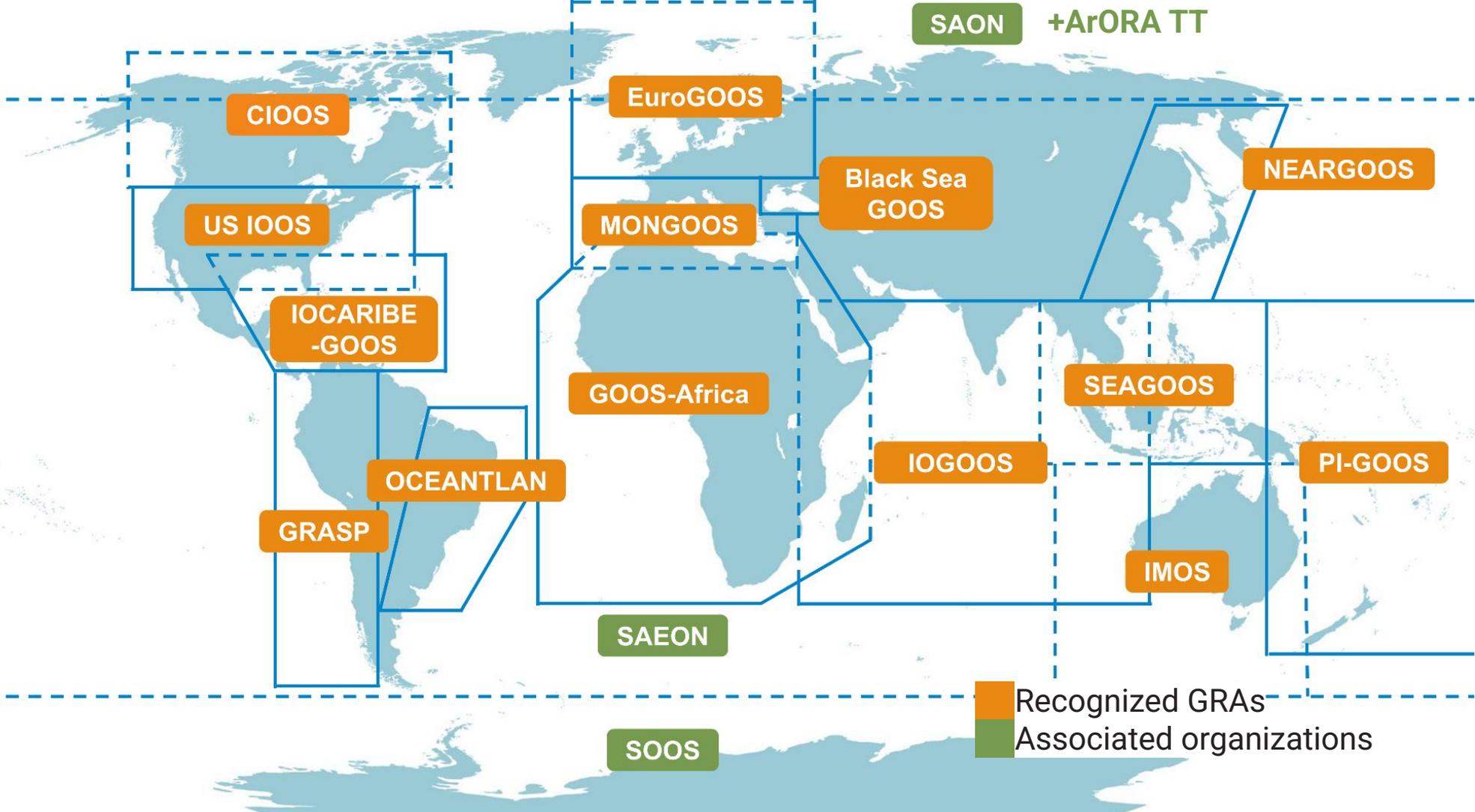
- monitoring and assessing oceans role in the global climate system (what you do not observe, you can't manage)
- assess ocean's response to changes related with human impact (pollution, warming, carbon dioxide)
- warning systems (e.g red tides, oil spills, tsunamis)
- global food security (fisheries)
- biodiversity conservation (wellbeing of species, interconnectedness)
- assessing oceans fitness to provide safe and environmentally “acceptable” transportation options
- assessing oceans fitness to provide safe and environmentally friendly recreational services
- **providing validation information for mathematical models and satellite observations**



GOOS Today

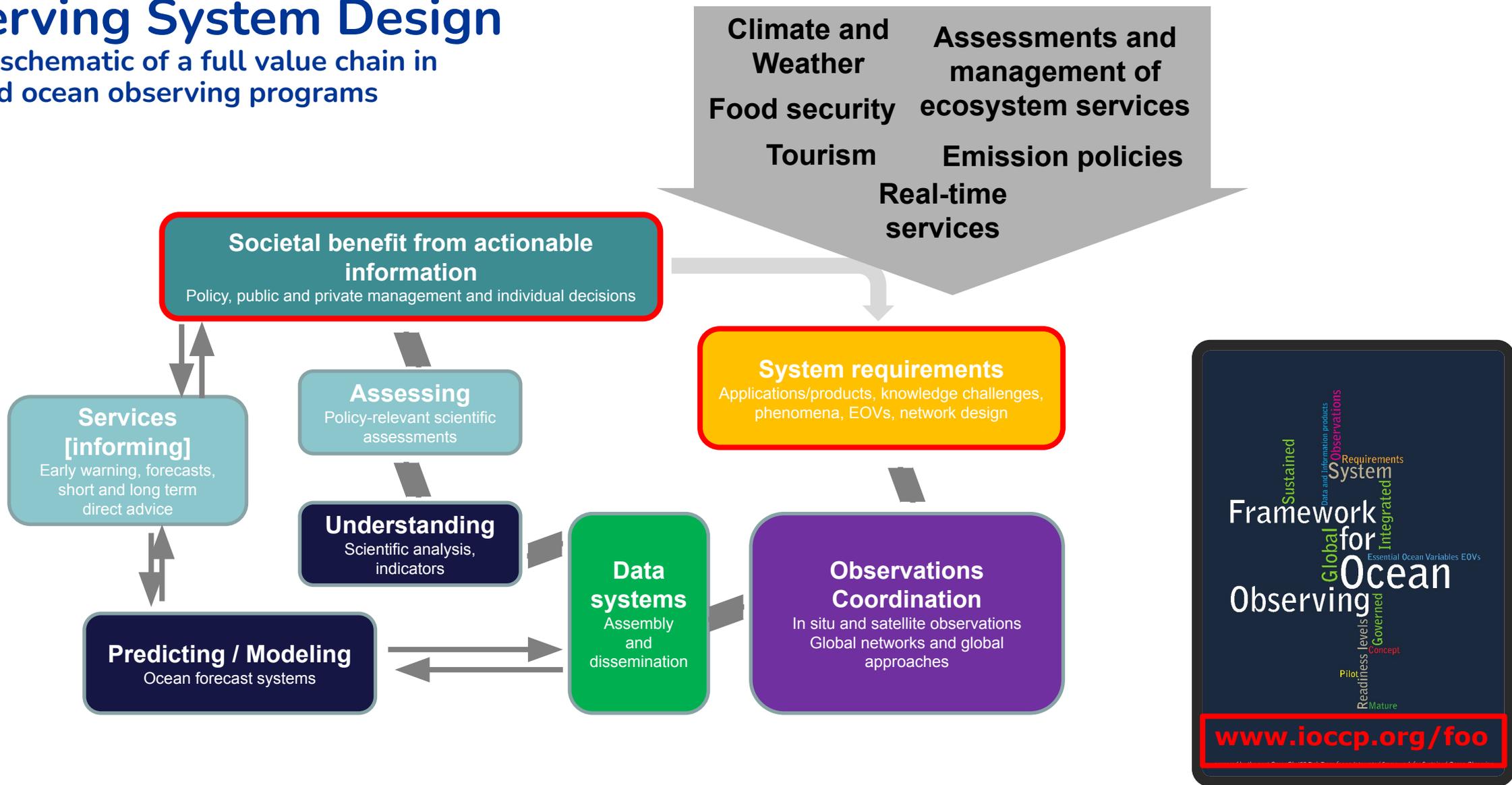


GOOS Regional Alliances

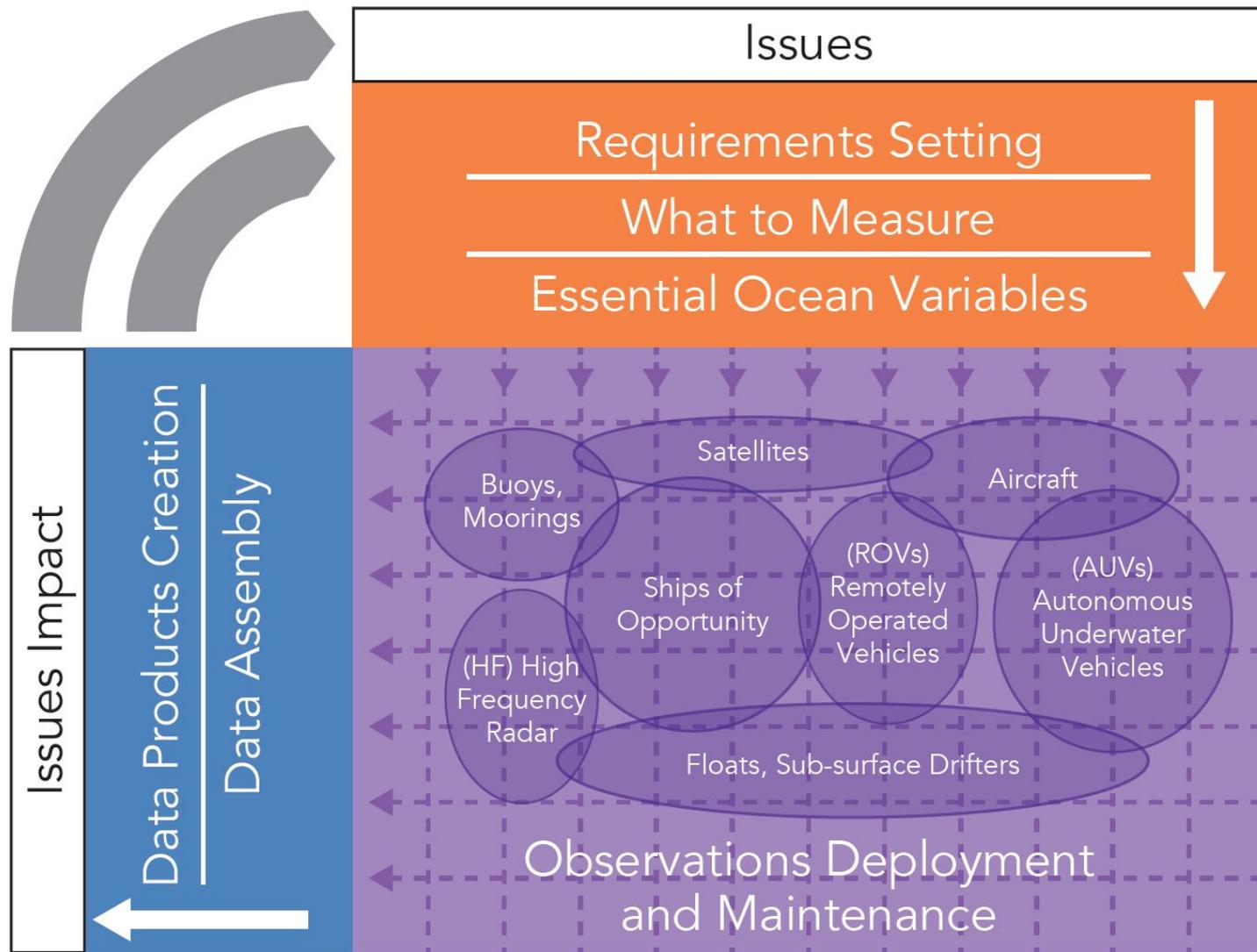


Observing System Design

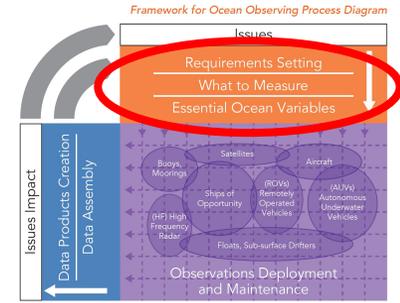
A broad schematic of a full value chain in sustained ocean observing programs



Framework for Ocean Observing Process Diagram



Societal Drivers and Scientific Applications Ocean Biogeochemistry



- **The role of ocean biogeochemistry in climate**
 - Q1.1 How is the ocean carbon content changing?
 - Q1.2 How does the ocean influence cycles of non-CO₂ greenhouse gases?
- **Human impacts on ocean biogeochemistry**
 - Q2.1. How large are the ocean's "dead zones" and how fast are they changing?
 - Q2.2 What are rates and impacts of ocean acidification?
- **Ocean ecosystem health**
 - Q3.1 Is the biomass of the ocean changing?
 - Q3.2 How does eutrophication and pollution impact ocean productivity and water quality?



The role of ocean biogeochemistry in climate

Q 1.1: How is the ocean carbon content changing?

(Air-Sea Fluxes)

- Carbonate system
- DOC
- Transient Tracers
- O₂
- Macronutrients (NO₃, PO₄, Si, NH₄, NO₂)
- ¹³DIC, ¹⁴DIC

Q 1.2: How does the ocean influence cycles of non-CO₂ greenhouse gases?

- N₂O
- CH₄ (regional)
- DMS
- Halocarbons/O₃-depleting substances
- O₂



Human impacts on ocean biogeochemistry

**Q 2.1.: How large are the ocean's dead zones and how fast are they growing?
(Ocean deoxygenation)**

- O_2
- Nutrients (NO_3 , PO_4 , Si, NH_4 , NO_2)
- Transient Tracers
- Export rates and/or Ar/ O_2
- Inorganic Carbon

**Q 2.2: What are rates and impacts of ocean acidification?
(Ocean acidification)**

Detection

- Inorganic Carbon (saturation state as derived variable)
- O_2
- Nutrients (NO_3 , PO_4 , Si, NH_4 , NO_2)
- Atmospheric deposition of anthropogenic sulfates
- Transient Tracers
- ^{13}DIC
- PON, POP, DON, DOP
- Ra isotopes (coastal)

Impact

- Inorganic Carbon (saturation state as derived variable)
- Dissolution Rates
- PIC, POC
- Phytoplankton Functional Groups
- Benthic and Pelagic Species
- ^{231}Pa , ^{230}Th



Ocean ecosystem health

Q 3.1: Is the biomass of the ocean changing?
(Primary production, eutrophication, and more...)

Q 3.1a: Is production changing

- Macronutrients (NO_3 , PO_4 , Si, NH_4 , NO_2)
- Micronutrients (eg. Fe)
- O_2
- Carbonate System
- O_2/Ar
- O_2 isotopes
- Opal, POC, CaCO_3

Q 3.1b: Is biomass changing

- POM (POC, PON, POP)
- Chlorophyll
- Macronutrients (NO_3 , PO_4 , Si, NH_4 , NO_2)
- Particle size spectra



Ocean ecosystem health

Q 3.2: How does eutrophication and pollution impact ocean productivity and water quality?

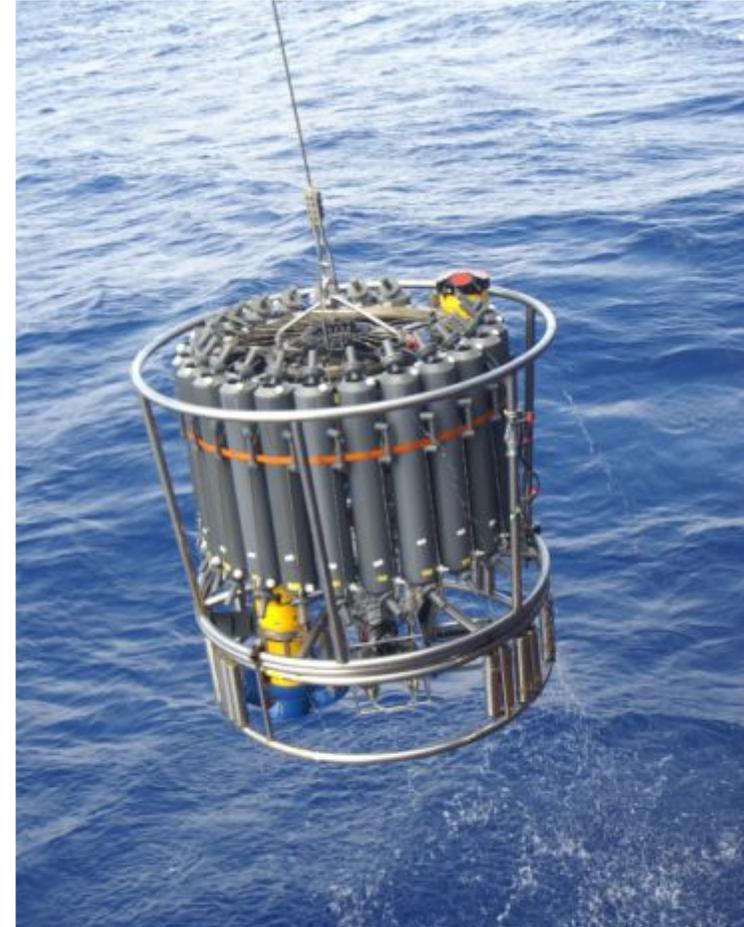
(Primary production, eutrophication, and more...)

Q3.2a: Eutrophication

- Macronutrients (NO_3 , PO_4 , Si, NH_4 , NO_2)
- O_2
- POC, DOC
- $^{18}\text{O}/^{16}\text{O}$
- Ra isotopes (coastal)

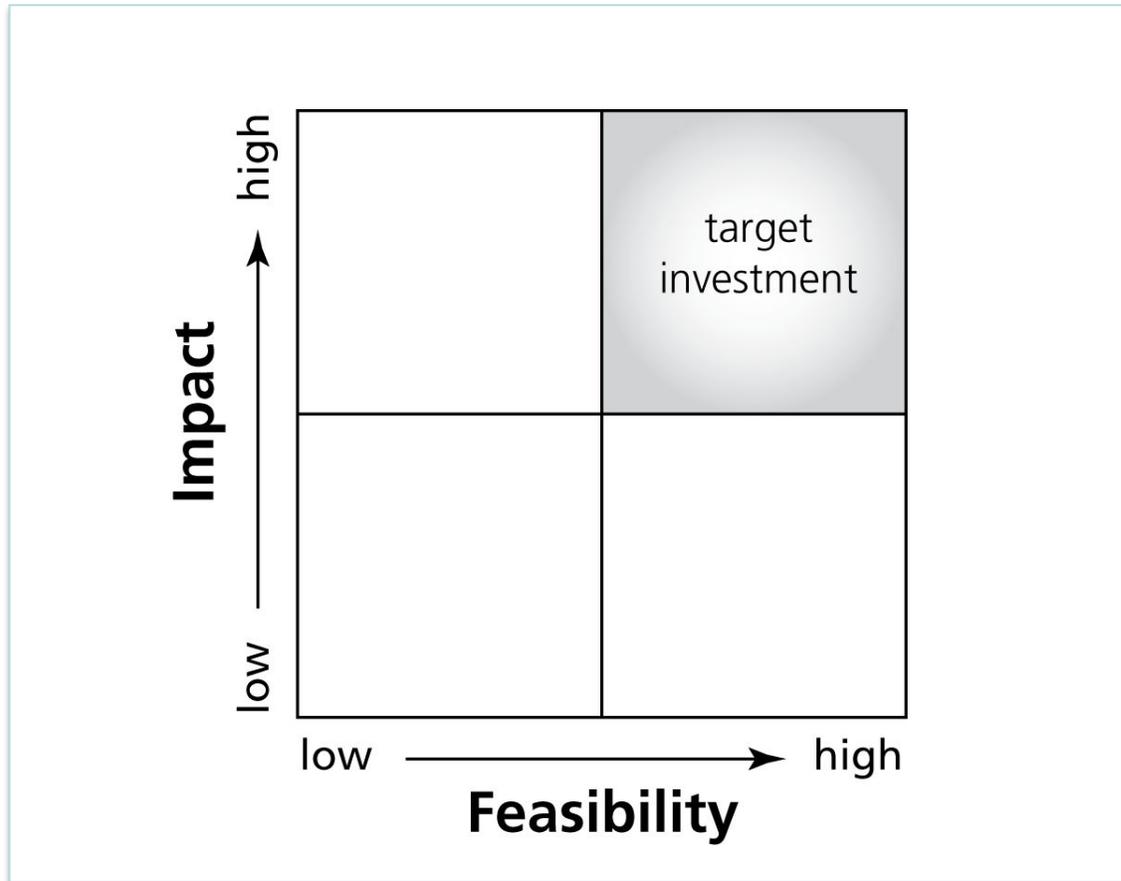
Q3.2b: Pollution

- Dioxin
- POPs (particulate organic pollutants)
- Plastics
- Heavy Metals



Driven by requirements, negotiated with feasibility

Essential Ocean Variables



Check for updates

OPEN ACCESS

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GOOS Essential Ocean Variables: the backbone of a sustained and evolving global ocean observing system

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The need for ocean information has never been greater. From climate change to food security and extreme events, we need to understand the role of the ocean and better predict change and impact. This is only possible with the sustained collection of a key set of ocean observations. The Global Ocean Observing System (GOOS) coordinates international efforts to collect these Essential Ocean Variables (EOVs), which span physics, biogeochemistry, biology and ecosystem realms. Guided by three expert panels, these EOVs are used to define the needs and design of a sustained, fit for purpose global ocean observing system, aimed at maximizing investments in observing infrastructure. As the GOOS EOVs are increasingly used, it has become important to discuss and refine the understanding of this framework, to ensure that the right balance is struck between their essential nature and the need to expand to new domains and integrate with key global policies. In this paper we provide a description of the EOVS framework, discuss some of the challenges in

GOOS Essential Ocean Variables (EOVs)

The **minimum set of ocean variables** needed to assess ocean state and variability for important global ocean phenomena, and to provide essential data for applications that support societal benefit.

Derived from sustained individual measurements, or combinations of measurements, that can be undertaken at global scale and in a cost-effective manner.

One tool to speak to:

- Observing systems and data collectors - guidance for collecting observations, observing approaches, SOP and BP
- Researchers - phenomena, processes and events to observe
- Data managers - data management requirements
- Policy and decision makers, funders - highlight EOV importance and applications, status of observing system

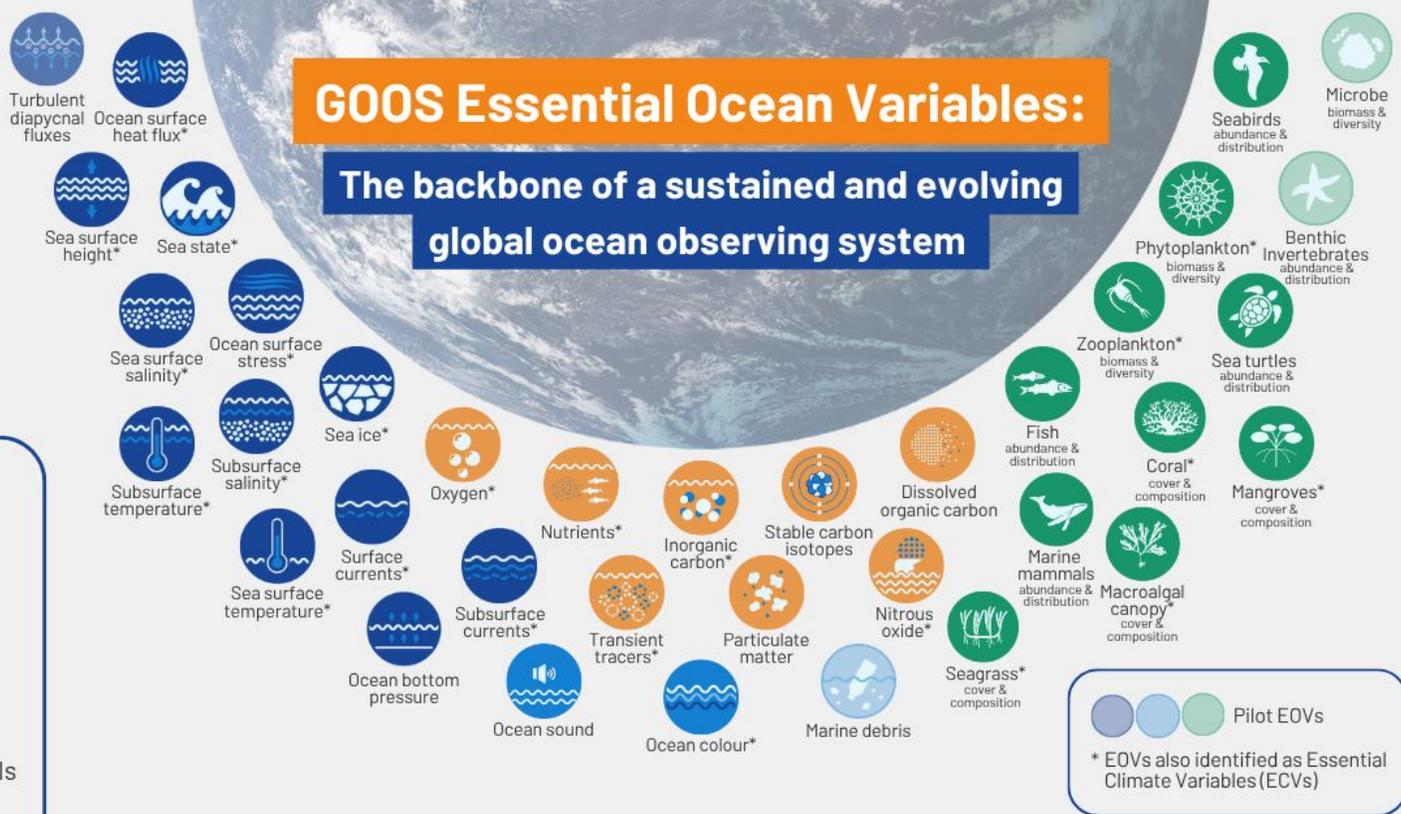
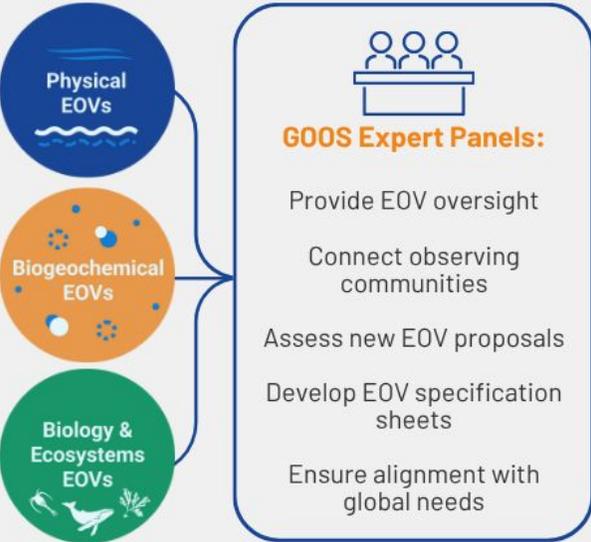
Setting Requirements: Essential Ocean Variables



WHY OBSERVE THE OCEAN?

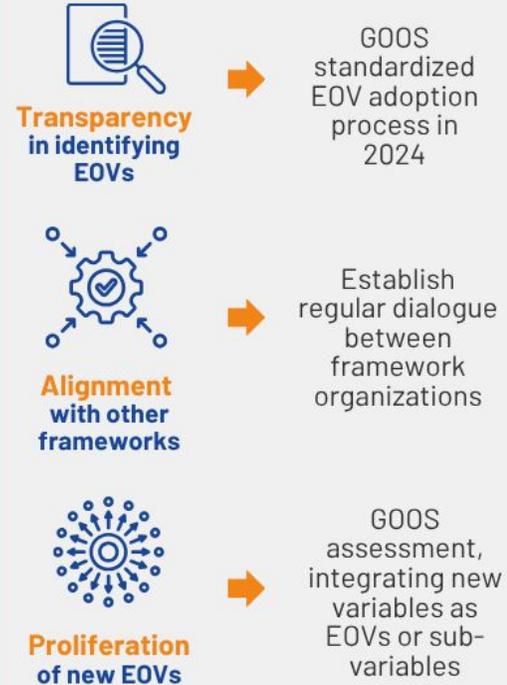
To predict and understand the ocean's role in climate, food security, and extreme events, we rely on sustained ocean observations.

Essential Ocean Variables (EOVs) are the minimum set of variables needed to assess ocean state and variability.



A decade on, the EOVS framework must evolve to balance its core function with emerging societal needs and global policies.

CHALLENGES & RECOMMENDATIONS



The Specification Sheet



Version: 2.0 Month Year

Essential Ocean Variable Specification Sheet

Fish abundance and distribution



Global Ocean Observing System (2021). Essential Ocean Variable Specification Sheet: Fish abundance and distribution. GOOS Reference No; DOI: [to be assigned, e.g. by depositing on the Zenodo repository]

EOV Specification Sheet cu



Version: 0.0 Month Year

Essential Ocean Variable Specification Sheet

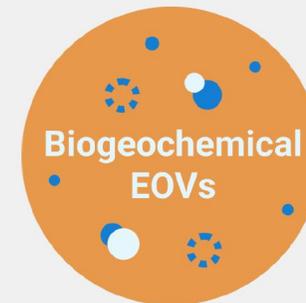
Sea ice



GOOS • GOOS • WCRP
EOV Specification Sheet curated by: **OOPC** Ocean Observations Physics and Climate panel

Essential Ocean Variable Specification Sheet

BGC EOVS



EOV Specification Sheet curated by:



Global Ocean Observing System (2025). Essential Ocean Variable Specification Sheet: [EOV name]. GOOS Reference No; DOI: [to be assigned, e.g. by depositing on the Zenodo repository]



Essential Ocean Variable (EOV) Specification Sheets

Background & Justification

Defines the societal & scientific drivers, pressures, & applications related to the EOV

Funders and decision makers

SDG

Applications

EOV data informs decision making to meet societal requirements

Phenomena to Observe

Provides examples of processes, events, or ocean properties to observe with the EOV based on societal and scientific drivers

Researchers

Data Management & Information

Provides guidelines to contribute to open access data repositories that enable global knowledge

Data managers

EOV Observing specifications

Defines the ideal observations of this EOV to capture the phenomena of interest

Observing systems and data collectors

Observing approaches

Illustrates sampling approaches to measure the EOV and capture the phenomena

GOOS Biogeochemistry Essential Ocean Variables (EOVs)

Specification Sheets

(version: 25.08.2017; Ocean Colour added on 24.09.2018)

 [Oxygen](#)

 [Nutrients](#)

 [Inorganic Carbon](#)

 [Transient Tracers](#)

 [Particulate Matter](#)

 [Nitrous Oxide](#)

 [Stable Carbon Isotopes](#)

 [Dissolved Organic Carbon](#)



 [Ocean Colour](#)



can download all GOOS EOVS Specification Sheets (Physics & Climate, Biogeochemistry, Biology & Ecosystems) from www.goosocean.org/eov

EOV Specification Sheets:
www.goosocean.org/eov
www.ioccp.org/foo

Essential Ocean Variables: Specification Sheet

Essential Ocean Variable (EOV): Inorganic Carbon

Background and Justification

The ocean is a major component of the global carbon cycle, exchanging massive quantities of carbon in natural cycles driven by the ocean circulation and biogeochemistry. Since seawater has a high capacity for absorbing carbon, the ocean also is a significant modulator of the rate of accumulation of carbon in the atmosphere, and thus slows the rate of global warming. The net carbon uptake of the ocean is approximately 25% of each year's anthropogenic emissions. Due to the chemistry of carbon in water, this uptake is causing a decline in ocean pH, also known as ocean acidification. The ecological consequences of ocean acidification are a focus for much of the present research. Understanding current carbon uptake by the ocean is critical for understanding how the carbon cycle and climate are evolving under the impact of human activities, and the mechanistic understanding developed is needed in the interest of improved prediction of the state of the climate system. Understanding and predicting rates of ocean acidification are also fundamental to understanding the ocean's biogeochemical evolution. The observations required to constrain the carbon system at a point in space and time are any two of Dissolved Inorganic Carbon (DIC), Total Alkalinity (TA), partial pressure of carbon dioxide ($p\text{CO}_2$) and pH, and associated physical variables (temperature and salinity). The carbon system is in a delicate balance such that high quality observations will continue to be required.

EOV Specification Sheets:

www.goosocean.org/eov

www.ioccp.org/foo

Essential Ocean Variable (EOV): Inorganic Carbon

Name of EOV	Inorganic Carbon
Sub-Variables	Dissolved Inorganic Carbon (DIC), Total Alkalinity (TA), Partial pressure of carbon dioxide ($p\text{CO}_2$) and pH. <i>[At least two of the four Sub-Variables are needed.]</i>
Derived Products	Saturation state (aragonite, calcite), Dissolved carbonate ion concentration, Air-sea flux of CO_2 , Anthropogenic carbon, Change in total carbon
Supporting Variables	Surface and subsurface Temperature, Surface and subsurface Salinity, Ocean vector stress (wind speed), Atmospheric column-averaged dry-air mole fraction of CO_2 ($x\text{CO}_2$), Barometric pressure, Oxygen, Calcium concentration, Transient tracers, Oxygen to argon ratio (O_2/Ar)
Responsible GOOS Panel	GOOS Biogeochemistry Panel Contact: ioccp@ioccp.org



Table 2: Requirements Setting (Inorganic Carbon)

Societal Drivers	<ol style="list-style-type: none"> 1. The role of ocean biogeochemistry in climate 2. Human impacts on ocean biogeochemistry 3. Ocean ecosystem health 			
Scientific Application(s)	<p>Q 1.1. How is the ocean carbon content changing?</p> <p>Q 2.1. How large are the ocean's dead zones and how fast are they growing?</p> <p>Q 2.2. What are rates and impacts of ocean acidification?</p> <p>Q 3.1. Is the biomass of the oceans changing?</p>			
Readiness Level <i>[as defined in the FOO]</i>	Mature			
Phenomena to Capture	1 Air-Sea Fluxes	2 Storage / inventory	3 Ocean Acidification	4 Primary production
Temporal Scales of the Phenomena	Monthly	Annual	<u>Coastal</u> Daily <u>Open Ocean</u> Seasonal	Seasonal to decadal
Spatial Scales of the Phenomena	1-250 km	100-1000 km	<u>Coastal</u> 0.1-100 km <u>Open Ocean</u> 100-1000km	<u>Coastal</u> 1-100 km <u>Open Ocean</u> 100-1000 km
Magnitudes/Range of the Signal to Capture	2 Pg C yr ⁻¹	20 Pg C decade ⁻¹	<u>Saturation states</u> 0.1 decade ⁻¹ <u>pH</u> 0.01 decade ⁻¹	0.5 Pg C yr ⁻¹ decade ⁻¹ (net community production)
Current Uncertainty Relative to the Signal				
Target Uncertainty Relative to the Signal	±10%	±10%	±20%	

Table 3: Current Observing Networks (Inorganic Carbon)

Observing Approach	Ship-based Underway Observations	Ship-based Repeat Hydrography	Moored Fixed-Point Observatories	Drifters	Ship-based Fixed-Point Observatories	Profiling floats
Readiness Level of the Observing Approach for this EOJ	Mature	Mature	Mature	Mature	Mature	pH: Pilot pCO ₂ : Concept DIC: Concept TA: Concept
Leading Obs. Network	SOOP-CO ₂	GO-SHIP	OceanSITES			Biogeochemical Argo
Network Readiness Level	Concept	Mature	Pilot			Pilot
Phenomena Addressed	1,3	2,3	1,3,4	1,3	1,3,4	2,3,4
Spatial Scales Currently Captured by the Observing Network	<u>Horizontal coverage:</u> global, every 10°, denser in the coastal domain <u>Vertical coverage:</u> surface	<u>Horizontal coverage:</u> global, every 20° <u>Vertical coverage:</u> full depth	<u>Horizontal coverage:</u> <u>Vertical coverage:</u>	<u>Horizontal coverage:</u> <u>Vertical coverage:</u>	<u>Horizontal coverage:</u> <u>Vertical coverage:</u>	<u>Horizontal coverage:</u> every 10°, denser in the coastal domain <u>Vertical coverage:</u>
Typical Obs. Frequency	Weekly to decadal	Decadal	Sub-daily to seasonal and annual	Hourly to annual	Weekly to decadal	Weekly to annual
Supporting Variables Measured	Atmospheric / ocean pCO ₂ , Surface temperature and salinity		Surface and subsurface temperature and salinity, Wind speed, Atmospheric CO ₂	Surface and subsurface temperature	Wind speed, Atmospheric and ocean pCO ₂	
Sensor(s)/Technique	Equilibrator, Permeable membrane, IR, CRDS	Benchtop instruments	Equilibrator, Permeable membrane	Spectro-photometric	Titration, equilibrator	Spectro-photometry; variety of sensors are being developed
Accuracy/Uncertainty Estimate (units)	pCO ₂ : ±2 µatm	TA/DIC: ±2 µmol kg ⁻¹ pH: ±0.005 pCO ₂ : ±2 µatm	pCO ₂ : ±5 µatm	pCO ₂ : ±5 µatm pH: ±0.005	TA/DIC: ±2 µmol kg ⁻¹ pH: ±0.005 pCO ₂ : ±2 µatm	pCO ₂ : ±5 µatm pH: ±0.005
Reporting Mechanism(s)	Individual Networks Annual Reports; IOCCP Annual Report					

Table 4: Future Observing Capacity					
Observing Approach	Surface Autonomous Vehicles	Moored Fixed-point Observatories	Autonomous Underwater Vehicles	Ship-based Underway Observations	
Novel aspect of the observing approach	Novel observing approach and network (OceanGliders) for pH and pCO ₂ .	Resolving full water column measurement of pH and pCO ₂ .	Novel observing approach resolving water column measurements of pH and pCO ₂ .	New sub-variables measured (DIC/TA) using new sensors/techniques.	
How does this novel aspect impact our observing capacity?					
Readiness Level of the Observing Network	<p>pH Pilot</p> <p>pCO₂ Concept</p> <p>DIC Concept</p> <p>TA Concept</p>	<p>pCO₂ (surface) Mature</p> <p>pCO₂ (interior) concept</p> <p>pH Concept</p>	Concept	<p>underway pCO₂ Mature</p> <p>underway DIC/TA</p> <p>underway pH</p>	
Spatial Scales Captured by the Observing Network	20°, surface	1 km	10-1000 km, full depth	Every 10°, Denser in the coastal domain, Surface	
Typical Observing Frequency	Daily to monthly	Sub-daily to seasonal and annual	Daily to monthly	Weekly to annual	
Time-Scale Until Part of Observing System					
Supporting Variables Measured					

Table 5: Data & Information Creation					
Observing Approach	Oversight & Coordination	Data Quality Control	Near Real-time Data Stream Delivery	Data Repository	Data Products
Ship-based Underway Observations	IOCCP	Level 1: PIs Level 2: SOCAT		NCEI OCADS SOCAT PANGAEA	SOCATv4 LDEO Climatology GLODAPv2 SOCOM
	Mature	Mature		Mature	
Ship-based Repeat Hydrography	Surface IOCCP	Surface Level 1: PIs Level 2: SOCAT		Surface NCEI OCADS SOCAT PANGAEA	
	Interior GO-SHIP, IOCCP	Interior Level 1: PIs Level 2: GLODAP RG		Interior NCEI OCADS	
Moored Fixed-Point Observatories	OceanSITES, IOCCP			OceanSITES GDACs (US NDBC , Ifremer , Coriolis)	
Drifters					
Ship-based Fixed-point Observatories	OceanSITES, IOCCP				



Table 6: Links & References	
Best Practices, Guides and Other Background Documentation	Dickson, A.G., C.L. Sabine, and J.R. Christian, eds. (2007), Guide to best practices for ocean CO₂ measurements , PICES Special Publication 3, 191 pp., Guide to Best Practices in Ocean Acidification Research and Data Reporting (Eds: Riebesell U., Fabry V. J., Hansson L. & Gattuso J.-P., 2010. 260 p. Luxembourg: Publications Office of the European Union). Addendum , 2015-11-13 Certified Reference Materials (CRMs): https://www.nodc.noaa.gov/ocads/oceans/Dickson_CRM/batches.html
Links for Contributing Networks	GO-SHIP: http://www.go-ship.org OceanSITES: http://www.oceansites.org/index.html
Links for Near-Real Time Data Stream Delivery	
Links to Data Repositories	NCEI OCADS: https://www.nodc.noaa.gov/ocads/ SOCAT: http://www.socat.info PANGAEA: https://www.pangaea.de/
Data Product Links and References	SOCATv4: http://www.socat.info GLODAPv2: http://glodap.info/ LDEO Climatology: https://www.nodc.noaa.gov/ocads/oceans/LDEO_Underway_Database/ SOCOM: http://www.bgc-jena.mpg.de/SOCOM/

Glossary of terms

A **Framework for Ocean Observing (FOO)** is a guide for the ocean observing community to establish an integrated and sustained global observing system that addresses the variables to be measured, the approach to measuring them, and how their data and products will be managed and made widely available. FOO is available from: <http://www.ioccp.org/index.php/foo>

A **GOOS Essential Ocean Variable** is a sustained measurement or a group of measurements necessary to assess state and change at a global level, and to increase societal benefits from the ocean *[on scales from global to regional]*.

Sub-variables are components of the EOVS that may be measured, derived or inferred from other elements of the observing system and used to estimate the desired EOVS.

List of abbreviations

EOV – Essential Ocean Variable
GOOS – Global Ocean Observing System
IOCCP – International Ocean Carbon Coordination Project
FOO – Framework for Ocean Observing
pCO₂ – Partial pressure of carbon dioxide
DIC – Dissolved Inorganic Carbon
TA – Total Alkalinity
nm – nautical mile = 1.852 km
µatm – 10⁻⁶ atmospheres (pressure)



Review and update of decade-old BGC EOVS Specification Sheets

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Review and update of decade-old BGC EOVS Specification Sheets

• Current status

- **BioGeoSea** started on 1 September 2025 as one of 3 “sister projects” alongside BioEcoOcean and ObsSea4Clim,
- GOOS BGC hosted at IOPAN is a partner with one of the responsibilities to significantly **update BGC EOVS SS in line with concepts developed across 3 GOOS Panels,**
- New staff member, **Malek Belgacem**, started at IOPAN in March 2026 and lead the work,
- **Stakeholders and users** identified to **discuss gaps** in existing BGC EOVS SS’s,
- IOCCP/BGC Panel members agreed as Lead Authors of some EOVS SS’s, wider community experts to be approached soon,



Observing Networks	SOCNET	International	in preparation
	GO-SHIP	International	http://www.go-ship.org/
	Biogeochemical Argo	International	https://biogeochemical-argo.org/
	Ocean Gliders	International	https://www.oceangliders.org/
	OceansITES (moored point observations)	International	https://www.oceansites.org/oceansites/index.html
	METS-RCN (ship-based point observations)	International	https://www2.whoi.edu/site/mets-rcn/

Data Product Developers and Data Specialists	SOCAT	International	https://socat.info/
	GLODAP	International	https://glodap.info/
	GO2DAT	International	https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2021.724913/full
	SPOTS	International	https://essd.copernicus.org/articles/16/1901/2024/
	ODIS	International	https://oceaninfohub.org/odis/
	EMODnet Chemistry	EU	https://emodnet.ec.europa.eu/en/chemistry
	SeaDataNet	EU	https://www.seadatanet.org/

Expert Communities	GOA-ON (Ocean Acidification)	International	https://www.goa-on.org/
	GO2NE (Ocean Deoxygenation)	International	https://www.ioc.unesco.org/en/go2ne
	IMDOS (Marine Debris)	International	https://imdos.org/
	OBPS (Best Practices)	International	https://www.oceanbestpractices.org/

BIOGEOSEA



Funded by the European Union

BGC Essential Ocean Variables

Review and improvement of decade-old BGC EOVS Specification Sheets

- **Transition from the approved template to content population and refinement (Version 3.1) .**
 - **Content Population (BGC EOVS v3.0):** Coordination between GOOS Biogeochemistry Panel and BioGeoSea experts to assign 2 Lead Authors per EOVS to help migrate current Spec Sheets (v2.0) to the new v3.0 template.
 - **Targeted Consultation (small, direct, remote consultations):** Deployment of BioGeoSea Stakeholder Engagement Strategy to assess utility and feasibility of structure and content (Gap Analysis).
 - BioGeoSea partners and GOOS elements (eg. BioGeoSea Task 2.6 and OceanGliders Network/Program)
 - Specific BGC content analyzed, rather than a wider scope of an element (relevant for OCG networks, OBPS)
 - Indirect EOVS users to be consulted on their needs/if any
 - **Creation of Draft 3.1:** Discrepancies identified in Gap Analysis might/will guide content and structure modifications. Incorporating these modifications will result in the EOVS SS v3.1 ready for holistic stress-testing.

Table 2: Requirements Setting					
Societal Drivers	1. The role of ocean biogeochemistry in climate 2. Human impacts on ocean biogeochemistry 3. Ocean ecosystem health				
Scientific Application(s)	Q 1.1. How is the ocean carbon content changing? Q 1.2. How does the ocean influence cycles of non-CO2 greenhouse gases? Q 2.1. How large are the ocean's "dead zones" and how fast are they changing? Q 2.2. What are rates and impacts of ocean acidification? Q 3.1. Is the biomass of the ocean changing? Q 3.2. How do the eutrophication and pollution impact ocean productivity and water quality?				
Readiness Level (as defined in the FOI)	Concept to Mature (depending on the Scientific Application)				
Phenomena to Capture	1 Eutrophication	2 Primary production	3 Calcification	4 Export fluxes	5 Remineralization
Temporal Scales of the Phenomena	Coastal Daily to weekly Open Ocean Weekly to monthly	Coastal Daily to weekly Open Ocean Weekly to monthly	Monthly	Monthly to annual	
Spatial Scales of the Phenomena	Coastal 1-100 km Open Ocean 100-1000 km	Coastal 1-100 km Open Ocean 100-1000 km	1-250 km	Coastal 1-100 km Open Ocean 25-500 km	
Magnitudes/Range of the Signal to Capture	0.5 mmol C m ⁻³			POC; 0.5 Pg C yr ⁻¹ decade ⁻¹ CaCO ₃ ; 0.05 Pg C yr ⁻¹ decade ⁻¹ BSi; 10 Tmol Si yr ⁻¹ decade ⁻¹	
Current Uncertainty					



2. Phenomena to observe - what we want to observe with this EOVS

This section presents examples of priority phenomena for GOOS that can be (partly) characterised by this EOVS's sub-variables. This list is not exhaustive but serves to provide general guidance on how observation efforts can structure their planning and implementation to observe certain phenomena.

The GOOS application area(s) the phenomena are relevant for are depicted as follows: Climate, ocean health, operational services.

PHENOMENA TO OBSERVE	Phenomenon #1	Phenomenon #2	Phenomenon #3
HORIZONTAL			
VERTICAL			
TEMPORAL			
HORIZONTAL			
VERTICAL			
TEMPORAL			
SIGNAL TO CAPTURE			
SUB-VARIABLES NEEDED TO MEASURE			
SUPPORTING VARIABLES NEEDED			

BGC EOVS Gap Analysis

Review and improvement of decade-old BGC EOVS Specification Sheets

<p>a. Structural inconsistencies</p> <ul style="list-style-type: none"> - The structure of tables and figures is not fully coherent. <p>Example:</p> <ul style="list-style-type: none"> □ Figures often duplicate information already present in tables □ There is no clear link between requirements and observing systems 	<p>b. Incomplete requirement definitions</p> <ul style="list-style-type: none"> - Current uncertainty relative to the signal - Target uncertainty - Temporal and spatial scales - Vertical coverage 	<p>c. Technology and observing system developments not reflected</p> <ul style="list-style-type: none"> - Expansion of BGC-Argo - Autonomous sensors - Machine learning QC and bias correction - Improved sensor calibration and intercomparison exercises
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Critical elements □ because they define how observations should be designed.

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BGC EOVS Gap Analysis

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<p>d. Data management and FAIR principles are weak</p> <ul style="list-style-type: none"> List some repositories but do not describe the data flow from platform to products Missing metadata standards Data submission pipelines Interoperability guidance Links to best practices 	<p>e. Alignment with international frameworks</p> <ul style="list-style-type: none"> <input type="checkbox"/> GOOS EOVS framework <input type="checkbox"/> GCOS Essential Climate Variables <input type="checkbox"/> WMO Rolling Review of Requirements <p>Example: GOOS (9 BGC EOVS) GCOS (6 BGC ocean ECV)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Current doc. do not clearly explain these differences 	<p>f. Societal and policy relevance</p> <p>Example:</p> <p>background section do not connect observations to policy frameworks, such as:</p> <ul style="list-style-type: none"> biodiversity conventions SDG14 ocean health monitoring.
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BGC Essential Ocean Variables

Review and improvement of decade-old BGC EOVS Specification Sheets

- Validate Draft 3.1 (likely Inorganic Carbon and Oxygen) via real-world implementation scenarios.
 - International/Regional Case Study:
 - Planned Partner: GOOS Regional Alliance (GRA).
 - Action: Consultation session at the XII GRA Forum (Hyderabad, India, 23-24 March 2026).
 - Target 1: Assessment of the level of awareness about BGC EOVS and elements of the Spec Sheets, discussion on potential gaps identified by GRA practitioners (based on questionnaire shared prior to the meeting)
 - Target 2: Initial identification of a non-Atlantic region for trans-continental stress-testing of a couple of updated EOVS Spec Sheets.
- Validate Draft 3.1 (likely Inorganic Carbon and Oxygen) via real-world implementation scenarios.
 - National Case Study in Europe:
 - Planned Partner: Well established national observing infrastructure.
 - Action: Engage with BioGeoSea partners to engage with an appropriate and willing partner
 - Target 1: Testing feasibility of the content and structure with advanced practitioners
 - Target 2: Consolidating feedback into the final draft and/or developing recommendations for future work by GOOS Panels.

3. GOOS Observing Specifications or Requirements

This section outlines ideal measurements for an optimal observing system for this Essential Ocean Variable (EOV). It offers guidance on creating a long-term system to observe key phenomena related to the EOVS. These values are not mandatory, and no single system is expected to meet all requirements. Instead, the combined efforts of various observing systems should aim to meet these goals. Observations at different scales are also valuable contributions to global ocean observation if shared openly.

EOV	DEFINITION							
	Resolution			Timeliness	Uncertainty Measurement	Stability	Sampling approach	References
	Spatial Horizontal	Spatial Vertical	Temporal					
PHENOMENA								
EOV SUB-VARIABLE								
IDEAL								
DESIRABLE								
MINIMUM								

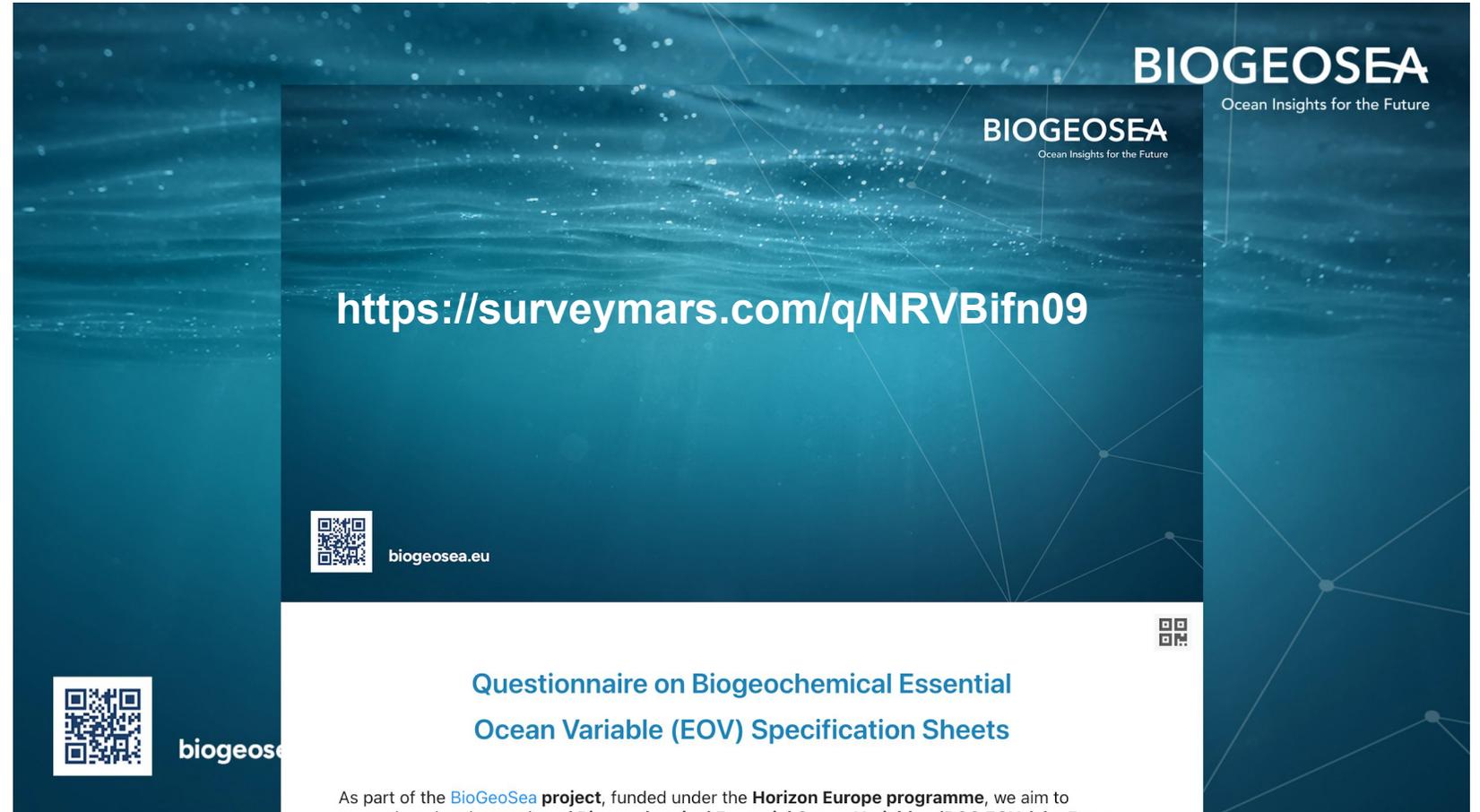


Real-world implementation scenarios

- 2-3 specific monitoring needs
- Ideally across scales
- Ideally utilizing multiple EOVS SS
- Ideally engaging multiple observing networks/capacities
- Ideally testing appropriateness of the SS for various readiness levels of implementers

BGC Essential Ocean Variables

Review and improvement of decade-old BGC EOVS Specification Sheets



The banner features a dark blue background with a network of white lines and dots, resembling a molecular or data structure. The text is as follows:

- Top right: **BIogeosea** Ocean Insights for the Future
- Center: <https://surveymars.com/q/NRVBifn09>
- Bottom left:  biogeosea.eu
- Bottom center: **Questionnaire on Biogeochemical Essential Ocean Variable (EOV) Specification Sheets**
- Bottom right: 
- Bottom left (partially visible):  biogeosea.eu

At the bottom, a small line of text reads: "As part of the **Biogeosea** project, funded under the **Horizon Europe** programme, we aim to strengthen the observation of Biogeochemical Essential Ocean Variables (BGC EOVS) for Europe..."



IOCCP

International
Ocean Carbon
Coordination Project



Biogeochemistry Panel



A communication and
coordination service
for marine biogeochemistry

 www.ioccp.org

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