GCOS

KEEPING WATCH OVER OUR CLIMATE

WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

27th Session of the Ocean Observations Panel for Physics and Climate (OOPC-27)

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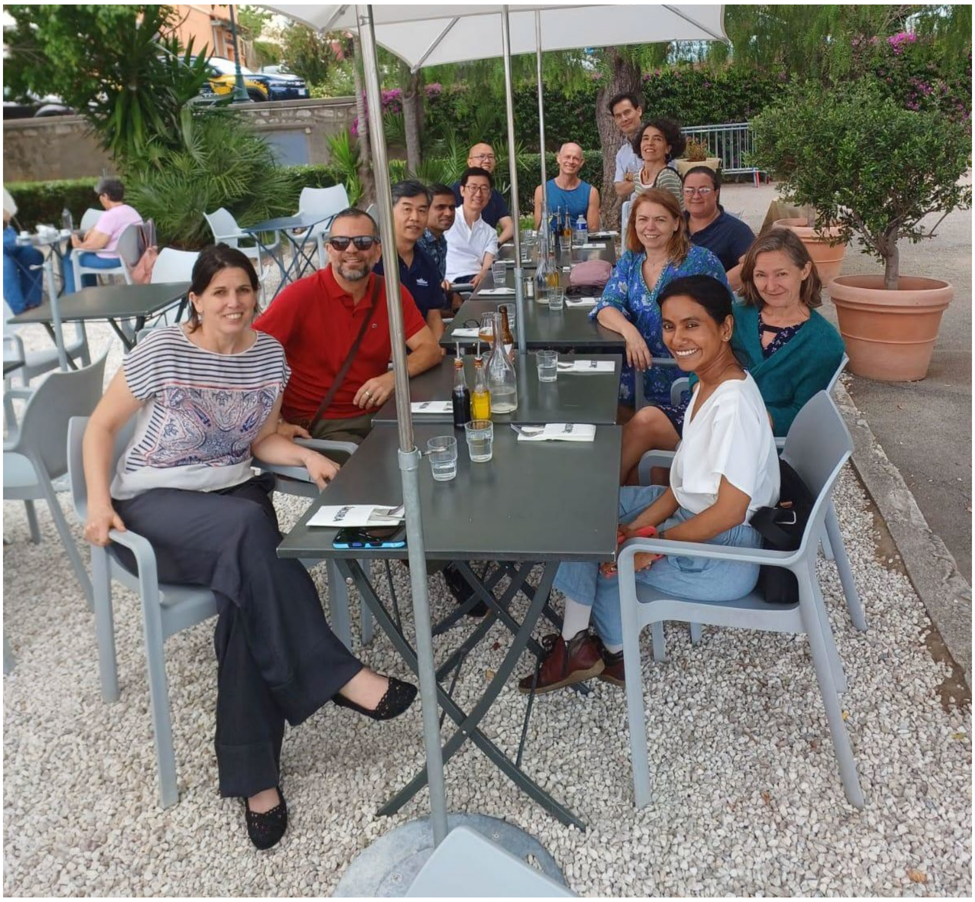

GCOS KEEPING WATCH OVER OUR CLIMATE

WMO unesco Intergovernmental Oceanographic Commission International Science Council UN environment programme

GOOS Global Ocean Observing System

WCRP

DAY 1: MONDAY 2 JUNE 2025

Introduction

The 27th Session of the Ocean Observations Physics and Climate Panel (OOPC) was held in Villefranche-sure-Mer (near Nice), France, kindly hosted at the IMEV Headquarters (Institut de la Mer de Villefranche) with the support of their staff, who is gratefully acknowledged.

The OOPC-27 meeting took place on 2-4 June, in the same week that the One Ocean Science Congress, and just one week before the Third UN Ocean Conference happened in Nice. This allowed to optimize the carbon footprint of the team, as several of the members were attending both meetings.

The three main areas where progress was sought were:

1. Actions in GCOS Implementation Plan where a mid-term assessment was required.
2. On-going and new actions related to the provision of guidance for the development of the global ocean observing system, led by OOPC experts, embedded in/related to WCRP, GOOS and/or GCOS programmes, and or WMO and IOC initiatives.
3. EOV/ECV specification sheets: preparatory work.

Furthermore, the meeting provided an opportunity to discuss the current situation with the global observing system for the ocean under substantial pressure and facing a significant reduction in investments, with consequent risk of observing capability decline and reduced data availability.

It is important to note that the in-situ meeting had an online follow-up meeting held on 11 July where the main actions stemming from the in-situ session were discussed. Those consolidated actions are presented in this report, in the main text and in Annex 2.

All presentations are available at the minisite of this meeting, hosted in the OceanExpert platform.

1.1 Welcome and OOPC meeting planning

1.2 Activity report since last in person meeting (Bonn, 2023)

Sabrina Speich and Weidong Yu, Co-chairs of OOPC, welcomed the participants and recalled progress since the last in-person meeting in 2023. Most of the actions which were proposed or already on-going in 2023 showed remarkable progress including Marine Heatwaves, Ocean Indicators, Pan-tropical Observing system and the Statement of Guidance for the Oceanic Earth System Category (WMO), and only one of the activities was on hold. They thanked OOPC members for their engagement and ex-officio representatives from WCRP and BioEco panel who attended in person, as well as participants online.

Belén Martín Míguez, OOPC scientific officer, presented the agenda and some details on logistics at the IMEV.

1.3 Parent bodies: WCRP

Hindumathi Palanisamy representing the World Climate Research Programme (WCRP), outlined its structure, initiatives, and ongoing challenges. As GCOS, WCRP is a programme co-sponsored by the World Meteorological Organization (WMO), the International Oceanographic Commission (IOC), and the International Science Council (ISC), and it focuses on advancing climate science. Key updates include a revised strategic plan from 2019 to better connect climate science with societal needs, exemplified by the Kigali Declaration from their Open Science Conference. The programme is undergoing leadership changes and is adapting its science and implementation plan to be more dynamic. A significant portion of the discussion focused on CLIVAR (Climate and Ocean Variability, Predictability and Change), one of WCRP's core projects, highlighting new working groups and research foresight activities like tropical basin interactions and marine heatwaves, which seek to enhance understanding and collaboration, particularly concerning observational gaps and the integration of biogeochemical aspects. WCRP faces challenges such as funding uncertainties and the need to rebuild trust in climate science, advocating for stronger collaborations across the scientific community.

1.4 Parent bodies: GCOS and GOOS

Global Climate Observing System

Caterina Tassone, Head of the Global Climate Observing System Programme (GCOS) Secretariat provided an overview of GCOS, a programme established in 1992 to address the systematic observations agenda of the UNFCCC. It is co-sponsored by WMO, IOC, ISC and UNEP, receiving funds from sources like the European Commission, the US State Department, NOAA and Germany. GCOS works through three expert panels: atmosphere, ocean (OOPC), and terrestrial, governed by a steering committee and supported by a secretariat.

GCOS is hosted by the WMO and has strong connections with its Infrastructure Commission, especially regarding observations and networks. GCOS manages four atmospheric networks (atmospheric): GSN (GCOS Surface Network), GUAN (GCOS Upper Air Network, GRUAN (GCOS Reference Upper Air Network) and GCOS Surface Reference Network (GSRN, pilot phase).

Caterina also mentioned that GCOS is partner to the iClimateAction project, funded by the EU Horizon Europe programme. This project aims at increasing coordination and synergies among GCOS, GEO, and WMO to improve alignment in climate data creation, management, and utilisation.

Finally, she announced that a joint panel meeting with GCOS's three panels and WG Climate is planned for 9-13 February in Harwell, at ESA headquarters. The main outcome is to kick off the drafting of the GCOS Status Report, which is expected to be published in February 2027 (ready in fall 2026).

Global Ocean Observing System (GOOS)

The Director of the GOOS, Joanna Post, presented an overview of the programme. Established in 1991, it has the same co-sponsors as GCOS, and sits within the IOC, from which it receives most of its mandates. Increasingly, GOOS is also recognised by WMO, highlighting the ocean's role in the climate system. Joanna highlighted the role of GOOS in coordinating global ocean observing networks, partners, and scientific networks. Its work follows the GOOS 2030 strategy published in 2019. Very importantly, GOOS advocates for ocean observing to be recognised as critical infrastructure for science and society. As part of this advocacy, GOOS coordinates with GCOS for advocacy at UN meetings, including COPs, and WMO Congresses.

Joanna outlined some of the current core activities such as the management of the Essential Ocean Variables (EOVs) and the development of ocean observing best practices; the building of a cohesive digital infrastructure, including an IOC data architecture, to connect various data streams and delivery spaces; the development of carbon and biodiversity plans, with the carbon plan specifically responding to the GCOS Implementation Plan and the Greenhouse Gas Watch. She highlighted efforts to engage with the private sector, and strengthening national and regional implementation through focal points and alliances. She mentioned that GOOS is undergoing a governance review to optimise its structure, mission, and scope, with a proposal for evolution over the next few years.

Similarly to WCRP, GOOS is facing a critical situation with depletion in funding for both the programme and the observing system itself. A high-level meeting will be set up during UNOC to discuss the critical funding depletion situation facing the ocean observing system

Discussion

The critical role and increasing pressure on oceanographic research vessels was discussed, and there was caution against solely relying exclusively on systems like Argo. It was agreed that there is a need for clear, granular messaging on critical ocean infrastructure that goes beyond just Argo or vessels to include diverse components like research vessels.

OOPC experts also asked about the funding situation and the responsibilities of the official co-sponsors. In reality, co-sponsors (WMO, IOC, ISC, UNEP) do not provide sufficient funds for the running of the programmes. In view of the budgetary challenges, GCOS, GOOS and WCRP must work together and understand their relative niches. It was recognized that while the three programmes have many elements in common as well as 30 years of history, their relative dimensions in terms of communities engaged, budget, experts and size of their secretariats are also very different.

1.5 Report from BioEco

Lucille Chapuis, member of the BioEco panel and co-lead of the Ocean Sound EOV, introduced the panel and its structure and members. A key aspect of their work involves the BioEco portal and its metadata repository, particularly its connection with OBIS (Ocean Biodiversity Information System) for coordinating observations and improving data management. Chapuis also discussed the Biodiversity Plan, which seeks to identify monitoring gaps, align biological EOVs with policy frameworks, and define standard methods for marine biodiversity data. Lucille also presented the results of a survey distributed amongst BioEco members emphasizing the multiple and reciprocal connections between the biological and ecological EOVs and the ECVs. Lucille also presented a summary of the status of several GCOS IP Actions from a biological perspective.

- **B3:** New Earth observing satellite missions: There is a strong consensus that new satellite missions could fill gaps for BioEco sub-variables, with 90% of respondents indicating satellites can measure their EOVs. A critical point raised is the importance of avoiding "silos" between various Earth Variable (EV) communities and working with the commercial sector for calibration. There's also a high value placed on main satellite data organisations becoming ODIS (Ocean Data and Information System Catalogue) and WIS (WMO Information System) 2.0 nodes.
- **B6:** Expand and build a fully integrated global ocean observing system: Priorities for observation include coastal zones, estuaries, wetlands, shallow submerged habitats, and areas of exchange with land, due to their large impact on climate processes. Significant sampling gaps exist in the deep sea, open ocean, poles, and below ice, as well as in regions like Africa, South America, South Asia, and Russia. Long-term time series are scarce globally, leading to patchy and inconsistent coverage. OBIS is advocated for as a central repository for metadata from all BioEco EOVs.
- **B7:** Augmenting Ship-Based Hydrography and Fixed-Point Observations: There is widespread agreement that existing platforms could be better equipped with sensors measuring BioEco sub-variables. The need for cost and complexity of technologies to decrease is critical to achieve good coverage. It is also essential for GOOS/GCOS to define data formatting and dataflow standards, similar to what the WMO has done for meteorology. Examples of relevant sensors include fluorometers, flow cytometers, bio-optic sensors, eDNA samplers, and various imaging systems.
- **C1:** Develop monitoring standards, guidance and best practices for each ECV: The BioEco Panel has developed targeted best practices for their EOV specification sheets. It was emphasised that ECV and EOV methodologies should not be managed by separate organisations; again, joint meetings and processes are needed to promote harmonised or standardised methods.

- **F3:** Improve monitoring of coastal and Exclusive Economic Zones (EEZs): This is highly relevant for all BioEco EOVs. A significant challenge is that data from EEZs often require particular permissions and licensing that are rarely linked in metadata, creating legal risks and hindering data use. Many coastal states lack access to equipment and expertise for monitoring, especially with newer technologies like eDNA sequencing. BioEco panel advocates for encouraging small-scale surveys, as coastal monitoring is often more accessible and can add significant value.

Other areas of clear interaction OOPC/BioEco highlighted by the survey include:

- **Marine Heatwaves:** Most BioEco EOVs are relevant for understanding the impact of marine heatwaves. The approach involves identifying taxa or functions sensitive to heat stress to create cross-EOV/ECV data products and indicators.
- **Polar Regions:** Plankton, microbes, and macroalgae are present throughout polar regions and can inform physical variables. For instance, phytoplankton form the base of Arctic food webs, and ice algae influence ice properties. Efforts are underway to connect ODIS to polar data federations.
- **Sea-Air Fluxes:** Microbial, phyto, and zooplankton are relevant to sea-air fluxes, but their occurrence data are rarely shared. It's suggested that the IOC and WMO should request such data, as it is crucial for understanding and modelling carbon and nitrous oxide exchanges, which are mediated by microbial activities.

Final Thoughts and Next Steps: The BioEco Panel advocates for full integration of biology and ecosystem EOVs into climate understanding and modelling. There is an urgent call for closer collaboration between WMO constituents and ocean observation agencies. A joint process involving IOC, WMO, GEO BON, and other custodian agencies is deemed essential for the management of ocean-specific ECVs, EOVs, and EBVs. The current state of data is described as a "mess" due to a lack of capacity for assessment and concrete guidance. Data systems should connect to ODIS and declare their Essential Variable (EV) assets, and a specific focus is needed on EV data flow and compatibility between overlapping ECVs and EOVs. BioEco also believes in advocating for manageable and affordable activities that enable smaller nations to contribute.

Looking ahead, the BioEco Panel aims to reaffirm its role in supporting OOPC ECVs/EOVs within the GOOS/GCOS/IOC/WMO Framework. This will involve developing joint position papers or implementation guidance on the biological relevance in climate observations, minimum requirements for integrated system design, and data flow and metadata governance (e.g., alignment with ODIS/WIS2.0). Such efforts are expected to foster alignment and demonstrate unified priorities to funders, space agencies, and national bodies.

1.6 Report from GRA/NFP/ETOOFS

Jing Li, from the GOOS Secretariat in Paris, provided a summary of the current status, challenges and way forward for three of the core elements of GOOS: GOOS Regional Alliances (GRAs), National Focal Points (NFPs), and the Expert Team on Operational Ocean Forecast Systems (ETOOFS).

The GOOS Regional Alliances (GRAs) were first established in 1996, there are currently 14 recognised GRAs, highly diversified, reflecting different regional contexts and issues they address. Besides, they largely operate with self-organised governance mechanisms and the connection with GOOS can be loose, with unclear contribution paths to GOOS networks and data flow. Potential connections to OOPC include leveraging GRA datasets, engaging in regional/national pilot projects for OOPC initiatives (e.g., ocean indicators, pan-tropical observation system), and reflecting regional/national requirements to OOPC.

The network of GOOS National Focal Points (NFPs) currently has 81 members and several issues exist, including a high turnover rate, unbalanced geographical distribution and activeness and lack of engagement with GOOS "central". As a consequence, GOOS sometimes does not have sufficient understanding of the national priorities and what support is required by NFPs.

The Expert Team on Operational Ocean Forecast Systems (ETOOFS) aims to provide high-level standards, support, and guidance to states and organisations for developing efficient, reliable, and interoperable ocean monitoring and forecasting systems. ETOOFS has developed a comprehensive guide on operational ocean forecasting, which is undergoing review for a joint IOC-WMO publication. Nevertheless, some challenges remain and there is a need to revise their Terms of Reference and membership.

During the online follow-up meeting, OOPC members recognized that previous attempts to connect with the GRAs had not been successful in spite of having them as an ex-officio, and that this is still pending. But they also mentioned that one of the members of the panel is heavily involved in one of those GRAs and could be a facilitator (**Action OOPC 27/1**).

N°	Action	Responsibility/Deadline
OOPC-27/1	Explore ways of connecting with the GRAs using PI-GOOS as an entry point	Belén, Bipen/2026

1.7 Assessment of GCOS Implementation Plan Actions

Belén recalled that as part of the upcoming GCOS Status Report, an assessment of progress against what was suggested in the 2022 Implementation Plan Actions will have to be included. For that, "*rapporteurs*" have been assigned to each of the Actions and during the meeting they presented their analysis of the situation since the publishment of the 2022 GCOS IP, including a scoring (from 1 =Not done, 2= Started with progress, 3 = Underway with significant progress, 4 = Progress on track, 5 = Fully accomplished achieved).

1.8 GCOS IP B2: Development and implementation of the Global Basic Observing Network (GBON)

Hao Zuo is the *rapporteur* for GCOS IP Action B2: "Development and implementation of the Global Basic Observing Network (GBON)" from the ocean perspective. Hao reminded that the Global Basic Observing Network (GBON) is a crucial component of the WIGOS framework, designed to identify the basic requirements for global numerical weather prediction (NWP). Its purpose is to enhance global weather and climate observations to improve forecasts and disaster preparedness. GBON was approved by the WMO in 2019, with implementation beginning in 2023, focusing on surface and upper-air observations via the WMO Information System (WIS). WMO Members are responsible for establishing and managing GBON within their national jurisdiction, including ocean variables in their Exclusive Economic Zones (EEZs). The Systematic Observation Financial Facility (SOFF) is an associated initiative to assist Least Developed Countries and Small Island Developing States in meeting their GBON obligations. Hao was part of a Task Team developing GBON Requirements for Marine Observations with the following characteristics:

- For marine areas, GBON currently focuses on surface marine stations in EEZs, specifically requiring measurements of atmospheric pressure (SLP) and sea surface temperature (SST).
- These observations are to be exchanged in real-time through WIS2 (WMO Information System).
- A horizontal resolution of 500 km or higher is required over marine areas, with an hourly observation frequency.

- Members are encouraged to add additional observation parameters like waves, winds, and air temperature, but these are not currently mandated for GBON compliance.

Hao explained some of the main challenges to work on guidance for GBON compliance in the marine domain, as platforms in the ocean are different to the ones fixed on land, with platform moving, potentially bearing several sensors pertaining to different members etc. The task team concluded, amongst other things:

- Drifting buoys identified as the most cost-effective platform for SLP and SST measurements, with low capital ($4,000 USD) and maintenance costs ($500 USD annually).
- Regarding compliance scenarios, Scenario 1 ("Everything in your EEZ") is proposed, meaning all observations falling within a Member's EEZ, both domestic or foreign contributions, are counted towards compliance. This is seen as simple to implement and parallels land station guidance, but may drive Members towards more expensive fixed platforms.

Hao also explained the advances and next steps for GBON:

- The WMO Manual on WIGOS has been amended to encourage Members to operate GBON stations in areas of global commons, including the High Seas and the Antarctic.
- Compliance guidance has been adopted for land and upper-air stations and is proposed for surface marine stations in EEZs.
- Compliance is monitored using the WMO Data Quality Management System (WDQMS), which provides near-real-time monitoring of data availability and quality from NWP centres.
- A roadmap and proposal are being prepared for future GBON expansion, ensuring affordability and exploring climate monitoring for new funding sources (e.g., SOFF).
- Future steps include defining EEZ and open ocean national responsibilities, developing a model for an Ocean GBON, and potentially including ocean projects in SOFF by 2027.

There is a recognition that High Seas observations are equally or more critical for NWP, and the mandate should expand to include them in the future. From an ocean perspective, the Action is on track (4).

1.9 GCOS IP Action B7. Augmenting ship-based hydrography and fixed-point observations with biological and biogeochemical parameters

The objective of Action 2 (B7) is to augment existing ship-based hydrography and fixed-point observations by incorporating biological and biogeochemical (BGC) parameters. Tammy Morris is the *rapporteur* for this Action.

She mentioned the main challenges to fully implement this action including:

- Lack of sustained funding and coordination for ship-based hydrography. Research vessels are often the primary platforms, leading to limited spatial and temporal resolution, particularly in remote regions like the Southern Ocean and the Arctic.
- Need for more advanced sensors and instruments capable of accurately, reliably, and autonomously measuring biological and BGC variables across diverse platforms, including moorings, floats, gliders, and buoys. BGC measurements are often complex, making sensor development challenging.
- Need for improved data management, quality control, and synthesis activities to ensure that biological and BGC data are available, accessible, interoperable, and usable for various applications. OceanOPS contains primarily metadata, the actual data often requires extensive searching through individual institute websites or servers.

- Lack of standardization and harmonization among biological and BGC sensors across different observing systems.

Having said that, many of the GOOS networks have made progress in this direction, and Tammy reviewed them all:

a) Underway Flow-Through Systems (Surface Ocean): Primarily concerns SOOP (Ship of Opportunity Programme), which often measures surface ocean parameters. There is a broader push for "accessible technologies" for deployment beyond traditional research vessels.

b) GO-SHIP (Global Ocean Ship-based Hydrographic Investigations Program): Focuses on repeating decadal hydrographic lines and high-resolution CTD casts. The BioGO-Ship Study Group proposes eDNA sampling as a level 2 parameter for their lines, with two BioGO-Ship sections planned for 2024. GO-SHIP is also proposing a DIC (Dissolved Inorganic Carbon) working group related to best practices for DIC measurements. Continued organization with BGC-Argo is vital, as BGC-Argo floats require CTD reference casts from ships, and efforts are ongoing to deploy these floats from non-research vessels.

c) OceanSITES Moorings: Concerned with long-term deepwater reference station observations. A 2022 FMARS paper provides recommendations for plankton measurements on OceanSITES Moorings, suggesting that accessible technologies could be deployed at these sites. While deep-water stations are challenging due to maintenance needs, there is a push to maximize the use of existing platforms.

d) Uncrewed Surface Vehicles (USVs) and Gliders: An emerging GOOS network of USVs, known as SUN Fleet (the Surface UNcrewed Fleet, see Section 2.10), has been established. These vehicles are highly versatile, capable of making many kinds of measurements, including biogeochemistry and biology, as they can be equipped with numerous sensors and often generate power via solar energy. The coastal monitoring for fisheries is expected to be a significant driver for the expansion of this network.

Discussion

The current status for B7 is considered underway with significant progress (3), reflecting qualitative progress in increasing the number of BGC and biological variables monitored and optimising available platforms. However, quantifying this progress (e.g., by the number of stations measuring specific variables over time) is difficult due to fragmented data and insufficient funding for data curation. Lucille from the BioEco panel showed interest in the SUN Fleet network, and its potential to incorporate biological sensors (**Action OOPC 27/2**).

N°	Action	Responsibility/Deadline
OOPC-27/2	OOPC to provide information to BioEco on the SUN Fleet network for their assessment	Meghan/Lucille/2026

1.10 Space Agencies GCOS IP Actions (A2+A3+B9+F2)

Tony Lee and Stefan Kern are the two OOPC members in charge of reporting in all Actions related to satellite observations. Their report bases heavily in the document "Space agencies Response to GCOS Implementation Plan". They introduced each of the Actions and provided an individual assessment for each of the activities within the Actions indicating positive and negative aspects considered in the assessment.

Overall progress in addressing satellite observation gaps and ensuring continuity of critical missions is mixed. While many areas show "Progress on track," significant vulnerabilities remain, primarily stemming from the uncertain future of several key NASA missions due to budget constraints and the inherent risks of some first-generation satellite technologies. Sustained international cooperation and proactive planning are essential to mitigate these identified challenges and secure the long-term climate data records required for climate monitoring.

ACTION A2: Address gaps in satellite observations likely to occur in the near future

ACTION A2.1: Altimetry in the polar regions

Assessment 3: Underway with significant progress.

Advancements:

- CryoSat-2 (Ku-Band radar) and ICESat-2 (laser) are expected to continue until the launch of CRISTAL A (2028) and mid-2030s, respectively, ensuring overlap with CRISTAL.
- Current radar altimetry coverage up to 81.5° latitude is considered fail-proof due to multiple operational missions (CryoSat-2, Sentinel-3A/B, HY-2C/D, SARAL/AltiKa).
- Future missions like Sentinel-3C/D, HY-2E, S3NG-Topo, and CRISTAL A/B are expected to sustain sea level and sea state observations in polar regions after 2026, with contributions from European and Chinese-funded missions.

Concerns:

- NASA's ICESat-2: Future data provision is unclear, no successor is planned, and there is no alternative in case of failure. The combination of laser altimeter data (from ICESat-2) with radar altimeters is crucial for progress in sea ice, snow, and ice sheet remote sensing, making the lack of a successor a significant concern.
- CRISTAL A: While a successor, it is the first dual-frequency ESA mission, which introduces inherent risks.
- Observation Gap: A critical observation gap would occur if CryoSat-2 fails before CRISTAL A is fully operational. Space agencies have not provided a proper solution for this.
- Algorithm Development: Overlap between CRISTAL and ICESat-2 is possibly essential for development and testing of retrieval algorithms using CRISTAL data, because ICESat-2 can serve as a very important reference satellite.

ACTION A2.5: Sea surface salinity measurements

Assessment 4: Progress on track.

Advancements:

- Space agency response is adequate, with L-band Soil Moisture & Ocean Salinity (SMOS) and Soil Moisture Active Passive (SMAP) missions extended.
- China launched the HY-4a ocean salinity detection satellite (L-band) in 2024, which could serve as a gap filler if a gap arises between European and US satellites.
- Copernicus Imaging Microwave Radiometer (CIMR), including L-band, is on track for 2029-2042 and is an operational mission committed by ESA.

Concerns/Challenges:

- Potential Data Gap: Current L-band missions (SMOS, SMAP) may not overlap with CIMR (2029 launch). SMOS (launched 2009) is very old and may be decommissioned before 2029.
- NASA Budget Uncertainty: SMAP (launched 2013) continuation is uncertain due to potential NASA budget cuts for operating costs (staff, ground station, data quality control and archiving, distribution), which can amount to millions of dollars per satellite per year. This could lead to a gap if it is shut down.

- Resolution Degradation: While CIMR ensures continuity as an observable ECV, its effective resolution (70 km) is a degradation compared to SMOS and SMAP (33 km), impacting detection of mesoscale variability.
- Explorer Mission Proposals: Two proposals for high-resolution (10-km) salinity mission concepts to ESA's Earth Explorer (EE)-12 were not selected.

ACTION A2.7: Global scale ice surface elevation

Assessment 2: Started with little progress.

Advancements:

- CryoSat-2 is expected to continue until the launch of CRISTAL A (2028) and ICESat-2 until the mid-2030s, providing a defined time horizon.
- Space agencies are aware that the de-orbiting of the ASTER sensor aboard TERRA, which provided high-resolution stereo sensor capabilities for Digital Elevation Models (DEMs), will cause a data gap.

Concerns:

- ASTER Continuation: No continuation of ASTER is in sight, and no efforts are being made to even consider a new stereo system.
- Alternative Solutions: The status of alternative solutions, such as using radar altimetry, is not sufficiently clear or documented in space agency responses.
- NASA Earth System Explorers: Respective NASA missions are still in the conception phase; if selected, the earliest launch would be in 2030/2032, which is considered too late.
- Data Security: All these sensors are from NASA, making future data provision and plans unsecure. There is a general concern that space agencies are aware of the upcoming impact on the NASA Earth science fleet due to budget cuts, but their own budgets limit their ability to fully step in.
- International Plans: Plans from other space agencies (Chinese, ESA, JAXA, ISRO) are not sufficiently clear in the received responses, indicating a lack of detailed information or commitment.

ACTION A3: Prepare follow-on plans for critical satellite missions

ACTION A3.5: Sea ice and icebergs (or floating ice)

Assessment 4: Progress on track.

Advancements:

- The space agencies' response is comprehensive and adequate, convincingly listing recent developments and future plans for sensing capabilities across spatial scales and ECV quantities.
- There is a reasonable balance in contributions from different space agencies.

Concerns:

- Chinese Fengyun-MWRI: This mission, with its potentially fundamental role in continuing DMSP microwave imagers (SSM/IS) that are fading out, was not explicitly mentioned in the WGClimate response. This is crucial, especially if the last NASA-DMSP SSMIS and the upcoming JAXA AMSR3 fail, as Fengyun-MWRI could provide a proper gap fill.
- CIMR Risks: While CIMR (launching 2029) combines capabilities of ESA-SMOS and JAXA-AMSR2, it is considered a high-risk mission due to its foldable antenna. If CIMR fails and other critical missions like AMSR3 also fail, reliance would shift solely to the Chinese program. The concern is the lack of clarity on alternatives if CIMR does not work.
- NASA Component Insecurity: The future of NASA components remains unsecure, a recurring concern also noted for other actions (A2.1, F2.3).

ACTION B9: Improve estimates of latent and sensible heat fluxes and wind stress

Space Agency Response Assessment: The space agency response is broad, encompassing activities beyond just latent and sensible heat fluxes and wind stress (e.g., radiative heat flux).

Latent & sensible heat fluxes: Assessment 2: Started with little progress.

- Challenges: The "Butterfly" mission concept, aimed at measuring these fluxes from space, is being refined (Butterfly-2) for synergy with ESA's CIMR. However, a potential Announcement of Opportunity by NASA, necessary to re-propose the concept, has been pushed from 2025 to 2026, and its release remains uncertain. This delay contributes to large uncertainty, especially given upcoming changes in NASA Earth science budget.

Wind stress: Assessment 4: Progress on track.

- Progress: A suite of satellites with active and passive sensors is planned/proposed to meet WMO/GCOS requirements.
- Challenges: A significant gap exists in the 24-hour time block for future measurements, with only one satellite mission proposal (ODYSEA) currently planning to cover this gap. ODYSEA, crucial for monitoring diurnal winds and storm tracking and meeting WMO requirements, is currently in the proposal stage (Step-2 proposal due June 2025), with a decision expected late 2025. There is uncertainty whether NASA will select two missions out of four, or even if they have the budget for two. International collaboration, particularly with CNES, is a key aspect of this proposal.

ACTION F2: Improved ECV satellite observations in polar regions

ACTION F2.1: Sea surface salinity of polar oceans

Assessment 4: Progress on track.

Advancements:

- Space agency response is adequate. CIMR's multi-frequency passive microwave radiometer (L, C, X, K, Ka bands) is designed to improve polar-ocean SSS retrievals by better removing surface thermal and roughness effects compared to single L-band measurements.
- ESA Earth Explorer-12 selected CryoRad, a broad-band passive radiometer, which, while not primarily for ocean salinity, offers improved sensitivity to polar-ocean salinity.
- ESA-NASA discussions are ongoing for potential collaboration to include broad-band frequencies near L-band to enhance sensitivity to polar-ocean SSS.

ACTION F2.3: Sea ice thickness

Assessment 3: Underway with significant progress.

Advancements:

- This assessment largely mirrors A2.1 on polar altimetry, as sea ice thickness relies heavily on these missions. CryoSat-2 and ICESat-2 are expected to continue until CRISTAL A and mid-2030s, respectively. Current radar altimetry coverage up to 81.5° latitude is fail-proof, ensuring Southern Ocean coverage beyond 2025 with successor satellites.

Concerns:

- Similar concerns to A2.1: unclear future for NASA's ICESat-2 data, no planned successor, and no alternative in case of failure. Critical observation gap in high-latitude Arctic if CryoSat-2 fails. Successor CRISTAL A is a first dual-frequency ESA mission, making it risky. The role/potential benefit of the SWOT mission was not discussed.

ACTION F2.4: Surface temperature for all surfaces (SST & IST)

Assessment 4: Progress on track.

Advancements:

- Space agency response is adequate. CIMR will provide all-weather Sea Surface Temperature (SST) with unprecedented 15-km resolution and coverage, including polar oceans. JAXA's AMSR3 will provide 25-km SST, both significantly improving upon current 55-km resolution microwave SSTs.

- The Group for High Resolution SST (GHRSST) synthesises all-weather passive microwave SST (lower resolution) with high-resolution infrared SST (not all-weather) to produce blended level-4 SST products.
- The suite of existing and future sensors for observing surface temperature of sea ice and land ice is well developed and fail-proof, with sufficient overlap of operational and explorer missions, securing future extension. A "true pole-to-pole" mission is not required and technically not feasible.

Concerns:

- A significant fraction of key sensors are on NASA satellites, necessitating careful monitoring of future plans and data availability to avoid observation/data access gaps.

ACTION F2.6: Albedo for all surfaces - sea ice

Assessment 4: Progress on track.

Advancements:

- Space agency response is very adequate. CEOS and CGMS agencies produce multiple satellite-derived albedo products, including high latitudes.
- True "pole-to-pole" orbits are not required, as convincingly laid out in the response.
- The suite of existing and future sensors for visible and near-infrared spectrum for albedo retrieval is well developed, global, and fail-proof, with sufficient overlap of operational and explorer missions, ensuring future extension and a good balance between agencies.

Concerns:

- Similar to surface temperature, a notable proportion of key sensors are on NASA satellites, requiring careful monitoring of future plans and data availability to prevent observation and/or data access gaps.

1.11 B8. Coordinate observations and data product development for ocean CO_2 and N_2O + Ex-officio BGC

The GCOS action B8 focuses on the global Ocean Observing System for carbon and biogeochemistry, experiencing significant challenges in securing sustained funding. Maciej Telszewski is in charge of the International Ocean Carbon Coordination Project, which is de facto the home for the Biogeochemistry panel of GOOS, hence, responsible for advancing ocean observing in that domain. Maciej explained that while satisfactory progress has been made in forming operational elements for the Surface Ocean Carbon Observing System, which includes the SOCONET observing network and SOCAT data management, long-term funding remains a critical issue. SOCONET is now part of the OCG and is negotiating the Service Level Agreement with OceanOPS. Maciej also referred to a previous report of progress presented by Katrin Schroeder, from OOPC.

The system faces immense stress due to a lack of sustained operational funding for both hardware implementation and coordination, and difficulties in attracting skilled professionals. The availability of surface ocean carbon data has been declining in the last few years. SOCAT, which has been operating since 2011 on research funding, is at risk of collapse without more sustainable support. Current coordination funding, largely from the European Union's Tricuso project, is only secured for four years, which is inadequate for the required scale of operations. Maciej also touched upon activities related to the monitoring of other GHG gases (N2O and CH4), led by the new steward for this line of work, Gregor Rehder.

Discussion

The group reflected on the decoupling between a community that is deemed largely ready in terms of technical and operational capacity for measuring carbon and GHG gases in the ocean, and the lack of sustained funding to support that capacity at a global scale. The goal is to transition from reliance on short-term research grants to intergovernmental, operational funding, allowing for the consistent delivery of high-quality data and services, including coordination with atmospheric observations. This makes it difficult to do a proper overall assessment on progress for the GCOS IP Action. There were also some discussions at the WMO group of experts GGMT (Greenhouse Gases and related Tracer Measurements) meeting, where both GAW and IOCCP came together (as experts, not the Secretariat). It was also discussed the potential of OceanOPS to provide useful statistics, flagging and help with the running of the network as with other physical EOVs. However, for analysis until 2025, we would still have to ask the IOCCP. There was also a clarification regarding SOCONET, as the intention is to expand SOCONET definitely for N2O and maybe CH4.

1.12 B6: Expand and build a fully integrated global ocean observing system

This item refers to one of the Actions in GCOS IP, that recommends an integrated approach to fill in critical gaps that limit the monitoring of ocean state. The solution does not rely on one single technology or platform, but on the concurrent expansion of networks. While this expansion has been happening more or less steadily with progress in spite of the impact of COVID19, the situation has radically changed in 2025. This topic was merged with the following one.

1.13 Brainstorming: the US and the ocean observing system

David Legler, co-chair of GOOS and Director of the Global Ocean Monitoring and Observing Program of NOAA, participated in the meeting and informed OOPC members of some of the changes already happening and foreseen in the activities supported by his program, including product updates. During the follow up on-line meeting OOPC discussed options to mitigate and adapt to those changes, including the importance of advocacy and demonstrating the value of the different data streams. As a result, several ideas were discussed including, running experiments to analyse the impact of removing moorings/platforms on the estimation of heat content (**Action OOPC 27/3**). OOPC should advocate the importance of ocean observations whenever there is a possibility and stand ready to provide prioritization guidance if this is formally requested by GOOS or GCOS.

N°	Action	Responsibility/Deadline
OOPC-27/3	Analyse the impact of loss of observing platforms in the uncertainty associated to the estimation of Ocean Heat Content and other sensitivity studies	Lijing/Hao/Karina/October 2025

DAY 2: TUESDAY 3 JUNE 2025

2.1 Working on the EOV/ECV Specification sheet template

Ana Lara-López is the project officer providing support to the BioEco panel, and she gave a presentation on the updated specification sheet template, which should be used by GOOS panels to present information related to EOVs and their observational requirements and guided the participants through its main sections and how to fill them in:

- Background & Justification: The specification sheet can be used to justify the scientific importance of the variables. It means to be high level and for a broad audience

- EOV Information: Basic details on the definition for the EOV, sub-variables, supporting variables and products that can be derived from the EOV.
- Phenomena to Observe: This part presents examples of priority phenomena that the EOV's sub-variables can help characterise. It details the ideal observations needed to capture the phenomena of interest and illustrates sampling approaches to measure them.
- EOV Observing Specifications or Requirements: This section outlines the observational requirements for an optimal observing system for the EOV. It provides values for spatial horizontal, spatial vertical, and temporal resolution, timeliness, uncertainty. It's noted that no single system is expected to meet all these requirements, but combined efforts should aim to achieve these goals, and observations at different scales are still valuable if shared openly.
- Observing Approach, Platforms and Technologies: This section provides examples of approaches and technologies used to collect data for the EOV to help observe priority phenomena, including details on recommended methods and best practices.
- Data Management & Information: It provides information on how to contribute data to the Global Ocean Observing System (GOOS), emphasising that access to data and information is at the core of an ocean observing system. This section is particularly important in the case of BioEco, since observational communities for those variables are still not fully mobilised. The section specifies where to deposit data (e.g., OBIS for BioEco data), where to add metadata (e.g., BioEco Portal), and provides instructions for submission and data ingest, covering standards, conventions, data Quality Control (QC), and data exchange conventions. It also includes information on data products and data schemas for individual EOVs.
- Appendices: The sheets also typically include additional sections such as Applications (A1), which detail how the EOV contributes to other essential variable frameworks (like Essential Climate Variables (ECV) and Essential Biodiversity Variables (EBV)), multilateral environmental agreements, and global indicators (e.g., Sustainable Development Goals (SDG), Convention on Biological Diversity (CBD)). Another appendix is the Readiness level assessment (A2).

Additionally, the specification sheets include sections for "EOV information" (covering EOV definition, sub-variables, supporting variables, and derived products), "References", "Contributors", and "Acronyms and Abbreviations". A "Glossary of terms" is also provided to define key

Discussion

OOPC experts inquired about the connection between the GOOS Indicators and the EOVs, and the representation of typical scales for different phenomena. This connection can be included in the Appendix where relevant additional information can be added.

There were questions about the level of detail needed for the supporting variables, which in some cases can imply including a lot of extra information. It is up to the experts to decide how much details they want to include, but it is important to be conscious of the audience for these specification sheets and whether extra details are really useful or not. In any case, it was stressed several times the need to provide some traceability and justification to the information that is included in the sheets.

BioEco colleagues shared some insight on how they had proceeded with the development of the first version of the specification sheets for their EOVs. These included assigning two stewards per EOV and organizing calls to sort out questions as the work advanced. They stressed the need to go down from the complexity that scientists seek for, to something that is really useful and understandable, bringing it down to the basics.

A practical example: EOV/ECV specification sheet for surface currents

Belén proposed to make a first attempt to fill in the specification sheet for currents collectively, following the work initiated by the former member of OOPC Rick Lumpkin and Tammy Morris for surface currents. Only two sections of the specification sheet were covered and below there is a summary of the discussion that followed.

- Background & Justification: As mentioned, the specification sheet can be used to justify the scientific importance of the variables, but we should also write it in such a way that it is understandable for non-scientists, managers etc. The audience is high level (not overly technical, understandable by managers/non scientists) and has to be properly referenced and traceable. To make sure we are referencing the right policy mechanisms connected to the EOVs we could engage with the appropriate Secretariats working for other programmes to validate our references, and this could also be a tool to facilitate co-creation.
- EOV Information: There was a discussion on how to properly define what we mean by surface current and a longer discussion on what supporting variables are vs sub-variables. This took some time, as the current definitions did not match the ones used in the first versions (2016, 1017) of the EOV specification sheets. The discussion continued on Day 3 (see end of Section 3.1)
- It was stressed that we need to be careful and leverage previous discussions information available (e.g., in documents such as IPCC reports, standard vocabularies etc.) instead of re-inventing things.
- It was agreed that the most efficient approach would be to start with a few "pilots" which would serve as an example for the group (**Action OOPC 27/4**). Some members of OOPC volunteered for this.

N°	Action	Responsibility/Deadline
OOPC-27/4	Develop completely filled-in pilot specification sheets that can be used as an example for the rest of the panel	Tony (currents) and Ronald (air-sea fluxes) following an example from Stefan

2.2 Marine Heatwaves

Mélanie Juza is leading this OOPC Activity and gave a presentation where she introduced the marine heatwaves phenomenon in connection with the rise of global air surface temperature. She defined marine heatwaves and reviewed some of their most characteristic features. OOPC Activity around Marine Heatwaves focuses on the definition of observing requirements for monitoring extreme events and implementing adaptation strategies. This is strongly connected with the Observing Co-design Ocean Decade Programme, where marine heatwaves is one of the exemplars. Mélanie explained the revival of the Marine Heatwaves exemplar, with a new leadership (including Mélanie) and governance structure, and the decision to work with pilot regions. Strong efforts are being made to leverage on-going projects/initiatives which can be running in the pilot regions, including connection with the modeling community. The selection of the pilot regions is on-going bearing in mind the need to account for diversity in observational capacity.

Mélanie invited comments from OOPC experts on: (1) availability of support from organizations such as WMO, in particular to connect with early warning programs; (2) connections with the community and services; (3) selection of the pilot regions; (4) potential integration of marine heatwaves as an ocean indicator.

Discussion

OOPC experts raised the issue of marine heatwaves also occurring in the Polar regions and asked her to expand on the selection of the pilots. Mélanie explained that the intention of the pilot regions is to generate a model that can then be transferable to other areas of the world. Right now, the Steering Committee for the MHW exemplar does not count on experts from polar regions. The connection between this exercise and the provision of early warning services was highlighted as a criterion of success. It was also mentioned that the MHW are generally located in the subtropical regions and there are investigations between the occurrence of MHW and the seasonal forecasts in the continent. The MHW observing systems will have to be adapted to be able to provide information about this.

2.3 ECV Rationalization

This item was not discussed in length in the interest of time. Belén simply reminded OOPC experts about the process by which the list of ECVs has been updated with the participation of representatives from OOPC. A Public Review has been launched and she invited OOPC experts to sign in and provide feedback (**Action OOPC 27/5**).

N°	Action	Responsibility/Deadline
OOPC-27/5	OOPC experts to participate in the GCOS ECV Rationalization Public Review	All/Public Review closes on 8 September

2.4 Ocean Indicators

Karina von Schuckmann, the leader of the Activity on Ocean Indicators, presented the current status of this collaborative effort involving OOPC and GOOS. This initiative aims to address the current lack of a clear, unified definition and criteria for ocean indicators, fostering multidisciplinary approaches across biodiversity, ecosystem, and biogeochemistry panels. The work has resulted in an agreed-upon definition of an ocean indicator and a set of six core criteria, with a methodology developed for their evaluation. Karina introduced the current nine pilot indicators that have been proposed and assessed using this new framework (3 indicators per GOOS panel). All this work has been reflected in a paper co-authored by 30 experts and submitted to Marine Policy. The presentation finished with suggestions for further developments in the short, mid and long term to make sure that the indicators can be fully taken advantage of. In the short term, GOOS should ensure that these indicators are properly made visible on the GOOS site. In the mid term, Ocean Indicators bear a lot of potential for being the bases of regular reporting similar to what happens with the WMO State of the Climate Report (which uses Climate Indicators). In the long term, as a multi-disciplinary endeavor, indicators could contribute to developing ocean narratives to better inform policy and reporting. An example of such a narrative is illustrating a "triple planetary crisis" for the ocean, combining indicators like plastic pollution, endangered biodiversity (corals, tuna), and physical changes (sea level rise, acidification) to support policies and reporting.

Discussion

A discussion followed on how Indicators synthesize/facilitate the communication vs the EOVs/ECVs themselves, that are restricted to observational data. It was stressed that there is confusion around groups of experts using similar but not totally consistent methodologies to develop Climate Indicators and Ocean Indicators and that all efforts should be made to ensure proper communication and consistency. It was mentioned that Earth Energy Imbalance (EEI) and Terrestrial Water Storage (TWS) have been adopted as new Climate Indicators for WMO and some discussion followed whether someone from GCOS community had been involved in suggesting that or not, and how TWS was related to the ECV TWS. Again, it is clear that there is a need to homogenize and get a common understanding between experts involved in developing those frameworks (Essential Variables and Indicators). This would also simplify the task for experts.

2.5 Heat and Freshwater Fluxes and Storage/ Action B10 Identify gaps in the climate observing system to monitor the global energy, water and carbon cycles

Lijing Cheng and Karina von Schuckmann are co-leading this Activity related to the GCOS IP Action B10, to identify gaps in the global climate observing system for monitoring the Earth's energy, water, and carbon cycles. The ultimate goal is to enhance climate projections and reduce model biases by continuously reviewing and improving observations, especially regarding consistency and uncertainty. Heat and Freshwater *fluxes* at the interphase air-sea/ice-sea/land-sea, ocean heat and freshwater *content*, and ocean heat/freshwater *transport/redistribution*, are all key elements contributing to the ocean energy and water budget and need to be considered**.** Carbon cycle is beyond the scope of OOPC and is not part of this activity.

Lijing reported that a significant achievement in this regard is the multidisciplinary international Earth heat inventory initiative, with initial articles published in 2023[1]. This effort brought together the global community, provided robust observing system recommendations, and introduced a new global indicator for climate change monitoring (Earth Energy Imbalance). A crucial finding was the detection of a doubling of the Earth energy imbalance over the past two decades compared to the long-term trend, generating new momentum in climate research and fostering dialogue between observations and climate models. An update is planned for 2025/2026, including connections to climate models.

Current work heavily focuses on uncertainty assessment and quantification of Ocean Heat Content (OHC) and Temperature (T), noting differences in error ranges up to tenfold, and employing a "super-ensemble approach". Various methods for assessing ocean heat/freshwater transport and flux are being evaluated, though observations show that ocean heat/freshwater changes do not always equal the sum of transport convergence and surface flux. A "constraint approach" and an "Ocean reanalysis inter-comparison project" are also underway where both Lijing and Karina are involved. Another area of work is the examination of compound long-term changes**,** specifically Climatic Impact-Drivers (CIDs) and their Time of Emergence (ToE) from climate noise. "Hotspot" regions like the Subtropical North Atlantic and Mediterranean Sea are identified, indicating a potential transition to different ocean states characterized by combinations such as warming, salinization, and deoxygenation.

Future plans include continuous assessment of the Earth energy imbalance, improved knowledge of OHC/T/S changes, and identifying observation gaps through comprehensive uncertainty assessments. The initiative also aims to link ocean changes to support risk assessments, foster collaboration with other projects, and coordinate with WMO and IPCC reports. Discussions are also underway for a potential WCRP CLIVAR Research Foci. A session in the 2026 Ocean Sciences Meeting will be convened ("Changing Ocean Physical Conditions in a Warming Ocean").

In relation to the degree of achievement of the Action B10 as described in 2022 GCOS Implementation Plan, experts considered this was 4 = Progress on track.

[1] von Schuckmann, K et al. Heat stored in the Earth system 1960–2020: where does the energy go?, Earth Syst. Sci. Data, 15, 1675–1709, https://doi.org/10.5194/essd-15-1675-2023, 2023.

Discussion

Following the presentation, OOPC members reflected on how this kind of analysis could translate into concrete suggestions for, for instance, increasing the sampling in the deep ocean. The question does not have a simple answer, as this will depend on the accuracy which can be achieved, the type of instrument used etc. Metrics for model evaluation were also discussed as an area of interest, in view of the uncertainty intrinsic to observations used for that. For example, the uncertainty in ocean heat content in the tropical region is quite low, because the sampling is relatively good. However, the air-sea fluxes show enormous variability, which contrast with this relatively low error in the case of heat content. There was also a consideration of the potential of the heat content estimations to constraint the estimations of air-sea fluxes.

2.6 Boundary systems

Under this item Tammy Morris recalled that the Boundary Systems Task Team (BSTT), established in 2018, was tasked with guiding GOOS observing networks on deploying assets in coastal and boundary current regions, complementing GOOS objectives. The Task Team, looked to knowledge obtained from historically well-observed boundary current systems and mature integrated observing systems, and from climate analysis and modeling communities working in those areas. This was done through a series of webinars focused on 6 different boundary systems. The Task Team produced a final paper summarizing their findings which was published in "Oceanography"[2].

In the same space, the GOOS Co-Design Boundary Current Exemplar, is investigating how ocean observing networks observe and adapt to better capture boundary current dynamics. After some preparatory work (two online workshops and one in person) the Agulhas Current region was identified as a pilot area. A workshop for the Agulhas Current was held in South Africa to understand priority gap areas and develop a "Backbone Observing System" – the minimal sustained observations necessary to capture key processes and constrain regional numerical simulations. Expected outcomes include an overview of observation and modeling gaps, a list of essential variables (EOVs/ECVs) required, and a draft system design.

Discussion

Given the obvious connections between the previous work done by the BSTT and the current exemplar part of the Observing Co-Design programme, there is a need to decide whether the BSTT should continue and what its role should be. In her presentation Tammy proposed to define new Terms of Reference for the TT considering what was initially proposed and what was achieved as reflected in the 2024 paper. A possibility would be to have a TT oriented to advise the exemplar that could be activated on an ad hoc basis. OOPC members believe that continued guidance, gap analysis, and best practices for boundary current systems are still needed from OOPC's perspective, and boundary currents are essential for indicators and EOVs. Tammy will consult with the former members of the Task Team whether they would be willing to remain in such a TT, with an advisory role (**Action OOPC 27/6**).

N°	Action	Responsibility/Deadline
OOPC-27/6	Propose Terms of Reference for an advisory group and inquire the former members of the Task Team whether they would be willing to be part of it	Tammy Morris supported by OOPC officer/by October 2025

[2] Ayoub, N.K., et al. Oceanography 37(4):82–91, https://doi.org/10.5670/oceanog.2024.504.

2.7 Polar regions

Stefan Kern introduced this item, summarizing work related to ocean observations in the polar regions.

Stefan first introduced a number of relevant projects where he is directly involved, and which are funded by European Space Agency (ESA) and focus on sea ice observations and involve the evaluation and quality assessment of Earth Observation (EO) products:

- CCI+ Phase 2/2 extension, which is ongoing until the end of 2026 and deals with ECV quantities such as sea-ice concentration, sea-ice thickness, and Arctic sea ice melt/freeze indicators.
- The SAGE project (running until March 2028) focuses on the new ECV quantity: sea-ice age, also contributing to further development of retrieval of the ECV quantity sea-ice drift, involving European and Canadian partners.
- SO-SIMBA (Southern Ocean sea-ice mass balance), active until November 2026, aims to create comprehensive datasets for sea-ice thickness, snow depth, and sea-ice volume/mass in the Southern Ocean based on observations.

Stefan then highlighted the Arctic Monitoring and Assessment Programme (AMAP). AMAP issues reports on the status of the Arctic for policymakers, stakeholders, scientists, and the public. Major AMAP reports have been released since the 1990s, with the latest in 2024 and a new one planned for late 2026. Stefan is leading Chapter 5, "Changing Marine Climate," a novel focus area for AMAP, covering aspects like changing sea ice and upper ocean conditions, ocean acidification, marine heatwaves, biogeochemical/ecosystem changes, and the Atlantic Meridional Overturning Circulation (AMOC). AMAP reports are considered more comprehensive and in-depth than the shorter, annual US-based Arctic Report Card.

Finally, Stefan provided an overview of key Arctic observation organizations and initiatives as stemming from his discussion with former member of OOPC, Benjamin Rabe. These include:

- GOOS, EuroGOOS, and ArcticROOS, integrating European oceanographic and sea-ice activities in the Arctic, largely through project-based work like Arctic Passion.
- SAON (Sustainable Arctic Observation Network), which is much broader than the previous ones, encompassing observations from land and rivers, outreach to indigenous communities, and hosting the Arctic Observation Summit (AOS).
- ArORA (Arctic Ocean Regional Alliance), a newly established, high-level organisation linked to G7 FSOI activities, designed purely to plan and coordinate Arctic observation networks without involvement in data management or research. Its project office will be under SAON and they have the ambition to become a GOOS Regional Alliance. Ben Rabe is part of the task team working to develop ArORA.
- Finally the IASC (International Arctic Science Committee), is a broad overarching organisation bridging marine sciences, socio-economic interests, and indigenous people, providing funding for networking activities.

Regarding Arctic observation systems, Argo floats continue to be deployed, with Canada having successfully tested tracking them underneath sea ice over several hundreds of kilometers, offering significant promise for under-ice observation. Additionally, ice-tethered buoys with CTDs are still in use, and Distributed Biogeochemical Observations (DBO) networks are developing.

Discussion

The group discussed similarities, overlaps and differences between the initiatives presented and reflected on the complexity of the landscape and difficulties to discern which ones are the most relevant ones for the oceanographic community in terms of scientific/political content.

During the follow-up online meeting, the SOOS was discussed again. Ronald suggested some contacts and it was agreed that OOPC would make an effort to establish connections (**Action OOPC 27/7**).

N°	Action	Responsibility/Deadline
OOPC-27/7	Establish contact with representatives from SOOS to explore better ways of being informed/improve the connection	Belén supported by Ronald/by November 2025

2.8 Pan-tropical ocean observing system

The OOPC Co-chair, Weidong Yu, informed on the progress achieved for the building of a Pan-tropical Ocean Observing System. This idea originated from discussions at the Joint Panel Meeting in Bonn in 2023 where a CLIVAR representative was present (Mike McPhaden) followed by a session in the Barcelona Ocean Decade conference session and leveraged existing efforts within a CLIVAR Foresight activity. A recent paper by Foltz et al.,[3] reviews the initiative, which aims to address common issues identified during decadal reviews of tropical basin observing systems in the Indian, Pacific, and Atlantic oceans. A key driver is the need for better coordination and synergy across these basins to understand their linkages and interactions, thereby demonstrating the value of tropical ocean observations.

The initiative is driven by several critical observational gaps and scientific needs:

- Sea-Air Flux Biases (TPOS): There is significant divergence in surface sea-air flux datasets, particularly over the tropics, despite a good constraint of upper ocean heat content.
- Maritime Continent Gaps (IndOOS): A long-standing recommendation, pending for 15 years, is to add flux buoys in the eastern Indian Ocean between Australia and Indonesia. This "Maritime Continent" is a critical point connecting the two basins, important for both oceanographic and atmospheric processes, including the Madden-Julian Oscillation (MJO) and remains very poorly observed.
- Inter-basin Interaction: The three tropical basins are closely connected at interannual and longer timescales, with the fast-moving MJO affecting global weather and climate. A unified system is vital for understanding these interactions and improving sub-seasonal to seasonal (S2S) prediction.
- TPOS Concerns: The Tropical Pacific Observing System (TPOS) has expressed concern over data gaps in the Western Pacific, impacting ENSO and weather prediction, as well as climate records. But this might be at least partially mitigated by Argo floats and potentially USV.

Discussion

It was mentioned that there are several initiatives trying to evaluate the impact of decreasing observations both in the Indian and Pacific tropical regions, connected to COVID19 period. Resources are needed to support this kind of assessment, and connect with OceanPredict to see if there is any interest in this. The emerging OCG network SUN Fleet, or the marine mammals network AniBOS can help fill in some of the gaps left by decreasing moorings, and between eastern and western basins in the Pacific.

[3] Foltz GR et al., (2025). Toward an integrated pantropical ocean observing system. Front. Mar. Sci. 12:1539183. doi: 10.3389/fmars.2025.1539183

In 2023 there was already the idea for OOPC/CLIVAR to join forces. While there was no Working Group formed, several activities happened as mentioned by Weidong. This idea should be followed up. Hence, the next steps include forming a Joint Working Group OOPC/CLIVAR to coordinate efforts and encourage emerging networks, as the previous CLIVAR foresight group will be dismantled at the end of 2025 (**Action OOPC 27/8**).

N°	Action	Responsibility/Deadline
OOPC-27/8	Discuss the possibility of establishing a Joint Working Group between OOPC and CLIVAR, to continue the work of the CLIVAR foresight group	Weidong Yu, Hindumathi Palanisamy next PanCLIVAR meeting (22/09/2025)

2.9 WMO Statement of Guidance for Oceanic Applications/RRR

Hao Zuo presented this item in his capacity as a point of contact for the application "Ocean forecasting and real-time monitoring", within the WMO Oceanic ESAC (Earth System Application Category). OOPC has played a very relevant role in the development of this activity, for the benefit of WMO and GOOS.

Hao explained that the WMO Rolling Review of Requirements (RRR) is a systematic process that compiles user requirements for observations within the WMO Integrated Global Observing System (WIGOS) framework. Oceanic Applications represent a new ESAC within the RRR. Emma Heslop, from GOOS Secretariat, coordinates the work developed for this Oceanic ESAC.

The Oceanic Applications are categorized into several specific Application Areas (AAs) including:

Ocean Forecasting and Real-Time Monitoring (AA 3.1)/ Coastal Forecasting (AA 3.2)/ Oceanic Climate Monitoring and Services (AA 3.3)/ Tsunami Monitoring and Detection (AA 3.4)/ Marine Environmental Emergency Response (AA 3.5)/ Maritime Safety (AA 3.6)/ Ocean Biogeochemical Cycles (AA 3.7, not implemented yet)

Most AAs have completed their requirements gathering and variable submissions. AA 3.1, for instance, focuses on observations essential for monitoring ocean state and supporting forecasting systems, identifying 18 variables, including Ocean temperature, Sea-ice concentration, and Chlorophyll concentration. They justified the impact of observing these variables for AA 3.1, defined requirements and identified gaps in the observing system, as well as potential solutions to fill in those.

Information from the first 6 AA has been summarized in a Statement of Guidance (SoG) document. The SoG has identified 8 high-priority variables from the 35 relevant to the 6 AA and includes a gap analysis, including recommendations, which need to work across all the application areas, which is challenging. Hao gave the example of subsurface temperature, what main gaps had been identified and what solutions were proposed in the SoG to address them. The SoG concludes by stressing that the Global Ocean Observing System is critical infrastructure, requiring operational funding, widespread national contributions, and coordinated data sharing. The SoG has been shared with and reviewed by a large number of stakeholders from the ocean observing and scientific community. Hao finished by presenting the next steps which will hopefully lead to a consolidated final version of the SoG to be endorsed by WMO and widely communicated.

Discussion

There were comments from OOPC members regarding some of the details of the document for instance, in terms of the recommendations suggested to address gaps and whether to suggest specific technologies. The importance of sampling within EEZs and encouraging sharing data by nations was also highlighted. Coastal and EEZs need to be also quite properly accounted for, as the analysis seems to be rather open-ocean driven. OOPC members reacted strongly to one of the tables presented by Hao that will need to be properly explained, so this will be brought back to the team working in the SoG (**Action OOPC 27/9**). Belén gave some background on the final objective of this SoG exercise, which is very much for the WMO to raise the profile of ocean observations and stress their importance as a critical infrastructure, and the need for a more operational and sustainable system for the ocean.

N°	Action	Responsibility/Deadline
OOPC-27/9	Consider suggestions from OOPC in the draft statement of Guidance	Belén/Hao/July 2025

2.10 GCOS IP B9 – Air-Sea Fluxes - OASIS

Meghan started by highlighting a significant finding regarding wind data interoperability presented in Ricciardulli et al. (BAMS 2025). They identified a mismatch between satellite and Tropical Atmosphere Ocean (TAO) buoy winds: since 2020, TAO buoy winds have been reporting approximately 10% higher than collocated satellite measurements from various radiometers and scatterometers. The NOAA/NWS National Data Buoy Center (NDBC) attributed this discrepancy to an upgrade of its wind tunnel in 2020 and its calibration procedures. NDBC is currently conducting a comprehensive review of all TAO wind data from before and after this upgrade to characterize any potential calibration bias and will publish recommendations for post-processing methodology. This example underscores that interoperability experiments are vital and should be routinely carried out for all observing networks.

Then Meghan presented the key activities related to the Air-Sea Fluxes - OASIS/GCOS IP Action B9. Key initiatives include:

- Developing Recommended Practices: Work is underway for direct air-sea fluxes, air temperature, and skin temperature, involving experts like Lucia Gutierrez Loza and Laura Riihimaki.
- Making Flux Data Products FAIR: Resources such as the MarineFlux Explorer and OceanSITES ERDDAP dashboard portals have been created to provide access to ship-based and mooring time series fluxes and other Essential Ocean Variables (EOVs).
- Expanding the Observation Network: The Surface UNcrewed Fleet (SUN Fleet) was endorsed as an emerging network of the Global Ocean Observing System (GOOS) in April 2025.

Overall, the assessment of progress for this IP Action would be 3 (Underway with significant progress).

OASIS is currently halfway through the Ocean Decade and is developing a partnership with SOLAS (Surface Ocean Lower-Atmosphere) to establish a long-term vision beyond 2030. Their mission is to create a practical, integrated approach for observing air-sea exchanges related to the Energy, Water, Carbon, and Life Cycles.

Next, Ronald focused on studies on Air-Sea interactions led by Brazilian researchers (but also Argentina and Peru), primarily from the National Institute for Space Research (INPE), mostly in the Southwestern Atlantic's Brazil-Malvinas Confluence region and the Southern Ocean. They use ship-mounted micrometeorological instruments that measure at 20 Hz frequency, allowing for direct measurements of latent, sensible heat, momentum, and CO2 fluxes. This system took about 10 years to develop, with approximately 60% of collected data being useful.

Their findings highlight that oceanographic fronts strongly drive atmospheric conditions, leading to significant turbulence and high winds along the entire marine atmospheric boundary layer (MABL - 700 to 1000 m height) on the warm side of fronts, contrasting with stable, weak winds at the sea surface and with a vertical shear along the MABL on the cold side. Crucially, their direct measurements reveal errors of up to 100% in Air-Sea heat fluxes derived from model parameterizations and reanalysis products like ERA5, particularly near oceanographic fronts in the Southwestern Atlantic Ocean and in the Drake Passage. Mesoscale ocean features are also critical, influencing CO2 fluxes (e.g., warm core eddies acting as CO2 sources) in ways current models cannot capture.

Discussion

OOPC members discussed the reliability of atmospheric models in coastal regions near Antarctica due to difficulties resolving katabatic winds. The aerosol transport from Africa westwards in the ITCZ was also mentioned together with the fact that Air-Sea interaction processes concern in fact the boundary layers of both the ocean and the atmosphere, and not just the ocean-atmosphere interface. Finally, a significant challenge is the lack of a proper data centre to pre-process and distribute the 20 years of collected data by Brazil. This led to the conclusion that Essential Ocean Variable (EOV) specification sheets should include information on data centres where relevant data can be recovered, enhancing data accessibility and promoting "FAIR" (Findable, Accessible, Interoperable, Reusable) data principles.

DAY 3: WEDNESDAY 4 JUNE 2025

3.1 Renewal of members and call for new members

The officer of OOPC, Belén Martín Míguez, presented this item around the continuation of OOPC members serving the panel. She explained that, given that there is a new GCOS reporting cycle getting initiated, with the development of the GCOS Status Report, Implementation Plan and the update of the specification sheets, it is important that members who are in the panel, remain throughout the whole cycle. OOPC experts present in the meeting expressed their intention to continue and to join the next Joint Panel Meeting that will kick off the reporting cycle in February 2026 (Harwell, UK). Weidong, co-chair of the panel, however, mentioned that he would like to step down.

She also explained that membership renewal requires the Steering Committee approval after six years. She confirmed with the members of OOPC serving more than 6 years that they would remain in the panel, so that the formal approval can take place (**OOPC-27/10**). Belén also provided some insights into the current financial situation of the GCOS programme, which will be depleted of funds by 2028, given the current political context in the US (US State Department is, together with the EU, the main contributor to GCOS Trust Fund).

Belén indicated that there are two vacancies now due to the departure of Rick Lumpkin and Peter Oke, so a call for experts should be issued (**OOPC-27/11**). The current team is very complementary, and the vacancies give a chance to add new expertise in areas where it is needed. She invited a discussion on which should be those key areas. OOPC members commented on the following issues:

- Southern Ocean Oceanography/Hydrography is an area where the panel would benefit from extra knowledge. Ronald Souza could explore outreach to SOOS for potential candidates or an ex-officio membership related to Southern Ocean expertise.

- Aspects related to data management and accessibility (FAIR Principles) are important too and they will need to be properly reflected in the specification sheets, but OOPC members considered that it was not necessary to engage someone specific for this. Stefan Kern offered to take on the task of guiding the panel's efforts in data management and FAIR data principles within the specification sheets.
- New candidates should ideally be non-European to maintain geographical balance, with a preference for candidates from the Southern Hemisphere, Australia, or Oceania.
- It was noted that the connection with OCG is less clear since Rick Lumpkin's departure, and that the connection of candidates to the OCG networks would be an advantage. Alternatively, the panel could generally increase its involvement with OCG by attending their meetings.
- The preferred method for finding new members is to open a call to ensure applicants have genuine interest, though direct invitations could also be considered.

At the follow-up online July meeting, the following points were raised:

- In terms of geographical distribution, in addition to the Southern Ocean, Caribbean/SIDs are also interesting.
- Meghan expressed interest in stepping down gradually to allow a new NOAA representative to gain international exposure and understanding.

N°	Action	Responsibility/Deadline
OOPC-27/10	Solicit the approval by GCOS SC of the renewal of membership for OOPC experts who have reached the end of their 6-y term.	Belén, Sabrina, July 2025

N°	Action	Responsibility/Deadline
OOPC-27/11	Prepare and launch a call for experts	Call launched end of summer, to have candidates ready to join the JPM in Harwell (2026)

Before moving to the next item, OOPC experts mentioned that it would be good to close the conversation around the new EOV/ECV specification sheets, as there was a need to clarify the definitions of sub-variables and supporting variables, addressing confusion between the 2017 definition and a newer one.

Sub-Variable Definition:

- Old: Sub-variables were defined as "components of the EOV"

For heat flux, this included latent heat flux and longwave radiation. For currents, it referred to geostrophic and Ekman currents

- New: Sub-variables are now considered "key measurements used to estimate the EOV"

Some OOPC members found this definition confusing, as it would imply that "state variables" (like air temperature, humidity, winds, and Sea Surface Temperature (SST) for heat flux) would become sub-variables, which was previously not the case. Meghan Cronin found this new language very confusing. However, by looking at the ECV Sea Ice this was better understood. The sub-variables of Sea Ice (e.g, Sea Ice Temperature, Sea Ice thickness, Sea Ice Albedo), are key measurements that clearly inform about one aspect of the Sea Ice, they are needed to estimate/deliver the EOV.

Supporting Variable Definition:

- Old: Supporting variables were "other EOV for measurement from the observation system data needed to deliver the EOV" (e.g., air temperature, humidity, winds, and SST for latent heat flux)
- New: Supporting variables are "additional measurements that provide the scale or context to the sub variable".

It was noted that supporting variables are relatively less important as requirements will not be defined for them. They are not so crucial to estimate the ECV, you would not think of those as a "component" of the ECV, but they can be helpful. For instance, for sea ice, the supporting variables could be environmental (like SST and salinity).

The group also discussed that the goal of EOVs is to organise communities around essential measurements. The specification sheets aim to provide context and justification for observations, linking measurement needs to observable phenomena

Regarding phenomena, the focus is on identifying phenomena that "drive the requirement" (e.g., climate change signal for climate applications, or operational forecasts for higher time/spatial resolution) to avoid an overwhelming number of tables.

Requirements will be categorised into "minimum," "desirable," and "ideal," consistent with WMO frameworks.

3.2 D2: Global Climate Data Centres

Belén reminded the group of the scope of GCOS IP Action D2, which tries to do an audit of the current availability of global climate data centres for the ECVs, understood as data facility that archives and distributes global coverage historical and real time quality controlled data for at least one ECV. While some preliminary work had been done at the last Joint Panel Meeting in Bonn, 2023, and a big part of the information was found, biological and biogeochemistry variables were still missing. In addition to that, some qualification of the identified climate data centres was needed to properly understand their relevance and fitness for use. She also explained that these audits will ultimately trigger some decisions.

Ronald explained that he can help in filling in the table, with the caveat that he still has to become familiar with those templates, and that the new trend is eddy covariance.

Stefan completed the discussion by summarising progress in Action D1 of GCOS IP, which is also related to data management and climate data centres. A group of GCOS experts considered Core Trust Seal Principles (CTS) (well established set of requirements used for assessing data centres in general) and how suitable those CTS principles could be for the purpose of qualifying data centres for climate specifically. The group mapped how well the climate data centres participating in the study met or not the CTS requirements, and whether there is a need to develop something alternative. The group has not finished its work yet. It was clarified that the Table for D2 is not only composed by data centres that comply with CTS.

3.3 C3: General improvements to in situ data products for all ECVs

This GCOS IP Action recommends performing reassessments of in situ based estimates and to have multiple independently produced estimates for each ECV. Lijing Cheng is the *rapporteur* for this Action and summarised progress so far.

The field of in situ gridded data products is seeing substantial progress, with numerous products now available for ocean temperature and heat content (OHC). Over 30 global temperature products exist, alongside a recent "bloom" in AI-based products, with more than 10 for Argo-only data and many other AI-driven offerings.

A significant focus is on data quality issues, particularly biases, which are pervasive in ocean data and impact scientific and operational applications. Efforts include updating and implementing corrections for XBT, bottle, MBT, and animal-borne sensor (APB) biases. A notable "puzzle" is the Argo salinity bias, which shows a negative offset before 2010 and positive after 2020, leading to an "unphysical" global salinity increase in products after 2015. The community, particularly Euro Argo, has been reluctant to admit this bias.

Data quality control (QC) is a critical area, with the International Quality-controlled Ocean Database (IQuOD) leading initiatives to establish best practices for temperature auto-QC and conducting an ongoing salinity QC intercomparison. A key development is the recognition that dynamic QC thresholds are essential, as climate change means static thresholds can reduce positive anomalies, impacting OHC estimates (e.g., an 8% trend difference after 2005).

Additionally, interpolation (mapping) techniques are being rigorously assessed through projects like MAP-EVAL, which uses high-resolution model outputs as "truth" to validate different methods. Uncertainty quantification remains a complex challenge, with IQuOD striving to assign uncertainties to both individual measurements (considering instrumental precision, calibration, and drift) and gridded products (accounting for sampling, mapping, and vertical interpolation errors).

There has also been a "bloom" of ocean oxygen data products recently, prompting new international projects to compare mapping methods, refine QC, and assess biases. A specific challenge identified is a systematic offset in historical Soviet Union and US oxygen data from 1950-1990, raising questions about the accuracy of past oxygen time series. Despite significant progress across these areas, a truly comprehensive understanding of all error sources is still being sought.

Discussion

According to the progress reported by Lijing in the different lines of work, the scoring for Action C3 in the Implementation Plan would be 4 (progress on track).

3.4 D5: Undertake additional in situ data rescue activities

Action D5 of the GCOS Implementation Plan encourages in situ data rescue activities by augmenting existing archives and continuing efforts to digitize historical data from hard copy or image forms. According to Lijing, the overall progress has been "little". While organizations like IODE and IQuOD have data rescue activities, data holders often lack motivation to share data, and have insufficient organization.

Current efforts involve the use of AI tools to extract information, but the process is far from straightforward and still requires significant human effort for one-by-one verification. Lijing then mentioned other relevant activities like the ACRE project, Canada (with a focus on Arctic data), and Australia - the CSIRO Atlas of Regional Seas (CARS).

Lijing presented the main challenges impeding a faster rescue of data and OOPC members contributed several reflections.

Key Challenges in data rescue include:

- Limited funding: It is difficult to justify standalone funding because small additions of data have minimal immediate impact on estimates like ocean warming; combining efforts with larger, climate-related activities is suggested for better funding prospects.
- Lack of motivation and willingness to share: People perceive low benefits for the considerable effort involved.

- Poor coordination: International organization and coordination among different groups, often with varying regional interests (e.g., Arctic vs. Western Pacific data), remains challenging.
- Data curation and sharing: Ensuring that rescued data are Findable, Accessible, Interoperable, and Reusable (FAIR) is a persistent problem.

Proposed Actions and Opportunities to advance data rescue include:

- Involve citizens: Implementing citizen science programs, using apps for digitizing data, could mitigate time and resource constraints, drawing on successful models from atmospheric data rescue in Italy and the UK.
- Utilize Data Ingestion Projects: Collaborating with existing data ingestion projects, such as EMONET in Europe, could streamline the process of making rescued data FAIR and integrating it into broader databases.
- OOPC Guidance: The OOPC (Ocean Observations Physics Panel) could strategically guide where to prioritize data rescue efforts to achieve maximum scientific impact, especially in data-sparse regions.
- Learn from the atmospheric community: Adopting successful strategies and lessons learned from the more established atmospheric data rescue efforts is encouraged.
- Promote Comprehensive Regionalization: Advocating for a broader and more comprehensive ocean regionalization, including open ocean areas, could support improved regional reporting and overcome current limitations based on national boundaries.

Discussion

Some OOPC members mentioned citizen science initiatives in Europe, through the use of mobile phone/apps. Regarding the step where data would be made available (which is also a bottleneck), the Data Ingestion project (part of EMODnet) could be a possibility. OOPC members also considered the benefits of having cross-panel conversations on the topic with AOPC, who might have good examples of data rescue initiatives. Finally, it was suggested that maybe some datasets are more worth rescuing than others, and OOPC could provide guidance in that respect.

3.5 F3: Improve monitoring of coastal and Exclusive Economic Zones

Bipen Prakash is the *rapporteur* of Action F3 of GCOS Implementation Plan, which targets the improvement of monitoring of coastal and Exclusive Economic Zones (EEZs). In his presentation Bipen focused on the Pacific Island region. While the approach is not strictly global, he highlighted that it covers 20% EEZs. Besides, 90% of the population of these regions lives within 5 km of the coast (if Papua New Guinea is excluded), and their infrastructures are closer than 500m. From an economic point of view, the ocean, and in particular fisheries, play a fundamental role (>90% of government revenue for some island states through licensing fees). And yet, the region is poorly observed.

Several efforts to improve the situation have been happening in the last years and Bipen presented them:

- The Pacific Island Global Ocean Observing System (PI-GOOS) has been re-established and is hosted by SPC (Pacific Community), acting as a network of regional organizations reporting to the Pacific Meteorological Council (PMC) to improve coordination.
- Sea level and geodetic monitoring involves 14 permanent tide gauges with GNSS and levelling data across 13 PICTs, providing continuous data since the early 1990s. Plans include deploying two temporary tide gauges per PICT (Pacific Islands Countries and Territories) over the next five years, targeting 40 observation-based tidal predictions.

- Waves monitoring has seen the deployment of around 40 wave buoys since 2018. An additional ~30 buoys are planned.
- Marine water quality monitoring is being implemented in Niue, Tuvalu, and Cook Islands.
- The Pacific Island Ocean Acidification Centre, established in 2021, provides training and equipment.
- The Fish SOOP (Ship of Opportunity) program partners with tuna fishing vessels for low-cost sub-surface temperature profiling, with approximately 50 sensors to be deployed by the end of this year.
- Digital Earth Pacific uses satellite data for environmental changes, with demonstration products for coastline, water, and mangrove changes.

Concerning the bottlenecks for further progress, these were the main points:

- Limited national investment in ocean observation, with most funding coming from regional or bilateral programs.
- Limited coordination across ocean disciplines and sectors.
- Insufficient national capacity to maintain observation systems.
- Absence of a unified regional strategy guiding investments.
- High costs of procurement and communication for continuous data streaming.
- Poor data curation and sharing, with limited visibility of activities across the region.
- Project-based funding, leading to limited sustainability of observations beyond project lifecycles.
- Vandalism of low-cost buoys.

Some opportunities and future plans to enhance monitoring efforts in the Pacific Island region are:

- The Weather Ready Pacific Decadal Investment Programme represents a significant USD 190 million investment with a substantial focus on ocean observations.
- A Regional CoastPredict Project is in development to support 7 PICTs.
- Efforts are underway to initiate GOOS Co-Design Exemplar Projects, such as a tropical cyclone exemplar.
- Funding support from IMOS (Australian Integrated Marine system) is contributing to PI-GOOS.
- There is potential to leverage the IOC Ocean Best Practices Framework.
- Strengthened coordination is expected through the re-established PI-GOOS, which includes representation from all small island states and reports through the Pacific Meteorological Council.
- Progressive development includes continued investment in temporary tide gauges and expansion of subsurface temperature profiling.

Discussion

On the topic of sharing data, OOPC reflected on how the pressure of the European Commission when issuing call for fundings has generated more open data. It was mentioned that the progress in this region is remarkable and there were questions on whether it would be possible to do comparison with other regions characterized by a high density of small island states like in the Caribbean. Indicators related to climate as well as with changes in tuna fishery were also mentioned.

N°	Action	Responsibility/Deadline
OOPC-27/12	Connect with representative from other regions with coastal/island states, to gain a global view of how observation systems are evolving worldwide	Bipen supported by Belén/January 2026

3.6 C4: New and improved reanalysis products

Hao Zuo is the *rapporteur* for this Action, which recommends the implementation of new production streams using improved data assimilation systems and better collections of observations, develop coupled reanalysis etc.

Action C4 comprises five key activities, primarily carried out by reanalysis centres, academia, and space agencies. Hao summarised and assessed progress under each of the activities in the ocean realm:

1. Implement new production streams: This involves using improved data assimilation systems and better observation collections, focusing on higher resolution, better handling of systematic biases, and enhanced quality control in data-sparse areas. This activity is on track (4). Numerous new ocean and sea-ice reanalyses have emerged since 2022, including SODA4, GLORYS12, ECMWF's ORAS6, ECCO V4r5, C-GLORSv5, Met Office's FOAM, and CORA2, many at high resolution, with ORAS6 showing improved SST biases.
2. Develop coupled reanalysis (ocean, land, sea-ice): This is underway with significant progress (3). For instance, ERA6 will be a one-way coupled reanalysis, positively impacting ocean wave forecasts and providing a better fit to near-ocean surface observations.
3. Improve the capability of sparse-input reanalysis: The aim is to cover the entire 20th century and beyond. This is also underway with significant progress (3). Examples include CIGAR (1961-2023) and ORAS6, which is planned to cover from 1950 to Near Real-Time (NRT) by the end of 2025.
4. Develop and implement regional reanalysis: the assessment for this activity was not finished.
5. Reduce data latency: This activity is on track (4). ORAS5 has been released in NRT via C3S CDS since 2023, and GLORYS12 is released via CMEMS with a one-month delay.

3.7 OceanObs29

Fei Chai, from Xiamen University, China, presented the latest developments concerning the preparation of OceanObs29. This decadal conference is being planned in Qingdao, China, following the impactful OceanObs19 which produced 140 heavily-cited white papers that influenced UN Decade programs. An ad hoc committee was established to guide the selection of the program committee for OceanObs29. The application deadline was extended to 20 June, with over 230 applications received, including 70 from early career ocean professionals (ECOPs) across 60 countries. Efforts are underway to ensure diverse representation, including underrepresented regions like South America and stakeholders beyond traditional ocean observing, such as industry and indigenous knowledge communities. A meeting in Hong Kong in November 2025 will facilitate the handover to the selected program committee.

3.8 End of meeting

Since many of the OOPC experts could not remain till the end of the meeting, the wrap up with the agreement on the main actions was scheduled for a later, on-line session. The OOPC co-chairs and the Secretariat thanked OOPC experts again for their commitment and valuable input, and reminded them that the group would be meeting again in Harwell in February 2027.

ANNEX 1: AGENDA

Day 1: Monday 2 June 2025				
TIMES	**Block**	**Nº Item**	**Description**	**Speaker**
09:00-09:30	**Reporting from OOPC led activities**	1.1	Welcome, introduction of Agenda	OOPC Chairs, OOPC officer
09:30-10:00		1.2	Report from the Chairs + OOPC Officer	OOPC Chairs
10:00-10:30	**OOPC partners**	1.3	Report from parent bodies: **WCRP (inc. CLIVAR)**	Hindumathi K. Palanisamy
10:30-11:00	***Coffee break***		***Coffee break***	
11:00-11:30	**Interactions with OOPC partners**	1.4	Report from parent bodies: **GOOS**, **GCOS**	Joanna Post, Caterina Tassone
11:30-12:00		1.5	Ex-officio: OCG, GRAs, **BioEco**, BGC, CLIVAR	Lucille Chapuis
12:00-12:30		1.6	Ex-officio: **OCG, GRAs**, BioEco, BGC, CLIVAR	Ann-C Zinkann, Jing Li
12:30-13:00		1.7	Discussion/questions	ALL
13:00-13:30	***Lunch break***		***Lunch break***	
13:30-14:00				
14:00-14:30	**GCOS IP**	1.8	GCOS IP Actions: work ahead	Belén
14:30-14:50		1.9	B2: Development and implementation of the Global Basic Observing Network (GBON)	Hao
14:50-15:10		1.10	B7.Augmenting ship-based hydrography and fixed-point observations with biological and biogeochemical parameters	Tammy
15:10-16:00		1.11	Space Agencies Actions (A3+B3+C2+D4+F2)	Stefan, Tony
16:00-16:30	***Coffee break***		***Coffee break***	
16:30-16:50	**GCOS IP**	1.12	B8. Coordinate observations and data product development for ocean CO2 and N2O + Ex-officio BGC	Maciej
17:00-17:30		1.13	B6: Expand and build a fully integrated global ocean observing system	Sabrina, ALL
17:30-18:00	**The future of the OOS**	1.14	Brainstorming: the US and the ocean observing system	David Legler + ALL

Day 2: Tuesday 3 June 2025

TIMES	Block	Nº Item	Description	Speaker
09:00-09:30	**EOV/ECV specification sheets**	2.1	Working on the template	Ana Lara Lopez/Belén
09:30-10:00		2.2		ALL
10:00-10:30				
10:30-11:00	***Coffee break***		***Coffee break***	
11:00-11:20	**Reporting from OOPC-led activities**	2.3	Marine Heatwaves	Mélanie
11:20-11:40		2.4	ECV Rationalization/EOV paper	Belén
11:40-12:00		2.5	Indicators	Karina
12:00-13:00		2.6	Heat and Freshwater Fluxes and Storage/ Action B10 Identify gaps in the climate obs system to monitor the global energy, water and carbon cycles	Lijing/Karina
13:00-13:30	***Lunch break***		***Lunch break***	
13:30-14:00				
14:00-14:20	**Reporting from OOPC-led activities**	2.7	Polar Regions	Stefan
14:20-14:40		2.8	Boundary systems	Tammy
14:40-15:00		2.9	Pantropical Observing System	Weidong
15:00-15:20		2.10	WMO Statement of Guidance for Oceanic Applications/RRR	Hao
15:20-16:00		2.11	Air-Sea Fluxes -OASIS/Action B9 GCOS IP	Meghan + Ronald
16:00-16:30	***Coffee break***		***Coffee break***	
16:30-17:00	**EOV/ECV specification sheets**	2.12	Presentation of Example: Currents/Air-Sea Fluxes	Tammy/Ronald (TBC)
17:00-17:30		2.13	Each steward works on their specific EOV	Individual work
17:30-18:00				

Day 3: Wednesday 4 June 2025

TIMES	Block		Item Description	Speaker
09:00-09:30	**Other topics**	3.1	Renewal of members and call4new members	Belén, ALL
09:30-10:00 10:00-10:30	**GCOS IP**	3.2	D2: Global Climate Data Centres	Belén, ALL
10:30-11:00	***Coffee break***		***Coffee break***	
11:00-11:30	**GCOS IP**	3.3	D2 (con't) +D1: Governance of Data Centres	Stefan, Lijing
11:30-12:00		3.4	F3: Improve monitoring of coastal and Exclusive Economic Zones	Bipen
12:00-12:30		3.5	C3: General improvements to in situ data products for all ECVs	Lijing
12:30-13:00		3.6	D5: Undertake additional in situ data rescue activities	Lijing
13:00-13:30 13:30-14:00	***Lunch break***		***Lunch break***	
14:00-14:30	**GCOS IP**	3.7	C4: New and improved reanalysis products	Hao
15:00-15:30	**Other topics**	3.8	OceanObs29	Fei Chai/Weidong
15:30-16:00		3.9	**AOB**	ALL
16:00-16:30	***Coffee break***		***Coffee break***	
16:30-17:00	**End**	3.10	**End of Meeting**	OOPC Chairs

ANNEX 2: LIST OF ACTIONS

N°	Action	Responsibility/ Deadline
OOPC-27/1	Explore ways of connecting with the GRAs using PI-GOOS as an entry point	Belén, Bipen/2026
OOPC-27/2	OOPC to provide information to BioEco on the SUN fleet network for their assessment	Meghan/Lucille/2026
OOPC-27/3	Analyse the impact of loss of observing platforms in the uncertainty associated to the estimation of Ocean Heat Content and other sensitivity studies	Lijing (+ Hao, Karina)/October 2025
OOPC-27/4	Develop completely filled-in pilot specification sheets that can be used as an example for the rest of the panel	Tony (currents) and Ronald (air-sea fluxes) following an example from Stefan
OOPC-27/5	OOPC experts to participate in the GCOS ECV Rationalization Public Review	All/Public Review closes on 8 September
OOPC-27/6	Propose Terms of Reference for an advisory group and inquire the former members of the Task Team whether they would be willing to be part of it	Tammy Morris supported by OOPC officer/by October 2025
OOPC-27/7	Establish contact with representatives from SOOS to explore better ways of being informed/improve the connection	Belén supported by Ronald/by November 2025
OOPC-27/8	Discuss the possibility of establishing a Joint Working Group between OOPC and CLIVAR, to continue the work of the CLIVAR foresight group	Weidong Yu, Hindumathi Palanisamy next PanCLIVAR meeting (22/09/2025)
OOPC-27/9	Consider suggestions from OOPC in the draft statement of Guidance	Belén/Hao/July 2025
OOPC-27/10	Solicit the approval by GCOS SC of the renewal of membership for OOPC experts who have reached the end of their 6-y term.	Belén, Sabrina, July 2025
OOPC-27/11	Prepare and launch a call for experts	Call launched end of summer, to allow candidates to join the JPM in Harwell (2026)
OOPC-27/12	Connect with representative from other regions with coastal/island states, to gain a global view of how observation systems are evolving worldwide	Bipen supported by Belén/January 2026

ANNEX 3: LIST OF PARTICIPANTS

OOPC Members:

Sabrina SPEICH, France (Co-chair)
Weidong YU, China (Co-chair)

Lijing CHENG, China
Meghan CRONIN, United States
Mélanie JUZA, France
Stefan KERN, Germany
Tony LEE, United States
Tamaryn MORRIS, South Africa
Bipen PRAKASH, Fiji
Ronald SOUZA, Brazil
Karina VON SCHUCKMANN, France
Hao ZUO, United Kingdom

Absent:

Katrin SCHROEDER, Italy

Experts:

David LEGLER, United States
Hindumathi PALANISAMY, Switzerland
Caterina TASSONE, Switzerland
Ann-Christine ZINKANN, United States
Sam SIMMONS, UK
Ana Lara LÓPEZ, Australia

GCOS Secretariat:

Belén MARTÍN MÍGUEZ

(Names in *italics* indicate remote participation)

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