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SHIP OBSERVATIONS TEAM
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Session Report Version 1.0

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NOTES

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EXECUTIVE SUMMARY

The Twelfth Session of the Ship Observations Team (SOT-12) was held from 15 to 18 May 2023, at the Bureau of Meteorology, Melbourne, Australia. Participants were welcomed by Mr. Bryan Hodge, the General Manager of the Observing Systems, and Joel Cabrie, from the Bureau of Meteorology. The Session was held as a hybrid meeting and was chaired by the Ship Observations Team Chairperson, Mr. Darin Figurskey (United States). The meeting included two breakout sessions to allow the Voluntary Observing Ship (VOS), together with the Automated Shipboard Aerological Programme (ASAP), and the Ship-of-Opportunity Programme (SOOP), Panels to address specific issues related to their programmes. The session timetable is provided in Annex 1.

The hybrid session was attended by about ninety participants representing thirty three countries. A list of participants is in Annex 6. All supporting documents and presentations submitted to the session are available at https://goosocean.org/sot-12.

This is the first SOT session to include in-person attendance since the COVID pandemic. Therefore, the SOT-12 agenda was prepared with more discussion time after each major topic, allowing participants to have interactive discussions. This change in the agenda was noticeable throughout the meeting with many productive detailed discussions on major topics such as SOT panel activities, SOT metadata, task team activities, Turbowin, and industry collaboration. It was also apparent that the ship-based observations are slowly returning closer to pre-pandemic levels with the ease of pandemic-related restrictions. SOOP is still experiencing restrictions related to indemnification.

SOOP, VOS and ASAP provided updates of the Panel activities on the first day of the meeting and focused on the areas of metadata submission to OceanOPS, data exchange, scientific advancements, and challenges. Panel members are requested to review and keep up-to-date metadata in the OceanOPS database and are also requested to migrate their systems to use SOT Identification (SOT-ID) when submitting the data. Ships are involved in almost all ocean observing networks, and the ship metadata is a shared resource with shared responsibility. Thus, the ship metadata needs to be kept current.

Participants discussed the future of the Turbowin software that was developed by The Royal Netherlands Meteorological Institute (KNMI) several decades ago to send meteorological observations from ships at sea to the Global Telecommunication System (GTS). Maintenance of the Turbowin is a shared responsibility, and SOT members are requested to contribute towards the development of the next-generation Turbowin, including, but not limited to, actively joining the Turbowin Partner Board to coordinate future Turbowin requirements and to ensure the long-term sustainability of Turbowin through financial support.

Organizational reports from the World Meteorological Organization (WMO), Intergovernmental Oceanographic Commission (IOC) of UNESCO, Observation Coordination Group (OCG), and OceanOPS, as well as the national reports, were presented and discussed on the second day of the session. Speakers highlighted the importance of SOT Panels' contribution towards major high-level objectives of WMO. These include: the Global Basic Observing Network (GBON), new unified Data Policy, WMO Information System 2.0 (WIS2.0), Rolling Review of Requirements (RRR), and Early Warning for All (EW4All); IOC/UNESCO initiatives such as UN Decade projects and contribution to GOOS; OCG priorities such as cross-network collaboration, OCG data policy, and capacity

development; and, OceanOPS priorities such as metadata management and implementation of the five-year strategic plan.

Participants appreciated the new national report production through the OceanOPS system. Most participants agreed that there is more room to improve the information accuracy, presentation, and clarity of the auto-generated national report. To improve the auto-generated national report, SOT members are requested to update OceanOPS with accurate and up-to-date metadata, while OceanOPS will work on the technical improvements.

Reports from Task Teams (TT), and associated programmes and projects, were presented on the third day of the session. All TTs have reviewed their Terms of Reference (ToR). Updates were discussed and approved at the session for the TT on Recruitment, Promotion, and Training (TT-RPT), TT-VOS Metadata, and TT on Expansion of Independent Class Observations (TT-EICO). Revised ToR for the TTs mentioned above are provided in Annexes 2, 3 and 4, respectively. In addition, participants agreed on the importance of delayed mode data and work that needs to be completed on this subject. Therefore, all participants endorsed the ad-hoc TT on VOS Delayed mode data transitioning to a full-fledged TT to continue to work under the existing ToR. All existing TTs will continue their activities during the next intersessional period.

With respect to SOT associated programmes and projects, the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Project, International Research Vessel Operators Group (IRSO), International Quality-controlled Ocean Database (IQuOD), Ferrybox Task Team, Global Temperature and Salinity Profile Programme (GTSPP), Science Research on Commercial Ships (RoCS), International Hydrographic Organization (IHO), Group for High-Resolution SST (GHRSST), and Global Ocean Surface Underway Data (GOSUD) reported on their activities related to SOT panels. The exchange of relevant metadata between OceanOPS and these projects and programmes was identified as a key interest for all parties. It was also identified that projects like SAMOS can benefit from initiatives like WIS2.0. Applicable projects and programmes are encouraged to share the observation data in real-time for the use of a broader audience, including National Meteorological and Hydrological Services (NMHSs). Further, SOT is encouraged to continue their engagement in these programmes and projects to benefit each other.

SOT partners, including the Data Buoy Cooperation Panel (DBCP), and industry representatives, were invited to the SOT-12 session. Accordingly, Ocean Racing Panel and the Antarctic Circumnavigation by Lisa Blair made presentations on their activities and identified areas where collaborations can be strengthened. Participants agreed with the importance of engagement with these groups to increase the cooperation between sailors and science tremendously.

SOT Chair presented an overview of the SOT five-year strategy, including mission and vision statements and four overarching strategic goals. Participants endorsed the strategy and thanked the chair and executive board for their leadership in preparing this document. During the upcoming intersessional period, the SOT will assess the value of developing a concise implementation strategy for the tenets in the SOT Strategy. Participants reviewed the SOT ToR, and the revised and SOT-12 approved ToR is provided in Annex 5.

SOT Chair for the last five years, Mr. Darin Figurskey, announced his resignation from the post as of the SOT-12 session. Accordingly, the secretariat issued a call for the chair nomination before the SOT-12 session. Following the SOT operating principles, Dr. Huai-min Zhang was appointed as the chair of the SOT by acclamation. All participants very

highly appreciated the leadership, dedication, and professionalism of Mr. Figurskey and thanked him while wishing him the very best in his future endeavors. No new nominations were made for the rest of the executive board membership, and they were re-elected.

Participants were invited to consider hosting the SOT-13 session during the same time in 2015. All agreed that there is value in meeting where SOT has never been held before to engage with the local communities. South America, Africa or other underrepresented regions were suggested as preferred locations.

12th SHIP OBSERVATION TEAM (SOT-12) SESSION REPORT

1. OPENING OF THE SESSION

1.1 Opening Remarks from the host

Chair of the Ship Observation Team (SOT), Mr. Darin Figurskey, officially opened the 12th SOT session on the 15th of May 2023, at 08:00 AET. Local host, Mr. Joel Cabrie, introduced the General Manager of the Observing Systems and Operations of the Bureau of Meteorology, Mr Bryan Hodge, who gave a welcome speech. He highlighted the importance of observations, particularly at the time we are in with increasing weather-related disasters and accelerating climate change.

1.2 Adoption of the Agenda and objectives of the meeting

Chair of the SOT, Mr. Darin Figurskey, presented the draft agenda and the participants agreed with the agenda items and approved it. The approved Agenda is provided in Annex 1. Mr. Figurskey mentioned that there may be some adjustments to the time of a few presentations to accommodate remote presenters.

1.3 Working arrangements, and instructions for those participating virtually

On behalf of the World Meteorological Organization (WMO) Secretariat Ms. Champika Gallage welcomed the participants to the SOT-12 session. She outlined working arrangements and reminded the participants that nominations for the SOT chair position were open until 17:00 AET on the 16th of May 2023.

2. SIXTEENTH SESSION OF THE SOOP IMPLEMENTATION PANEL (SOOPIP-16)

2.1 Report from the SOOPIP Chairperson

Dr. Francis Bringas, co-chair of the Ship of Opportunity Programme (SOOP) provided an update on the SOOP activities. He said that SOOP is an international program mainly involved in the implementation, maintenance, enhancement, and data management of upper ocean measurements from Ships of Opportunity (SOO), including Expendable BathyThermographs (XBTs) but not limited to SOO, ThermoSalinoGraphs (TSGs), pCO2 systems and Continuous Plankton Recorder (CPR) systems. Additionally, SOOP supports other observational platforms, including the deployment of drifters and profiling floats. Members of this panel also participate actively in other operational or data management international projects such as International Quality-controlled Ocean Database (IQuOD), Global Temperature and Salinity Profile Programme (GTSPP), Global Ocean Surface Underway Data (GOSUD), and Voluntary Observing Ships (VOS). He further mentioned that SOOP also supports scientific and operational efforts to help improve our knowledge of the ocean environment, through data analysis and contribution to modelling efforts, with applications in:

- Meridional heat transport and meridional overturning circulation studies and assessment
- Studies and monitoring of surface current variability
- Contribution to upper ocean heat content studies
- Input for climate and weather forecast models
- Climate and Ocean Dynamic research
- Determination of boundary regions in ocean currents
- Support efforts to globally quantifying carbon dioxide in the ocean
- Operations have been carried during the last 20+ years and the observations collected are critical for understanding long-term changes in the marine environment

Dr Bringas mentioned that currently, there are 13 countries participating in the global XBT Network (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, New Zealand, South Africa, United States), with contributions at different levels which may be provision of probes or equipment, logistics, ship recruitment or ship riders, and data quality control (QC) and distribution. Approximately 90% of the XBT profiles collected are submitted to the Global Telecommunication System (GTS) in near real-time (FM 63-XI Ext. BATHY and BUFR TM 315004) and they are also available in delayed mode on different institutional websites (for example NOAA/AOML[1], Scripps[2], IMOS/AODN[3]) and global repositories including the World Ocean Database (NOAA/NCEI) and GTSPP (NOAA/NCEI).

Dr Bringas said that during the last few years, a study was conducted on the environmental impact of XBT deployments. XBTs expendable material weight ~900g per probe (composed of Zn, Cu, Al, and plastic). This represents ~2,100 metric tons of material introduced into the global ocean after over 2,360,000 deployments during 1960-2020. Currently 16,500 deployments are conducted annually, which represents 15 tons of material per year. Concentration levels of trace elements from XBTs since 1960 are several orders of magnitude lower than US Environmental Protection Agency recommended levels. Relative to sources of pollution such as marine coatings and fishing gear, XBTs are a negligibly small contribution. To put this into perspective, all the XBT probes deployed since 1960 would fit in just one-third of an Olympic size swimming pool, while the amount of plastic introduced by these XBTs is equivalent to the plastic waste generated by 33 individuals in a developed country during their lifetime.

He said that the TSG operations are conducted as part of the SOOP activities. TSGs measure Sea Surface Temperature (SST) and Sea Surface Salinity (SSS) along ship tracks. Further he mentioned that more than 60 ships are currently collecting and reporting approximately 5 million TSG records per year (during 2021-2022). TSG data are distributed in real-time and near real-time through GOSUD and archived in GOSUD and NCEI. Data are also distributed in delayed mode by GOSUD.

As part of SOOP, pCO2 operations are also conducted, said Dr. Bringas. The main objectives of this sustained effort are to: Produce CO2 data at sufficient accuracy to constrain sea-air CO2 fluxes to 0.2 Pg C yr^{-1}; Facilitate capacity building through

[1] http://www.aoml.noaa.gov/phod/goos/xbtscience/data.php; https://www.aoml.noaa.gov/phod/hdenxbt/,

[2] http://www-hrx.ucsd.edu/index.html

[3] https://portal.aodn.org.au/

instrumentation and data reduction guidance to attain a global network of SOOP-CO2; Create CO2 flux maps and related data products. The global pCO2 Program is conducted by researchers in more than 15 countries, with observations collected globally, including at high latitudes, and with hundreds of cruises per year carried out to collect over a million observations annually.

Dr Bringas listed the accomplishments for SOOP during the last few years that include:

- 75% of recommended transects are active despite ongoing restrictions and constraints, with 6 additional transects (not recommended) also active.
- Collection of more than 10,500 XBT profiles, 1,000,000 pCO2 and 5,000,000 TSG annual obs.
- Transmission of more than 90% of XBT profiles to the GTS in RT. Perform delayed mode QC on XBT data for science applications
- Recommendations from the XBT Science Team to the GTSPP and IQuOD projects were for close collaboration and participation of SOOP panel members in GTSPP Steering Group
- SOOP continues to support the deployment of other observational platforms such as drifters and Argo floats
- Continued active development of software for data collection and instruments for data collection and transmission (Iridium antennas, data recorders, automated weather stations)
- XBT data has been used in more than 1,900 scientific and technical publications since 2000
- Continue to review and update the maintained XBT transects, creating up to date maps and Key Performance Indicators (KPIs) via OceanOps
- Ongoing review of the metadata formats and content supplied to OceanOps yearly
- Ongoing revision and updates of GTS data distribution formats and templates

He identified the most important challenges and difficulties for the program which include:

- Some restrictions in travel, ship and facilities access still exist and require a high level of adaptability in order to maintain operations.
- Level funding for ocean-spanning routes, and high scientific value in sustained boundary current observations, lead to challenges in adapting the design of existing networks to meet the new constraints and requirements.
- GTS delivery in BUFR format is not complete for all agencies. BUFR template changes are required
- Adoption of the SOT-ID scheme still to be completed
- Reduction in support for some transects and for the XBT program overall
- Challenges in ship recruitment for different transects continues due to requirements from shipping companies to grant permission to SOOP personnel to conduct observations

Participant from Chile, Cpt. Alejandro de la Maza offered to assist with XBT deployments and GO_SHIP activities with ship time from RV Cabo de Hornoson line AX22.

2.2 SOT Technical Coordinator report on SOOP support activities

The OceanOPS Technical Coordinator (TC) of the SOT, Martin Kramp, reported on his SOOP-related activities in the intersessional period. He attended the regular SOOP calls

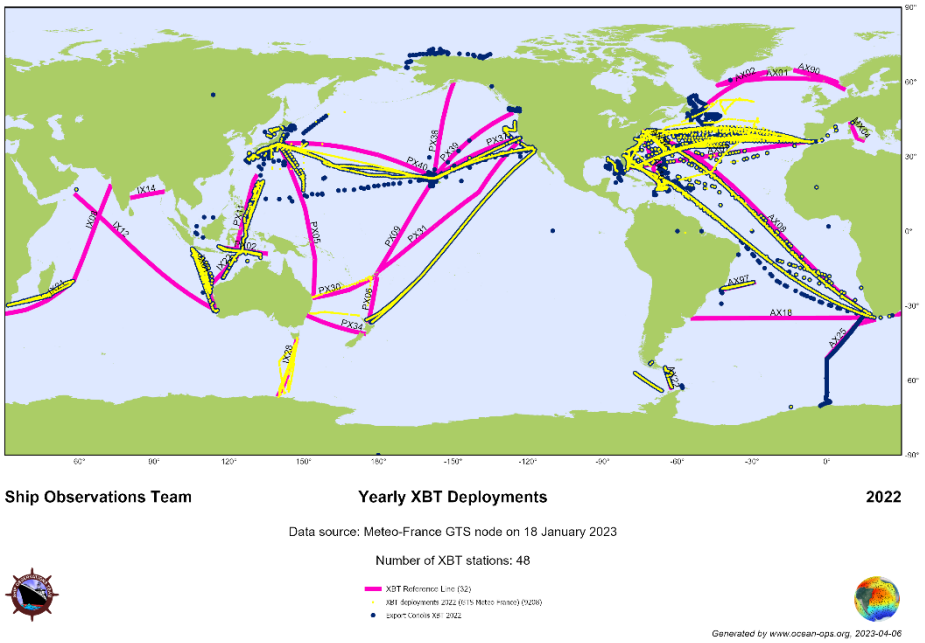
and contributed to the re-established GOSUD steering committee in metadata matters. As part of the implementation of the new SOT metadata format and corresponding user interface, a tool for allocation of unique cruise identifiers and registration/management of repeat cruises (as typically the case with XBT operations) was developed by OceanOPS and is ready for testing.

Regarding ship recruitments, the TC reported that a partnership is underway with FleetMon[4] as a key provider of satellite AIS data and the goal to identify ships which are repeatedly sited on lines which are difficult to occupy (e.g. IX12), or which face technical issues (ship at sea but no incoming data). He also contributed to the SOT recruiting Best Practices document. The meeting noted that OceanOPS drives a high-level partnership initiative with the CMA-CGM shipping company that has been identified by the SOOP as key to success in XBT matters on several lines.

For innovative third party SOOP contributions with miniaturized, self-funded underway systems (T/S/pCO2/meteo) on ocean racing yachts in under sampled ocean areas (e.g. around Antarctica) the TC worked with the Coriolis team at Ifremer on a data format and processing protocol that allows for the GTS ingestion of a met-ocean suite of parameters that exploits the broad potential of the latest, still unused BUFR template TM308014, for which the encoding is presently being developed. The TC reported that the performance analysis of the XBT network is waiting for input from the XBT science team, with a session preceding SOT-12; questions comprise new targets for occupation of reviewed XBT lines / network and whether the data taken into account must be available from the GTS (in BUFR and with line information) or set together from multiple sources. The TC stressed that regular maintenance of platform/station/contact metadata in the OceanOPS system by the operators is of high importance and that new SOOP subgroups (underway systems etc.) should appoint members for the metadata and Task Team on Key Performance Indicator (TT-KPI), and follow the rules established by the SOT regarding SOT-IDs.

Mr. Kramp also reported that the mapping of data streams remains a priority and ongoing activity of the GOOS Observations Coordination Group. Lastly, based on the success of the GO-SHIP bibliography under Google, the meeting noted that the TC had prepared a SOOP-XBT Google environment which was populated by Ciley Sampson (SAWS) with more than 1400 XBT based science publications that have been cited almost 100 000 times in total and more than 40 000 times over the last 5 years.

[4] https://www.fleetmon.com/



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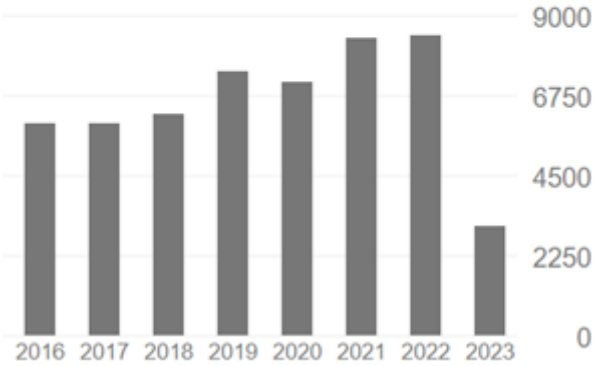


Statistics from the XBT bibliography available at:
https://scholar.google.com/citations?hl=en&user=832uZ-MAAAAJ

2.3 XBT Science Team report

The chair of the XBT science team, Dr. Shenfu Dong, provided a report on the XBT science activities. She mentioned that the 7th XBT Science Team (XST) workshop was held in Melbourne, Australia, n May 11-12, 2023. There were 46 registered participants from 26 countries. The goals of the workshop were to exchange recent scientific advances in using XBT data, share experiences of current logistics and data management, and discuss collaboration and integration with other ocean observing platform platforms. The workshop

included 16 science presentations, 7 national reports, 7 presentations on the relationship and integration of the XBT program with other platforms, and 4 presentations on community input on the global XBT. The workshop provided a forum to enhance discussions on improvement of data quality, data quality control procedure, and metadata submission.

Several presentations stressed the importance of the XBT measurements in monitoring the boundary currents. Examination of 3 XBT transects crossing the Gulf Stream showed that, though the surface transport proxy from altimeter showed good agreement with the transport derived from the XBT transects, the maximum correlation between the depth-integrated Gulf Stream transport and transport at depth is below the surface mixed layer, suggesting that the optimal depth to monitor the Gulf Stream transport variability is within 100-400 m depth level. Variations in the western boundary current observed from the XBTs were used to investigate their links to the extreme events (marine heat waves and cold spells). XBT members continue to develop methods to combine XBT data with observations from other observing platforms to improve the estimation of boundary current transports. XBT data along AX32 in the North Atlantic between New Jersey to Bermuda has coastal observations since 1977, which helped to detect the accelerated warming along the U.S. East Coast. In the Southern Ocean, observations along AX22 across the Drake Passage allowed identification of unique long-term changes in the region: warming in the subsurface (100-300 m) near Antarctica and cooling within the Polar Front region since 1996.

Different from the dominance of the XBT data in global ocean heat content estimation prior the Argo era, study of the impact of the different observing platforms on the ocean heat content estimates indicated that the XBT data still play an important role, second to the Argo data, in particular along cruise lines and in the mid-latitudes. Multiple XBT lines in the North Atlantic are combined to study the subsurface structure of the North Atlantic tripole. Changes in the tripole are closely linked to the meridional overturning circulation and its associated heat transport. A new method was recently developed to derive the meridional overturning circulation and meridional heat transport at 22S in the South Atlantic using the high-resolution measurements at the western boundary for the Brazil Current combined with the Argo data from ocean interior. This method can be applied to other latitudes where boundary currents are sampled from XBTs or other platforms routinely.

Common challenges discussed in national reports are the prohibititon of re-occupation of some of the important XBT transects causing difficulties in the desired operation. Great effort from the XST in continuing to sample the majority of the transects with help of crew and maintaining and enhancing the relationships with shipping companies. However, a few lines, including AX01, AX02, AX18, and PX05, have not been re-occupied since the start of the COVID-19 pandemic due to the restrictions imposed by shipping companies , cancellation of shipping routes, complications in logistics, and decommissioning of ships. Level or reduced funding and increase in costs (probes, shipping, personnel) made it difficult to keep the desired operation. XST is also facing issues of loss of experienced employees (retirement, resignation) and personnel shortage.

New activities and recommendations were made:

1. Making the Indian XBT data along IX14 (crosses the Bay of Bengal monthly since 1991) public and help to send their data via the GTS.

2. Establishing a "new" HR-XBT transect PX36 between Christchurch NZ and Antarctica managed by U. Naples, Italy that has been occupied multiple times in summer since 1994 by an Italian icebreaker.
3. Adding 1-2 XBT/XCTD transects in the Caribbean Sea and GoM for extreme weather (tropical cyclone) research and forecasts.
4. Collecting surface atmospheric data for estimating air-sea heat exchange and heat budget
5. Continue the effort to reinstate transects recommended by the international community (for example AX01, AX02, AX18, PX05).
6. Development of new technologies for data acquisition and transmission (AmverSEAS, Iridium Transmitter, Weather Station, XBT autolauncher, XBT data recorder).
7. Continue the development and maintenance of an XBT data management system that meets all the community requirements for data distribution and applications.
8. Work with the OceanOPS team improving implementation and utilization for the benefit of all XBT program participants.

2.4 XBT Data flow and tranmission

Mr. Joaquin Trinanes reported that the monitoring of the data flow and transmission of XBT data is essential to ensure the timeliness and quality of the measures as well as to maximise the impact and use of the collected data. His presentation described the procedures in place at NOAA/AOML to monitor the data flow and to ensure the transmission in Near Real Time (NRT) of the bulletins, ship to shore, and also from there to the GTS and other data repositories. In addition, it was described how data from multiple databases are integrated to produce the most comprehensive report of the global XBT program.

2.5 Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP)

Dr. Bernadette Sloyan reported on the activities of GO-SHIP. She mentioned that GO-SHIP brings together scientists with interests in physical oceanography, the carbon cycle, marine biogeochemistry and ecosystems, and other users and collectors of hydrographic data to develop a globally coordinated network of sustained hydrographic sections as part of the global ocean/climate observing system. Providing network status for 2012-2023, she mentioned that with the ship time provided by 10 countries, out of 55 core lines, 47 (86%) were completed and 4 are planned to be completed. The planning and commitments for the 2024-2030 decadal survey are well underway where GO-SHIP has 20 commitments for core sections and proposals are in preparation for other sections. GO-SHIP is working towards expanding national involvement through regional collaborations. As a result, proposals for a 2026 repeat of western Pacific P15S sections include Australian and New Zealand Programme Investigators (PIs). Dr Sloyan provided information on Level 1 (high priority), Level 2 (highly desirable), and Level 3 (ancillary) data requirements and detailed information are provided in the presentation[5].

Dr Sloyan mentioned that bio-GO-SHIP is a new contribution to the programme which was launched as a pilot project on the US GO-SHIP on lines P02 in 2022 and A16N in 2023.

[5] Link to 2.5 ppt

Supporting SOT through underway measurements, GO-SHIP provides underway SST, meteorological data, nutrients and pCO2. GO-SHIP also contributes to the Surface Ocean CO2 Reference Observing Network (SOCONET) which is a volunteer group of established operators providing sustained quality global surface ocean CO2 and atmospheric data from SOOP, Automated surface Vehicles (ASV) and moorings. SOCONET focuses on the operational aspects of measurements of CO_2 in both the ocean surface and atmospheric marine boundary layers. SOCONET tracks observations and data following established network principles.

Action 2/1*: Continue the application/development of new technologies for data acquisition and transmission (data recorders, antennas) (SOOPIP participating institutions, Ongoing)*

Action 2/2*: Continue the development and maintenance of a flexible XBT data management system that meets all the community requirements for data dissemination and applications. (SOOPIP participating institutions and any group doing data distribution in real-time and delayed-mode, Ongoing)*

Action 2/3*: Highlight the importance of the SOOP network for science (in scientific publications, presentations in meetings and workshop, seminars) and other areas such asparticipating in the XBT Science Team, Ongoing)*

Action 2/4*: Work with other ocean observing platforms and end users to enhance SOOP data usage (in scientific publications, research and collaborative projects) (Members of the SOOPIP panel also participating in the XBT Science Team, Ongoing)*

Action 2/5*: Review the network annually to meet the needs of the community (SOOPIP co-Chairs and vice-Chairs in partnership with the XBT Science Team Chairs, ongoing)*

Action 2/6*: Enhance partnerships with other programs like Argo, drifting buoys, VOS etc (SOOPIP participating institutions, Ongoing)*

Action 2/7*: Continue the work with the TSG, pCO2, Ferrybox, CTD and CPR community in operational and data management efforts within those groups (SOOPIP members, Ongoing)*

Action 2/8*: Work with WMO to update XBT BUFR sequence template to include salinity data from XCTD probes. (SOOP-EXB, Dec 2023)*

Action 2/9*: Appoint (additional) SOOP members for metadata and KPI TTs with the aim to set up and maintain missing items in the OceanOPS environment, including tools, targets, and reference tables, based on recommendations of the XBT Science Team but not limited to the XBT network. [find volunteers] (SOOPIP co-Chairs, Dec. 2023)*

Recommendation 2/1: *WMO to implement the XBT recommendation to adjust the template TM315004*

Recommendation 2/2*: Investigate the possibility of issuing a letter from IOC that can be used by SOOP recruiters/organizers as a template to satisfy indemnification. This letter*

is to reassure these shipping companies that technical personnel conducting observations will be careful to be out of the way of normal ship operations, will not cause delays or any issues for normal ship operations, and will collect data that will help these same companies by improving weather forecasts, safety at sea, etc. (SOOP Chairs with IOC, December 2023)

3. THIRTEENTH SESSION OF THE VOS PANEL (VOSP-13)

3.1 Report by the VOSP Chairperson

The VOS Panel (VOSP) vice-chairperson, Mr. Joel Cabrie, reported on the activities of the Voluntary Observing Ship Scheme, a network within the Ship Observations Team (SOT), during the last intersessional period. VOS Chair Mr. Henry Kleta has been on secondment in another role for much of the intersessional period.

VOS Panel - Terms of References
Terms of Reference (ToR) of the VOS panel were reviewed and adopted. SOT-12 adopted VOS ToRs are provided below.

The Voluntary Observing Ship (VOS) Panel shall:

a. Review, recommend and coordinate the implementation of new and improved specialized shipboard meteorological instrumentation, siting and observing practices, as well as of associated software;

b. Support the development and maintenance of pilot projects;

c. Oversee and encourage members to upgrade their VOS to report according to standards meeting climate user requirements, including reporting the required climate and ship parameters in both real time (GTS) and in delayed mode (via VOS GDAC); Develop and implement activities to optimize ship inspections and recruitment, including promotional and training material;

d. Develop and implement activities to optimize ship inspections and recruitment, including promotional and training material;

e. Prepare annually a report on the status of VOS operations, data and metadata availability and data quality;

f. Conduct user engagement and collect use and application cases for VOS data, demonstrating the value chain of VOS observations for science and societal benefits;

g. Regularly review the membership of the Panel and bring in new members (geography/gender/age) to TTs.

Reporting on the performance of the VOS network in 2022, Mr. Cabrie mentioned that approximately 4700 VOS were registered as stations in the OceanOPS metadata database by end of 2022 and 2885 stations provided real-time observations to the GTS in 2022. This is about 5% increase compared to 2020. Further he mentioned that about 26% of the VOS fleet is automated which is a significant increase since SOT-11. Also 25 active VOS programmes provided VOS real-time data in 2022.

Mr. Cabrie provided the status of real time data distribution. He highlighted that based on the OceanOPS counts there were about 3.96 million VOS observations in the GTS in 2022, averaging 300,000 observations per month from approx. 1600-1700 ships. E-Surfmar Observation counters state about 3.97 million VOS observations in the GTS in 2022.

Mr Cabrie highlighted that only 13 VOS programmes provided delayed mode data to the VOS Global Data Assembly Centres (GDACs) in 2022, which is about 1.25 million IMMT observations. This is about 32% of the 2022 VOS data provided into the VOS GDACs in International Maritime Meteorological Tape (IMMT) format.

Providing a status update on the PMO network, he mentioned that according to OceanOPS information, 60 Port Meteorological Officers (PMOs) and Offices provide service in 15 countries / territories.

Providing an update on the VOS activities with Maersk, Mr Cabrie reported that the pilot phase with third party data submitted from Maersk ship-owned instruments was not satisfactory. Whilst data volumes were very high, the lack of metadata and the quality of some parameters, like pressure made the uncertainty in data quality unacceptably high. Data submitted multiple times per hour to the GTS led to QC alarms at ECMWF. If continued, instrument type, location and maintenance details will be required. More details are available on the Agenda item 11.3 Task Team on Instrument Standards and Satellite Communications Systems (TT-ISSC).

3.2 SOT Technical Coordinator report on VOS support activities

The OceanOPS Technical Coordinator (TC) of the SOT, Martin Kramp, reported on his activities in the intersessional period, with finalization and implementation of the new SOT metadata format as top priority. With the transition to the new metadata format in September, preceded by a corresponding webinar and creation of a guidance document and video, almost all VOS operators migrated within a few months to the new format and now maintain metadata in the new system. The two biggest VOS fleets however (USA, Germany) still submit metadata in Pub47 bulk files per email, for which the mapping from old to new format has become a very time-consuming and dissatisfying effort for all involved parties (see TT-Metadata report for further details).

The TC reminded the meeting that as per the decision of the SOT, all new stations, and significantly modified existing stations (e.g., manual to automated, or transfer to another ship) should use a new, truly unique SOT-ID (allocated by OceanOPS on behalf of the Members), and that the use of (non-unique) call signs shall be avoided for any new stations. This practice has not (yet) been adopted by many station operators and makes the synchronization / mapping even more challenging.

The TC reminded meeting participants that regardless of the ID used in GTS submissions, a SOT-ID is automatically allocated for all stations/platforms registered in OceanOPS. Operators can switch to the SOT-ID in data submission at any time and are encouraged to do so. The OceanOPS system monitors incoming GTS data for such changes and will adjust and archive the metadata automatically.

The meeting noted that a protocol was successfully set up by OceanOPS to submit a subset of VOS metadata to WMO OSCAR, noting that OceanOPS is tasked to do so on behalf of the Members for all GOOS-OCG networks. This protocol is presently suspended because

some VOS had been registered multiple times in the OceanOPS database and the duplicates in consequence been submitted to OSCAR, where it is extremely difficult/impossible to modify any submitted data. The meeting agreed that appropriate training and discipline with metadata submission is required to avoid such issues. The submission of metadata to OSCAR will resume as soon as this issue is cleared. The submission protocol for SOOP and ASAP metadata is still under development.

The TC contributes to all SOT Task Teams (TTs) and Executive Board (EB); and beyond SOT, also OCG and WMO working groups. But (VOS) operator assistance with the new metadata format, SOTIdentification (SOT-ID) allocation and submission protocols remains the main activity for the TC at present. The new protocol with pre-compiled national reports, based on metadata submitted by the operators to OceanOPS, and corresponding data available from the French GTS node, has already helped with identifying, and sometimes solving, many issues with SOT data and metadata, in particular for VOS. Typical issues are missing or incorrect metadata, or incoherencies with GTS identifiers, headers, or duplicates (BUFR/TAC, BUFR/BUFR etc) on the data side. These issues will be addressed in more detail in other TT reports and during the National Report session.

The TC reported that from discussions with ship officers some frustration was noted that already recruited ships are contacted by Port Meteorological Officers (PMOs) from other National Meteorological and Hydrological Services (NMHSs), sometimes additionally during inconvenient times, such as when carrying out port operations. This issue and how to avoid it by using the OceanOPS tools will be addressed in detail under agenda item "cross-cutting ship coordination".

The meeting noted with appreciation that partnerships set up by OceanOPS with the ocean racing community allow for regular collection of data in under-sampled areas like the Southern Ocean, using high-tech equipment mostly funded by the participants or organizers or as third-party data with instruments already on board (in particular for meteorological measurements/VOS scheme). The meeting noted that such vessels may also deploy drifters and floats and encouraged the TC to foster such partnerships.

Mr Kramp reported that the QC relay tool[6] is in principle, operational; VOS operators are notified when a station appears on an E-Surfmar blacklist and take action as appropriate. The procedure should however be optimized with a working group, as at present, without action from the operator, a QC relay case is never closed, and new quality issues are ignored.

Regarding the VOS Donation project, Mr. Kramp reported that all three instrument packages (including each a Mintaka Star, Star X and Star XG) had arrived at OceanOPS in April 2023. The selected applicants of the project were notified by the SOT Chair. Some minor issues had been reported with the setup of Mintaka instruments recently, for which the origin is still unclear. In a related matter, and with reference to the WMO secretariat report on WMO Global Basic observing System (GBON)- Systematic Observations Financing facility (SOFF) and United Nations (UN) Early Warning for All (EW4All), the TC

[6] http://esurfmar.meteo.fr/qctools/

reported that for support of new VOS programs through these initiatives, technical specifications must be drafted.

Statistics, performance indicators and maps are almost unchanged since the last session, reports Mr. Kramp. With the new metadata format now in place, many additional products are possible and are planned to be addressed with the TT-KPI, including the Observation Coordination Group (OCG)-wide monitoring of the BUFR, SOT-ID migration, and VOS duplicate recruitments, with focus being on parameters (e.g., Sea Level Pressure (SLP) across VOS and DBCP).

3.3 E-Surfmar Expert Team on VOS status report

Reporting on the E-Surfmar VOS programme activities, Mr Olivier Desprez mentioned that 23 additional European Common AWS (EUCAWS) were installed in 2022, across participating members. Results of the barometer intercomparison study for VOS have been published and presented at the TECO meeting. The migration from Pub47 format to the new SOT metadata format was completed on 15th September 2022 by OceanOps with strong support and involvement of E-Surfmar members. Turbowin+ 4.3 has been released in July 2022 following a partner board and version 4.4 released in January 2023. As part of R&D actions, the EUCAWS mini logger prototype has been delivered, tested, and validated. Stations have been ordered and one unit will be delivered to each member who wants it. Discussions are taking place with international partners to develop the next generation of Turbowin.

On the data QC front, Mr Desprez reported that the supervision portal is accessible to all E-Surfmar program members and an automatic monthly monitoring report for VOS and buoys is available through this portal. He also mentioned that E-Surfmar is progressing on implementing a Mini EUCAWS on a surface marine drone. He noted that legacy issues with the former jcomm.info website and content remains; existing links that referenced to jcomm.info are not properly redirected. IOC/ International Oceanographic Data and Information Exchange (IODE) was requested to investigate to find a more suitable situation.

3.4 Discussions

It was noted that E-Surfmar is working with a French company to modify the EUCAWS system to install in an Automated Surface Vehicle (ASV). Participants agreed that a discussion is necessary to clarify where these new mini EUCAWS installations on ASV activities should be coordinated; under the Data Buoy Cooperation Panel (DBCP) or SOT. OCG is leading these discussions with applicable ocean observing networks.

Recent public interest in NRT ocean data and information highlight the importance of NRT observations as well as their data quality monitoring and suggest an (ad hoc) Task Team to work on this. The backdrop of this suggestion is the recent rapid ocean surface warming and the implication for a potential quick onset of an El Nino event, with some SST products showing record breaking values in late March/early April 2023, which tied or surpassed the previous record set in 2016 - which was an El Nino year. Analyses of the discrepancies on whether events are record-breaking or not among the different international SST products illustrate the importance of observational data quality and signal to noise ratios.

Ship SSTs (mostly from VOS) showed relative consistency with buoy and Argo float SSTs between 2017-2019, but ship SSTs became increasingly warm relative to buoy/Argo float SSTs starting from 2020. The reason is unclear yet, and it's unknown whether it's related to the COVID-19 pandemic which hindered VOS equipment maintenance and calibrations. But the public has a demand for near-real-time data on events such as whether we have a record-breaking warm ocean surface or not, implicating the importance of near-real-time data quality monitoring, and fixing quality drifting issues once revealed. It was suggested that XBT Science Team establish an ad-hoc VOS Science and Data Quality Task Team to address that.

The number of SST measurements from ships are reducing due to automation. Therefore, VOS operators are requested to install SST sensors together with the transition to AWS on ships.

Action 3/1: *VOS operators are requested to review and keep up-to-date VOS metadata in the OceanOps metadata database and automatically-generated national reports to ensure accurate data. Report any inconsistencies of the data in national reports to the OceanOPS TC (VOS operators, July 2023)*

Action 3/2: *VOS operators are requested to provide quarterly delayed mode data to the VOS GDACs. (VOS operators, quarterly and ongoing)*

Action 3/3: *VOS operators to review and update their VOS metadata in the OceanOPS metadata database and report issues to the TC or dedicated GitHub (VOS operators, ongoing)*

Action 3/4: *SOT station platforms operators (in particular VOS) to migrate to SOT-ID in data submission (immediately for new stations, encouraged asap for existing stations) (VOS operators, SOT-13)*

Action 3/5: *SOT Station/Platform operators (in particular VOS) to consult ship metadata in OceanOPS before any recruiting activity, avoid duplication and consult other existing/preceding users of the ship (SOT members, ongoing)*

Action 3/6: *TT-ISSC to review the OceanOPS QC relay tool (TT-ISSC, SOT-13)*

Action 3/7: *Encourage and facilitate the participation of VOS donation project participants in next PMO workshop (TT-RPT and SOT-EB, July 2023)*

Action 3/8: *Foster partnerships with the ocean racing community with the aim of increasing the data coverage in data-sparse ocean areas (SOT-TC, SOT-13)*

Action 3/9: *Members still using Pub47 bulk uploads to start using the reference tables of the new format (e.g. model), and migrate to the new format as soon as possible (VOS Operators; SOT-13)*

Action 3/10*: VOS Panel to investigate the installation of one lidar on a recruited vessel and report findings to the SOT (VOS Panel, SOT-13)*

Recommendation 3/1: *Content in the legacy JCOMM website (jcomm.info) is not correctly redirected to access historical information. IOC/IODE is requested to investigate how a more suitable situation could be obtained for the legacy JCOMM information access. (IODE, Dec 2023)*

4. CROSS-NETWORK SHIP COORDINATION

The OceanOPS Technical Coordinator, Martin Kramp, reminded the meeting of the background to the decision of the SOT to split metadata in the new format into three sections, for ship, station, and sensors: Ships are required by almost every in-situ marine observing network, either for installation of equipment on the ship (typically SOT, GO-SHIP), or to deploy/maintain/recover free drifting or moored equipment (typically DBCP, Argo, OceanGlider). The aim of a shared ship metadata repository is to track the activities of ships across all these networks. This not only allows the monitoring of performance and contribution of a ship (which can host a weather station, underway systems, deploy XBTs, floats, drifters etc.), but also allows for simplified exploitation of synergies and the ability to speak to ship owners and officers as a community, rather than as an isolated national program.

Mr. Kramp also reminded the meeting why the occasional presence of multiple stations of the same panel, but often operated by different programs (e.g. manual VOS in addition to an AWS) was a key driver for establishing the SOT-ID scheme. The TC stressed that ship metadata are a shared resource with shared responsibility. The OceanOPS system is designed to request users who submit doubtful ship metadata to check the corresponding values – ship names, flags, and call signs, change frequently, but this is not so for ship dimensions and never for International Maritime Organization (IMO) numbers. While such tests can be performed on the fly when data are submitted through the OceanOPS GUI or bulk uploader, such a test is NOT possible with metadata submitted in Pub47 format. Given that outdated metadata had been identified in Pub47 datasets, ship metadata in Pub47 format are presently not overwritten.

The TC reminded the meeting that for ships without IMO numbers, an International Council for the Exploration of the Sea (ICES) code may be used as an alternative, noting that OceanOPS is in the ICES code allocation committee. While ICES codes can change, codes for the same hull are linked and allow for a simple and full lifetime tracking of the hull. The TC showed typical ship metadata records in the OceanOPS system, including ship histories, and explained why a ship that changed the name, in consequence, leads to intentional multiple hits in OceanOPS queries. For showing the performance of initiatives that comprise multiple hulls (e. g. a sailor moves from one yacht to the next, or an RV is replaced, potentially with the same name) additional tags in OceanOPS would be required.

The meeting noted with appreciation that masking schemes have ended. The meeting also noted that it is nevertheless possible to hide ship identities from non-authorized users; if the operator of a station/platform makes such a request, the ship must in consequence also be masked across all other networks that run activities with the same vessel, and hiding ship identities should thus be limited as much as possible and requires TC validation. Given its perfect memory, only the ship type and dimension are submitted to WMO-Observing Systems Capability Analysis and Review (OSCAR) tool, in case hiding the ship identity should become a requirement at a later stage of ship's lifetime.

In addition to identifying ships of interest, the emerging partnership with Fleetmon will allow for the exploitation of a vast database of ship details. Fleetmon on the other hand is interested in showing contributions to the GOOS on its own website, and exchange of data will thus be of mutual benefit.

The TC requested all operators to contribute the most accurate ship metadata they can, and in order to benefit from the cross-network information, to establish a harmonized and balanced communication with volunteers, and to avoid double recruitments, from the same panel in particular.

The meeting also noted that in addition to unique station/platform identifiers, OceanOPS has been tasked to allocate unique cruise IDs which are available over the full lifetime of a cruise (which is not the case for e.g. Expocodes used by the RV community, which require that a ship has already started a cruise). The cruise ID is also used by the new OceanOPS cruise management tool, which allows simplified management of repeat cruises, as is often the case with the XBT community. SOT agreed that ship operators should request to hide ship metadata only in justified situations.

Action 4/1: *SOT operators to familiarize with the structure of the new SOT metadata format, and to communicate tutorials and instructions with regard to ship/station/cruise metadata and identifiers in their organizations as appropriate (SOT operators, ongoing)*

Recommendation 4/1: *OceanOPS to optimize Ship Name Queries in the sense that present and former name(s) are retained (OceanOPS)*

Recommendation 4/2: *OceanOPS to cooperate with AIS tracking companies for a comprehensive set of ship metadata, and identification of target ships (OceanOPS)*

5. TURBOWIN

Ms. Yvonne Schavemaker and and Mr. John van de Vegte from the Royal Netherlands Meteorological Institute (KNMI), reported on the status of the Turbowin. Ms. Schavemaker mentioned that the current TurboWin software which is used to send meteorological observations from ships at sea to the GTS is mainly in use on conventional VOS ships, but also on ships that are (partly) automated , to offer the opportunity of adding meteorological/visual data on board the ship. Visual data is important for safety at sea and climate research purposes. Data are entered into TurboWin by the ship's staff and sent via satellite connection or internet to the GTS. TurboWin is an easy to set up and cheap method of collecting meteorological data, which is often well compatible with the ship's capabilities.

TurboWin was developed by The Royal Netherlands Meteorological Institute (KNMI) several decades ago and continues to be maintained by them today. Interest in the software has grown and in recent years, maintenance and development of TurboWin has been supported through EUMETNET's E-Surfmar program. The software is open source, and anyone can download it from GitLab[7]. Anyone using TurboWin is able to send in feature requests. To ensure the focus is set on the development of commonly recognized priorities from the

[7] https://gitlab.com/KNMI-OSS/turbowin/turbowin

user requests, a TurboWin partner board was set up, led by MeteoFrance programme manager of E-Surfmar. This Partner board meets every six months, and after a software version is released and tested, decide on the features that will be incorporated in the next software version.

Recently it has become clear that feature requests from the Partner board are sometimes impossible to implement based on the current codebase. After a thorough review of the software, it was concluded TurboWin is technologically end-of-life. Also, maintenance will stop in 2025. This implies a major challenge. A shared effort is required to rebuild a future-proof, modular and safe next generation TurboWin to secure the continuous ingestion and use of global meteorological observations from visual observations and sensors.

SOT agreed to support the need for a next-generation TuboWin. Participants also agreed that the next-generation Turbowin partner board needs to include all stakeholders such as the ice observing community who are willing to use the system for sea ice observations. All participants agreed that there is a need to collect all requirements and expectations from the community and also look at other similar software e-logbooks that could serve as a replacement for the Turbowin software.

Action 5/1*: In collaboration with EUMETNET and WMO, SOT to stimulate provision of funding from the global community, including NMS's, to support the development of a next generation TurboWin. (SOT members, SOT-13)*

Action 5/2: VOS Panel to start working with Turbowin partner board on requirements and analysis for next-generation TurboWin (VOS Panel, SOT-13)

6. FIRST SESSION OF THE AUTOMATED SHIPBOARD AEROLOGICAL PROGRAMME (ASAP-1) PANEL

6.1 Report by the ASAP Chairperson

Mr. Rudolf Krockauer, the chairperson of ASAP reported on the activities of the panel. He mentioned that 21 ships worldwide provided regular upper air soundings on the GTS throughout the year. 14 out of 18 ships of the European ASAP (E-ASAP) fleet are merchant ships in regular service between North America and Europe. The remaining four are government ships (two German research vessels, one Norwegian research vessel, and one Spanish hospital ship).

Mr Krockauer mentioned that the total number of E-ASAP soundings on the GTS was 3681 in 2022. Taking into account the total number of launches on board versus the received soundings on the GTS, the average output (GTS/Launches) was 91%. The main reasons for failed launches are technical problems of the equipment, unfavorable wind conditions at 15-20 knots sailing speed, unexperienced operators, and poor satellite communication.

He further said that 389 soundings were received from the German research vessel Polarstern. Two Japanese research vessels (Keifu Maru and Ryofu Maru) transmitted around 97 soundings in the West Pacific to the GTS (mainly 2nd term 2022). 78 soundings were received from the South Korean research vessel Araon in July/August 2022.

Providing statistics of the ASAP Mr. Krockauer indicated that in total, 4247 soundings were received in 2022 from all ASAP stations. The distribution is as 87% E-ASAP (year-round,

mainly North Atlantic), 9% RV Polarstern(year-round), and 4% three other research vessels (Keifu Maru, Ryofu Maru, Araon; specific research expeditions).

Detailed information on these items are provided in the report[8] and all are requested to refer to the report for details.

6.2 SOT Technical Coordinator report on ASAP support activities

The OceanOPS Technical Coordinator of the SOT, Martin Kramp, reported that during the analysis of the 2022 ASAP operations a number of issues were identified which are either already partly solved or still under investigation. Issues comprise GTS-headers, identifiers, and missing or outdated metadata in general. More frequent interaction between OceanOPS and the station operators is required, the latter requiring a review of contact points.

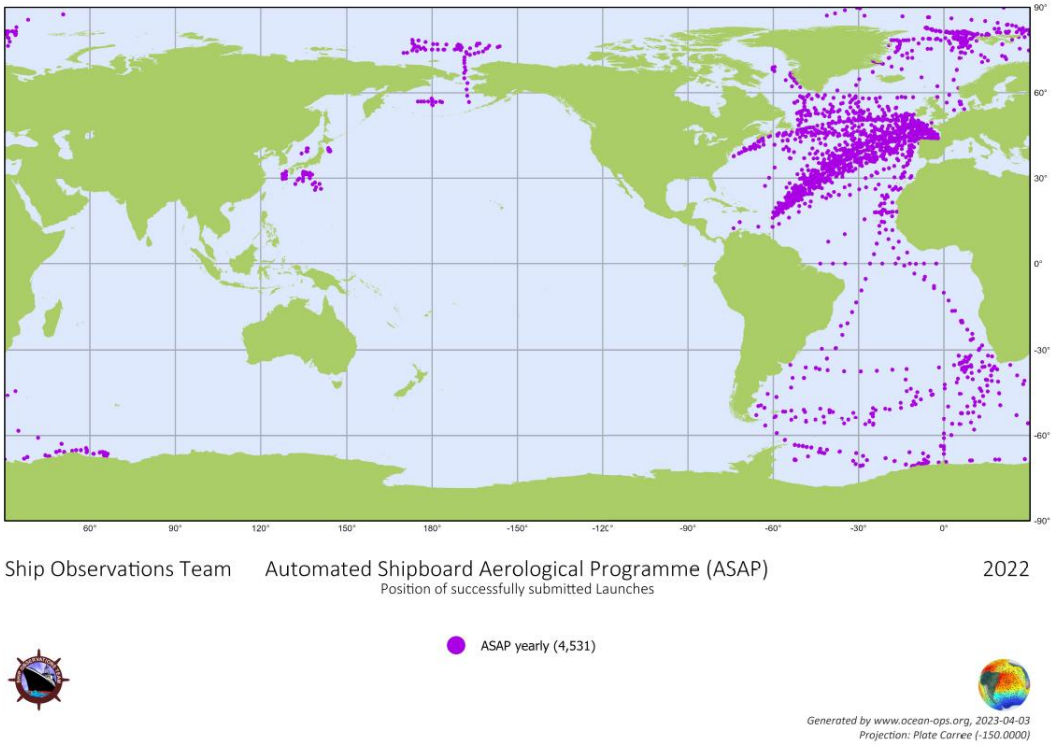
The TC added to the Chair report that in the intersessional period the Japanese RV Mirai made ASAP soundings, and after facing some technical issues with the satellite submission system South African RV S.A. Agulhas II also successfully launched ASAP balloons again with data available through the GTS. In general, ASAP data are reported in BUFR, but a few TAC reports still remain. Most ASAP stations use SOT-IDs, but some, even recent stations, still use call-signs.

The meeting noted that more active participation in the Task Team on Key Performance Indicators (TT-KPI) would help to agree on useful maps and indicators for ASAP. Launches can be completely unsuccessful or lead to multiple (and intended) GTS ingestions on the way up, and more recently also down, with a variety of options in terms of accounting.

SOT members have been encouraged, without success, to strengthen the network and achieve a broader, ideally global coverage. Through WMO GBON-SOFF, and related UN EW4All (see WMO secretariat report) it is hoped that more progress can be made in the upcoming years.

In addition to the complexity of running ASAP stations (e.g. refill of gas bottles in changing ports of call, etc.), funding remains the biggest issue. A pilot project was started in 2022 in partnership with the Schmidt Ocean Institute (SOI, philanthropic Non-Governmental Organization (NGO) running the RV Falkor), aiming to install a hydrogen generator on the new vessel to avoid gas refills. The budget was eventually frozen for 2023 but the project will hopefully make progress in 2024.

[8] https://wmoomm-my.sharepoint.com/:w:/g/personal/mkramp_wmo_int/EaUf2DwS1uJKqMcihkAQyKQBrjkg3np_z19836elmhFn0g?e=OvmYp7



6.3 Data issues and developments

Mr. Rudolf Krockauer stated that ASAP data are transmitted to the GTS in BUFR format. Soundings from the European E-ASAP fleet are semi-HiRes data with levels of 10-20 sec (plus standard and significant levels). Several stations provide ascent and descent profiles (thus doubling the number of profiles). It is planned to implement ascent and descent profiles on board all stations of the E-ASAP fleet.

6.4 Review and approval of ASAP Terms of Reference

Mr. Rudolf Krockauer reported that the Terms of Reference (as decided by SOT 9) remain unchanged and available on OceanOPS website[9].

6.5 Discussion, Q&A

It was noted that ASAP uses biodegradable balloons which reduces environmental impact. Representatives from the Bureau of Meteorology, Australia reported that they use blue color balloons in ASAP to avoid sea creatures eating and consuming balloons.

Participants noted changes to the data delivery through GTS (e.g. changes from TAC to BUFR, etc.). These changes need to be announced to the data users through different channels. All operators are requested to use the WMOOperational Newsletter[10] and

[9] https://tinyurl.com/bdd7bfpy

[10] https://community.wmo.int/en/news/operational-newsletter

METNO[11] messages through the GTS notification system to notify the GTS data users about changes and updates to the data distributions.

Action 6/1: *Operators of ASAP stations to maintain metadata in OceanOPS, updated including contacts (ASAP operators, SOT-13)*

Action 6/2: *TC and relevant TTs to continue ASAP project with SOI, as a pilot for similar projects with other entities (TC, TT-EICO, TT-RPT, SOT-13)*

Action 6/3: *Operators of ASAP stations to migrate to BUFR and use SOT-IDs if not done yet (ASAP operators, SOT-13)*

Action 6/4: *ASAP is requested to connect with GCOS as GCOS Implementation Plan action D2 aims to identify observations that don't have archives (ASAP, SOT-13)*

Action 6/5: *ASAP to develop a plan to archive all their data. This can be accomplished through a GDAC. Suggest checking the possibilities with GRUAN network data archival (ASAP, SOT-13)*

7. PARALLEL VOS/ASAP and SOOP BREAKOUT SESSIONS

VOS, ASAP and SOOP Panels had seperate discussions individually to address panel specific issues.

8. ENVIRONMENTAL STEWARDSHIP

On behalf of Ms. Shannon Kaya, the coordinator of the Environmental sustainability of INFCOM, Mr Michael Earle presented the activities towards environmental stewardship by the INFCOM. He mentioned that global weather and environmental prediction drive requirements for Earth system observations and associated observing systems. Within the overarching framework of the World Meteorological Organization (WMO) Integrated Global Observing System (WIGOS), the Global Basic Observing Network (GBON) programme sets requirements for the spatial coverage and temporal frequency of observations. The environmental impacts of meeting these requirements can be significant (e.g. new infrastructure with additional service and maintenance requirements, more waste). The transition to more environmentally sustainable observing systems and methods to mitigate these impacts is challenged by: (1) the criticality of observations via established systems/methods to prediction; (2) financial and operational feasibility considerations; and (3) the requirement for clear guidance from WMO to Members and the vendor community to inform implementation.

To address the third challenge, the WMO has launched a dedicated initiative to promote the development and adoption of environmentally sustainable observing system technologies and practices, with Canada as the international Focal Point. The Environmental Sustainability of Observations initiative aims to foster collaboration among WMO Members and industry, with the goal of developing practical and pragmatic recommendations for WMO consideration. This initiative covers meteorological, marine,

[11] https://community.wmo.int/en/activity-areas/operational-information-service/volume-c1

hydrological, and atmospheric chemistry domains, and considers both advocacy and technical perspectives.

A WMO survey was disseminated to benchmark current approaches and perspectives associated with the implementation of environmentally sustainable observing systems and practices. The survey was distributed electronically to 193 WMO Member States and Territories in August 2022, and closed in December 2022. A total of 103 responses were received, providing a broad perspective on how environmental sustainability is considered in current and planned approaches to network planning, procurement, siting and installation, operations, and decommissioning. The survey also gathered input on how Members perceive the opportunities and challenges associated with implementing more sustainable systems and approaches.

A panel discussion was held at the WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO) and Meteorological Technology World Expo (METEXPO) in Paris, France, in October 2022. Key take-aways from the discussion, which was led by representatives from both NMHSs and industry, included the need to improve the environmental sustainability of observing systems and methods, to justify observations based on their impacts to prediction and climate monitoring, and for early and open communication among implicated parties. Other focal points of the discussion included the value of automation, the necessity of maintaining data quality, and the potential financial barrier imposed by new technologies or methods.

The initiative has been advanced further via the integration of text promoting environmentally sustainable observing systems and approaches into WMO documentation, including technical specifications for surface and upper air, which are included in Systematic Observations Financing Facility (SOFF) documentation and the adoption of a new network design principle in the WIGOS manual. Two events are planned in the fall to promote the sharing of information, best practices, and new advancements and to develop plans and recommendations for the next stages of the initiative. In the meantime, opportunities for alignment with other groups and initiatives, notably those focusing on marine observations, are actively being explored, in the interest of collaboratively advancing a paradigm shift toward more environmentally sustainable approaches to Earth system observations.

9. ORGANIZATIONAL /ADMINISTRATIVE REPORTS

9.1 Report from Observations Coordination Group

Chair of the Observation Coordination Group (OCG), Dr. David Legler, mentioned that OCG of GOOS works to efficiently operate, maintain, coordinate and integrate a comprehensive in-situ global ocean observing system comprised of nine global networks and the number is increasing. The OCG has targeted 5 foci over the past 5 years, namely, Requirements, Observing Advances, Standards and Best Practices, OceanOPS, and Data management. Dr. Legler highlighted a number of OCG accomplishments. OCG led GOOS involvement in WMO Rolling Review of Requirement Process (RRR), OCG engagement in ocean integration in WMO Global Basic Observing Network (GBON), three OCG emerging networks (Glider, AniBOS, and High Frequency (HF) Radar) advancing to mature status, publishing of six best practises and another three in progress, OCG report card moving to GOOS wide report card, publication of the Ocean Observations from the National Jurisdictions (OONJ)

workshop report[12], capacity development webinars and workshops and OceanOPS five year strategy implementation on track are some highlights. Elaborating on future plans and opportunities of OCG, Dr Legler mentioned that OCG will develop metrics to measure network maturity, continue the dialogue with industry, assist observing technology development and integration the OCG Data Strategy and participate in the 8th WMO workshop on impact of observing system. Finally, he thanked Mr. Darin Figurskey, who announced his departure from the SOT chair position after SOT-12, for his exemplary leadership.

9.2 Report from the SOT Chairperson

SOT Chairperson, Mr. Darin Figurskey, provided a report on Chairperson activities primarily organized by the guiding principles in the SOT Strategy. With respect to global leadership in data and metadata requirements and coordination, the SOT made the official transition from E-Surfmar metadata to OceanOPS-hosted metadata, and the SOT task team on metadata (TT-Metadata) will continue to refine its work incorporating team and partner feedback. Following SOT-11, in 2021 the SOOPIP completed "XBT Operational Best Practices for Quality Assurance Version 1.0". Challenges continue with respect to observations in exclusive economic zones (EEZ), and the SOT encourages, and will continue to participate in efforts toward, furthering solution spaces as suggested by the 2020 GOOS Ocean Observations in Areas under National Jurisdiction (OONJ) Workshop.

Turbowin as presented under Agenda item 5, is a user-friendly electronic logbook software developed and maintained as opensource freeware by the Royal Netherlands Meteorological Institute (KNMI) and funded by the European network of National Meteorological Services (EUMETNET) through its Surface Marine Programme (E-Surfmar) and endorsed by the SOT. Turbowin is about 20 years old and does not adhere to current technology standards. A new software version must be developed and requires significant investment that cannot be managed within existing regular contributions.

Expanding the world's ship observations in space and number, in 2021 all panels showed an increase in observations from the previous year as networks and relationships were gradually rebuilt from COVID-19 impacts. Rebuilding efforts continue at present. Active efforts are in place to pilot the gathering of meteorological and oceanographic data and metadata, and ensuring their quality control, while also starting development of guidance documents on how to submit the quality data and metadata. Industry coordination continues successfully, for example, with Maersk cooperation to enable the installation of automated weather sensors on Maersk-owned vessels.

The SOT continues with a diverse Executive Board (EB), and the Chair thanks the board, and the SOT EC, for its service. The SOT is requested to approve the slate of volunteers for the SOT EB for term two per the SOT EB terms of reference. In particular, additional, active participants from across the globe are requested in task teams as it can be most efficient for succession planning of panel chair positions to come from experienced task team participants. This will only help the SOT increase its geographical diversity.

The SOT will continue to work through the OCG to inform GOOS efforts and to be functionally connected to WMO Technical Commissions. In addition, the SOT has been working hard on a capacity building effort to encourage the development of new national VOS networks. With the process for obtaining equipment being more well known through the SOT and especially the WMO, any future efforts should proceed more smoothly.

[12] https://www.goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=29549

It is requested that the SOT approve the financial report, which includes the SOT spending plan for the upcoming intersessional period. During the last two intersessional periods, SOT spending was limited due to COVID-19. It is expected that SOT spending will increase during the upcoming intersessional period due to efforts for capacity development and PMO training, and possibly in support of technological advances for SOT initiatives through OceanOPS.

Action 9.2/1: *NMHSs that participate in the SOT and its panels are strongly recommended to actively join the Turbowin Partner Board to coordinate future Turbowin requirements and to ensure the long-term sustainability of Turbowin through shared responsibility, including funding of the software's maintenance and development (NMHSs, SOT-13)*

Action 9.2/2: *At least five individuals from across the globe, including at least one each from the continents of Africa, South America and Asia, become new, active members in SOT task teams (SOT-EB, SOT-13)*

Recommendation 9.2/1: *OCG is strongly recommended to continue participating in efforts toward and furthering solution spaces as suggested by the GOOS Ocean Observations in Areas under National Jurisdiction (OONJ) Workshop (OCG, SOT-13)*

9.3 Report from OceanOPS

The OceanOPS Technical Coordinator, Martin Kramp, reported on status and activities of OceanOPS in general, and then addressed items of particular interest for the SOT such as SOT-ID, BURF migration, metadata, RTC, etc..

Based on the 2021-25 OceanOPS Strategic Plan[13] which had been developed with all its stakeholders, the centre is on track and provides key monitoring capabilities and coordination tools for networks and GOOS decisions. The Report Card[14] is produced on a yearly basis. Of all metadata for operational systems submitted to OceanOPS, around 80% are now provided to WMO-OSCAR. Metadata for fixed observing systems are presently harmonized to OceanOPS before addressing the metadata requirement of BioEco systems. OceanOPS provides intergovernmental support for EEZ issues and has made good progress in basin-based coordination meetings (metadata + gaps + ships + coordination = coverage improvement).

The cooperation with the International Research Ship Operators (IRSO) allowed for a pilot project with the Marine Facility Planning[15] tool, used by a growing number of RV operators: RV cruise plans are now available through the OceanOPS system and can be cross-checked with other analysis tools, such as drifter or float coverage, helping to find unexploited synergies and opportunities to implement the GOOS more efficiently. The meeting discussed the role of RVs (and OCG associated programs like GO-SHIP, Ferrybox in general) as contributor to SOT panels, noted (with reference to the WMO secretariat report, GHG symposium[16]) in particular the requirement to foster Greenhouse Gas (GHG)

[13] https://www.ocean-ops.org/strategy/

[14] https://www.ocean-ops.org/reportcard2022/

[15] https://maas-se.nl/mfp/

[16] https://community.wmo.int/en/meetings/wmo-international-greenhouse-gas-monitoring-symposium

observations and acknowledged the article "Sailing through the southern seas of air–sea CO2 flux uncertainty[17]" published early May 2023.

When many ship operations were canceled because of the pandemic, OceanOPS mounted a sailing boat charter with funding from NOAA/WHOI and Euro-Argo, which allowed for the carbon-free deployment of around 100 instruments (surface drifters and Argo floats) throughout the Atlantic before gaps in the arrays became significant. The OceanOPS Team regularly contributes to conferences and publications like the AMS article on "Effects of the pandemic on observing the global ocean[18]", driven by Dr. Tim Boyer.

A number of private sector and industry partnerships are underway and are planned to be part of the UN Ocean Decade endorsed "Odyssey" project driven by OceanOPS, but presently on hold because of budget restrictions: The OceanOPS team has grown with now 8 permanent staff members that are under contract with either WMO or UNESCO/IOC, but decreasing national contributions, inflation, and growing IT requirements have despite substantial financial support from WMO led to a situation which presently does not allow any planned promotion of existing, nor recruiting of new staff members; travel has been reduced significantly, and the outsourced web designer is presently not on duty; necessary web developments are collected through Github and will be addressed as soon as Mr. Thomas Latter, software developer, can be re-recruited, most likely after the summer. Fundraising for OceanOPS will be a top priority for the new established OceanOPS Manager position (Mathieu Belbeoch), noting that the upcoming full migration of the OceanOPS IT system from CLS to Ifremer represents an additional challenge.

OceanOPS is involved in ongoing partnership discussions with key players of the shipping industry like CMA-CGM, PONANT or MSC; the meeting noted that WMO Services/MMOP[19] recommended that OceanOPS and SOT actively participate again in the (second, 2024) WMO-IMO extreme maritime weather symposium[20]. The meeting requested to investigate if in cooperation with MMOP, and with particular reference to brochure No. 4[21], a joint publication could replace the VOS brochure. The TC stressed that in discussion with shipmasters it was often unclear to them how their own met-ocean observations or instrument deployments feed into met-ocean products/services and make their own shipping safer and more efficient in near-real time.

The meeting discussed if the static SOT and VOS websites should be overhauled. Similar to the special budget that had been allocated for the webdesign of the OceanOPS SOT GUI, OceanOPS (as host of the sites) is able to make such overhauls if budget for the outsourced webdesigner is available from the SOT budget.

With reference to the report from the Task Team on Expansion of Independent Class Observations(TT-EICO), the meeting noted that OceanOPS and SOT-EB members helped review an article lead-authored by Roberta Weisbrod (Interferry[22], in IMO partnership) with focus on more weather observations through AIS submissions. A particular interesting

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[17] https://royalsocietypublishing.org/doi/10.1098/rsta.2022.0064

[18] https://journals.ametsoc.org/configurable/content/journals$002fbams$002f104$002f2$002fBAMS-D-21-0210.1.xml?t:ac=journals%24002fbams%24002f104%24002f2%24002fBAMS-D-21-0210.1.xml

[19] https://community.wmo.int/en/activity-areas/Marine

[20] https://public.wmo.int/en/events/meetings/2nd-wmo-imo-symposium-extreme-maritime-weather-bridging-knowledge-gap-towards-safer

[21] https://library.wmo.int/index.php?lvl=notice_display&id=22138

[22] https://interferry.com/

point, related with efforts of Damian Foxall (11th hour racing[23]) to report navigational hazards to ships in the vicinity of the observing vessel, is the concept of taking a short-cut for urgent observations (ship-to-ship instead of ship-to-satellite-to-shore-to-satellite-to-ship), including, but not limited to, meteorological observations. To avoid duplication of efforts (including on observer side to submit observations, and related with NGTW) the meeting recommended to continue the ongoing discussions.

The meeting noted that OceanOPS presently runs a pilot project with individual QR codes added to the well-established OceanOPS recovery stickers on autonomous floats and drifters to facilitate instrument tracking.

The meeting also noted that the recent OceanOPS visit of new DBCP Chair Dr. Nelly Florida (BMKG) sparked the idea of a joint DBCP-SOT Capacity Development workshop, possibly hosted by BMKG in fall 2024.

The TC reported that many SAILDRONES were reported to OceanOPS as VOS (sample[24]) and requested a decision if saildrones are under SOT responsibility (including ID and metadata scheme), if required through the upcoming OCG meeting.

With regard to metadata submissions in general the TC encouraged the SOT to continue the ongoing work with OceanOPS and raise quality and quantity of metadata in the database. The OceanOPS API[25] is well documented and was tested by i. a. metadata TT members; new functions will be added if clear specifications are provided, and as soon as resources are available.

The TC reminded the SOT that the protocol with national reports[26] from Members to the WMO has changed and is now based on review of contact/program information, metadata and data statistics available in (and pre-compiled by) the OceanOPS system. Per decision of the SOT, the OceanExpert system is no longer maintained for the SOT. All information is available through, and also submitted to, OceanOPS. The SOT is spearheading this new reporting protocol for all WMO-coordinated marine observing networks, with the aim that Members are not required to update multiple databases: Through the OceanOPS system, WMO can maintain other services and lists. The TC reported that based on early feedback from Members the script was already optimized, but a working group should address the 2024 format with further feedback collected during SOT-12.

Action 9.3/1: *Members of the SOT to investigate if (better) financial support of OceanOPS is possible and report to the SOT-EB (SOT members, September 2023)*

Action 9.3/2: *Members to report recommendations/feedback for the 2023 Report Card to Editorial Board Member Liz Kent (SOT members, May 2023)*

Action 9.3/3: *The SOT, through its EB/EC, to review if stronger cooperation with IHO on collection of bathymetry data could be possible now, taking into account outcomes of the*

[23] https://www.11thhourracingteam.org/news/damian-foxall-named-11th-hour-racing-team-sustainability-manager/

[24] https://www.ocean-ops.org/board/wa/Platform?ref=PYU7AGZ

[25] https://www.ocean-ops.org/api

[26] https://wmoomm-my.sharepoint.com/:w:/g/personal/mkramp_wmo_int/ETB2gHQkfbNFgvQBecQmNNIB0ovAif4hlAfcoDqkisO4uw

first, and aims of the second WMO-IMO symposium on extreme maritime weather, and application of UNCLOS (SOT-EC, Dec 2023)

Action 9.3/4: *The SOT TT-RPT to investigate with WMO MMOP if a joint publication could be possible that comprises ship recruiting needs, potentially beyond SOT (e.g. Argo, DBCP), as an alternative to the existing, outdated VOS brochure (TT-RPT, Dec 2023)*

Action 9.3/5: *TT EICO / ISSC to continue discussions with working groups led by Roberta Weisbrod and Damian Foxall on data submission by AIS, including ship-to-ship reporting, and aiming to streamline observation/submission efforts performed by ship officers (TT EICO /TT- ISSC, SOT-13)*

Action 9.3/6: *SOT EB to develop a recommendation with respect to SAILDRONES as part of the SOT, and if required involve the OCG (SOT-EB, OCG 14)*

Action 9.3/7: *Members to keep the OceanOPS database updated, including ship, station, contact and program metadata (SOT members, ongoing)*

Action 9.3/8: *TT-KPI to review existing indicators and maps for the SOT and make recommendations to the EC for re-design or new products if required (and potentially parameter-based beyond SOT) (TT-KPI, Oct 2023)*

Action 9.3/9: *TT-RPT to make a concept with the Panel Chairs for an overhaul of static websites and SOT-EB to discuss with OceanOPS a way forward (TT-RPT, April 2024)*

Recommendation 9.3/1: *OceanOPS to continue playing a leading and coordinating role in high-level partnership agreements with the shipping industry, including harmonized 3rd party instrument standards and funding of instruments/data processing by the partners (ongoing)*

Recommendation 9.3/2: *OceanOPS to report to the SOT EB on progress with QR code pilot projects in other OCG networks, and the EB to make a corresponding recommendation for the SOT (SOT-13)*

9.4 Review of new national report procedure

The meeting discussed the new protocol for production of National Reports, which are to be submitted by its members to WMO on a yearly basis. Following up on decisions from earlier SOT sessions, draft reports are now pre-compiled by OceanOPS and include station, sensor and ship metadata, contact and programme information, and observation statistics (mostly derived from GTS data available at the French node). Demo clip[27] and further instructions[28] were circulated by OceanOPS in March by video-clips; based on the first feedback from program managers, the scripts were already optimized ahead of the SOT-12 session. The meeting agreed that remaining incoherencies are mostly based on lacking or outdated metadata, some others are related to data flow issues, and the new protocol was acknowledged by the meeting as a good tool to identify and also solve such issues in a timely manner and without duplication of efforts. The meeting also agreed that the SOT Committee should lead the review of the protocol for the next annual report, and in

[27] https://youtu.be/IPCrUdT8l1s

[28] https://wmoomm-my.sharepoint.com/:w:/g/personal/mkramp_wmo_int/ETB2gHQkfbNFgvQBecQmNNIB0ovAif4hlAfcoDqkisO4uw

particular discuss further items to add, such as sensors, GTS headers, data delivery templates, SOOP lines and operation modes. Participants also requested to have a 2 step process, step 1 to allow corrections in OceanOps, step 2 for manual corrections and to allow NFP and programme managers to change the roles of the people in their programmes.

Action 9.4/1: *Members to familiarize with the new protocol for National Reports and make corresponding corrections in the pre-compiled documents (SOT members, May 2023)*

9.5 Report from the WMO Secretariat (data policy/GBON/SOFF)

Ms. Champika Gallage from the WMO Secretariat reported on the key initiatives of WMO which are directly relevant to the SOT community.

WMO Unified Policy for the International Exchange of Earth System Data
Ms. Gallage reported that the WMO Unified Policy for the International Exchange of Earth System Data was approved at the Extraordinary Congress (Cg-Ext) session held in 2021 under Resolution 1. This replaced the former Resolution 40 (Cg-XII) and Resolution 25 (Cg-XIII) , and Resolution 60 (Cg-17) . This single 'unified' data policy across multiple domains includes Weather, Climate, Hydrology, Atmospheric Composition, Cryosphere, Oceans, and Space Weather and aims to broaden and enhance the free and unrestricted international exchange of Earth system data. For oceans, it covers in-situ and remotely sensed observational data both in and above the ocean and at the sea surface, from the open ocean to the coast, along with other data that provide necessary input to ocean monitoring and prediction and for a variety of other Earth system applications. This policy acknowledges the right of governments, based on their national laws and policies, to choose the manner by and the extent to which they make data available domestically or for international exchange, so it does not override national data policies.

Rolling Review of Requirements
Highlighting the WMO Rolling Review of Requirements (RRR) process, Ms. Gallage mentioned that RRR jointly reviews Members' evolving requirements for observations and the capabilities of existing and planned observing systems. As a result, through so-called "Statements of Guidance" experts in each application area address the extent to which the capabilities meet the requirements, and they produce gap analyses with recommendations on how these gaps could be addressed.

A revised description of the RRR process was approved through Resolution 3.2(1)/1EC-76 as part of the updates to the WIGOS Manual (WMO No 1160). This revised description of the RRR process includes recognition of Earth System Application Categories: Space; Atmosphere, Oceans; Hydrosphere and Terrestrial; and Cryosphere; together with the overall Integrated Earth System. Interfaces are recognized as important areas for activities that have significant requirements for observations. New arrangements are included for collaboration between all the Application Areas within each category – to identify gaps in observing system capabilities and to provide guidance on the most important and achievable priorities for addressing the gaps in that Earth System Application Category.

WMO organized a series of roundtable discussions with ocean experts on the contribution of the ocean community to the WMO RRR process. GOOS has notionally agreed to take the co-ownership of some ocean Application Areas (i.e. Ocean Mesoscale forecasting &

real-time monitoring, Oceanic climate monitoring, and services) together with Services Commissions (SERCOM). IOC/GOOS was invited to use this RRR process to lead and own ocean applications which are not included in WMO at the moment, such as the Biogeochemical cycling application.

Global Basic Observing Network (GBON)

Ms. Gallage provided an update on the GBON (Resolution 34 (Cg-18)) and stated that GBON is a subset of the surface-based subsystem of WMO Integrated Global Observing System (WIGOS), used in combination with the space-based subsystem and other surface-based observing systems of WIGOS, to contribute to meeting the requirements of Global National Weather Prediction (NWP), including reanalysis in support of climate monitoring.

Regulatory material on GBON is published in the Manual on WMO Integrated Global Observing System (WIGOS), WMO No. 1160. The WMO 76th Executive Council adopted several amendments to the Manual through Draft Resolution 3.2(1)/(EC-76). These amendments include the new GBON designation process, among others. Sections 3.2.2.10, 3.2.2.11, and 3.2.2.14 identifies the GBON regulations on the surface marine meteorological domain.

WMO Cg-Ext in 2021, through Resolution 2 on GBON technical regulations had requested the Commission for Observation, Infrastructure and Information Systems (INFCOM) to explore, in collaboration with the WMO- Intergovernmental Oceanographic Commission (IOC) Joint Collaborative Board (JCB), possible initiatives to strengthen the exchange of surface-based Earth system observations over the global ocean, for example via an extension of GBON into this domain. Initial ocean integration to GBON will be led by the ocean representative in the Task Team on GBON (TT-GBON) with assistance from ocean community members (i.e., DBCP, SOT, Satellite community/GHRSST, etc.)
The EC-76 approved the draft Guide to the GBON through Draft Resolution 3.2(3)/(EC-76), which will be included as a new chapter of the Guide to the WMO Integrated Observing System (WMO-No.1165).

Early Warning for All (EW4All)

In March 2022, the United Nations Secretary-General Antonio Guterres announced a new UN global initiative to ensure that everyone is protected by early warning systems within the next five years, and WMO is tasked to spearhead this activity. People-centered Multi-Hazard Early Warning System (MHEWS) will support the EW4All initiative. MHEWS has four pillars,

1. disaster risk knowledge,
2. detection, observations, monitoring, analysis, and forecasting hazards,
3. warning dissemination and communication, and
4. preparedness and response capabilities.

WMO is responsible for pillar two while United Nations Disaster Risk Reduction (UNDRR), International Telecommunication Union (ITU) and International Federation of Red Cross (IFRC) will lead pillars 1, 3 and 4, respectively. At the COP27, WMO launched the Executive Action Plan 2023-2027 for EW4All. Under the key action areas of pillar 2 it identifies the need to close ocean observation gaps in the coastal regions.

Systematic Observations Financing Facility (SOFF)

SOFF was established through Resolution 3 of the WMO Cg-Ext in 2021. This is initiated as the primary vehicle to provide the necessary financial and technical support for the implementation and sustained operation of the GBON in the least developed countries (LDCs) and small island developing States (SIDS) and of the limited technical advisory support it provides to other developing countries. SOFF is a United Nations Multi-Partner Trust Fund created by WMO in collaboration with the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the United Nations Multi-Partner Trust Fund Office. Members with capacity are requested to contribute financially and provide expert readiness technical advisories, including peer-to-peer, to support the implementation of SOFF. SOFF support will be available for ocean observations once the ocean domain GBON requirements are clearly defined and technical specifications are clarified and documented.

Establishment of the Advisory Group on the Oceans (AG-Oceans)

Study Group on Ocean Observations and Infrastructure (SG-OOIS) prepared the final report proposing optimal functional connections between WMO and IOC-GOOS bodies, programmes, and systems, aiming at ensuring effective and sustainable ocean observing infrastructures in the context of the WMO Earth System approach. SG-OOIS identified eight major areas where functional connections are requested and issued 29 recommendations in eight main domains.

The report stated that the three most important items are improving the connection between WMO and GOOS regional bodies, establishing new functional connections to the revised Rolling Review of Requirements (RRR) process, and establishing an Advisory Group on Oceans (AG-Oceans). The new Advisory Group on Oceans will function as an entry point for INFCOM technical developments, ensuring a smooth translation of requirements from the ocean-observing communities into INFCOM activities and also translating INFCOM outputs into ocean outcomes. This would support the work of, inter alia, the Observations Coordination Group (OCG) and the GOOS Steering Committee.

Through Draft Resolution 5.2/1, INFCOM-2 established the Advisory Group on Oceans (AG-Ocean) to provide overall coordination on the application of ocean monitoring, including but not limited to observations, data management, data sharing, data utilization, and products, and the activities related to the terms of reference of the Infrastructure Commission.

WMO International Greenhouse Gas Monitoring Symposium

WMO organized a three-day symposium on International Greenhouse Gas Monitoring that was attended by 170 stakeholders in-person and about 600 online. Outcomes of the symposium identified that WMO, due to its intergovernmental nature and its role in international coordination, is uniquely positioned to play a significant role in advancing the scientific and technical coordination of activities such as observations, data assimilation and modeling to develop products to inform policy decisions. Based on the symposium results, EC-76 made a recommendation to the 19th Congress to endorse the concept of the WMO-coordinated Global Greenhouse Gas (GHG) monitoring Infrastructure.

Ocean experts participated and delivered keynote speeches at the symposium highlighting the pCO2 measurement activities, Surface Ocean CO_2 Atlas (SOCAt), and GLobal Ocean Data Analysis Project (GLODAP) for Carbon. Speakers further identified the need for

sustainable funding, coordination, and extension with high-quality surface CO2 and surface-to-deep ocean carbon transport measurements with a balance between physical and biological processes.

The symposium outcomes include actions on GHG observation networks which include; supporting existing and stimulating further development of both surface and space-based observing systems for the atmosphere, ocean and land surface and stimulating their further development; working with observational communities to establish standards for development, deployment, inter-calibration, data acquisition, and data exchange for both in-situ and space-based measurements; and exploring mechanisms for improving sustainability and geographic coverage of greenhouse gas and related observations.

The WMO Education and Training Programme (ETRP) assists Members, in particular, developing countries and countries with economies in transition, in obtaining personnel specially educated and trained to internationally agreed standards to carry out the activities and operations of National Meteorological and Hydrological Services (NMHSs) required at the global, regional and national levels for the effective provision of meteorological and hydrological services in support of sustainable development of Member countries. Most of these courses are delivered in collaboration with Regional Training Centers (RTCs). Online courses, including Marine Meteorology, are available through the ETR Moodle site. One of such recently added online self-directed course is on Public-Private Engagement in Weather, Climate, and Water Services. SOT members are encouraged to make the best use of these resources.

Action 9.5/1: *As identified in the WMO data policy, Annex 1 section 6, SOT members are urged to share core and recommended in-situ data in real-time using the recommended data formats (SOT members, ongoing)*

Action 9.5/2: *In preparation for ocean integration into GBON and for small island developing states (SIDs) and least developed countries (LDCs) to receive SOFF assistance, countries without PMOs are urged to establish a national PMO network. (VOS members with the assistance from TT-RPT, SOT-13)*

9.6 Presentation and discussion of WIS2.0

Dr. David Berry from WMO secretariat presented plans on the evolution of the WMO Information System (WIS2.0), highlighting the use of public infrastructure, such as the World Wide Web and Internet, for telecommunications, and the use of open standards and APIs to facilitate access to the data and information. Dr. Berry outlined progress made within the current pilot phase, the key components of the WIS2.0, including the global services, and how ship observing community may use the WIS2.0 to exchange data. Dr. Berry further noted that information on the WIS2.0 is available at the WMO community website[29].

9.7 Report from the IOC Secretariat

Dr. Emma Heslop provided an overview of the GOOS and how SOT and its panels play a big role in global ocean observations. She elaborated on the core coordination of GOOS activities under expert panels. She highlighted the large number of observations provided

[29] https://community.wmo.int/en/activity-areas/wis/wis2-implementation

by the thirteen global ocean observing networks coordinated through the OCG of GOOS, contributing to forecasting modelling and climate studies. Collectively GOOS (OCG and networks) tries to address system integration, new technologies, and evolution of the global system. GOOS collaborates with many WMO initiatives and new connections are being made in the areas of RRR and GBON. Dr. Heslop summarized the GOOS Steering Committee (GOOS SC) meeting outcomes and highlighted the importance of regional systems, the unique opportunity afforded by ocean decade activities and support for core GOOS functions.

Dr. Heslop provided the results for the survey on Ocean Observations in Areas under National Jurisdiction (OONJ), including seven responses from the Ship of Opportunity Programme (SOOP). A request will be made at the IOC Assembly in June 2023 to set up an ad-hoc committee of Member States to consider the issues identified in the survey and make suggestions for action in 2024. In addition, she also presented the GOOS Work Plan 2024-2025, GCOS Implementation Plan & JSG GCOS Review Report (new MoU), WMO-IOC Joint Collaborative Board (JCB), and New IOC data Policy also will be included in the IOC Assembly.

To help achieve the GOOS 2030 Strategy and the Ocean Decade outcomes, GOOS has launched 3 integrated programmes that will be foundational building blocks for the Ocean Decade (co-design, coastal ocean and capacity development). The co-design project initiated 6 exemplar projects to address key gaps in integrated ocean observing through the entire value chain.

Concluding her talk, Dr. Heslop reiterated the important role PMO's play in ocean observations and offered support from GOOS in many areas, including improving functional connections with stakeholders, negotiating with shipping companies, increasing the visibility of VOS and SOOP. Dr. Heslop suggested including Dr. Ting Yu as the IOC secretariat to support the SOT.

10. NATIONAL REPORTS

Thirteen countries/territories (USA, UK, The Netherlands, Germany, E-Surfmar, France, South Africa, Australia, Norway, Japan, Hong Kong, China, Chile) presented their national reports at this session. Some of the national presentations were pre-recoded accommodating remote participants especially those with time zone differences.

Many countries indicated that the ship observation activities are already at or moving toward pre-pandemic levels. Rollout plans to integrate ships with AWS are progressing well. This transition will increase the number of observations but decrease the limited number of visual observations coming from ships. This is likely to impact the availability of non-automated visual observations such as cloud cover, visibility, etc. and needs to be addressed.

Some members indicated that metadata in OceanOPS has room to improve such as improving tools for manual entry of some metadata, eliminating errors in bulk upload of metadata, mismatch in observation count, etc. Using Iridium telecommunications in the Indian Ocean was identified as an unresolved issue. GOOS and WMO secretariat were requested to address this issue with India.

A few countries raised the concern that some of the data collected by ships that are not shared on the GTS, such as TSG and pCO2 data, are not reflected on the OceanOPS autogenerated national report. There should be a mechanism to resolve this. Participants suggested to produce national reports per shipping company to show their contribution to the data pool and also to improve forecast and model outputs.

Presenters of national reports highlighted the value of advocating to ship masters and owners the importance of observations, which helps to recruit more ships to VOS and improve observation quality. In-person engagement with the ships is important. Presenters also highlighted the importance of getting quality instruments on the ships to deliver reliable observations.

Action 10/1: *Invite ship masters to the next SOT sessions to increase awareness of their contribution to the weather, climate and other related products (SOT-EB, SOT-13)*

Action 10/2: *Create promotional material to provide to ships to show their contribution for the global good (TT-RPT, SOT-13)*

Recommendation 10/1: *Investigate the possibility of issuing a letter from IOC that can be used by SOOP recruiters/organizers as a template to satisfy indemnification. This letter is to reassure these shipping companies that technical personnel conducting observations will be careful to be out of the way of normal ship operations, will not cause delays or any issues for normal ship operations, and will collect data that will help these same companies by improving weather forecasts, safety at sea, etc. (SOOP Chairs with IOC, December 2023)*

11.RECOMMENDATIONS AND ACTIONS BY THE TASK TEAMS

11.1 Task Team on Recruitment, Promotion and Training (TT-RPT)

The chairperson of the TT-RPT, Ms. Mardene de Villiers reported on the activities of the TT. She mentioned that during the last intersessional period, the main tasks of the TT were, conclusion of VOS Donation Program, planning PMO-7 workshop and webinar/video creation and made available for the PMO community. Three applications were received for the VOS donation programme, from 3 countries (Russia, Chile and Argentina) where all three countries will receive low-cost sensor packages. Following WMO procurement process, Mintaka AWS won the contract to supply 3 AWS, and the equipment packages have been delivered to the OceanOPS for redistribution to the identified countries. She mentioned that TT-RPT is planning to organize the PMO-7 workshop and Pacific Community (SPC) from Fiji has shown interest in hosting this in late 2023. Currently TT-RPT is in discussion with SPC and will notify the SOT members as soon as details are confirmed. Ms. Villiers also listed webinars and videos made available for PMO community; SOT-ID, SOT User Groups, Contacts: Where to find on OceanOPS and tutorials.

Task team proposed adjustments to the Terms of Reference and the revised and approved ToR are provided in the Annex 2.

Action11.1/1: *Review member lists (NFP, PMO, TT membership and ensure current lists are maintained and available from the SOT website (TT-RPT, 30 September 2023)*

Action11.1/2: *Arrange the 7th PMO workshop with a focus on the South Pacific area. (TT-RPT, September 2023).*

Action11.1/3: *Create a guidance documentation for the VOS Donation program which will accompany the instrumentation. (TT-RPT, July 2023)*

Action11.1/4: *Update VOS Brochure with SOT activities and with OceanOPS details. (TT-RPT, September 2023).*

Action11.1/5: Create a quick reference document for Turbowin+ (setup, use, download log files, etc.) (TT-RPT, September 2023)

Action11.1/6: *Review member lists (NFP, PMO, TT membership and ensure current lists are maintained and available from the SOT website (TT-RPT, 30 September 2023)*

11.2 Task Team on Metadata (TT-Metadata)

Ms. Emma Steventon, the chair of the TT-Metadata reported on the progress of activities in three-phases.

Phase 1: The OceanOPS website is declared operational; the ESURFMAR VOS Metadata database user interface is switched off and all users are to start providing and submitting their metadata in the new SOT metadata format, via the OceanOPS user interface or bulk upload tool. This phase was completed as of 15th September 2022 and OceanOPS is now the official metadata repository for SOT networks (although noting that further development is still needed for SOOP). All countries with the exception of the US and Germany have begun submitting their metadata in this way.

In order to achieve this the task team efforts were focused primarily on the following activities: agreeing and updating the WIGOS metadata standard code tables to meet the needs of the SOT networks and WIGOS requirements; agreeing field entry formats, common units & ISO standards; and consequently working with OceanOPS technical staff to implement these structures into the OceanOPS user interface.

A small sub-team of task team members was assembled to carry out dedicated testing of the OceanOPS user interface, logging all issues, bugs and new functionality requests in the SOT OceanOPS GitHub repository. The sub-team met routinely until all blocking issues had been resolved and the interface was suitable for operational use by the SOT community.

The task team also agreed that given the provision of SOT-IDs there is no longer a need for traditional masked IDs, with ships being 'non-hidden' by default and 'hidden ships' only available to view by registered/authorized OceanOPS users.

The new metadata format was documented and circulated to the user community prior to a training webinar being held on the 12th September 2022. This document followed a similar structure to the WMO. Pub.47 metadata standard and consisted of a table to list each field along with a description, format, condition, code table links and an example entry. Version 1 of this document is available on the SOT website and a link provided in the references below.

The webinar provided an opportunity to introduce the new metadata format to the user community and explain the phasing out of WMO Pub47. Led by the OceanOPS Technical Coordinator, Martin Kramp, participants were guided through the structure of the format,

the key features of the OceanOPS user interface and how to submit metadata and request SOT-IDs. A permalink[30] gives access to format, webinar recording and further instructions.

Phase 2: Now moving into Phase 2, which is scheduled to run until 2024, the work of the task team will focus on migrating outstanding users, notably the USA and Germany from Pub47 to the SOT metadata format and continue to resolve bugs and inconsistencies in the OceanOPS user interface. The technical coordinator will continue to work with the SOOP community to ensure their transition runs smoothly and their needs are met. Further user documentation will be developed to assist both users submitting metadata and those looking to export it, as well as how to request new content for reference tables. The task team will continue to work with the TT-RPT to ensure wider training needs are met and that sufficient documentation and supporting webinars are provided. Another stream of work will be to engage with ESURFMAR over the development of the next generation of the TurboWin software, a first version of which is scheduled to be made available by 2025.

Currently the OceanOPS to Pub.47 format daily export still occurs in a slightly degraded version, but by the end of Phase 2, this export will end and all users must have migrated to using the new SOT Metadata format.

Phase 3: due to end by 2026 will see WMO Pub.47 metadata submission no longer possible and migration to the SOT Metadata format will be considered complete.

SOT-12 reviewed and approved the ToR and the new ToR is provided in the Annex 3

Action 11.2/1*: Prepare instructions for how users can request to add a new sensor to OceanOPS reference tables (TT-Metadata, September 2023)*

Action 11.2/2: *Produce a user guide for how to use the OceanOPS system to extract/export metadata (TT-Metadata, September 2023)*

Action 11.2/3*: Work with Turbowin Partner Board to discuss requirements for integrating the new OceanOPS metadata format for SOT within the next generation TurboWin software (TT-Metadata, December 2023)*

Action 11.2/4*: Regularly review the OceanOPS SOT Github repository for updating metadata reference table values and issues regarding the OceanOPS tool (TT-Metadata, Ongoing)*

Action 11.2/5*: All users to have migrated to using the new OceanOPS metadata format for SOT and submitting their metadata via the OceanOPS interface by the end of migration phase 2, noting that the OceanOPS to Pub47 export will end by Dec 2024. (SOT operators, December 2024)*

Action 11.2/6*: Metadata migration Phase 3 to end December 2026, at which point WMO. Pub47 metadata submission is no longer possible. Any users still providing metadata in Pub47 format are requested to have migrated to the new SOT metadata format by December 2024. (SOT operators, December 2026)*

Action 11.2/7: *Prepare a service note on Pub47 retirement with timelines and publish it in WMO Service Note. (TT-Metadata, Dec 2023)*

[30] https://www.ocean-ops.org/metadata/sot

Action 11.2/8: *TT-Metadata to work with delayed mode data providers including ICOADS on a protocol regarding the availability of detailed ship information from vessels for which the "hide ship details" option is activated in OceanOPS. (TT-Metadata, Dec 2023)*

11.3 Task Team on Instrument Standards and SatComm Systems (TT-ISSC)

Mr Jean-Baptiste Cohuet, Chair of the TT-ISSC reported on the Task-Team activities. During the last intersessional period, the main tasks of the Task Team on Instrument Standards and Satellite Communications Systems were:

ISO standard

TT-ISSC contributed to the ISO standard "Ships and marine technology — General specification for shipborne meteorological instruments". That will be published soon. This document describes the generic specifications for meteorological measurements onboard a ship.

Systems and telecommunications used (VOS)

In 2022, 5223402 observations (FM13 & BUFR) from 4144 different GTS-IDs have been received at the French GTS node, which is a huge increase compared to previous years, partially due to Maersk measurements being transmitted on the GTS from mid-2022 every 10 minutes.

Reference tables[31] for OceanOPS metadata database for observing systems and sensors models have been developed. A mapping from all the free-text Pub47 entries has been established to initiate the database. However, metadata are not complete and are still missing or inconsistent for many stations. Details are given in the report[32].

WMO n°8

WMO proposed the development of a new Volume on Ocean measurements to the *Guide to Instruments and Methods of Observation (WMO No. 8)*. The topic of marine measurements is currently presented in WMO No. 8, Volume III (Observing Systems), Chapter 4: Marine Observation[33]. Efforts to contribute to this new volume for the measurement from ship activities started during this intersessional period and will continue during the next period, including extended SOOP activities (e.g. underway systems, plankton recorders)

Transition to BUFR

Transition to BUFR is still not completed in particular for Australia, Canada, India, South Korea, Brazil, Argentina, Thailand, and Russia (see the full report on TT-ISSC[32] for more details in annex D). The template 308014 approved in 2016 is still not used and no messages are seen on the GTS at the moment, but it was noted that tests will begin shortly (e.g. France, UK). Centers that are sending both FM13 and BUFR are encouraged to stop

[31] https://github.com/OceanOPS/sot-metadata/tree/main/tables

[32] https://wmoomm-my.sharepoint.com/:w:/g/personal/mkramp_wmo_int/EYU90hb6_A5FpNPGD9iVXrsBGbBSKeusYlSXQRZcf7NXhw?e=mZBqwf

[33] https://community.wmo.int/activity-areas/imop/wmo-no_8

FM13 diffusion. Also centers that are converting BUFR back to FM13 (mainly NOAA KWBC) are asked to stop this conversion.

Action 11.3/1: *Members to update their metadata in OceanOPS database and clean inconsistencies. (SOT members; Dec 2023)*

Action 11.3/2: *Centers that are sending both FM13 and BUFR to the GTS are encouraged to stop FM13 dissemination. (SOT members; December 2023)*

Action 11.3/3: *Centers that are converting BUFR back to FM13 are asked to stop sending these FM13 to the GTS. (SOT members; December 2024).*

Action11.3/4: *Incorporate SOOP program into the TT-ISSC with analysis of the GTS data for SOOP vessels. Include Rebecca Cowley and Lisa Krummel in the TT to support the incorporation. (TT-ISSC, SOT-13)*

Recommendation 11.3/1: *DWD to filter inaccurate/bad 3rd-party data received from MAERSK ships before GTS insertion.*

11.4 Task Team on Key Performance Indicators (TT-KPI)

The chair of the task team, Dr. Elizabeth Kent, briefly introduced the team, its terms of reference and its current membership. Dr. Kent then reviewed actions from SOT-11 and summarized the work of the task team over the inter-sessional period.

The TT-KPI met twice during the inter-sessional period and made some progress on reviewing the static maps and agreeing the appropriate KPIs for the XBT network. It is proposed that the TT-KPI is reappointed with current membership and with actions rolled-over from SOT-11 with deadlines during the remainder of 2023.

Action 11.4/1: *Further develop metrics on spatiotemporal coverage, relating those metrics to the requirements as specified in the WMOs RRR (in coordination with the GOOS OCG/networks, GCOS AOPC and OOPC, and other relevant groups). (TT-KPI; Dec 2023)*

Action 11.4/2: *Further enhance metrics on:*

- *data flow (to include monitoring the use of the latest BUFR sequences for marine data);*
- *quality of observations (particularly linking to the MeteoFrance QC tools, blacklisting and error statistics -mean error and RMSE);*
- *and the percentage of VOS in a particular class reporting the parameters required to meet that classification. (TT-KPI; Dec 2023)*

Action 11.4/3: *Review monthly-OceanOPS products, including static maps, in liaison with the TT- KPI and adjust those as necessary. (SOT-TC, TT-KPI; by September 2023)*

Action 11.4/4: *Consider the development of a single, integrated KPI for all SOT (and OCG) networks (TT-KPI, SOT-TC, (& OCG); June 2023)*

11.5 Task Team on the Expansion of Independent Class Observations (TT-EICO)

Mr Darin Figurskey, chair of the Task Team on the Expansion of Independent Class Observations (TT-EICO), reported on the activities and stated that TT-EICO has met regularly since 15 November 2021. The primary task team efforts have been to: gather observations from the Bulk Xaymaca (managed by Science Research on Commercial Ships [Science RoCS]), led by Woods Hole Oceanographic Institution (WHOI) for proof of concept; consider quality control; create a vision for a dataflow framework; pilot possibilities; and coordinating the integration of the Open-GTS with WIS 2.0. The task team is also in the very early stages of the development of a guidance document. This guidance document will focus on how to collect third-party data, data formats, how quality observations can be contributed to the GTS, the definition of a trusted node, and data flow via trusted nodes and data acquisition centers (DACs).

A challenge will be maintaining some level of coordination and cooperation with numerous global initiatives for collecting and transmitting third-party data, while making steady progress on the task team goals. It may end up being, and likely will be, impossible to coordinate all such efforts. It is important for the SOT to commit to this effort over the long-term, as patience and steady progress, along with taking advantage of targets of opportunity, can have the benefit of more weather and ocean observations for society and the blue economy.

Participants appreciated the work completed by the TT-EICO and agreed to continue the activities of TT-EICO until SOT-13 under the updated and SOT-12 approved ToR provided in Annex 4.

Action 11.5/1: *Inform the TT-EICO of coordination and resource opportunities for the Open Access to GTS Project (Open-GTS Project) as an endorsed action forming part of the UN Decade of Ocean Science for Sustainable Development 2021-2030. (SOT, SOT-13)*

Action 11.5/2: *Complete a guidance document for third-party data, to include the recommendation, and a possible method, for specific quality controls for the data, preferably before GTS ingestion. (TT-EICO, SOT-13)*

Action 11.5/3: *Initiate coordination with a prospective DAC or GDACs including developing a business case and agreements. (TT-EICO, SOT-13)*

11.6 Ad-hoc Task Team on VOS Delayed Mode data (TT-VOS-DMD)

The chair of the task team, Dr. Axel Andersson, introduced the purpose and terms of reference of the task team. The ad hoc task team did not have a formal meeting during the intersessional period. However, several related activities where members of the task team are involved were reported to the SOT EC. This also includes involvement in relevant WMO task teams in INFCOM and SERCOM. It is proposed that the TT-VOS-DMD is reappointed with the proposed membership.

Participants agreed to continue the work of the task team and approved to establish it as a Task Team and approved Callum Stone as the vice chair of the group.

Dr Andersson also provided an update on the activities related to Marine Climate Data System (MCDS) and VOS GDACs. He provided status on volume and frequency of delayed-

mode data being received and processed by the VOS-GDACs. He reminded VOS data providers that they should use the same call sign ued in GTS when submitting the data to the GDCAs. He further stressed that if SOT-ID is used in the GTS for real-time data desimination, the same SOT-ID should be used as call sign in IMMT. The suggested procedure for active/running systems is:

a. Extract delayed mode data from system (TurboWin) (and submit data to GDACs)
b. Change ID from call sign to SOT-ID
c. ID visible on the GTS and in DM data will change simultaneously

Participants endorsed a number of ongoing actions related to MCDS and they are included below. VOS DACs (and SOT in general) should stay up to date with MCDS developments in order to ensure they know how they might be affected in the future or how they may contribute in the present.

Action 11.6/1: *Data Acquisition Centres (DACs) that did not submit data during 2022 should do so in 2023 or alternatively contact a VOS-GDAC for advice. (DACs; end of 2023)*

Action 11.6/2: *Support the migration of former Contributing Members (CMs) to VOS-DACs in the new MCDS. (TT-VOS-DMD, 2024)*

Action 11.6/3: *The VOS-GDACs should proactively contact DACs that have not submitted data for a number of years to offer assistance and encourage submission of data (VOS-GDACs, end of 2023)*

Action 11.6/4: *SOT to keep/establish contact with relevant WMO bodies to promote the clarification responsibilities regarding relevant regulatory documents. (SOT-EB, ongoing)*

Action 11.6/5: *Data/metadata management and exchange to be considered in the development process of TurboWin replacement. (TT-DM, SOT-13)*

Action 11.6/6:
The IMMT format and the MQCS need to be revised in order to:

- *be compatible with parameters, flags, and accuracies provided in the BUFR format;*
- *be flexible for future changes in other fields such as the IMO number;*
- *maintain compatibility with OceanOPS meta data structure (e.g. new VOS Classes);*
- *provide accurate quality flags for all relevant parameters.*

(TT-VOS-DMD, SOT-14)

Action 11.6/7: *Countries not yet registered a DAC are encouraged to register a DAC and contribute their data. (VOS data contributors, ongoing)*

Action 11.6/8: *DACs should submit their observations only once. If there is a requirement to resubmit data (e.g. quality improvements) then the VOS-GDACs should be made aware of this. (VOS DACs, ongoing)*

Action 11.6/9: *All DACs should submit data files in a single IMMT format version,– preferably IMMT-5 and quality checked using MQCS-7 making use of its increased coding capabilities. (VOS DACs, ongoing)*

Action 11.6/10: *DACs not able to submit their data because of issues with digitizing or converting into the IMMT format, should contact VOS-GDACs for advice. (VOS DACs, ongoing)*

Action 11.6/11: *VOS DACs should apply MQCS to data prior to submission. This can assist in identifying and solving significant problems, in particular issues within date/time and position. (VOS DACs, ongoing)*

Action 11.6/12: *DACs are encouraged to convert and submit AWS data to the GDACs. (VOS DACs, ongoing)*

Action 11.6/13: *VOS operators are urged to include all data/metadata required for complete IMMT datasets. (VOS operators, ongoing)*

Action 11.6/14: *If possible, DACs should ensure all masked call signs (i.e. 'SHIP') are converted back to the original ID prior to submitting to the GDCS (VOS DACs, ongoing)*

Action 11/1: *All TT chairs are requested to recruit early career scientists/experts to each task team and also consider the gender and regional balance in those new recruitments as part of succession planning and capacity development. (TT-Chairs, SOT-13)*

12. REPORTS BY ASSOCIATED PROGRAMMES AND PROJECTS

12.1 Shipboard Automated Meteorological and Oceanographic System (SAMOS) Project

The Chair of the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative, Mr. Shawn Smith (Florida State University, USA) reported on the activities during the intersessional period. SAMOS aims to improve the quality of meteorological and near-surface oceanographic observations collected in-situ on research vessels (RVs).

The SAMOS initiative focuses on high-temporal sampling (1-min. interval) meteorological and near-surface oceanographic data collected by the scientific instrument system permanently installed on individual RVs. The SAMOS initiative does not provide instrumentation to RVs, but leverages instrumentation owned by the RV operators. During the last period (13 Sept. 2021 – 10 April 2023), the Marine Data Centre at the Florida State University (FSU) processed 12.8 million one-minute SAMOS data reports from 30 RVs operated by the U.S., Australia, and New Zealand.

Experts from the SAMOS team have been active contributors to the SOT TT-ISSC and TT-EICO. This includes contributions to an International Organization for Standardization draft

for shipborne meteorological instruments and a draft data flow for independent (third-party) VOS.

Ongoing development of WIS2.0 may provide an opportunity for the SAMOS imitative to serve weather and ocean data to a wider community. The SAMOS chair seeks recommendations from WMO regarding how the initative may approach serving data via WIS2.0, if such a service is useful to the community.

Recommendation 12.1/1: *The SAMOS initiative seeks recommendations from WMO regarding how the initiative may approach serving data via WIS2.0, if such a service is useful to the community. (WMO Secretariat, SOT-13)*

12.2 International Research Vessel Operators Group (IRSO)

On behalf of Mr Grey Foothead from the International Research Ship Operators (IRSO), Martin Kramp made a presentation on the IRSO activities. The IRSO represents 50 organizations from 32 countries who manage or operate approximately 100 of the world's leading marine scientific research vessels. IRSO membership is open to all research ship operating institutes or national research programmes that are engaged in marine science. IRSO members meet annually to share information, solve problems and discuss matters of mutual interest to better support marine scientific research efforts at sea. The main topics and objectives of the annual agenda are: Vessel operations and future technologies, Developments in national research fleets and activity reports, Cooperation and Outreach, Compliance/Legal/Insurance, and Manning, Training, Health and Wellbeing.

RV operations are mostly back to pre-COVID19 schedules. The pandemic affected all vessel schedules, some countries worse than others. Efforts to catch up on postponed science cruises continue with protocols to prevent COVID-19 coming aboard still in place, but are gradually being reduced as the risks reduce.

Many national organisations have, or are in the process of replacing their aging RV's. The new technologies and versatility of these new research platforms will enhance the capability and efficiency of marine science data acquisition. IRSO membership is expanding and we have some recent new members from Peru, Chile and India. Selected Industry participation at IRSO meetings is also welcomed as IRSO seek to learn about emerging technologies that can enhance our science activities and improve vessel operating efficiencies.

The particular interest for the SOT is ongoing discussions between IRSO and OceanOPS regarding the sharing of ship metadata and cruise plans. The meeting noted that a protocol is now in place which allows for data exchange between the Marine Facility Planning (MFP) tool, which is used by a growing number of RV operators, and the OceanOPS system, including detailed geography information. The meeting also noted that some RVs are not contributing to the SOT panels, but with connectivity issues getting smaller now the submission of RT data should shortly be possible and encouraged by all RVs. Existing underway systems and corresponding data flows should be identified and then ideally become part of SOOP.

12.3 International Quality-controlled Ocean Database (IQuOD)

Dr Rebecca Cowley reported that the IQuOD project is supported by IODE and SCOR, and pulls together expertise from the international research community (data producers and users). IQuOD aims to provide a single 'best' version of ocean profile data. IQuOD also shares the code and tools developed. The goal of IQuOD is to maximize the quality, consistency and completeness of the long-term global subsurface ocean profile database, beginning with temperature. IQuOD includes derived metadata (e.g. observation methods from the characteristics of the data) for expendable bathythermographs (XBTs) and has uncertainties assigned to each individual temperature observation. Some uncertainties have been assigned to depth and salinity.

In the last few years, v0.1 of the dataset was released, containing intelligent metadata and uncertainty assignments to temperature profile data. Several papers have been released (see https://www.iquod.org/publications.html). IQuOD will soon include Automated QC flags from the IQuOD community auto-QC benchmarking tests (due to be released mid-2023). Many duplicates have been identified in the WOD/IQuOD and have been removed. Expert QC flags (including from AI algorithms) are the next issue to be tackled by the IQuOD community.
More information and links to publications and data are available at IQUOS website[34].

12.4 Ferrybox Task Team

Mr. Andrew Luke King provided an update of the EuroGOOS FerryBox Task Team activities. This includes an overview of the ships of opportunity in operation in European seas and elsewhere, new installations, partners/institutes involved, and links to relevant research infrastructures. A summary of actions related to technology development, data management and handling, citizen science/ocean literacy, and industry cooperation was also be presented. Opportunities and challenges were highlighted from the perspective of Task Team members and from the bigger picture perspective of European and global ocean observing. SOT requested to have an expert from the Ferybox community to join the TT-Metadata to add requirements of Ferrybox community in OceanOPS metadata database.

Recommendation12.4/1*: Requested to have a member from Ferrybox, community to join the TT-Metadata (FerryBox)*

12.5 Global Temperature and Salinity Profile Programme (GTSPP)

Dr. Christopher Paver from the the GTSPP presented the activities of the programme. He explained that the mission of the GTSPP is to provide a timely and complete database and information for ocean temperature and salinity profile data of known and documented quality, develop and implement data flow monitoring systems to improve the capture and timeliness of real-time and delayed mode data, improve and implement agreed and uniform quality control and duplicates management systems, and facilitate the development and provision of a wide variety of useful data, analyses, and information products to clients. He explained the data flow of real-time time and delayed mode which is being achieved in World Ocean Database (WOD). Delayed mode data partners are CSIRO, BOM, AOML and SIO. There are number of data products available through NCEI GTSPP webpage and JMA Data Quality reports. GTSPP is facing number of administrative

[34] http://www.iquod.org/

and technical issues. Reduced funding support, personnel shortages, and having issues with integrating BUFR format are few of those challenges.

12.6 Science Research on Commercial Ships (RoCS)

Ms. Laura Stolp reported that Science Research on Commercial Ships (Science RoCS) is an ad hoc multi-institution group of scientists, engineers, data managers, and administrators, whose goal is to transform ocean science by outfitting commercial ships with a suite of "maritime appropriate" scientific sensors. The integrated observing systems hosted on each commercial ship will advance interdisciplinary science related to air-sea interactions, oceanographic and atmospheric dynamics, forecasting, and feedbacks among ocean physics, biology and chemistry.

In 2021 during SOT-11 it was recommended that a dialogue be opened between Science RoCS and OceanOPS, TT-EICO, and the Open-GTS initiative with TT-EICO providing recommendations, procedures, and documentation on how best to provide NRT weather and ocean observations (and associated metadata) to meet the needs of SOT members. Since then Science RoCS has initiated the process to include the Bulk Xaymaca metadata into OceanOPS, and meteorological data from the vessel is flowing (SOT ID FDJV78U) into the Open-GTS in NRT. The Bulk Xaymaca also has an OS 75 ADCP which is currently sending engineering data to shore. The hope is to create a pathway for this data into the Open-GTS.

Over the year Science RoCS has helped the Global Argo Program identify ships for float deployments along commercial routes in the Atlantic Ocean and western Caribbean and has helped scientists from NOAA/PMEL find a commercial route in the Pacific for pCO2 measurements as part of the SOCONET. Another key component of Science RoCS is routine measurement of upper ocean velocities using Acoustic Doppler Current Profilers (ADCP), and there is an emerging community of modelers that are seeking to assimilate upper ocean currents into forecast systems.

Action 12.6/1: *To continue providing Science Research on Commercial Ships (RoCS)with recommendations, procedures, and documentation on how to provide real-time weather and ocean observations (and associated metadata) to meet the needs of SOT members as new vessels are recruited. (VOSP Chair, SOOP Chair, SOT13)*

12.7 International Hydrographic Organization (IHO)

The Assistant Director of the International Hydrographic Organization (IHO), Mr. Sam Harper, reported on crowd-sourced bathymetry (CSB) data collection efforts. With reference to the UN EW4All initiative and with bathymetry presently discussed as potential EOV, Mr. Harper reported that a growing number of countries agreed with the collection of CSB in their territorial waters, noting that vast areas of the ocean are presently still uncharted. The interpretation of United Nations Convention on the Law of the Sea (UNCLOS) and Marine Scientific Research (MSR) remains one of the biggest barriers for the collection of depth information. Mr Harper reported that a mechanism is now in place which allows to filter and then reject data from within exclusive economic zones (EEZs), so that the potential thread for the VOS in case of extending the measured variables to bathymetry might be less important now. Through its executive bodies, the SOT was encouraged to review its position in this matter, with the aim to harmonize SOT and IHO activities with the shipping community.

12.8 Group for High-Resolution SST (GHRSST)

Dr Helen Beggs reported on the Group for High Resolution Sea Surface Temperature (GHRSST) activities. She mentioned that the GHRSST[35] is an open international science group that coordinates research and operational developments in satellite-derived sea surface temperature (SST) and promotes the application of satellites for monitoring SST. It achieves these aims by enabling SST data producers, users and scientists to collaborate within an agreed framework of best practices.

Dr Beggs mentioned that in-situ SST data have long been used to ground-truth satellite-derived SST observations, including within GHRSST. SST at centimetres to several metres depth ("SSTdepth") measured by drifting buoys, moorings and Argo floats are widely used by meteorological, academic and space agencies for bias-correction and verification of satellite SST products. Well-calibrated and high frequency observations of ship SSTdepth, such as those produced by the Australian Integrated Marine Observing System (IMOS), research vessels or Saildrones, are also used by GHRSST to validate satellite SST products and are particularly useful in coastal highly dynamic regions to verify their feature resolution. In addition, near real-time observations of SSTdepth from ships of opportunity, available from the Global Telecommunication System (GTS), are routinely ingested into most operational SST analyses used for Numerical Weather Prediction and other applications. They often provide the only SST observations in near-coastal, cloudy regions lacking in other in-situ and satellite SST observations and are therefore valuable. It is requested that meteorological and oceanographic agencies focus on improving the quality and uncertainty of ship SST data supplied to the GTS, to improve the accuracy of SST analyses and climate data records, particularly in near-coastal regions.

The most valuable SST observations for satellite verification, however, are those provided from infrared radiometers on ships of opportunity that measure the temperature in the thermal "skin" at around 10 microns depth ("SSTskin"), the same depths as measured by infrared radiometers on satellites. GHRSST uses the fiducial ship SSTskin observations from the International Shipborne Radiometer Network (ships4sst.org) for SI traceable verification of satellite SST products. The international network of universities and agencies deploy autonomous infrared SST radiometers on ships of opportunity (ferries, cruise ships and research vessels). Delayed mode SSTskin data are processed after cruises with all pre- and post-cruise calibration information, quality-controlled, and total uncertainties are estimated. The data are converted to the in-situ radiometer format (L2R), which is based on the GHRSST level 2 satellite SST (L2P) format, and available through the Ships4SST database[36] hosted by Ifremer.

Dr Beggs mentioned that SST data collected by the AniBOS are not yet used for satellite SST validations.

Action 12.8/1: *TT-ISSC is requested to focus on improving the total standard uncertainty in measured ship SSTdepth supplied to the GTS to be less than 0.2 K, to improve the quality of SST analyses and climate data records (TT- ISSC, SOT-13)*

[35] https://www.ghrsst.org

[36] https://ships4sst.org

12.9 Global Ocean Surface Underway Data (GOSUD)

Dr. Francis Bringas presented the work of the Global Ocean Surface Underway Data (GOSUD). The GOSUD Project was established in 2001 with the aim to acquire, quality control, store in standard format, and distribute underway sea surface temperature and sea surface salinity observations. Other activities include the maintenance and improvement of data management procedures and recommended practice, in cooperation with other relevant data centers (such as NOAA/NCEI) or projects (such as SOOP). Currently data processed and distributed by GOSUD comes from research ships, SOOP vessels, and more recently also from Saildrones. In addition, GOSUD ingests and processes data obtained from the GTS. Data providers can submit their data to GOSUD in both real-time and delayed mode, and through different mechanisms, including ftp and emails. As an added service, recently GOSUD started submitting some of the TSG data received by the project in near real-time into the GTS. In addition to the ftp servers hosted by IFREMER, the GOSUD data and metadata are available through different services and data archives, including NOAA/NCEI, Copernicus Marine Environment Monitoring Service (CMEMS) in situ TAC, SeaDataNet, OceanOps, and Seanoe.

13.INDUSTRY AND PARTNER PRESENTATIONS

13.1 Data Buoy Cooperation Panel (DBCP)

DBCP chair, Dr. Nelly Florida, reported to the meeting on major updates of the Data Buoy Cooperation Panel. She first recalled the new DBCP Strategy 2022-2027 that laid out mission of the Panel with six strategic pillars to serve needs and requirements of users.
She briefed on governance of the Panel and pointed out that, DBCP executive board appointed chair, vice chair, and representatives for scientific excellence, innovation and technology development, environmental stewardship, diversity and inclusivity, data value and impact, etc, are responding to the Strategy. She noted technical supports are provided by the technical coordinator at OceanOPS, and joint Secretariats at WMO and IOC on administrative matters. Dr Florida invited the SOT community to consider and help to nominate representatives for the task teams for operational excellence, partnership and international cooperation.

Dr. Florida further introduced task teams that help DBCP to implement activities on thematic areas, such as data management, best practices and technology development, capacity building, etc. She highlighted two new task teams that will look into environmental stewardship, and data impact and value, which is also relevant to the work of SOT.

Dr. Florida reminded the meeting that there are persistent gaps in the Indian Ocean and Southern Ocean for drifters, and tropical RAMA-OMNI moorings redeployments have been pending. She expressed appreciation for drifter deployments facilitated by SOT. Dr. Florida recalled preliminary discussions of possible joint capacity building activities, and expected to have concrete planning in the coming years. She then invited SOT to fill in a survey on environmental stewardship and drew attention to a planned workshop on this matter. Lastly, she recommended regular communications with SOT on collaboration opportunities.

It was suggested that there should be a DBCP representative at the next GHRSST event that will take place in India. Dr Helen Beggs requested DBCP to confirm the resolution and accuracy of the SST measurements from drifting buoys to GHRSST.

Action 13:1/1: *SOT is requested to assist DBCP with deployment opportunities, especially in the Indian Ocean and in the Southern Ocean. (SOT operators, SOT-13)*

Action13.1/2: *SOT is invited to discuss possibilities of joint capacity development activities (i.e., Port Meteorological Officers training) with the DBCP Task Team on Capacity Development. (TT-RPT, December 2023)*

Action 13.1/3: *SOT members are requested to complete the Environmental Stewardship Survey and join the workshop planned by the DBCP Task Team on Environmental Stewardship. (SOT members, December 2023)*

Action13.1/4: *DBCP requested SOT-EB to have regular communications on collaboration opportunities between the two groups. (SOT-EB, ongoing)*

Recommendation 13.1/1: Dr *Helen Beggs requested DBCP to confirm the resolution and accuracy of the SST measurements from drifting buoys to GHRSST (DBCP Chair, Dec 2023)*

13.2 Global Shipping Representative

This agenda item was removed due to unavailability of representative to provide information.

13.3 Fleetmon

Due to unavoidable reasons Fleetmon was not able to attend the session to make a presentation.

13.4 Antarctic Circumnavigation

Ms. Lisa Blair gave a presentation on her record-breaking sailing story (circumnavigating the Antarctic solo and unassisted), and her passion for the ocean, environment, and climate change, for example, by launching a climate actioncampaign. She shared several videos taken during her sailing to show the audience an indication of what life was like in the Southern Ocean. It was noted with appreciation Ms. Blair's contributions to the ocean observing community by providing ship-borne atmospheric and ocean observations data, deploying drifters, Argo floats, and collecting other measurements.

In 2022 Ms. Blair broke the record sailing from Australia around Antarctica back to Australia, fully below 40 degrees South, single-handed, unassisted and nonstop, carrying a deck-drifter as AWS, an underway system (rented from The Ocean Race), and deploying drifters and floats.

The participants highly appreciated Ms. Blair's sharing of her inspiring stories and her contributions to ocean observations. She emphasized the importance of measuring ocean currents, ice measurements, and ice lines, which are incredibly important for navigation. She also announced her plan for a solo non-stop curriculum navigation of the Arctic Circle with the aim to promote sustainable ship building. She noted her concerns about deploying plastic drifter buoys while advocating to reduce plastic use.

13.5 Ocean Racing Panel (TOR/IMOCA)

Mr. Stefan Raimund from The Ocean Race (TOR), Mr.Damian Foxall from 11th Hour Racing and Me. Claire Vayer from IMOCA reported on data collection efforts from the ocean racing community. TOR leads every 3 or 4 years a fleet of racing boats from Europe around Antarctica back to Europe, fully crewed and in several legs, leaving all big continental capes to port. After successful trials in former editions, the full fleet is now equipped with underway instrumentation for e.g. SST, SSS, pCO2, or microplastics. In addition to atmospheric data from ship-owned instruments, data subsets are now submitted through an OceanOPS coordinated protocol on an hourly basis to the Coriolis data center, from there encoded to BUFR and through the French node ingested to the GTS. Delayed mode data flow into archives/products like GOSUD and SOCAT. Given that similar races take place regularly with the same boats (Vendée Globe), full round-the-world datasets are now available almost every year. In addition to SOT contributions, the participants also take up to two buoys or drifters per leg, which allowed in March (leg 3) for the seeding of instruments around Antarctica every 25 degrees. During the stopovers, hundreds of thousands of visitors come to so-called "Race Villages", where sustainability activities further increase the already very important outreach effect of such events. The partnership which was set up by OceanOPS between the IMOCA boat class and UNESCO's IOC during COP 21 (2015, Paris) has facilitated the cooperation between sailors and science tremendously. Damian Foxall introduced his project on reporting hazards for navigation, including ship-to-ship via AIS, with particular focus on avoiding collisions with marine mammals, and noting that this initiative also led to the visualization of surface drifters on electronic navigation charts. The meeting agreed that there is some overlap with other initiatives that aim to submit navigational hazards (like unexpected extreme weather) to vessels in vicinity via AIS, and encouraged in general an extended cooperation with this community.

14.ORGANIZATIONAL MATTERS

14.1 Review of SOT Strategic Plan

SOT Chair mentioned that at SOT-11, the SOT completed version 2.1 of its implementation strategy. Valuable OCG comments just prior to SOT-11 resulted in the action to further review and refine the implementation strategy with a view to it becoming an even more strategic document. While the actual action was to label the SOT Strategy as "version 3", the completely new document that became the SOT Strategy was titled, "Ship Observations Team Strategy (2022 – 2026), First Edition", and can be found at OceanOPS website[37].

He further explained that the SOT Strategy includes mission and vision statements, along with four overarching strategic goals. During the upcoming intersessional period, the SOT should assess the value of developing, and consider whether it has the capacity to develop, a concise implementation strategy for the tenets in the SOT Strategy. Regardless, there should be a focus on achieving specific milestones outlined by the actions from SOT-12 and mapping those actions to the Strategy.

[37] https://www.ocean-ops.org/sot/strategy.pdf

Action 14.1/1: *The SOT should assess the value of developing and consider whether or not it has the capacity to develop a concise implementation strategy for the tenets in the SOT Strategy. (SOT-EB, SOT-13)*

Action 14.1/2: *The SOT should focus on achieving specific milestones through the actions from SOT-12 and mapping those actions to the Strategy. (SOT-EB, SOT-13)*

14.2 Review and approval of SOT Terms of reference

Dr Elizabeth Kent led the discussion on reviewing the SOT ToR. SOT-13 reviewed and approved ToR are provided in Annex 5.

14.3 Financial Report

Ms. Champika Gallage provided the funding status of the SOT. SOT activities are primarily funded through extrabudgetary funds and managed in two trust funds (TF), Woods Hole Oceanographic Institution (WHOI) TF and DBCP TF, at WMO. WHOI TF is solely to manage funds received from NOAA/USA under a five-year funding agreement which will end in June 2024 and will be renewed. All other contributions are managed through DBCP TF.

SOT TC salaries are paid from the NOAA funds in WHOI TF. All TCs travel expenses, including SOT TC, are covered through the OceanOPS funds. All other SOT-related expenses are covered from the SOT project funds managed in the DBCP TF.
Six member countries (Australia, Canada, Germany, India, New Zealand, and South Africa) and E-Surfmar make annual contributions to the DBCP TF. Since 2018, as agreed with the regular funders, the contributions have been distributed among SOT, DBCP, and OceanOPS in the fractions of 8%, 31%, and 61%, respectively, except for E-Surfmar where their funds are distributed in proportions of OceanOPS 70%, DBCP 15%, and SOT 15%

Table 1: Regular Contributions from Members

Donnor	Currency	Contribution	In US$ (04 April 2023)	OceanOPS US$	DBCP US$	SOT US$
E-Surfmar	Euro	55’000	59’950	41’965	8’993	8’993
Meteorological Services of New Zealand	Euro	1’800	1’962	1’197	608	157
Environment and Climate Change Canada	CA$	35’000	25’900	15’799	8’029	2’072
Bureau of Meteorology, Australia	Euro	11’700	12’753	7’779	3’953	1’020
National Institute of Ocean	US$	5’000	5’000	3’050	1’550	400

Technology, India						
South African Weather Service (SAWS)	Euro	4'000	4'360	2'660	1'352	349
BSH, Germany	Euro	3'600	3'924	2'394	1'216	314
Total	US$		113'849	74'843	25'701	13'304

In 2021 the only expense from the SOT budget is for the IT contract to develop SOT metadata at the OceanOPS, amounting to US$ 10,121. Funds were received from all regular contributors to the DBCP TF in 2021. The 2021 Financial report is provided in Annex 1.

For 2022, all regular contributions except South Africa were received. Some of the contributions ear-marked for 2022 were received in 2021 and 2023. Therefore, the total contributions received in 2022 are lower (US$10,257) than the regular amount (about US$ 13,300). The 2022 Financial report of the DBCP TF is provided in Annex 2.

Table 2: Status of the SOT budget in 2023

Description	**Amount in US$**
Carry forward from 2021	51,615
Expenses in 2022 (SOT chair and other travel)	(2,428)
Contributions received in 2022	10,257
Balance as of 31 December 2022	**59,444**

Anticipated contributions and expenses for 2023-24 are provided in Table 3, and SOT reviewed and approved these expenses.

Table 3: Anticipated budget for SOT in 2023-24

Description	**Amount in US$**
Carry forward balance from 2022	59,444
Expected income in 2023(assuming all regular contributions will be received)	13,300
Expenses in 2023	
SOT Chair and other travel	(15,000)
Other SOT expenses (Instrument donation)	(27,000)
Carry forward balance from 2023	**30,744**
Expected income in 2024(assuming all regular contributions will be received)	13,300
Expenses in 2024	
SOT Chair and other travel	(5,000)
Other SOT expenses	(20,000)
Carryforward balance from 2024	**19,044**

SOT operates with a small budget with contributions from a small number of countries. SOT members are requested to consider financial contributions towards SOT activities.

Action 14.3/1: *SOT members are requested to contribute financially towards SOT activities. (SOT members, SOT-13)*

14.4 Status of Task Teams - Continuation of Current Teams and Development of new Teams

Participants agreed to continue all existing task teams. Some of the new activities such as developing the GBON Technical specification of SLP and SST for tendering and review and update of the WMO Guide on Instruments and Methods of Observations (WMO-No. 8) will be carried our by the existing TT-ISSC. Participants further agreed to continue the ad hoc-task team on VOS Delayed Mode data (TT-VOS-DMD) as a full fledged task team, recognizing the importance of the work on delayed mode data and its ongoing contribution to the Marine Climate Data System.

14.5 Executive Board and Chair and candidates' election

Ms. Gallage explained that all executive board members are elected for two terms (4 years total) and eligible to continue one additional term if there are no new nominations. She announced that the current chair of the SOT, who has served two terms, indicated his desire to step down from the position at the SOT-12. Accordingly, SOT members were informed about the SOT chair's intention and requested to provide nominations to select a successor. One nomination was received for the SOT chair post from Dr. Huai-min Zhang.

Ms. Gallage further confirmed there were no nominations from the floor. Therefore Dr. Huai-min Zhang was appointed as the chair of the SOT by acclamation. All other executive members are eligible to serve another term (2 years) and they are willing to continue in their respective posts. As there were no new nominations for the rest of the executive board membership, the existing executive board will continue their membership for another term. Ms. Gallage thanked outgoing chair Mr. Darin Figurskey for his extraordinary leadership and welcomed the new chair, Dr. Huai-min Zhang.

15. REVIEWS OF THE SOT ACTION ITEMS

All participants reviewed the action items from the SOT-12 session. Open Action Items from SOT-11 session were included under respective Agenda items of the SOT-12 session. Ms Gallage mentioned that the draft Action Items will be distributed to the participants within couple of weeks and requested to review them by the deadline. Compiled list of Actions and Recommendations are provided on the website[38].

16. NEXT SESSION OF THE SOT

Participants were invited to consider hosting the SOT-13 session during the same time in 2025. All agreed that there is a value to meeting where SOT has never been held before to engage with the local communities. South America or Africa or other underrepresented regions were suggested as preferred places. The newly appointed chair is requested to search for opportunities to have the next SOT session in South America or Africa. In case of the absence of any offers, USA and France will consider hosting the SOT-13 session pending Permanent Representative approval. The date and place of the SOT-13 will be finalized by the Executive Board by mid 2024 and SOT members will be notified.

Action 16/1: *SOT Chair to investigate having the next SOT-13 in a region/area underrepresented in SOT membership. (SOT EXB, May 2025)*

17.CLOSING OF THE SESSION

SOT-12 session closed at 15:10pm on Thursday 18th May 2023

[38] https://wmoomm-my.sharepoint.com/:f:/g/personal/mkramp_wmo_int/Ehp-MYbQe6NFtSChg8Zhm9gBenCmBDF1YlPuAiuMeCISqw?e=CzX8v3

Annex 1

Timetable

Monday (15 May 2023) **Day 1: OPENING, Panel discussions** **Link**: Click here to join the meeting **Meeting ID**: 442 017 333 067 **Passcode:** GD8kc6		
07:30-08:00 AEST	**REGISTRATION (ON-SITE)**	
08:00-08:20 **(your time)**	**1 OPENING OF THE SESSION – WELCOME FROM HOST** 1.1 Opening Remarks from the host (*Joel Cabrie or other*) 1.2 Adoption of the Agenda and objectives of the meeting *(Darin Figurskey)* 1.3 Working arrangements, instructions for those participating virtually (*Champika Gallage*)	Elizabeth Kent
08:20-09:45	**2 SIXTEENTH SESSION OF THE SOOP IMPLEMENTATION PANEL (SOOPIP-16)** 2.1 Report from the SOOPIP Chairperson (*Francis Bringas*) 2.2 SOT Technical Coordinator report on SOOP support activities (*Martin Kramp*) 2.3 XBT Science Team report (*Shenfu Dong*) 2.4 XBT Data flow and tranmission (*Joaquin Trinanes*) 2.5 Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP) (*Bernadette Sloyan*) Discussions, Q/A	Elizabeth Kent
09:45-10:15	**Coffee break**	
10:15-11:45	**3 THIRTEENTH SESSION OF THE VOS PANEL (VOSP-13)** 3.1 Report by the VOSP Chairperson (*Joel Cabrie*) 3.2 SOT Technical Coordinator report on VOS support activities (*Martin Kramp*) 3.3 E-Surfmar Expert Team on VOS status report (*Olivier Desprez*) Discussions, Q/A	Justine Parks
11:45 -12:00	**Group Photograph**	
12:00 – 13:00	**Lunch Break**	
13:00-13:20	**4 Cross-network ship coordination** (*Martin Kramp*)	Darin Figurskey

13:20-13:55	**5 Turbowin** (*Yvonne Schavemaker/John van de Vegte*)	Joel Cabrie
13:55-14:10	Discussion Q&A	
14:10-15:00	**6 FIRST SESSION OF THE ASAP PANEL (ASAP - 1)** 6.1 Report by the ASAP Chairperson (*Rudolf Krockauer*) 6.2 SOT Technical Coordinator report on ASAP support activities (*Martin Kramp*) 6.3 Data issues and developments (*Rudolf Krockauer*) 6.4 Review and approval of ASAP Terms of Reference (*Rudolf Krockauer*) Discussion, Q&A	Joel Cabrie
15:00-15:30	**Coffee break**	
15:30-17:30	**7 Parallel VOS/ASAP and SOOP BREAKOUT SESSIONS**	
	Meeting Room: **Link:** Click here to join the meeting **Meeting ID**: 451 025 110 750 **Passcode**: zNgGXG	**Meeting Room:** **Link:** Click here to join the meeting **Meeting ID**: 439 643 368 006 **Passcode**: q8PXUa
	VOS/ASAP Panels - Migration to BUFR: implementation status and challenges (*Martin Kramp*) - Other Items (*Joel Cabrie*) - Review and approve Terms of Reference (*Joel Cabrie*)	**SOOP Panel** - Interactions with other networks (*Tamaryn Morris*) - International Ocean Carbon Coordination Project (IOCCP)(Denis Pierrot) - Thermosalinograph observations (*Francis Bringas*) - Other items (*Justine Parks*) - SOOP-specific ship recruitment and operational issues (*Zach Barton*) - Boundary currents workshop updates and plans (*Tamaryn Morris*) - AX97 transect: The perspective of a rider in a Navy ship (*Ivenis Pita*) - Review and approve SOOP ToR (*Justine Parks)*

17:30	**End of the Day 1**

	Tuesday (16 May 2023) **Day 2: WMO/IOC/OCG and National Reports** **Link**: Click here to join the meeting **Meeting ID**: 442 017 333 067 **Passcode:** GD8kc6	**MODERATOR**
08:00-09:45 AEST(your time)	**WELCOME TO DAY-2** (*Darin Figurskey)*	
08:00-08:15	**8 Environmental Stewardship (***Shannon Kaya- **Remote***)**	Jean-Baptiste Cohuet
08:15-09:25	**9 ORGANIZATIONAL /ADMINISTRATIVE REPORTS**	Tamaryn Morris
08:15-08:30	9.1 Report from Observations Coordination Group (*David Legler-**Remote***)	
08:30-08:50	9.2 Report from the SOT Chairperson (*Darin Figurskey*)	
08:50-09:10	9.3 Report from OceanOPS (incl. SOT-ID, BUFR, Metadata, RTC.) (*Martin Kramp*)	
09:10-09:25	Discussion Q/A	
09:25-09:45	**Coffee Break**	
09:45-12:00	**10 NATIONAL REPORTS: APPROXIMATELY 10 MINUTES EACH PLUS TIME FOR ONE OR TWO QUESTIONS [TEMPLATE] IN COUNTER-ALPHABETIC ORDER, RECORDINGS AT THE END** 10.1 - United States 10.2 - United Kingdom 10.3 - Netherlands 10.4 - Germany 10.5 - France 10.6 - E-Surfmar	Mardene De Villiers
12:00-13:00	**Lunch Break**	

13:00-15:00	**NATIONAL REPORTS CONTINUED: APPROXIMATELY 10 MINUTES EACH PLUS TIME FOR ONE OR TWO QUESTIONS** 10.7 - E-ASAP 10.8 – South Africa 10.9 - Australia 10.10 - Norway (recorded?) 10.11 - Japan (recorded) 10.12 - Hongkong, China (recorded) 10.13 - China (recorded) 10.14 - Chile (recorded)	Mardene De Villiers
15:00-15:30	**Coffee break**	
15:30-17:00	**9 ORGANIZATIONAL /ADMINISTRATIVE REPORTS CONTINUED**	Emma Steventon
15:30-15:50	9.4 Review of new national report procedure (*Martin Kramp*)	
15:50-16:10	9.5 Report from the WMO Secretariat (data policy/GBON/SOFF) (*Champika Gallage*)	
16:10-16:30	9.6 Presentation and discussion of WIS2.0 (*David Berry-**Remote***)	
16:30-16:45	9.7 Report from the IOC Secretariat (*Emma Heslop-**Remote***)	
16:45-17:00	Discussion Q/A	
17:00	**End of the Day 2**	
18:00	**GROUP DINNER**	

	Wednesday (17 May 2023) **DAY 3: REPORTS FROM TASK TEAMS AND ASSOCIATED PROGRAMMES** **Link**: Click here to join the meeting **Meeting ID**: 442 017 333 067 **Passcode:** GD8kc6	**MODERATOR**

08:00-09:40 AEST (your time)	**11 RECOMMENDATIONS AND ACTIONS BY TASK TEAMS**	Axel Andersson
08:05-08:30	11.1 Task Team on Recruitment, Promotion and Training (TT-RPT, *Mardene De Villiers*)	
08:30-08:55	11.2 Task Team on Metadata (TT-Metadata, *Emma Steventon*)	
08:55-09:20	11.3 Task Team on Instrument Standards and SatComm Systems (TT-ISSC, *Jean-Baptiste Cohuet*)	
09:20-09:40	11.4 Task Team on Key Performance Indicators (TT-KPI, *Elizabeth Kent*)	
09:40-10:00	**Coffee Break**	
10:00-10:20	11.5 Task Team on the Expansion of Independent Class Observations (TT-EICO, *Darin Figurskey*)	Francis Bringas
10:20-10:40	11.6 Task Team on VOS Delayed Mode data (TT-VOS-DMD, *Axel Andersson*)	
10:40-11:45	Plenary Discussion including Recommendations from Task Teams	
Speeches from Chairperson Candidates in case more than one application		
12:00-13:00	**Lunch break**	
13:00-15:00	**12 REPORTS BY ASSOCIATED PROGRAMMES AND PROJECTS**	Martin Kramp
13:00-13:20	12.1 Shipboard Automated Meteorological and Oceanographic System (SAMOS) Project (*Shawn Smith - remote*)	
13:20-13:40	12.2 Research Vessel Operators Group (IRSO) (*?*)	
13:40-14:00	12.3 International Quality-controlled Ocean Database (IQuOD) (*Rebecca Cowley*)	
14:00-14:20	12.4 Ferrybox Task Team (*Andrew Luke King*)	
14:20-14:40	12.5 Global Temperature and Salinity Profile Programme (GTSPP) (*Christopher Paver*)	
14:40-15:00	Discussion Q/A	
15:00 -15:30	**Coffee Break**	
15:30-15:50	12.6 Science RoCS (*Laura Stolp*)	Rudolf Krockauer

15:50-16:10	12.7 IHO (*Sam Harper*)	
16:10-16:30	12.8 Group for High-Resolution SST (GHRSST) (*Helen Beggs*)	
16:30-16:50	12.9 Global Ocean Surface Underway Data (GOSUD) (*Francis Bringas*)	
16:50–17:10	Discussions Q/A	
17:10	**End of Day-3**	
	Thursday (18 May 2023) **DAY 4: INDUSTRY PARTNERS & ORGANIZATIONAL MATTERS** **Link**: Click here to join the meeting **Meeting ID**: 442 017 333 067 **Passcode:** GD8kc6	**MODERATOR**
07:30-09:00	**VISIT TO BOM (OPTIONAL)**	
09:00-11:00 AEST (your time)	**13. INDUSTRY AND PARTNER PRESENTATIONS**	
09:00-09:20	13.1 Data Buoy Cooperation Panel (DBCP) (*Nelly Florida*/*Lance Braasch*)	
09:20-09:40	13.2 Global Shipping Representative	Darin Figurskey
09:40-10:00	13.3 Fleetmon (*Lars Brandstäter-* ***Remote***)	
10:00-10:20	13.4 Antarctic Circumnavigation (*Lisa Blair*)	
10:20-10:40	13.5 Ocean Racing Panel (TOR/IMOCA/CLIPPER/...)	
10:40-11:00	Discussion Q/A	
11:00-11:30	**Coffee break**	
11:30-12:00	**14. ORGANIZATIONAL MATTERS**	
11:30-11:45	14.1 Review of SOT Strategic Plan (*Darin Figurskey*)	Justine Parks
11:45-12:00	14.2 Review and approval of SOT Terms of reference (*Elizabeth Kent*)	

12:00-13:00	**Lunch break**	
13:00-13:15	14.3 Financial Report (*Champika Gallage*)	Joel Cabrie
13:15-13:30	14.4 Status of Task Teams - Continuation of Current Teams and Development of new Teams (*Darin Figurskey*)	
13:30-13:45	14.5 Executive Board and Chair candidates election (*Champika Gallage*)	
13:45-14:10	**Coffee Break**	
14:10-15:00	**15. Review of the SOT action Items** Review the open actions from SOT-11 and draft actions from SOT-12 (*Champika Gallage/Martin Kramp*)	Darin Figurskey
15:00-15:15	**16. Next Session of the SOT** Date, and place of the next SOT session. (*SOT Chair*)	
15:15-15:30	**17. Closing of the session**	
15:30	**End of the SOT-12 Session**	
16:00	**Turbowin Partner Board Meeting (*Jean-Baptiste Cohuet*)**	Jean-Baptiste Cohuet

Annex 2

Task Team on Recruitment, Promotion and Training (TT-RPT)

Terms of Reference approved at the SOT-12, May 2023

The Task Team will:

1. Review existing promotional material including:
    a. SOT Certificates and Awards,
    b. Posters, brochures, and flyers,
    c. Relevant news and articles for use in SOT or VOS publications, national newsletters or publications,
    d. VOS website content,
    e. SOT 'Recruitment Presentation' and promotional videos,

2. Analyse replies to the VOS Scheme Questionnaire and identify issues that need to be addressed by SOT to improve the performance of the VOS Scheme. Review the need for and content of future questionnaires;

3. Monitor and review the suitability of the current VOS and Third-Party VOS Classes and ensure as many ships as possible report to required climate standards;

4. Monitor and develop global standards, practices and instructions for Port Meteorological Officers and assist with the coordination international or regional PMO Training Workshops;

5. Maintain relevant training documents, videos, instructions and guidance material for SOT Operators, PMOs and observers and propose new documents where appropriate;

6. Encourage initiatives to increase VOS SOT recruitment, particularly in data sparse areas such as the Polar regions;

7. Propose initiatives to assist member countries seeking to establish new national SOT networks;

8. Review relevant GOOS publications to ensure they are up to date with respect to SOT, recruitment, promotion and training;

10. Liaise with other GOOS Networks (e.g., DBCP) and Task Teams, as appropriate, regarding the development of common promotional material and training manuals (e.g., reference guides for ship riders collecting XBT data);

11. Assist the SOT executive board by developing and providing necessary input to the proposed Ship Forum (e.g., generic ship design standards);

12. Verify Task Team Membership on an annual basis and advise SOT EB and SOT TC of any changes.

Annex 3

Task Team on VOS Metadata (TT-VOS Metadata)

Terms of Reference approved at the SOT-12, May 2023

The Task Team shall:

1. Develop a new composite metadata structure for SOT observing networks based upon new WIGOS metadata standards and existing WMO Pub No 47 metadata requirements;

2. Regularly review metadata requirements for SOT observing networks and propose amendments or recommendations, where considered appropriate;

3. Review the compliance of SOT networks with WIGOS requirements and liaise with OSCAR Working Groups where required;

4. Monitor related work undertaken by other GOOS observing networks to ensure that, where appropriate, consistent harmonised metadata provisions are developed;

5. Liaise with the Task Team on Recruitment, Promotion and Training concerning metadata training for VOS operators, Focal Points and PMOs;

6. Determine the minimum SOT metadata requirements to be aligned with OSCAR mandatory metadata;

7. Verify Task Team Membership on an annual basis and advise SOT EB and SOT TC of any changes;

8. Review all relevant metadata content in WMO Publications to ensure they are up to date, and comply with Quality Management terminology;

9. Liaise with the Task Team on Expansion of the Independent Class (EICO) to determine the minimum metadata requirements for Independent class ships and ensure they align with OSCAR mandatory metadata;

10. Liaise with KNMI regarding the implementation of the new composite WIGOS metadata structure within TurboWin software;

11. Regularly review OceanOps SOT Github protocols for updating metadata reference table values and issues regarding the OceanOps tool.

Annex 4

Task Team on Expansion of Independent Class Observations (TT-EICO)

Terms of Reference approved at the SOT-12, May 2023

The Task Team on the Expansion of Independent Class Observations will:

1. Review, recommend and coordinate the expansion of independent class observations, including, but not limited to, any related projects and/or programmes through the United Nations Decade of Ocean Science for Sustainable Development along with citizen science initiatives;

2. Support the development and maintenance of new pilot projects to include gathering of meteorological and oceanographic data and metadata, and their quality control, inclusive of the SOT panels;

3. Ensure coordination as necessary with WMO, to include the WMO Information System, the Observations Coordination Group, OceanOPS, and others as appropriate;

4. Liaise with the SOT Task Team on Recruitment, Promotion and Training, and with other relevant task teams, where necessary, and encourage contact with other relevant marine organizations (e.g., IMO, ICS, etc.) to help promote independent class observations;

5. Develop a guide on the submission of metadata, in coordination with OceanOPS, for independent class VOS and other third-party vessels across SOT panels;

6. Develop a guide on the submission of observations, in coordination with the OCG, to the WMO GTS / WIS through the Open-GTS or similar initiative;

7. Coordinate to ensure the updating of WMO manuals as appropriate; and,

8. Include interested nations, including developing countries, as part of any demonstration and/or implementation.

Annex 5

Ship Observations Team (SOT)

Terms of Reference, approved at the SOT-12, May 2023
(Changes are highlighted in yellow)

The Ship Observations Team shall:

(a) Respond to requirements for ship-based observational data and metadata expressed by relevant international programmes and/or systems in support of marine services, and coordinate actions to implement and maintain the networks to satisfy these requirements;

(b) Provide continuing assessment of the extent to which those requirements are being met;

c) ~~Oversee and monitor~~ Engage with the implementation of methodologies as determined by the scientific and operational communities for constantly controlling and improving the quality of data;

(d) Review marine telecommunication facilities and procedures for observational data collection, as well as technology and techniques for data processing and transmission, and propose actions as necessary for improvements and enhanced application;

(e) Coordinate Port Meteorological Officer (PMO) operations globally, propose actions to enhance PMO standards and operations, and organize PMO and observers training, and greater PMO collaboration;

(f) Review, maintain and update as necessary technical guidance material relating to ship observations and PMOs;

(g) Liaise and coordinate as necessary with relevant expert teams, WMO Technical Commissions executive bodies, working groups, the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS) and its Observation Coordination Group (OCG), as well as with other interested parties, such as the International Maritime Organization (IMO), the International Hydrographic Organization (IHO) and other relevant international organizations;

(h) Participate in the planning activities of the appropriate observing system experiments and major international research programmes as the specialist group on meteorological and oceanographic observations based onboard ships;

(i) Seek and co-ordinate new opportunities for deploying and/or recovering various kinds of measuring devices as recommended by the relevant panels and widely publicize those opportunities;

(j) Develop as necessary new pilot projects and/or operational activities and establish new specialized panels as required;

(k) Carry out outreach, capacity development and other activities as agreed by participating Members/Member States to implement and operate the SOT observing programmes and to promote and expand them internationally, seek collection of third party data from ships, and collaborate with the ~~industry~~ private sector, academia and citizen science initiatives ~~in the~~with a view to enhance the collection of data from ships;

(l) ~~Develop improved~~ Provide ~~real-time~~ feedback to volunteer ships regarding the quantity, ~~and~~ quality and impact of the observations that they submit ~~and that are inserted on the GTS;~~ and,

(m) The SOT shall execute its business during the intersessional period through the SOT Executive Board (EB) ~~executes SOT business during SOT intersessional period.~~ with technical support and coordination through OceanOPS.

The Terms of Reference of the SOT EB shall be:

1. To seek guidance from the SOT at its regular sessions regarding specific issues to be addressed by the SOT EB, panels, and task teams during the intersessional period;

2. To act promptly to deal with any SOT-related administrative, financial, and planning issues and opportunities that might arise, within the guidelines established and reviewed regularly by the team;

3. To authorize the chairperson or the vice-chairperson as delegated, to commit any expenditure necessary for the resolution of these issues and the promotion of the team's aims and objectives, up to the maximum amounts that might be agreed in advance by the SOT EB, by the SOT at regular session, or by the availability of funds;

4. To assist the chairperson with regard to continuing the arrangements, including financial arrangements, to secure the services of a technical coordinator;

5. To set working priorities for the technical coordinator according to the SOT at its regular sessions, and provide further guidance during the intersessional period;

6. Confer by electronic mail, with a minimum of four EB teleconferences held annually, and at least two of those including the Chairs and vice-Chairs of the SOT Task Teams or their representatives;

7. To exploit opportunities to confer at other meetings face-to-face;

8. To conduct ~~regular team~~ meetings ~~of SOT approximately~~ biennially, following an agenda developed by the SOT EB;

9. To consult with SOT members, task team chairpersons, the technical coordinator, and secretariats during the intersessional period as required; and,

10. To report its activities to the SOT at its regular session, and throughout the intersessional period as appropriate.

Membership:

- The membership of SOT EB shall be constituted by:
- The SOT Chair;
- The SOT vice-Chair;
- The VOS Panel Chair(s);
- The VOS Panel vice-Chair(s);
- The SOOP Implementation Panel Chair(s);
- The SOOP Implementation Panel vice-Chair(s);
- The ASAP Panel Chair(s);
- The ASAP Panel vice-Chair(s);

- The SOT Technical Coordinator (ex officio);
- A representative from the IOC Secretariat (ex officio); and,
- A representative from the WMO Secretariat (ex officio).

SOT-EB Working Procedures:

• A quorum of the SOT EB will be at least ~~three~~ four members, including the SOT Chair or a designee, VOS Panel Chair(s) or designee(s), ASAP Panel Chair(s) or designee(s), and SOOP Implementation Panel Chair(s) or designee(s).

• Any SOT member can attend SOT EB meetings as an observer, subject to availability of virtual or actual meeting room space. If required, the chairperson will make a final decision as to which observers may attend. The chairperson may also invite other persons to attend at the chairperson's discretion.

• A summary of each EB meeting will be made available for the SOT.

• The term of SOT EB members is for two years (equal to the intersessional period between SOT meetings). They shall be eligible for re-election in their respective capacities, but would serve in principle for no more than three consecutive terms in that capacity. Elections will be decided by a simple majority if a quorum of SOT members is present during the regular biennial meeting. Nominations for vacant positions on the EB will be made prior to, or at, the meeting so that a vote can be taken at the end of the meeting.

• A quorum of a biennial meeting will consist of at least seven SOT members, with one member per WMO Member State/Territory or IOC Member State represented. If more than one member representing one WMO and/or IOC Member State/Territory is attending, the representatives from that particular State/Territory have to decide whose vote shall be counted. If a quorum is not present at the meeting, elections shall be by unanimous vote. If a unanimous vote cannot be achieved, membership shall be determined by the Secretariats.

• In principle, EB membership should assure regional and gender balance as far as possible.

• The SOT EB may establish time-bound substructures for the discharge of specific tasks during an intersessional period. The cost shall not exceed the availability of funds. Such temporary substructures shall be discontinued at the end of every intersessional period unless agreed to continue by the SOT members at the biennial meeting.

Annex 6

Participants List

	Name	Organization	Country
1	Aidan McMahon	Australian Bureau of Meteorology	Australia
2	Alejandro de la Maza	Chile Navy Weather Service	Chile
3	Anan Sirithanyarat	Thai Meteorological Department	Thailand
4	Andrew Luke King	Norwegian Institute for Water Research	Norway
5	ARCENE Mohamed	National Agency for Civil Aviation and Meteorology(ANACM)	Senegal
6	Axel Andersson	German Weather Service (DWD)	Germany
7	Bernadette Sloyan	CSIRO	Australia
8	Callum Stone	UK Metoffice	UK
9	Catalina Gucianu	PFA	Romania
10	Catia M Domingues	National Oceanography Centre (NOC)	UK
11	Champika Gallage	WMO	Switzerland
12	Chandravani		Malaysia
13	Chin-chi Lam	Hong Kong Observatory	Hong Kong-China
14	Chow Shi Kin	Hong Kong Observatory	Hong Kong-China
15	Christine Coatanoan	Ifremer	France
16	Christoper Paver	NOAA	USA
17	Dam TOURAY	Ministry of Fisheries & Water Resources.	Gambia
18	Darin Figurskey	Ocean Prediction Center/DOC/NWS/NOAA	USA
19	David Berry	WMO	Switzerland
20	David Dellinger	NOAA	USA
21	David Legler	NOAA/OAR - GOMO/GOOS	USA
22	DelaMaza Alejandro	Chilean Navy Weather Service	Chile
23	Denis Pierrot	NOAA	USA
24	Dick Shum Lau	Hong Kong Observatory	Hong Kong-China
25	Elizabeth Kent	National Oceanography Centre (NOC)	UK
26	Emma Heslop	GOOS/IOC/UNESCO	France
27	Emma Steventon	Met Office, UK	UK
28	Faiza Al-Yamani	Kuwait Institute for Scientific Research	Kuwait
29	Fasihah Suhaimi	Malaysian Meteorological Department	Malaysia
30	Francis Bringas	Atlantic Oceanographic and Meteorological Laboratory, NOAA	USA
31	Gustavo Goni	NOAA	USA
32	Helen Beggs	Bureau of Meteorology	Australia
33	Huai-Min (John) Zhang	National Centers for Environmental Information, NOAA	USA
34	Inês Martins	Instituto Hidrográfico	Portugal
35	Ivenis Pita	University of Miami	USA
36	Janet Sprintall	Scripps Institution of Oceanography	USA
37	Jean-Baptiste Cohuet	Météo-France	France

38	Joaquin Trinanes	NOAA	USA
39	Joel Cabrie	Bureau of Meteorology	Australia
40	Juan Leonardo Moreno Rincon	General Maritime Directorate	Colombia
41	Julian Rodriguez	Australian Bureau of Meteorology	Australia
42	Justine Parks	Scripps Institution of Oceanography	USA
43	Kan Ogawa	Japan Meteorological Service	Japan
44	Kathy Tedesco	NOAA	USA
45	Laura Stolp	Woods Hole Oceanographic Institution (WHOI)	USA
46	Lijing Cheng	Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences (CAS)	China
47	Lisa Krummel	Bureau of Meteorology	Australia
48	Mardene De Villiers	South African Weather Service	South Africa
49	Martin Kramp	OceanOPS/WMO	France
50	Mathé A. Jean - Paul ATTIGLAH	laEE/ Université de Lomé	Togo
51	Mathias haba	Agence Nationale de la Météorologie	Guinea
52	Mauro Cirano	Federal University of Rio de Janeiro	Brazil
53	Mayu Yamamoto	Japan Meteorological Service	Japan
54	Michael Earle	Environment and Climate Change Canada	Canada
55	Michael Linthon	Instituto Oceanográfico de la Armada (INOCAR)	Ecuador
56	Mikael Stenström	Swedish Meteorological and Hydrological Institute (SMHI)	Sweden
57	Mike Potochney	NOAA	USA
58	Olivier Desprez de Gésincourt	Météo-France	France
59	Pallavi Govekar	Bureau of Meteorology	Australia
60	Peter Busumprah	Ministry of Fisheries and Aquaculture Development Early Career Ocean Professionals	Ghana
61	Philippe Gautier	Météo-France	France
62	QiYang	Shanghai Marine Meteorological Center, Shanghai Meteorological Bureau, CMA	China
63	R.Chandra Vani P.Rajoo	Malaysian Meteorological Department	Malaysia
64	Raja Acharya	India Meteorological Department,Ministry of Earth Sciences Government of India	India
65	Rebecca Cowley	CSIRO Environment, Climate Atmosphere Ocean Interactions	Australia
66	Rudolf Krockauer	German Weather Service (DWD)	Germany
67	Sam Harper	International Hydrographic Organization	Monaco
68	Shawn R. Smith	Center for Ocean-Atmospheric Prediction Studies, Florida State University	USA

69	Shenfu Dong	Atlantic Oceanographic and Meteorological Laboratory, NOAA	USA
70	Solène Routaboul	CLS	France
71	Sorot Sawatdiraksa	Thai Meteorological Department	Thailand
72	Steve Knowles	MetService	New Zealand
73	Susan West	International Affairs /NWS/NOAA	USA
74	Takahiro Ishihara	Japan Meteorological Service	Japan
75	Tamaryn Morris	South African Weather Service	South Africa
76	Teeratham Tepparaj	Thai Meteorological Department	Thailand
77	Tina Leiding	German Weather Service (DWD)	Germany
78	Toru Suzuki	Marine Information Research Center	Japan
79	Vasiliy Melnikov	Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet)	Russian Federation
80	Vinciane Unger	Météo-France	France
81	Werenfrid Wimmer	National Oceanography Centre, Southampton	UK
82	Wittaya Rugkid	Thai Meteorological Department	Thailand
83	Xia Tianzhu	Tianjin Binhai New Area Bureau of Meteorology)	China
84	YAMAMOTO Mayu	Japan Meteorological Agency	Japan
85	Yuri Cotroneo	University Parthenope of Naples - Italy	Italy
86	Yvonne Schavemaker	Royal Netherlands Meteorological Institute (KNMI)	Germany
87	Zach Barton	Atlantic Oceanographic and Meteorological Laboratory, NOAA	USA
88	Zhanar Naurozbayeva	RSE Kazhydromet	Kazakhstan

Annex 7

List of Acronyms

ADCP	Acoustic Doppler Current Profilers
AET	Australian Eastern Time
AG-Ocean	Advisory Group on Ocean
AOPC	Atmospheric Observation Panel for Climate
ASAP	Automated Shipboard Aerological Programme
ASV	Automated Surface Vehicle
ASV	Automated Surface Vehicles
AWS	Automatic Weather Station
CMEMS	Copernicus Marine Environment Monitoring Service
CPR	Continuous Plankton Recorder
CSB	Crowd-Sourced Bathymetry
CTD	conductivity, temperature, and depth
DACs	Data Aquisition Centers
DBCP	Data Buoy Cooperation Panel
DMD	Delayed Mode Data
E-ASAP	European Automated Shipboard Aerological Programme
EB	Executive Board
ECVs	Essential Climate Variables
EEZ	Exclusive Economic Zones
EOVs	Essential Ocean Variables
E-Surfmar	Surface Marine programme of the Network of European Meteorological Services
ETRP	Education and Training Programme
EUCAWS	European Common AWS
EUMETNET	a grouping of 31 European National Meteorological Services
EW4All	Early Warning for All
FSU	Florida State University
GBON	Global Basic Observing Network
GCOS	Global Climate Observing System
GDACs	Global Data Assembly Centers
GHG	GreenHouse Gas
GHRSST	Group for High-Resolution SST
GLODAP	GLobal Ocean Data Analysis Project
GOOS SC	GOOS Steering Committee
GOSUD	Global Ocean Surface Underway Data
GTS	Global Telecommunication System
GTSPP	Global Temperature and Salinity Profile Programme
ICES	International Council for the Exploration of the Sea
ID	Identification
IHO	International Hydrographic Organization
IMMT	International Maritime Meteorological Tape
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission of UNESCO
IODE	International Oceanographic Data and Information Exchange
IQuOD	International Quality-controlled Ocean Database
IRSO	International Research Ship Operators
KNMI	The Royal Netherlands Meteorological Institute

KPIs	Key Performance Indicators
LCDs	Least Developed Countries
MCDS	Marine Climate Data System
MFP	Marine Facility Planning
MQCS	Minimum Quality Control System
MSR	Marine Scientific Research
NCEI	National Centers for Environmental Information
NGO	Non-Governmental Organization
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
NRT	Near Real Time
OCG	Observation Coordination Group
OOPC	Ocean Observations Physics and Climate
OSCAR	Observing Systems Capability Analysis and Review
PIs	Programme Investigators
PMOs	Port Meteorological Officers
QC	Quality Control
RoCS	Research on Commercial Ships
RRR	Rolling Review of Requirements
RTC	Regional Training Center
RVs	Research Vessels
SAMOS	Shipboard Automated Meteorological and Oceanographic System
SG-OOIS	Study Group on Ocean Observations and Infrastructure
SIDs	Small Island Developing States
SLP	Sea Level Pressure
SOCAt	Surface Ocean CO_2 Atlas
SOCONET	Surface Ocean CO_2 Reference Observing Network
SOFF	Systematic Observations Financing facility
SOI	Schmidt Ocean Institute
SOO	Ship of Opportunity
SOT	Ship Observation Team
SPC	Pacific Community
SSS	Sea Surface Salinity
SST	Sea Surface Temperature
TC	Technical Coordinator
TF	Trust Fund
TOR	The Ocean Race
ToR	Terms of Reference
TSG	ThermoSalinoGraphs
TT	Task Team
TT-EICO	Expansion of Independent Class Observations
TT-ISSC	Task Team on Instrument Standards and Satellite Communications Systems
TT-KPI	Task Team on Key Performance Indicators
TT-RPT	Task Team on Recruitment, Promotion, and Training
UK	United Kingdom
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
USA	United States of America
VOS	Voluntary Observing Ships
WHOI	Woods Hole Oceanographic Institution

WIGOS	Integrated Global Observing System
WIS2.0	WMO Information System 2.0
WMO	World Meteorological Organization
XBT	Expendable BathyThermographs
XST	XBT Science Team