Intergovernmental Oceanographic Commission

Workshop Report No. 311

First IODE/GOOS Data Workshop

IOC Project Office for IODE, Oostende, Belgium
30 September – 2 October 2024

Final revision 18/12/2024

UNESCO

Intergovernmental Oceanographic Commission

Workshop Report No. 311

First IODE/GOOS Data Workshop

IOC Project Office for IODE, Oostende, Belgium

30 September – 2 October 2024

UNESCO

IOC/2024/WR/311
Paris, October 2024
English only

For bibliographic purposes, this document should be cited as follows:
First IODE/GOOS Data Workshop, 30 September – 2 October 2024.
IOC Workshop Reports, 311, UNESCO (English)

Published in 2024
by the United Nations Educational, Scientific and Cultural Organization
7, place de Fontenoy, 75352 Paris 07 SP
(IOC/2024/WR/311)

Table of Contents

1. Executive Summary

IOC IODE-GOOS Data Workshop: Executive Summary

The IOC IODE-GOOS Data Workshop, held 30 September - 02 October 2024, focused on enhancing collaboration between the International Oceanographic Data and Information Exchange (IODE) and the Global Ocean Observing System (GOOS). The goal was to enhance coordination and discuss an integrated and scalable IOC digital architecture that would improve data sharing, management, and accessibility, across ocean systems, and enhance the IOC's support to key United Nations mandates.

Key objectives of the Workshop:

- **Identify roles and synergies**: Clarifying the mandates, responsibilities, and connections between GOOS and IODE, for all Essential Ocean Variables (EOVs).
- **Develop a joint vision for an IOC Data Architecture**: Establishing a co-evolved, integrated, FAIR and CARE aligned, IOC data architecture to support the ocean digital ecosystem.
- **Technical foundation**: Developing the technical architecture for a unified IOC Data space to be presented at the IOC Assembly in 2025.
- **Coordination:** Define coordination between GOOS and IODE to evolve and mature the IOC Data Architecture.
- **Future planning**: Outlining next steps (short and long term) for meeting future user needs.

The joint vision for an IOC Data Architecture

The Workshop participants agreed on a basic schema for the IOC Data Architecture, linking key IOC components into a holistic ecosystem. Figure 1 illustrates this schema, which is further described in Box 1.

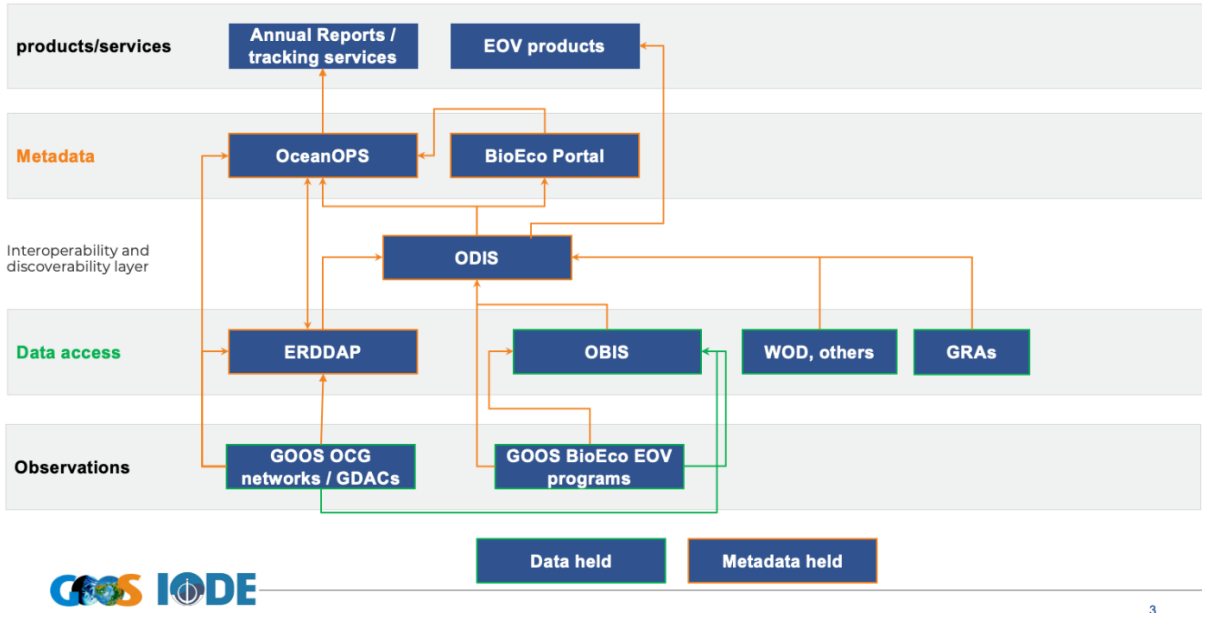


Figure 1: Schematic of the proposed IOC Data Architecture that will be developed further through the proposal. This schematic ws adjusted from the Workshop Report to show the key IOC components. Key to acronyms: IODE Ocean Data Information System (ODIS), IODE Ocean Biodiversity Information System (OBIS), GOOS OceanOPS (WMO-IOC Joint Operational Centre Ocean Observing), ERDDAP™, World Ocean Database (WOD), GOOS Regional Alliances (GRAs), GOOS Observation Coordination Group (OCG), GOOS Ocean Observing Networks/Global Data Assembly

Centres (networks/GDACs), GOOS Biological and Ecological EOV Observing Communities (BioEco EOV programmes)

Many elements of the proposed IOC Data Architecture already exist, however the workshop outlined an approach forward to optimise connections between existing elements, as well as clarification of support needed, that would strengthen delivery of ocean data for operational services. As a first step, the Workshop participants agreed to set up a working group to develop a proposal for the IOC Data Architecture for the IOC Assembly in June 2025. Key steps in the short and longer term are outlined in the Workshop Report, and summarised below.

For the short term, the workshop participants agreed to:

- Develop a proposal for the IOC Data Architecture that can be presented in draft form to the 14th GOOS Steering Committee in February 2025; the 28th IODE Committee Meeting Data Management in March 2025; and in final form to the 33rd IOC Assembly in Paris in June 2025
- Establish and start the work of the IOC Data Architecture Working Group to write a proposal for a cross IOC data architecture/space. This would include a number of aspects such as vision, structure, governance and resource needs. The Working Group will be supported by a jointly funded (IODE-GOOS) consultant, and initial activities include to:
    - Map the data flows - what to govern and what to implement - look at optimisation/eliminating redundancy
    - Create ‘rules’ of coordination, responsibilities - ODIS broker, services, data flows
    - Select showcase pilots that demonstrate data flows and the broker services, and test that assumptions regarding the architecture are robust
    - Set minimum metadata requirements, including provenance, licensing,EOV data precision, and a semantic identifier for ‘GOOS’ EOV data.
    - Develop a joint resource strategy and solicit feedback from key stakeholders to shape the IOC Data Architecture.

For the longer term, the workshop participants highlighted key aspects to consider in the planning for, and the implementation of, an IOC Data Architecture, including a phased plan and regular input from stakeholders, including to:

- Create a phased implementation plan that identifies goals and roles of different IOC groups, with clear regional support, including for SIDS.
- Establish a pathway to mature the IOC Data Architecture and its associated digital ecosystem into an IOC Data Space to support advanced data handling.
- Establish regular consultation and need/opportunity assessments with:
    - IOC Member States
    - IOC regional sub-commissions
    - Ministries for digital transformation and/or ocean-related affairs
    - Ad hoc groups, as required
    - IOC programmes (and their governing bodies)
- Create Minimal Viable Product(s) to support value demonstration and to test robustness and utility of the architecture.
- Implement a quality assessment framework to support certification of data quality and reporting of GOOS EOVs and SDG Indicators or related data.
- Support the maturation of digital culture for all those using or contributing to the IOC Data Architecture.
- Include, in the implementation plan, key metrics to address the digital divide and monitor and enable digital equity.
- Provide a phased plan that includes resource requirements for each phase, and related success markers.

- Undertake a review (2030), and check that IOC is:
  - Responding to operational needs for global initiatives
  - recognised as the trusted source for ocean data
  - enhancing NODC capacity where needed, and successfully entraining new ocean data (e.g. from private sector)

The Workshop Report contains a detailed description of the existing infrastructure elements, the ideas and planning suggested towards an IOC Data Architecture, and a list of actions. The workshop can thus provide the basis for the planning and development of the ***IOC Data Architecture.***

Box 1: IOC Data Architecture - technical concept and function

Core ideas:

- Based upon concepts which have shown great utility in both GOOS and IODE: open and modular technology, distributed-yet-federated system designs, metadata-driven exchange and orchestration, and an interoperability-first approach to data management and system engineering
- Based on, and extending, the IODE Ocean Data Information System (ODIS) Architecture, which federates digital asset catalogues from over 50 data sources (including continental-scale data hubs)
- Providing consistent implementation of the FAIR and CARE Principles, with alignment to the UN Ocean Decade Data and Information Strategy and its Implementation Plan
- Assess and preserve data provenance and lineage metadata, allowing derivative data products to be traced back to the point of truth (e.g. observations or models)
- Recognising that the GOOS EOVs are an essential element within this architecture

Function and attributes:

- Serve as the foundation of global ocean data sharing, powering global solutions and the IOC mission
- Support global services and data products - available to all - to detect, consolidate, and deliver GOOS-certified EOV data of documented quality
- Coordinate data and information across the IOC value chain to support operational services
- Deliver data about or supporting EOVs, SDG indicators, and other artefacts into global assessment and multilateral processes
- Provide IOC with a clearly defined, unique niche in the ocean digital ecosystem for more efficient investment
- Interface - at scale - IOC's core digital capacities with other existing architectures and infrastructures (e.g. WMO's WIS 2.0, UNEP's WESR)
- Bridge digital divides and help mature digital ecosystems globally through digital capacity transfer

Technical building blocks:

- Central ERDDAP™ servers operated by GOOS OCG will consolidate ocean observing data, including EOV data, from across global or thematic ocean observing networks. The GOOS ERDDAP™ server will then become an ODIS "Hypernode" (a node which, itself, contains a network of other nodes, in this case observing network ERDDAPs - OCG Data Implementation Strategy).
- OceanOPS, the IOC-WMO Operational Centre, will link its operational metadata - describing the state of the global ocean observing system - to ODIS and/or the GOOS Hypernode, while also enriching its services

- The IODE Ocean Biodiversity Information System (OBIS) - already an ODIS Node - will establish mechanisms to detect, identify, validate, and relay (meta)data relevant to GOOS BioEco EOVs, becoming a GDAC for BioEco EOVs
- Leveraging the capacity of the envisioned IOC architecture, the GOOS BioEco Portal will enhance its current mapping of biological and ecological observing networks with EOV (meta)data streams gathered from the GOOS Hypernode and all other ODIS Nodes.
- GOOS and/or other IOC activities focused on delivering curated EOV based services (such as the biogeochemical EOV focused Global Ocean Data Analysis Project; GLODAP) will explore how to build and maintain services and portals (similar in nature to the BioEco Portal) using the new capabilities provided through the IOC Data Architecture.

Enabling connectivity, inclusivity and supporting delivery:

- Using GOOS EOVs (and ECVs, where relevant), ensuring semantic identifiers and provenance, and connecting key elements across GOOS and IODE (as seen in Figure 1: OBIS, OCG ERDDAP™, OceanOPS, BioEco Portal, EOV Portals and services) through the ODIS Architecture, (meta)data can more easily flow across disciplines, such that they can become globally FAIR
- Secure and preserve provenance, conformance, and quality metadata, to ensure downstream products can be traced back to their raw components for validation and auditing, and be (re)used with confidence
- Expand the discoverability of EOV (meta)data across all ODIS Nodes, to support GOOS in extending its coverage
- Support IOC programmes in efficiently harvesting data from all sources to create products with known provenance, and in the establishment of ODIS nodes
- Co-implement CARE-aligned technologies and practices to recognize, respect and engage local and Indigenous knowledge holders

Figure 2: Workshop participants

2. Welcome by local host

Mr Peter Pissierssens, Head of the IOC Project Office for IODE, Oostende, Belgium welcomed the participants. He provided local information regarding the working hours for the meeting, coffee breaks and lunch. In this regard he referred to the timetable made available to all participants.

He recalled the objectives of the meeting as "*To establish optimized collaboration between IODE and GOOS, develop an integrated view of the data landscape and lay the ground for the development of an integrated, efficient, future facing, and FAIR data landscape between GOOS and IODE and across GOOS OCG, BioEco and BGC data components*".

The expected outcome of the meeting were defined as:

- A vision and first draft technical outline of an integrated GOOS-IODE data landscape
- Governance/collaboration mechanism ongoing
- Set of long and medium term actions
- Outline response to IOC MS (GOOS) and IODE Management Group
- A means to evolve for new requirements and a list of new needs that are visible

He then briefly recalled that the IODE Committee at its 27th Session (March 2023) (paras 197 to 199 of the summary report) had instructed its Co-Chairs "*to engage with the OCG Data Strategy implementation Plan to ensure that it is fit for purpose from the ocean data management community standpoint*". The Committee also "*urged IODE experts to participate in (online) OCG meetings*". It had further "*noted with appreciation the ambitious plan for a BioEco Data Portal that is an integrated resource for national, regional and global ocean observing system monitoring and planning and instructed IODE OBIS to identify the resources needed to fulfil this in a 2023-2025 planning proposal*".

The IODE Management Group, at its February 2024 meeting had "requested GOOS to organize a joint GOOS-IODE meeting on data, possibly during the Thirteenth Session of the GOOS Steering Committee, 14-17 April 2024, Spain, and to share the data implementation plan well in advance. This meeting could not be held in April 2024. The meeting of 30 September to 2 October is the requested meeting but with an extended agenda.

He reported that IOC EC57 (2023) requested GOOS to provide a proposal to the IOC Assembly 2025 to evolve GOOS, in consultation with its sponsors, Member States and GOOS Steering Committee. Part of this proposal considers: Support for the work being undertaken within the Ocean Decade to create a functioning Digital Ecosystem that fully enables end-user applications, and that recognizes that such an ecosystem has three key underlying components, namely, 'observations and data collection', 'data management and sharing', and 'analytics modeling and predictions,' with the intention to weave, using co-design concepts, such a Digital Ecosystem into the fabric of GOOS. GOOS SC at its 13th meeting, April 2024, had as action item 9.1 to Create and adopt a cross GOOS Digital Infrastructure/Ecosystem Strategy in alignment with IODE, Ocean Decade Data Strategy and other partners.

He noted that the meeting would have two components: discussions focusing just on cooperation between IODE and GOOS on day 1 and the morning of day 2, followed by a more

IOC wide and Ocean decade part in the afternoon of day 2 and throughout day 3. The meeting would be expected to end on Wednesday 2 October by 15:30.

He closed by referring to a number of background documents mentioned in the agenda document.
He invited participants to briefly introduce themselves (name and function in GOOS, IODE or IOC). He invited participants to upload their PPT to the web site as soon as possible. The list of participants is added as Annex II. The Agenda of the meeting is added as Annex I.
(add Ana Lara-Lopez who participated online)

3. GOOS/IODE welcome and introduction

In her introductory words Ms Lotta Fyrberg, IODE Co-Chair referred to the words from Mr Pissierssens and stressed the need for an integrated data system. She hoped to identify many areas of cooperation.
In her introductory words Ms Joanna Post, Head Ocean Observations and Services Section (OOS) referred to the previous introductions, and noted that the Thirteenth GOOS Steering Committee, April 2024, had an action item 9.1 to ‘’Create and adopt a cross GOOS Digital Infrastructure/Ecosystem Strategy in alignment with IODE, Ocean Decade Data Strategy and other partners’’.

4. Strategic Priorities for GOOS and IODE

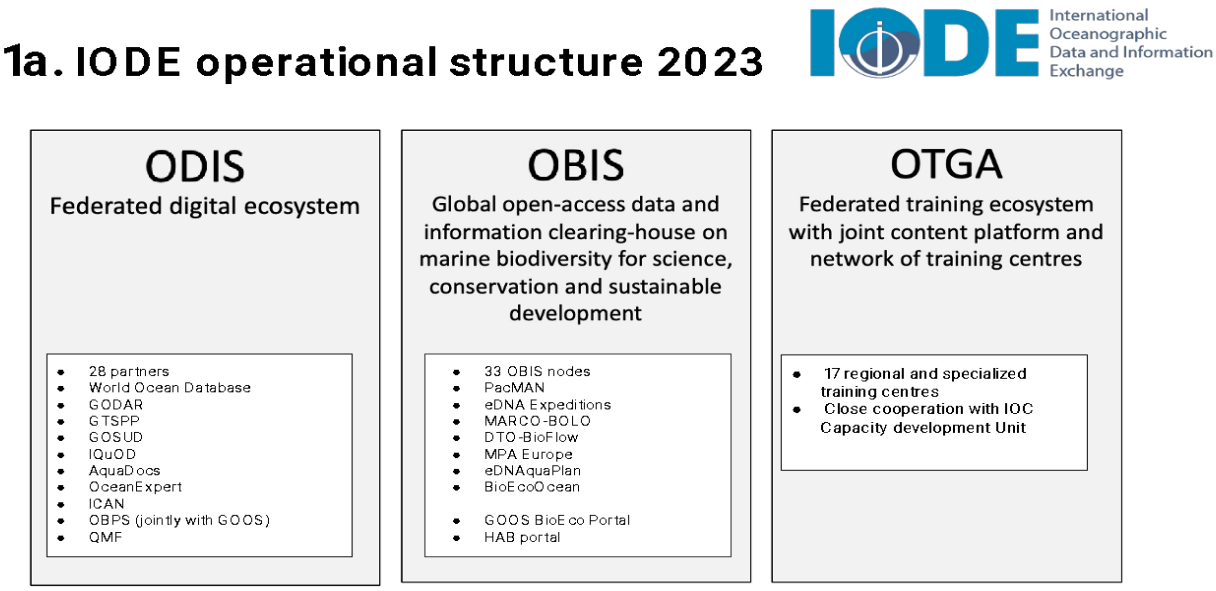
Ms Fyrberg and Ms Post explained that this agenda item will outline the strategic priorities for both IODE and GOOS for the next years, where do both organisations want to be in 5 years time, how is an integrated GOOS-IODE data system a part of that vision, what do both organisations want out of such a system. The question to answer would be “what do IODE and GOOS want out of an integrated IODE-GOOS FAIR data landscape”.

4.1 IODE

Ms Lotta Fyrberg provided a presentation on the strategic priorities of IODE, after the restructuring of the IODE programme by IODE-27 (2023).

She explained that IODE was established in 1961. Formally the IODE started out as a Working Group on Oceanographic Data Exchange which was created by the First IOC Assembly (19-27 October 1961). The Working Group became a Working Committee in 1973 through Resolution VIII-31, adopted by the 8th Session of the IOC Assembly (5-17 November 1973). It is a Primary Subsidiary Body of the IOC with the prime objective “*to enhance marine research, exploitation and development, by facilitating the exchange of oceanographic data and information between participating Member States, and by meeting the needs of users for data and information products*”. The *IODE focus audience has been the ocean science community. Below are key extracts from the presentation.*

IODE programme structure 2023-…



She explained that IODE revised its programmatic structure at IODE-27 in March 2023. It is now composed of 3 programme components: ODIS, OBIS and OTGA. Former IODE projects such as World Ocean Database, GTSPP, GOSUD etc are now programme activities.

Outcomes/outputs/products or services of the programme activity

- OBIS is considered as the ocean biodiversity "authority" within the UN and is seen as the 'super' GDAC for all BioEco EOVs by GOOS. OBIS also provides services that go beyond the IODE remit, through the BioEco Portal it provides a view of the GOOS BioEco observing system, and creates information products and tools for science, assessments (e.g. IPBES, World Ocean Assessment, IOC State of the Ocean Report) and decision making (MPAs, EBSAs, invasive species). Member States are now using OBIS for national reporting to the CBD as referred to in the 2023 targets and 2050 goals of the CBD Global Biodiversity Framework

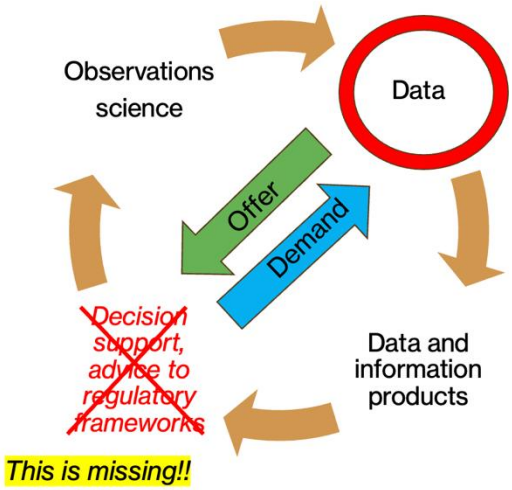
- ODIS is recognized as a global digital ecosystem for ocean data and promoting IOC's important role as a global network of ocean data centres, hosted by IOC Member States which is essential for these Member States to comply with their obligations in international frameworks (e.g. SDG, BBNJ).

- OTGA is recognized as the training system of choice through its global network of regional and specialised training centres, and affiliated partners, hosted by IOC Member States, that coordinates a standardized and accredited learning management system and promotes global collaboration, including south-south cooperation, in ocean related learning.

Current and potential users of the outputs, products or services: how do they assist research, ocean policy and management, industry, multilateral processes (e.g. SDG, BBNJ, …)

- IODE data centres (NODCs) have been established by Member States mainly in ocean science government institutions. As such the main users of NODC data (and IODE programme activities) are ocean scientists;
- IODE associate data units (ADUs) are composed of national, regional, international and commercial entities. Main users are ocean scientists
- OBIS nodes are either NODCs or ADUs

How does the programme activity contribute to the IOC value chain?



- What is currently missing in IOC is a unit/section that deals with decision support. This results in a lack of users of data beyond the science community
- We see the same problem at the national level (see previous topic)
- IOC programmes are insufficiently visible/appreciated in the Ocean Decade

Strategic planning for the next 5 years: priorities

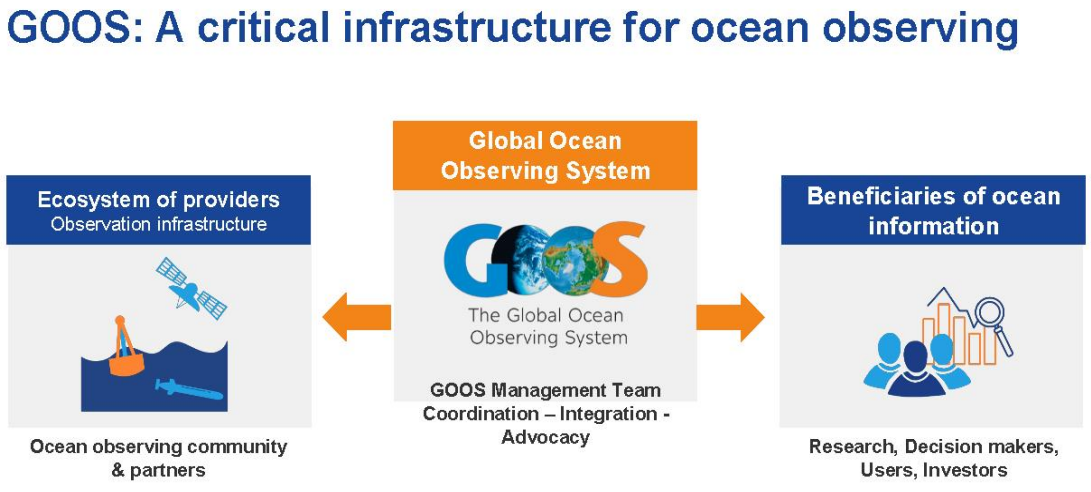
- Further develop the IOC **Ocean Data and Information System (ODIS)** into a global ocean data and information ecosystem making available data and information sources of all member states and to all member states
- Further develop the **Ocean Biodiversity Information System (OBIS)** into a globally interconnected community of practice, facilitating seamless and near-real-time data flows, from biological observations to practical applications.
- Ensure that all **IOC Member States have the necessary capacity** to manage ocean data and information (as part of the IOC value chain) and to develop products, services and policy advice for sustainable ocean planning and management
- Align IODE with the Ocean Decade objectives/implementation plan as well as SOPM
- Focus on building a (wider) user audience among ocean policy and management, industry, multilateral processes

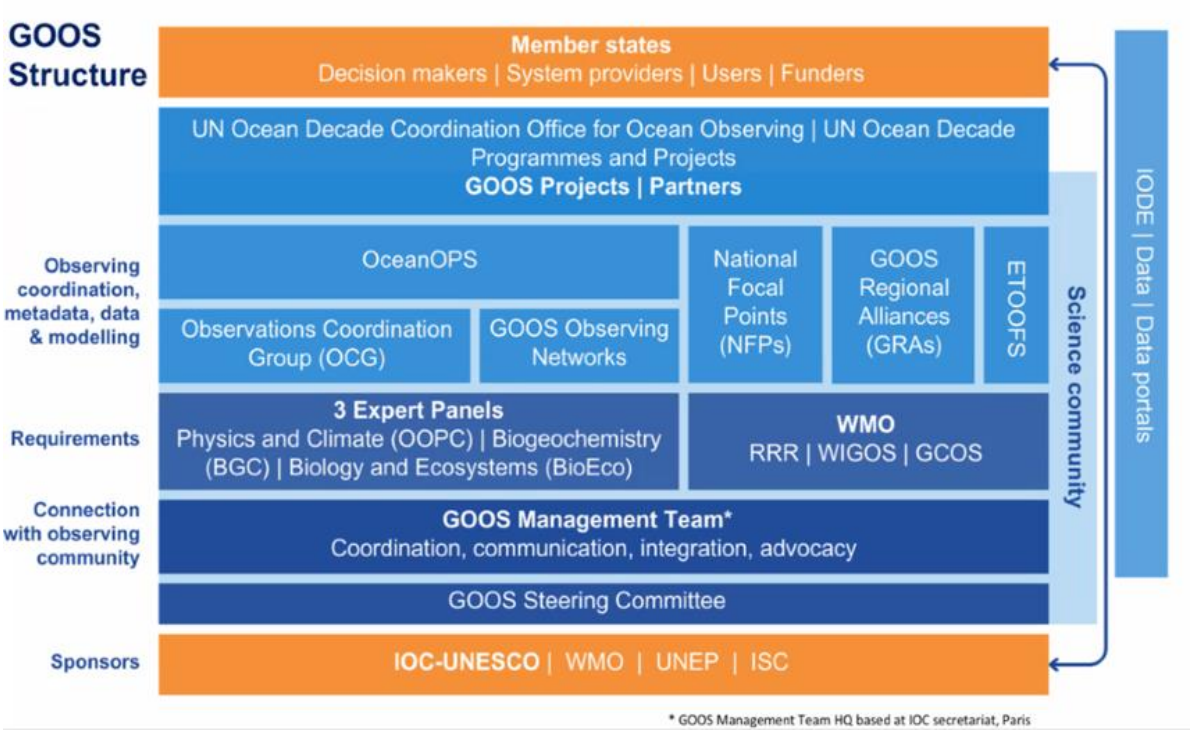
Goals for an Integrated IODE-GOOS FAIR data landscape

- Meet user requirements both on a National and Global level
- A global digital representations of the marine ecosystem
- An implemented Ocean Decade Data Strategy

4.2 GOOS

Ms Joanna Post provided a presentation on the strategic priorities of GOOS. *Below are key extracts from the presentation.*





GOOS Today

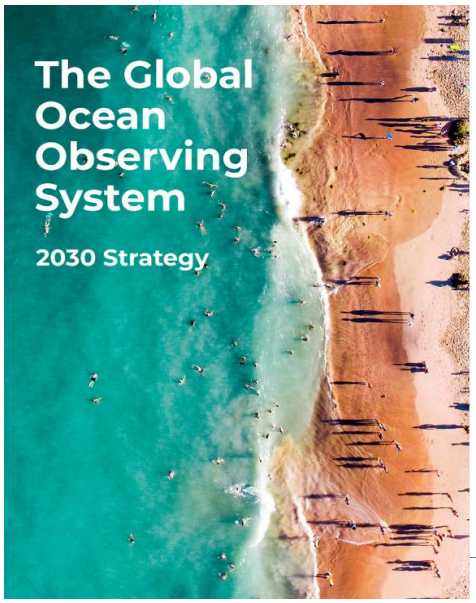
84 countries

8,000+ observing platforms

13 global observing networks
(+3 emerging)

638 long-term biological monitoring programmes across 12 EOV observing networks

>120,000 observations per day – reach operational systems



Underpinning a wide range of applications

Vision: A truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, wellbeing and prosperity

2030 Strategy

Goal 2: System integration and delivery, provide authoritative guidance on integrated observing system design, sustain, strengthen and expand observing system implementation, and ensure FAIR data

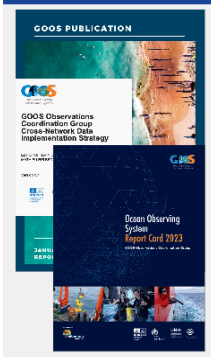
SO7. Ensure GOOS ocean observing data and information are FAIR with appropriate quality and latency

Outcomes foreseen:

- An identified GOOS data architecture as part of broader oceanographic, atmospheric, and earth system data architectures
- Data products based on EOVs/ECVs
- More data available, more appropriately, to more users
- Meaningful data metrics

Developments – building blocks - since 2019

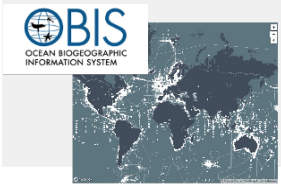
GOOS Observations Coordination Group (OCG)



- OCG network data mapping
- OCG Data implementation strategy
- WMO unified Data Policy - EOVs
- Open GTS – piloted WMO
- OCG ERDAAP server
- Report Card – cross GOOS
- Best practices documented

GOOS Biology and Ecosystems Expert Panel

- BioEco Portal launched - metadata
- BloEco network data flows integrated with OBIS
- Best practices documented



GOOS Biogeochemistry Expert Panel

- BGC Panel work towards BGC value chains (not stable) GDAC and products

GOOS IODE

Not yet fully integrated, sustained or trackable…
GOOS has been provided with increased funding to achieve greater impact

7

GOOS data connected to support alignment

16 OCG Networks
12 BioEco EOV networks

OceanOPS
BioEco Portal

15 GRAs
76 National Focal Points

The Global Ocean Observing System

Many connections to support alignment
Developments based on this knowledge
Not all parts of GOOS or partners are connected & even across GOOS roles not well understood

WORLD METEOROLOGICAL ORGANIZATION
IODE
OBIS OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM
2021 2030 United Nations Decade of Ocean Science for Sustainable Development
UN environment
MBON Marine Biodiversity Observation Network
GEO BON Group on Earth Observations Biodiversity Observation Network

Data strategies
- WMO Unified Data policy
- Revision of IOC Strategic Plan For Data
- UN Decade Data Strategy

Task Team members
- WMO
- IODE
- Decade

Cross membership
- OBIS – BioEco Panel
- OCG - IODE

Adoption standard/open technologies:
- ODIS architecture
- federated system approach
- ERDDAP

GOOS IODE

8

Aspirations noted from the GOOS SC-13 discussions

What do our users want from a digital ecosystem infrastructure?

- Access for each EOV to all observational data, from wherever in the world, with a known uncertainty documented in the metadata
- GOOS ocean data ecosystem that is foundation for the IODE 2030 Data, Decade 2030 Data Implementation Plan, WMO WIS 2.0
- EOV products that are user-led

What are the main barriers to a cross-GOOS strategy?

- Not having a cross-GOOS strategy, standards, vision, governance

- Building EOV data from platform-based networks
- Evolving beyond discipline based view

What are the opportunities?

- Use our skilled people + existing building blocks
- Adopt ODIS framework - metadata aggregator - key for cross Bio-Physics-BGC
- Harmonise metadata. inc. GRAs, and extend metadata standards to sensor manufacturers
- Harmonise best practices with OBPS

GOOS SC-13 – outcomes

Action 9.1 Create and adopt a cross GOOS Digital Infrastructure/Ecosystem Strategy in alignment with IODE, Ocean Decade Data Strategy and other partners.

Executive Council 57 Decision:
Proposal for Assembly 2025 and ongoing outreach

A first step – is a proposal for assembly 2025 – whilst building coordination, integration and advocacy
Proposal for evolving GOOS (outlining what needs to be done as a first step)

1. Focus GOOS to be fit for purpose to meet the needs of Member States
2. Review components and revise TOR, as well as MoUs with sponsors and partners
3. ***Create a functioning Digital Ecosystem to enable end user applications***
4. Evolve a user and uptake strategy
5. Determine a process to set a new GOOS strategy synergised with Decade Challenge 7 **and** across IOC processes

A sustained and sustainable critical ocean observing infrastructure
From the coast to the open ocean – From the surface to the sea floor national – regional – global

1. Co-designed ocean observing system for operational services, as well as research
2. FAIR data for the Essential Ocean Variables with clear standards, QA and QC
3. Equitable, federated global ocean digital ecosystem and data community
4. Global, regional and national coordination, integration and advocacy
5. Build new economic thinking, literacy, capacity, innovation and partnerships

For weather there are dedicated national organisations with that specific mandate. The mandate for ocean science and observation is scattered across many national organisations and other entities, in the biological and ecological area there is a lack of a regulatory environment around ocean data.

Discussion

A significant part of the discussion focused on the ODIS architecture and how this would function to integrate with GOOS and other elements. During the discussions it was clarified that ODIS is a federation of partners. In this architecture there may be sub-systems, and GOOS (through the 'GOOS' ERDDAP - see OCG Data Implementation Strategy) is such a

sub-system, a self regulated, well ordered system, with its own identity - a Hyper Node. Such an architecture is open and forward looking, moving away from the need for an organisation to capture a digital domain, the participants have a certification process and require compliance with ODIS data strategies.

ODIS operates at the metadata level. From the digital perspective, GOOS will likely be an observation-centric sub-net of a larger ocean data mesh (thus being a data mesh itself), that nests in and co-shapes ODIS (where it will be a hypernode).

It was also noted that observation QC is what GOOS does. Metadata QC is under OceanOPS and future functions envisioned for ODIS. GOOS would play an active part in the ODIS system, working with other portals so portals evolve how to better deliver data to users. GOOS has its internal organization according to GOOS needs and then negotiates the interface to the broader ODIS system, while also playing an active role in this system. Finally it was agreed to develop data flows around GOOS Essential Ocean Variables - including coordination between IODE and GOOS to evolve synoptic identifiers that will enable clear provenance for GOOS data.

5. Mapping the current situation

Ms Post explained that the objective of this session was to bring together presentations from the different elements that currently constitute the IODE-GOOS data landscape, from observations to data management and data access by users, across GOOS components, and across organizations including WMO. What are the data strategies, where is there convergence, what are the visions for an integrated digital ecosystem, what are the opportunities and the issues.

The questions to answer were:

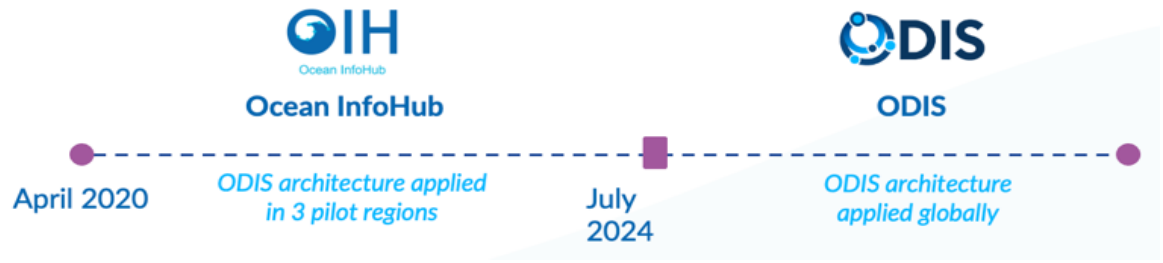
- What is the current landscape?
- What are the current plans and strategies including OCG Data Strategy and IOC Strategic Plan for Ocean Data and Information Management and how they support observations and data communities

5.1 IODE and ODIS

Ms Lucy Scott and Mr Pier Luigi Buttigieg provided an overview of, and introduction to the IODE Ocean Data and Information System (ODIS) and its regional Ocean InfoHubs. ODIS is a federation of independent systems that uses common conventions to share and exchange their (meta)data over the Web. *Below are key extracts from the presentation.*

ODIS is a global initiative supported by the IOC/UNESCO to:

- Improve access to marine and coastal data and information
- Provide an openly accessible online platform to network stakeholders and facilitate the exchange of Ocean data and knowledge



OIH worked closely with existing IOC databases and in three regions. Now we have ODIS a programme component.

ODIS objectives

- Harness the proliferation and diversity of Ocean data, online data systems and other digital resources;
- Connect global and local digital systems and infrastructures using Web architecture;
- Support IOC member states and institutions;
- Raise awareness of global data and information resources among local users;
- Overcome challenges of trust through socio-technical innovation in some regions and communities.

The Ocean Data & Information System (ODIS) is now a global infrastructure that can help any organisation or individual to share their ocean (meta) data with the Web, as well as to access a growing ecosystem of Ocean data.

Partner network

- Composed of ODIS Nodes, through which data providers and partners can communicate, discover and share data, and connect;
- With high scalability: gains richness and efficiency with growing number of nodes.
- Currently links 50 data sources from 42 partner organisations (see list of most of these below)

African Coastal and Marine Atlas catalogue (ACMA)	Canadian Integrated Ocean Observing System (CIOOS)	Latin America and the Caribbean Region (LAC) Geospatial
IOC Africa Data Portal	European Directory of Marine Environmental Research Projects (EDMERP) SeaDataNet	Latin America and the Caribbean Region (LAC) Institutions
AquaDocs	European Directory of Marine Organisations (EDMO) SeaDataNet	Latin America and the Caribbean Region (LAC) Training
Argovis ARGO Collection	European Marine Observation and Data Network (EMODnet)	Latin America and the Caribbean Region (LAC) Vessels
Better Biomolecular Ocean Practices (BeBOP) as part of Ocean Biomolecular Observing Network (OBON)	EurOcean Organizations	MARine COastal BiOdiversity Long-term Observations (MARCO-BOLO)
Benguela Current Convention (BCC) GeoData Portal	EurOcean Projects	Marine Institute Data Catalogue (Ireland)
Belgian Marine Data Centre (BMDC)	EurOcean Vessels	Marine Training EU
British Oceanographic Data Centre (BODC)	Global Biodiversity Information Facility (GBIF)	Marine Spatial Atlas for the Western Indian Ocean (MASPAWIO)
Caribbean Marine Atlas catalogue	Indian National Centre for Ocean Information Services (INCOIS)	Marine Environmental Data and Information Network (MEDIN)
CLIVAR and Carbon Hydrographic Data Office (CCHDO)	Latin America and the Caribbean Region (LAC) Documents	Research Coordination Network for Marine Ecological Time Series (METS-RCN)
Canary Current Large Marine Ecosystem (CCLME)	Latin America and the Caribbean Region (LAC) Experts	Marine Information Management System (MIMS)
		NCEI Marine Microplastics Catalogue

In addition, we work with 70-80 other organizations that may be interested in sharing their metadata or that are interested in what we do.

ODIS can also identify gaps in data coverage. Some of the partners are small groups while others are large networks. The partners do not just include NODCs but also regional organisations. We are reaching out to all NODCs and ADUs to participate. In some cases the willingness is there but they need assistance to participate (e.g. in developing countries).

- Partners **do not change internal workflows or existing (meta)data systems**: A common Web interface through JSON-LD/schema.org and LOD paradigms is the key to common FAIR implementation.
- Specifications are lightweight, easy to implement, and resilient to gain/loss of parts.
- Partners aligned to ODIS are also discoverable by Google Dataset search and others.
- Partners retain their own data and complete control over what they share through their node or nodes. Essential for CARE compliance and interfaces with sensitive data in corporate or other realms
- All documentation is online, free and open https://book.oceaninfohub.org/index.html

Global Search Portal

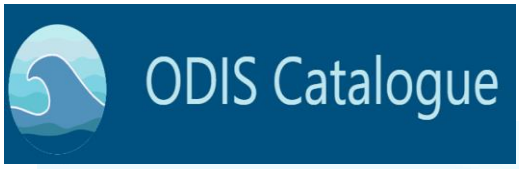
A Global Search portal has been developed as a demonstration of ODIS (https://oceaninfohub.org). The portal currently contains over 130,000 content items in seven content categories: (i) Experts (27,000); (ii) Institutions (13,000; (iii) Documents (42,000); (iv) Training (1,500); (v) Vessels (113); (vi) Projects (3,600); and (vii) Datasets (48,000).

Linking to ODIS: Getting started

https://book.odis.org/gettingStarted.html

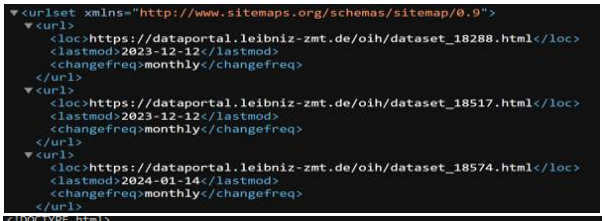
Quick Steps

1. Register your portal in ODIS Catalogue
   - make sure you (or someone in your organization) has an OceanExpertID (jump to that below)
   - add your entry into ODIS Catalogue (jump to that below)
2. Prepare your JSON-LD metadata (jump to that below)
3. Create your sitemap (jump to that below)
4. Register your sitemap in your ODIS Catalogue entry (jump to that below)
5. Review the FAQ (jump to that below)

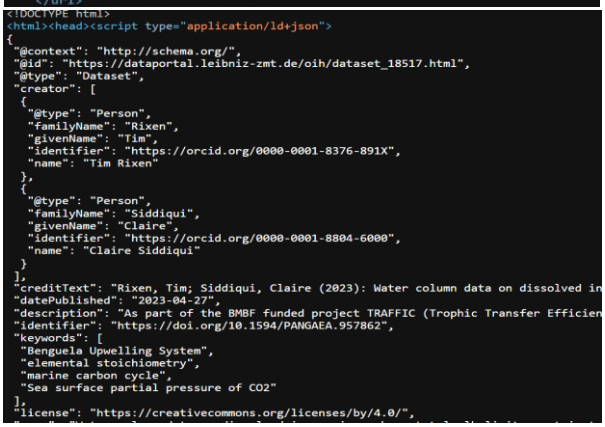


ZMT DATA PORTAL

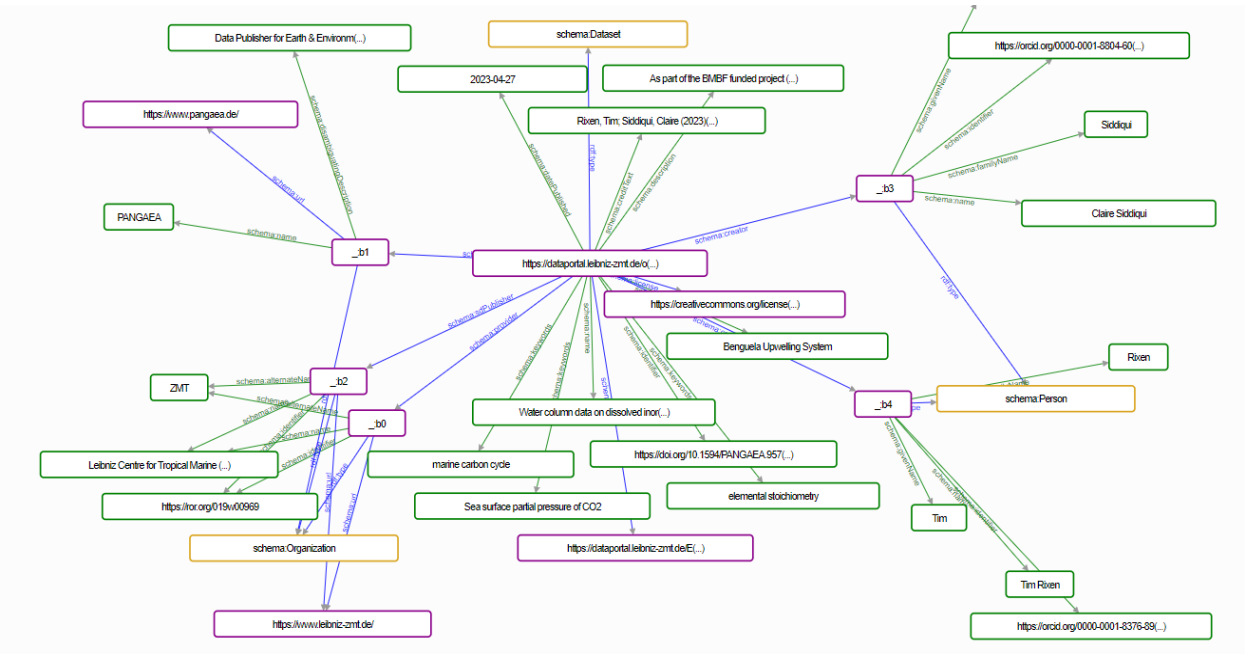
This resource is online	Last check was 29/09/2024 23:39
First entry: 29/11/2023	Last update: 30/11/2023
Submitter/Owner of this record	Dr. Birte Hemmelskamp-Pfeiffer (OceanExpert : 62945)
Submitter/Owner Role	Other
Datasource URL	https://dataportal.leibniz-zmt.de/
Parent Project URL	
ODIS-Arch URL	https://dataportal.leibniz-zmt.de/sitemap.xml
ODIS-Arch Type	Sitemap
English name	ZMT Data Portal
Original (non-English) name	

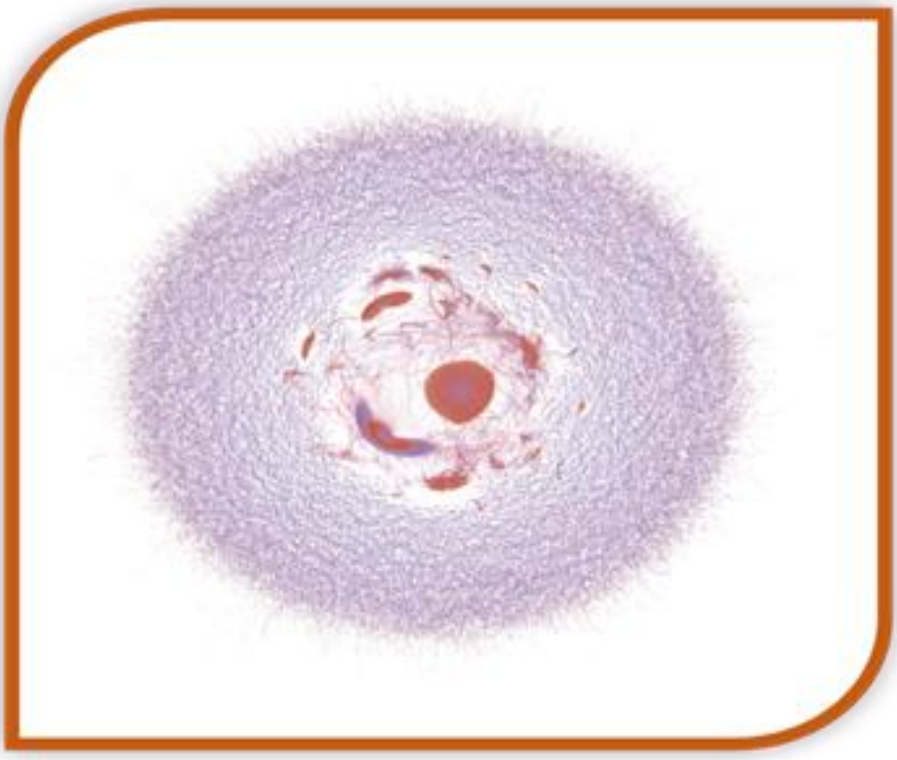


```
<urlset xmlns="http://www.sitemaps.org/schemas/sitemap/0.9">
  <url>
    <loc>https://dataportal.leibniz-zmt.de/oih/dataset_18288.html</loc>
    <lastmod>2023-12-12</lastmod>
    <changefreq>monthly</changefreq>
  </url>
  <url>
    <loc>https://dataportal.leibniz-zmt.de/oih/dataset_18517.html</loc>
    <lastmod>2023-12-12</lastmod>
    <changefreq>monthly</changefreq>
  </url>
  <url>
    <loc>https://dataportal.leibniz-zmt.de/oih/dataset_18574.html</loc>
    <lastmod>2024-01-14</lastmod>
    <changefreq>monthly</changefreq>
  </url>
```

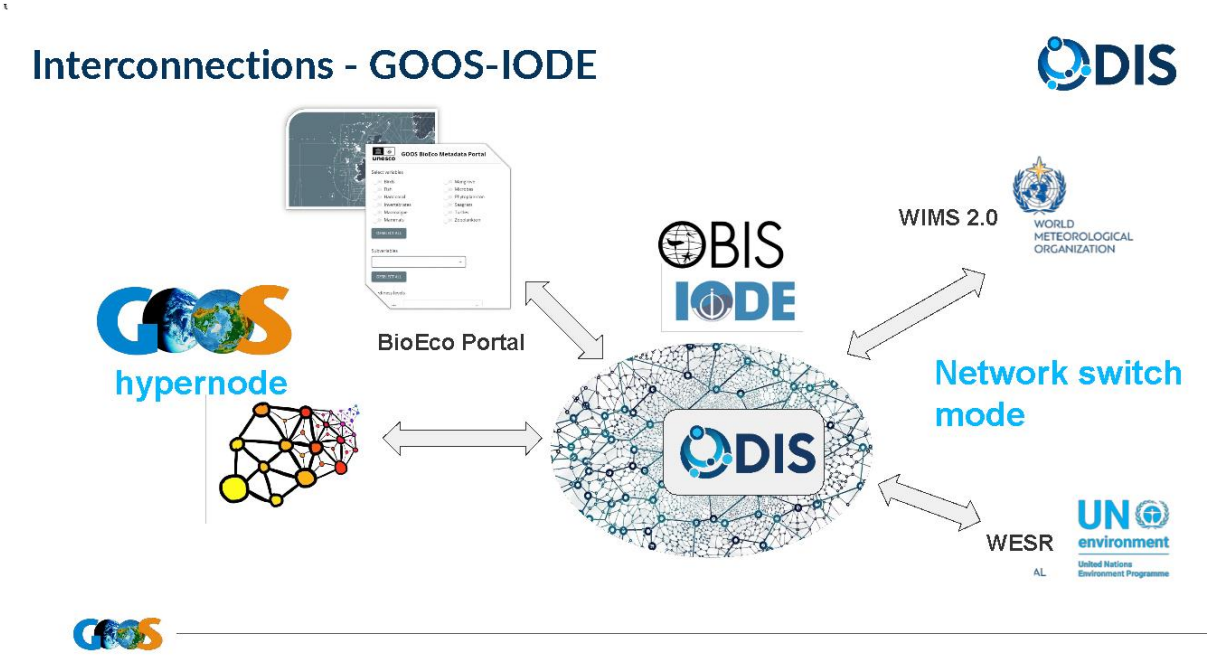


```
<!DOCTYPE html>
<html><head><script type="application/ld+json">
{
 "@context": "http://schema.org/",
 "@id": "https://dataportal.leibniz-zmt.de/oih/dataset_18517.html",
 "@type": "Dataset",
 "creator": [
  {
   "@type": "Person",
   "familyName": "Rixen",
   "givenName": "Tim",
   "identifier": "https://orcid.org/0000-0001-8376-891X",
   "name": "Tim Rixen"
  },
  {
   "@type": "Person",
   "familyName": "Siddiqui",
   "givenName": "Claire",
   "identifier": "https://orcid.org/0000-0001-8804-6000",
   "name": "Claire Siddiqui"
  }
 ],
 "creditText": "Rixen, Tim; Siddiqui, Claire (2023): Water column data on dissolved in
 "datePublished": "2023-04-27",
 "description": "As part of the BMBF funded project TRAFFIC (Trophic Transfer Efficien
 "identifier": "https://doi.org/10.1594/PANGAEA.957862",
 "keywords": [
  "Benguela Upwelling System",
  "elemental stoichiometry",
  "marine carbon cycle",
  "Sea surface partial pressure of CO2"
 ],
 "license": "https://creativecommons.org/licenses/by/4.0/",
```





This is the collective data catalogue (above)



Who are the key users/how ensure data reaches them

Who to ensure that data reach the user? ocean internet is very fragmented and has become a data swamp. We are not trying to do a global cleanup.

What would be your vision for an integrated digital ecosystem

We cannot be naive: there are major changes happening to the Internet itself. Geopolitical policy is affecting this. Companies like Google and others have changed how the internet works. GOOS. IODE and IOC are nested in this. We cannot take the web for granted so we need to create an entity that can deal with a changing internet,

- A splinternet with negotiated data spaces (e.g. European, US, …). ODIS will be a public data space, and we will need to negotiate how these talk to each other,
  or
- An IOC-coordinated linked data mesh for the global ocean data space. We can have a UN wide data space.

Discussion - What are the opportunities and the issues in creating an integrated digital ecosystem

Mr Buttigieg recalled that when the internet started it was just a few computers talking to each other. Then the world wide web was born, and you could see everything in that web, this is no longer true. Now regulators and countries have data policies, and some countries now have their contained internet that does not allow certain external sites. That is splinternet. These

data enclaves will grow further in future. Therefore, we need to be prepared with building a consolidated IOC system, this work is also risk management..

Mr Buttigieg further responded to a question regarding SeaDataNet: partners share certain data through SeaDataNet. But some partners may wish to share data which they are not sharing through SeaDataNet. They can become individual partners in ODIS. As such, some can be ODIS partners twice: once through GOOS and one direct.

What is the benefit of partnering in GOOS if data can simply be shared through ODIS was questioned. Although ODIS in itself is open and people can share what they want, Mr Buttigieg responded that the QC within the GOOS hypernode is a huge added value. GOOS is a community that has peer reviewed its data. The question was asked how we can harmonize the data sets from different nodes. Mr Buttigieg responded that we first need an asset catalogue. Then partners can negotiate deeper data interoperability that can then lead to synthesis products. This has been started in a very limited way and more work will be needed.

5.2 OCG and OceanOPS

Mr Kevin O'Brien introduced this item. He explained that we started a few years ago how data was flowing in the networks. It turned out to be somewhat chaotic.

OCG Data flows

- OCG data mapping exercise:
  - Identify gaps in data/metadata flow and recommended best practices
  - Identify potential efficiencies to improve metadata and data access, discovery and use (to be documented in OCG data strategy)
- Already out of date (new emerging OCG networks approved)
- Strategy: https://goosocean.org/document/31176

OCG Cross-Network Data Implementation Strategy

Why?

- Many existing or developing data strategies
  - WMO Unified Data policy
  - Revision of IOC Strategic Plan For Data
  - **UN Decade Data Strategy**
- Ocean community pushing for compliance with FAIR data principles - what does that mean?

This Implementation Plan is an effort to define specific and actionable ways OCG network/programs can move towards FAIR compliance

- Improve (meta)data discovery, accessibility and usability for all stakeholders
- Improve access to distributed (meta)data endpoints through federated, uniform data services

Data and Metadata Implementation Requirements:

- Real Time Data (2)
- Delayed Mode Data (4)
- Metadata (3)
- Best Practices (3)

GOOS OCG Data Implementation Requirements

Real Time Data

OCG-R1	Data shall be exchanged in real time (with minimum delay) via the WIS/GTS of the WMO in approved formats/templates.
OCG-R2	Data shall be available in real time or near-real time on the Internet through interoperable services (preferably ERDDAP) freely and without any restriction. Community agreed quality control procedures shall be applied in real-time and adjusted values made available when possible.

Delayed Mode Data

OCG-R3	Each network shall have at least one identified Global Data Repository. This Global Data Repository may be one or multiple (mirrored) repositories, or they may be data endpoints that can be federated into a virtual global repository.
OCG-R4	Data and data products shall be available through publicly accessible ERDDAP services. These distributed ERDDAP services will be federated under a single OCG ERDDAP focal point.
OCG-R5	NetCDF is the preferred data file format, though ERDDAP services can act as a data format translator if needed.
OCG-R6	Additional platform metadata should be available through the Global Data Repository and harvestable by machine-2-machine services.

Metadata

OCG-R7	Networks shall have a defined uniform metadata content that includes at least the minimum OceanOPS requirements, thereby ensuring that they are compliant with the WIGOS metadata requirements. Note that OceanOPS is the authoritative source through which WIGOS metadata are submitted to OSCAR for all oceanographic and marine meteorological platforms.
OCG-R8	Discovery and Use metadata shall be based upon a well-documented community standard, including a persistent and unique WMO/WIGOS identifier allocated by OceanOPS and use controlled vocabularies.
OCG-R9	Platform and Discovery metadata shall be exchanged with OceanOPS utilizing machine-2-machine services.

Best Practices

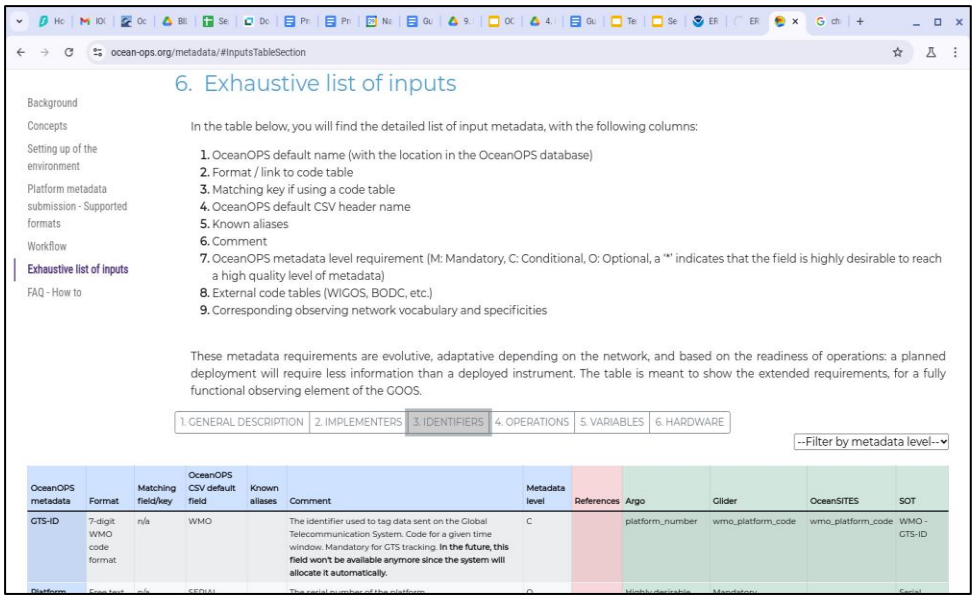
OCG-R10	Each network should have an active data team.
OCG-R11	Each network should have identified best practices on data infrastructure and workflows and data Q.C.
OCG-R12	Raw/real-time data, delayed mode data and data products should be archived and have unique identifiers created (i.e., Digital Object Identifier (DOI)) for citation and reuse.

OceanOPS is the heart of GOOS platform metadata

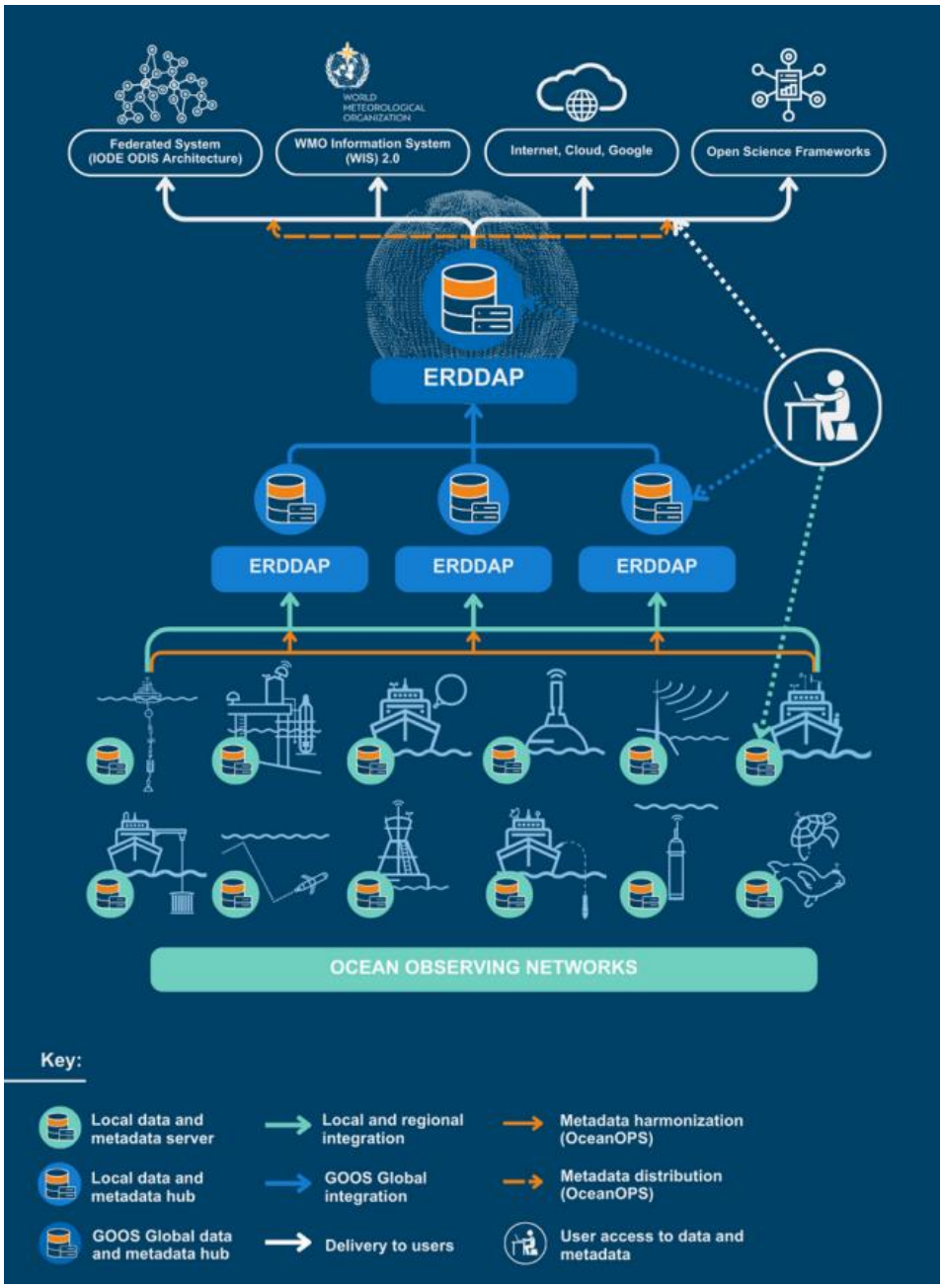
- GOOS network platform metadata flows through OceanOPS and into WMO OSCAR
- Used to track RT data flows and provide feedback on data QC to providers
- Metadata available through API (soon ERDDAP?)

We are working to:

- Implement uniform content for networks to provide
- Improve m2m exchange of the metadata with networks/OceanOPS



All networks provide their data to OceanOPS.



OCG Cross-Network Data Implementation Strategy

The OCG Cross-Network Data Strategy was released in May 2024 and GOOS OCG is now working on implementation with the networks.

- ERDDAP services where needed for delayed mode data and metadata
- Federate distributed ERDDAP nodes in GOOS OCG focal ERDDAP
  - Datasets from AniBOS, DBCP, GLOSS, GO-SHIP in place
- Leverage these ERDDAP services for metadata exchange with OceanOPS as well as IODE Ocean Data Information System (ODIS)
- OCG Data Task Team being formed

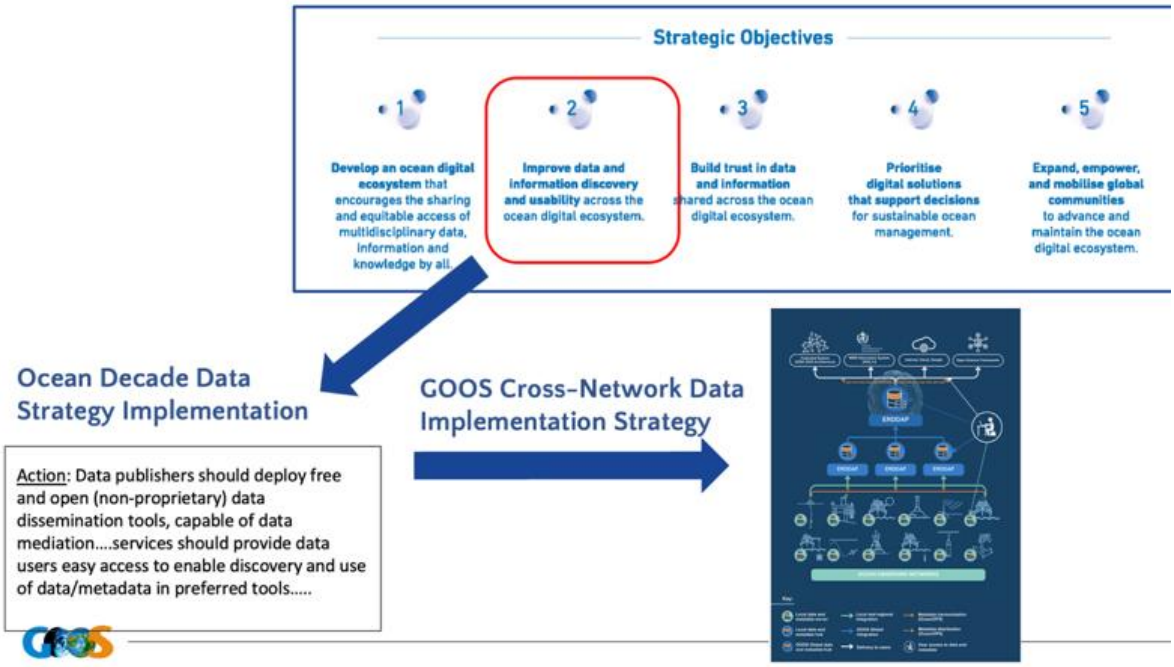
OCG Linking with IODE/ODIS

Integration with IODE Ocean Data and Information System (ODIS)
When data is in ERDDAP it already speaks the language that ODIS uses (JSON LD).

OCG links to WMO

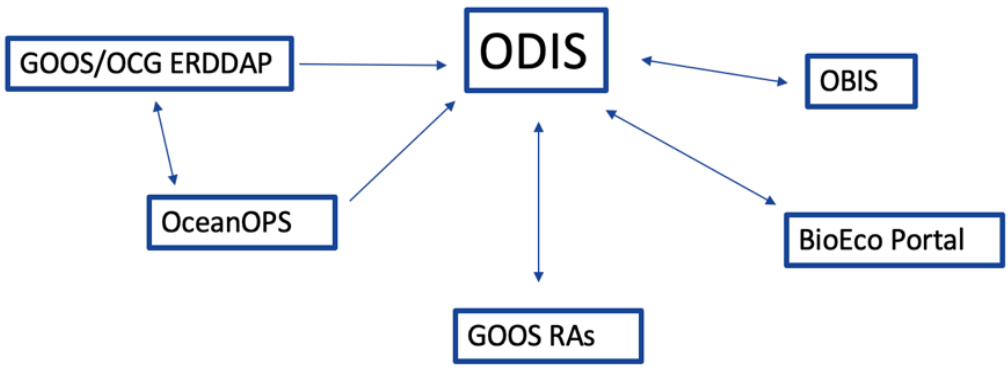
- Important link is from OceanOPS to WMO - metadata submission
- WIS 2.0 evolution
  - ERDDAP can be used as a data exchange service on the WIS2
  - A pilot project is in early stages to demonstrate this connection

Integration with UN Decade Data Strategy and Implementation



What could a cross-GOOS infrastructure look like?

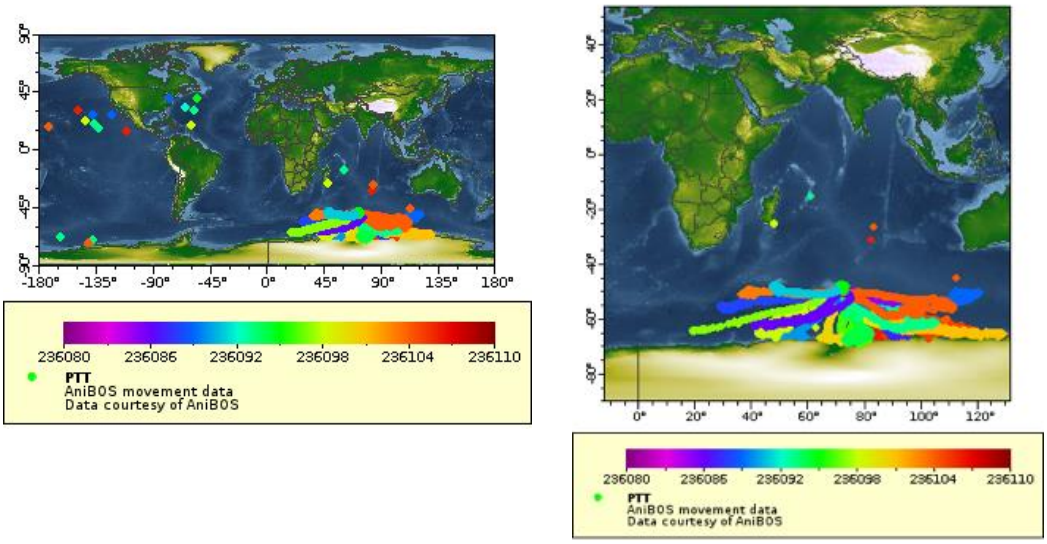
Within GOOS, we will harness the power of ERDDAP to provide an easy federation of distributed data nodes. ODIS seems well placed to act as the glue between disparate systems.



One common element is potentially a platform (ship, mooring, USV, animal, drifter, etc)

- How to link data at several repositories to the observing platform?
- Could a unique OceanOPS platform ID link all of these datasets back to the observing platform?

An agreed “first attempt” to as a link between the Bio-Eco community and GOOS OCG data processes. the AniBOS movement data added to OCG ERDDAP.



GOOS OCG Data Users

- Members of the GOOS Networks
- Cross-network projects
- Global stakeholders
  - WMO
  - ODIS
  - UN Decade projects (DiTTO, etc)
- Who knows?

Opportunities

- People have begun to galvanise around the issue of open data and metadata
- Ocean data community is moving in roughly the same direction (ie, FAIR, etc)
- We have defined strategies and implementation plans

… and Issues

- How to effectively and efficiently connect the BioEco community and Physical ocean communities?
- How to bring the National/Local data repositories/producers into the conversation?
- How to integrate third party and/or commercial data?

Discussion

It was noted that the footprint of OCG in ODIS already exists and will grow. An important technology within the OCG is ERDDAP. While using APIs requires knowledge about partner APIs, ERDDAP can negotiate APIs. A challenge has been to link with other initiatives like Copernicus, EMODnet etc. and this is where we can use ODIS as those entities can be their own nodes in ODIS.

It was questioned why data producers that have been working to adapt to regional networks like EMODnet should do extra work for OCG. It was noted that this can be negotiated through ODIS. Once you are in ODIS ecosystem things can be negotiated.

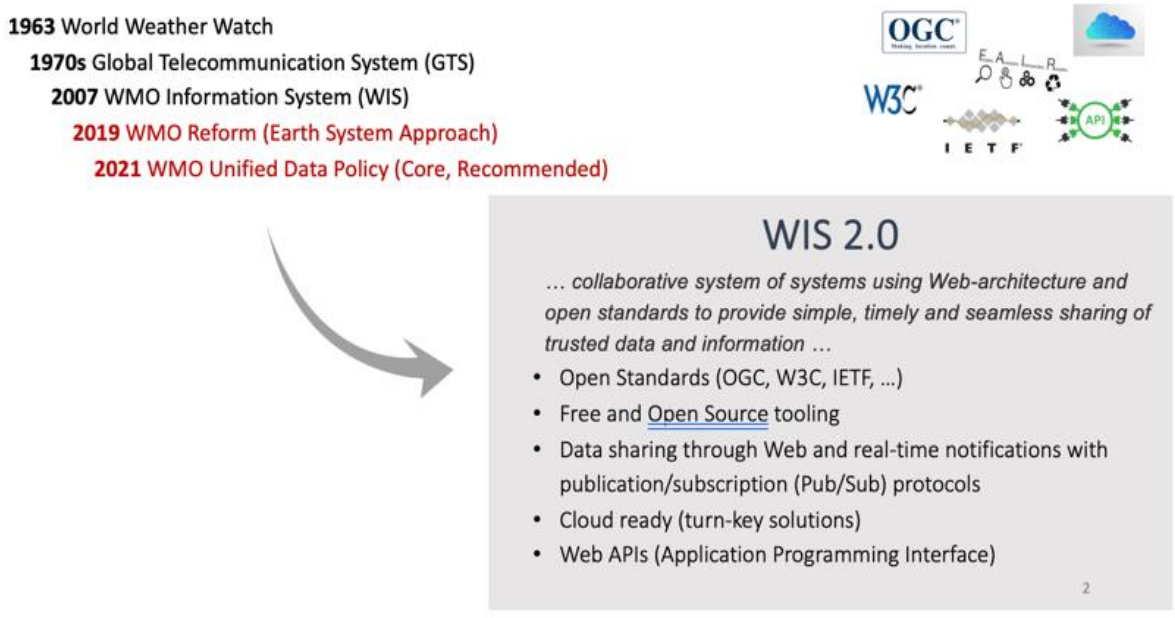
Ms Isensee noted that we want to move away from focusing on specific products or collecting data for just a few products. We need to be able to ingest data from various sources.
Mr Buttigieg responded that there is an important step we can take here: GOOS hypernode can talk to EMODnet node and can then tell what data need to be ingested.

Mr Buttigieg noted that data KPIs are usually not good. We need to trace data so there is a good provenance chain so all steps get credit. So we need to look closer at data KPIs and signalling provenance.On this topic it was further observed that accreditation of data is not properly solved. We often see on papers that “data comes from network X”.

5.3 WMO WIS 2.0

Mr Tom Kralidis provided his presentation online.

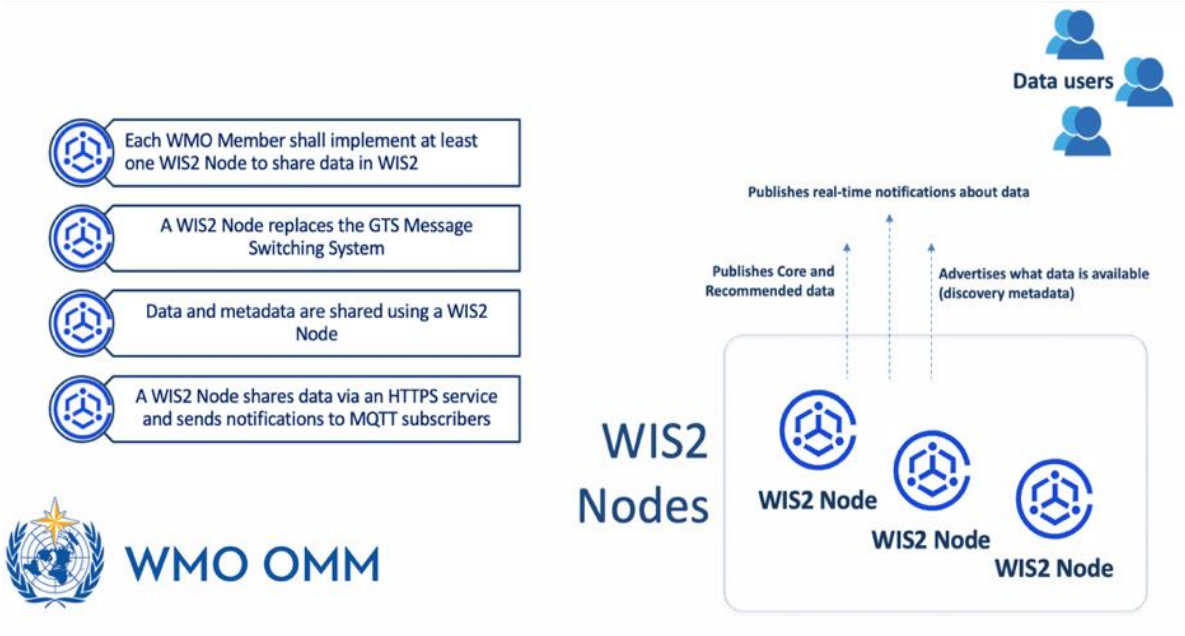
Evolution of WMO data exchange



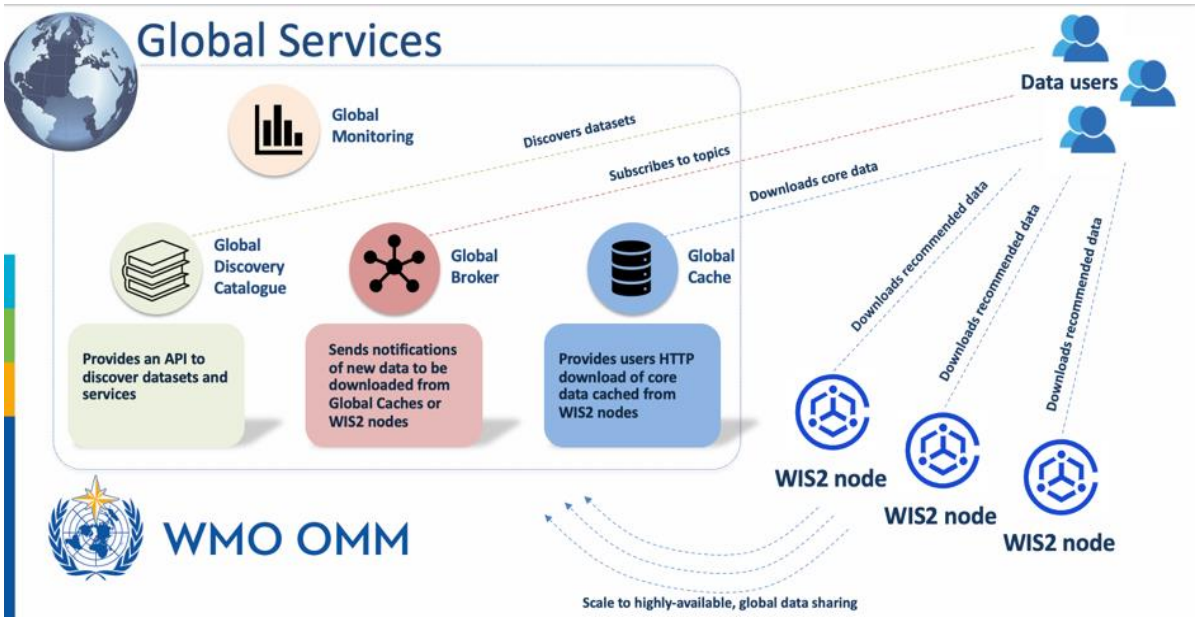
WIS Architecture

One to many nodes.

WIS2 Components: WIS2 Nodes



WIS2 Components: Global Services

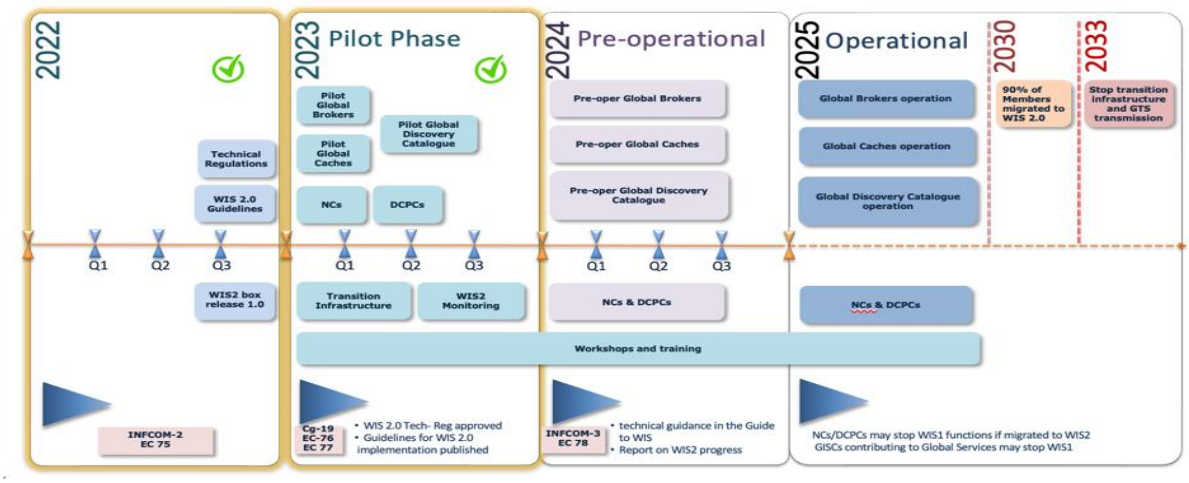


WIS2 Components and Standards

Component	Protocol/Interface/API	Content/Encoding(s)
Global Discovery Catalogue	HTTP/S OpenAPI OGC API – Records	- WCMP2 / OGC - API Records - Topic Hierarchy - Notification message (GeoJSON)
Message Replay API	OGC API – Features	- Notification message (GeoJSON)
Global Broker	MQTT/S	- Notification message (GeoJSON)
Global Cache	HTTP/S	Programme specific: - GRIB2 - BUFR4 - WaterML2 - CF/NetCDF - GeoJSON
WIS2 Node	HTTP/S MQTT/S (OpenAPI) (OGC API)	- WCMP2 / OGC - API Records - Topic hierarchy - Notification message (GeoJSON)
Global Monitoring	HTTP/S	- OpenMetrics

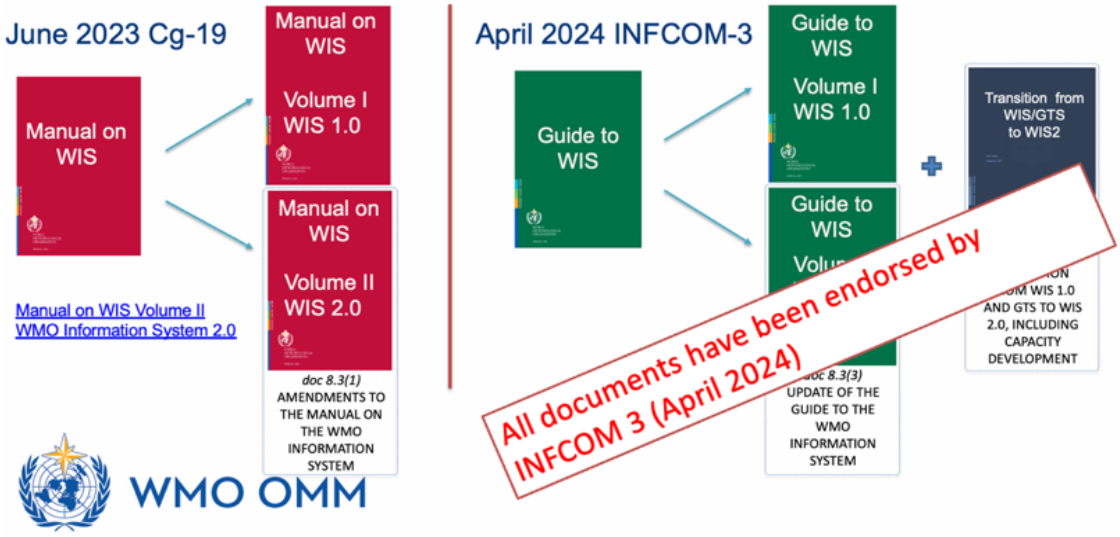
6

WIS2 progress: Pilot Phase complete

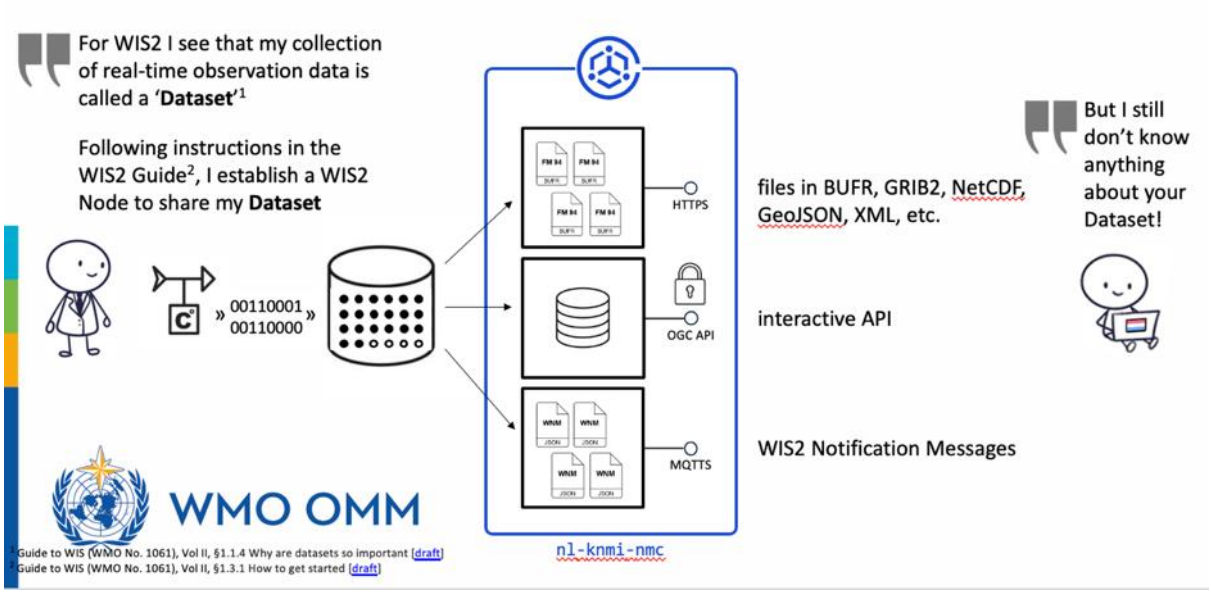


WIS2 Global Service instances

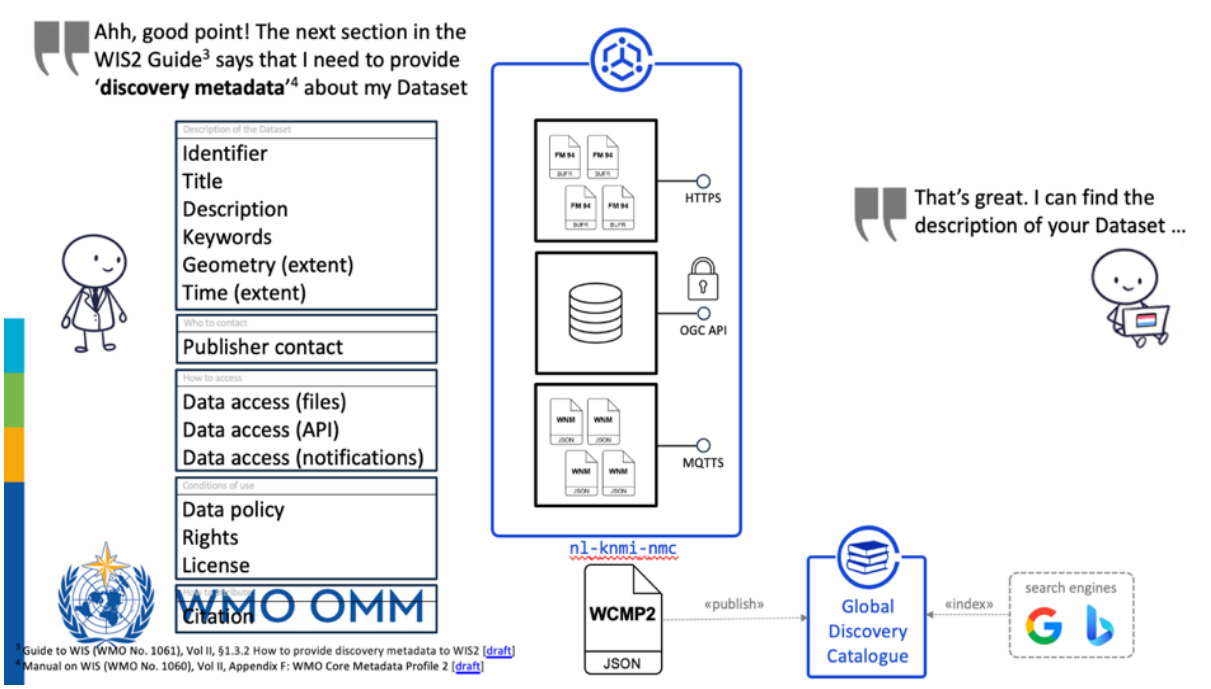
WIS2 regulatory material



Publishing data



Publishing metadata



WMO Core Metadata Profile 2.0 (WCMP2) - *The new standard for WIS Metadata*

- WCMP2 is an extension of the International Standard OGC API - Records
- Discovery metadata describes a given dataset or collection
- Aligning with the WIS 2.0 Principles, discovery metadata will be published to the Global Discovery Catalogue

Guide to WIS (WMO No. 1061), Vol II, §1.3.2 How to provide discovery metadata to WIS2 [draft]

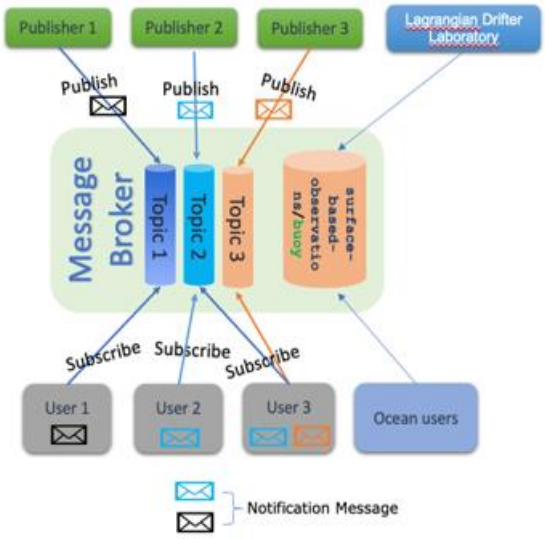
Manual on WIS (WMO No. 1060), Vol II, Appendix F: WMO Core Metadata Profile 2 [draft]

Description of the Dataset
Identifier
Title
Description
Keywords
Geometry (extent)
Time (extent)
Who to contact
Publisher contact
How to access
Data access (files)
Data access (API)
Data access (notifications)
Conditions of use
Data policy
Rights
License
How to attribute
Citation

Top Hierarchy and Notification Message

WIS2 Topic Hierarchy – *"Backbone" of the notification architecture where the messages will be available*

WIS2 Notification Message – *Format of the Notification Messages*



WIS 2.0 topic hierarchy

Level	Name	Description
1	**channel**	Location of where the data originates from (data providers [origin] or global services [cache])
2	**version**	Alphabetical version of the topic hierarchy (currently a)
3	**system**	Fixed value of wis2 for **WIS2**
4	**centre-id**	Acronym as specified by member and endorsed by the PR of the country and by WMO
5	**resource-type**	WIS2 resources types (data, metadata, report [from monitoring activities])
6	**data-policy**	Data policy as defined by the WMO Unified Data Policy. Notifications for **core** and **recommended** data are available by subscription to Global Brokers. recommended data are downloaded from the original NC/DCPC and may require authentication/authorisation
7	**earth-system-discipline**	As per Annex 1 of resolution 1 Cg-Ext-2021 ('atmospheric-composition', 'climate', 'cryosphere', 'hydrology', 'ocean', 'space-weather', or 'weather')
8	**earth-system-discipline-category**	As proposed by domain experts and further approved by INFCOM

Example:

```
Example:
origin/a/wis2/ca-eccc-msc/data/core/weather/ surface-based-observations/synop
cache/a/wis2/int-ecmwf/data/core/weather/prediction/forecast/medium-range/deterministic/global
```

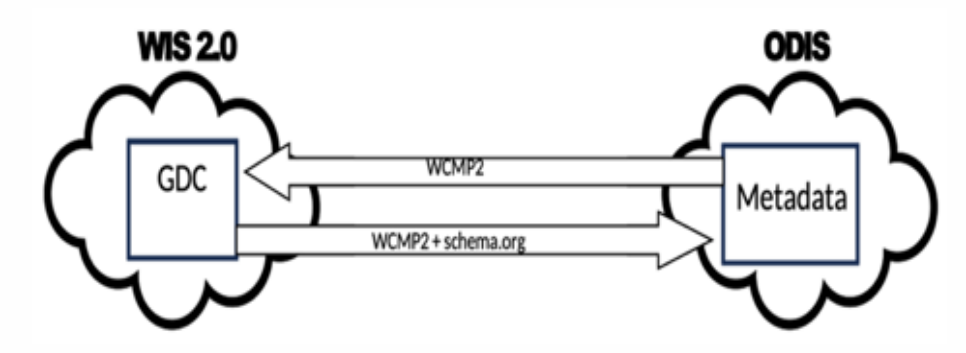
OGC Standards Implementation

- Discovery Metadata encoding
  - OGC API – Records – Core (Record)
  - GeoJSON
- Notification Metadata encoding
  - GeoJSON
- Global Discovery Catalogue API
  - OGC API - Records
- Replay API
  - OGC API – Features

- Data Access
  - OGC API - EDR, Features, etc. (recommended)
- *Pub/Sub (pending)*
  - OGC API – Pub/Sub
- OGC Modular Specification (ModSpec) development adoption
  - Core + extension
  - Requirements, recommendations, permissions

WIS 2.0 Interoperability with ODIS

- OceanInfoHub
- System to system interoperability
- schema.org



Integrating data and metadata publishing pipelines

- Data
  - Generate/transform data (to BUFR, NetCDF, etc.)
  - Publish data to a web server (HTTP)
  - Publish notification message of data (MQTT)
- Metadata
  - Create WIS2 discovery metadata (WCMP2)
  - Publish notification message of metadata (MQTT)

Standalone tooling

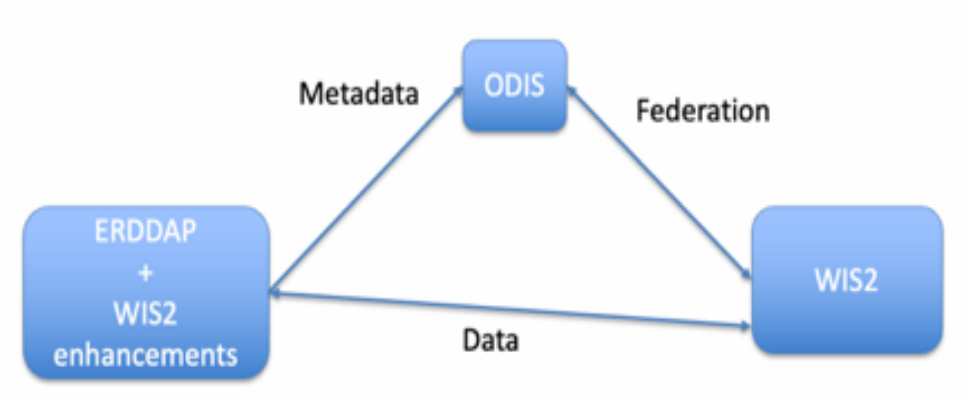
- Components of wis2box modular architecture
- Can be used standalone
- Flexible, can work with files or streams, tighter integration
- Data
  - BUFR tools (csv2bufr, synop2bufr, ecCodes)
- Metadata
  - pygeometa (geopython.github.io/pygeometa)
- Publishing
  - pywis-pubsub (github.com/wmo-im/pywis-pubsub)

Putting it all together: examples

- MSC wis2node: github.com/ECCC-MSC/msc-wis2node
  - BUFR data and WIS2 metadata created externally
  - Data / metadata publisher
  - Uses pywis-pubsub and pygeometa and minimal Python to chain together publication workflows
- wis2node-metadata-mgmt: github.com/wmo-cop/wis2node-metadata-mgmt
  - Metadata management and creation/publication
  - Uses GitHub Pages to for HTTP/storage

ERDDAP / ODIS / WIS2 Considerations

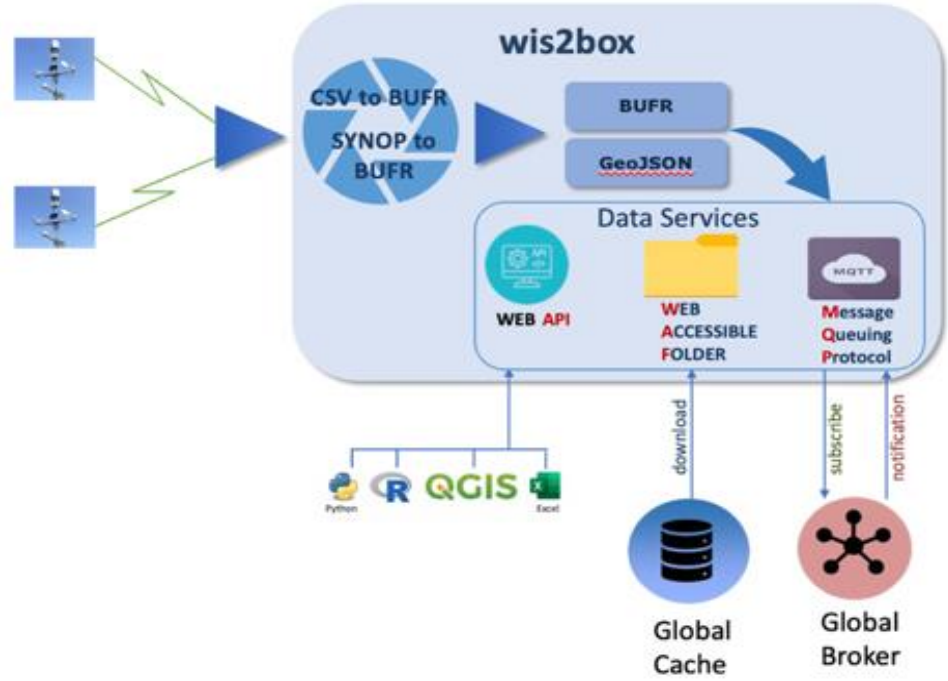
- Extending ERDDAP with WIS2 support
  - MQTT broker/service
- wis2box Component reuse



Reference Implementations

WIS2 in a box: enabling broad participation in WIS2

- "WIS2 in a box" is a Reference Implementation of a WIS2 Node
  - MQTT
  - HTTP
- **Software** (not hardware)
- **Publishing facility/capability** compliant to WIS 2.0 Architecture
  - Provides basic data transformation
  - Can **integrate** with existing data management systems
  - Adds API and user interface
  - Core and recommended data (access control)
  - Cloud or on-premises



WIS 2.0. does not prescribe data formats as these are discussed within the various domains.

Discussion

On a question regarding data standards Mr Kralidis responded that WIS 2.0 has pipes to allow for data discovery, access and visualization. There is standardization on how to put pipes together. We are not prescribing e.g. new NetCDF profile; we leave that to the domains. (e,g. GRIB, BUFR).

It was noted how similar the WIS2 and ODIS structures are. This is no accident as both are following the Web architecture and standards from W3C (and OGC etc).

5.4 IODE-GOOS BioEco and OBIS

Mr. Ward Appeltans reported on the data landscape related to marine biodiversity, stating that all three key components of a functioning digital ecosystem—namely, ‘observations and data collection,’ ‘data management and sharing,’ and ‘analytics, modeling, and predictions’—are already well-advanced and in progress for BioEco.

In this context, it is important to highlight the collaborative structure established through a cooperation agreement signed in 2016 between the GOOS Biology and Ecosystem (BioEco) Panel, the Ocean Biodiversity Information System (OBIS), and the Marine Biodiversity Observation Network (MBON), under the Group on Earth Observations (GEO). This agreement recognized OBIS's key role in data sharing, interoperability, quality control, integration, and visualisation, with tools to support the development of EOV products such as indicators for assessments. As a result, OBIS became the de facto BioEco GDAC. To fulfil this role, the OBIS community extended and adopted a new data standard in 2017, moving from

Simple Darwin Core to Event Core and an extended Measurement or Fact Extension. This was a crucial step in accommodating the rich set of sub- and supporting BioEco variables.

With recent support from EU projects like Marco-Bolo and BioEcoOcean, OBIS now has temporary human resources to collaborate with GOOS BioEco panel experts in identifying the minimum set of (meta)data requirements and preferred data schemes for publishing BioEco EOVs into OBIS resulting in comprehensive training resources documented in the OBIS manual and training modules in IOC's OceanTeacher Global Academy (OTGA).

OBIS is also assisting GOOS with the development and maintenance of the GOOS BioEco Portal, which currently holds information on over 600 long-term biological observing programs. Although currently a manual process, the BioEco Portal will eventually move towards a more automated workflow through its connection with ODIS. The integration of the BioEco Portal and OBIS will be key to establishing a global ocean biodiversity monitoring system, helping countries and parties to the Convention on Biological Diversity (CBD) monitor the implementation of the marine elements of the Global Biodiversity Framework (GBF).

In terms of analytics, modeling, and predictions, OBIS is developing advanced data access services, including gridded products, to enable fast integration of biodiversity and other (climate) variables. These services support modeling species and habitat ranges, including future predictions of shifts, which have implications for current and future resource management and area-based planning (such as determining where to protect 30% of the ocean). These models also support assessments, such as risk analysis of invasive species spread, directly linking to target 6 of the CBD Global Biodiversity Framework.

Discussion

It was asked if OBIS has links to satellite data. Mr Appeltans responded that nearly 400 datasets in OBIS are on tracked animals using satellites, and satellite based polygons of habitats can be incorporated into OBIS. OBIS is also using the Copernicus services for species distribution modelling and quality control.

Regarding citizen science, he noted that citizen science data is included in OBIS already. For example, apps that identify species exist and the bigger question with these is the importance of confidence level criteria. In the BBNJ context, if OBIS data is used for legal issues, like permits, then we need confidence level criteria, especially for citizen science data. OBIS is frequently asked to provide a solution to archive images, while for the moment it does not have the resources to do so it relies on external hosting solutions like Flickr or others, which is not ideal.

It was noted that there are 36 GOOS EOVs, and 54 GCOS ECVs, with the EOVs being one of the domains covered, however there is not any information on which are needed/being accessed by users. Maybe we need to look at those that are important for specific themes/regions and understand is all the GOOS EOV's are essentiality functions?

It was noted that there is a need to generate DOIs (e.g. via AquaDocs) for GOOS specification sheets which can then be included in ODIS metadata. It was also noted that we could extract

abiotic variables such as pH, O_2, temperature, salinity etc data from OBIS into the respective GDACs connected to ODIS, which would further enhance visibility of all sustained EOV data..

A rough proposal for a GOOS EOV data flow statement was proposed, as follows.

To ensure that EOV (meta)data is readily discoverable across ocean data system, it is proposed that:

1. Metadata describing GOOS EOV datasets/digital assets must be discoverable in ODIS.
2. GOOS EOV metadata conform to the ODIS EOV specification: https://book.odis.org/thematics/variables/index.html
   2.1) This metadata record must include:
   2.1.1) A known semantic identifier for the EOV (or one of its sub or supporting variables): e.g. http://purl.obolibrary.org/obo/ENVO_01001844
   2.1.2) A link back to the DOI of the EOV GOOS Specification Sheet
   2.1.3) Keyword values including "IOC Global Ocean Observing System (GOOS) Essential Ocean Variable"
3. The subject data of the EOV must conform to the requirements set in the respective EOV, if applicable

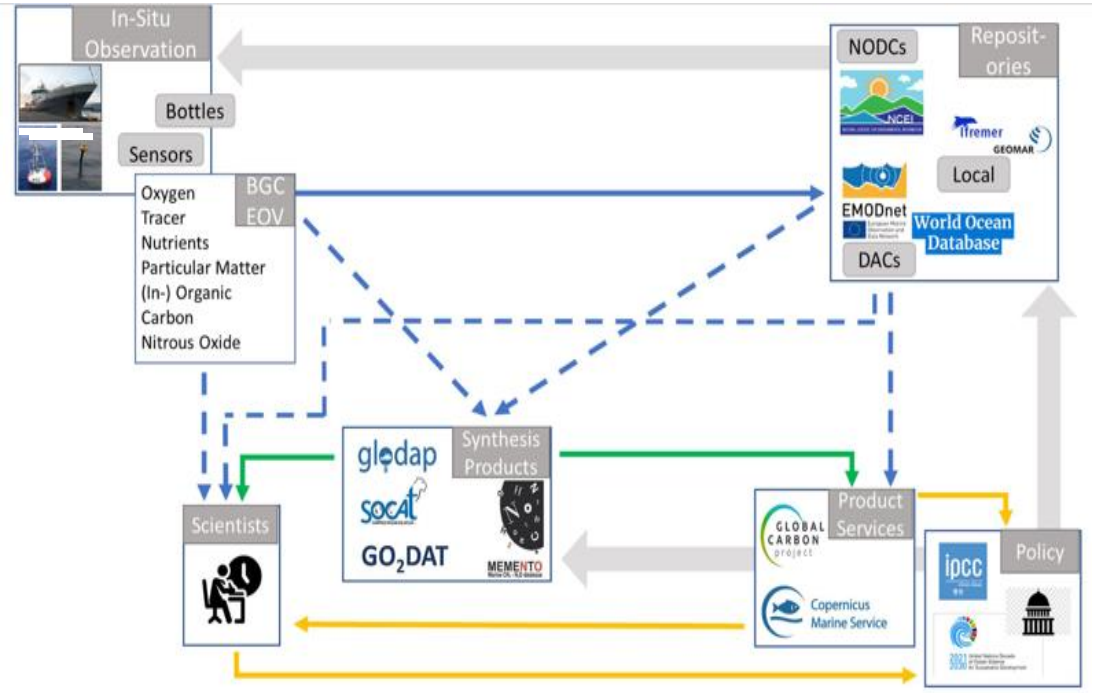
Agreeing such a data flow could be an outcome of this meeting, or the IOC Data Working Group (see later), and be submitted to the GOOS Steering Committee in 2025.

5.5 GOOS BGC

Mr Nico Lange, and Ms Veronique Garçon introduced this item.

BGC Data Landscape – Present Status

- Data collected by GOOS networks provided by
  - National and regional data centers (BSH, BCO-DMO, SeaDataNet)
  - Specific GDACs (Ifremer, NCEI, CCHDO)
  - Data products (WOD, GLODAP)
- Data collected outside of GOOS networks with limited impact on global products, could be uneasy to access them sometimes
- Multiple synthesis products developed (terminated; living)
  - Cross-platform and/or cross-EOV
  - Specific scientific rationales in mind
  - Often underfunded (i.e., based upon substantial ‘volunteer work’)
- Varying interconnections between data sources
- Multiple data submissions – too much work, and leads to data duplication
- Different data/metadata schemes; levels of quality
  Weak (non-existent), often unstructured, chaotic (meta)data links from data source to global provision



- No clear functions to each entity assigned, i.e., multiple entities doing similar work but differently;
- Relies upon multiple submissions, i.e., not using a federated system
- Different levels of data has different type of users; Single access points for different levels/users would increase impact, usability
- Many more synthesis efforts that are not linked to a GOOS observing network nor to IODE
- Making use of IODE network not really in place

BGC Data Landscape – SOCAT

- In situ surface ocean fCO2 measurements from ships, moorings and autonomous surface vehicles
- 38.6 million fCO2 values with an estimated accuracy of < 5 µatm in the main synthesis
- 8.1 million fCO2 values with an accuracy of 5 - 10 µatm are separately available
- Community-led, expert quality-control and EOV-focused synthesis
- Ingestion software available and in use
- + 800 citations

BGC Data Landscape – GLODAP

- Provides access to quality-controlled surface to bottom ocean biogeochemical data, with an emphasis on seawater inorganic carbon
- 1.4 million water samples from the global oceans collected on 1108 cruises
- Community-led, expert quality-control and platform-focused synthesis
- Manual ingestion
- Develops uncertainty estimates (GLODAPv3)
- + 600 citations

Vision - BGC (Meta)Data Portal

1. Defined, separated and specific tasks for different data management entities (generator, archive, DAC, ETL, broker service, access point)

2. FAIR principles implemented

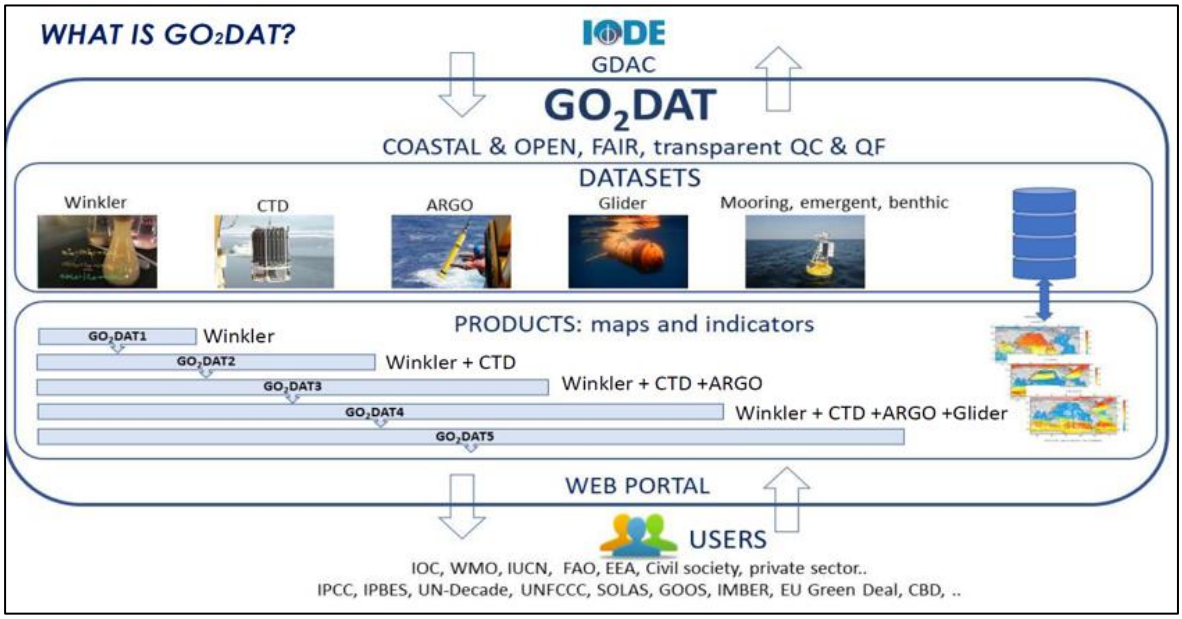
- Templates for structured metadata across EOV's and platforms (schema.org)
- Use of (partly non-existing) controlled vocabularies
- Use of ERDDAP services
- Improved uncertainty attribution
- Improved synergies with existing entities (OceanOPS, GOOS, ODIS, Argo, EMODnet, etc)
- Established automated links from NODCs to (partly non-existing) GDACs
- Implemented “submit once – use many times”
- Brokerage services utilizing structured metadata to enable more automated data flows (ETL: extract; transform; load) developed

Uncertainties based either upon instrument precision, or crossover consistencies, or replicate measurements, are not comparable. Collect information on precision (based on replicate measurements, indicated by the relative variability) and on accuracy (based on a fit with golden standard which could be e.g. GO-SHIP cruises).

GO_2DAT Prototype

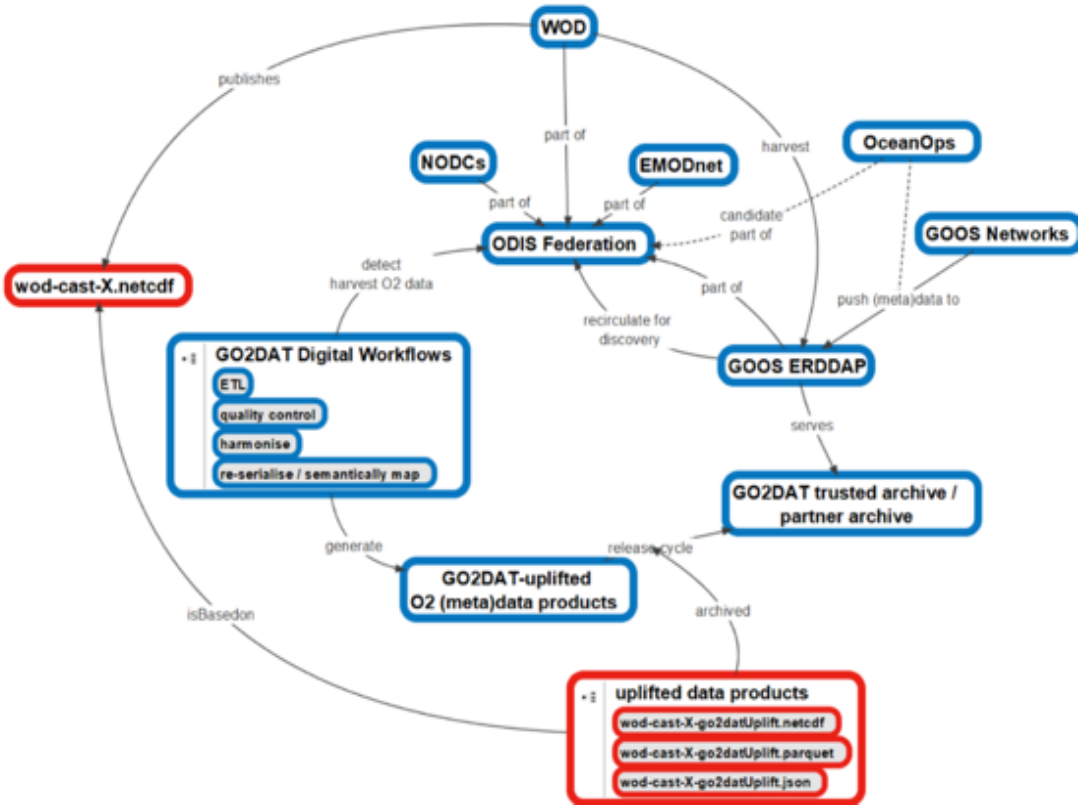
A global ocean oxygen database and atlas for assessing and predicting deoxygenation and ocean health in the open and coastal ocean.

The GO_2DAT Project: *Transforming our knowledge of ocean O_2 changes for sustainable ocean management*



…to be updated to align with ODIS federated system within the OceanData2030 framework

- O2 highest ranked EOV in feasibility and impact
- Builds upon existing structures and common structured metadata
- Utilizes ODIS-federation for (meta)data harvesting
- Automates data ETL
- Utilizes ERDDAP as a service for flexible data extraction
- Provides single access point for O2 data
- Establishes feedback loops to original data sources
- Roadmap: Grégoire et al., 2021 to be updated within GOOS digital ecosystem infrastructure framework



Integrated Digital Ecosystem – Opportunities and Issues

- Use structures and tools developed for GO_2DAT as basis for other EOVs
- GEF-FAO CHO_IP (Clean and Healthy Ocean Integrated Project) project starting spring 2025, 1 FTE to work on data gathering, QC, QF, uncertainty attribution
- Insertion within the GOOS Digital Infrastructure/Ecosystem Strategy for all EOVs, tight collaboration with IODE/ODIS
- DataExpo: A deep learning-based tool, using natural language processing technology for extensive machine reading of webpages *(Lu, B. et al., 2023, DataExpo: A One-Stop Dataset Service for Open Science Research).*
- Visualisation, mapped data products as part of new EU proposal led by Toste Tanhua: BioGeoSea “Enhancing Biogeochemical Essential Ocean Variables for European and Global Assessments” which has just been submitted

Discussion

The meeting briefly discussed the need for DACs and GDACs. It was noted that IODE has not established this while WMO established several. GOOS has a number of GDACs in its network data flows and this is a recommendation of the OCG Data Implementation Plan, however there is no formal process established for this. An attempt had been made to establish a DAC for oxygen but this was not successful.If we virtualize the global system then someone can host a DAC and make these data available,and GOOS can govern such DACs. Establishing DACs or GDACs would also provide redundancy in the system and should be considered. GOOS or IODE can look at providing validation for these. In this regard reference was made also to Core Trust Seal.

6. What are current weaknesses and strengths/what do we want?

Ms Emma Heslop explained that the aim of this session was to work on Strengths and Weakness, Opportunities and Threats (SWOT) with moderated discussion around defining features of what we want, the key components, and how we make this future robust and take advantage of new technology already on the horizon.

The questions to answer were:

1. What are the strengths and weaknesses of what exists currently?
2. What are the opportunities and threats currently?
3. What do we want - in order to support users and meet mandates? What are the key components?
4. How does new technology and innovation fit into the equation?

1 and 2 were discussed through a SWOT analysis, results below:

Strengths (internal)	*Weaknesses (internal)*

• General alignment to modern distributed data practices (ODIS,WIS2,ERDAP)
• We are all looking outward to see how to deliver services
• All invested - been working together for some time - skilled people, FAIR principles, common implementation approach
• Long history / sustained commitment from Member States
• Success stories on how to share data (EMODnet, GDAC, OBIS…and working across nations)
• Part of UN - critical awareness of international focus
• IOC Statutes (informing MS on actions)
• Working towards same goal
• GRAs could help get all data shared, can NFP help?
• ODIS has matchmaking capability
• Work with existing strengths
	• Underused / ignored significance of IOC being UN
	• Not enough skilled people:
	  • data
	  • liaison to user groups
	• GOOS/IODE/IOC weak in the UN System - underappreciated
	• Our strengths are not recognised - unique value of IOC in running this
	• Data sharing not a cross cutting priority in IOC
	• Data management and sharing not recognized as essential in all IOC communities of practice and relevant DM practices are insufficiently known and used
	• Shared vision and an ongoing governance system to support implementation
	• Fragmentation geographically and politically:
	  • difficult to create products
	  • several entities doing the same thing
	  • multiple submissions by one agency
	  • different versions out of one data set
	  • inefficiencies
	  • different time horizons for users
	• Some entities/MS still do not share data
	• Collective access and benefits sharing regime (funding mechanism) enable our competitors to such a degree that we are outcompeted
	• We do not have awareness of licencing and restrictive usages
	• Insufficient linkage between what we do at technical level and top level of governance where decisions on data sharing are made
	• Lack of capacity in under-resourced countries / communities
	• Everyone working in niches

Opportunities (external)	*Threats (external)*
• Engagement with private sector • Recognised need for more ocean data - from UN / private sector / governments	• Non support for multilateralism - others can step up and do it

• Ocean Decade • Agree a coordinated approach • Use the WMO Unified Policy and other mechanism more • Communicate better on what are doing • Be an exemplar to a wider community to influence other communities than the ocean (e.g. NASA, heliophysics, CDIF…) • Opportunity to demonstrate mechanisms to balance protection and openness (appetite for data sharing with products and building trust) • Creating a “marketplace” to enable trading/sharing/negotiating data (preposition ourselves in emerging digital economy) • Optimise green computing - sharing metadata not data - data mesh architecture • Private sector could create products • Private sector could design the technology we need • Provision/refining of indicators • Use Ocean Decade and UNGA to raise awareness with top-level government for data sharing and also to avoid data colonialism • Work with diversity of partners to build a system for global community • Need a plan - staged approach - guidelines • Roll out feature (“ocean in a box”)	• Being part of UN can make it slow to innovate • Too slow and others will do it (with our innovation)! • Unique role of IOC is not recognised • HL engineering takes over good ideas of the system • Need to ‘police’ nodes • Geopolitics and emerging regulatory frameworks • Access and benefit sharing - digital equity • Fear by different countries of asymmetries in benefits from sharing data - digital colonialism. • Involving over-capacity nations so that they invest in us • Lack of resources and lack of optimised allocation of resources • Lack of redundancy in data systems • No clear identification of ownership of separate parts of system • Ensure we identify manageable list of tasks

3. What do we want (Question 3)

- IOC has defined a clear niche in a digital ecosystem which is unique to us and highly investable
- Wherever you are in the world - you want to be able to access (EOV) data - free and unrestricted
- We need IOC technical integration
- We need new partners to improve data coverage as widely as possible
- Clear link/role for each member of the value chain / data ecosystem
- Start with Minimum Viable Product (MVP)
- Promoting/proving the benefits of Improving access to global data sets
- Collaborative buy-in by all in process and its outcomes

- Joint vision and clear / deliverable GOALS
- Phased approach
- Buy-in from IOC regions / Decade regional coordinating committees…
- Implementation plan
  - focus on how we make it happen
  - clear timeline
  - applicable KPI for regions (e.g. has 'someone' collected data within your domain of interest)
  - working with success stories
  - key outcomes/products
  - use system to find and integrate products that not used before
  - identify resource requirements

It was noted that our work here would need to be shared with the IOC regions to seek their engagement in the proposed way forward. In developing regions there is often a disconnect between the scientific level and high-level government which leads to under-resourcing of ocean research, observation and management. It was noted that the Ocean Decade can assist with raising awareness for the need for ocean research, observation and management for sustainable ocean planning and management. ODIS demonstrators/pilots may assist to "sell" the idea.

It was agreed that a document needs to be prepared for the IOC regional bodies that make it clear what benefit they can have from ODIS/IOC Data Architecture. An analysis of their work plan is needed to identify where ODIS could immediately help. Priorities would need to be identified.

It was noted that improving access to global data sets, publications etc is already a benefit: many OIH country partners say that having access to external data and information on their region is beneficial.

7. What would be the ideal coordination structure to manage an integrated "data and information flow" in 2030 –

Ms Joanna Post explained that the aim of this session was to develop ideas around what an ideal coordination structure to manage an integrated IODE-GOOS system might look like, Currently the coordination is loose and based on trust, team members participate in each other's planning processes to develop alignment, this has functioned well for a number of years, however in order to bring about the change we want to see and develop a fully integrated system, that we can jointly advocate for, we will need to envision a coordination structure, to enable such a system to advance and evolve.

The questions to answer were:

1. How should we strengthen our GOOS-IODE connections?
2. Do we need a new coordination structure or just some better guidelines for the existing structure?
3. What functions would a coordination structure undertake?
4. What potential partnerships should we look for, within and beyond GOOS and IODE?

The meeting established two break-out groups that each met for 45 min. The plenary then resumed and each group presented the outcome of its discussions.

Group 2: presented by Arno Lambert

He summarized the discussions of Group 2 as follows:

- Keep it simple (KISS)
- Need better ways to align across IOC: establish a group. Other partners should be included (UN (e.g. WMO WIS) as well as others).
- Create a Vision: QC EOV DATA FOR ALL
- MISSION:
  - Identify the metadata standards across IOC
  - Seek better ways to align across IOC:
    - people
    - teams (programmes)
    - tasks
    - simple data flows, visualise data flows: these can support simple products as proof of concept
    - real-time/delayed mode data flows
  - Report to the IOC Assembly
  - Investigate benefit analysis/licensing
- Deal with or solve data blindspots

Discussion

The points that were discussed included the need to visualise data flows and to be able to demonstrate proof of concept with a few simple products. The difference between delayed mode and real-time data flows is important to consider, and much of the discussion is focused on delayed mode data flows.

Group 1: presented by Pier Luigi Buttigieg

- ODIS architecture holds the technical governance structure for the relationships between nodes/components
- Need to agree on standards for exchange
- Verify GOOS ‘brand’ data
- Unique niche - UN entity
- GOOS has observations to data chain, IODE is coordinating data from GOOS and other data nodes
- GOOS data are well represented
- GOOS hypernode is a node in the ODIS federation - ODIS watches the ecosystem
- From the ODIS pool you have “plumbing” to other portals, all talking and monitoring the same things. ODIS is monitoring the health of the system
- GOOS data is recognised as “gold standard”
- ODIS is technically simple, reliable and sustainable

Discussion

We have IODE and GOOS structures. GOOS is the observation layer and it has a data management component. IODE deals with observation as well as other data. We need to make sure that the data coming from GOOS are represented well in the IODE systems. GOOS as well as OBIS will be hyper nodes.

UN assessments will be able to be fed through ODIS and its specialised portals, the GOOS EOVs will support these assessments and indicators, GOOS data sources can be given "gold standards" while other data sources that are not "trusted" will not. ODIS architecture is neutral while at the Ocean Information Hub (OIH) portal level and for assessments etc. we can be selective in what we use. Further, GOOS data could be identified as such in the metadata, identified as GOOS 'gold standard,' similar to the endorsement system in Ocean Best Practice System, a mark of quality and assurance.

8. Technically integrated structure - presenting and discussing a first sketch

8.1 Introductory presentations and discussions

Mr Pier Luigi Buttigieg explained that the aim of this session was to present a first sketch of a technical integrated system and discuss how this functions for all the services and needs across: IODE, GOOS Physics, Biogeochemistry and BioEco data flows, and tracking or analysis services used by WMO and GOOS, plus considering the FAIR data accessibility across ODIS and other structures.

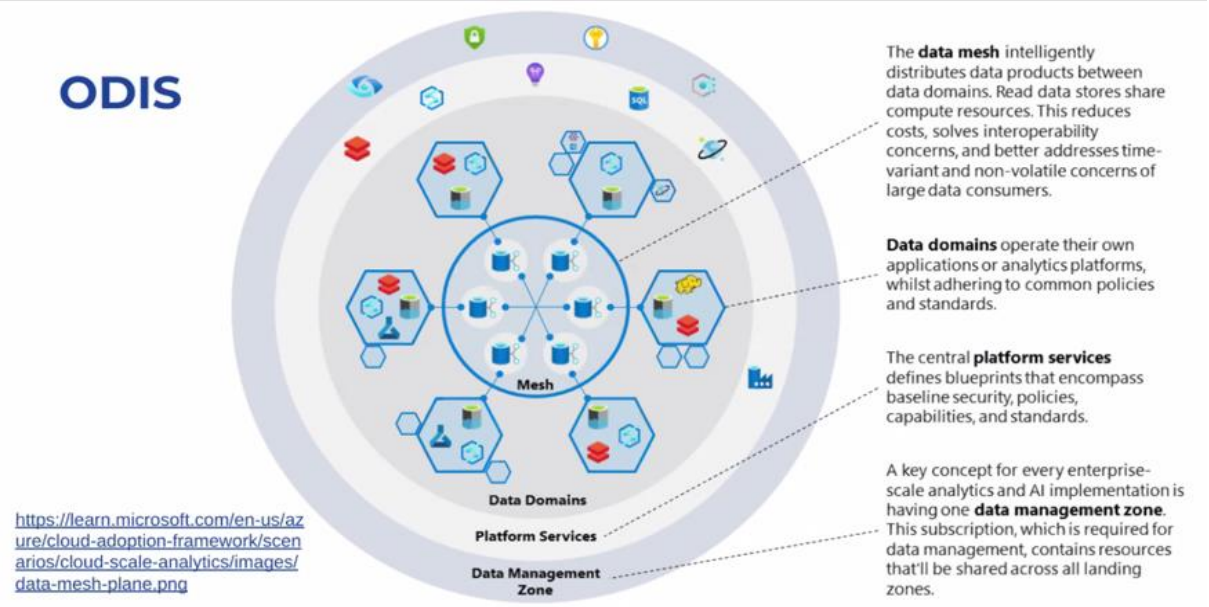
The questions to answer were:

1. Can existing and future services be developed and delivered across this infrastructure? What are the roles of the different GOOS - IODE components in this structure?
2. Does this meet the strategic aims of IODE and GOOS?
3. Do we understand what constitutes minimum FAIR metadata?

To guide the discussions Mr Pier Luigi Buttigieg, Mr Ward Appeltans and Mr Kevin O'Brien introduced a "first sketch" for an integrated and future-ready technical infrastructure.

Mr Buttigieg first introduced a few key points regarding ODIS

- What is ODIS - important to understand some key points:
  - Agnostic architecture across which to build our services
  - Mission is to ensure a healthy, transparent, exchange of metadata
  - Nodes contribute to ODIS - nodes are single point sources of data, e.g. a NODC, a regional hub, a corporate actor
  - Matchmake needs/requirements for data ingest with data product development and deployment



ODIS is not IODE specific. It ensures a healthy, transparent exchange of (meta)data. IODE is custodian of the system, however ODIS has shared ownership. ODIS is also about asking for data, not just about pushing data, so ultimately we can digitise the need and not just the offer. The architectures/data flow across GOOS-IODE were noted:

GOOS OCG Cross-Network Data Implementation Strategy

- OCG data strategy is aligned with the ODIS architecture
- OCG ERDDAP node is an ODIS **Hyper Node** (a self-organised multiple source node), it is also a potential node to other systems e.g. WIS2.0
- OceanOPS in placing its metadata in ERDDAP makes it available to ODIS and to complete metadata
- OceanOPS provision of unique identifiers is required
- OceanOPS/OCG network/GDAC work on data and metadata quality is contributing to overall data quality
- GRAs can also be ODIS nodes - and OCG/OceanOPS can track additional data

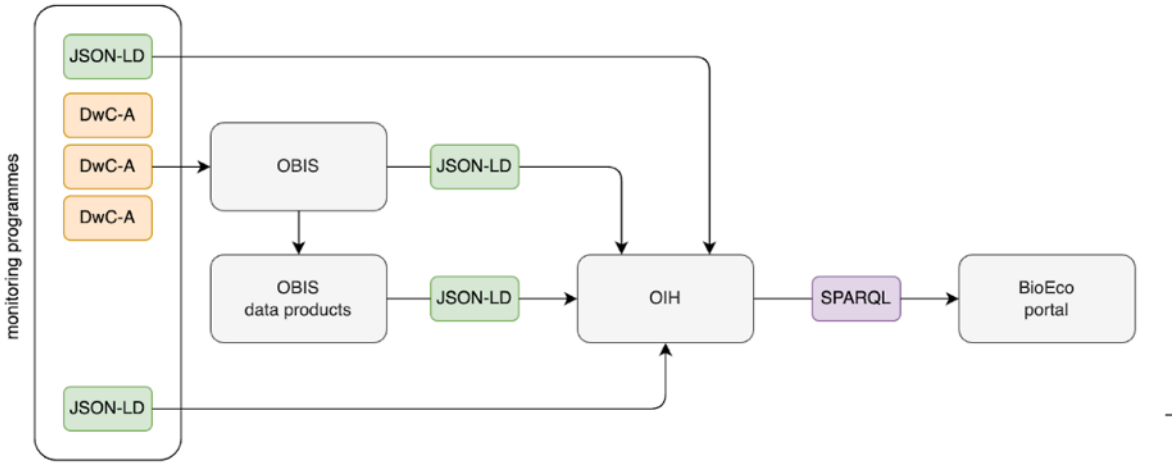
OBIS/BioEco data flow

- BioEco data flow is already connected to ODIS, but there is a need to a) recognise GOOS BioEco EOV networks (metadata) b) consider/issue unique identifiers (like for OCG networks) for sustained observing elements
- An 'OceanOPS' for the BioEco data flow? Options discussed:
    a. extend OceanOPS,
    b. create similar capability in OBIS using ODIS technology

Solution b) offers advantages and would allow the BioEco Portal to recognise networks and have the data accessible through OBIS, which will act as a super GDAC

There may be a need to also create/define a more formal recognition for GDACs

Planned BioEco system:



Discussion

It was asked how we should consider having an OceanOPS-like functionality for the BioEco space, would OBIS have an expanded mandate to do what OceanOPS is doing for biodiversity data. There is biological and ecological data already flowing through the global (GOOS OCG) networks, and this is a trend that is set to continue as use of existing infrastructure is sought for BioEco variables. The systems, OBIS, OceanOPS and the GOOS BioEco Portal should therefore be interoperable. Currently OceanOPS metadata are not pushed to ODIS.

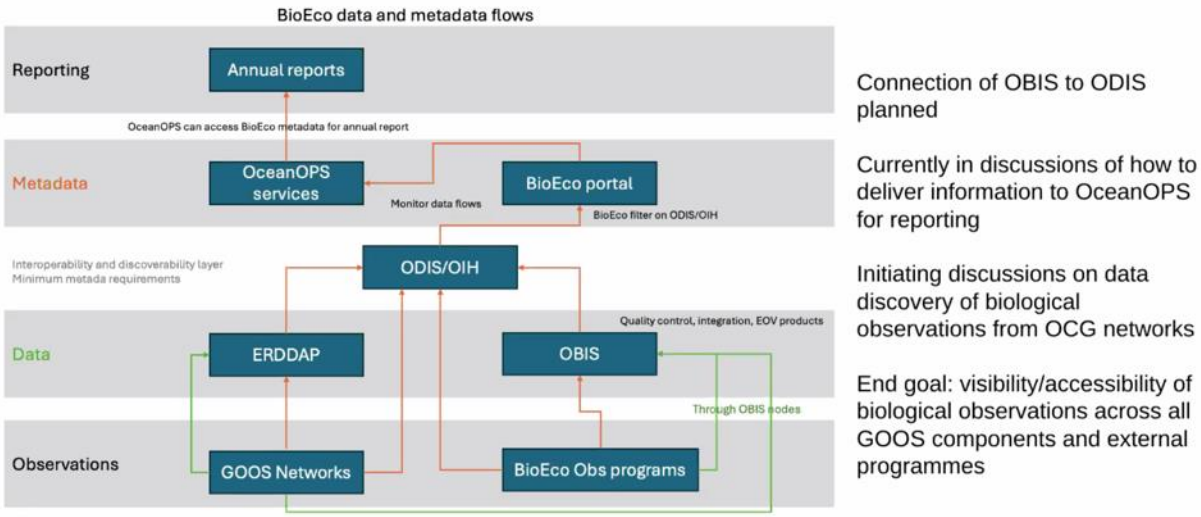
OBIS would benefit from being able to 'discover' biology data in OCG networks, which the GOOS hypernode architecture would enable.

Regarding the difference between OBIS and the BioEco Portal Mr Appeltans clarified that OBIS contains metadata about the data as well as all raw data collected with the biological and ecological variables. However, the BioEco Portal is an interface to see where the sustained observing programmes are, what they measure and how, and if possible with links to the actual data (which can be OBIS). Programmes have to publish their programme metadata via GeoNode or in the future via ODIS Cat (preferred) and actual raw data and metadata are standardized to DarwinCore and Ecological Metadata Language respectively and published to OBIS via IPT or other direct ways to harvest the DarwinCore Archive. .. OBIS also covers more variables than EOVs, it is a biodiversity data system that also collects data from non-sustained projects and programmes.

The BioEco Panel is working with OCG networks to identify biological observations that the OCG are collecting and trying to connect these through OBIS. An example is AniBOS which is now also publishing the species tracks to OBIS via the Ocean Tracking Network, one of the thematic nodes in OBIS. Also they are working on trying to make sure that when EOV observing communities are thinking about EOVs they are thinking about data pipelines. At same time the BioEco Panel is working with OceanOPS to make sure that OBIS and ODIS

are connected to OceanOPS so it can report on BioEco observations, through elements like the GOOS Ocean Observing Report Card.

Current BioEco data and metadata flows.



Green = data
Orange = metadata

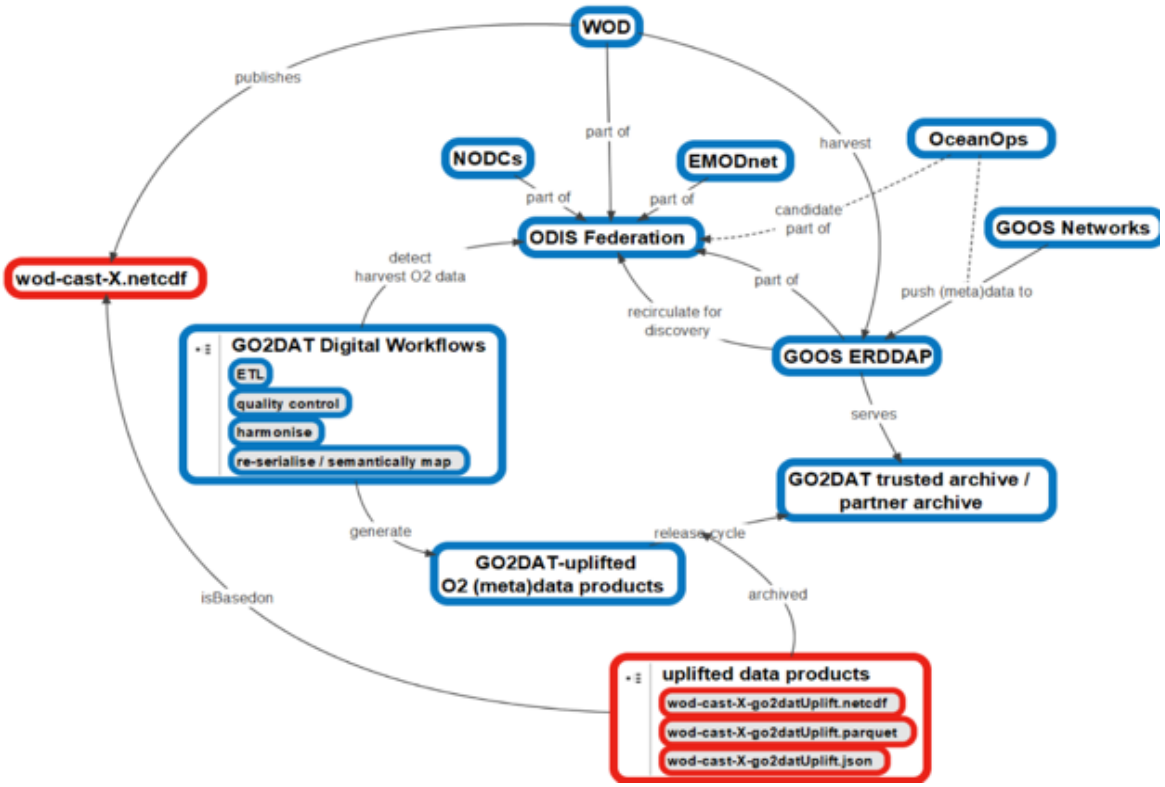
BGC Data flow

Issues

1. Data collected by GOOS networks provided by
   - National and regional data centers (BSH, BCO-DMO, SeaDataNet)
   - Specific GDACs (Ifremer, CCHDO)
   - Data products (WOD, GLODAP, EMODnet)
2. Data collected outside of GOOS networks has limited impact on global products
3. Multiple synthesis products developed (terminated; living)
   - Cross-platform and/or cross-EOV, Specific scientific rationales in mind, Often underfunded (i.e., based upon substantial 'volunteer work')

ODIS solves many issues:

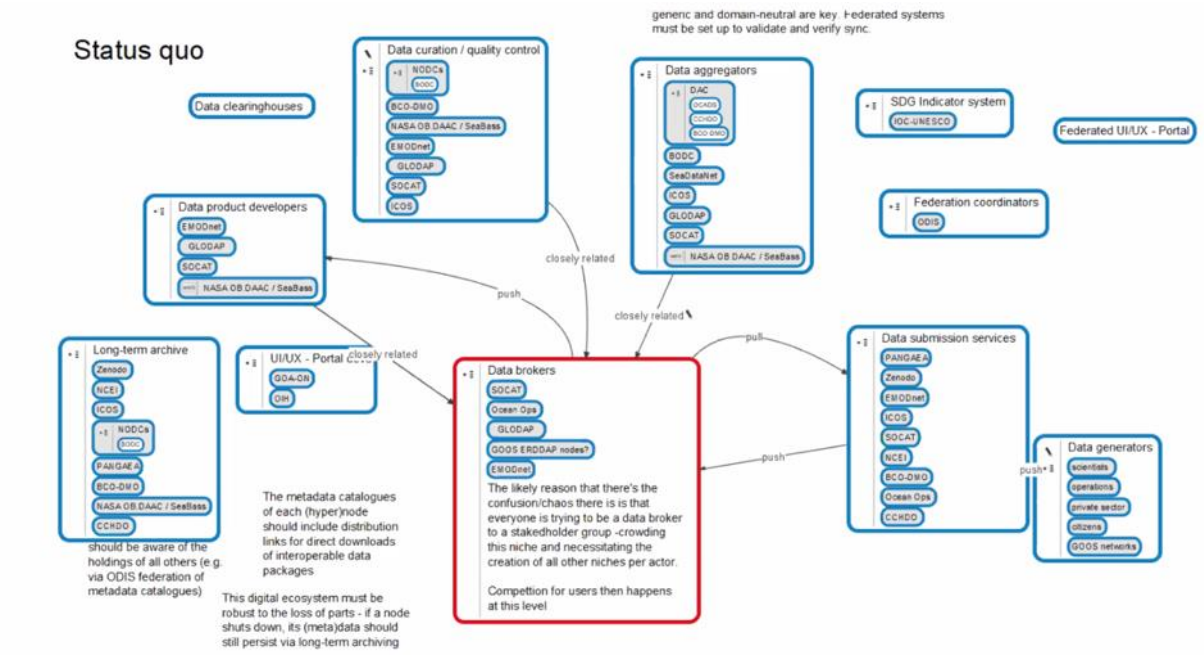
- OCG ERDAAP and other data sources (WOD, CCHDO…) connect into ODIS, so all data can be combined
- BGC Panel can define and promote metadata standard/s. ODIS has an outline (here) and work with OceanOPS/SOCONET will help. A BGC standard can be pushed across community networks, others. This will enable data to be harvested and combined
- Value chains (e.g. SOCONET-SOCAT-SOCCOM) can run across the ODIS architecture, enabling harvesting of variables and creation of products without a designated single value chain



Schema of current and envisioned BGC data flow.

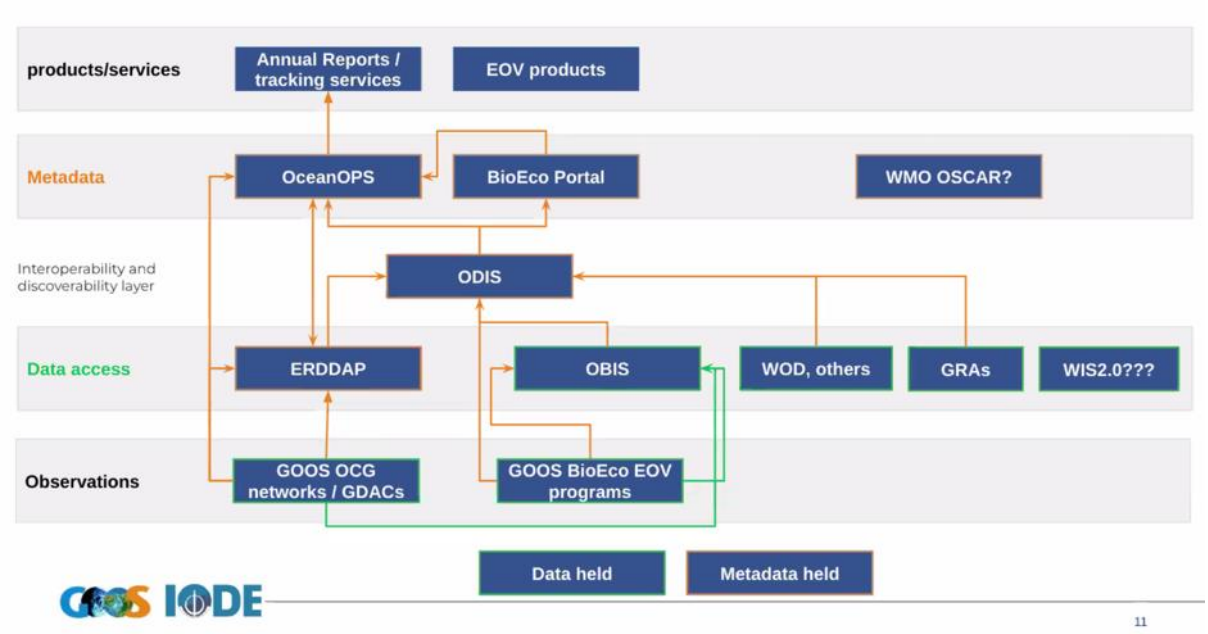
BGC needs

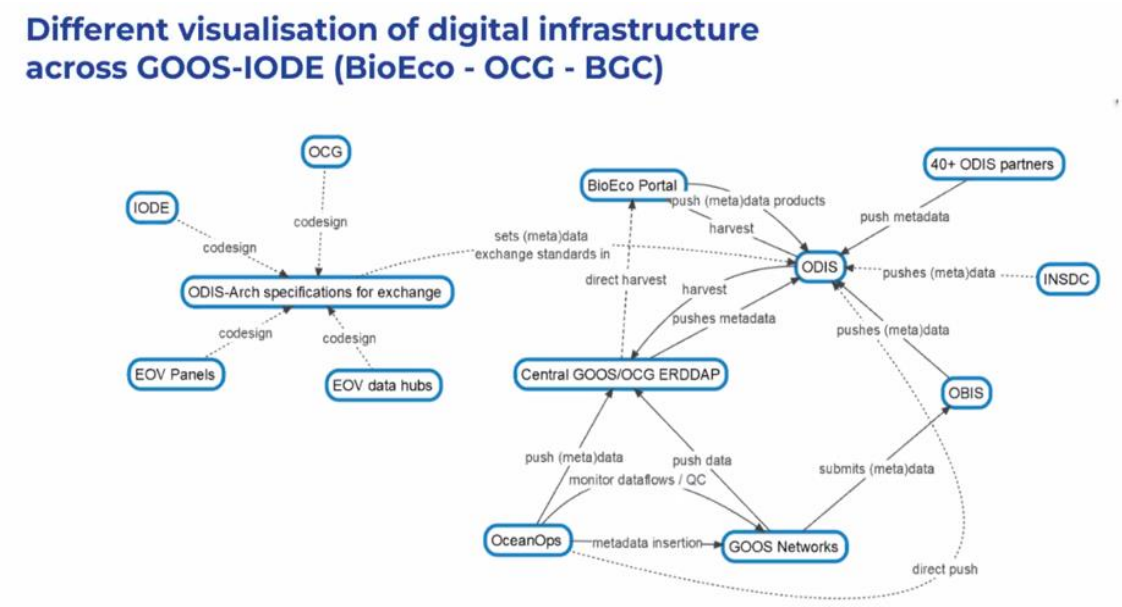
- Builds upon existing structures and common structured metadata
- Utilizes ODIS-federation for (meta)data harvesting
- Establish automated links from NODCs to (partly developed) GDACs
- Improve synergies with existing entities (OceanOPS, ODIS, etc.)
- Implement “submit once – use many times”
- Embrace FAIR principles
- Develop consistent metadata across EOV's (and platforms)
- Develop tools utilizing templates to enable more automated data flows
- Support creation of multiple value chains for products
- Establishes feedback loops to original data sources



8.2 The proposed "First sketch"

Below is the proposed GOOS-IODE integrated Data Architecture, to support the cross disciplinary and cross GOOS-IODE needs. It was noted by Mr. Buttigieg that this is a first sketch of what technically we have in mind, and that nobody wants is to take data away from those that have it: this is an architecture to support all needs. This is essential.





Advantages of the proposed architecture and how it supports/solves the issues discussed:

- BioEco: identify GOOS EOV networks (using OBIS and Ocean Expert)
- BioEco: develop BioEco unique identifiers
- BioEco Portal: track BioEco networks automatically (M2M)
- OBIS/BioEco Panel/BGC: will set minimum metadata standards (with the community/OceanOPS/OCG), will push these standards and be able to track if the metadata is complete across ODIS
- BGC: use OBIS to assemble products across repositories and sources - OCG networks, WOD, etc. - with metadata standards and attributions
- OceanOPS: can leverage ODIS to create advanced services, complete EOV views cross GOOS, analyse completeness of metadata, and arrival of data (DM) at other (ODIS) sources
- OceanOPS/OCG ERDAAP/networks: self organised hyper node providing vital quality control, unique identifiers and complete metadata, continue and are recognised within ODIS - GOOS identifier and provenance metadata standards
- GDACS: create certification/standards, expand concept for for BGC and BioEco - role recognised
- ODIS provides a forum to agree the standards for exchange

Discussion

It was noted that we probably have the capacity to rapidly pilot functionality with specific data flows across BioEco/BGC/OCG, including GOOS OCG observing networks that are now in pilot linking in BioEco data (AniBOS/BioEcoGO-SHIP), and test services function across the architecture. It would be important to have an example to showcase next year what is possible as we ask for resources. The IOC OSS suggested that we could also showcase the system for one BGC EOV, in terms of proving the ability to find, access and aggregate the available data across sources.

The discussion indicated the need to strengthen and expand GDACs, this will reinforce redundancy in the system and will support stability. The redundancy will evolve greater assurance, and ODIS robustness. ODIS can verify sources by pinging systems and running basic diagnostics.

A note of caution was sounded that in terms of creating a support infrastructure and services/products, not to underestimate the sustained funding that will be required, across years. It will be important to look at the details and make solid recommendations.

The question was posed as to what the resource needs would be to effectively run this collaborative structure - including resource management?
With regard to GDACS, it was noted that we should not over-bureaucratize. We have done a lot already. Some bureaucracy is needed to stabilize the governance. However, increasing the identified GDACs will support and simplify the GOOS OCG network data flow.

For IODE and GOOS

- GOOS: The proposed architecture serves to connect the GOOS system, networks (GDACs), EOVs, metadata standards, and known services. GOOS can efficiently feed into AND run the services it wants across this architecture
- IODE: enriches its data landscapes considerably, and ODIS Cat has new key data,
- IODE and GOOS/OCG can work together to integrate GRAs

Mr Pissierssens. IODE programme manager, noted that in terms of resources ODIS will require a permanent ODIS Manager as well as 1-2 technical staff to assist new nodes. Occasionally additional expertise may need to be contracted for new technology development and implementation.
It was noted that every node or candidate node also provides an in-kind contribution through the staff time invested in joining ODIS.

It was noted that we also need funding to deliver on specific products/systems (e.g. BioEco portal and other portals). We will need additional IOC funds for that. In addition, externally resourced components are needed to augment our system.

9. What are the defined actions that could be taken to support developing this? Does the coordination structure support the technical?

Ms Lotta Fyrberg explained that the aim of this session was to Identify tangible steps that could be taken now in order to develop an integrated GOOS-IODE data system, at the technical level. The question to answer was: What are the defined actions that could be taken to support developing this, GOOS and IODE? This was discussed and conclusions are included in the following agenda items.

10. User and system needs across IOC and Decade

Mr Kevin O'Brien explained that the aim of this session was to, with an IODE-GOOS integrated system in mind, broaden the view point and consider users within global and national services, view from work on data in the Ocean Decade, and within science. Understand how an integrated GOOS-IODE system supports users - services and science.

The questions to answer were:

- What are cross IOC priorities to address in the next 5 years?
- How are the needs for ocean data and information going to evolve?
- What would be the ideal structure for collecting, managing and serving ocean data/information to end-users?
- What rules/guidelines are needed for the FAIR and CARE ocean data and information ecosystem – i.e. implement Ocean Decade Data Strategy?
- Does the proposed integrated system meet these needs? What role does it play?

He explained that the following 5 presentations would guide the discussions on this topic.

10.1 Multi Hazard Early Warning Systems

Mr Denis Chang Seng (IOC TSR) introduced this agenda item. His presentation is available from https://oceanexpert.org/document/35322

The meeting noted that for tsunami warning the data need to be available in "hyper" real-time whereas GOOS usually deals with synoptic (within 6 hours). It was noted that this data could still be available through ODIS, with metadata tags that states that this data is 'tsunami', but that ODIS (IOC Data Architecture) is not responsible for the delivery of data, for the pipeline for tsunami services - as this has to be a different contractual route to ensure the critical hyper real-time delivery of tsunami data and associated services.

10.2 Research needs (science networks)

Ms Kirsten Isensee presented this agenda item. Her presentation is available from https://oceanexpert.org/document/35323. She explained about:

(i) **the global call to collect ocean acidification data and the SDG 14.3.1 data portal** that has been developed with IODE assistance and progress with the SDG 14.3.1 reporting. 638 stations in 42 countries reported relevant data in 2024.

To improve the data flow, not just for SDG 14.3.1 Indicator, but for a truly global ocean acidification data collection, the next steps are: Develop a federated data system, which that will connect existing data bases and allow the to exchange of the relevant ocean acidification and ocean carbon data between the platforms. This way, data will only need to be submitted once, to one database, and will then automatically be available to other users.

In order to do this, there needs to be cooperation between the databases, and an alignment of the data and metadata requirements as well as the vocabularies. We are currently working

on this, together with partners at national and international databases as well as some National Oceanographic Data Centres, NODCs.

Detailed required next steps:

1- Integrate data and metadata by enhancing the interoperability and establishing a federated data integration/ingestion system using ERDDAP services is the goal.

2- Machine-to-machine metadata exchange :

- Mapping and implementation of **standardised vocabularies**
- Integration of **missing standardised vocabularies** in the field of enriched metadata according to the SDG 14.3.1 Methodology
- Controlling and **aligning the metadata requirements** in agreement with data generators and the scientific community to provide needed enriched metadata

3- Data exchange:

- Data availability in a standardised form using standardised vocabularies.
- With the development of the federated system the 14.3.1 portal would become one of the platforms to be harvested on a regular basis and could act as a mirror to support visualization/exchange and ensure long term availability of the data.

4- Metadata:

- Agreement on data and metadata requirements, and adoption of the metadata template by all data centres
- Possible adaptations to facilitate the process:
    - create data type specific metadata templates, allowing users to only enter metadata elements related to the specific type of data (e.g., mooring, underway);
    - enable users to prepopulate all metadata elements based on previously published datasets of similar type, and modify them from there instead of starting from scratch as required;
    - automatically generate some set of metadata elements, such as the bounding box longitude and latitude, start date, end date, and minimum and maximum sampling depths.

5- Vocabularies

Key requirements

- The vocabulary(ies) adopted need to comply with the FAIR data principles and in particular enable cross-domain interoperability;
- It needs to enable machine-access (i.e. compliant with web standards) as well as human readability;
- If more than one vocabulary is used for the same concept then they will need to be mapped, and the mapping will need to be maintained;
- Many variable-naming vocabularies exist, and we need to avoid creating new ones unless necessary;
- Most variables needed by the Ocean Acidification (OA) community, including e.g. Temperature of pH measurement, already have a vocabulary code in either the CF Standard Names or the BODC PUV;
- Existing vocabularies should be reviewed by experts to ensure they are correct, and superfluous or ambiguous ones can be deprecated;

6- IODE support and collaboration

- ODIS support
  - Inclusion of SDG 14.3.1 in ODIS
  - Technical support for maintenance and upgrades of the SDG 14.3.1 Data Portal
  - Improved search and download functions
  - Integration into federated data system
  - Visualization tools embedded in the federated system, according to the SDG 14.3.1 methodology, to include maps showing the origin of the datasets received, organised by data quality; maps depicting trends for long-term datasets (>5 years).
  - Support with the communication of SDG 14.3.1 Indicator data requirements to NODCs, ADUs and other relevant national agencies to improve data flow

(ii) The Clean and Healthy Ocean Integrated Program (CHO-IP) - Possibilities to advance on ocean oxygen data

Ms Scott reported that addition of the GO2DAT system in the ODIS Federation will be completed by the end of 2024.

10.3 Decade - Vision 2030 / Decade DCO/DCC

Mr Jan-Bart Calewaert/ Mr Enrique Alvarez presented this item. His presentation is available from https://oceanexpert.org/document/35325

The meeting noted that that OceanData2030 is not something different from ODIS.
In this regard reference was made to:

"The Strategic Ambition for Ocean Decade Challenge 8 *is to have in place by 2030:*

- *The enabling environment [Infrastructures, Tools, Services and Content], for the creation of and access to an increasing number of digital representations and (twin) applications of the Ocean*
- *All observations, datasets, data products, information and knowledge outputs generated by Decade Actions should be shared and easily available to all.*
- *A global Digital Atlas with at minimum 10 societally relevant global base-layers & minimum 10 local use cases (prioritizing SIDS and LDCs)."*

The following ***tools, systems and services*** *to be developed and in place by 2030:*

1. *A federated global Ocean Data Discovery & Access Service (DDAS) with map viewer + Ocean Data Helpdesk and distributed Data Ingestion Service;*
2. *A global Technical and Organizational Structure for Ocean Forecasting;*
3. *A user-friendly reference global Digital Atlas of the Ocean;*
4. *Set of platforms & mechanisms to easily store & exchange ocean information & knowledge;*
5. *Enhanced Capacity Development & Training resources/facilities tailored to user-needs;"*

Discussion

Mr Calewaert reported that in terms of the Digital atlas we are still in embryonic state. Synergy that could work is what we have in Europe (Digital Atlas of the Sea). Most data layers there

are powered by EMODnet. There was a question around the longevity of outputs like a digital atlas, as they are hard to maintain.

Mr Pissierssens explained that we need to use the Ocean Decade to bring ODIS and the products and services discussed at the meeting to a higher level of government, in order to attract more resources. In this line, noting that IOC heard the call and are going through transformation internally to reach this. The work of the Ocean Decade can be to continue to provide input on how, as the Ocean Decade brings in the private sector, more users, more stakeholders (indigenous) etc - to continue to use the data architecture and to test our ideas.

One role identified for the DCO/DCC's could be interface between IOC data architecture and Decade Actions - to stress test it. There could also be a cross-cutting role to audit how resources are being used to implement digital solutions in the Decade and to make sure they "fit" in the overall plan and architecture.

There was some discussion regarding how we might look at model data, are we going to distinguish an IOC Data Space for models and observations. Separating does not make sense for users, as we need the exchange to feed both layers, with verification of authenticity and accuracy, with provenance chains. However within this we need to distinguish between model and observation data. The DCC is building an atlas of forecasting systems, some level of coordination with the IOC Data Architecture would be useful to prove interoperability. Some thought should go into representing model outputs, there needs to be some caution with regard to labelling 'fit-for-purpose', need uncertainty, provenance, bias, diagnostics so that users have the information to assess for themselves.

10.4 Decade Data Strategy

Mr Pier Luigi Buttigieg introduced this item. His presentation is available from https://oceanexpert.org/document/35324

Achieving the Ocean Decade vision and overcoming these Challenges requires an enabling environment for a distributed ocean digital ecosystem that connects across disciplines and geographic boundaries - including the frameworks, infrastructure, people, tools and resources.

For this reason, the Ocean Decade Coordination Unit decided to develop a data and information strategy to address these critical issues, with the ambition of leaving a legacy behind that endures beyond 2030.

The Ocean Decade's Data Coordination Group was convened in Nov 2022 to develop an overarching data and information strategy for the Decade that would endure beyond 2030.

Then in 2023, a sub-group was convened to work on the implementation plan for this strategy. Both of these groups include data experts from around the world, brought together through a public call for candidates.

The vision of the Strategy is to reach our Vision to put in place by 2030 "**A trusted, inclusive, and interconnected ocean data and information ecosystem that is actively used for**

decision making to support sustainable ocean management." It includes 5 strategic objectives, as shown below.

A second group of 27 global ocean data experts convened - the Data Strategy Implementation Group – is currently working on a draft implementation plan which was first unveiled at the Ocean Decade Conference in Barcelona in April 2024.

Why does the implementation Plan matter to the ocean science community? For several reasons:

- Aligning to a multilateral mission - The implementation plan will guide you and your data teams to concretely and meaningfully align your system to others contributing to the Ocean Decade.
- We're better together - If our digital capacities are implemented using similar norms, they can robustly and sustainably work together – this will help the Ocean Decade's partnership thrive well past 2030.
- The world is watching - Claims that data, software, or other digital assets are
- FAIR or CARE compliant / Useful to societal stakeholders and rights holders / Supporting SDG information flows, are testable – and more and more systems will continuously test them.
- Efficiency gain - The implementation plan is there to help systems save massive resources by aligning as early and as profoundly as possible, before expensive (and often infeasible) post-hoc alignment becomes a necessity.

The strategy implementation plan includes a series of recommended actions – organised by project phase, such as planning data acquisition, sharing, publishing, etc. – that collectively will help the community of ocean data producers, custodians and users meet the strategic

objectives of the data strategy and lay the foundations for the globally distributed data and information digital ecosystem.

The implementation plan is being finalized in October 2024 and there will be a review phase in November 2024, with final publication and roll-out in Q4 2024 or Q1 2025.

Discussion

It was noted that many participants in this meeting are also involved in the Decade Challenge 8 White Paper. This will also promote the sustainability of what has been achieved.

It was also noted that when the GOOS hypernode is in place then that will be an excellent showcase. In science the published paper is your currency so people hold on to their data until they have published. We need to change this culture. Data needs to be open from the beginning. FAIR data publication needs to be a currency too.

10.5 Ocean Decade work on private and/or community science data

Mr Louis Demargne presented this agenda item. His presentation is available from https://oceanexpert.org/document/35326

In the Ocean Decade there is a decentralized coordination, with multiple entities helping to coordinate activity in a particular domain. This allows a bottom-up approach, bringing in outside expertise. Illustrated below are two such groups that focus on issues related to ocean data and information.

The Data Coordination Group was convened in Nov 2022 to develop an overarching data and information strategy for the Decade that would endure beyond 2030. In parallel, the Corporate Data Group was convened to focus on filling data gaps by unlocking privately owned ocean data. The Vision 2030 is then helping both groups to set the priorities for data sharing, capacity development, etc.

The Corporate Data Group (CDG) is composed of 10 private-sector organisations from different industries (energy, fisheries, coastal engineering and telecom). The group is co-chaired by IOC and Fugro.

The goal of this group is to understand what are the barriers to data sharing and to develop strategies and guidelines for private-sector industry to share their ocean data into the public domain for the benefit of science.

As discussed with the CDG members, industry's top 3 barriers to data sharing, include:

1. **Legal/contractual** - data ownership not always clear, or split between multiple organisations
2. **Technical** - knowledge of where and how to share data, not always easily accessible
3. **Incentives** - lack of incentives, risk/reward not clear, resources required, etc.
4. Others: commercial sensitivity, liability risk

When we started working with the CDG, we quickly realised that different types of ocean data presented different types of barriers and regulatory constraints. For this reason, the CDG decide to work on 3 use-cases, each one focusing on a specific type of data.

The 3 use cases are on the following data types:

- Bathymetry data
- Biodiversity data - Marine Mammal Observations
- MetOcean Data - still to be decided, but could be CTD data or ADCP data

For each of these use-cases the goal is to produce a data sharing guidelines and to demonstrate the positive impact, as a way to incentivise others to share data.

Call to Action – April 2024

Based on the group's experience to date on the use cases, the CDG drafted and pronounced the following call to action, which was pronounced at the 2nd Ocean Decade Conference in April 2024, in Barcelona, Spain. The call highlights actions required not just from Industry, but also from academia, national governments and civil society.

Conclusion

The conclusion and next steps for the CDG are as follows:

1. **Identify priority datasets and make them visible** (e.g. by sharing metadata) - A first task is to prioritise those datasets that will have the biggest immediate impact. The Ocean Decade provides a good framework to determine where we should focus our efforts. The Vision 2030 process, in particular, identified the information products we must develop by 2030, which will inform the underlying data needed. Once these datasets are identified, we must make them discoverable and accessible. HUB Ocean and the Ocean Decade's Corporate Data Group are working towards this goal with industry and UNESCO's ODIS programme led by IODE is also setting the foundations for a federated data ecosystem accessible to all users.

2. **Demystify data sharing**:
    a. Make data sharing as simple as possible - We should also demystify data sharing. We can do this first by demonstrating how the benefits and impact of sharing data outweigh the perceived risks and the efforts required to share.
    b. Demonstrate how benefits/impact outweigh perceived risks and effort - we must find ways to make data sharing as simple as possible, providing clear guidelines and automating the process as much as possible, aligning data producers and users around a common set of standards.
    c. Increase visibility, acknowledgement - once the data is shared, increased visibility and acknowledgement of how and where the shared data is being used would also encourage further engagement.

3. **Industry and governments must work together** – the incentives for industry to share data are not always understood. At the same time, national governments can be reluctant to share ocean data, given the geopolitical context. Therefore, industry and governments must work together to establish pathways that facilitate data sharing and benefit both stakeholders

equally. For example, governments could require data sharing as a mandatory step of the permitting processes for offshore operations, as is the case already in the UK.

Discussion

It was suggested that companies could become ODIS nodes and share data through ODIS. Mr Demargne responded that this option could be explained to them as this would indeed be the most direct way to collaborate.

Regarding HUB Ocean, it was asked what is the role of HUB Ocean and what agreement exists between IOC and HUB Ocean regarding what they can/should do with the data. Mr Demargne informed the meeting that the founder of HUB Ocean became emissary for data sharing in Decade. They will use the data in their platform but will share. There is no agreement. Mr Appeltans informed the meeting that HUB Ocean has been invited to become an OBIS node (IODE ADU). “Once these datasets are identified, we must make them discoverable and accessible. HUB Ocean and the Ocean Decade’s Corporate Data Group are working towards this goal with industry and UNESCO’s ODIS programme led by IODE is also setting the foundations for a federated data ecosystem accessible to all users.”:

Attention was called to licensing for ocean activities. It was noted that there is a GOOS use case for wind farms where the German government required the private sector to collect data as a part of the terms of the licence. The wind farms now collect many more observations than the minimum, this has been really successful.

Mr Demargne informed the meeting that he had asked companies to identify variables they collect and match these with EOVs. It was noted that the examples given in the presentation as the first demonstrator variables were EOVs already or applying to be EOVs: marine mammals (BioEco EOV), sub surface temperature, and sub surface salinity (CTD), and bathymetry (IHO is in the process of proposing as a new EOV). It was also noted that companies may be gathering data about the same things EOVs are about, but in some cases they may not be collecting EOVs, however now that GOOS has given the green light to create official semantics for the EOVs in the Environment Ontology, we can include multilingual labels and synonyms to allow a reference for automated scanning of the ODIS knowledge graph to relate to EOVs. This will help EOV portals discover and link back to data that is about the same phenomena as EOVs to supplement its true GOOS EOV data flows if this is the case. An example was given for the GESAMP marine debris types - http://purl.obolibrary.org/obo/ENVO_06105101. Noting the multilingual forms:

has_exact_synonym: plastica; 塑膠; Plastik

has_narrow_synonym: Kunststoff

The IOC Data architecture would enable provenance. which would be useful to the public and the private sector alike.

Mr Chang Seng informed the meeting that some governments are unwilling to share data including those that are essential for tsunami warning. When we talk about “priority data sets” we need to define what is meant with “priority”, is it based on outcome, saving lives?

Mr Demargne responded that the Corporate Data Group (CDG) plans to use outcomes of the Vision2030 process. Each group should come up with ideas on what products should be ready by 2030. E.g. EOVs. The Group would then go back to the private companies and find out what they have, and if they are willing to share. The CDG has a task to go through this process (using the white papers), identify data gaps, and assess the potential of industry as an element to fill these gaps.

It was noted that there is a need for more data managers at the national as well as international level as quality control and data management in general is labour intensive and time consuming.

It was also noted that if we ask industry for data they often ask where they should deposit the data. and that the question is not storage but processing. One suggestion was that we will need to look at this on a case by case basis as someone will need to do the data management and the expertise may not be available or insufficient in the company or data centre in the country where the company is located. However, until we develop some test cases it will be hard to know.

11. Does the technical and coordination structure support evolution?

Mr Pier Luigi Buttigieg explained that the aim of this session was to discuss if the technical solution discussed in session 7 will meet the future needs as outlined in session 9 from across IOC and the Ocean Decade. The questions to answer were identified as:

1- **Can we define these future needs?**

The meeting **noted** that:

- To some extent the data ecosystem is unpredictable and therefore needs may be difficult to identify fully;
- There is currently a lack of redundancy in data centre repositories. While data centres in the northern hemisphere generally have backup arrangements this is often not the case in the global south. That is a high risk factor for ODIS; GOOS also needs to consider this in its data implementation, some rationalisation between GDACs and networks will be important;

The meeting identified the following **needs**:

- Need to align ourselves across IOC/Decade and decide on a communication message including on the needs for more data and increased spatio-temporal sampling to support many socio-economic areas;
- Need to communicate at the highest possible level of government and not just to peers at the scientific and technical level;
- We will need to deal with model data. It was noted that it has been started at the DCC for ocean prediction'. Would we envision GOOS (ETOOFS) branding for model data, signifying that these models are interoperable and have reached some level of sophistication. How would we distinguish between 'ready/level 5' operational ocean forecasting and climate models - this needs some thought on how to correctly signal

model data in this marketplace - BUT also how we signal difference between model and in situ.
- While ODIS deals with metadata we also need to consider “EOV data lakes” that federate data;
- A data ingestion service similar to that of EMODnet may be needed but that will also require a curator service;
- It will be important to identify the human resource needs in our plan;

2- What is not met with the existing infrastructure/envisioned infrastructure?

- There will be a computing cost, there is a lack of a plan for the computing cost. Data from Digital Twins and hi-res models will be a bigger issue;
- We need to take into account the Green Computing initiative and caution against consuming too much energy. In this regard concern was expressed about the energy use of digital twins;
- On the same subject we should try to position the data sources as close as possible to the modelling facilities. In this regard legal implications of moving data may need to be considered;
- Investments in infrastructure made by member states and their data centres should also be taken into account when reporting;
- Companies need some level of certainty to orientate their data flows to contribute
- Also need better relations with private sector to reduce costs where possible
- Imagery and videos are an important resource but require huge amounts of storage space; Such that there is no plan for mass image and video data storage today, there is also the danger that much of it is not useful
- What other models can we explore to fund this. While we welcome private sector data, the data management of these data will have a cost and the private sector will need to be called upon to assist with the additional cost for NODCs, ADUs and other data centres. In this regard it was noted that we are building a “marketplace”: One offer from us could be a custodian for private sector data, curate it, broker it, we could break up into modular services that they could elect to purchase from us

With regard to data ingestion it was noted that GEBCO has the staffing capacity to handle incoming data, they are a broker and staffed as such. Can we get GEBCO to share their resource plan, for example. EMODNET set up an ingestion service in the Vision Paper 8 and have discussed this.

An idea was suggested that we have a ‘GOOS Portal’ for data ingestion, both manual and automated, and focused around the EOVs. However, what resources would be required for such an initiative. IHO is small and they have a couple of data managers for one variable, bathymetry, so scaling for 36 variables could lead to a large number of people. However it was noted that GOOS could consider a distributed system, for example OBIS has 33 nodes and 60 people located through the node network.

3- How do we evolve, do we need additional skills/knowledge/technology?

- Coming into the digital future means we need more stable staff. Hiring contractors is not sustainable and they do not carry the knowledge for long term work.
- In ODIS the code was kept simple to understand so others can work on it;
- It was observed that some of the OBIS nodes have contracts with industry so we need to be careful not to compete. Nodes in our network can also establish private-public partnerships.
- There is a requirement that to run an OBIS node the node needs to have at least 1 staff that has completed the OBIS training course in OTGA. So certification of data centres is important.
- This certification of skills is a normalisation within the IODE family and is an important component to shaping a unified digital culture;
- We need to take into account “digital equity”: as the majority of IOC member states are global south countries, we need to ensure that they can be equitable partners in the ocean data space we are building;
- How can we improve on what has been tried before, there are IODE regional and national instances, but often that fail if they do not offer clear products that their governments recognise. Need to ensure the evolution of the system is equitable.

12. Defining Elements of an IOC data architecture

Under this agenda item the discussions held in the previous sessions were summarised and an outline of the agreed elements of a IOC Data Architecture were presented.

The meeting reviewed and revised the SWOT analysis that had been discussed under agenda item 5, adding in elements from sessions 7, 8 and 9:

Strengths (internal)	**Weaknesses (internal)**

• General alignment to modern distributed data practices (ODIS,WIS2.0, ERDDAP™)
• We are all looking outward to see how to deliver services
• GOOS, IODE, IOC all invested - skilled people been working together for some time, FAIR principles and common implementation approach
• Long history / sustained commitment from Member States
• Success stories on how to share data (EMODnet, GDAC, OBIS…and working across nations)
• Part of UN - critical awareness of international focus
• IOC Statutes (informing MS on actions)
• Working towards same goal
• GRAs could help get all data shared… NFP too?
	• Under used or significance of IOC being UN ignored
	• not enough skilled people
	  ○ data
	  ○ liaison to user groups
	• GOOS /IODE/ IOC weak in the UN System - underappreciated
	• Our strengths are not recognised - unique value of IOC in running this
	• Data sharing not a cross cutting priority in IOC
	• Data management and sharing not recognized as essential in all IOC communities of practice and relevant DM practices are insufficiently known and used
	• Shared vision and an ongoing governance system to support implementation
	• Fragmentation geographically and politically

<table>
<tr>
<td>

ODIS has matchmaking capability
Work with existing strengths

</td>
<td>

difficult to create products
several entities doing the same thing
multiple submissions by one agency
different versions out of one data set
inefficiencies
different time horizons for users

Some MS still not share data
Collective access and benefits sharing regime (funding mechanism) - enable our competitors to a degree that we are outcompeted
We do not have internal awareness of licencing and restrictive usages
insufficient linkage between what we do at technical level and top level of governance where decisions on data sharing are made
lack of capacity in global south / under-resourced countries / communities
everyone working in niches

</td>
</tr>
<tr>
<td>
Opportunities (external)

Engagement with private sector
Recognised need for more ocean data - from UN / private sector / governments
UN Ocean Decade
Agree a coordinated approach
Use the WMO Unified Policy and other mechanisms more
Communicate on what we are doing
Be an exemplar to a wider community to influence communities other than the ocean (e.g NASA heliophysics, CDIF)
Opportunity to demonstrate mechanisms to balance protection and openness (appetite for data sharing with products and building trust)
Creating a “marketplace” to enable trading/sharing/negotiating data (preposition ourselves in emerging digital economy)
Optimise green computing - sharing metadata not data = data mesh architecture
Private sector could create products
Private sector design the technology we need

</td>
<td>
Threats (external)

Non support for multilateralism
Others can step up and do it
Being part of the UN can make it slow to innovate…
Too slow and others will do it (with our innovation)!
Unique role of IOC is not recognised
HL engineering takes over good ideas of the system
Need to ‘police’ nodes -
Geopolitics and emerging regulatory frameworks
Access and benefit sharing - digital equity
Fear by different countries of asymmetries in benefits from sharing data - digital colonialism
Involving over-capacity nations so that they invest in us
Lack of resources and
Lack of optimised allocation of resources
Lack of redundancy in data systems
No clear identification of ownership of separate parts of system
Ensure we identify manageable list of

</td>
</tr>
</table>

• Provision of and refining of Indicators • Use UN Ocean Decade and UNGA to raise awareness of top level government for data sharing and also to avoid data colonialism • Work with diversity of partners to build a system for global community • Need a plan - staged approach - guidelines… • Roll out feature (“ocean in a box”)	tasks

1. WHAT IS OUR JOINT VISION

The meeting noted that IOC has defined a clear niche in the digital ecosystem which is unique to IOC and highly investable.

- IOC as the gateway to all ocean data - with core GOOS certified EOV data clearly identified
- Wherever you are in the world you want to be able to appropriately access EOV data
- EOV Data of documented quality, following FAIR & CARE principals, available for All
- Harnessing all parts of the IOC value chain to deliver trusted information to as many users as possible
- High value products that get delivery of the EOV data into the hands of the global assessments and multilateral processes, that can be traced back to the point of truth (i.e. observations)
- IOC has defined a clear niche in the digital ecosystem which is unique to us and highly investable, that is aligned with other architectures and built on existing infrastructure.
- IOC data architecture and associated products and services will bridge the digital divide and help mature digital ecosystems globally

References will be needed to support the terms of the vision:

(1) IOC Data Policy, WMO Unified Data Policy, and GOOS data is free and unrestricted
(2) Define Ocean Data: be it from in situ, modelling, analytics, public and private sector
(3) Define the IOC Value Chain - IOC Medium Term Strategy page 16

A potential example of a KPI is Global ocean data and data flows clearly mapped.

2. IDEAL COORDINATION STRUCTURE

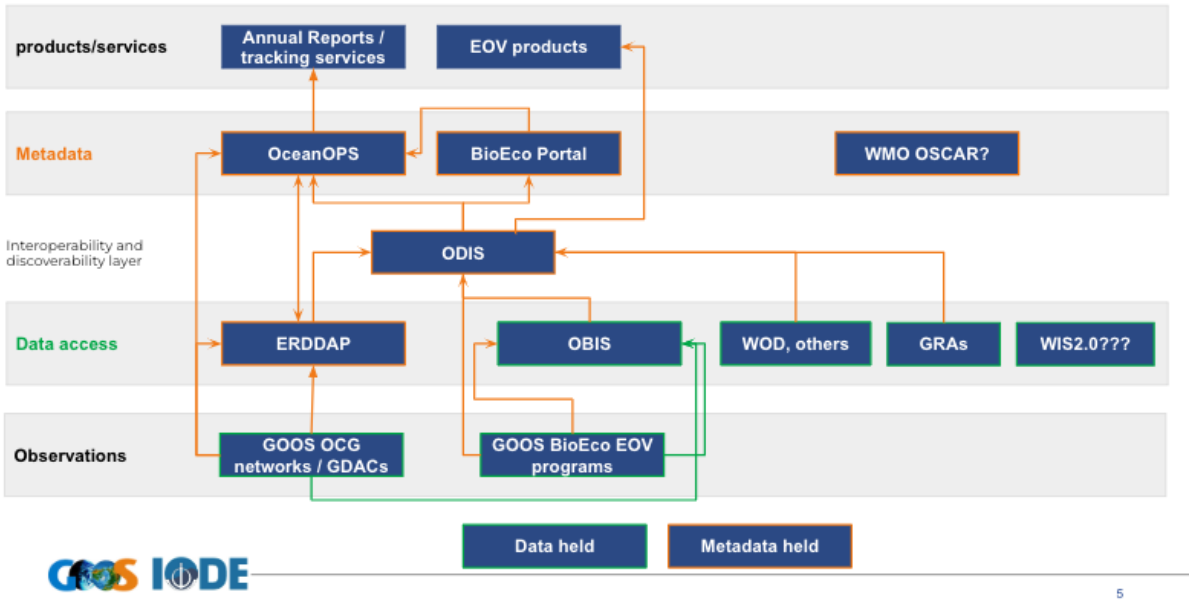
The meeting recalled the discussions on an ideal coordination structure (agenda item 5):

- Create a cross IODE-GOOS-IOC Working Group (see later actions for its work), consider if with UN partners
- ODIS architecture holds the technical governance structure for the relationships between nodes/components, agree standards for exchange, verify GOOS ‘brand’ data
- UN connection is unique and brings value
- Vision - QC EOV Data FAIR All

- Joint Session/agenda item at IOC Assembly

3. DATA ARCHITECTURE

The meeting recalled the discussions on the first draft of a Data Architecture (agenda item 7):



For the further discussions the following questions were identified:

1. What are the **concrete steps** that need to be taken short-term and longer-term (see 12.1, 12.2)
2. What are the **barriers or blockers to implementation**? (see 12.3)
3. **What new partners are needed**? (see 12.4)

13. Implementation Roadmap

13.1 Short-term

The meeting agreed on the following short-term timeline to develop a proposal for a cross IOC data architecture.

1. **Develop a draft proposal for the IOC Data Architecture** that can be presented in draft form for discussion at to the (i); GOOS Steering Committee in February 2025; (ii), the 28th IODE Committee Meeting Data Management in March 2025;, and a final version for submission to the IOC Assembly in Paris in June 2025
    a. This task will be implemented by a consultant, hired by GOOS and IODE. The GOOS Director and IODE Co-Chair agreed on a financial allocation covering 4 months. (December 2024)
    b. Around April 2025 a briefing session for Member States could be organized
    c. IODE was requested to (i) include in its work plan and budget 2025-2026, a request for a permanent ODIS manager position, as well as a financial allocation for 1-2 technical staff to assist new nodes. (to be included in the draft

decision prepared by IODE-28 for IOC-33); (ii) urge NODCs and ADUs to join ODIS as nodes, and to allocate staff time to establish and maintain their nodes; and (iii) instruct GTSPP, GOSUD to link to OceanOPS and ODIS

2. **Establish and start the work of the IOC Data Architecture Working Group** to devise the proposal for a cross IOC data architecture/space - Vision, Governance, Technical, Unique offer, Advocacy, Capacity, Diversity, Initial deliverables, Resource need, Risk

    a. This task will be started by the consultant referred to under 1a.

    b. The tasks of the group (terms of reference) will include:

        (1) Map the data flows - what to govern and what to implement - look at optimisation/eliminating redundancy
        (2) Create 'rules' of coordination, responsibilities - ODIS broker, services, data flows
        (3) Select showcase pilots that demonstrate data flows and broker service test assumptions are robust
        (4) How would a plan address capacity (for example, training session or ODIS in a box, tools, SOPs)
        (5) Develop joint IODE/GOOS (and other IOC programmes) budget strategy, extra-budgetary accelerated services, what required beyond and how we are advocating to get it
        (6) Communicate on the proposed IOC data architecture/space - create visuals - reference meeting Decade recommendations - gain feedback
        (7) Ingestion (sketch idea) - corporate data other data (sharing costs), certainly of listening to lower risk
        (8) Technical resources required, including computing power
        (9) Model data - consider IOC system and signalling
        (10) Digital equity and data availability,there is diversity but strengthen our explicit consideration in the planning. UNEP has some work in this area (see potential partners)

    c. The meeting agreed on the following initial focal points for the Working Group:
        - ODIS- Lucy Scott/Pier Luigi Butttigieg
        - OBIS/BioEco - Ward Appeltans/Pieter Provoost
        - OCG/OceanOPS - Kevin O'Brien/Mathieu Belbeoch
        - GOOS general - Emma Heslop/Joanna Post
        - SDG 14.3.1/Science - Katherina Schoo/Kirsten Isensee
        - GOOS BGC/IOCCP - Veronique Garcon/Nico Lange
        - IODE general - Peter Pissierssens/Lotta Fyrberg
        - DCC/DCOs Infrastructure - Terry McConnel, Enrique Alvarez, Jan-Bart Calewaert

3. Short-term practical actions

- GOOS ERDDAP OceanOPS OBIS ODIS bridge – before IOC Assembly as a proof of concept
- Communication: make sure we have a map/diagram of the schema – hyper nodes etc
- Prototype for metadata semantics for identifying EOVs
- Clear implementation plan for oxygen (others) EOV/SDG data flow to show Assembly
- Engage all stakeholders required to implement (missing GRAs)
- Articulate as useful to MS: ahead of the Assembly but after the IODE committee meeting and GOOS SC. Proposed date: late April (online).

13.2 Longer term - post proposal making collaborative structure real (out to 2030)

The meeting participants highlighted key aspects to consider in the planning for, and the implementation of, an IOC Data Architecture, including regular input from stakeholders.

1. **Post IOC Assembly:**
    a) Use input and discussions at IOC Assembly to gain view of what key Member State issues this plan responds to/answers;
        - Prioritise what needs to be done, using Minimal Viable Product (MVP) concepts to support initial deliverable products and services;
        - Advocate for the IOC Data Architecture, starting after the IOC Assembly, create communication materials and maintain visibility of progress and impact, to ensure knowledge transfer, buy-in and transparency (see below).

2. **Implementation considerations:**
    - Consider capacity development and communication for the architecture, such as training sessions, ODIS in a box, development of tools, and understanding of relevance vis a vis IOC processes (e.g. SOP);
    - Ensure cross-walk between the views of the system by EOVs and between elements providing services for internal and external consistency - *OceanOPS, BioEco Portal, BGC Portal;*
    - Consider that portals, such as an oxygen EOV portal, are filters on ODIS - ensuring the system is functioning and are also early product deliverables
        - Assess collective access and benefits sharing regime (how is this related to funding mechanisms and visibility for contributors to the system)
    - Make clear the decisions that are being made, i.e. communicate on the decisions that are being made at the Architecture develops, for example consider licencing and signaling on any restrictive usages, for example for some commercial data
    - Consult and implement operational GOOS EOV metadata tag system - to support certification and checking provenance
    - Continue to map the structure as it is evolves, and to support efficiency
    - Develop a IOC digital culture for practitioners - develop an IOC digital culture for practitioners, with training through OTGA, and ensuring SOPs/practices are documented
    - Consider data systems and redundancy arrangements for a robust system

- During implementation it will be important to gather cost and value information, to evaluate and inform on the cost of value chains including the environmental cost, to assess that the architecture is green and offers value

3. **Creating a robust Implementation Plan:**
    - Create a detailed Implementation Plan that states phases, identifies goals and the roles of different IOC groups, including timelines, and with clear regional relevance, including the engagement of SIDs (structure for engagement). The Implementation Plan should also articulate key deliverables for each phase.
    - During implementation assessment should be made as to how far we have come to reduce the digital divide, therefore thought should be given to identifying some key metrics within the implementation planning
    - Regular consultation with regional hubs, other ad hoc consultations, and possibly also some higher level consultation with government ministers for digital transformation etc., on use and on product output. This should be part of the implementation to ensure plans meets the needs of key stakeholders (e.g. data and digital infrastructure minister)
    - Undertake a review 2030, and check that IOC is now providing a significant amount of the information needed for key global initiatives e.g. World Ocean Assessment (WOA), and that IOC recognised for its work in this area and as a trusted source. In addition, has this work had an impact on reinvigorating NODCs, and successfully entrained new ocean data (e.g. public sector)
    - Ensure that the implementation is carefully done, for a project of this scale IOC needs, a) a phased plan, b) with each phase a resource plan, and c) success markers. Although it is important to sell the dream, it is equally important to be realistic about cost, as new capacity is developed IOC has to deliver increased value. A key way of ensuring that this is embedded in the project is to ensure the iterative nature of the project, i.e. do get feedback, before moving onto the next step, for example through applying MVP concepts

13.3 Potential barriers

The meeting participants additionally considered what the potential barriers to implementation of an IOC Data Architecture:

- **Need to document** the IOC Data Architecture concept straight away! (Undertaken through this report and the planned proposal)
- **Identifying who takes charge** of what processes: the anchors of this architecture are IODE and GOOS, and sign off on any proposal will be through IODE and GOOS technical and management levels
- **Users**, we need to reach out and ensure key minimum viable products (MVPs) are useful/can be used, in the spirit of co-design. If users do not receive benefit we will face issues
- **Need effective communication across IOC**, on who, what, how, and resource implications - there are different phases, and multi level engagement needed, careful and consistent communication is important
- **Insufficient technical input** to the architecture plan. This can be partially solved through communication within our system on questions and engaging with relevant internal

stakeholder groups, including GOOS OCG Data TT, GOOS GRAs, and IODE/OBIS nodes; we can also draw on GOOS networks for internal review. How we engage with external stakeholders should also be determined in planning, other potential groups include the Ocean Enterprise Initiative (previously Dialogues with Industry), and the Ocean Decade Corporate Data Group.

13.4 Potential partners to consult and integrate

The meeting participants considered key potential partners, beyond IOC, in the implementation of the IOC Data Architecture

- With regard to model data planning, in a second phase, consult with UN Ocean Decade Collaborative Centre (DCC) Ocean Prediction and the GOOS Expert Team on Operational Ocean Forecasting Systems (ETOOFS)WMO Information System 2.0 (WIS2)
- UNEP digital equity work
- Space agencies: CEOS, CGMS, ESA, NASA, ISRO, etc.

14. Closing

Ms Lotta Fyrberg thanked the participants for the active discussions during this meeting.
Ms Emma Heslop noted the considerable progress made.

ANNEX I

AGENDA

1 Welcome by local host
2 GOOS/IODE welcome and introduction
3 Strategic Priorities for GOOS and IODE
4 Mapping the current situation
  4.1. IODE and ODIS
  4.2. OCG and OceanOPS
  4.3. BioEco and OBIS
  4.4. BGC
  4.5. WMO WIS 2.0
5 What are current weaknesses and strengths/what do we want?
6 What would be the ideal coordination structure to manage an integrated “data and information flow” in 2030 -
7 Technically integrated structure - presenting and discussing a first sketch
8 What are the defined actions that could be taken to support developing this? Does the coordination structure support the technical ?
9 User and system needs across IOC and Decade
  9.1. Multi Hazard Early Warning Systems
  9.2. Research needs (science networks)
  9.3. Decade - Vision 2030 / Decade DCO/DCC
  9.4. Decade Data Strategy
  9.5. Private sector data
10. Does the technical and coordination structure support evolution?
11 Defining steps to integration
12 Implementation roadmap
13 Closing of the meeting

ANNEX II
LIST OF PARTICPANTS

IODE

Mr. Ward APPELTANS
Programme manager OBIS
UNESCO / IOC Project Office for IODE
InnovOcean Campus
Jacobsenstraat 1
8400 Oostende
Belgium
Email: w.appeltans@unesco.org

Ms. Katarina Lotta FYRBERG
Co-Chair IODE 2023-2025 & Marine Data Manager
Oceanographic Unit
Sveriges meteorologiska och hydrologiska institut
Folkborgsvägen 1
SE-601 76 Norrköping
Sweden
Tel: +46 31751 8978
Email: Lotta.Fyrberg@smhi.se

Mr. Arno LAMBERT
IT Services Manager
UNESCO / IOC Project Office for IODE
InnovOcean Campus
Jacobsenstraat 1
8400 Oostende
Belgium
Tel: +32 (0)59 34 14 62
Email: a.lambert@unesco.org

Mr. Peter PISSIERSSENS
Head, IOC Project Office for IODE, Oostende, Belgium and IOC capacity development coordinator
UNESCO / IOC Project Office for IODE
InnovOcean Campus
Jacobsenstraat 1
8400 Oostende
Belgium
Email: p.pissierssens@unesco.org

Ms. Lucy SCOTT
Ocean InfoHub Project Manager; Marine Scientist
UNESCO / IOC Project Office for IODE
InnovOcean Campus
Jacobsenstraat 1
8400 Oostende
Belgium
Tel: +27 (0) 82-879-5006
Email: l.scott@unesco.org

GOOS

Mr. Mathieu BELBEOCH
OceanOPS Manager
INF/WIGOS/OceanOPS
World Meteorological Organization
Case Postale 2300
7bis, avenue de la Paix
CH-1211 Geneva
Switzerland
Tel: +33 2 29 00 85 86
Email: mbelbeoch@ocean-ops.org

Ms. Véronique GARCON
Senior scientist
Laboratoire D'etudes En Géophysique Et Oceanographie Spatiales, Observatoire Midi-Pyrénées
14, Avenue E. Belin
31400 Toulouse
France
Tel: +33 5 61 33 29 57
Email: veronique.garcon1@univ-tlse3.fr

Mr. Patrick GORRINGE
International Ocean Relations and Contracts
Sveriges meteorologiska och hydrologiska institut
Folkborgsvägen 1
SE-601 76 Norrköping

Sweden
Email: patrick.gorringe@smhi.se

Ms. Emma HESLOP
Programme Specialist
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +34 6 45 43 93 88
Email: e.heslop@unesco.org

Mr. Nico LANGE
NORCE - Norwegian Research Centre
Nygårdsgaten 112
5008 Bergen
Norway
Email: nlan@norceresearch.no

Mr. Kevin O'BRIEN
Senior Research Scientist
Joint Institute for the Study of the Atmosphere and Ocean
University of Washington
24 Kincaid Hall
Seattle, WA 98159
United States
Tel: +1 (206) 526 6751
Email: kevin.m.obrien@noaa.gov

Ms. Joanna POST
Head, Observations and Services Section
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Email: j.post@unesco.org

Mr. Maciej TELSZEWSKI
IOCCP Project Director
International Ocean Carbon Coordination Project
Polish Academy of Sciences – Institute of Oceanology
Instytut Oceanologii Polskiej Akademii Nauk Powstańców Warszawy 55
81-712 Sopot
Poland
Tel: +48 587311610
Email: m.telszewski@ioccp.org

IODE and GOOS

Mr. Pier Luigi BUTTIGIEG
Data Scientist, Digital Architect
Deep-sea ecology and technology
Alfred Wegener Institut
Bussestr. 24
27515 Bremerhaven
Germany
Tel: +494212028984
Email: pier.buttigieg@awi.de

IOC Ocean Science

Ms. Kirsten ISENSEE
Programme Specialist - Ocean Carbon Sources and Sinks
Ocean Science Section
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33 (0)1 45681814
Email: k.isensee@unesco.org

Ms. Katherina SCHOO
Associate Project Officer - Ocean Acidification
Ocean Science Section
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +330145681147
Email: k.schoo@unesco.org

IOC TSR

Mr. Denis CHANG SENG
Programme Specialist (Ocean Observation & Services Section /Tsunami Unit)
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33 1 45 68 09 51
Email: d.chang-seng@unesco.org

Ocean Decade

Mr. Louis DEMARGNE
Data & Knowledge Management Officer
Decade Coordination Unit
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +31655855501
Email: l.demargne@unesco.org

Mr. Enrique FANJUL
DCC Technical coordinator
DCC Oceanprediction
Mercator Océan
2 avenue de l'Aérodrome de Montaudran
31400 Toulouse
France
Tel: 34 658631948
Email: enrique.a.f.trabajo@gmail.com

Invited expert

Mr. Jan-Bart CALEWAERT
Lead Manager of the Decade Coordination Office for Data Sharing
Decade Coordination Office (DCO) for Ocean Data Sharing (ODS)
UNESCO / IOC Project Office for IODE
InnovOcean Campus
Jacobsenstraat 1
8400 Oostende
Belgium
Tel: +32 497 43 33 71
Email: jb.calewaert@unesco.org

WMO

Ms. Champika GALLAGE
Senior Scientific Advisor
World Meteorological Organization - Observing System and Information Department
Case postale 2300
7 bis, Avenue de la Paix
CH-1211 Geneva 2
Switzerland
Tel: +41 2 27 30 80 96
Email: cgallage@wmo.int

Mr. Tom KRALIDIS
Senior Geospatial Architect
Meteorological Service of Canada
4905 Dufferin Street, 4N113
Toronto Ontario
Canada
Email: tomkralidis@gmail.com

[end of document]