WORLD METEOROLOGICAL ORGANIZATION

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Intergovernmental Oceanographic Commission

SHIP OBSERVATIONS TEAM

ELEVENTH SESSION

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13 to 16 September 2021

Virtual Meeting

2021

Meeting Report

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NOTES

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This publication is available in pdf format, at the following link:
https://goosocean.org/sot-11

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Virtual Team Participants

Those with known and available webcams shown

EXECUTIVE SUMMARY

The Eleventh Session of the Ship Observations Team (SOT) was held from 13 to 16 September 2021. The Session was held virtually 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) and Ship-of-Opportunity Programme (SOOP) Panels to address specific issues related to their programmes.

The virtual session was attended by 113 participants representing more than 40 countries. With respect to WMO's commitment to gender equality[1] there were 34 female participants, accounting for approximately 30% of the meeting. A list of participants is attached at **Annex I**. All supporting documents and presentations submitted to the session are available at https://goosocean.org/sot-11.

As a consequence of restrictions arising from the COVID pandemic the meeting was held virtually for the first time. The Team expressed its sympathy to those members whose lives and families may have been impacted by the pandemic. It was also recognised that working restrictions imposed during the pandemic have had a negative impact on the ability of many SOT members to inspect and operate vessels and, consequently, to maintain the previously achieved volume of observations. SOOP was especially impacted due to limited travel and recruitment opportunities, although the impact on VOS was less significant due, in part, to the increased use of Automated Weather Stations (AWS).

Three Industry/Partner presentations were made on the first day of the meeting and focused on areas which could potentially involve synergies with future SOT network operations. Sixteen national reports were also presented on the first day of the session which not only reported on the status of members' networks but also identified opportunities and challenges at the national level.

The Team recognised the work completed by various task teams during the intersessional period including, in particular, the progress made on developing composite metadata standards, and the successful delivery of the virtual Port Meteorological Officer Workshop (PMO-6) (16-18 March 2021).

The Team agreed to establish two new task teams: one ad-hoc task team to deal with issues related to the collection of delayed mode IMMT data; and a new task team to coordinate the expansion of independent class observations. Having completed its primary functions, the Team also agreed to discontinue its task team on the development of universal unique IDs.

Following initial consideration by the SOT Executive Board the Team also agreed that the Automated Shipboard Aerological Programme (ASAP) should be re-instated as a separate SOT Panel to oversee and enhance international upper-air activities and operations. Terms of Reference and membership for all SOT Panels and task teams were reviewed in detail and agreed (**Annex IV**).

Changes to leadership positions within the SOT Executive Board and Committee were agreed at the session. SOT Vice Chair Dr. David Berry (United Kingdom), SOOP Implementation Panel (SOOPIP) Chair Ms. Rebecca Cowley (Australia) and Vice Chair Dr. Gustavo Goni (United States), and the VOSP Vice Chair, Mr. Sai-tick Chan (Hong Kong, China), all stood down from their positions. The SOT is grateful to them for their service and commitment. Ms. Elizabeth Kent (United Kingdom) was elected as the new SOT vice Chair, and Dr. Tamaryn Morris (South Africa) and Francis Bringas (United States) were elected as the co-Chairs of SOOPIP with Ms. Justine Parks (United States) as vice Chair.

[1] WMO Congress 17, Resolution 59 : https://ane4bf-datap1.s3-eu-west-1.amazonaws.com/wmocms/s3fs-public/RESOLUTION_59Cg-17.pdf?LHIsIKDN0fXvAOjCGPZdJE6.V.VQemy6

The VOS Panel (VOSP) reported that, despite the impact of COVID restrictions, there had been a slight increase in the number of stations providing real-time data to the GTS (approx. 2750 in 2020) and noted that approximately 10% of the VOS fleet is currently automated. Furthermore, the number of active national VOS networks had increased to 25.

Cooperation with Danish-based shipping company Maersk has continued and the 50th EUCAWS station was recently installed onboard one of their vessels, making Maersk one of the biggest fleets of automated marine meteorological data in the world. Maersk has decided that all of its company-owned vessels (approximately 300 vessels) should participate in the VOS network.

The SOOPIP is making great strides in its efforts to develop standards and best practices. In particular, best practices for recruiting vessels are currently under development. The Panel continues to build on its coordination with associated networks and engagement has increased with the CPR, TSG, and pCO_2 networks activities with a view to advancing common interests. Development of best practice documentation for all SOT networks is expected to be a be focus of the coming intersessional period.

Whilst the Team approved the SOT Implementation Strategy, version 2.1, it agreed that additional work should be undertaken during the coming intersessional period to refine it into an even more strategic document, reflecting the Team's evolving priorities and short/long term goals. The Team also approved its financial report, which detailed SOT spending plans for the upcoming intersessional period. To reduce the burden on maintaining additional Trust Funds, and with the agreement of the Australian Bureau of Meteorology (BoM), all funds in the ASAP Trust Fund have been transferred to the DBCP Trust Fund for pure SOT activities, with spending authority granted to the SOT Chairperson. Accordingly, the ASAP Trust Fund is now closed.

As a capacity building effort to encourage the development of new national VOS networks, expressions of interest were invited from the National Meteorological and Hydrological Services (NMHSs) to be recipients in the VOS Donation Program. Dependent on available funds the program aims to provide selected NMHSs with digital barometers and GPS units interfaced with Turbowin+ software, to act as a semi-automated weather station for an initial period of 1 year. Thereafter, provided the equipment has been deployed and operated successfully, recipients will take responsibility for maintaining and operating the assets themselves. Three prospective national recipients are being assessed.

Several presentations at the session highlighted the opportunities afforded by the UN Ocean Decade of Ocean Science for Sustainable Development (Ocean Decade) to promote projects and programmes supporting expansion of observations for healthy, predictable, and safe oceans. Independent, or "third party", observations, engaging citizen scientists, are expected to play a key role in Ocean Decade efforts promoted by SOT and, in particular, the Open-GTS project could simplify the dataflows for real time in-situ third party data. Furthermore, an OceanOPS "Odyssey" UN Ocean Decade application has already been submitted as an umbrella project for citizen science/private sector initiatives.

OceanOPS continues to be the focal point for all SOT network operational activities. Database implementation of the new SOT metadata format was one of the biggest SOT achievements in the intersessional period and further improvements have been made to the OceanOPS dashboard. An OceanOPS web-designer will be funded through the SOT budget to start work on the SOT-specific GUI requirements. The overall SOT metadata format follows the concept of an integrated GOOS-wide metadata standard, for which an OCG workshop was hosted in early 2021.

The importance of developing functional connections with the expert teams and standing committees that have been established to support the new Commission for Observation, Infrastructure and Information Systems (INFCOM) and Commission for Weather, Climate, Water and Related Environmental Services and Applications (SERCOM) was highlighted. SOT members supported the recommendations from the 73rd Executive Council for the implementation of Global Basic Observing Network (GBON) requirements identified in WMO No. 1160 and agreed to provide input to further develop the GBON to include the full range of ECV and EOV for the marine/ocean domain.

1. OPENING OF THE SOT SESSION

1.1 Opening Remarks from the SOT Chair

The SOT Chair, Mr. Darin Figurskey (United States) opened the session at 0900 UTC on 13 September 2021.

Mr. Figurskey began by recalling the success of the previous SOT-10 session held in Hong Kong and thanked the Team for helping to sustain the networks and to continue observations during the intersessional period which had been overshadowed by the COVID pandemic. He expressed his deep sympathy to those members who had been affected, suffered, or lost someone during the intersessional period due to the pandemic, and acknowledged innovative coordination, extreme effort, and perseverance displayed by members during this difficult time.

Despite these challenges, Mr. Figurskey highlighted the many achievements for the SOOP, VOS and ASAP programmes during the intersessional period, including:

SOOP

- Seamless leadership transition within the SOOPIP
- Good progress on developing standards and best practices (agenda item 9.2.1.2 refers)
- The recent cross network workshop on boundary currents
- Developing closer relationships with Ferrybox and the CPR/TSG/pCO_2 communities

VOS

- Hosting the virtual PMO-6 conference (agenda item 9.1.1.5 refers)
- Validating the SOT metadata structure (agenda item 4.2 refers)
- Codifying SOT IDs at the WMO's INFCOM session (agenda item 4.1.1 refers)
- Coordination with Maersk and establishing relationships with other industry partners (agenda item 9.1.1 refers)
- Coordination with Iridium on the functions for its SafetyCast GMDSS service (agenda item 13.2 refers)
- Coordination with the Global Cryosphere Watch (GCW)
- Tracing Open-GTS observations from beginning to end through Deutscher Wetterdienst (DWD) and NOAA dataflows
- New involvement by Denmark and Thailand in VOS activities.

ASAP

- Coordination with the '*Polarstern'* Arctic research expedition (agenda item 9.1.2 refers)
- 1350 additional upper air soundings in 2020 compared to 2019
- The potential addition of two new US vessels in ASAP, operating in the Great Lakes.

Looking forward, Mr. Figurskey identified several key areas and opportunities for the coming intersessional period, including:

- Working through the UN Decade of Ocean Science (agenda item 11 refers)
- Development of SOT-wide KPI's (agenda item 5 refers)
- Capacity development (agenda item 12 refers)
- Developing functional connections with newly formed Commission expert teams
- Hosting periodic webinars; and,
- Developing best practices and continued metadata transition activities

Mr. Figurskey encouraged more members to participate in the work of the SOT and its task teams, and expressed his hope for an in-person meeting for the 2023 SOT-12 session. He thanked all members of the SOT for their hard work and service during the intersessional period since SOT-10, and also thanked members of the Executive Board, the Technical Coordinator and the WMO/IOC Secretariats for their work in preparing for the session.

1.1.1 Adoption of the Agenda

The Team adopted the agenda subject to minor changes to the session timetable necessary to accommodate the schedule of the IRSO presenter, and to changes in the sequence of presentations during the VOS Panel breakout session.

With members agreement an additional item 10.3 on reinstating the ASAP Panel was added to the agenda during the meeting.

A copy of the final agenda is at **Annex II**

Because this was the first SOT session to be held virtually, the need to keep to careful track of time during the meeting was stressed. A detailed timetable was made available to all members prior to the meeting.

1.1.2 Report of the SOT Chairperson

Elaborating on his opening remarks the SOT Chair, Mr. Darin Figurskey, submitted a summary report on the key SOT activities during the intersessional period, most of which were subject to further detailed consideration during the session. These included:

SOT Leadership
The SOT Executive Board (EB) continues to meet frequently, approximately every six weeks via video teleconference. The SOT Executive Committee (EC) has met more frequently than normal during this intersessional period, approximately every two to four months. All meeting minutes are made available to members via the "Committee Meetings" link at: https://www.ocean-ops.org/sot/index.html. Task team meetings have been particularly frequent in support of metadata efforts.

SOT Governance
Following SOT-10, the SOT had codified its EB terms of reference and the SOT Implementation Strategy, version 2.0. A draft version 2.1 of the implementation strategy, version 2.1, was prepared for discussion under agenda item 10.2.

COVID - 19
SOOP was especially impacted by COVID – 19. Of 25 XBT lines, only 18 lines collected data due to limited travel and recruitment opportunities. The XBT program experienced ~50% data reduction and pCO_2 ~30% data reduction. Fortunately, ~ 50% of the XBT lines that were initially halted due to the pandemic have been able to resume in some form. PMO visits to VOS were also much reduced.

WMO published a press release on COVID–19 impacts on the global observing system[2], while articles on the impacts of COVID–19 were the subject of articles issued by WMO[3] and UNESCO.

[2] https://public.wmo.int/en/media/press-release/Covid-19-impacts-observing-system
[3] https://public.wmo.int/en/resources/bulletin/impacts-of-Covid-19-restrictions-observations-and-monitoring

Maersk
Shipping Company Maersk remains committed that its fleet will take ocean observations vital for weather and climate prediction and, in June, 2021, the 50th EUCAWS station was installed onboard a Maersk vessel, making Maersk one of the world's biggest fleets of automated marine meteorological data (agenda item 9.1.1 refers). It is important that GOOS and its associated networks coordinate through the SOT and its VOS Panel on interactions with Maersk to ensure consistency of message and effort.

PMO – 6
Over 100 participants registered for the Sixth International Port Meteorological Officers (PMO-6) Workshop which was held virtually on 16 March and 18 March 2021. As a result of workshop feedback, occasional webinars are planned to keep the SOT and PMOs abreast of SOT items of interest. (agenda item 9.1.1.5 refers)

Capacity Development
As a capacity building effort to encourage the development of new national VOS networks, the SOT is calling for expressions of interest from the National Meteorological and Hydrological Services (NMHSs) as the recipients in the VOS Donation Program. More information is available under agenda item 12.

New contributions to VOS from Denmark and Thailand will bring the number of active VOS programs to 25, up from 23 in 2019. There are also potentially two new U.S. participants in ASAP from the Viking vessels '*Octantis'* and '*Polaris'* that are expected to conduct expedition cruises in the Great Lakes.

Standards and Best Practices
SOOP is making great strides in its efforts to develop standards and best practices. Vessel recruiting best practices are in progress. Future efforts will focus on XBTs, CPR, PCO_2, and TSG.

Environmental Stewardship
Whilst SOOP recognises that XBTs deposit materials in the ocean that are not retrieved, it is believed that the positive impact on society through the measurements obtained outweighs the environmental impact of the deployed probes.

Cross-network Initiatives
SOOP continues to build on its coordination with associated networks. Engagement has increased with the CPR, TSG, and pCO_2 networks particularly through quarterly virtual conference calls. SOOPIP hosted a boundary current workshop on 13 May 2021 which was a great step forward in building partnerships to identify the critical regions that need studying, along with resources to conduct and further such studies.

Metadata
The SOT task team on metadata has worked extremely hard to near completion on a new metadata format. A one-page flyer has been developed and shared with PMOs on how to provide metadata. At its meeting on 10 June 2021, the SOT EB decided to have historic (Pub47) metadata handled by OceanOPS. The work of the metadata task team can help inform other OCG networks' efforts to update, and possibly expand, their metadata formats.

SOT-IDs
The use of SOT-IDs was approved at the first session of the Commission for Observation, Infrastructure, and Information Systems (INFCOM-1) held from 12 April to 16 April 2021. Through OceanOPS the uniqueness of the identifiers can be maintained. Members are requested to continue working toward the use of the SOT-ID for their ship observing networks.

WMO Restructuring
As a consequence of WMO restructuring the SOT EC has developed a list of prioritized engagement needs, with particular respect to WMO Commission standing committees, study groups, and expert teams. However, the active SOT membership does not contain enough individuals to monitor and participate in all these activities. The SOT EB has reached out to

individuals in other networks, and with associated entities, to help in maintaining connections. SOT will make every reasonable effort to maintain functional connections and engage in critical decisions affecting ship observation related policies.

Membership
Several changes are anticipated in the membership of both the SOT EB and EC (agenda item 10 refers) and support is requested for those that have volunteered to assume leadership roles. These volunteers have demonstrated their commitment to SOT activities, the furthering of SOT goals, and the building of partnerships. Active participation from among the greater SOT community is requested in SOT task teams to help ensure the infusion of new ideas.

UN Ocean Decade of Ocean Science for Sustainable Development
The UN Ocean Decade of Ocean Science for Sustainable Development, or the Ocean Decade for short, provides an opportunity for engagement in, and the promotion of, projects and programmes supporting expansion of observations for a healthy, predictable, and safe ocean. Independent, or "third party", observations, engaging citizen scientists, are expected to play a key role in Ocean Decade efforts promoted by the SOT. These efforts will need to be designed to complement the observations from established networks, freely accessible with adequate metadata and innovative methods of transmission, and include interested, developing nations in any implementation.

1.2 Opening Remarks from the IOC Secretariat

Dr. Emma Heslop, representing the International Oceanographic Commission (IOC) of UNESCO, stressed the importance of observations to GOOS, and to wider society. In situ observations, together with those taken above and below the ocean surface provide critical input to help make decisions on, for example, climate analysis, maritime services, and the health of the ocean.

Dr. Heslop referred to the forthcoming 26th UN Climate Change Conference (COP26)[4] and highlighted the challenges around climate, sustainable development and ensuring safety of life at sea. SOOP, ASAP and VOS networks therefore have an important role to play. She specifically mentioned the amount of effort that had been expended by operators to keep stations operable (e.g., ensuring remote calibration/maintenance) despite the challenges arising from COVID.

Dr. Heslop also drew attention to those agenda items that are of relevance to the wider work of GOOS and IOC and which will provide cross network opportunities, such as the 'Ocean Decade' projects, capacity development, and metadata. The development of functional connections with the expert teams and study groups established under the INFCOM and SERCOM is also an overarching area that is being given particular focus by OCG.

The SOT Chair Mr. Figurskey thanked Dr. Heslop, and the IOC Secretariat, for their work in support of the meeting. He also took the opportunity to extend thanks to Ms. Champika Gallage and Dr. Dominique Berod of the WMO Secretariat, to Mr. Martin Kramp the SOT Technical Coordinator, and to all the OceanOPS team under the leadership of Mr. Mathieu Belbeoch. Without their efforts the SOT meeting could not have taken place.

1.3 Opening Remarks from the WMO Secretariat

Dr. Dominique Berod, Head of Earth System Monitoring Division of WMO, welcomed participants on behalf of the WMO Secretary General and the Director of the WMO Infrastructure Department. He endorsed the comments previously made by Dr. Heslop that the SOT plays a major role in providing the data necessary to understand weather, climate, and what is

[4] https://ukcop26.org/

happening in the ocean. Such data are interconnected and have a marked impact on society, population, ecosystems, hydrological cycles, economy, etc., and are needed by scientists and to assist decision makers.

Dr. Berod emphasised the need to have an integrated approach in order to understand the whole earth system and said that the SOT community will be a major contributor to this objective. WMO is working to better understand such earth systems, and SOT efforts allow an integrated approach with inter-operable data; SOT data need to be used multiple times by multiple users for multiple purposes, and hopefully with multiple benefits.

In this respect WMO is therefore increasing its support to ocean observing as a whole. He briefly drew attention to the changes made to the WMO Secretariat structure and governance and pointed out that that ocean observations are now a full component of the Earth Monitoring Division. Furthermore, he advised that the WMO core budget was funding a new Ocean Manager position within OceanOPS and that interviews for the position were currently taking place. In addition, a new position for a metadata clerk at OceanOPS, Brest, was being established to help better support the SOT community.

Dr. Berod concluded his opening remarks by giving special thanks to the SOT Chair for his restless efforts on behalf of the Team. He also thanked Dr. Heslop of the IOC secretariat for her support to the ocean observing community, and specifically thanked SOT Technical Coordinator Mr. Martin Kramp, and Ms. Sarah North as WMO Contractor, for their work in making all the essential preparations for the session. The SOT Chair thanked Dr. Berod for his comments and WMO for its ongoing support.

1.4 Virtual Meeting Instructions

Ms. Sarah North, WMO Contractor, instructed members on how to use the basic functions of Microsoft Teams during the meeting - notably with respect to the chat function to enable general side discussions during each presentation, and by raising virtual hands to advise the meeting moderators if they wish to ask any specific questions. She stressed the need for meeting etiquette and for participants to mute their microphones when not speaking. Because there were so many participants, she also asked members to limit their use of video to avoid any bandwidth issues.

Ms. North highlighted the important roles that the rapporteurs and moderators would play in ensuring the success of the meeting. She pointed to the basic guidance and template she had developed to help rapporteurs capture the main issues and decisions arising from the meeting and asked for rapporteur records to be posted on a SharePoint directory within 24 hours of the end of the session. The main moderator roles were to introduce presenters and to make sure that discussions kept to time, whilst also monitoring issues or questions raised by members via the chat function or raised hands.

The Team noted that all sessions would be recorded for the purpose of writing the final report and that it was intended to delete the recordings afterwards. However, at the end of the session it was subsequently decided to make the recordings available via a web link on the overview page of the SOT-11 website. [5]

[5] https://oceanexpert.org/event/3065#overview

2. NATIONAL REPORTS

Mr. Sai-tick Chan (Hong Kong, China) chaired the National Report session. Reports were presented in alphabetical order by the following Members/Member States:

Australia (Mr. Joel Cabrie)
Canada (Mr. Puneet Jaswal)
Chile (Mr. Alejandro de la Maza)
China (Mr. Yang Jinkun & Shang Wenyan)
France (Mr. Jean-Baptiste Cohuet)
Germany (Mr. Henry Kleta)
Hong Kong, China (Chow Chi Kin)
India (Mr. Balakrishnan Nair)
Japan (Mr. Yamamoto Mayu)
Netherlands (Mr. Arjan Kramer)
New Zealand (Mr. Steve Knowles)
Russian Federation (Mr. Vasily A Melmikov)
South Africa (Ms. Tamaryn Morris & Ms. Mardené de Villiers)
Spain (Ms. Elena Tel)
United Kingdom (Mr. Fraser Cunningham)
United States of America (Mr. Michael Potochney & Mr. Francis Bringas)

The reports summarized the relevant activities in each country for all SOT ship-based observations. They included information about national organisational structures and resources, current and planned SOT network activities, data contributions in real time and delayed mode, new initiatives and future plans. All national presentations are available at https://goosocean.org/sot-11. Some of the salient points from each presentation are as follows:

- The Australia Bureau of Meteorology is involved in both VOS and SOOP activities and manages a fleet of 43 manual VOS, five ships which have been upgraded to use the automated pressure and temperature recording (APTR) system, 1 Shipborne AWS, and 4 XBT SOOP ships operating on three frequently repeated XBT lines. In addition, CSIRO perform high resolution XBT sampling on three transects and the Royal Australian Navy (RAN) perform ad-hoc XBT sampling (although for security reasons RAN data is not provided in real time). Plans are in place to tender for a new ship AWS system to replace their outdated system, which is eventually hoped to roll out to about 10 ships. Further APTR systems will also be rolled out to suitable coastal vessels, and work will continue to replace mercury thermometers with digital systems. A new Antarctic re-supply vessel RSV '*Nuyina'* is due for delivery soon.

- The active Canadian fleet comprises 42 ships, mostly operated by the Canadian Coast Guard, and all equipped with AVOS automated systems producing hourly observations. A small number of manual observations are however received from staff on coast guard vessels. Observation numbers are typically high in the summer but decrease in winter months due the lakes being frozen. Five ships were lost recently due to retirement and a rigorous selection process is in place to find suitable replacements, with an eventual goal of 50 automated ships. A new network viewer has been developed to view the location of, and data from, all their fleet. Data is still produced in FM-13 format, although it is hoped to migrate to BUFR in the future. Canada is also getting close to implementing SOT-IDs.

- Chile operates a fleet of six naval ships, comprising one tall ship, a scientific research ship, three logistic/transport ships, and one new Antarctic icebreaker research vessel. The tall ship '*Esmeralda'* normally operates around the world but due to the pandemic has been limited to coastal waters. However, '*Esmeralda'* and research vessel '*Cabo de Hornos'* may, in future, be available to assist SOOP in the southeast Pacific Ocean. Six vessels have been identified as possible candidates under the VOS Donation Program (Agenda item 12 refers). A target list of navy vessels as potential VOS recruits has been prepared, including a list of possible ferries and cargo vessels that operate in the Patagonian channels and the Magellan Strait. Chile maintains good regional co-ordination links with Peru, Colombia and Ecuador.

- The Chinese fleet comprises 115 ships equipped with AWS systems and there were 29 new recruits in 2020. There are four main types of AWS installed on the Chinese fleet, all made in China. From April, 2017 efforts were made to share the Chinese VOS data onto the GTS using eight carefully selected and well operated vessels. By 2019 seven vessels were transmitting data to the GTS operationally, but this number reduced to four ships in 2020 due to the impact of COVID. China is also actively carrying out marine data sharing services providing oceanographic data to meet the needs of national and local governments and institutions. A target of over 400 VOS has been set and a special fund has been allocated to achieve this. Big marine data studies are being undertaken aimed at marine disaster early warning and forecasting, and global climate change.

- France is involved with VOS, ASAP (managed by Météo-France) and SOOP operations (managed by Ifremer, SHOM and IRD). A network of 73 mostly automated VOS ships is in place, i.e., 15 Batos, 4 Baros, 29 Mercury, 21 EUCAWS and 5 ships using TurboWin+, one of which is fitted with APTR. There are four ASAP ships operating between Europe and the West Indies and making three soundings per day. For SOOP there are 21 TSG ships, 2 pCO_2 ships, 5 CTD ships and 6 XBT ships. For the future France is working on SST sensor comparisons and on the harmonisation of internal marine dataflows. They also plan to continue their fleet modernisation, and to work on further development of a miniaturized EUCAWS system. For SOOP there is an initiative to collect ocean data by equipping a fishing vessel and its nets with sensors.

- German ASAP ships are now fully integrated into the E-ASAP programme although ASAP profiles are also made available from the research vessels '*PolarStern'* and '*Sonne'.* For SOOP Germany doesn't operate any XBT lines, but they do have data from nine fixed stations in German waters and the scientific community is providing pCO_2 data, although not yet to the GTS. The German VOS fleet comprises 456 NMHS-operated class ships, and 95 NMHS Cooperative class ships. 20% of the VOS fleet are equipped with AWS systems (mostly EUCAWS) and they contribute 90% of the data, all of which is pushed to the GTS. DWD continues to work closely with the shipping company Maersk and has now installed 50 EUCAWS systems on Maersk vessels. The main challenges were due to mechanical issues/damage, and the need to make declarations of conformity for equipment placed on observing vessels.

- Hong Kong has participated in the VOS Scheme since 1949. In 2020 there were 78 ships recruited and one further ship was recruited in 2021. Two ships are installed with automated systems - one AMOS system developed by the UK Met Office, and one modified 'deck' drifter. Data was lost from the battery of the deck drifter and, due to COVID restrictions, maintenance visits have had to be postponed. However, a new deck drifter was purchased for the '*OOCL Savannah'* and this is now disseminating data to the GTS. 17,332 manned observations were distributed on the GTS, and 10,000 automatic observations. 46 (58%) of the Hong Kong fleet are now installed with digital barometers and 76 ships are using TurboWin electronic logbooks. The Hong Kong Observatory is undertaking trials of an ultrasonic (Gill GMX200) anemometer on a fishing vessel. It is also planned to install a EUCAWS system on a suitable ship as a pilot project (the system is currently on test at the Observatory).

- The Indian AWS system (IRAWS) has been commissioned on 35 ships although one system was lost in 2014 and four were decommissioned in 2020/2021. Data is lost when ships are in drydock, and several systems are having GPS reporting errors. The aim, however, is to operationalise 34 AWS systems by October, 2021 and thereafter to eventually increase to 50 AWS systems integrated with oceanographic parameters. Work is also planned to integrate water quality observation systems into the existing AWS network and to undertake real-time simulation experiments to optimize the AWS system. It is also planned to collaborate with other Indian Ocean Rim countries, in particular for the recruitment of VOS, and to utilise fishing boats for automatic met ocean data collection. Integration of pCO_2 sensors on selected ships is also planned, and progress is being made on systems to allow the real-time data transmission of SOOP data.

- In December, 2020 there were approximately 600 manually reporting ships in the Japanese VOS fleet, most of which use their own ships' instruments and transmit observations by Inmarsat Code 41, or by email. For SOOP the JMA operates two research vessels (*'Ryofu Maru'* and *'Keifu Maru')* which undertake regular CTD sampling on PX45 and PX46 lines, amounting to 121 messages. 595 BATHY messages and 6022 TESAC messages are also received from Japanese research ships and training vessels. For ASAP, 417 upper-air radiosonde TEMP messages were provided by research ships '*Ryofu Maru'* and '*Mirai'* operating in the Western Pacific. *'Keifu Maru'* will also contribute to ASAP from March, 2022. PMO visits to ships were ended in April, 2021 due to COVID-19 and barometer checking services are provided by email or online[6]. JMA is now working on discontinuing the call sign masking scheme used by Japanese ships, and it is expected to end in March, 2022. Some ships have already quit the masking scheme.

- The Netherlands (KNMI) continues its work to further develop the TurboWin+ electronic logbook software in conjunction with the E-SURFMAR Program. This can be downloaded from https://gitlab.com/KNMI-OSS/turbowin/turbowin. KNMI operates 70 conventional VOS as well as two EUCAWS systems on the *'Lagarfoss'* and *'Atlantic Klipper'.* For SOOP all three Dutch SOOP vessels are inactive due to the COVID restrictions. Every year 14 drifter buoys are deployed just below Iceland and two will be deployed in the Arctic. Future plans include installing four more EUCAWS systems this year on an Ocean Wide Expeditions ship in data sparse areas of the Arctic and Antarctic. A further 10 EUCAWS systems are planned for 2022 and consideration is being given to adding sonic weather sensors and seawater temperature measurements. Water leakage problems with the EUCAWS are being addressed in conjunction with the manufacturer.

- New Zealand VOS currently has 37 manually reporting ships and two AWS ships. 27 of these ships regularly visit New Zealand Ports and only 19 are currently reporting regularly. Automatic weather reports have increased very slightly over the last two years and currently stand at just over 9k reports, whereas manual observations have dropped quite sharply during the same period. This is partly due to there being no PMO support in New Zealand at present but is also due to COVID restrictions. Similarly, drifter buoy deployments were substantially reduced, although five beached drifters were recovered. Mercury thermometer replacements on the VOS have also been suspended due to COVID. Once a new PMO is recruited it is hoped that the program will be able to recover to its former glory.

- There are 25 branches in Russia's ROSHYDROMET, of which 11 are marine related. There was a decrease in the overall number of VOS vessels between 2017 and 2020 falling from 111 ships to 79. One of the reasons for the decrease may be due the removal of the VOS program from ROSHYDROMET due to 'inconsistencies'. However, the number of AWS systems has increased from 5 to 11 during the same period. The time is ripe to reinvigorate Russian VOS activity and the future goal is to equip most suitable ships and research vessels with AWS systems.

- South Africa is involved with VOS, SOOP and ASAP activities. Responsibility for VOS is mostly related to research and cargo ships operating out of Cape Town harbour, whilst SOOP responsibility is for the XBT transects along the AX25 line and CrossRoads line on behalf of NOAA. TSG, CPR and pCO_2 observations are also undertaken opportunistically. ASAP upper-air observations are undertaken from the *'SA Agulhas II'* once a day at midday using a manually-launched weather balloon. Challenges relate to the submission of historical data and metadata, particularly for SOOP activities, and the migration to BUFR format. Future plans involve finalising documents for the standards and best practices team and reaching out to neighbouring African countries for recruitment of VOS.

- Spain has 12 ships providing met-ocean data operated by four different agencies. Eleven of the ships report meteorological data and eight undertake TSG measurements. The hospital ship '*Esperanza del Mar'* has been equipped with upper-air sounding equipment since 2002

[6] https://marine.kishou.go.jp/baro-chk/index.html

and typically transmits one sounding each day via iridium when at sea off the coast of West Africa. It also hosts an AWS system. Hospital ship *'Juan de la Cosa'* has been fitted with a EUCAWS system. Meteorological data is sent via the GTS while SOOP type data tends to be sent to a server via ftp. The Balearic Islands Coastal Observing and Forecasting System (SOCIB) is operating a catamaran which is equipped with meteorological and TSG systems. Collaborations are also being established with the fisheries administration for TSG data and plans are in place to build a new research vessel.

- The United Kingdom VOS fleet in July, 2021 comprised 228 NHMS operated ships, 175 conventional manually-reporting ships and 53 ships fitted with automated AMOS/2x. In 2020 80,000 observations were received from manually-reporting VOS and 364,000 from AMOS systems. In addition, 550,000 observations were received from third party offshore platforms. In the last two years work has concentrated on the rollout of the new AMOS/2x system although there have been some issues around CE markings that have had to be resolved. Coding has been developed to convert the AMOS data to IMMT format for submission to the GDACs. Pilot rollouts for the Met Office's SurfaceNet marine and land data processing system are in hand and data will be sent in BUFR format. Future plans include improving metadata using a WIGOS compliant database, and getting the AMOS rollout back on track after what has been a difficult year.

- The United States VOS program operates under the NWS Office of Observations, with 12 PMOs spread across five regions. In 2020 the US VOS accounted for over 30% of the worldwide VOS observations and almost 36% of VOS ship numbers. Current focus is on updating the Enhanced Manual Observing System (EMOS) which uses a Mintaka system relaying sensor data to a computer with TurboWin software. This has helped to significantly increase observation numbers to ~1.2 million observations this year. For SOOP, XBT deployments were heavily impacted by COVID (falling from 8926 profiles in 2019, to 3248 in 2020). 90% of XBT profiles are sent in real time using iridium, and work continues on upgrading AMVERSEAS for recording and transmitting XBT and TSG observations. The US SOOP pCO_2 systems are on 50 ships and provide approximately 30% of the global data available in the Surface Ocean CO_2 Atlas (SOCAT). SOOP TSG systems are deployed on 15 ships contributing ~200,000 observations. Engineering developments include an AOML XBT weather station which is now in use on two ships, an XBT data recorder which is in the test and validation stage, and the AOML Iridium transmitter which has been in operation on US SOOP ships since 2015. International collaboration with international partner countries continues to be a key factor for US SOOP operations.

The impact of COVID on SOT network operations was evident in almost all the national reports although the loss of observations from VOS fitted with automated systems was only slight when compared to the loss of data from manually reporting VOS. Data losses were mainly caused by inability to inspect or resupply manually reporting ships, and by the large number of ships laid up or scrapped during the period, whereas automated systems were only affected by the inability to perform scheduled maintenance or essential repairs onboard. SOOP Operations were impacted far more than VOS due in part to the loss of ship-riders on board.

3. INDUSTRY / PARTNER PRESENTATIONS

3.1 Kongsberg

Mr. Peer Fietzek, Senior Business Development Manager, Ocean Science at Kongsberg Maritime (KM), Germany GmbH, gave a presentation addressing the benefits of advanced digital infrastructure for meteorological and oceanographic data collection from connected vessels. He began his presentation by recalling the OceanObs'19[7] discussions concerning the linking vessels and the advantages of establishing an advanced digital infrastructure for meteorological and

[7] https://www.oceanobs19.net

oceanographic parameters. The percentage of vessels with automated data acquisition is far lower than it should be, so connected vessel technology provides the opportunity to digitally transform the shipping industry. In particular, merchant fleet automation and data sharing will allow for route and fuel usage to be optimised leading to more efficient, safer and sustainable operations (e.g., CO_2 emission reductions).

The strong trend towards vessel automation in the maritime sector therefore offers clear advantages related to operational efficiency and eco-friendliness. A central element within this development is the connectivity of, and regular data exchange between, the seaborne platforms and on-land workplaces facilitated by cloud technologies. In the coming years, this will enable more remote operations and advanced logistics solutions, paving the way for autonomous vessels and smart ports.

Within a decade it is aspired to find fully integrated end-to-end logistic solutions, in which all parts of the value chain seamlessly share and exchange information and achieve the most energy efficient and environmentally friendly transport of products. This trend towards more connected and accessible vessels that sail the ocean has tremendous potential for the enhanced and automated collection of meteorological and oceanographic data.

In many cases data is still not shared in an automated fashion with the GTS. Data today are still relatively scarce and hardly meet the threshold requirements for numerical weather prediction. The current time of growing environmental awareness and focus on sustainability further helps to realize business cases in this framework and stimulates new concepts for public/private partnerships.

Blue Insight is a digital ocean toolbox and cloud-based ecosystem for ocean and meteorological data. It has been specifically developed to enable, automate and ease data collection, visualization, contextualization, management and distribution from a wide range of sea-going platforms, e.g., glider vehicles, uncrewed surface vehicles (USV), ships and vessels. This professional solution is built on matured cloud and connected vessels framework components (*c.f. Kognifai[8], Vessel Insight[9])* and meets latest security demands. Through a range of different modules Blue Insight is flexible, scalable and expandable. The openness of Blue Insight enables seamless platform and unrestricted sensor integration covering various physical, chemical or biological parameters.

Blue Insight integrates with the existing information technology system onboard a vessel, facilitates sensor platform interaction and delivers cloud storage and data management capabilities as well as visualization and dashboard functionalities allowing the data to be viewed via an Ocean View system in two and three dimensions. Besides preparation and streamlining of sensor data, selected interfaced sensors can also be remotely controlled and operated.

The advanced toolbox also offers more in-depth data handling capabilities, onboard as well as cloud-based, such as quality assurance or automated data analysis based on artificial intelligence or machine learning applications. The open nature of the environment also allows for processing based on third party supplied algorithms. Data within the cloud can be converted to common formats and automatically forwarded to external cloud or database systems.

The first Blue Insight applications are of versatile nature. In this regard the Team was particularly interested to learn about the meteorological data (barometric pressure, air temperature, humidity, wind speed and direction) that is being collected onboard the barque, '*Statsraad Lehmkuhl'*, and automatically forwarded to the Norwegian Meteorological Institute and the Norwegian Marine Data Center (NMDC) for further usage and dissemination. Other Blue

[8] https://www.kongsberg.com/digital/solutions/kognifai/
[9] https://www.kongsberg.com/digital/solutions/vessel-insight/

Insight projects and initiatives were also noted including the *One Ocean Expedition*[10]*, Glider II*[11] *and Crimac*[12]*.*

Mr. Fietzek suggested that with more than 30,000 vessels globally featuring equipment produced by Kongsberg Maritime (KM), around 10,000 vessels equipped with KM automation systems and KM employees being onboard more than 11,000 vessels each year, KM was able to offer propeller to the bridge solutions and was well placed in the maritime market.

The Team recognised the potential that connected vessels have for the advanced collection of oceanographic and meteorological data, and the digital solution offered by Blue Insight to facilitate the collection and sharing of environmental data. Accordingly, it was agreed that SOT should enter discussions with Kongsberg regarding the future potential Blue Insight projects.

Actions:

A3.1/01 - *Open discussions with Kongsberg regarding demonstration projects using Blue Insight. (SOT Chair; November, 2021).*

3.2 SubCtech

Mr. Stefan Wolfgang-Herbert Marx, CEO at SubCtech, reported that through intensive cooperation with scientists and their institutes, ship operators and shipyards, users, and decision-makers, SubCtech had developed a family of "underway" monitoring systems and had successfully implemented them on over 40 ships.

SubCtech has been in the ocean engineering business for 11 years with older roots. Close cooperation with customers and partners from both the industry and the scientific sector has enabled them to contrive innovative and reliable instruments. Moreover, those partnerships have helped them to keep up with new trends and the latest developments.

Using experience gained in many previous monitoring projects, SubCtech has implemented a standardized monitoring platform. Through the co-development of the EUREKA EU-417 MERMAID project in the 1990s and the co-development of the EU-FERRYBOX in the 2000s, SubCtech's employees have implemented the technologies required for technicians, engineers, and scientists.

Particular attention was drawn to SubCtech's involvement in measuring greenhouse gases and other essential ocean parameters. For example, SubCtech's greenhouse gas analyzers (CH_4, CO_2, H_2O) are deployed all over the world and can measure precisely in the atmosphere, the ocean surface and in the water column. Research vessels are typical operational areas for the instruments.

Beside greenhouse gas analyzers, SubCtech can also provide powerful sensor systems for underway in-situ measurements of oceanographic and meteorological parameters. SubCtech's OceanPack™ systems operate also on land stations, ships of opportunity and even on sailing/ racing yachts, as small world-wide operating platforms. Combined with an autocleaning unit, the systems can be operated autonomously for long-term use. Submerged and atmospheric observation systems expand the range of SubCtech's monitoring solutions.

SubCtech's compact, robust and lightweight Ocean Data Acquisition System (ODAS) is especially designed for the extreme harsh conditions on board small ocean sailing vessels. Operating high precision instruments on racing sailing boats provides an innovative approach for ocean

[10] https://oneoceanexpedition.com/
[11] https://www.akvaplan.niva.no/en/projects-networks/glider/
[12] https://crimac.no/en/projects/crimac

observation. Ocean races such as the Vendée Globe, the Barcelona World Race, Clipper Round the World Yacht Race, or The Ocean Race (former Volvo Ocean Race), take place nearly every year. During those sailing events, the yachts provide scientific data from sea areas that would otherwise have few or no observations (see Figure 1).

The OceanPack RACE® system requires minimal maintenance and can be equipped with a large number of sensors, including conductivity, temperature, pCO_2, pH, bio-optics and atmospheric pressure. The system can also be extended with external devices, such as a weather station, GPS or an embedded sampler for microplastic particles.

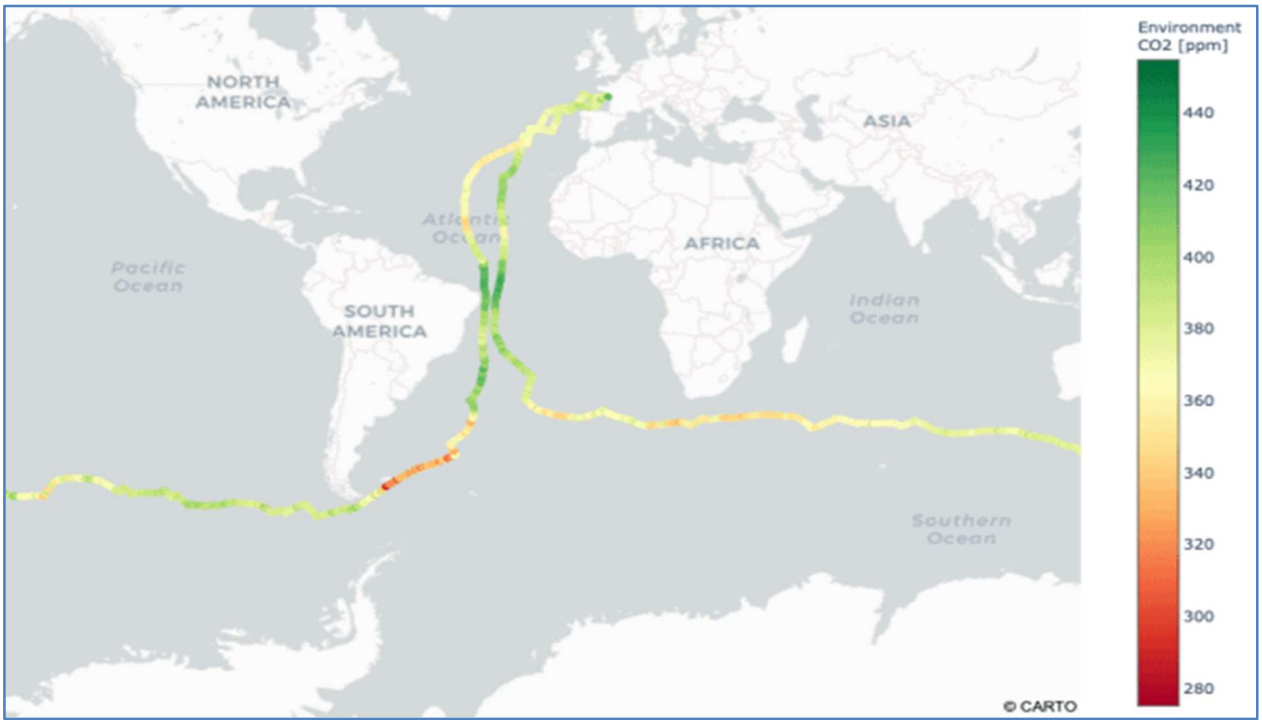

Figure 1 – Scientific data provided by an OceanPack RACE® system during 2020 Vendée Globe

Development of the system for racing yachts began in 2009. The first prototype tested was in 2009/2010 with Ifremer, leading to the fifth generation which was installed together with microplastic samplers on Volvo Ocean Race yachts 2017-2018 such as the *'Turn the Tide on Plastic'* and *'AkzoNobel'.* Unique data sets of CO_2 and microplastic around the world were recorded. The latest sixth generation of the OceanPack RACE system was installed together with microplastic samplers on 2020-2021 Vendée Globe yachts such as the *'Seaexplorer - Yacht Club de Monaco'* and the *'Newrest - Art & Fenêtres'*.

It was noted that SubCtech has developed an innovative microplastic sampler for underway systems (see Figure 2). While previous methods were based on towing of huge nets and required a skilled crew for operation, the SubCtech system works autonomously and does not depend on a calm sea state. The instruments are operated at high boat speed and during all sea conditions, with a low demand on manpower. Samples are separated by size fractioning and can be connected with lab based analytical methods.

Use of such systems on racing yachts and equipping large ships, including the new icebreakers from Australia *'Nuyina'* and China *'Xue Loing 2' ('Snow Dragon'),* demonstrate that even the most distant points on earth can be reached.

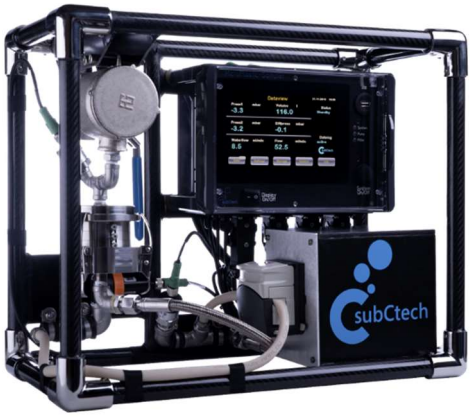

Figure 2 – Microplastic Sampler by SubCtech, RACE version with carbon frame

Automatic calibration, automatic cleaning, automatic pre-processing of data, automatic data transmission, and automatic event control help scientists and ship operators enormously and extend the service life to many months. An essential factor is the standardization of the mechanics, the electronics down to the connector layout, the data via NMEA and the processing algorithm.

Standardization also enables the flexible and modular use of practically all sensors. The latest technologies such as spectral pH or TA measurements can also be incorporated. The OceanPack™ system is an open platform and is not limited to specific parameters or sensor providers.

New instruments such as fully automatic plankton samplers, networking dataloggers or laser spectrometers for greenhouse gases, complete the SubCtech product portfolio and meet all the requirements of scientists or monitoring authorities. Underwater versions can also sample the water column.

SubCtech continues to work closely with leading institutes, users and scientists, and is involved in a number of citizen science projects. Furthermore, SubCtech is ready to provide technical solutions for the United Nations Decade of Ocean Science for Sustainable Development.

3.3 Science RoCs

Mr. Shawn Smith (United States), Senior Research Associate at the Center for Ocean-Atmospheric Prediction Studies, presented an overview of the aims and activities of the Science Research on Commercial Ships (Science RoCS) initiative.

Science RoCS is an ad-hoc group of scientists, technicians, data managers and other parties that are seeking to build partnerships with international commercial shippers to improve the science community's ability to observe and characterize ocean physics, dynamics, chemistry, and biology. They envision a future where scientific data collection on commercial ships is the new industry standard, providing repeatable measurements in under-sampled, remote regions, on scales not otherwise accessible to the scientific community[13].

The overall program objectives are to:

[13] https://web.uri.edu/gso/files/Science-RoCS_Ocean-Shots-Poster_Final-2.pdf

(1) develop a global program to continually scan the ocean's sub-surface velocities at high horizontal resolution;

(2) collect multiple data streams, including ocean currents and weather, with "Integrated Observing Platforms" hosted on commercial ships; and,

(3) partner with existing global programs to provide:

(a) deployment opportunities; and,
(b) a portal to connect to industry for easier commercial ship access to remote regions and routes of high scientific value.

Since many of the measurements planned by RoCS are of specific interest to SOT, and more broadly for GOOS, the RoCS team seeks opportunities to collaborate with SOT. Specifically, RoCS plans to distribute observations in real-time to support operational users but needs input from the VOS and SOOP panels regarding data and metadata exchange protocols.

It was questioned whether it would be preferrable for RoCS vessels to work through NMHS or to use newer data exchange services, e.g. the Open-GTS initiative. Connecting members of the RoCS team to OceanOPS should promote a dialog on metadata standards to support GOOS and provide OceanOPS with contacts to commercial shipping companies when they are looking for ocean platform deployment opportunities. It was, therefore, suggested that there is an opportunity for SOT and OceanOPS to leverage, and contribute to, the development of tools envisioned by Science RoCS to coordinated deployment requests.

The Team noted that there are several areas for potential collaboration between Science RoCS and the SOT. Since many of the planned RoCS observations (meteorology, thermosalinographs, XBT, pCO_2) are presently coordinated by the VOS and SOOP panels of SOT, there needs to be closer coordination between RoCS and SOT to ensure maximum benefit to the operational and research communities from RoCS observations.

One of the key components of Science RoCS is routine measurement of upper ocean velocities using Acoustic Doppler Current Profilers (ADCP). Presently, there is no coordinated international data management of shipboard ADCP observations; however, there is an emerging community of modelers that are seeking to assimilate upper ocean currents into forecast systems.

RoCS is planning routine shipboard ADCP and bathymetry measurements which will provide several of the essential ocean variables desired by GOOS. Bearing in mind the need to develop a unified approach to ADCP data, Mr. Smith invited SOT to consider whether it can provide guidance or support to developing a coordinated international shipboard ADCP program.

RoCS also plans to develop tools to support communication between scientists interested in deploying ocean observing technology (including floats, drifters, etc.) and the commercial shipping community. Improving these communication channels has long been a mission of SOT and OceanOPS, with a vision to streamline the requests made of commercial operators and ensure some centralized workflow from request to actual sensor/platform deployment.

Recognising the unique research capability afforded by Science RoCS will help fill the need for in situ oceanographic, meteorological and seabed data, and that Science RoCS fits well with existing SOT/OCG activities, the Team agreed the following actions aimed at establishing closer collaboration and synergies:

Actions:

A3.3/01 *— Review planned RoCS activities and open dialog between RoCS, OceanOPS, and appropriate SOT Panels and Task Teams to leverage these activities to support SOT members (SOT Chair, VOSP Chair, SOOP Chair, TC, SOT -Task Teams; SOT-12).*

A3.3/02 *— Provide 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 (VOSP Chair, SOOIPP Chair; November, 2021).*

A3.3/03 *— SOT/OCG to engage with Science RoCS regarding the possible development of a unified global shipboard ADCP program (SOT Chair, SOT-EB & OCG; December, 2021).*

3.4 International Research Ship Operators

Dr. Erica Koning, Chair of the International Research Ship Operators (IRSO)[14], explained that IRSO is a networking group of research ship operators representing 54 organisations from 35 member countries who manage over 100 of the world's leading marine scientific research vessels.

Previously known as the International Ship Operators Meeting (ISOM), IRSO was founded in 1986. IRSO members gather annually to share information and solve problems of mutual interest to better support the marine scientific community's research efforts at sea. Meetings are attended voluntarily and are hosted by participating countries/institutes. IRSO also acts as a voice to promote the research ship community and provide expert advice to other bodies as required.

Membership of IRSO is open to all research ship operating institutes or national research programmes that are engaged in the collection of data from ships at sea, and follow established protocols for the open publication of their results. IRSO has close links with and is attended by research vessel groups such as the European Research Vessels Operators (ERVO), the Ocean Facilities Exchange Group (OFEG) and the University-National Oceanographic Laboratory System (UNOLS). Meetings are sometimes held without industry, to allow open flowing discussions amongst research vessel operators. Links with new organisations, such as SOT, are welcomed.

The main topics and objectives on the IRSO annual agenda include:

- Best practice design and operation of research ships and associated scientific equipment
- Benchmarking and co-operation in support of marine research
- Developments in national research fleets, new builds, greening of vessels
- The exchange of ship time and equipment between countries
- Diplomatic issues, also related to new fields such as gliders, ASVs, floats etc

In addition to promoting research ship activities, the goals of IRSO are to share information amongst members on topics like new builds, infrastructure, and instrumentation.

Access to research cruise information is available through the Marine Facilities Planning (MFP) platform[15] software tool which helps synchronise cruise plans, and which is being used to guide and support marine scientists who want to go to sea, from application to reporting. Discussions are also taking place within the owner groups on how to make such information more available for other interested parties.

The Team agreed that it should increase its cooperation and communication with IRSO, noting that many research vessels don't currently host VOS or SOOP systems. This issue was further addressed during discussions on OceanOPS when the SOT Technical Coordinator reported on his attendance at former sessions of IRSO (see agenda Item 8). It was agreed that SOT, in liaison with OCG should establish closer cooperation with IRSO (Action A8.0/13.0 refers).

[14] https://irso.info/
[15] https://www.irso.info/wp-content/uploads/IRSO_MARINE-FACILITIES-PLANNING_POSTER_LO.pdf

4. METADATA

4.1 Metadata / ID Numbers

The Team was invited to consider the status of developments concerning SOT Identifiers (SOT-IDs) and Unique Identifiers (UIDs) as follows:

4.1.1 SOT -ID /WIGOS ID

The SOT Technical Coordinator (TC), Mr. Martin Kramp, reported on developments concerning the allocation and management of SOT-ID unique station identifiers.

The Team noted that since its original development by SOT, the SOT-ID identifier system had been recommended and approved first by OCG, and then by JCOMM-5[16], and was eventually passed to the WMO Commission for Observation, Infrastructure, and Information Systems where it was formally endorsed during its first session held virtually from 12 April to 16 April 2021 (INFCOM-1). Furthermore, OceanOPS now had been delegated authority by INFCOM to issue unique IDs for other marine observing systems such as floats and drifters following the WMO-ID concept.

It was explained that the SOT-IDs are the local identifier (4th block) of the longer WIGOS-ID (WSI), which OceanOPS allocates with issuer identifier 22000 (2nd block). The issue number (3rd block) is at this stage of no importance for the SOT because all allocated local identifiers are truly unique.

Recognising that a ship potentially hosts more than one instrument (package) the meeting recalled its decision to use SOT-IDs for every new SOT station, and its recommendation to migrate to using SOT-IDs for all existing stations (noting that OceanOPS already allocated SOT-IDs for all existing, or already closed stations). In addition, it had been decided to phase out existing masking schemes, in particular use of the generic ID "SHIP", subject to the agreement of those members still using them.

Mr. Kramp explained that a request from an operator to "mask" the ship will hide the corresponding ship metadata like name, IMO number, call-sign, etc. from non-authorized users. Vessel type and all station-related metadata such as sensor information will remain available, which is of high advantage for data users.

However, it was recognised that use of the mask option, which requires approval by the TC, should be limited as much as possible. In this respect the Team agreed again that, due to the current widespread use of AIS and similar technologies, any former security concerns are now less of an issue.

Together with the metadata task team, the following workflow has been developed for the transitional period to a new metadata format:

- Operators who would like to migrate to SOT-IDs for existing stations can look up these IDs on the OceanOPS website and start using this SOT-ID in GTS submissions at any time. In OceanOPS, the "GTS-ID" will be updated automatically. In metadata submissions using the presently still-valid Pub47 format, the SOT-ID must then be entered in the call-sign field.

- Operators who create a new station in the metadata database must first request a SOT-ID from the OceanOPS website, use this ID in GTS submissions, and submit it in the Pub47 call-sign field.

[16] https://library.wmo.int/doc_num.php?explnum_id=4528

Mr. Kramp reported that several operators had already successfully implemented this workflow. He also explained that the SOT-ID is the identifier that is used in submissions to the Observing System and Capability Analysis and Review tool (OSCAR[17]), which OceanOPS feeds with metadata for all marine stations. In OSCAR, only the vessel type is available as ship metadata and the GTS identifier is available as program-related identifier; consequently, for stations still using call-signs in their GTS submissions the call-sign will remain visible in this OSCAR field.

Several members raised questions or concerns regarding migration to SOT-IDs. For example, Mr. David Dellinger (United States) questioned why not simply use the ships IMO number. In response it was noted that not all ships are assigned IMO numbers, e.g., fishing vessels, sailing vessels, etc. and the SOT-ID concept allowed a unique ID to be assigned for each observing system installed on a ship. In response to another question from Mr. Alejandro de la Maza (Chile) concerning the availability of real time data Mr. Kramp explained that OceanOPS website users can access the location of the station and the data with a ~6-hour delay. Because the data stored in OSCAR is fed from OceanOPS there would also be a similar delay there. He added that more recent data may be a second step for OceanOPS, but it is not a requirement at the moment.

Mr. Shawn Smith (United States) also questioned how to get an SOT-ID for a ship that is not recruited to any National VOS, SOOP, or ASAP program. In response it was pointed out that there is an option "third-party" available on OceanOPS website, but this is currently controlled and can only be selected by the TC at present.

The meeting also noted that in terms of coherency and data history/integrity, the tracking of identifiers through the OceanOPS API[18] over the lifetime of a station has been tested and approved by selected data users and experts.

Actions:

A4.1.1/01 *– Use SOT-IDs for all new stations and phase out the use of masking schemes; migration to SOT-IDs is strongly recommended for existing stations (SOT Members; Ongoing).*

4.1.2 Report of the Task Team on Unique ID Observation Scheme

The Chair of the ad-hoc Task Team on Unique Identifiers (TT-UID) for observations, Dr. David Berry (United Kingdom), updated the meeting on the status of the task team and on outstanding activities/issues.

Dr. Berry recalled that the ad-hoc task team was initially set-up following SOT-8 to develop and make recommendations on the implementation of a UID scheme for VOS observations. He noted that implementation based on the Universally Unique Identifiers standard (UUIDs, IETF, 2005) was thereafter recommended and accepted at the tenth session of the Ship Observations Team (Recommendation R6.5/1).[19] Following SOT-10 a draft guidance note was written which Dr. Berry presented this to the Team (see **Annex III**).

The Team noted that it was agreed at SOT-10 to expand the terms of reference for the task team to include monitoring of the UUIDs within the VOS reports encoded using BUFR sequence 308014. Dr. Berry reported that as of March 2021 this sequence was not being widely used and that, as a result, monitoring of the use of UUIDs within this sequence had not been performed.

[17] https://oscar.wmo.int/surface/#/
[18] https://www.ocean-ops.org/api/1.0/help/
[19] SOT-10 report: https://oceanexpert.org/document/25459

Dr. Berry also noted that it was unclear that the previous recommendation to use UUIDs in the BUFR sequence had been communicated with the centres receiving and encoding the data. He queried whether this was an issue unique to the TT-UIDs or whether it was a wider issue with the SOT, noting that one solution would be to send out a summary of decisions and recommendations made during the session to key stakeholders.

In this context Ms. Sarah North suggested that the WMO Secretariat should be requested to consider the possibility of promulgating a formal letter to national focal points requesting their implementation of UUIDs.

Mr. Raja Acharya (India) suggested that UUIDs may help with identifying recruitment of ships by more than one country. It was noted, however, that this wasn't intended as an objective of UUIDs, and that the assignment of SOT-IDs was more useful for that purpose.

Mr. Henry Kleta (Germany) questioned how to distinguish the original observation and a copy if "repeating" centres leave the UUID unmodified. It was unclear if this was taken into account in the BUFR headers, but Dr. Berry said that the UUID was set once and was not intended to be modified further. Mr. Kleta suggested that the VOS GDACs needed to look at BUFR and that the workflow (i.e., IMMT data streams and equivalent data transmitted using BUFR TM308014) has to be tested when it is implemented to ensure that the new procedure will serve the purpose.

Closing his presentation Dr. Berry said the primary function of ad-hoc TT-UID had been completed. He therefore recommended that the monitoring function of the ad-hoc task team be merged with the monitoring of VOS dataflow performed by the Task Team on Instrument Standards and Satellite Communications (TT-ISSC) and that the ad-hoc TT-UID be discontinued. Mr. Jean-Baptiste Cohuet, Chair of TT-ISSC was in agreement with this proposal.

Actions:

A4.1.2/01 *– WMO Secretariat, in liaison with SOT EB, to consider the need to send a letter to NFPs advising of the need to implement UUIDs (WMO Secretariat & SOT EB: March, 2022).*

A4.1.2/02 *– Merge the monitoring function of TT-UID with that of the TT-ISSC and discontinue the TT-UIDs. (SOT EB & TT-ISSC: SOT-12).*

4.2 Metadata / Pub 47 – Including Report of the Task Team on Metadata

Mr. Henry Kleta, as the Acting Chair of TT-Metadata, reported on activities of the task team during the last intersessional period and reviewed the status of actions arising from the previous SOT-10 session. He encouraged more people to join the Task Team and contribute to the ongoing work of the Task Team.

The Team recognized and thanked the task team for its significant efforts in addressing this important topic (it being noted that they had met virtually on a frequent basis during the intersessional period). Particular thanks also were expressed for the work undertaken by Ms. Emma Steventon, Chair of the task team until her recent secondment to a different position. Mr. Kleta had also visited OceanOPS in September, 2020 for dedicated work on developing the future SOT metadata format.

Mr. Kleta explained that following the previous SOT-10 session the two previously existing metadata task teams (for VOS and SOOP) were merged into one SOT wide team, although no new ToRs were defined at the time. Accordingly, Mr. Kleta proposed revised Terms of Reference for the new combined task team.

The Team agreed the revised draft Terms of Reference for the task team, incorporating minor changes previously proposed by Ms. Champika Gallage (WMO). A copy of the revised Terms of Reference, together with the latest membership list, which were subsequently approved by the SOT Executive Board, are included in **Annex IV**.

Mr. Kleta introduced the SOT wide metadata format that had been developed by the task team and agreed by SOT-EB prior to the meeting. Noting that one ship can host one or more stations, and that one station can have one or more sensors connected to it, he explained the new format consists of three blocks:

- one block for ship metadata
- one block for station metadata
- one block for sensor metadata

The Team noted that the new format will replace the current VOS metadata format Pub47 and will be available for use by all SOT networks (VOS, SOOP and ASAP). For most fields, reference tables were defined to standardize input as far as possible.

The Team further noted that the new format is compatible with WIGOS/OSCAR requirements, and that OceanOPS will act as the metadata repository feeding the WIGOS/OSCAR database on behalf of station operators. Historical metadata will also be available.

Mr. Kleta pointed out that OceanOPS could still process old Pub47 format for mapping into the new metadata format, and could provide Pub47 feeds in parallel to data users (until SOT-12).

A copy of the new SOT metadata format is at **Annex V.** Please note that final adjustments to that format are still possible.

Mr. Kleta also drew attention to the mandatory fields necessary to request an SOT-ID, i.e.

- Name of Ship
- IMO number or ICES-code (if neither is available OceanOPS will handle ICES code request)
- Hide Ship Metadata Option (Yes/No), must be confirmed by SHIP-TC
- GTS-ID (ID of real-time dataflow in GTS, SOT-ID recommended)
- Class-Category (VOS: new VOS class, all other: NIL)
- Programme (autogenerated based on operator of station)

And, to the additional mandatory fields necessary to register a station in the OceanOPS database, i.e.

- Schedule of Observation
- Installation date
- Information on station (make, model, data transmission)
- Information on sensors (parameter, make, model, installation date)

Mr. Martin Kramp, SOT Technical Coordinator, advised the meeting on the procedures to get an ICES code, if required. He informed members that OceanOPS has an agreement with ICES (International Council for the Exploration of the Sea) for assignment of an ICES code to those ships that have not been assigned an IMO number, e.g., research ships, fishing or sailing vessels.

Responding to a question from Mr. Rene Rozeboom (Netherlands) about updating sensors in the database, Mr. Kleta clarified that, when the stop date of a retired sensor is entered in the

database, then a new set of metadata can be entered for the new sensor. This, therefore, allowed the full history of the metadata to be preserved.

Mr. Mike Potochney (United States) questioned what the term "conditional" meant for metadata entries. Mr. Kleta explained that this is a WIGOS term, effectively meaning that the metadata field shall be provided if available, but is not mandatory.

Mr. Shawn Smith (United States) questioned whether there is a plan to cross reference sensor name (make/model) to a controlled sensor vocabulary (e.g., SeaDataNet, NERC). Mr. Jean-Baptiste clarified that SOT builds its own lists, starting from Pub 47. Ms. Justine Parks suggested it might make sense to have standards and best practices developed in cooperation with each specific measurement parameter group to explain how to enter all the metadata for that parameter. Mr. Figurskey highlighted the need for training on metadata for the SOT community.

Mr. Kleta informed the Team regarding discussions being held with OceanOPS on implementation of the new metadata format into the OceanOPS database. In this respect he highlighted the plans for the way forward, whereby:

- OceanOPS will implement a new website front-end to allow easy entry of stations using the new SOT metadata format;
- OceanOPS will be able to receive Pub47 metadata and map the fields accordingly into the new metadata format for an interim period (It was suggested that this should be allowed until the next SOT-12 session); and,
- OceanOPS will be able to provide Pub47 feeds to data users such as archives for an interim period (It was again suggested that his should be allowed until the next SOT-12 session).

Actions:

A4.2/01 *– Metadata providers and users are requested to adapt their dataflows to the new SOT metadata format (Operators, Data archives, etc; SOT-12)*

A4.2/02 *– Agree the revised Terms of Reference for the Task Team on Metadata (SOT members; SOT-11; completed).*

5. KEY PERFORMANCE INDICATORS – Including report of the Task Team on KPI

The Chair of the ad hoc task team, Dr. David Berry, introduced the team, its terms of reference, and current membership. He then reviewed actions from SOT-10 and summarised the work of the task team over the intersessional period, noting that progress had been limited during this period due to his limited availability since assuming the role of Chair.

Dr. Berry then presented a short summary of the existing KPIs available through the OceanOPS dashboard and related work within the AOPC and OOPC on requirements settings, including the difficulty in relating the characteristics of observations from non-stationary platforms to existing requirements. In the course of his presentation Dr. Berry also pointed to the KPIs that are now included in the OceanOPS Annual Report Card concerning the status of implementation of ship-based meteorological, aerological and oceanographic measurements and their value to society.

Dr. Berry finished by noting the work previously done by the task team[20], particularly on requirements setting, and relating the requirements to the spatial sampling by the different networks. He recommended that the SOT promote the work of the task team to a full task team to continue the work previously undertaken, particularly focusing on the spatiotemporal coverage requirements. Dr. Berry also recommended that KPIs related to quality, use of latest BUFR templates, and VOS class be developed further.

Ms. Sarah North (WMO) explained that the ad-hoc task team designation was primarily for small self-contained and focused items. In view of the importance of KPI metrics, the Team agreed to migrate the team into a full SOT task team. The Terms of Reference for the task team are included in **Annex IV.**

Noting Dr. Berry's proposal to develop further metrics on spatiotemporal coverage related to requirements in the WMOs RRR, Dr. Heslop suggested SOT should ask OCG to support cross-network dialogue to help the task team effort.

Dr. Berry said that most of the KPIs concerning SOOP, VOS and ASAP were largely being met, but with the exception of VOS coverage where only 4% of grid cells meet the target of two observations/day, whilst the target is 75%. Mr. Kramp pointed out that because the VOSClim Class has been discontinued, the metrics needed to be revised to a take account of the new VOS classes.

Mr. Darin Figurskey, Chair of the SOT, suggested a single network wide KPI was needed, as discussed in recent meetings of the OCG. Martin Kramp commented that the groundwork was already laid for an integrated system, even going beyond SOT. The meeting agreed with a proposal from Mr. Martin Kramp that an additional action was needed for the task team to review the monthly products produced by OceanOPS, including static maps.

Ms. Sarah North (WMO) asked if there are still KPIs for the timeliness of real-time VOS observations, and enquired who currently monitors them. She suggested that this was important because GTS collectives are sent out from different centers at different times and, consequently, for consistency, timeliness data should be monitored by a single center. Mr. Martin Kramp explained that Météo France data is currently used for timeliness statistics, but a second data center may be a good idea for comparison purposes.

Dr. Emma Heslop suggested that to recognise different stakeholder requirements KPIs could perhaps be divided into separate categories, e.g. 1) those needed for internal stakeholder management (project and portfolio managers, programme Chairs); 2) those for external needs such as OCG Report Card, EOV coverage combined across the platforms, against EOV, RRR, GCOS identified requirements, etc., and 3) SOT level additional KPIs needed for the context of the SOT Strategy. She suggested SOT should consider asking OCG to have a Roundtable meeting on metrics/KPIs.

Dr. Berry informed the Team of his decision to step down as the current Chair of the task team. In addition to appointing a new Chair, he suggested that the membership of the task team needed expanding.

Actions:

A5.0/01 — *Promote the ad-hoc Task Team on KPI to a full Task Team and confirm its Terms of Reference (TT-KPI & SOT-EB; SOT-11, completed).*

A5.0/02 — *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; SOT-12).*

[20] https://goosocean.org/components/com_oe/oe.php?task=download&id=41073&version=1.0&lang=1&format=17

A5.0/03 — *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* Météo France *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; SOT-12).*

A5.0/04 *– Review monthly OceanOPS products, including static maps, in liaison with the TT-KPI (SOT-TC, TT-KPI; by September, 2022).*

A5.0/05 *– Consider the development of a single, integrated, KPI for all SOT (and OCG) networks (TT-KPI, SOT-TC, (& OCG); SOT-12).*

6. BUFR STATUS

The SOT Technical Coordinator (TC), Mr. Martin Kramp, reported on the status of the migration to BUFR. He reported that a number of VOS data producers have terminated the production of traditional alphanumeric code (TAC) and produce only table-driven code (TDC / BUFR) now. However, some operators still do not produce any TDC, and some centres presently produce both, i.e., TAC in FM13 and TDC per template 308009. Figure 3 shows the results of an analysis comparing the TDC and TAC data from location indicators, CCCCs, in February, 2020.

In addition, some centres take GTS data from other producers which is either only available in TAC, or without area indicator in the GTS header, and resubmit such data with a new header and in TDC. As a result, the GTS is full of duplicates which, because they lack unique observation IDs (see also item 4.1.2), are not always easy to identify. The use of generic "SHIP" masks by some members makes this situation even more difficult. While most of the VOS data is thus available in BUFR, protocols presently in place at some centres should be reviewed.

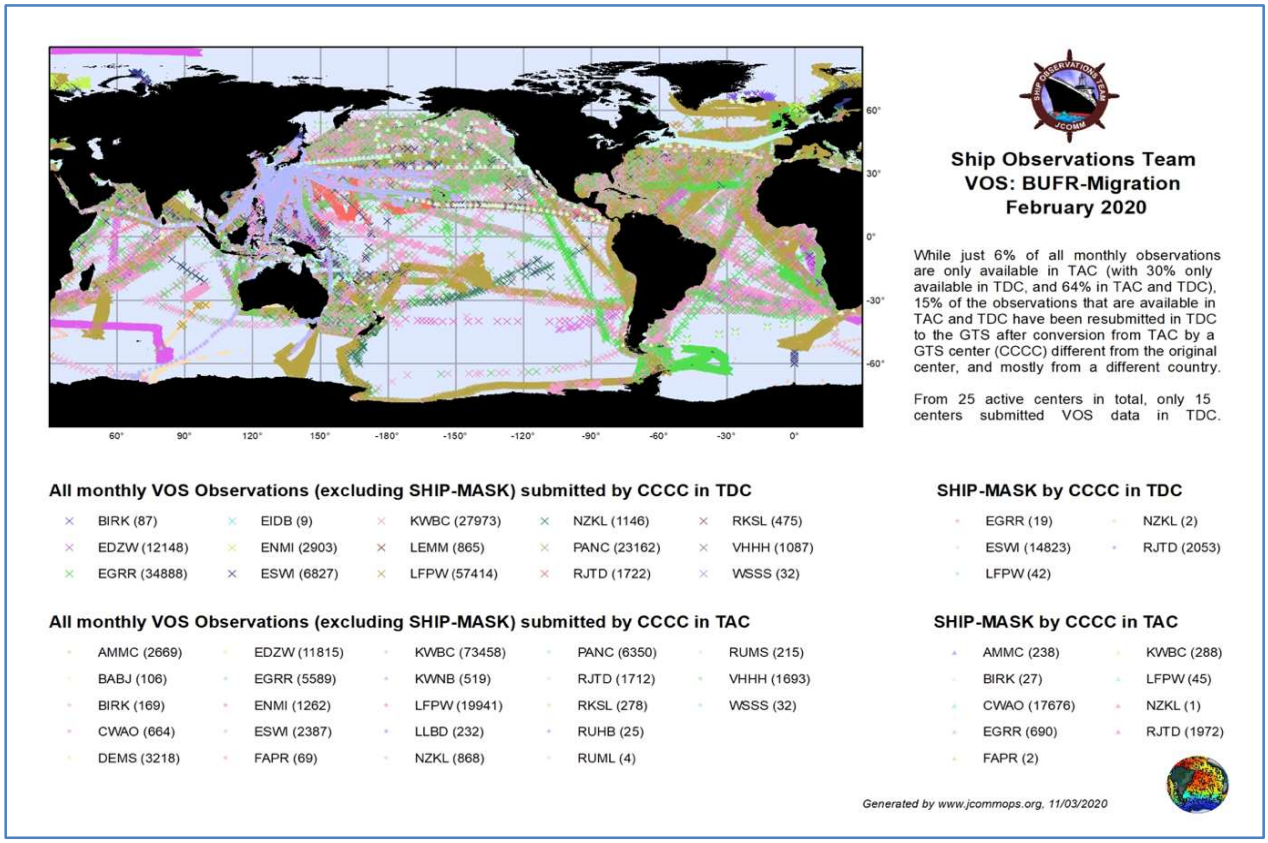

Figure 3 – Status of BUFR Migration – February, 2020

A data reanalysis undertaken in August, 2021 (Table 1) gave the following distribution of observations from each location indicator (CCCC)[21]. It was noted that only 9 centres were generating TAC, compared to 14 producing TDC. However, it was further noted that the percentage of GTS duplicates (for VOS) was greater than 50%.

TDC (not 'SHIP')	
CCCC	**Obs**
BIRK	76
EDZW	8151
EGRR	32272
ENMI	2212
ESWI	20170
KWBC	5048
LEMM	744
LFPW	111241
NZKL	1225
PANC	77640
RJTD	2168
RKSL	1286
VHHH	1185
WSSS	50
	263468

TAC (not 'SHIP')	
CCCC	**Obs**
AMMC	2824
BABJ	279
BIRK	180
CWAO	232
DEMS	3266
EGRR	2949
ESWI	1298
FAPR	18
KWBC	105484
LFPW	1955
LGAT	16
LLBD	240
NZKL	910
PANC	15261
RJTD	1901
RKSL	534
RUHB	70
RUMS	199
VHHH	1803
WSSS	50
	139469

TDC 'SHIP'	
CCCC	**Obs**
ESWI	529
NZKL	4
RJTD	4438
	4971

TAC 'SHIP'	
CCCC	**Obs**
AMMC	97
BIRK	3
CWAO	19631
DEMS	1
FAPR	4
KWBC	324
NZKL	1
RJTD	3636
	23697

Table 1 – GTS reanalysis of observations by CCCC in August 2021

The Team noted that XBT data from reference lines and ASAP data are now fully available in TDC. However, the Team also noted that although VOS template 308014 has been validated it is not in use by any data producer at present. It comprises additional fields for data and metadata.

It was clarified that Turbowin+ is not configured to send a full BUFR message as the file size is too large. In this respect it was recommended that Format #100 is the most suitable ship to shore format for generating a BUFR message. The receiving centres should be responsible for generating the BUFR messages sent via the GTS.

The Team was invited to consider whether a formal date should be set for ending the use of TAC messages, and whether all users are ready to only use BUFR, or to use latest BUFR templates like 308014. Dr. Emma Heslop suggested that Mr. Kevin O'Brien, GOOS data Vice Chairperson (United States) (NOAA) might be able to assist centres with their transition to BUFR.

Having discussed the status of BUFR implementation the Team agreed the following actions and recommendations:

[21] WMO volume C1: https://community.wmo.int/activity-areas/operational-information-service/volume-c1

Actions:

A6.0/01 – *SOT NFPs, who haven't already done so, to advise their future plans to migrate to BUFR, and all data producers to transition to TDC's (SOT Members, SOT NFPs, National data processing; SOT-12).*

A6.0/02- *Investigate which producers intend to use the new BUFR template 308014 in the near future, and set up a test procedure with data users (TT-ISSC, data users, National data processing centres; SOT-12).*

Recommendations:

R6.0/01 – *Populate all metadata fields available in GTS ingested data (Data Producers / National data processing centres; Ongoing).*

7. OPEN-GTS / THIRD PARTY

Mr. Darin Figurskey, SOT Chair, gave a presentation on the Open-GTS project and on third party data. As noted in the SOT Chair report, independent, or "third party", observations, engaging citizen scientists, are expected to play a key role in Ocean Decade[22] efforts promoted by the SOT. These efforts will need to be designed to complement the observations from established networks, freely accessible with adequate metadata and innovative methods of transmission, and include interested, developing nations in any implementation.

The Open Access to GTS, or Open-GTS, is a proposed project within the Ocean Decade which is designed to help increase the volume of observations available on the GTS. The Open-GTS workflow is currently being used to distribute Saildrone data on the GTS and has successfully supported the exchange of AIS pressure data from ~12 ships.

In order to fully realize a predicted ocean, it is vital to increase the volume of near-real time marine meteorological and oceanographic in situ data available to operational forecast processes. The availability of research-based in situ data has been limited by the operational mandates of the GTS, which is the primary global distribution mechanism for near-real time observations. The Open-GTS project has, therefore, implemented a workflow that simplifies how data producers provide in situ data for near-real time distribution via the current WMO GTS infrastructure.

Open-GTS has the potential to help significantly increase data observations from both data communities and geographic locations that have been under-represented in the operational data lifecycle. An example is the AIS-sampled marine meteorological and oceanographic data that are being collected by many commercial vessels but are not being integrated into the operational data processing workflows. The Open-GTS is currently implementing a pilot project to showcase distributing this data globally via the WMO GTS.

A major ongoing problem has been the scarcity of in situ data from vast areas of the world's oceans due to resource difficulties by vessel owners and operators, and by NMHSs in fully resourcing the Port Meteorological Officer program. In addition, there are many vessels not participating in VOS but still collecting data in a format not easily shared via the GTS.

Open-GTS therefore provides an opportunity to increase available data volumes, and increased assimilation of data will lead to model output improvements, and consequently increased forecast accuracy. Safety of life at sea should also improve, benefitting the global community and increasing the impact of investment in global ocean networks. Furthermore, the approach can be extended through the full ocean depth for a better understanding of our changing oceans and climate, and associated challenges.

[22] https://unesdoc.unesco.org/ark:/48223/pf0000261962

During his presentation Mr. Figurskey gave an explanation of how data harvested from observing platforms can be ingested into ERDDAP servers and thence encoded into BUFR for transmission onto the GTS, and how the ERDDAP servers make the data available to end users. He also drew attention to CoCoRaHS – the 'Community Collaborative Rain, Hail, and Snow' network in the United States. Summarising, Mr. Figurskey suggested that the ability of Open-GTS access to accept multiple format types was both significant and promising. The Open-GTS therefore has the capability to be an integral part of the expansion of independent class, or "third party", observations, and efforts are being made to secure partnerships for the Open-GTS with Ocean Decade programmes.

Third party data offers an opportunity to increase partnerships with industry, citizen science etc., and is not just for the VOS. As it was already codified as a separate VOS Class, this effort would not replace the traditional VOS but would complement it. Neither is it intended to be a repository for poorer quality observations.

Mr. Kramp reminded members that previous analysis of third-party data by the SOT at previous sessions had shown that it wasn't necessarily poor-quality data. He suggested, however, that there was a limit to the amount of data that could be processed. Consideration was also given to connections with IMO and the possibility of encouraging IMO to make weather observations mandatory, similar to AIS, given that both increase safety at sea. In response, Mr. Figurskey suggested that any attempts to change policy within IMO were likely to be hard to achieve, and it may therefore be better to harvest the citizen science and shipping company data that is known to exist, but which SOT currently isn't able to access. To emphasise the potential scope and volume of global data that might be available he drew attention to an interactive video at https://www.shipmap.org which shows the movements of the merchant shipping fleets derived from ships' AIS data in 2012.

Ms. Sarah North (WMO) suggested that SOT should consider the value of submitting a paper to the IMO outlining its plans for encouraging the supply of third-party data. The importance of SOT keeping a close eye on relevant developments arising from IMO meetings was also stressed. In this respect it is recognised that, whilst it was impractical for SOT members to regularly participate in IMO meetings, it was ultimately WMO/IOC responsibility to keep abreast of IMO developments and to disseminate information to the appropriate SOT/OCG networks.

Mr. Figurskey proposed that the SOT should create a new SOT Task Team to expand independent class observations, focused on, but not limited to, efforts through the Open-GTS and the Ocean Decade. He invited the Team to agree to the new task team and its proposed Terms of Reference.

Noting no objections the Team agreed, subject to final approval of the SOT Executive Board, to establish a new SOT Task Team on the expansion of Independent Class Observations (TT-EICO). Volunteers to participate in the new Team were invited.

Actions:

A7.0/01 *– Approve creation of a new Task Team on Expansion of Independent Class Observations and agree appropriate Terms of Reference (SOT members and SOT EB; October 2021)*

8. OCEANOPS

The SOT Technical Coordinator (TC), Mr. Martin Kramp, gave a comprehensive report on OceanOPS activities related to issues of specific interest for VOSP, SOOPIP and ASAP networks, and on activities extending beyond the scope of SOT Panels.

The meeting noted that the Brest-based OceanOPS centre now comprises seven permanent staff members including four Technical Coordinators (three WMO, including lead, and one IOC), one Coordinator for Science and Communication (IOC), one metadata clerk (WMO), and one IT engineer (CLS). Additional support is provided by an outsourced web-designer, working remotely from Toulouse. The recruitment of an additional Technical Coordinator (IOC) who will work remotely from the Mediterranean Sea was also almost completed.

The meeting recalled that SOT Technical Coordination is part of the Ship Coordinator position, which also comprises duties for the repeat hydrography program GO-SHIP and cross-cutting cruise coordination tasks to exploit synergies like deployment/recovery/maintenance opportunities for DBCP and Argo.

The OceanOPS centre was re-established as a WMO office in December, 2019 and subsequently renamed from JCOMMOPS to OceanOPS, following a 2021-2025 strategy review[23]. A strategy-based workplan was presented to the last session of the Observations Coordination Group (OCG)[24]. OceanOPS is part of the Earth System Monitoring Division headed by DDominique Berod under the newly formed WMO Infrastructure Department, in which ocean observations are now playing a more important role. A formal inauguration ceremony is planned for late 2021. As a joint WMO-IOC office, OceanOPS is, as before, part of the IOC Ocean Observations and Services Section headed by Mr. Albert Fischer.

At the OceanObs'19 Decadal Conference[25], a joint GOOS-JCOMMOPS booth informed the broader community about the activities of the centre. Of particular interest for the SOT was discussion with the Saildrone[26] developers, Kongsberg (see also agenda item 3.1), and on Sailing4Science initiatives. The SOT noted the success of operations with innovative underway equipment, innovative submission mechanisms for meteorological data, and deployment of drifters and floats (which fall outside the remit of SOT), always combined with outreach and media activities and financially mostly supported by citizen scientists, private sector or other third parties.

A corresponding session proposal for the 2022 Ocean Sciences Meeting (OSM) with title "Leveraging Existing Marine Platforms for Ocean Observing: Engaging the Commercial Sector on Local, Regional, and Global Scales" was co-authored by the SOT Technical Coordinator and accepted by the organizers.

A great success in early 2020 was the establishment of a company-wide VOS engagement by Maersk, driven by the VOS Chair, Mr. Henry Kleta. However, this success also highlighted the limits of NMHSs in terms of number of ships they can support, and further highlighted the urgent need for third-party approaches to data supply.

Partnerships were also a focus of the 2019 GOOS OCG OceanOPS Report Card, while the 2020 Report Card focused on, inter alia, COVID-19 impact and the UN Ocean Decade, and the 2021 Report Card on, inter alia, emerging networks and community collaboration. The report cards show the status of the Ocean Observing System in a harmonized approach across all networks, with integrated maps, cross-cutting statistics and trends.

[23] https://www.ocean-ops.org/strategy/
[24] https://goosocean.org/index.php?option=com_oe&task=viewEventRecord&eventID=3008
[25] https://www.oceanobs19.net
[26] https://www.saildrone.com

Report Cards have become a regular yearly product driven by OceanOPS, with an OCG editorial board working on the upcoming editions and improvements throughout the year. Another new product under development is a quarterly report published jointly by the Technical Coordinators, with a short status analysis of every individual OceanOPS-coordinated network, and a synthesis of the integrated system. One of the aims of this product is to serve as a regular newsletter to the observing community.

Mr. Kramp reported that OceanOPS is organizing a charter cruise in late 2021 with a large expedition sailing yacht that will deploy almost 100 floats in the Atlantic in areas difficult to access with ships of opportunity or research vessels. Key partners are WHOI/NOAA and Euro-Argo[27]. The vessel is also equipped with a weather station and recruited as VOS by Météo-France. The cruise will start in Brest in early November, call in at Woods Hole and finish in Cape Town.

OceanOPS was also involved in, and co-funded by, several EU projects including EuroSEA[28] for activities in-line with the OceanOPS workplan, which helped significantly to support the overall OceanOPS budget.

When the COVID pandemic hit the global ocean observing system, OceanOPS implemented a day-to-day tool for tracking real-time data of all networks.[29] OceanOPS analysed the status and estimated consequences, sharing information with steering committees of the individual panels, as well as the broader OCG. IOC and WMO published corresponding reports. SOOP XBT deployments, after an almost complete halt, slowly started to recover, sometimes with deployments performed in lower density by ship officers instead of ship riders. 19 of the current 33 XBT reference lines were sampled since June, 2020 (noting however that a few lines had previously not been occupied for a while before COVID).

The following graph (Figure 4) shows the number of daily observations received during the pandemic until SOT-11:

Figure 4 – Network observations received between the beginning of the Covid Pandemic and the SOT-11 meeting

[27] https://www.euro-argo.eu
[28] https://eurosea.eu
[29] https://www.ocean-ops.org/board/wa/DataTrackingModule

The impact of COVID on the VOS was less significant, at least in terms of observation numbers, never more than a 20% drop, because most AWS continue with the submission of data even while not at sea. However, coverage maps showed areas of decreased VOS observation numbers for a while, e.g., around Asia. PMOs reported that access to the ships was not always easy, but in many cases was eventually possible again due to long-lasting relationships with crew members.

Mr. Kramp attended the 2019 annual meeting of the International Research Ship Operators (IRSO) (see also agenda item 3.4). Increased cooperation and communication with this group was recommended, noting that many research vessels do not formally host VOS or SOOP stations. To better exploit synergies, a pilot project is underway to automatically synchronize cruise plans from the main research vessel operators with the OceanOPS database. This will be of particular interest for float and buoy operators in need of deployment, recovery, or maintenance opportunities.

Mr. Kramp reported that static websites for SOT and its panels are still maintained and updated with support of the TT-RPT, with the aim to have simple landing pages with basic information for the broader community and public. The end of JCOMM and related adjustments of workflows and restructuring of OceanExpert-driven websites led to several issues, notably with respect to the management of group members (TTs, Panels, PMOs, NFPs, etc.) and Terms of Reference.

Given that the production of automated SOT reports should comprise some contact information in addition to instrument and observation statistics, the meeting agreed that OceanOPS should now maintain the master database for SOT contact and group information by using the OceanOPS user group concept introduced by the Technical Coordinator. An example user group for the TT-RPT was noted[30]. OceanOPS will push this information to other bodies if required, or they pull them through the OceanOPS API. The management of user-group based mailing lists is planned but will require more time, for now the use of @jcommops.org based lists will continue (see also the discussion on agenda item 14.1.1).

Mr. Kramp also introduced further improvements of the OceanOPS dashboard. The meeting noted that while the development and database implementation of the new SOT metadata format was the biggest achievement in the intersessional period, this process is at present hardly visible from the GUI. The OceanOPS web-designer will be funded through the SOT budget in October, 2021 to work on SOT-specific GUI requirements. The SOT metadata format follows the integrated GOOS-OCG wide metadata standard[31], for which a workshop was hosted with OCG in early 2021.

In terms of Key Performance Indicators, Mr. Kramp recommended that the review of required SOT products be reviewed by TT-KPI. He introduced the recently implemented 5°x5° VOS coverage analysis which takes OSCAR requirement 251[32] into account with latitude-adjusted target values. This shows that areas like the North Atlantic are, in comparison to areas like most of the Southern Hemisphere, well covered by VOS. Cooperation with other networks like DBCP are therefore key to achieving an integrated global system, using the few available ships in under-sampled areas to seed autonomous instruments to achieve the target coverage required for ECVs/EOVs. The meeting noted that integrated analysis tools are under development.

Mr. Kramp reminded the meeting that VOS metadata updates are presently exclusively performed through the former E-SURFMAR database. Updates, or new stations, can be submitted by email in the existing csv or xml bulk formats, or per online duplication and modification of an existing station. With reference to agenda item 4.1.1 he stressed the importance of using SOT-IDs for new stations.

[30] https://www.ocean-ops.org/board?groupid=7006
[31] https://www.ocean-ops.org/metadata
[32] https://space-test.oscar.wmo.int/oscar-test/requirements/view/251

Updates of VOS metadata are normally processed within 48 hours of submission. Updates of ASAP and SOOP-XBT metadata are performed in intersessional panel meetings or in communication with the Chair of the ASAP TT. Metadata from other SOOP-networks such as TSG/GOSUD, pCO2 and CPR programs should be submitted to OceanOPS after completion of the new metadata format implementation.

A user guide and training webinars and videos will be produced in conjunction with the Metadata and RPT Task Teams, example training videos for OceanOPS were provided as background information[33], and an SOT flyer on "How to submit VOS metadata"[34] has also been produced. It was noted that Mr. Kleta joined the OceanOPS team in Brest for a period of four weeks in September, 2020 to work with the team on developing the new SOT metadata format.

The Team noted that the submission of SOT station metadata to WMO OSCAR started earlier in 2021. Only stations for which a minimum set of sensor information are available at OceanOPS are presently submitted to OSCAR, and only with a subset of metadata. As an example, Mr. Kramp drew attention to the following database extracts from OceanOPS[35] and OSCAR[36] for the same ship (Figures 5 & 6)

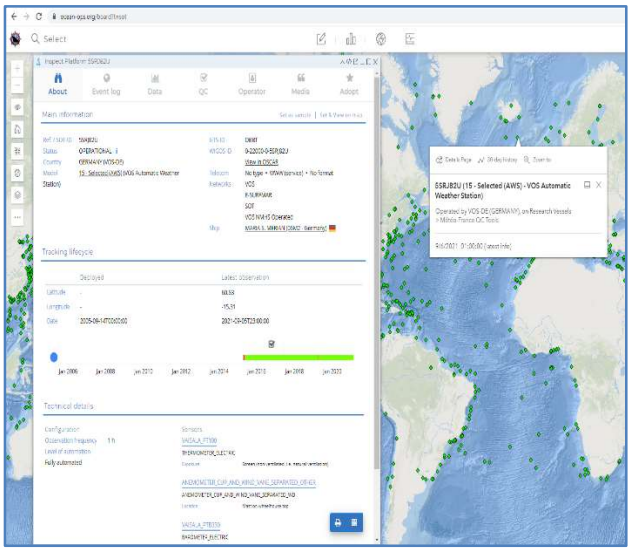

Figure 5: Example of metadata from OceanOPS

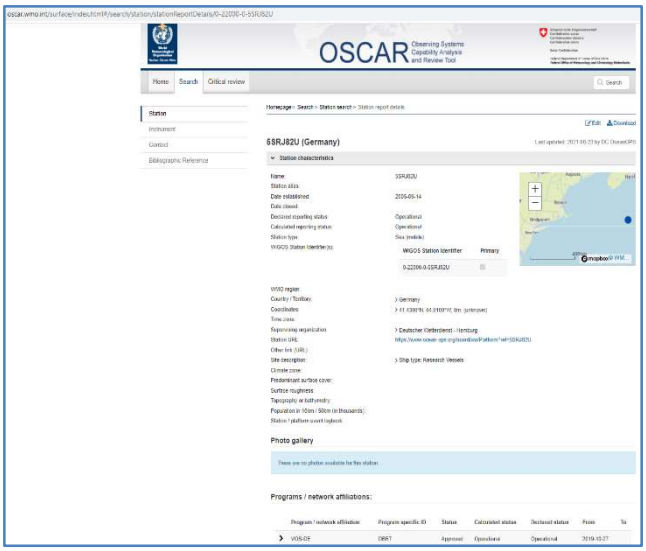

Figure 6: Example of metadata from OSCAR

Mr. Kramp was pleased to report that following communication with the relevant program managers the number of VOS double recruitments has decreased significantly. Stations still on the list are mostly intentional duplicates (e.g., due to having both an AWS and manual station on the same vessel).

The Team noted that analysis of satellite-transmitted AIS data with the aim of identifying ships that sail repeatedly in under-sampled areas, and on unoccupied XBT lines, had started for a short period in late 2019 but had no success. During the pandemic and teleworking period this activity, unfortunately, could not be continued.

The Team also noted that the IOC-UNESCO logo had recently changed and that the SOT certificate therefore needed to be adapted. A broader GOOS-OCG certificate, and certificate for the proposed Ocean Decade project (agenda item 11 refers), are also under development.

[33] https://youtu.be/TkOgHoa8baQ ;https://youtu.be/tmxVBRwFNu4 ; https://www.youtube.com/watch?v=1WmWnHUVWtM
[34] https://drive.google.com/file/d/1-Hz2-xY918bMN_suMTLkwrW3NheivV41/view?usp=sharing
[35] https://www.ocean-ops.org/board/wa/Platform?ref=5SRJ82U
[36] https://oscar.wmo.int/surface/index.html#/search/station/stationReportDetails/0-22000-0-5SRJ82U

Mr. Kramp reminded the meeting of the SOT action item list which is now maintained as a user-friendly Trello board[37].

With respect to the VOS Panel, Mr. Kramp reported that over the last month the following number of VOS with metadata (as per the new VOS classes) in the OceanOPS system had submitted data:

- 1362 NMHS Operated VOS
- 310 NMHS Cooperative VOS
- 1 NMHS Independent VOS

Compared to the following number of VOS which submitted data over the last 3 years:

- 2426 NMHS Operated VOS
- 751 NMHS Cooperative VOS
- 67 NMHS Independent VOS

The number of monthly unique observations from the global VOS fleet is presently almost 300,000 per month (see Figure 7), with around 10% available only in TAC - noting, however, that the data in TDC have often been reprocessed to TDC from native TAC by a GTS center other than the data producing center. Data are mostly submitted in a timely manner, with 97% of all observations available on the GTS within 120 min.

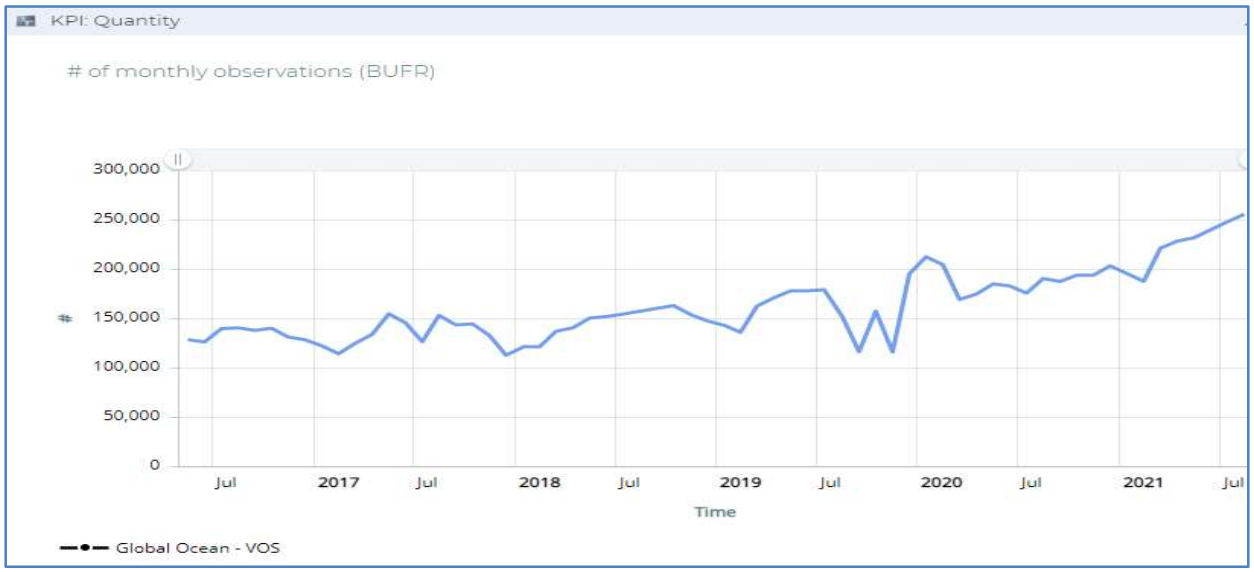

Figure 7 – VOS data quantity KPI July 2016 to July 2021

The meeting noted that there were 226 VOS (with metadata with recruitment dates during the last 5 years) in OceanOPS where corresponding observations could not be identified on the GTS; see following pie chart (Figure 8) for details of distribution by country.

[37] https://trello.com/b/fTxHWAqN/sot-actions

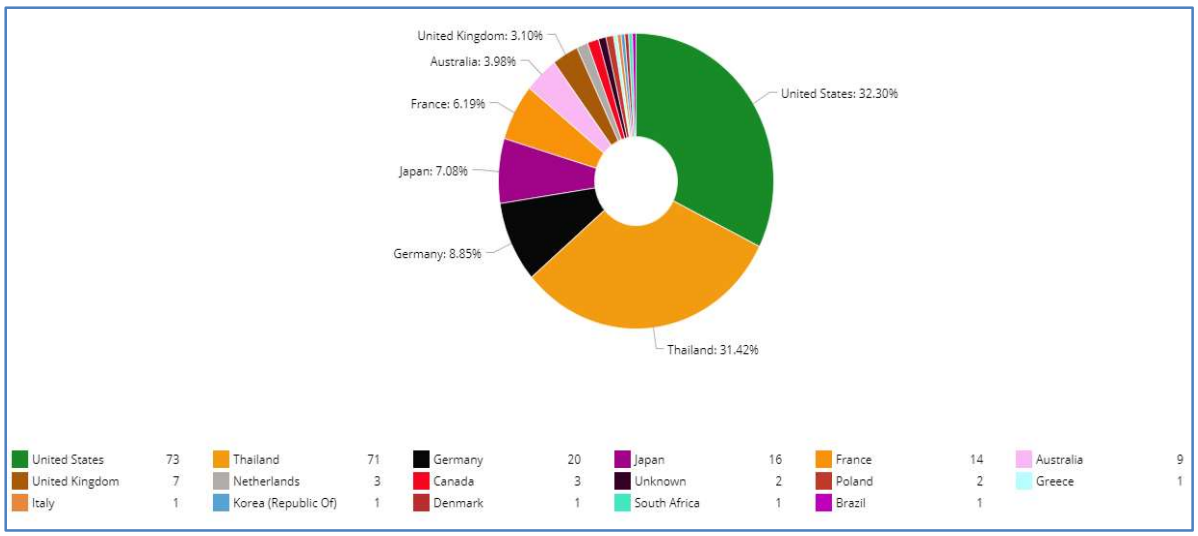

Figure 8 – Numbers of VOS that could not be identified on the GTS by country

For some of the stations involved this is the case because the generic SHIP mask is applied in GTS data submissions, and bilateral exchange of unmasked data with OceanOPS is not in place. In addition, it is because some station metadata have been submitted only very recently (e.g., Thailand). Furthermore, some members operating VOS do not yet share their data and, accordingly, are encouraged to reach out to the SOT Technical Coordinator if technical issues are the reason.

For the SOOPIP, the previously reported impact of COVID resulted in the number of 2020 XBT deployments being small when compared to former years (see map Figure 9 showing the status of deployments in January, 2021). Some data seem still to be unavailable at the French GTS node, and this will require further investigation.

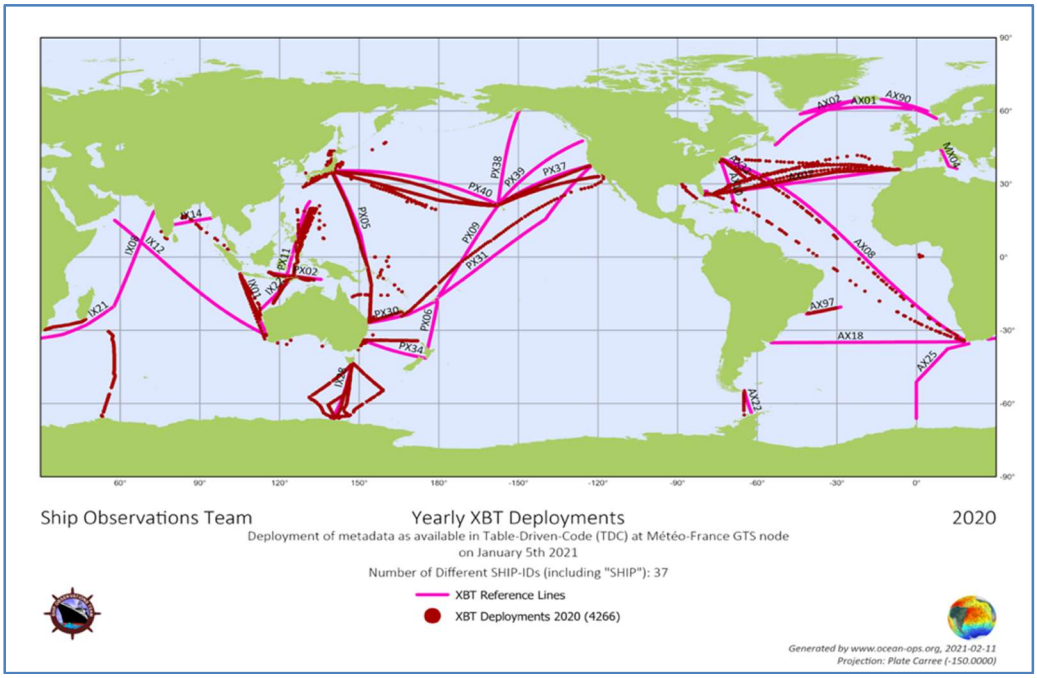

Figure 9 – XBT Reference lines and deployments 2020

The network status for XBT lines in July, 2021 is shown in Figure 10. Nine XBT stations provided data during the last month, compared to 55 that provided data over the past 3 years. For 16 XBT stations metadata are available in OceanOPS, but no data have been identified on the GTS. With the still ongoing COVID situation a performance analysis for the two-year intersessional survey was not performed. For other SOOP stations (TSG, pCO2, CPR, fishing gear) data and metadata are not collected yet.

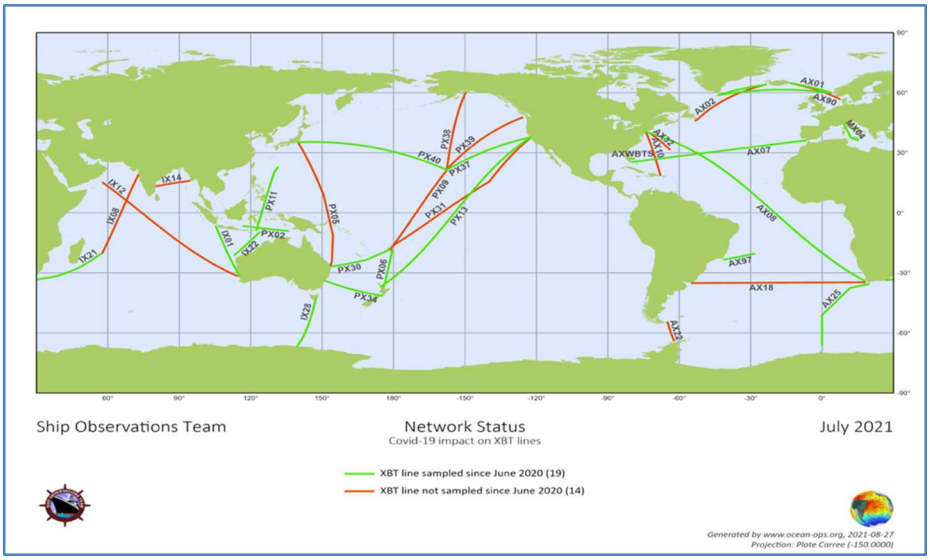

Figure 10 – XBT Network Status July, 2021

The vast majority of ASAP soundings are still performed by the E-ASAP program resulting in a stable number of stations and observations over the North Atlantic. The MOSAiC project with German research vessel *'Polarstern'* launched more than 1000 radiosonde balloons in high Arctic latitudes at the peak of the 2020 pandemic crisis. In addition, in recent weeks, many soundings in Arctic waters have been performed by Korean research vessel *'ARAON'* and Norwegian research vessel '*KRONPRINS HAAKON'*. 17 ASAP stations submitted data over the last month (Figure 11 below shows the position and number of ASAP reports in August, 2021). The Team was pleased to hear that some discussions are underway in the United States to equip a pair of cruise ships with ASAP launchers.

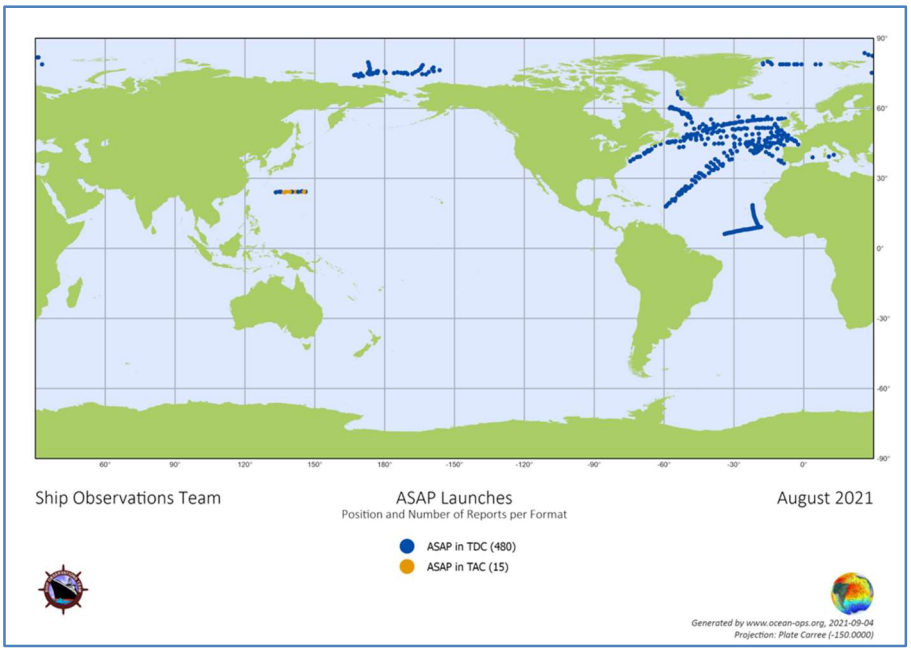

Figure 11 – ASAP Launches August 2021

Mr. Kramp also reported that driven by IOC, a data flow analysis effort is underway for near-real-time and delayed mode data of all GOOS networks, and also including the flow of metadata. The meeting noted that an OCG Data and Metadata Workshop was scheduled for 27 September at 17 UTC.

Actions:

A8.0/01 *– In liaison with the Open-GTS Project and industry partners who have GTS access (e.g., CLS), develop a strategy on how the expected increase in third party data, metadata/instruments could be managed (SOT EB, TT-EICO, & TC/OceanOPS; SOT12**).***

A8.0/02 – *Based on Maersk success, foster further company-wide recruitments, with focus on shipside funded and maintained AWS systems (TT-RPT, TT-EICO, TC: Ongoing).*

A8.0/03 *– Review content of the VOS brochure, with a view to developing a lighter and broader (SOT, OCG) document. (TT RPT & TC, VOSP Chair, SOOP Chair, OCG; SOT-12).*

A8.0/04 – *OceanOPS to maintain and make available contact information and user groups for Task Teams and other SOT groups (SOT NFPs, PMO Lists, etc), which list membership and TORs, and act as the primary repository for such information (replacing the OceanExpert repository) (OceanOPS; SOT-12).*

A8.0/05 – *Clear specifications for GUI development to be provided for review/comment by mid-October, with the aim to fully exploit the SOT-funded web-designer resources (TT-Metadata, SOT TC, OceanOPS web designer; mid-October, 2021).*

A8.0/06 – *Review existing monthly statistics, indicators and maps computed by OceanOPS, and suggest improvements, including OCG wide EOV/ECV analysis. (TT-KPI; December, 2021).*

A8.0/07 – *SOT operators, including new SOOP network operators (e.g., TSG/GOSUD, pCO_2, CPR…), to implement the SOT-ID management and new metadata format, and end all remaining masking schemes (SOT Operators; SOT12).*

A8.0/08 – *SOT operators to compare their observation numbers and station metadata availability at OceanOPS and report any issues back to the TC, in particular regarding transition to new SOT-IDs and metadata format (SOT Operators, SOT-TC; Ongoing).*

A8.0/09 - *Members who do not share data publicly or unmasked (GTS or elsewhere) to investigate if national data policies or technical protocols could be improved and report to the SOT-EB, and SOT TC (SOT Members, SOT EB & TC; April, 2022).*

A8.0/10 - *TC to update and circulate a revised SOT certificate with new IOC-UNESCO logo (TC; October 2021)* ***.***

A8.0/11 – *Operators to only use the revised SOT Certificate and send copies to certificate@jcommops.org (SOT Operators; Ongoing).*

A8.0/12 – *SOT Members to attend OCG Data and Metadata Workshop and assist with review of IOC driven data flow charts (SOT Members; October, 2021).*

A8.0/13 *- In liaison with OCG, as appropriate, establish closer cooperation with IRSO with a view to ensuring that all IRSO RVs are contributing to SOT activities. (SOT Chair, SOT TC, OCG; SOT-12).*

9. BREAKOUT SESSIONS

9.1 VOS and ASAP Breakout Sessions

The VOS Panel (VOSP) Chairperson Mr. Henry Kleta led the VOS and ASAP breakout sessions. He was pleased to note that approximately 60 participants took part in the breakout sessions, and he thanked all those taking part. The following detailed VOS and ASAP issues were considered during the breakout:

9.1.1 VOS Panel

The VOSP Chairperson, Mr. Henry Kleta, gave a report on the intersessional activities related to the VOS Scheme. He drew attention to the Terms of Reference for the Panel, which had been adapted and updated at the previous session, and requested the WMO/IOC Secretariats to ensure that they are shown correctly on all relevant websites and documentation. A copy of the Panel's current Terms of Reference are included in **Annex IV.**

Mr. Kleta then reported on his activities as the Panel Chair during the intersessional period. In addition to attending regular tele-conferences with the SOT Executive Board, SOT Executive Committee, and the various task teams, he also attended a number of teleconferences with the OCG including OCG Roundtable meetings and meetings to develop the Report Card. Other meetings that he attended, either virtually or in person, included:

- OCG 11
- CLIMAR 5
- E-SURFMAR VOS Expert Team meetings (as the Chair of Expert Team)
- PMO-6 workshop
- VOS discussions with Maersk
- VOS discussions with the GCW (Global Cryosphere Watch) concerning increased observations in the Polar regions and the need to harmonise network activities
- Meetings of the WMO Study Group on the Global Basic Observing Network (SG-GBON) to represent marine observation requirements
- An SOT metadata internship at OceanOPS for almost the whole of September, 2020

Performance of the VOS network in 2020

Mr. Kleta then drew the meeting's attention to VOS Scheme performance in 2020 (Figure 12). He requested operators to confirm their national observation numbers and advise the SOT Technical Coordinator of any discrepancies, e.g., due to double accounting of observations. In this respect he then proposed an action to implement new functionality in OceanOPS to allow operators to easily output information on their numbers of observations (i.e., observations counters per station, or several stations, or entire fleet) for a specified time duration. Furthermore, he proposed to implement additional functionality to generate maps to display these observations using VOS terminology. Such information would also assist VOS operators to explain and justify their VOS activities at the internal national level.

Mr. Kleta reported that in the WMO Pub 47 metadata database there were still approximately 4200 VOS Stations registered as active at the end of 2020. However, only approximately 2750 stations provided approximately 2.5 million real-time observations to the GTS in 2020. This figure differed from the number available via the OceanOPS database (i.e., 2.8 million). In general, the number of observations and stations in 2020 was slightly higher than in 2019 (plus ~10% observations and plus 4% stations respectively). The meeting noted that only approx. 10% of the VOS fleet is automated.

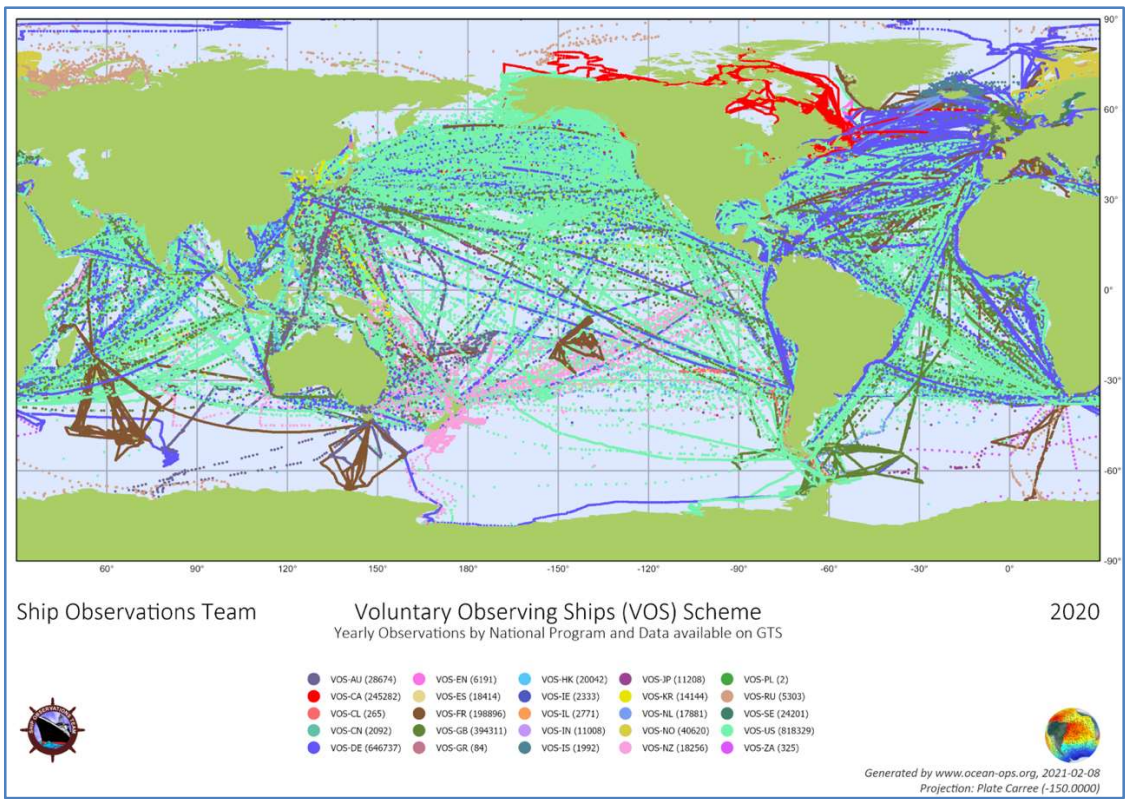

Figure 12 - VOS Scheme Performance in 2020 by national VOS programme

The number of active national VOS programmes had increased from 23 in 2019 to now 25 and a couple more national VOS fleets were expected to be listed in the coming year. Mr. Kleta pointed out that of these 25 national VOS fleets, only 14 had submitted delayed mode data to the VOS GDACs in 2020 (accounting for approximately 1.6 million observations).

Mr. Kleta therefore emphasised the need for operators to make every effort to make certain that their national delayed mode IMMT data is collected and submitted to the GDACs on a regular quarterly basis, thereby ensuring that the climate database is fully populated. He also stressed the need for VOS operators to keep their metadata up to date in the OceanOPS database (as observation numbers extracted from OceanOPS are only going to be accurate if the metadata is kept up to date).

In conclusion, Mr. Kleta reminded members that not all VOS observations put onto the GTS are actually found on the GTS. More importantly, he stressed the need to avoid re-ingestion of data (i.e., after conversion of formats) onto the GTS in order to avoid duplicate observations being counted, resulting in erroneous observation numbers. To avoid this problem, he proposed an action that where data is drawn from the GTS and re-ingested, then the use of special headers should be considered to allow duplicates to be easily identified, or alternatively to ensure that any conversions from the original observations can be identified.

PMO Network Status

Mr. Kleta thanked all Port Meteorological Officers (PMOs) for the essential work they do to support the VOS and to encourage the ongoing supply of observations. However, despite the fact that approximately 160 PMO and PMO offices are listed in WMO Pub. No. 9, Volume D, Part B, only 45 active PMOs were actually reported in the 17 annual SOT reports received for 2020. Furthermore, as a consequence of the COVID pandemic restrictions, a record low number of ship visits (approximately 1000) had been reported.

VOS operators and PMOs were therefore encouraged to ensure that their SOT annual reports are submitted via their National Focal Points (NFPs). WMO and IOC Secretariats were encouraged

to provide easy access to up-to-date NFP and PMO lists and to link to them on relevant websites (agenda item 14.1.1 also refers).

Recognising that some PMOs are not actually engaged in routine inspections of manually reporting VOS and others are effectively technicians concentrating on automatic weather stations, Ms. Sarah North suggested that a clearer definition of what constituted a PMO was needed. Mr. Kleta suggested this was probably an issue to refer to the TT-RPT to consider.

Discussions with Maersk

The meeting noted that Mr. Kleta continues to serve as the focal point for increased VOS involvement with the Danish-based shipping company Maersk, which had decided in 2019 that all of its company-owned vessels (in total approximately 300 vessels) should participate in the VOS network. Maersk remains committed that its fleet will take ocean observations vital for weather and climate prediction, and its contribution was the subject of an IOC-UNESCO news release[38].

In June, 2021, the 50th EUCAWS station was provided by Deutscher Wetterdienst (DWD) and installed onboard a Maersk vessel, making Maersk one of the biggest fleets of automated marine meteorological data in the world. It is important that GOOS and its associated networks coordinate through the SOT and its VOS Panel on any interactions with Maersk to ensure consistency of message and effort.

Maersk is planning to fully integrate the installed AWS into their onboard systems (using the NMEA feed from the AWS to their ship systems), and also wants to use an e-logbook system which might be TurboWin - but that remains for discussion, as Maersk doesn't want its officers to have to submit the same weather observation(s) on more than one occasion. Additional discussions between DWD and Maersk will be taking place in October concerning the provision of historic data from its ships' systems to the VOS GDAC based in DWD. Furthermore, the potential to receive near real-time data feeds from Maersk-owned systems onboard its vessels for GTS ingestion is under investigation.

Mr. Kramp questioned whether Maersk would be co-funding the new AWS systems and their maintenance. Responding, Mr. Kleta said that this was unclear and a matter still under discussion. Maersk might consider purchasing equipment but would most likely continue with EUCAWS systems.

SOT / VOS relevant websites:

Mr. Kleta drew members' attention to those websites that are of most relevance to the VOS, including:

- The VOS website (http://sot.jcommops.org/vos/)
- The WMO Pub47 metadata database (http://www.jcommops.org/sot/vos_eSURFMAR/vosmetadata_v6/)
- The OceanOPS website/database (https://www.ocean-ops.org/board?t=sot), and;
- The GOOS / SOT landing page (https://goosocean.org/sot)

There are still many legacy jcomm.info web pages and links that need to be worked on to ensure documents are kept accessible, as well as OceanExpert sites that have to be kept up to date and functional.

[38] https://ioc.unesco.org/news/global-logistics-giant-maersk-commits-300-commercial-ships-support-ocean-and-climate-science

ISO Project 23745 "General specification for shipboard meteorological instrument"

The Team noted that, in 2020, ISO committee ISO/TC 8/SC 13 "Marine Technology" had approved a new project No 23745 entitled "General Specification for Shipboard Meteorological Instruments". This has been added to the work programme of its working group 2 "Ocean hydrometeorological observation".

Mr. Henry Kleta, VOSP Chair, is the German delegate to ISO/TC 8/SC 13, while Mr. Jean-Baptiste Cohuet, Chair of the TT-ISSC and Mr. Sai-Tick Chan, VOS Panel Vice Chair, are involved in Working Group 2 as "contributors" representing WMO.

Noting that Mr. Chan is stepping down as Vice-Chair of VOSP, the Team recognised, and agreed, that a replacement contributor was needed for working group 2 and, accordingly, requested the WMO Secretariat to identify and appoint a replacement.

IMO

Attention was also drawn to draft revised IMO MSC/Circ. 803 "Participation of NON-SOLAS Ships in the Global Maritime and Safety System (GMDSS)", which is still being worked on at IMO and is not available yet. One of its provisions will be to invite non-SOLAS ships operating in high sea areas to participate in the VOS Scheme.

Development of the VOS network

Mr. Kleta reminded the meeting that following the SOT-9 session the IMO MSC Circular 1293 entitled "Participation in the WMO Voluntary Observing Ships (VOS) Scheme" was updated. A copy of the MSC Circular is available via the SOT VOS website and at MSC.1/Circ.1293/Rev.1 – 25 May 2018 .

Development of such documents at IMO highlighted the need for the SOT, via its WMO and IOC representatives, to have increased input and awareness of the ongoing developments within IMO committees and sub-committees.

Mr. Raja Acharya (India) enquired whether the SAMOS (Shipboard Automated Meteorological and Oceanographic System) could be considered in all VOS ships in order to improve data quality, continuity and understanding the biases in air-sea fluxes. Shawn Smith (FSU) clarified that the SAMOS project does not develop or deploy instrumentation. It simply ingests data from the sensors deployed by the research vessel operators.

Actions:

A9.1.1/01 *– All VOS operators and / or PMOs are requested to arrange provision of SOT annual reports via their National Focal Point (VOS Operators, PMOs, SOT NFPs; Annually).*

A9.1.1/02 – *VOS operators are requested to keep their VOS metadata up to date in the relevant metadata database. (VOS Operators; Ongoing).*

A9.1.1/03 – *OceanOPS to implement functionality to allow output of information on number of observations (observation counters per selected station/stations/fleet) for a specified period of time (month/year) and to generate maps showing only those observations (using VOS terminology). (OceanOPS; as soon as possible).*

A9.1.1/04 – *VOS operators are requested to provide quarterly delayed mode data to the VOS GDACs. (VOS Operators; Quarterly).*

A9.1.1/05 – *VOS operators are invited to compare their observation counts with those from OceanOPS in order to identify missing data and / or duplicates. (VOS Operators; Ongoing).*

Recommendations:

R9.1.1/01 – *If data are drawn from GTS and re-ingested, the use of special headers should be considered to make it clear that they are duplicates or compilations i.e., to allow easier identification of duplicates and / or original format data or conversions made from the original observations. (GTS data Centres/Nodes; Ongoing).*

R9.1.1/02 – *Secretariats to provide easy access to NFP and PMO lists (with input from WMO and IOC members) and keep them up-to-date, and link to them from relevant websites. (WMO/IOC Secretariats; as soon as possible/Ongoing; compare/merge with A8/04).*

R9.1.1/03 – *WMO Secretariat to organise appointment of a contributor to ISO&TC 8/SC 13/WG 2. (to replace outgoing VOSP VC) (WMO Secretariat; as soon as possible).*

R9.1.1/04 –*Secretariats to ensure that the ToRs are stated correctly on all relevant websites and documents are kept up to date. (WMO/IOC Secretariats; as soon as possible/Ongoing).*

9.1.1.2 E-SURFMAR Report

Mr. Jean-Baptiste Cohuet (France), Automated VOS Coordinator for the E-SURFMAR Programme, gave a report on E-SURFMAR VOS activities, including the QC Tools operated by Météo-France on behalf of E-SURFMAR.

E-SURFMAR is the Surface Marine Observations Programme of EUMETNET, coordinating marine observation activities for VOS and buoys in Europe. The participating members are: Belgium, Croatia, Czech Rep., Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, and the United Kingdom.

The main activities related to VOS during the last intersessional period were:

EUCAWS Automatic Weather Stations

E-SURFMAR has been working since 2009 on the development of a European Common Shipborne Automatic Weather Station (EUCAWS). Following a European tender, the EUCAWS system is now available on the market, and is sold by Stéréla, a French company and costs approx. €8,000 (for the station only, not including the weather sensors). It has been deployed on ships in Europe since 2017, and the current network consists of approximately 150 stations installed by several E-SURFMAR participating members. Figure 13 shows a typical EUCAWS installation while Figure 14 shows the global coverage of EUCAWS observations in 2020.

Figure 13 EUCAWS station

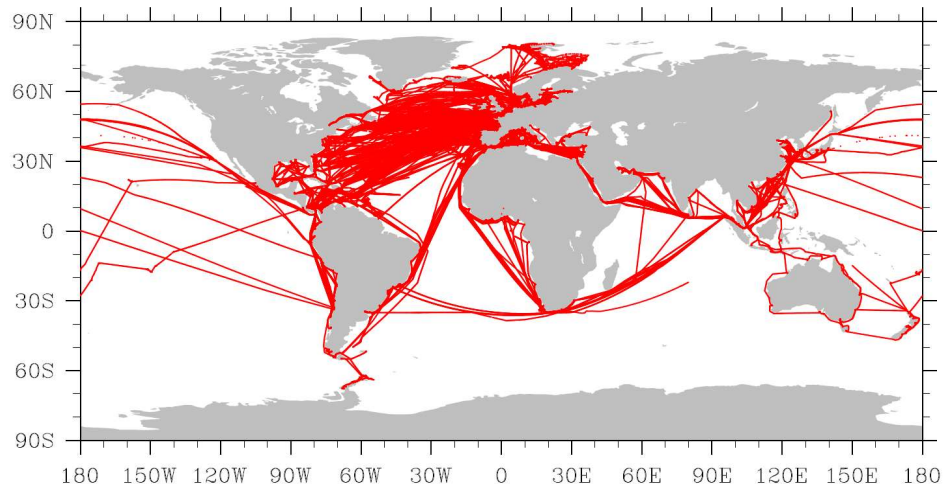

Figure 14 EUCAWS observations in 2020

In order to build capacity E-SURFMAR has set up an adoption programme to help facilitate its members to install and operate their first EUCAWS station. This will allow them to build their own experience with the system, and start developing a national automated VOS network.

The EUCAWS stations have demonstrated good performance so far, with the exception of water ingress on some systems that have had to be solved, mostly by the manufacturer.

E-SURFMAR has started to work with Stéréla on EUCAWS station miniaturisation, in order to make an Iridium datalogger available with the same functionalities as the EUCAWS. Reducing the size of the system will make it easier and simpler to install, e.g., on sailing ships where the EUCAWS cabinet often cannot be installed at present. It is also anticipated that it will be possible to reduce the cost of the system.

TurboWin development

TurboWin is a user-friendly electronic logbook software developed as freeware by the Royal Netherlands Meteorological Institute (KNMI) and is partially funded by E-SURFMAR Programme. The TurboWin software helps to code, log and transmit meteorological observations from observing ships. It includes built-in quality checks, help files, graphical displays, etc.

Whilst TurboWin can run in a fully manual mode, it can also be connected to a EUCAWS station, or can be connected to a single sensor. Observation transmission can be compiled in SHIP FM13 format or in #101 format and sent by email or Obs2Server. It also stores delayed mode data for later collection by PMOs and submission to the VOS-GDACs. The software, sources and associated documentation are available at: https://gitlab.com/KNMI-OSS/turbowin/turbowin/.

All the change requests to rectify bugs, or to introduce new functionality, are submitted through Gitlab, or via email to turbowin@knmi.nl. A TurboWin Partner Board meets every six months to provide a roadmap on new features to be implemented and to prioritize goals. All requests concerning changes to the content or functionality of TurboWin are discussed and decided by this Partner Board forum which includes active E-SURFMAR participants and other partner providing significant funding or in-kind contribution to TurboWin.

Data collection and processing

E-SURFMAR collects and processes VOS data into BUFR format from several dataflows, e.g., EUCAWS stations, #100 format, TurboWin Half-compressed messages, and #101 format that are transmitted by email or via Obs2Server. User interfaces allow messages to be configured for GTS ingestion. The challenges for the next intersessional period will be to:

- optimise internal dataflows for data processing;
- generate the new VOS BUFR template 3 08 014 for all the dataflows handled by E-SURFMAR;
- Include metadata in the BUFR messages; and,
- generate VOS climatological data in IMMT format from GTS data and OceanOps metadata, which will help some members who are not currently collecting IMMT data locally.

Barometer comparison

Pressure is the most important parameter measured at sea for numerical weather prediction. Traditionally, NMHSs equip Voluntary Observing Ships with high quality standard barometers with a very low uncertainty and drift. However, there are numerous sources of uncertainty for pressure measurements taken on a ship (changing height of the barometer, wind effect, waves, air conditioning) related to exposure and the barometer location.

The most recent intercomparison studies with pressure sensors for meteorology date back to the 1990s and are, therefore, not representative of the current state of sensor technology, or for commercially available off-the-shelf sensors. Consequently, E-SURFMAR has initiated a new dedicated barometer intercomparison study taking into account the following issues and developments:

- Several NMHSs are automating their VOS fleet by implementing EUCAWS systems;
- The expected growth in the number of automatic pressure report (APR) observations on national fleets, installed and maintained by NMHSs; and,
- Recognising the extension of VOS networks to include third party ships, and companies providing barometers themselves, it is questioned whether lower standard barometers could be recommended.

Because barometer prices vary between a few tens of euros to several thousand euros it is considered a worthwhile exercise to test them, both in a lab and in real shipborne conditions, to compare their behaviour and to verify that the manufacturer's information is correct.

Figure 15- Integration of 13 barometers on Research Vessel *L'Atalante*

The E-SURFMAR study mainly focuses on digital barometers that can be easily interfaced to TurboWin+ software; on those Automatic Pressure Report solutions that are already available and in use by some NMS; or, are in use on EUCAWS stations. The criteria considered necessary for selecting the barometer are:

- To be significantly less expensive than a VaisalaPTB330, which is the current reference standard for many NMS.
- To have an announced accuracy better than 1hPa, which is the threshold value specified in the WMO OSCAR requirements for Numerical Weather Prediction[39]
- To have a digital output, in order to permit it to be interfaced with to TurboWin or EUCAWS.

However, the following three exceptions to these criteria will be allowed following requests by some E-SURFMAR members:

[39] https://www.wmo-sat.info/oscar/variables/view/10

- The Vaisala PTB110 used by UK Met Office, which has an analogue output.
- The USB Dracal BAR20 barometer used by VOSbox, with a stated precision of 1.5 hPa.
- Seismology barometers developed at KNMI (LPS33HW & MS5837)

Two units of each of the following thirteen barometers were purchased for the comparison: Vaisala PTB110, KNMI MS5387, KNMI LPS 33HW, Dracal USB BAR20, Young 61302V, Thies 3.1157.10.000, Gill GMX300, Siap Micro TBAR HVS, Zoglab DBT500, Druck TERPS 8100, MINTAKA STAR, Vaisala PTB210, Vaisala PTB330.

The intercomparison exercise will be undertaken several steps i.e., paper comparison, calibration, field comparison, and new calibration. The field comparison will comprise installation of all thirteen barometers on a research vessel for a period of one year (Figure 15). Minute-sampled data will be stored onboard, while hourly data will be transmitted to shore. The results of the study will be made available in mid-2022.

9.1.1.3 E-SURFMAR QC Tools

E-SURFMAR continues to provide quality control tools to the community, including blacklist, real time comparison to models, monitoring reports, observations counters, etc., which are available on E-SURFMAR QC website: http://eSURFMAR.meteo.fr/qctools/

For monthly statistics, a new tool is under development and is applicable worldwide for all the VOS and buoys: http://eSURFMAR.meteo.fr/qctools/statistics/statistics.php It shows a synthesis by fleet of monthly performances, highlights suspicious data, and displays two years of monthly data for each parameter measured on a ship.

New developments are also expected in the next two years for E-SURFMAR members. Firstly, E-SURFMAR aims to develop a cartographic portal allowing the display of the most recent VOS locations, data visualisation, and warnings for ships in the blacklists. It is also expected to generate automatic monthly reports on European VOS performances, fleet by fleet.

9.1.1.4 VOS GDAC Report (Including Delayed Mode IMMT Data)

Mr. Axel Andersson (Germany) gave a report on the work of the Global Data Assembly Centers (GDAC) for VOS data within the Marine Climate Data System (MCDS). He outlined the history of the collection of delayed mode climate data which started with the Marine Climatological Summaries Scheme (MCSS) in 1963, and the creation of two Global Collecting Centres (GCCs) in 1994. The MCSS was subsequently discontinued in 2017 when it was replaced by the Marine Climate Data System (MCDS), and the VOS Global Data Assembly Centres (VOS GDAC) essentially replaced the GCCs within the structure of the new MCDS system.

The Team noted that the MCDS data flow is a formalised system for the long-term preservation of all kinds of marine climate data under the IOC/WMO umbrella, including Argo floats, moored buoys, drifting buoys, etc.

There are two VOS GDACs located in the DWD[40] in Hamburg and at the UK Met Office in Edinburgh. The VOS data collected by the PMOs and NMHS are quality controlled before being forwarded to the VOS GDACs, who then consolidate the data contributions and make the data publicly accessible via the internet. They also provide quality feedback to the data contributors and then forward the data to the Centres for Meteorological & Oceanographic Climate Data (CMOCs) where it is aggregated with data from different sources.

[40] https://dwd.de/vos-gdac

In the case of the VOS the data is also sent for inclusion in the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) long-standing data archive.

Mr. Andersson reported on the number of delayed mode VOS observations that had been contributed to the GDACs in 2020. Over 1.5 million observations had been submitted from 558 VOS, although only 14 of the 27 registered VOS countries had actually submitted data. 55% of the data were coded in the latest IMMT-5 format[41], while 43% were submitted in the previous IMMT-4 format and another 2% in even earlier formats. Further details of national data submissions, together with information on their spatial distribution, are given in the comprehensive Report of the VOS-GDACs at **Annex VI.**

Mr. Andersson invited members to consider the VOS GDAC report in detail and invited countries that have not already registered as Data Assembly Centres (DACs) for the contribution of data, to do so, in order that their data can be recognised in next year's report. He encouraged all DAC to submit data in 2021 and to contact one of the GDACs for advice if they are having problems in preparing their data submissions, e.g., due to digitising issues, or due to problems with converting data into the current IMMT format. All data submissions are important, even small data contributions.

The Team noted that in the last two years there had been a marked increase in the volume of data being submitted to the GDACs due to the increased volume of AWS data being submitted. Because automated data is submitted hourly, compared to the traditional six-hourly synoptic data from manually reporting VOS, it is anticipated that there will be further substantial increases in data volumes in the coming years.

Mr. Andersson also drew the meetings attention to the volumes of data received from ships that contributed to the now discontinued VOS Climate (VOSClim) project in 2020. The VOS GDACs had received and processed 489,310 observations from 226 VOSClim ships, representing 31% of the total data from the VOS during 2020. However, only 193,015 of the VOSClim observations actually contained the required additional VOSClim elements.

Bearing in mind that the VOSClim has been discontinued as a separate VOS class, and that there is no dedicated VOSClim class in the new metadata standard, Mr. Andersson invited the Team to consider how VOSClim ships and observations should be handled in the future. Mr. Kleta pointed out that following simplification of the VOS classes VOSClim ships would now be grouped under the "NMS Operated" class. Moreover, because the ToR call for the provision of as much high-quality data as possible, it should be a standard requirement for all VOS data to be reported both in real-time and in delayed mode including the additional VOSClim elements.

In reviewing the national IMMT data submissions shown in the GDAC report it was questioned why some active nations were failing to submit data on the required quarterly basis. In particular it was questioned why the United States as one of the largest VOS operators had not submitted any delayed mode data in 2020. In response, Mr. Eric Freeman explained that after some big priority shifts and team changes at NCEI in recent years, they now have a plan to get the US IMMT data flowing in fiscal year 2022. Because automating the process is part of the issue, he suggested that standardising all IMMT-related files from TurboWin would make the automation easier for all collecting NMHSs. Mr. Rene Rozeboom (Netherlands) also pointed to the lack of available staff resources to undertake the necessary basic quality control prior to submission to the GDACs. In this regard it was noted that VOS operators had an obligation to provide both real-time data as well as the delayed mode data required by climatological users.

Bearing in mind earlier discussions regarding the need to ensure the quality control of third-party ship data, Mr. Shawn Smith questioned whether the QC software used by the GDAC could be used, and whether it was freely available and open source. Mr. Andersson explained that whilst the MQCS software used to be freely available to members it is, unfortunately, no longer

[41] http://sot.jcommops.org/vos/documents/immt5.pdf

available on the WMO website. Notwithstanding, it was noted that the formats for IMMT-5 and MCQS can be found on the VOS-GDAC website at:

https://www.dwd.de/EN/ourservices/gcc/gcc.html

The Team recognised that there are several detailed delayed mode data issues that need to be addressed. In particular the IMMT format and the associated MQCS[42] needed revision in order to be compatible with the parameters, flags and accuracies provided in the BUFR format, and also to be compatible with the OceanOPS metadata structure. In addition, they need to have flexibility to cope with future changes, such as the IMO number, and provide accurate quality flags for relevant parameters.

In view of the number of complex issues that need to be addressed the Team agreed that a new ad-hoc task team should be established to investigate and propose changes, or alternatives, to the IMMT format. A copy of the Terms of Reference for the ad-hoc task team are included in **Annex IV**.

Mr. Shawn Smith questioned whether the new proposed ad hoc task team would in effect become a replacement for the ETMC but limited to the SOT level. It was clarified that it wasn't intended to replace ETMC which had now been disbanded and its functionalities transferred to various WMO working groups and other task teams. The new task team will however need to liaise with the relevant bodies which had taken over the work of ETMC in order to work on the specific tasks assigned.

Following his presentation Mr. Andersson proposed the following actions and recommendations, which were agreed to by the Team:

Actions:

A9.1.1.4/01 – *VOS operators to review the content of the 2020 GDAC Report to ensure their national data is being correctly submitted and processed (VOS Operators; DACs end of 2021).*

A9.1.1.4/02 – *Data Acquisition Centres (DACs) that did not submit data during 2020 should do so in 2021, or alternatively contact a VOS-GDAC for advice; (DACs; end of 2021).*

A9.1.1.4/03 – *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 2021).*

A9.1.1.4/04 – *VOS Operating countries that have not already done so are encouraged to register as a DAC and contribute their data to the GDACs. (VOS Operators, SOT NFPs; asap/end 2021).*

A9.1.1.4/05 – *Former Contributing Members (CMs) that have not already done so should migrate to VOS-DACs within the new MCDS (SOT & Former CMs; SOT-12).*

A9.1.1.4/06 – *DACs should submit their observations only once. If there is a requirement to resubmit data (e.g., due to quality improvements) then the VOS-GDACs should be made aware of this (DACs; Ongoing).*

A9.1.1.4/07 – *DACs should submit data files in one IMMT format only – preferably IMMT-5 quality checked to MQCS-7 making use of its increased coding capabilities (DACs; Ongoing).*

[42] http://sot.jcommops.org/vos/documents/mqcs-7.pdf

A9.1.1.4/08 – *DACs not able to submit their data because of issues e.g., with digitizing or converting into the IMMT format, should contact VOS-GDACs for advice (DACs ,VOS-GDAC; Ongoing).*

A9.1.1.4/09 – *DACs should apply MQCS to data prior to submission, so that the VOS-DACs can assist in identifying and solving significant problems (in particular issues concerning date/time/position) (DACs. VOS-GDAC; Ongoing).*

A9.1.1.4/10 – *To avoid data losses, common procedures should be developed for producing IMMT formatted observations directly from Automatic Weather Stations (AWS), or for converting such automated observations into IMMT format at a later stage. (SOT, TT-VOS DMD, DACs and VOS-GDAC; SOT-12).*

A9.1.1.4/11 – *To avoid TurboWin coding problems resulting in erroneous relative humidity values being submitted (in IMMT-4 and IMMT-5 files) VOS Operators and SOT members should update to TurboWin Version 5.6 software or newer (VOS Operators, SOT members, PMOs; as soon as possible).*

A9.1.1.4/12 – *All VOS observations should include the additional climate elements that were previously required for VOSClim class ships (VOS Operators and VOS-DACs; as soon as possible).*

A9.1.1.4/13 – *Whenever possible, DACs should ensure all masked call signs (e.g., 'SHIP') are converted back to the original ID prior to submission (DACs; Ongoing).*

A9.1.1.4/14 – *Observations should contain the same call sign as transmitted on the GTS i.e., the SOT-ID should be used as the call sign in IMMT submissions if it is used for GTS real time data (DACs; Ongoing).*

A9.1.1.4/15 – *The IMMT and MQCS formats need to be revised in order to:*
a. be compatible with parameters, flags and accuracies provided in the BUFR format,
b. be flexible for future changes in other fields such as the IMO-number,
c. maintain compatibility with OceanOPS meta data structure (e.g., new VOS Classes),
d. provide accurate quality flags for all relevant parameters (VOS GDAC & TT- VOS DMD; SOT-12).

A9.1.1.4/16 – *An (ad-hoc) Task Team should be set up to investigate and propose changes or alternatives to IMMT and MQCS. VOS-DACs should stay up to date with MCDS developments (SOT-EB, VOS-DACs, TT-VOS DMD; October, 2021).*

9.1.1.5 PMO-6 Review

Mr. Joel Cabrie (Australia), Chair of the Task Team on Recruitment, Promotion and Training (TT-RPT) reported on the Sixth International Workshop of Port Meteorological Officers (PMO-6) which was held virtually on 16 and 18 March 2021. 109 participants from 47 countries registered to attend the workshop, details of which are available at

https://oceanexpert.org/event/2610#overview together with all documents and presentations.

The Workshop focused on a variety of topics including the role of the PMO, OceanOPS support and resources, metadata, the SOT-ID, PMO resources, DBCP and SOOP activities, an overview of TurboWin software and interfacing with automated weather stations, and sea ice observations.

The aims of the workshop included encouraging PMOs to follow standard procedures for their national VOS fleets and ensuring that observed data complies with WMO standards. The workshop also provided the opportunity to strengthen relationships in a role which relies heavily on international cooperation, and which is becoming increasingly complex due to the increased use of automated systems and software.

Members' attention was particularly drawn to the outcome of a survey which was undertaken following the PMO-6 workshop. Feedback from the survey revealed that the most important topics for PMOs were how to use the TurboWin software, collection of VOS metadata and use of the OceanOPS database. These were largely mirrored in the survey as priority areas where PMOs considered that they required assistance, although other key areas identified were: how to establish a VOS network; selection of AWS sensors; sharing of real time data (on the GTS) and of delayed mode data; and, finding relevant information.

Based on the feedback from the survey it is planned to hold a series of webinars in the future which will aim to address the following priority topics:

- How to use OceanOPS
- Changes to VOS Metadata requirements
- Requesting an SOT-ID
- How to use TurboWin+
- Using QC Tools & recognising error patterns
- How to recruit ships and keep voluntary ships motivated
- Sharing data via the GTS

To encourage PMO capacity development going forward it was considered that more frequent webinars were needed, ideally every six months. The webinars will be hosted by TT-RPT, or the SOT EB or EC, and will be aimed at keeping the SOT and PMOs abreast of SOT activities and items of interest. They will also allow for more frequent interaction during intersessional periods. The first webinar is likely to take place later in 2021.

Mr. Henry Kleta suggested that webinars should be open to all interested in VOS meteorological data acquisition. Dr. Emma Heslop pointed out that the OCG were looking for more training webinars and that the OCG Capacity Development Team might be able to offer assistance in organising future webinars.

The outcome of the PMO-6 workshop was also considered during discussion on the report of the TT-RPT (agenda item 12.1 refers). Mr. Figurskey, Chair of the SOT, thanked the task team for its organization and leadership of a successful workshop.

9.1.1.6 Other Relevant VOS Topics & Recommendations

No further items were raised for discussion during the VOS breakout session

9.1.2 Task Team on ASAP, including QC monitoring report (TT-ASAP)

The Chair of the ASAP task team, Mr. Rudolf Krockauer (Germany), gave a report on the intersessional ASAP-related activities. He reported that the number of ships which provide regular upper-air soundings on the GTS throughout the year is approximately 21 worldwide. The primary user of ASAP data is numerical weather prediction.

The E-ASAP is the primary constituent programme for shipborne upper-air soundings and is based on a fleet of 18 ASAP stations located on 14 commercial vessels, three research ships, and one hospital ship. Most of the soundings are performed along the main trading routes between Europe and North America. Almost all E-ASAP stations provide data in BUFR compliant format using their assigned SOT-ID.

The total number of E-ASAP soundings on the GTS was 3180 in 2020 from 15 ships (see Figure 16 below)

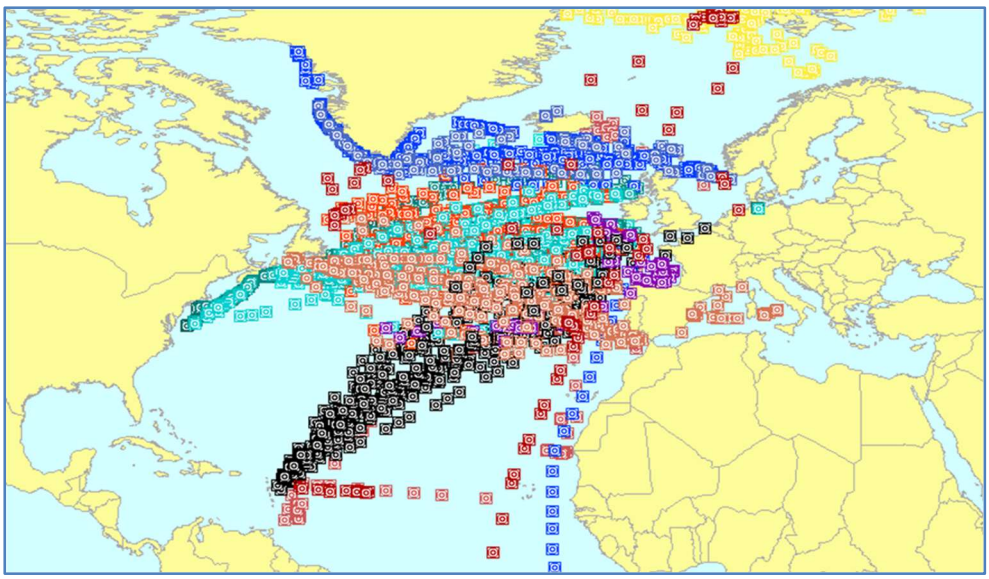

Figure 16 – E-ASAP Soundings in 2020

Taking into account the total number of launches on board compared to the number of soundings received on the GTS, the average output (GTS/Launches) was 91%. Main reasons for failed launches are:

- technical problems with the equipment;
- unfavourable wind conditions at 15-20 knots sailing speed;
- inexperienced operators; and,
- poor satellite communications.

A list of the 18 ships/stations contributing to E-ASAP (status July, 2021) is at **Annex VII.** Ten of these stations are operationally managed by the E-ASAP management team of Deutscher Wetterdienst (DWD) based in Hamburg, Germany. The other stations are part of the E-ASAP fleet but are managed by the NMHSs of France, Denmark, and Spain. Most soundings (>90%) are performed along the main trading routes between Europe and North America.

Detailed information on the performance of the ASAP stations in 2020 is included in the annual EUMETNET SOT ASAP report [43].

Japanese research vessels transmitted around 410 soundings in the West Pacific. Approximately 80 soundings on the GTS originated from the Japanese research vessel '*Ryofu Maru'* and approximately 330 further soundings were transmitted to the GTS from the research vessel '*Mirai'*. However, because of JMA's use of a masking scheme not all soundings can be identified on the GTS.

A further 1200 soundings were received from the German research vessel '*Polarstern'* in 2020, mostly during her MOSAiC expedition in the Arctic (September 2019 – September 2020).

In addition, approximately 110 soundings were received from the French research vessel *L'Atalante'* in the West Indies during January and February, 2020, and the German research vessel '*Sonne'* performed 153 soundings during an expedition to the tropical Atlantic in the period 06 July to 08 August 2021. The Technical Coordinator added that the Korean icebreaker Araon also continues to conduct ASAP soundings which are submitted to the GTS.

43 https://wmoomm.sharepoint.com/:w:/s/wmocpdb/EaF9EH4Udl5AoPtAfYce0H4BDE_L9IRw7bHPdAB05CALdw?e=hBb4SC

Globally, 4,531 soundings were received from all ASAP stations in 2020, mostly from the north Atlantic, Arctic Polar regions and the western North Pacific. The distribution was:

- 70% E-ASAP,
- 26% POLARSTERN,
- 4% Other Stations.

The global spatial distribution (see Figure 17) of ASAP soundings clearly shows the predominant coverage of the north Atlantic provided by the European E-ASAP fleet.

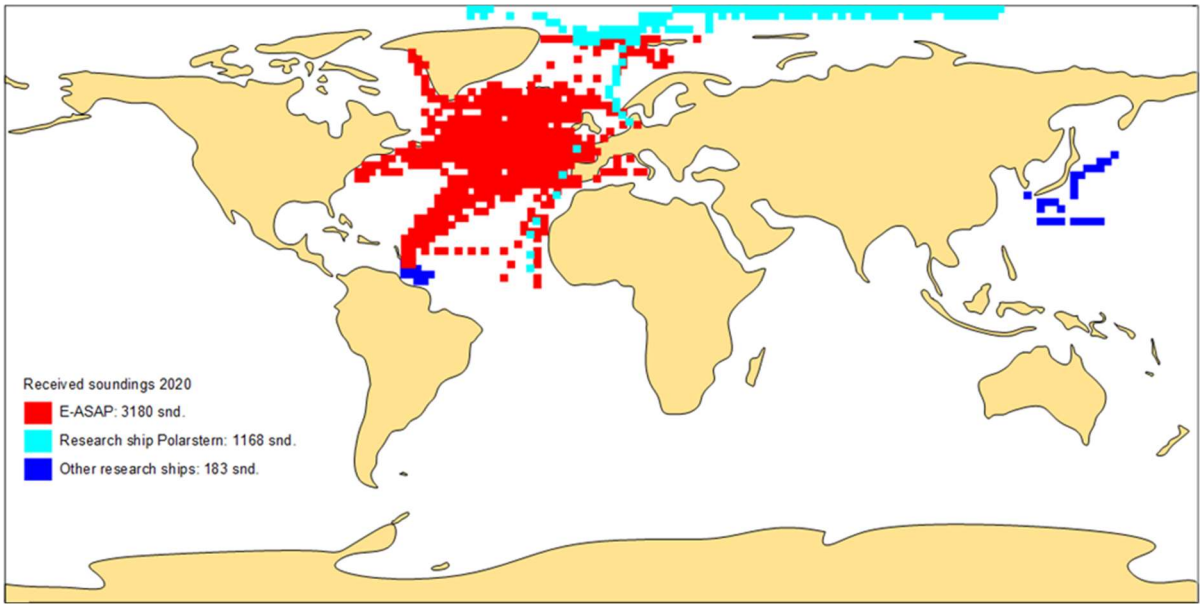

Figure 17 - Distribution of global ASAP soundings in 2020

Mr. Krockauer reported that data quality was generally good with very few soundings being rejected by ECMWF. Timeliness of the E-ASAP fleet was especially good with data on average being received within 19 minutes of the main synoptic hour, and the 30 hPa median burst height achieved was well within specified E-ASAP criteria. Bigger balloons used on the research vessel *Polarstern* also enabled excellent median burst heights to be achieved (7hPa). Mr. Krockauer pointed out that the average failure rate on E-ASAP ships was 10% due to a mixture of technical problems, unfavourable wind conditions, inexperienced operators, and poor satellite communications.

Mr. Mathieu Belbeoch (OceanOPS) questioned why some of the main implementers of the GOOS did not contribute to ASAP and asked what could be done to improve this situation. Responding, Mr. Rudolf Krockauer suggested that the costs and effort involved were the prime reasons. Each sounding costs approximately USD300 and, in addition, substantial effort was needed to maintain and manage ASAP stations. Mr. Henry Kleta (Germany) added that many European countries were reliant on E-ASAP which has been well organised, and as a consequence some members had withdrawn their own national ASAP involvement.

Noting that ASAP soundings and marine observations are included as components of the WMO's GBON, it was hoped that more members would be encouraged to contribute to the programme in future.

A9.1.2/01 *– Recognising that scientific studies confirm the positive impact of upper air soundings in data sparse regions SOT NFPs should encourage their NMHS to participate in global ASAP observations by installing and operating ASAP stations on board ships (SOT NFPs, SOT EB, ASAP Panel; Ongoing).*

9.2 SOOP Breakout Session

Ms. Justine Parks, incoming Vice Chair of the SOOP Implementation Panel (SOOPIP) introduced the breakout session. She reminded members that SOOPIP holds quarterly meetings, with everyone who works on SOOP measurements, or wants to be involved, being invited. She also thanked Ms. Rebecca Cowley and Mr. Gustavo Goni, the outgoing Chairs, for all their work and their commitment to SOOP over the years.

Historically the SOOPIP network was dominated by XBT deployments maintained along fixed transects on commercial shipping vessels, many of which have been in operation since the 1980s, making the observations invaluable for multi-decadal climate studies. Over time, SOOPIP's role has been expanded to include deployment of additional instrumentation that measures physical, chemical and biological parameters such as pCO_2, TSG, CPR, etc.

9.2.1 SOOPIP Status Report

Ms. Rebecca Cowley, the outgoing co-Chair of SOOPIP, introduced the status report and welcomed the new leadership team. She looked forward to hearing more about the contribution that new networks groups, such as the pCO_2 and CPR networks, will make to the future work of SOOP.

Dr. Francis Bringas, incoming SOOPIP co-Chair, presented the status report and began by explaining that SOOP is an international program mainly involved in the implementation, maintenance, enhancement, and data management of upper-ocean measurements from ships of opportunity.

This includes:

- Expendable BathyThermographs (XBTs);
- ThermoSalinoGraphs (TSGs);
- Partial Pressure of Carbon Dioxide (pCO_2); and,
- Continuous Plankton Recorders (CPR).

Additionally, SOOP offers support to other observational projects and operational activities including:

- deployment of drifters and profiling floats;
- the International Quality-Controlled Ocean Database (*IQuOD*);
- the Global Temperature-Salinity Profile Program (GTSPP);
- the Voluntary Observing Ship (VOS) Scheme; and,
- the Global Ocean Surface Underway Data (GOSUD).

SOOP supports scientific and operational efforts to help improve our knowledge of the ocean environment, through data analysis and contribution to modelling efforts.

XBT operations in SOOP are organized as a Global XBT Network, with transects sampled according to recommendations from the international scientific community, and more directly the XBT Science Team. The main objectives for collecting XBT data are to:

- Study and make assessments of Meridional Heat Transport (MHT) and Meridional Overturning Circulation (MOC);
- Study and monitor surface current variability;
- Contribute to upper ocean heat content studies; and,
- Initialize and validate models.

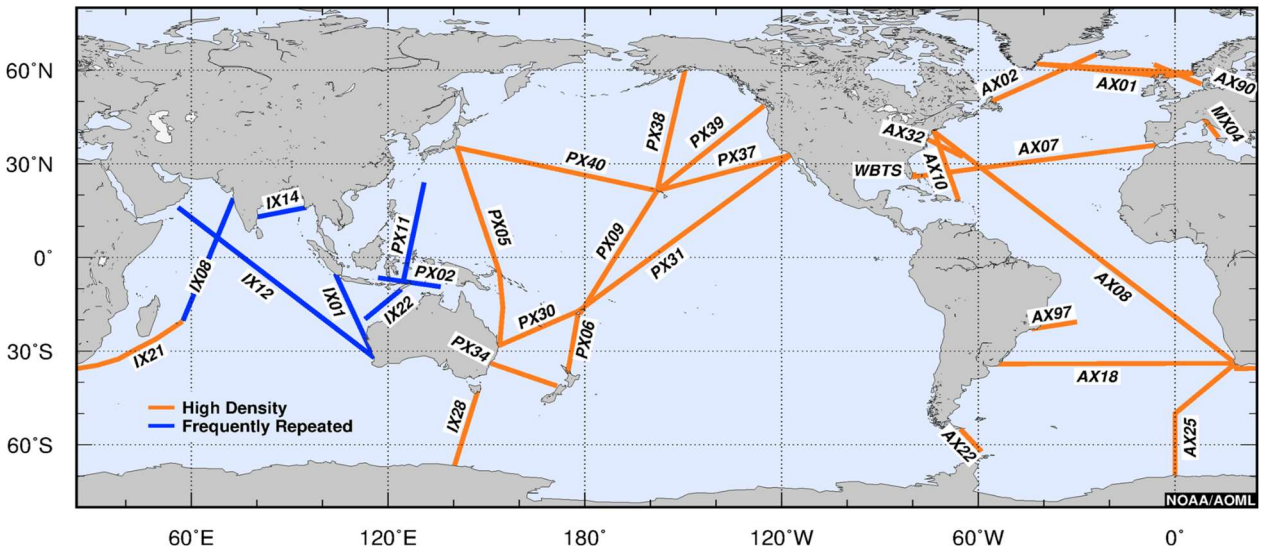

Figure 18 – Global XBT Networks

The Global XBT networks (see Figure 18) is an international effort carried out by several countries (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, New Zealand, South Africa, United States), with contributions from these countries in the form of probes, equipment, ship recruitment, ship riders or data quality control (QC) and distribution.

Frequently repeated XBT lines perform 6-8 deployments per day, with a deployment every 100-160 km, and conduct 12-18 transects each year. High Density/Resolution lines perform 18-35 deployments per day, with a deployment every 25-50 km, and conduct four transects each year (see Figure 19).

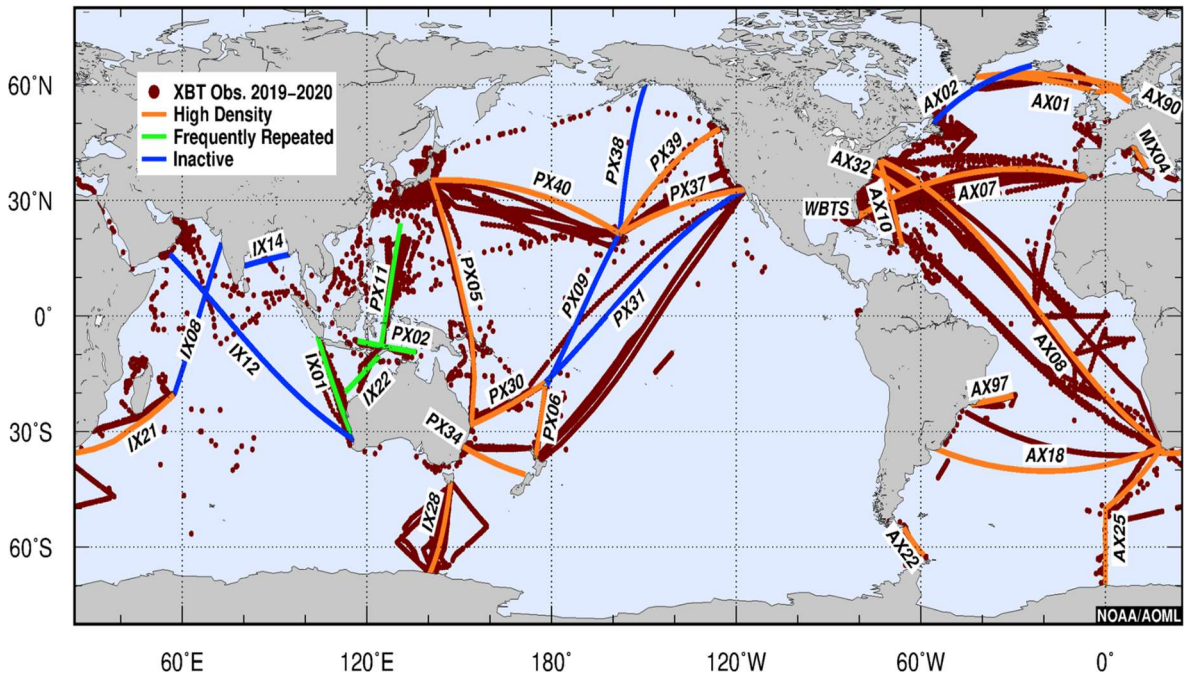

Figure 19 - XBT Network Status 2019 - 2021

Approximately 90% of the XBT data is transmitted, quality controlled and distributed in near real-time through the GTS and in many cases the data is being sent by the collecting institutions using BUFR format. XBT data is available from many different open access websites and data repositories, including:

- http://www.aoml.noaa.gov/phod/goos/xbtscience/data.php
- https://www.aoml.noaa.gov/phod/hdenxbt/
- http://www-hrx.ucsd.edu/index.html
- https://portal.aodn.org.au/

In addition, data can also be accessed via global datasets such as the World Ocean Database (NCEI) and the GTSPP (NCEI).

Dr. Bringas then addressed the TSG component of SOOP. TSG operations measure sea surface temperature (SST) and sea surface salinity (SSS) along ship tracks. Applications of TSG observations include the determination of boundary regions in ocean currents, climate and ocean dynamic research, providing input for climate and weather forecast models, and supporting efforts to establish a globally inventory of carbon dioxide in the ocean (pCO_2).

During the last two years approximately 80 ships have collected and reported more than 5 million TSG observations per year. 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. Figure 20 shows the global coverage of TSG observations since 2000.

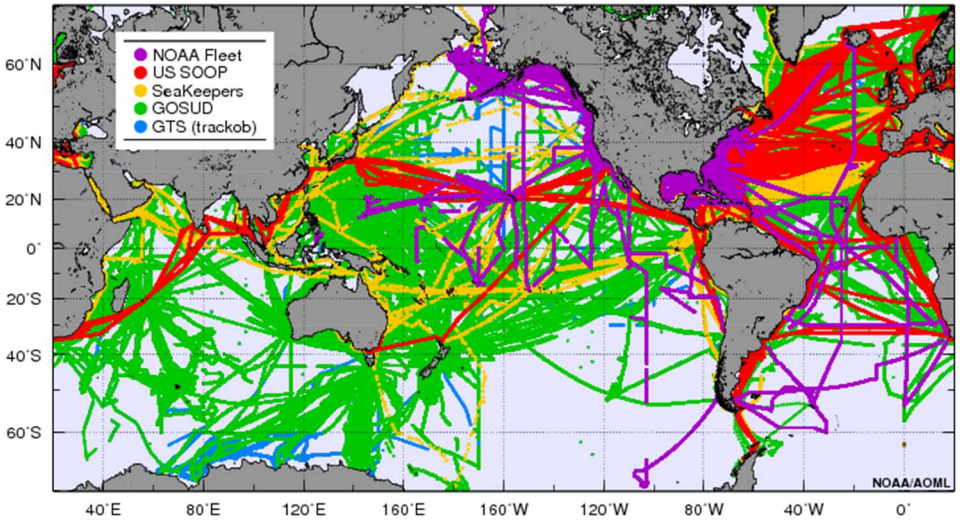

Figure 20 - Location of TSG observations conducted by the international community since 2000

TSG operations have been carried out for more than 20 years and are critical for understanding long-term changes in the marine environment. TSG observations are transmitted in real time and provide sea surface salinity measurements for satellite data validation at high latitudes and coastal areas where Argo floats are scarce.

Turning to pCO_2 operations Dr. Bringas reported these observations are carried out in order to:

- produce CO_2 data at sufficient accuracy to constrain sea-air CO_2 fluxes to 0.2PgC yr^{-1},
- facilitate capacity building through instrumentation and data reduction guidance to attain a global network of SOOP-CO_2, and
- create CO_2 flux maps and related data products.

This program is conducted by researchers in more than 15 countries, with observations collected globally, including at high latitudes. Every year hundreds of cruises are conducted to collect over one million observations.

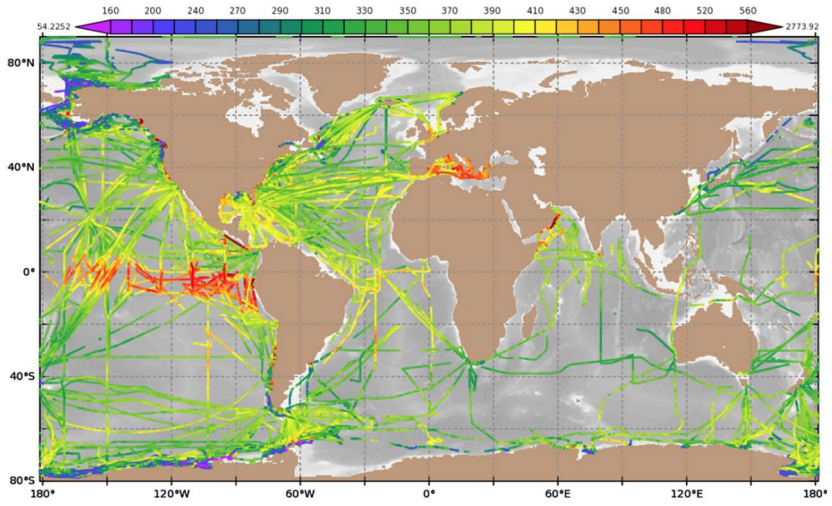

Figure 21 - Surface water pCO_2 along SOOP-CO_2 transects since 1990

In summary, Dr. Bringas highlighted the main accomplishments of the SOOP program during the intersessional period which included:

- Maintenance of 77% of recommended transects, despite recent restrictions;
- Collection of more than 12,000 XBT profiles (~10,000 along recommended transects), 1,000,000 pCO_2 and 500,000 TSG annual observations globally;
- Transmission of more than 90% of XBT profiles to the GTS in real time;
- Performing delayed time QC on XBT data for science applications;
- Recommendations from the XBT Science Team to the GTSPP and IQuOD projects;
- Supporting the deployment of other observational platforms, e.g., drifters and Argo floats;
- Continuing the active development of software for data collection and instruments for data collection and transmission (Iridium antennas, data recorders, automated weather stations);
- Continued use of XBT data in scientific and technical publications (more than 1800 since 2000);
- Continuing to review and update the maintained XBT transects, creating up to date maps and KPIs via OceanOPS;
- Ongoing review of the metadata formats and content supplied to OceanOPS yearly; and,
- Participation of the SOOPIP Chair and Vice-Chair in the OCG roundtable meetings.

However, during the intersessional period, the SOOP program had faced several challenges and difficulties, including:

- Severe restrictions in travel, ship, and facilities access since 2020, requiring 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, leading to challenges in adapting the design of existing networks to meet the new constraints and requirements;
- Work continues in GTS delivery in BUFR format, which is not complete for all agencies;
- Delivery of metadata to OceanOPS continues to be problematic for some agencies;
- Adoption of the SOT-ID scheme still to be completed; and,
- Reduction in support for some transects and for the XBT program overall.

Concluding his report Dr. Bringas drew members' attention to the future work plans for SOOP, which included:

- Continuing the application/development of new technologies for data acquisition and transmission;

- Continuing the development and maintenance of a flexible XBT data management system that meets all the community requirements for data dissemination and applications;
- Participating in projects to facilitate data distribution, such as the Open-GTS;
- Highlighting the importance of the SOOP network for science;
- Working with other ocean observing platforms and end users to enhance SOOP data usage;
- Reviewing the network regularly to meet needs of the community;
- Enhancing partnerships with other programs like Argo, drifting buoys, VOS, etc.;
- Seeking feedback from end users on the importance of SOOP data (e.g., for model assimilations); and,
- Continuing to work with the TSG, pCO_2 and CPR community in operational and data management efforts within those groups.

Actions:
A9.2.1./01 *– SOOPIP Chairs, in liaison with the Technical Coordinator, to create a SOOP Bibliography on the SOOP/SOT website (SOOPIP Chairs & TC; SOT-12).*

9.2.1.1 XBT Science Team: Updates and Recommendations

Dr. Shenfu Dong, AOML, reported on behalf of the XBT science team and expanded on the XBT overview previously reported by Dr. Bringas in the SOOPIP report. She reminded members that XBTs measure water temperature profiles from the sea surface to a maximum depth of 850 metres and that, on average, 20,000 XBTs are deployed each year.

The performance of the global XBT network was highlighted by the following statistics:

~10 collaborating countries are maintaining….>
~30 transects which monitor…..>
~20 ocean currents and have contributed…..>
>30 years of continuous records and contribute to….>
~100 publications per year.

In addition to the various uses of XBT data previously outlined by Dr. Bringas it was pointed out that XBT data has contributed to numerous PhD theses and to postdoc support. Dr. Dong also reiterated the impact of Covid on XBT operations and the resulting travel restrictions for ship-riders. As a consequence, some boundary transects are now done by ships crews in low resolution.

In partnership with shipping companies operating cargo vessels AOML has begun conducting continental shelf measurements of temperature profiles using XBTs along transects between the northeast of the US and Florida. They will provide temperature observations in regions where waters are currently undersampled and that are known to contribute to hurricane intensity changes.

Attention was drawn to several cases where XBT data had been used for scientific studies. These included:

- The 20+ year-round time series of simultaneous sADCP velocity and XBT measurements in Drake Passage enable computation of directly observed estimates of eddy heat fluxes *(SIO Ph.D. Student Manuel O. Gutierrez-Villanueva et al., 2020).*
- Sustained HR-XBT, Argo, and altimetry observations are combined to examine variability in subtropical Western Boundary Currents, e.g., Kuroshio, Agulhas, East Australian current: decadal changes related to PDO and long-term transport decrease *(SIO Ph.D. Student Mitchell Chandler -Zilberman, and Sprintall, in prep for JGR, 2021*).
- Variability in Western Boundary Currents: Significant correlation between Brazil Current transport and local coastal upwelling dominated by Ekman divergence (WEK). (Goes et al., 2019). The interannual variability of the Brazil Current between 25S and 35S is linked to the E-W propagating modes in the South Atlantic. The variability of the Brazil

Current transport has been linked to regional rainfall patterns of southeast Brazil *(Majumder et al., 2019).*
- Meridional Overturning Circulation and Meridional Heat Transport estimates from XBT and in-situ/satellite observations, long and short-term trends *(Dong et al., 2021).*
- Southern Ocean temperature trends *(Auger et al., 2021)*.

Concluding her presentation Dr. Dong pointed to the following recommendations made by Goni et al., 2019 in the OceanOPS paper for the XBT Science Team:

- Maintenance of long climate record.
- Improvement of data quality: allowing for better monitoring and analysis of climate change and variability.
- Simultaneous meteorological and oceanographic observations to calculate surface heat and moisture fluxes, which are critical for weather and climate research.
- Submesoscale (<10 km) ocean dynamics: increasing spatial sampling along selected portions of XBT transects.
- Internal tides: to help validate the altimetric internal tide observations, as well as ocean models including internal tides.
- Applications for sea level change and hurricane studies.

9.2.1.2 XBT Best Practices: Progress and call for contributions

Ms. Justine Parks, Vice Chair of the SOOPIP reminded members that one of the drivers for the development of best practices is in the SOOPIP Terms of Reference, which calls on the Panel to '*coordinate the exchange of recommended practices, and technical and developmental information about oceanographic instrumentation, relevant to the SOOPIP'.*

Ms. Parks reported that, in cooperation with Prof. Juliet Hermes, Ms. Tamaryn Morris, Ms. Mardené DeVilliers, and Mr. Joel Cabrie, a bibliography of existing SOT/SOOP best practices had been compiled on an internal shared drive for reference purposes, and to pinpoint where work is completed, or needed. In this regard she informed members that she had written a document entitled *'XBT Deployment Best Practices for Quality Assurance'* which is now in editorial review by some members of SOOPIP. An Australian collaborative "cookbook" for XBT Delayed Mode Quality Control is also in process. An XBT-specific Metadata Content and Format document is also needed and should be written as the testing phase for the OceanOPS metadata template progresses this year.

For pCO_2 best practices there is a NOAA Technical Report by Pierrot and Steinhoff, 2019 entitled '*Installation of Autonomous Underway pCO_2 Instruments Onboard Ships of Opportunity'.* This is located in the Ocean Best Practices System Repository (OBPS-R)[44] and will probably go forward for endorsement.

For TSG there is a best practice written for SOOPIP in 1999 and included in the GO-SHIP manual on '*Procedures to adjust underway thermosalinograph and oxygen measurements for surface CTD/O2 values for Go-Ship cruise's'.* This document likely needs updating. A newer draft is available from Mr. Rik Wanninkhof, but this newer, draft document may need updating as well. For CPR it is understood that Mr. David Johns may be working on a best practices draft.

Members noted that Ms. Parks is also spearheading the writing of best practices for SOT Vessel Recruitment and On-Board Conduct. She suggested that it should be non-specific to any measurement parameters and help avoid any pitfalls that might jeopardise the critical relationship with operators and crews of Voluntary Observing Ships or Ships of Opportunity.

The SOT website needs updating to create an easy to find directory of best practices. In this respect Prof. Juliet Hermes advised that she had developed a standard preface text for inclusion on such websites (see agenda item 13.1). Ms. Parks suggested that it may be best to have a

[44] https://repository.oceanbestpractices.org/discover

single location for all of SOT best practices, perhaps formatted like the Table of Contents used in the GO-SHIP manual, but also the individual network sites should link to it. For maximal discoverability, all SOT related S&BP should however also be stored in the OBPS Repository[45] and should be GOOS endorsed.

There are many resources available to assist the community in assembling and writing best practices. These include

- Towards a Best Practice for Developing Best Practices in Ocean Observation (BP4BP): Supporting Methodological Evolution through Actionable Documentation[46]
- Best Practices Document Template: Sensors (2021)[47]
- GOOS Best Practices Endorsement Process[48]

Member's attention was also drawn to the forthcoming Fifth Community Workshop of the IOC-UNESCO Ocean Best Practices System (20-24 September 2021).

Actions:

A9.2.1.2/01 *– SOOPIP Chairs, in liaison with Technical Coordinator, to flesh-out SOT/SOOP website. (SOOPIP Chairs & TC; Start 2022 -Complete before SOT-12).*

A9.2.1.2/02 *– In liaison with SOT-EB agree the format for presenting standards and best practices on the SOT/SOOP website. Consider a Table of Contents document with standardized formatting for each chapter (similar to the GO-SHIP hydrography manual). (SOT-EB, SOOPIP Chairs/Members; SOT-12).*

A9.2.1.2/03 *– Complete "XBT Observational Best Practices for Quality Assurance" and post on https://www.oceanbestpractices.org/ with GOOS endorsement. (Justine Parks; By end 2021).*

A9.2.1.2/04 *– Continue to promote completion of S&BPs for all measurement parameters under SOOP umbrella, including posting on https://www.oceanbestpractices.org/ with GOOS endorsement, especially for pCO_2, TSG and CPR. (SOOPIP Chairs/members; Significant progress by SOT-12).*

A9.2.1.2/05 *– Work with the SOT community to complete "SOT Vessel Recruitment and on-Board Conduct" and post on https://www.oceanbestpractices.org/ with GOOS endorsement. (SOOPIP with interested SOT-EC members, TT-RPT; complete by end of 2022).*

A9.2.1.2/06 *– Continue testing and implementation of ship and platform metadata templates leading to best practices document's specific to each measurement parameter. (The first will be "XBT Metadata Content and Format" because it is closest to finalization, but expand this for pCO_2, TSG, and CPR). (SOOPIP with TC; by SOT-12).*

9.2.1.3 Environmental Stewardship: XBT Environmental Impact

Mr. Christian Saiz reported on an assessment undertaken to investigate the impact that XBT deployments have on the environment. A global average of more than 16,000 probes were deployed during the last five years and with each probe having total mass of almost 900g these deployments resulted in almost 15 metric tons of materials per year into the ocean. The probes are mainly constructed of zinc, copper, ABS plastic and aluminium (see Figure 22), with zinc being the main component (61%) followed by copper (20.3%) and plastic (15.6%). Based on

[45] https://repository.oceanbestpractices.org/
[46] https://repository.oceanbestpractices.org/bitstream/handle/11329/1266/mg-84_e3.pdf?sequence=4&isAllowed=y
[47] https://repository.oceanbestpractices.org/bitstream/handle/11329/1243/Sensors%20Best%20Practices%20Document%20Template_Version_2021804.pdf?sequence=5
[48] https://repository.oceanbestpractices.org/handle/11329/1423

the average number of deployments the minimum natural concentrations of each component in the open ocean can be calculated.

Based on deep water corrosion rates the heaviest part of the probe (the zinc alloy nose) would take ~330 years to decompose and dissolve, whereas the copper wire would take ~ 3 years and the plastic anything between 100 and 1300 years. Consideration was also given to the toxicity and following the U.S. Environmental Protection Agency standards it was estimated that, in the worst-case scenario, it would take more than 225 million years of XBT operations to reach dangerous concentrations.

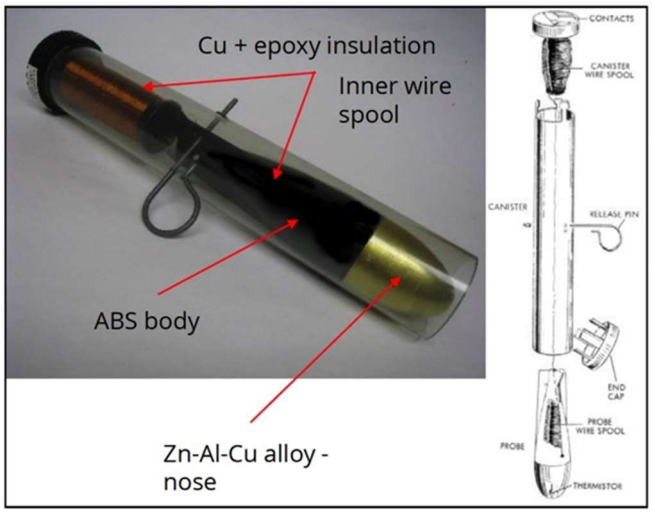

Figure 22 – XBT Probe Material Components

Natural and anthropogenic annual fluxes of the same materials showed that the XBTs have an insignificant impact on the environment, requiring from 4,560 years (for zinc) to more than 688 million years (for aluminium) of XBT operations to match those flux quantities. Other pollution sources such as marine coatings and fishing gear have a much greater impact on marine life.

The assessment also calculated the CO_2 emissions generated by each of the materials used in the production of probes relative to other sources of CO_2. This showed that the total CO_2 emissions for 16,500 probes produced each year would equate to the emissions from nine passenger cars/year or to the emissions of an average container ship travelling 40 kilometers. Compared to other platforms such as Argo floats, XBTs currently generate slightly less material input (78%) into the ocean, while the CO_2 production emissions are considerably less (25%). Moreover, they don't release lead, lithium, or anti-fouling materials such as Tributyltin oxide (TBTO).

The study also calculated values at other sources of marine pollution such as cigarette filters, aluminium cans, plastic bottles and caps, ship coatings and shipwreck and considered that the scientific value of the deployed XBTs outweighed the fact that the materials are lost.

The assessment concluded, inter alia, that XBT materials don't represent any significant hazard to the marine environment and will remain on the seabed with minimum interaction with surface marine life, and relative to other sources their impact is far too small to be considered a risk or a greater issue than other human activities in the ocean.
It was recognised that this information would be of great value to present to ship riders, ship officers and captains as evidence that the pollution hazard presented by XBTs is extremely small. It was further suggested that such information should be included in an infographic to take on board deployment vessels.

Actions:

A9.2.1.3/01 – *Create an XBT environmental impact pamphlet, and make available via the SOOP website to communities and especially vessel Masters deploying XBT's. (SOOPIP, TT-RPT, TC; complete by mid-2022).*

9.2.1.4 pCO_2 Operations Status Report

Mr. Denis Pierrot reported on the status of the SOOP pCO_2 program which is the largest ship of opportunity pCO_2 measurement campaign in the world. It is funded by the NOAA Global Ocean Monitoring and Observing Program (GOMO) and is a partnership of five institutions. Its goal is to constrain the flux of CO_2 across the air-water interface to within 20% on regional and seasonal scales to provide meaningful projections of future atmospheric CO_2 levels and surface oceanic CO_2 concentrations.

It is comprised of 15 ships of opportunity with automated CO_2 systems during 2020 and usually collects ~750,000 data points every year. Types of vessels used range from research vessels to cargo ships and cruise ships. The system comprising a dry and wet box is usually installed in the ships engine room and data is transmitted via a dedicated Iridium/GPS deck box. Coverage of the oceans has been inconsistent from year to year particularly in the Pacific, and some important routes have also been lost in the Atlantic.

The COVID-19 pandemic halted nearly all ship traffic and as a consequence the number of data points fell by 50%, from 760,000 in 2019 to 360,000 in 2020. Whilst research vessels recovered quickly, and allowed the program to collect data again, the cruise ships are still not operational and cargo ships are still very hard to access. One of the major issues the program encounters is the low ship recruitment rate, and finding vessels on routes of interest is very difficult for many reasons.

The program is going through a forced re-design of the underway system due to the retirement of the previous CO_2 analyzer. The new improved system design will be on the market soon, will require less frequent calibrations, and will incorporate a high precision, laser-based gas analyser that uses optical feedback to measure gases in the air.

The main issues for the program are:

- Data losses due to lack of access to ships;
- Increased system failures in hot engine room environments;
- Data losses due to lack of support on some ships, notably cargo ships; and,
- Ship recruitment.

The program foresees an increased importance of ship-based measurements due to increased requirements for ground truthing of new alternate technologies and biogeochemical models, etc. There is also likely to be an increased need to improve the constraint of the CO_2 flux in the global carbon cycle and the need to improve measurements, temporal, and spatial coverage to assess carbon dioxide removal (CDR), the efficacy of which will need to be assessed.

Actions:

A9.2.1.4/01 *– Work with the pCO_2 network to recruit more vessels to have underway pCO_2 systems. (SOOPIP Chairs/ members; Ongoing).*

9.2.1.5 CPR Operations Status Report

Ms. Tamaryn Morris presented the status report on behalf of Mr. David Johns, who could not be present due to the CPR community celebrating its 90th anniversary.

CPR Survey operations have continued throughout the COVID-19 pandemic, and during the first six months of 2021 there were 222 routes operated collecting 4500 samples with no significant issues. The samples collected in 2019 were subject to slight delays due to COVID lab restrictions. However, these are picking up now with most countries allowing access to labs again.

CPR[49] data continues to be used extensively in developing UK and EU marine policy and a Guinness World Record was awarded for the greatest distance sampled by a marine survey (over 7 million miles).[50]

CPR tows take place in the north Atlantic, north Pacific, around Australia and into the Southern Ocean and south of South Africa. With respect to tow routes the following information was noted:

- The Gulf of Maine route has successfully restarted, and discussions are taking place with NOAA to restart a second route.
- A new route from South Africa to Brazil should be towing recorders in late October as part of the AtlantECO Project[51].
- The new route around Alaska into the Arctic is now sampling for the fourth consecutive summer.
- In the Southern Ocean the Australian Antarctic Division was only able to tow on a single voyage during 2020/21 due to COVID and shipping constraints.
- January, 2021 marked the 30th anniversary of the *'Aurora Australis'* deploying its first CPR.
- The South African CPR program conducted an annual tow between Cape Town and Marion Island (April, 2021) and between Cape Town and Antarctica (December, 2020 / January, 2021).

A *"Report on the Status and Trends of Southern Ocean Zooplankton"* based on the SCAR SO-CPR Survey was published as a bulletin in June, 2021.[52] This substantial bulletin brings together all the information and highlights achievements over nearly 30 years of SO-CPR dataset analyses.

A paper looking at Bergmann's rule using global copepod data collected through the Global Alliance of CPR Surveys[53] was also published this year (Campbell et al, 2021). Supporting Bergmann's rule, the authors found temperature better predicted size than did latitude, or oxygen, with body size decreasing by 43.9% across the temperature range (-1.7 to 30ºC). Body size also decreased by 26.9% across the range in food availability. The results provide strong support for Bergmann's rule in copepods but emphasises the importance of other drivers in modifying this pattern. As the world warms, smaller copepod species are likely to emerge as 'winners', potentially reducing rates of fisheries production and carbon sequestration.

9.2.1.6 Other Relevant SOOP Topics and Recommendations

Although no further topics were raised some members questioned the status of the Global Ocean Surface Underway Data (GOSUD) within the SOT framework. In this regard it was recalled that whilst GOSUD currently remains an IODE project it had been recommended that it should establish a closer relationship with, and report to both, OCG and SOT. (SOT-10, agenda item 7.5 referred).

The work of SOOPIP during the forthcoming intersessional period will predominantly be focused on continuing to adapt operations to the impacts of the COVID-19 pandemic and then recovering from those impacts. Another major focus will be on creating standards and best practices relevant to the network.

[49] https://www.cprsurvey.org/services/the-continuous-plankton-recorder/
[50] https://www.mba.ac.uk/blog/continuous-plankton-recorder-survey-goes-distance-win-guinness-world-record
[51] https://www.atlanteco.eu/
[52] https://www.scar.org/scar-library/reports-and-bulletins/scar-bulletins/5672-scar-bulletin-206/
[53] http://www.globalcpr.org/

10. EXECUTIVE BOARD STATUS

Mr. Figurskey, SOT Chair, reported that the Executive Board was undergoing a period of transition with the SOT Vice Chair Dr. David Berry (United Kingdom), the SOOPIP Chair Dr. Rebecca Cowley (Australia), and the SOOPIP Vice Chair Dr. Gustavo Goni (United States), leaving their positions. The Team recorded its gratitude to all of them for their years of service, their commitment to science and observations, and their friendship.

It was further noted that VOS Vice Chair, Mr. Sai-Tick Chan (Hong Kong, China), will also be departing his current position at the end of the calendar year and that a change in his position will take him away from his role in SOT and the EB. The Team recalled the leadership role and hospitality shown by Mr. Chan, and all representatives of the Hong Kong Observatory, at the SOT-10 session. On behalf of the SOT members, Mr. Figurskey thanked him for his service and wished him well for the future.

Volunteers for the vacated Executive Board positions included Dr. Elizabeth Kent (United Kingdom) as the SOT Vice Chair, and the following representatives of the SOOPIP: Ms Tamaryn Morris (South Africa) and Dr. Francis Bringas (United States) as co-Chairs; and Ms. Justine Parks (United States) as Vice Chair. The volunteers for the Chairs of the SOOPIP have already been performing executive functions on an interim basis, and their passion and enthusiasm for the SOT mission have been exemplary.

Accordingly, the Team was invited to approve the following slate of volunteers for the SOT EB during the next intersessional period and, as per the SOT EB Terms of Reference, for one term:

- **SOT**
  - Mr. Darin Figurskey, Chair (United States)
  - Dr. Elizabeth Kent, Vice Chair (United Kingdom).

- **VOS Panel**
  - Mr. Henry Kleta, Chair (Germany)
  - vacant, Vice Chair.

- **SOOP Panel**
  - Dr. Tamaryn Morris, co-Chair, Logistics and Development (South Africa)
  - Dr. Francis Bringas, co-Chair, Data Management (United States)
  - Ms. Justine Parks, Vice Chair (United States)

- **ASAP Panel** (section 10.3 refers)
  - Mr. Rudolf Krockauer, Chair (Germany)
  - Mr. Henry Kleta, Vice Chair (Germany)

In addition, the SOT EB will also include the following members:

- WMO Secretariat, Mr. Dominique Berod
- IOC Secretariat, Ms. Emma Heslop
- SOT Technical Coordinator, Mr. Martin Kramp

The Team approved the Executive Board nominees listed above, and members were requested to support them during the coming term.

Reflecting decisions regarding SOT task team membership made during the session, the leadership of the SOT task teams established for the coming intersessional period will be as follows:

- **TT-Recruitment, Promotion, and Training (TT-RPT)**
  - Mr. Joel Cabrie, Chair (Australia)
  - Ms. Mardené DeVilliers, Vice Chair (South Africa)

- **TT-Instrument Standards and Satellite Communications Systems (TT-ISSC)**
  - Mr. Jean-Baptiste Cohuet, Chair (France)

- **TT-Metadata**
  - Ms. Emma Steventon, Chair (United Kingdom) (*currently on secondment*)
  - Vice Chair: Vacant

- **TT-Key Performance Indicators (TT-KPI)**
  - Dr. Elizabeth Kent, Chair (United Kingdom)

- **TT-Expansion of Independent Class Observations (TT-EICO)**
  - Mr. Darin Figurskey, SOT Chair, Chair (United States)

- **Ad hoc Task Team on VOS Delayed Mode Data (TT-VOS-DMD)**
  - Mr. Axel Andersson, Chair (Germany)
  - Vice-Chair: Vacant

SOT members were asked to consider supporting the task teams through their time and talents. Currently, many of the SOT EC are the active members of multiple task teams. To help ensure SOT activities retain momentum and benefit from the skills of a diverse, global community, more active members are necessary.

The Team also agreed the Terms of Reference for the SOT Panels task teams, subject to final approval by the SOT Executive Board and Executive Committee at its meeting on 26 October 2021, attached at **Annex IV.**

Actions:

A10.0/01 *– Approval of the volunteers for membership of the SOT EB, and the current members of the SOT EB that wish to remain as members of the SOT EB, for term one (as per the SOT EB Terms of Reference) (SOT; SOT-11).*

A10.0/02 *– Approve revised Terms of Reference for all SOT Task Teams and Panels, and notify OCG as necessary (SOT & SOT EB; October 2021).*

10.1 SOT Financial Report

Mr. Figurskey, SOT Chair, began by thanking Ms. Champika Gallage, WMO Secretariat, for her work in compiling the necessary information for inclusion in the financial report. The Team noted that funds related to SOT Panel activities are derived from the following Trust Funds (TF) managed by WMO:

- The JCOMM/WHOI Trust Funds to manage the contributions received from NOAA (WHOI-TF);
- The ASAP Trust Fund (ASAP-TF); and,
- The DBCP Trust Fund (DBCP-TF).

Copies of the financial statements for each of these Trust funds are at **Annex VIII**.

Funds received from NOAA are managed in the JCOMM TF and the WHOI TF which are primarily used for OceanOPS staff salaries and the IT services of OceanOPS according to the donor instructions. The JCOMM TF was closed with the expiration of the 5-year funding agreement on 30 June 2020. The WHOI TF was established to receive funds from the NOAA funding agreement established for the period 7/1/2019 to 6/30/2021.

The ASAP-TF consisted of money owed to the Bureau of Meteorology (BoM) following the termination of the Worldwide Recurring ASAP Project (WRAP). The Team recalled the conditions proposed by SOT-5[54] regarding the use of the remaining funds within the ASAP Trust Fund (i.e., SOT-5 final report, paragraphs I-7.2.3.4 and I-7.2.3.5). As agreed at the SOT-8, the control of the ASAP-TF spending is with the SOT Focal Point for the BoM. This TF has been dormant for several years. To reduce the maintenance burden of an additional TF, the Australian BoM Focal Point (Mr. Joel Cabrie) approved to transfer all funds in ASAP-TF (CHF 12,906) to the DBCP TF SOT project line for pure SOT activities and granted spending authority to SOT Chair. Accordingly, the funds were transferred, and the ASAP-TF was closed in 2021.

The DBCP-TF was first established over 30 years ago, to support the activities of the DBCP Panel, and is managed by the DBCP Panel. Over the years the DBCP-TF has evolved into a multi-user trust fund providing space for other Panels/Groups (i.e., DBCP, SOT, OceanOPS, OceanSITES, etc.) within the Observation Coordination Group (OCG), primarily to benefit from its lower service charge (3%). At the DBCP-33 (Brest, France, October, 2017) meeting, where all the funders were present, the DBCP Panel agreed to distribute its funding management responsibilities to individual Panels. Accordingly, SOT Chair on behalf of the SOT Panel has the spending authority over the SOT Project line of the DBCP TF starting from 2018.

The DBCP TF receives contributions for activities of the DBCP, SOT, OceanOPS and the WMO. At DBCP-33[55], the Panel also agreed that contributors to the trust fund should identify how their contributions should be distributed among the DBCP, SOT, OceanOPS and WMO projects. If no instruction is given by the funder, contributions will be made to the general operation of OceanOPS, DBCP, and SOT at the following ratios: OceanOPS 61%, DBCP 31%, and SOT 8%. This was determined based on previous years' spending behaviours. This decision was implemented as of January, 2018.

Regular contributions to the DBCP-TF and the distribution of funds among different programmes are detailed in Table 2. As indicated in the table, from the regular contributions received from seven donors, SOT receives approximately 14,000 US$ per year for pure SOT activities. Travel of SOT Technical Coordinator (TC) is covered under OceanOPS project funds in the DBCP-TF, while SOT TC salaries are covered in the WHOI TF. The OceanOPS financial report is available at:

https://goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=28462

Two DBCP TF statements are included in **Annex VIII** - the final statement for 2020 detailing the spending information for each project, including SOT; and, an interim statement as of 15 July 2021, which details the balance available for each project, including the SOT.

[54] https://oceanexpert.org/document/3830
[55] https://oceanexpert.org/document/21365

Table 2: Summary of National Contributions and distribution among the programmes

Contributor	In Currency of Payment	In US$ (as of 02/07/2021)	Total contribution towards OceanOPS	Total contribution towards DBCP	Total contribution towards SOT
		Estimate	Estimate	Estimate	Estimate
E-SURFMAR	€55,000	65,032	42,552	9,755	9,755
Meteorological Services of New Zealand	€1,800	2,128	1,298	660	170
Environment and Climate Change Canada	CAD$ 34,000	27,390	16,708	8,491	2,191
Bureau of Meteorology, Australia	€11,700	13,834	8,439	4,289	1,107
National Institute of Ocean Technology, India	US$5,000	5,000	3,050	1,550	400
South African Weather Service (SAWS)	€4,000	4,730	2,885	1,466	378
BSH, Germany	€3,600	4,257	2,597	1,320	341
Totals		**122,371**	**80,499**	**27,530**	**14,342**

Note:
Except for E-SURFMAR all other contributions are distributed at the ratios; OceanOPS 61%, DBCP 31%, and SOT 8%. E-SURFMAR ratios for distribution are OceanOPS 70%, DBCP 15%, and SOT 15%.

Table 3 below indicates the estimated budget approved by the SOT EB for the 2021. (excluding support cost)

Table 3:

SOT– Item Description	Estimated budget for 2021 (US$)
SOT - General Activity	$8,000
Capacity Development	$20,000
SOT Chair and Other Travel	$5,000
Other	$5,000
Total	**$38,000**

The SOT Chair explained that future SOT spending will have a near-term focus on capacity development initiatives for nation or nations, depending on available funds, dedicated to developing and sustaining a new VOS network or networks. Some financial support would also be given to OceanOPS for essential web work.

Table 4 shows the estimated SOT budget approved by the SOT EB for 2021, and the estimated budget for the coming intersessional period (excluding support costs).

Table 4:

SOT– Item Description	2021 (US$)	2022 (US$)	2023 (US$)
SOT - General Activity	$8,000	$3,000	$3,000
Capacity Development	$20,000	$5,000	$5,000
SOT Chair and Other Travel	$5,000	$5,000	$5,000
Other	$5,000	$1,000	$1,000
Total	**$38,000**	**$14,000**	**$14,000**

Following a request from the SOT Chair, the Team approved the estimated SOT budget shown in Table 4 above with no objections.

The SOT Chair concluded his presentation by drawing the Team's attention to the OceanOPS budget and to the level of support that the OceanOPS team gives to OCG (including SOT) activities and networks. The target SOT network contributions by SOT to OceanOPS amounts to approximately 116k$ each year. Considering the regular contributions by SOT and Eumetnet/E-Surfmar (~79k$), and the planned contribution to dedicated web development (8k$), there remained a funding gap of approximately 30k$.

Recognising SOT contributions were made by relatively few members the SOT Chair suggested that there was a need to diversify the current national contributions. He therefore invited all SOT members to talk to their national permanent representatives, or funders, to see if they might be able to make a contribution, no matter how modest, to help support the ongoing work of OceanOPS.

Actions:

A10.1/01 – *Approval of the SOT financial report estimated budget (excluding support cost) for next intersessional period. (SOT; SOT11).*

A10.1/02 – *Members to consider contributing to the DBCP-TF towards SOT activities (SOT Members, & Permanent Representatives: Ongoing).*

10.2 SOT Implementation Strategy

Following SOT-10, the SOT codified its Executive Board Terms of Reference[56] and the SOT Implementation Strategy, version 2.0. One of the overarching SOT mission statements in the implementation strategy is '*the promotion of the free and unrestricted exchange of quality ship-based weather and ocean observations for a better understanding and prediction of the marine environment and to support safety of life at sea'*.

[56] https://www.goosocean.org/index.php?option=com_oe&task=viewGroupRecord&groupID=156

Also included in the implementation strategy are Terms of Reference for the SOT, SOT EB, VOSP and SOOPIP. The SOT EB Terms of Reference stipulates that the term for SOT EB members is 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.

The Team noted that a further update to the implementation strategy, version 2.1, had now been completed. This new version removes references JCOMM and JCOMMOPS necessitated by WMO Technical Commission restructuring, updated internet links, adds references to WMO Technical Commissions, and includes other miscellaneous updates and wording changes.

The SOT Chair thanked the SOT Executive Committee for its input into this latest version and suggested that it should serve the SOT well as it executes its activities during the next intersessional period and beyond. However, members noted that some additional comments on the latest draft of the strategy had been received from OCG just prior to the meeting. With these in mind the SOT, under the leadership of the new SOT EB, it is planned to further review and refine the implementation strategy with a view to it becoming an even more strategic document, to be labelled version 3, by SOT-12.

With respect to paragraph 5.2 of the Implementation Strategy it was noted that JCOMM Technical Report No. 72 "An Oceanographer's and Marine Meteorologist's Cookbook for Submitting Data and Metadata in Realtime and Delayed-Mode", contained some outdated references and needed updating. It was agreed that this document should be updated prior to it being referenced in the next version 3 of the implementation strategy, and that SOT should coordinate closely with OCG on future revisions.

The Team approved the updated version 2.1 of the SOT Implementation Strategy, which will be added to the SOT website in due course (action A14.1.1/01 refers). A copy of the approved version 2.1 is at **Annex IX.** (Note- this version also includes the revised Terms of Reference for the ASAP Panel agreed following discussions on agenda item 10.3).

Actions:

A10.2/01 – *Approval of the SOT Implementation Strategy, Version 2.1 (SOT; SOT-11).*

A10.2/02 – *Review and further refine the SOT Implementation Strategy as an even more strategic document, to be labelled version 3 (SOT EB/SOT Members; by SOT-12).*

A10.2/03 *– Coordinate with the Observations Coordination Group for the update of "An Oceanographer's and Marine Meteorologist's Cookbook for Submitting Data and Metadata in Realtime and Delayed-Mode" (OCG / SOT; Complete by SOT-12).*

10.3 SOT-ASAP: From Task Team to Panel?

Recalling previous discussions within the SOT Executive Board, Mr. Henry Kleta invited the Team to consider the Executive Board's proposal to reinstate ASAP as a fully independent panel under the SOT umbrella, i.e., together with SOOP and VOS. The decision to demote the ASAP Panel to a task team had been made in 2004, in response to changes in the management and operation of shipborne upper-air networks at the time. However, ASAP continues to be an independent upper-air observing network that compliments the surface and sub-surface observing networks of the VOS and SOOP programs.

The Team was invited to consider Terms of Reference for the proposed new ASAP Panel. These were largely unchanged from the ToRs for the current task team, although it was recognised that further consideration and refinement may be needed by the SOT Executive Board, and the OCG may need to be advised accordingly. The positions of Chair and Vice Chair for the proposed new Panel would be unchanged (i.e., Mr. Rudolf Krockauer and Mr. Henry Kleta, respectively).

No objections were raised to the proposed change in ASAP status and, accordingly, the Team agreed the following action:

Action:

A10.3/01 – Recognise ASAP as a separate SOT Panel and approve changing the ASAP Task Team into an SOT Panel with appropriate new Terms of Reference (SOT EB & OCG November, 2021).

11. OCEAN DECADE

11.1 Discussion of UN Decade of Ocean Science for Sustainable Development

The UN Ocean Decade of Ocean Science for Sustainable Development ("Ocean Decade") provides an opportunity for engagement in, and the promotion of, projects and programmes supporting expansion of observations for healthy, predictable, and safe oceans.

Dr. Ann-Christine Zinkann (United States), International Ocean Liaison, Oceanic and Atmospheric Research, NOAA, presented a report detailing recent developments arising from the Ocean Decade and reminded members that there was a first call out in October, 2020 for Ocean Decade programmes. She explained that a "Decade Action" is a shared global effort that builds on previous accomplishments in ocean science.

Decade Actions fall into four distinct tiers – Programmes, Projects, Activities, and Contributions – which are aimed at creating new collaborations across disciplines, geographies, and generations, and/or provide a new source of support. Decade Programmes can be global or regional in scale and tend to be longer-term (multiyear) initiatives, while Decade Projects are more short-term, focussed initiatives that typically contribute to the broader Decade Programmes. A Decade Activity is typically a one-off stand-alone activity while a Decade Contribution supports the Ocean Decade by provision of in-kind or financial support.

In response to the call, more than 240 actions for endorsement from 53 countries had been received by January, 2021. Following review by the IOC secretariat the first 60+ programmes were endorsed in June, 2021 and were announced at an international launch event. Another call out is expected in September/October, although it is not clear at present whether this will focus on programmes or projects. Details of endorsed Decade Actions are available at:

https://www.oceandecade.org/resource/166/Announcement-of-the-results-of-the-first-endorsed-Decade-Actions-following-Call-for-Decade-Actions-No-012020

Dr. Zinkann highlighted some of the United States' submissions (from NOAA, NASA, NSF, the Smithsonian, etc.) that had already been endorsed.

Attention was also drawn to the Ocean Decade Laboratories which are creative, interactive platforms for supporting Ocean Decade action around the globe. Each laboratory is a self-contained event focusing on one of the seven outcomes of the Ocean Decade and allows participants to leverage the opportunity for exchange, collaboration, and the creation of suitable partnerships. In addition, each laboratory consists of two parts – a core event organised by the first international Ocean Decade Conference, and a range of satellite activities hosted by stakeholders. Further details on how to participate are available at:

https://www.oceandecade-conference.com/en/ocean-decade-laboratories.html

and a timeline for the seven laboratory outcomes is given in Figure 23 below.

Figure 23 - Timeline for Ocean Decade Laboratory programs

The Team noted that satellite activities[57] can also be proposed by any institution interested in engaging in the Ocean Decade and, in this respect, Mr. Figurskey drew particular attention to the "Open Access to the GTS" project satellite activity listed at https://www.oceandecade-conference.com/en/satellite-activities.html which aims to significantly increase the volume of near-real-time data that is exchanged globally, thereby improving forecasts (agenda item 7 also referred). He explained that the Open-GTS project was hoping to latch onto other larger programmes with similar goals. The satellite event would take place on 16/17 September and Mr. Kevin O'Brien, as the project manager for the Open-GTS activity, would be participating and providing detail on how the system works.

11.2 OceanOPS "Odyssey" Program Submission

The SOT Technical Coordinator, Mr. Martin Kramp, reported on the OceanOPS "Odyssey" UN Ocean Decade application.

Recent successes with third party initiatives (e.g., the Sailing4Science ocean racing community; commitment of Fugro in GOOS and Seabed 2030 efforts; Kongsberg trials with ship management systems; and, the Ponant tourist cruise ship/icebreaker with underway equipment) revealed the need for better coordination, standardised best practices and a harmonised approach with a single point of contact. Furthermore, they offered significant potential for outreach to the broader public, as well as the possibility of stimulating shipping companies to become involved.

With such initiatives in mind, OceanOPS had made a submission for an Ocean Decade umbrella project for citizen science/private sector initiatives. The submission was initially for a programme application, but it was subsequently recognised that it should be a project falling under one of the wider GOOS programme applications.

[57] https://www.oceandecade-conference.com/files/A%20Predicted%20Ocean_Program_Satellite_Activities.pdf

The OceanOPS submission was established together with the GOOS co-Chair Mr. Toste Tanhua (Germany) and the OCG data Vice-Chair Mr. Kevin O'Brien (United States), and has the following goals:

- Transform the GOOS: Complement existing networks and operators with third party contributors;
- More data with increased number of instruments, observations, ships, and data coverage;
- Alternative funding of instruments and ship time;
- Innovative and harmonized data streams and formats (including Open-GTS, netCDF);
- Standards/OBP for citizen science/private sector participants on alternative vessels/platforms;
- Single point of contact, efficient coordination; and,
- Advocacy and outreach of ocean science, solutions and observing.

Mr. Kramp advised that a small steering committee would be needed to guide the project and a dedicated dashboard/website would be needed together with a brochure, and communication plan. He also drew the Teams attention to a proposed draft *Odyssey* certificate that could encompass a broader OCG certificate.

This proposed certificate would recognise different levels of appreciation depending on the scope of activities related to marine data collection undertaken on board, and could possibly be in the form of bronze/silver/gold stars or medals to encourage increasing levels of participation. The certificates could also be issued for a year of participation to further encourage repeat participation and would be generated and monitored through the OceanOPS GUI.

It was recommended that the task team on recruitment, promotion and training (TT-RPT) should be involved in this work, and that there should be connections at the higher OCG levels due to the potential to involve other GOOS networks and panels.

Dr. Heslop supported the submission and questioned whether there would be value in OceanOPS hosting a workshop involving other parts of OCG in order to help progress the project and to help source GOOS funding.

Action:

A11.2/01 – *Exploit synergies with the Odyssey project (TT-RPT; SOT 12).*

12. CAPACITY DEVELOPMENT

As a capacity building effort to encourage the development of new national VOS networks, the SOT is calling for expressions of interest from the National Meteorological and Hydrological Services (NMHSs) to be recipients of the VOS Donation Program. The pilot program aims to provide selected groups with one or more digital barometer and GPS units to be interfaced with Turbowin+ as a semi-automated weather station for use on a VOS for an initial period of one year. The program will be dependent on the availability of funds.

Guidance and training will be provided by the SOT for the duration of the capacity building effort to assist the recipients to implement the systems successfully. Once the capacity building effort is concluded, and the recipient has demonstrated that the equipment has been deployed successfully, it is expected that the recipient will then take responsibility for maintaining and operating the assets. Further discussion on the VOS donation programme took place during agenda item 12.1 below.

12.1 Report of the Task Team on Recruitment, Promotion, and Training (TT-RPT)

The Chair of the Task Team on Recruitment, Promotion & Training (TT-RPT), Mr. Joel Cabrie (Australia), reported the activities and progress of the task team during the intersessional period. During the last intersessional period, the task team had implemented two major capacity development initiatives, namely delivery of the Sixth International PMO Workshop (agenda item 9.1.1.5 refers) and the VOS Donation Program.

Mr. Cabrie said that the PMO-6 workshop had been a great success, with broader participation made possible due to its being held virtually. Future workshops will also be held in a hybrid mode with both in-person and virtual sessions. The meeting noted that the video of the workshop is available at:

https://drive.google.com/drive/folders/1cBHM-8-2LwL6_6Tzs-vaRpxWC-I57w8U

and all documentation and presentation are available at:

https://www.goosocean.org/index.php?option=com_oe&task=viewEventDocs&eventID=2610

The actions arising from PMO-6 were noted by the Team, and in particular:

- Development of a user manual on VOS metadata submission to OceanOPS;
- Creating short, targeted, YouTube videos to add to the YouTube channel demonstrating how to submit metadata and how to request SOT-ID's from OceanOPS;
- Arranging more frequent and focussed sessions on PMO activities (e.g., 6 monthly webinars to address particular topics); and,
- Harmonising efforts and collaboration on sea ice observations with the Global Cryosphere Watch (GCW) programme.

The Team noted that submissions to take part in the VOS Donation Program were requested by 15 September 2021. Three responses had been received, but the deadline would be extended a further couple of weeks to allow for late submissions. A copy of the Call for Expression of Interest to be a donor recipient is at **Annex X.**

Ms. Tamaryn Morris advised that the VOS donation information had again been extended to Namibia and Angola. In this regard it was suggested that Mr. Abubakr Babiker, the newly appointed Technical Coordinator (Infrastructure) for the WMO Regional Office for Africa, might be a good focal point to reach out to.

It is planned to identify the successful candidates for the VOS Donation Program in early November, 2021 and to begin procurement of equipment by mid-November, 2021. Supporting documentation for the roll out of VOS donations will be undertaken in early 2022 with a view to commencing implementation on board candidates' vessels in mid 2022.

Mr. Cabrie explained how the TurboWin+ software used for the donation program can be easily interfaced with a Mintaka barometer/GPS to allow automated pressure values, longitude and latitude to be output via the ships email every hour. He suggested that this provided a good starting point for any nation looking to participate in the VOS Scheme.

Mr. Cabrie also reported that the VOS Website had been updated at the end of January, 2021 to, inter alia: add references to the new VOS Classes and remove references to VOSClim and WMO Pub 47; add the new SOT certificate; and, the PMO Buddy list. A PMO Best Practice Guide has also been added to the website providing important guidance on avoiding duplicate recruitments, as well as providing a general overview of PMO duties. This is an updated version of the old PMO quick reference guide.

Priority was placed on developing a comprehensive Turbowin+ user guide. This was completed for Turbowin+ version 4.0 and is now also available from the updated VOS website. However, several new versions of Turbowin+ have since been released and the user guide will need to be reviewed and amended to incorporate any changes.

A TurboWin+ setup video has also been developed and is available on the YouTube channel. However, due to the many different configurations possible in the software, it became difficult to capture all the necessary information in one video. Consideration may therefore be given to making a further series of short videos focussing on the more common configurations.

Mr. Cabrie concluded his presentation by welcoming Mr. Philippe Gautier (PMO, France) as a new member of the task team. However, he stressed the need for concerted efforts to identify further members to join the task team and help share the workload. Bearing in mind the need for information and training expressed at the PMO-6 workshop Mr. Figurskey supported the call for new members to become involved, not only representing VOS network interests, but the interests of all SOT networks.

In considering team membership issues it was noted that the membership lists for National Focal Points (NFPs), Port Meteorological Officers (PMOs) and the various SOT Task Teams (TTs) were inaccurate and that there were discrepancies between lists found at different locations. This issue was further considered during discussion on agenda item 14.1.1 when an action was assigned to the task team to review the SOT website to include links to current membership lists (in liaison with the Technical Coordinator and the WMO/IOC Secretariats).

To progress the aims of the task team, the Team agreed to the following actions:

Actions:

A12.1/01 – *Create a series of Turbowin+ videos (setup, use, download log files, etc.) (TT-RPT; June, 2022).*

A12.1/02 – *Review the feedback from the PMO-6 survey to better inform the structure and delivery of the next PMO workshop (TT-RPT; SOT-12).*

A12.1/03 – *Arrange targeted 6-monthly PMO webinars to focus on individual topics of interest. The first of which to be scheduled within 6 months of SOT-11(TT-RPT; March, 2022).*

13. OCEAN BEST PRACTICES

13.1 Best Practices

Prof. Juliet Hermes (South Africa) began her presentation by defining what exactly is meant by "best practices". She explained that a best practice is a methodology that has repeatedly produced superior results relative to other methodologies with the same objective. This could include documents, manuals, videos, handbooks, standard operating procedures, etc. To be fully elevated to a best practice a promising method will have been reviewed, adopted and employed by multiple organisations (Pearlman et al, 2019).

GOOS encourages best practices throughout the lifecycle of observations from mission design right through to delayed mode quality control. Prof. Hermes drew particular attention to the OceanOPS Report Card where best practices are listed as one of the network goals using a star rating system. The aim was to achieve three stars for all observing networks. She suggested, however, that this star system was slightly subjective as some best practices may not be easily identifiable, accessible, or not documented.

All OCG networks need to be encouraged to use a similar specific tag/link on their websites so that users can access the best practices. In this regard she proposed a standard website standard

text (Figure 24) that could be used by SOT and other networks to highlight the fact that best practices are an essential component across all observing networks, and that OCG is committed to ensuring such practices are comprehensive, findable, and used. The best practices could then be included in a table or list on the web site.

> *"Best Practices have always been an essential component across all areas of the observing system and the OCG ocean observing networks are committed to ensuring that their best practices are comprehensive, findable and are used. OCG, the IOC and the WMO Integrated Global Observing Systems (WIGOS <http://www.wmo.int/pages/prog/www/wigos/index_en.html>), are seeking increased collaboration with partner organisations towards the objective of harmonized standards, and better traceability of observations to standards. In an ongoing effort to ensure this SOT is working at providing best practices for the life cycle of all EOVs observed under the program, for each stage of the observation life cycle. The SOT is contributing to this effort by compiling this list of best practice documents available and will identify gaps in the documentation and where documents need to be updated."*

Figure 24 – Proposed best practices text for SOT website

The Teams attention was drawn to the Ocean Best Practices System (OBPS) website at:

www.oceanbestpractices.org

and to the system flow diagram below (Figure 25). The OBPS Repository (OBPS-R) is the main hub of the website and fed by contributing networks, organisations, and programs, which can be easily searched by users to find relevant best practice documents, videos, presentations, etc., and currently holds approximately 1400 best practices. Guidelines to help depositors and editors get started with new best practices are also included, together with templates for the submission of best practice documents for sensors, ocean applications and data management.

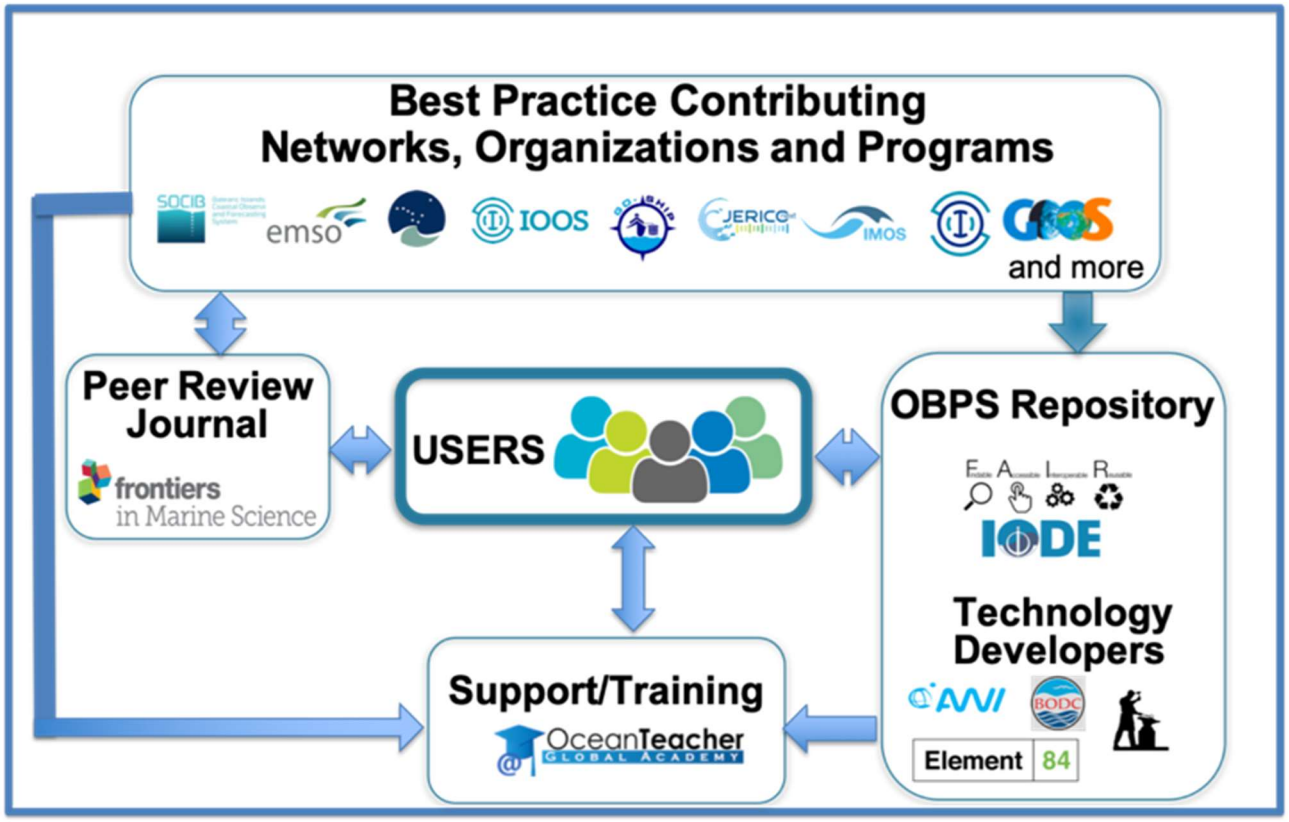

Figure 25 – Best Practices System Flow diagram

To qualify for "GOOS endorsement" the best practice is expected have undergone a community review, i.e., to:

1. have completed a rigorous community review process;
2. be approved by the leadership of the relevant network;
3. be fit for the purpose and fully satisfies the definition of a best practice on the OBPS;
4. have been recognized through the relevant GOOS body;
5. be available and identifiable within the OBPS Repository, (or will be submitted as soon as endorsement is received); and,
6. be updated at relevant timeframes.

When all the criteria are met an endorsement certificate can be issued and the best practice can, therefore, be identified and discoverable as one that is trusted by the GOOS community.

The Team noted that registration was open for participation in the fifth OBPS Community Workshop entitled "An Ocean of Values", to take place from 20 to 24 September 2021, and that the International Association for the Physical Sciences of the Oceans (IAPSO) had issued a call for proposals for Best Practices Study Groups.[58]

Prof. Hermes has been working closely with Ms. Tamaryn Morris and Ms. Justine Parks to develop SOOP best practices (see also Agenda Item 9.2.1.2). Mr. Rudolf Krockauer had also produced a best practices document addressing factors to be considered when recruiting a new ASAP ship, which, hopefully, will soon achieve GOOS endorsement and can then be uploaded to the OBPS repository. For the VOS, attention was drawn to the VOS videos on the YouTube channel. Prof. Hermes invited members to consider whether any cross programme/networks best practices could be developed.

Ms. Justine Parks reported that she is starting work on developing SOT Vessel Recruitment and On-Board Conduct best practices document which will include information on how to recruit ships, how to behave on board, etc. and would also address concerns about double recruiting. She invited interested SOT members to contribute to her work on creating this document. In this regard Prof. Hermes referred Ms. Parks to a best practices document addressing gender type, inclusivity, and diversity on board vessels.

Mr. Darin Figurskey reiterated the importance of this work on best practices which will help the global community in the years to come.

13.2 Task Team on Instrument Standards and Satellite Communication Systems, including Review of WMO Pub No 8

The Chair of the Task Team on Instrument Standards and Satellite Communications Systems (TT-ISSC), Mr. Jean-Baptiste Cohuet (France), reported that during the last intersessional period, the main tasks were to:

- Collect and update of information concerning instruments, telecommunication and dataflow used by the observing ships.
- Monitor the telecommunication systems used globally.
- Follow the application of Iridium to be part of GMDSS, and construe possible consequences for Code 41 messages.
- Work in liaison with TT-metadata to create sensors and AWS list from pub47 entries, and to design new telecom tables separating data communication method and telecom services.
- Draft VOS AWS standards documentation.

[58] *http://iapso.iugg.org/index.php?option=com_acymailing&ctrl=archive&task=view&mailid=110&key=caf415945acc41218462264d7e211f37&tmpl=component*

- Work on a new version of the JCOMM TR63: "Recommended Algorithms for the computation of marine meteorological variables", especially true wind and pressure measurements.

Mr. Cohuet reviewed the status of actions arising from the last session and reported on the task team's terms of reference and current membership. He thanked the departing task team members, including the Vice Chair Ross Bannister (New Zealand), Mr. Massaya Konishi (Japan), Dr. Dave Berry (United Kingdom) and Mr. Damian Napoles (Netherlands) for their participation. Subject to formal approval by the SOT Executive Board, the Team agreed new Terms of Reference for the task team, including the decision to include the monitoring functions of the now discontinued task team on Unique IDs (TT-UID) (Agenda item 4.1.2 referred). A copy of the Terms of Reference for the task team is included at **Annex IV**.

Mr. Cohuet reported on statistics that had been computed over a six-month period in 2020 to analyse and compare the telecom systems used firstly by observation, and secondly by VOS (Figures 26 and 27).

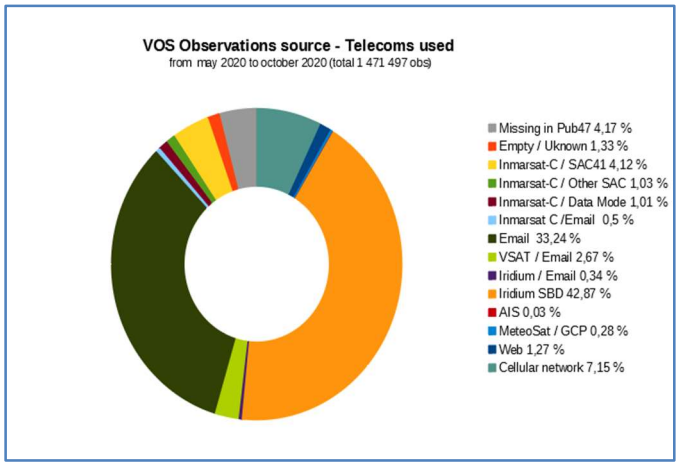

Figure 26: Telecoms used by observation

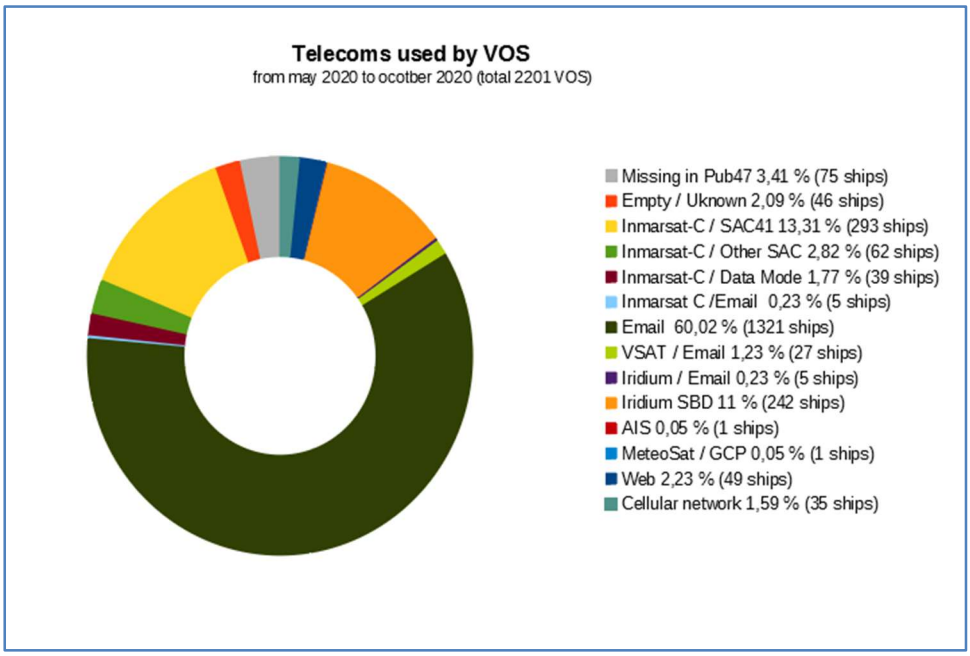

Figure 27: Telecom used by VOS

The Team noted that email is now the system of transmission most used by VOS (60% of active ships) and in particular that the percentage of manual ships using email was still increasing. In total 33% of observations are now sent by email. For AWS systems Iridium SBD (Short Burst Data) remains the most used system, accounting for only 11% of active ships but producing 42% of the observations sent to the GTS.

Inmarsat Code 41 is still used by many ships (14-19% of the VOS recognising that the non-registered ships are usually sending their messages in code 41) representing 4-8% of messages on GTS, which is still significant. A good development is that the proportion of ships sending messages to the GTS which are not registered in WMO Pub 47 (ships without metadata) has been reducing, from 25% of active ships in 2018 to only 5% currently. The following figures compare the relative volumes of observations from registered and non-registered VOS:

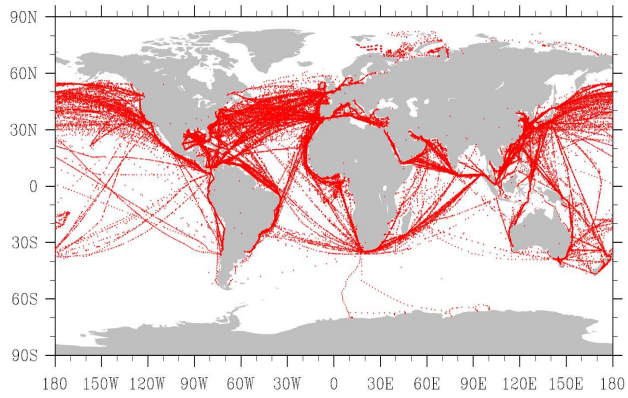

Figure 28: Registered VOS observations transmitted in Code 41 in 2020

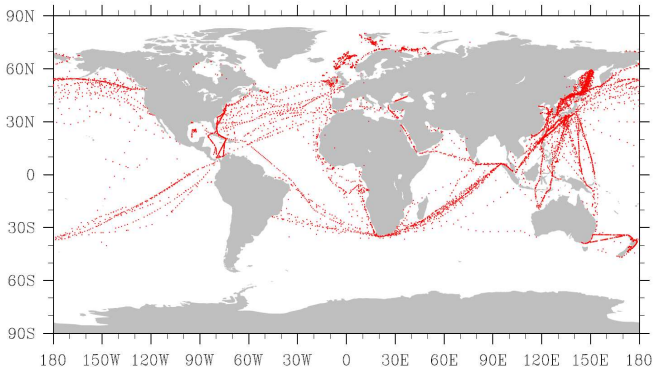

Figure 29: Non-registered VOS observations in 2020 using Code 41 (except SHIP)

In discussing the increasing use of email for sending observations, Mr. Martin Kramp, Technical Coordinator, agreed that it is important to clearly distinguish between stations that use email, and number of observations actually submitted by email.

The Team noted that last year Iridium was certified by IMO to offer GMDSS services in early 2020, and later that year had contacted WMO for information on how to implement a similar Code 41 system as the long-standing Inmarsat system. However, in December, 2020 Iridium announced that its GMDSS service would become operational without a code 41 reverse charging system.

Bearing in mind that some ships will soon be equipped with new Iridium GMDSS systems, Mr. Cohuet suggested that an Iridium transmission system that is free of charge to the ship is still needed. He proposed four possible options (Table 6) that need to be discussed with Iridium, and identified the potential drawbacks of each option. One of the principal differences between Iridium and Inmarsat is the fact that Iridium works though a single gateway allowing messages to be sent to a different address irrespective of the ships position.

Mr. Joel Cabrie questioned whether it would be possible to have a central processing center for Iridium GMDSS, potentially funded through the SOT. Mr. Cohuet recognised whilst that was one option that could be discussed there was no budget available for it, and in addition it was difficult to estimate how many ships would use a centralised system. Also, creating individual contracts for each country could be extremely complicated. Mr. Cabrie also highlighted the potential opportunity that Iridium transmission offers to those countries that do not already have a path to GTS for their observations.

Table 6 – Pros and Cons of proposed Iridium observation charging systems

N°	Description	Advantages	Drawbacks
1	According to the position of the ship the message is routed and charged to a Met Service responsible for the area	All the areas are covered All the ships can send a message	All the countries responsible for the area need to have a contract with an Iridium provider and have to be able to send the messages on the GTS. Unfair system: few countries are paying for the whole community
2	According to the position of the ship the message is routed to a designated destination and charged to a designated Met Service (responsible for the area) or another organization.	All the areas are covered All the ships can send a message	Arrangements/contracts should be made about destinations and who is paying for (all or certain) areas. This can take some time. Depending on arrangements, the system can be more or less fair regarding who is bearing the costs.
3	National Codes 41 are established. The messages are routed according to the code.	Each country pays for its recruited ship	Risk to lose the non-recruited ships Much paperwork to get a global system working. Very probably only very few national codes will be set.
4	Global system with only one recipient	Simple system Can handle format evolution like #101	Need for a reliable dataflow

Ms. Sarah North drew attention to the proliferation of new low orbiting satellite systems like Starlink, OneWeb, etc., and suggested that the task team should also look into leveraging these new systems for broadband transmission of observations. Mr. Martin Kramp suggested that future email transmission will become so cheap and easy with such satellites that the problems of how to pay for observations will become minimal. Mr. Henry Kleta reminded members that the IMO GMDSS regulations state that free weather transmissions are mandatory, and that this should also apply to Iridium GMDSS.

The meeting recalled that during SOT-10 the TT-ISSC was asked to document minimal standards for Ship-borne Automatic Weather Stations (S-AWS) from a specification's perspective, including details on technologies used and best practices. The task team has progressed this matter and a draft document is available on the TT-ISSC google drive at:

https://drive.google.com/drive/folders/188rFUT4stlvjfREtIs_SiqLEuvyYSJ1g

One of the key ongoing tasks of the task team is the collection of technical information concerning instrument standards and guidelines currently being used by operators, and on the different types of instruments currently in use on VOS, SOOP and ASAP ships. Comprehensive information on current standards and practices derived from members national reports is given in **Annex XI**.

The Team noted that a spreadsheet listing GTS headers and dataflows is now available via SOT Website[59] at:

https://wmoomm-my.sharepoint.com/:x:/g/personal/mkramp_wmo_int/ETWeqFliifhBgP-XOiQkLF4BhnSkdis_iW4--nGD8fCD8A?rtime=kxW8Hh6b2Ug

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

Review of WMO Pub No 8

The Team noted that the ocean observing community was proposing the development of a new Volume to the "*WMO Guide to Instruments and Methods of Observation (WMO No. 8, the CIMO Guide)"*. The topic of marine measurements is currently presented in WMO No. 8, Volume III (Observing Systems), Chapter 4: Marine Observation (https://community.wmo.int/activity-areas/imop/wmo-no_8).

This chapter describes the observing systems employed for marine observations, mainly VOS and moored buoys, with brief descriptions of the variables observed and best practices primarily focused on marine meteorology. In addition, the TT-ISSC is working on the revision of JCOMM TR63: "Recommended Algorithms for the Computation of Marine Meteorological Variables".

The ocean community is quite diverse, with many marine observations focus areas and multiple ocean observing platform networks, each requiring a different set of best practices. The IOC/UNESCO maintains the Ocean Best Practices portal[60], separate from the WMO No. 8, with measurement practices covering many other ocean-related networks and measurements.

The intention is to develop a separate new volume to WMO No. 8 involving all the communities working on measurement of marine meteorological and oceanographic variables. This approach is better aligned with the recent update of WMO No. 8, organized by discipline specific volumes, such as the recent *Volume II: Measurement of Cryospheric Variables*.

It was noted that the new volume was the subject of ongoing discussion between IOC and WMO, and that initially the marine observation material from Volume III, Chapter 4 would be extracted and placed into a new independent volume. The new volume may then be amended to provide more details on the currently described measurement techniques and technologies.

It was further noted that JCOMM TR63, which was originally limited to dew point measurement, but now includes algorithms for true wind and pressure, will be incorporated in this new volume. Additional guidance and measurement practices may be gradually incorporated into the new volume in the future. The current draft of TR63 is at:

https://drive.google.com/drive/folders/188rFUT4stlvjfREtIs_SiqLEuvyYSJ1g

In the course of discussion, it was questioned whether information from the SOOP observation best practices could potentially be added to this new volume. Dr. Francis Bringas (United States) replied that this possibility should be looked into, but that more information was needed first.

Summing up it was recognised that the main challenges for the task team (TT-ISSC) in the coming intersessional phase will be:

- Contributing strongly to the review of the new marine volume of the CIMO guide, which will include JCOMM 63 TR documentation;
- Finalising the AWS standard documentation;
- Working with Iridium for a Code41 implementation system; and,
- Updating all the sensors and telecommunication metadata for national fleets in the OceanOPS system, according to the new metadata fields.

[60] https://www.oceanbestpractices.org/about/

Actions:

A13.2/01 – *Participate in the writing of the new marine volume of WMO Pub No 8 which should also include JCOMM TR 63 documentation. (TT-ISSC; SOT-12).*

A13.2/02 – *Work closely with Iridium to implement a Code41 system on Iridium GMDSS (TT-ISSC; SOT-12).*

A13.2/03 – *Update observing systems, sensors, and telecommunication metadata in OceanOPS database. (SOT NFP; SOT-12).*

A13.2/04 – *Agree the new TT-ISSC Terms of Reference (SOT & SOT EB; October, 2021).*

14. SECRETARIAT UPDATE AND ADJOURN

14.1 WMO Secretariat Report

Ms. Sarah North, representing the WMO Secretariat, reported on decisions of WMO governing bodies that were of relevance to the SOT. This included the outcomes of the Eighteenth World Meteorological Congress (Cg-18; held from 3 to 14 June 2019), The 1st Infrastructure and Information Systems Commission (Infrastructure Commission; held virtually from 12 April to 16 April 2021) and the 73rd Executive Council (EC 73; held virtually from 14 to 25 June 2021).

With respect to Cg 18[61] Ms. North drew particular attention to the following Resolutions:

- Resolution 1, which sets out the long-term goals and strategic objectives during the 2020-2023 planning cycle of the Organization. Ms. North invited members to consider how their national activities fit into the five long-term goals:

    1. Better serve societal needs: delivering, authoritative, accessible, user-oriented, and fit-for-purpose information and services;
    2. Enhance Earth system observations and predictions: Strengthening the technical foundation for the future;
    3. Advance targeted research: Leveraging leadership in science to improve understanding of the Earth system for enhanced services;
    4. Close the capacity gap on weather, climate, hydrological and related environmental services: Enhancing service delivery capacity of developing countries to ensure availability of essential information and services needed by governments, economic sectors, and citizens; and,
    5. Strategic realignment of WMO structure and programmes for effective policy and decision-making and implementation.

- Resolution 7, which establishes the following two new Technical Commissions (replacing the previous eight technical commissions):

    - **INFCOM** – Commission for Observations, Infrastructure and Information Services (Infrastructure Commission) and,
    - **SERCOM** – Commission for Weather, Climate, Water and Related Environmental Services and Applications (Services Commission).

    Noting the organigrams for the new Commissions (**Annex XII**) Ms. North stressed the need for the SOT and its task teams to establish, where appropriate, linkage and

[61] https://library.wmo.int/doc_num.php?explnum_id=9827

functional connections with the various expert teams and standing groups established under the Commissions' structure.

- Resolution 9, which establishes the Joint WMO-IOC Collaborative Board, as a high-level coordination mechanism with broader engagement of the key relevant bodies of the WMO and IOC.

With respect to the 1st Infrastructure Commission (INFCOM) meeting the Team noted that the connections for the Marine Climate Data System (MCDS) and the governance of SOT and DBCP were endorsed[62]. Both SOT and DBCP report to the Observations Coordination Group (OCG), but both bodies and their subsidiary bodies can now operate under their own governance, and decide on leadership appointments, although any changes to the SOT and DBCP Terms of Reference will need approval by the OCG Executive Board.

It was further noted that INFCOM had endorsed the experimental use of the Climate and Forecast Network Common Data Form (CF-NetCDF) profiles for marine and weather data[63].

Dr. David Berry explained that WMO formats like BUFR and GRIB aren't widely used outside the WMO community, whereas in the research communities netCDF is used much more extensively. However, because of the flexibility of netCDF, consideration is now being given to how it can best be adapted for use within the WMO framework. Dr. Berry also highlighted that there is a demonstration project going on with Saildrone data being delivered in NetCDF.

Turning to the 73rd Executive Council meeting Ms. North drew attention to the following recommendations, decisions and resolutions:

- Recommendation 3[64] - establishes a single "unified" data policy across multiple domains including Weather, Climate, Hydrology, Atmospheric Composition, Cryosphere, Oceans and Space Weather that aims to broaden and enhance the free and unrestricted international exchange of Earth system data.

  For oceans this 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.

  The unified policy distinguishes between core data, that "shall" be exchanged on a free and unrestricted basis, and recommended data that "should" be exchanged. Marine meteorological and oceanographic observations, as defined in the Manual on the WMO Integrated Global Observing System (WMO No. 1160) are considered as core data. The unified policy does not, however, override national data policies.

- Recommendation 4[65] - which recommends amendments to the WIGOS Manual (WMO-No. 1160), section 3.2.2, Global Basic Observing Network (GBON), which come into effect

[62] https://meetings.wmo.int/INFCOM-1-III/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-1-III/English/3.%20SESSION%20ARCHIVE/INFCOM-1(III)-d05-1-7-SG-OCEAN-OBSERVATIONSINFRASTRUCTURE-draft1_en.docx&action=default

[63] https://meetings.wmo.int/INFCOM-1-III/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-1-III/English/3.%20SESSION%20ARCHIVE/INFCOM-1(III)-d05-1-3(1)-CF-NetCDFdraft1_en.docx&action=default

[64] https://meetings.wmo.int/EC-73/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-73/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-73-d03-4(1)-WMOUNIFIED-DATA-POLICY-approved_en.docx&action=default

[65] https://meetings.wmo.int/EC-73/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-73/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-73-d04-2(2)-GBONapproved_en.docx&action=default

from 1 January 2023 subject to adoption by the Extraordinary Session of the World Meteorological Congress, in 2021 (Cg-Ext. 2021). The Team noted the following provisions that are of relevance to SOT:

3.2.2.10 Members shall maintain the continuous operation of a set of surface marine meteorological observing stations/platforms within their Exclusive Economic Zone that observe, at a minimum, atmospheric pressure and sea surface temperature located such that where opportunity exists, GBON has a horizontal resolution of 500 kilometres or higher, over the marine areas of their jurisdictions, for these variables, with an hourly frequency.

3.2.2.11 Members should facilitate other Members to make surface marine meteorological observations within their Exclusive Economic Zone, subject to the data being shared internationally (according to WMO overall data policy in 3.2.2.5).

- Resolution 10[66] - which authorizes OceanOPS, on behalf of Members, to issue WIGOS Station Identifiers for surface marine stations or sea stations contributing to GOOS, when asked to do so.

- Resolution 13[67] – which includes guidance on WIGOS Station Identifiers (WSIs) to be used by GOOS operators and OCG Networks and allocated by OceanOPS.

- Decision 8[68] - which endorsed the Atlantic Oceanographic and Meteorological Laboratory of the National Oceanic and Atmospheric Administration (USA), to operate as a Data Acquisition Center for Drifting Buoys under MCDS (subject to a parallel approval by IOC).

Dr. Dominique Berod (WMO) explained that the ultimate aim is for WMO to become more effective for its members, and to have data inter-operability thereby allowing a greater value chain from the data to the decision making. One of the primary aims is to improve national weather prediction and the essential GBON stations are fundamental to that aim. He explained that the goal is to unify the three current data policies – one for meteorology, one for hydrology and one for climate – and to identify the core data necessary for safety of life (typhoons, natural disasters, etc.). Additional recommended data, whilst important, is not mandatory. The final decisions on data policy will however be subject to the outcome of Cg-Ext. 2021 in October. The data policy is, therefore, a vital component of the full value chain including the GBON.

The SOT Chair, Mr. Darin Figurskey gave more detail on the work undertaken to identify those INFCOM and SERCOM working groups, standing committees, study groups, expert teams, etc., where the most important functional connections need to be made with SOT. This information has been captured in a spreadsheet to help inform SOT and to ensure that key developments concerning, for instance, metadata standards, observation measurements, maritime safety, etc., aren't missed. He called on any members who may be invited to participate in any of these groups to keep SOT advised. Mr. Figurskey finished the discussions on this item by thanking Ms. Champika Gallage (WMO), who was currently on leave, for all the support she has given the SOT on WMO related issues.

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[66] https://meetings.wmo.int/EC-73/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-73/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-73-d04%E2%80%932(3)-WIGOS-TECHREG-ANNEX-2-No-1160-approved_en.docx&action=default

[67] https://meetings.wmo.int/EC-73/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-73/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-73-d04-2(6)-WIGOSGUIDE-ANNEX-No-1165-approved_en.docx&action=default

[68] https://meetings.wmo.int/EC-73/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-73/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-73-d04-2(16)-MCDSDAC-DATA-approved_en.docx&action=default

Action:

A14.1/01 - *SOT members are requested to support the implementation of GBON requirements for SST and SLP observations identified in the WMO NO 1160 (section 3.2.2.10) and provide input to further develop GBON to include fuller range of marine/ocean EOVs and ECVs. (SOT members; Ongoing).*

14.1.1. SOT Focal Points / PMO & TT Lists

Ms. Sarah North reported that concerns had been raised in recent meetings of the SOT Executive Board regarding access to accurate and up-to-date membership lists for SOT National Focal Points (NFPs), VOS and SOOP Panels, PMOs, and task teams. Similar concerns had been expressed by several members during the preceding discussions at this session.

Membership lists for SOT NFPs and associated sub-groups are currently available from various sources, including:

- The OceanExpert dashboard site at https://oceanexpert.org/group/106
- The IOC legacy site at http://legacy.ioc-unesco.org/index.php?option=com_oe&task=viewGroupRecord&groupID=135
- The WMO Marine Meteorology and Oceanography Panel (MMOP) website at https://community.wmo.int/ship-observations-team-sot and at https://community.wmo.int/ocean-observing-groups-teams-panels-and-focal-points#SOT

National Focal Points are the appropriate contact points in each Member State for affairs regarding the implementation of the Global Ocean Observing System (GOOS) at national and global levels. The list of SOT NFPs is based on answers to Circular Letter 2666 requesting nominations for SOT (and GOOS, JCOMM, Argo, GLOSS, and DBCP) Focal Points. SOT Focal Points are nominated via one of three channels: IOC National Focal Point; Ministry of Foreign Affairs; and, Permanent Delegation to UNESCO. Scans of all nomination forms for focal points received to date can be found at:

https://goosocean.org/index.php?option=com_oe&task=viewDoclistRecord&doclistID=182

In addition, SOT Focal Points (and VOS, SOOP, and ASAP membership) are also traditionally collected by means of the SOT Annual Reports available at https://community.wmo.int/sot-annual-reports

Besides the duplication of lists, Ms. North pointed out that some lists contained out of date membership information, or inconsistencies, and that some of the associated terms of reference also needed to be verified and updated where needed. For instance, the task team on High Resolution Marine Meteorology (TT-HRMM) was still listed despite having been discontinued at the previous SOT-10 session. Some lists accessible via the SOT website (e.g., the task team on ASAP) were also inconsistent with those accessible via the OceanExpert website.

In discussing this item, it was suggested that such inconsistencies are, in part, due to the different ways in which IOC and WMO collect and store data. Whilst consideration was also given to the possibility of data synchronisation between OceanExpert and OceanOPS as a possible solution, it was recognised that this was not likely to be possible due to their use of different architectures.

To avoid such problems in the future Ms. North suggested that there should be clear accountability for ensuring membership lists are kept up to date and, to avoid confusion, legacy membership lists should be clearly displayed as such. She also proposed that task team membership should be added to the SOT Annual Report and that the Terms of Reference for each task team and Panel should include a new provision to require membership lists to be verified on an annual basis.

Notwithstanding the need to ensure the accuracy of lists on the aforementioned websites in the short term, the Team agreed that the primary repository for such information should in future be via user groups to be established within OceanOPS (Action A8.0/04 refers) using automatically generated SOT annual reports. Because of this change it was recognised the IOC Secretariat would eventually need to amend Circular Letter 2666 and the WMO Secretariat would need to revise its current instructions for the submission of SOT Annual Reports.

The following actions and recommendations were discussed and were subsequently agreed aby the SOT Executive Board:

Actions:

A14.1.1/01 – *SOT Website(s) to be reviewed and amended to include links to current membership lists (SOT NFPs, PMOs, TTs and SOOP/VOS Panel lists) and to also include a link to latest version 2.1 of the SOT Implementation Strategy (TT-RPT, SOT-TC, WMO/IOC Secretariats; by end 2021).*

A14.1.1/02 – *Task Team Chairs to review and confirm TT membership on annual basis and, accordingly, advise SOT-Technical Coordinator of any changes (TT Chairs; January each year).*

A14.1.1/03 – *Task Team ToRs and VOS/SOOP/ASAP Panel ToRs to be amended to include a requirement to verify membership annually (TT & VOS/SOOP/ASAP Chairs & SOT EC October 2021).*

A14.1.1/04 – *Task Team membership be added to the SOT Annual Report (SOT TC, WMO Secretariat; December, 2021).*

A14.1.1/05 - *WMO & IOC Secretariats to consider need to review Circular Letter 2666 to reflect future collection of SOT contact information via OceanOPS (WMO/IOC Secretariats (in liaison with SOT-TC); December, 2022).*

A14.1.1/06 – *OceanOPS to liaise with WMO Secretariat regarding future revised procedures and instructions for requesting submission of SOT Annual Reports via OceanOPS database/user groups (WMO Secretariat, SOT- TC; 2022).*

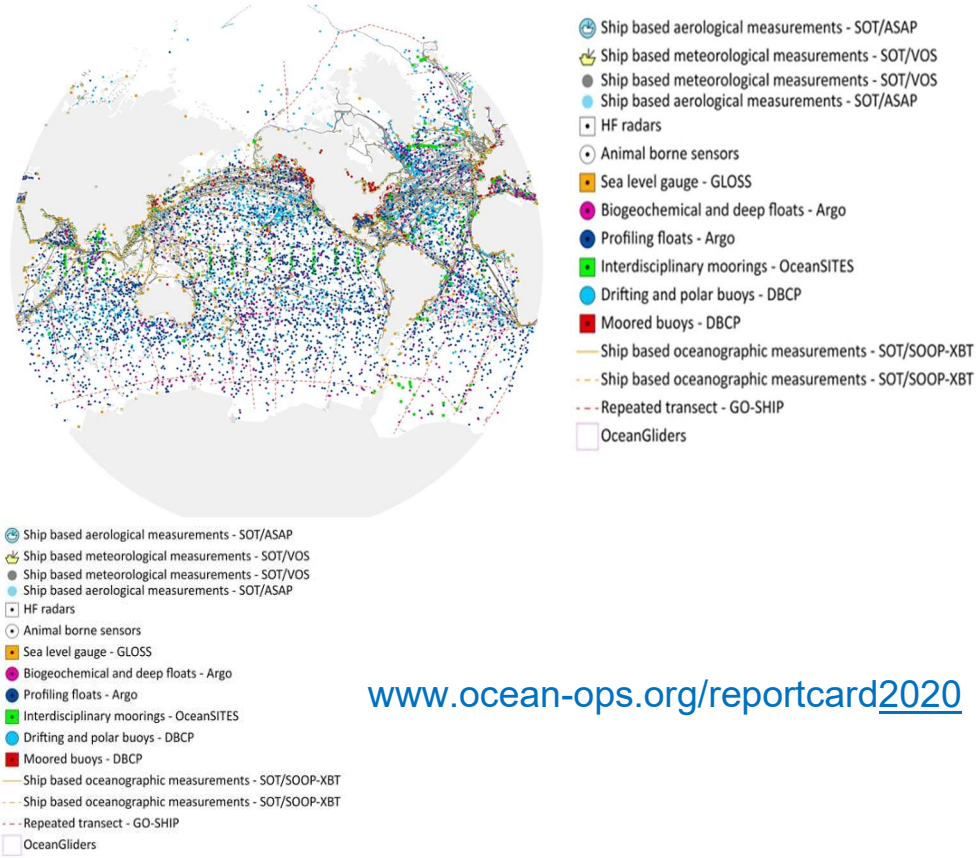
A14.1.1/07 - *IOC Secretariat to ensure that online SOT NFP legacy lists cannot be confused with current SOT NFP lists on the OceanExpert dashboard. (IOC Secretariat; end 2021).*

Recommendations:

R14.1.1/01 - *E-SURFMAR to strongly encourage its participating EUMETNET members to submit individual national SOT Annual Reports to future SOT sessions (E-SURFMAR VOS Chair & Members; annually).*

14.2 IOC Secretariat Report

Dr. Emma Heslop began her presentation by drawing the Teams attention to the interconnected nature of OCG networks, as depicted in Figure 30, and emphasised how important the SOT networks are to this integrated effort.



- Established arrays (Argo, DBCP), new networks (gliders, HF Radar)
- 86 countries, 8,933 in situ observing platforms, 170 satellites
- *in situ* ocean observations – 12 global ocean observing networks

www.ocean-ops.org/reportcard2020

Figure 30 – Observation Coordination Group networks 2020

Whilst the system structure has traditionally been based on climate and operational services, it is now increasingly addressing ocean health and human impacts. In this respect Dr. Heslop drew particular attention to the burgeoning BioEco observational networks which include 203 active long term biological observing programs covering 6-7% of the global ocean.

With regard to the Covid-19 impact it was noted that the majority of the GOOS in-situ observing networks had shown great resilience, partly due to the use of autonomous instruments, but also because of the efforts of the operators working from home, monitoring data flow, and developing workarounds for remote calibration. In general, commercial ships were less affected than research vessels.

Dr. Heslop then summarised issues relevant to SOT arising from the Thirty First Intergovernmental Oceanographic Commission (IOC-31)[69], the Tenth GOOS Steering Committee Meeting (GOOS SC-10)[70] and the Twelfth Session of the GOOS Observation Coordination Group (OCG-12)[71], from the perspective of the IOC Secretariat. In particular, she highlighted the following areas of most interest to SOT members:

UN Decade of Ocean Science for Sustainable Development
The Team noted that the first UN 'Ocean Decade' Programmes have now been endorsed, including the following three GOOS Ocean Decade Programmes[72] :

- **Ocean Observing Co-design** - will create a system co-designed with observing, modelling and key user stakeholders that will evolve ocean observing and give us the ocean we need for the future we want. (*Leads: Sabrina Speich, David Legler, Emma Heslop)*

[69] https://oceanexpert.org/event/3028
[70] https://oceanexpert.org/event/2921
[71] https://goosocean.org/index.php?option=com_oe&task=viewEventRecord&eventID=3008
[72] https://www.goosocean.org/index.php?option=com_content&view=article&id=297&Itemid=428

- **Observing Together** - will transform ocean data access and availability by connecting ocean observers and the communities they serve through enhanced support to both new and existing community-scale projects. (*Leads: Kim Currie and Molly Powers)*

- **CoastPredict[73] -** will redefine the science of observing and predicting the Global Coastal Ocean to help the Ocean Decade succeed in its aims and give us the ocean we need for the future we want. (*Leads: Nadia Pinardi, Villy Kourafalou, Joaquín Tintoré*.)

Dr. Heslop suggested that work for these three innovative programmes would become a part of the SOT landscape moving forward. The underlying mission of "Ocean Decade" is "*to catalyse transformative ocean science solutions for sustainable development, connecting people and our ocean"* and it has visibility at both national and UN levels. It provides a great opportunity for ambitious ideas across the observing systems that will make a step change difference to the outcomes for the ocean, society, and our relationship with the ocean. The Ocean Decade Implementation Plan is now approved, and work will begin on the collaborative centres, programme funding, project calls and further endorsements, etc.

A new call for projects would take place in October, 2021 and then every six months. Dr. Heslop, therefore, encouraged SOT to think of about what project areas it could potentially get involved with, e.g., "citizen science" observations from different vessels.

GOOS Implementation Plan
Dr. Heslop reported on the development the GOOS Implementation Plan. The OCG are leading initiatives in some areas of the plan, which intersects with key OCG and OceanOPS workplan actions, e.g., best practices, data and metadata, metrics, and the Report Card, which are part of the Implementation Plan. She said that GOOS would need to find additional resources to support the Implementation Plan, including resources for OCG.

GOOS Governance:
The Team noted that GOOS had commissioned study and survey of support structures for ocean observing which found that *"The present form of support arrangements for global and regional ocean observing systems lacked authority, clarity and transparency, and its effectiveness and efficiency were determined to be unsatisfactory for many stakeholders".* It, therefore, made a recommendation to renovate and rejuvenate the current hub-and-spoke arrangement.

The aim is to improve GOOS governance and supporting structures to make it more open and transparent. This would involve three steps:

1. Design a process of change with stakeholders
2. Assess internal architecture aligned with key functions
3. Ask co-sponsors (IOC, WMO, UNEP, ISC) to prepare for governance change

Value of ocean observing
Dr. Heslop also highlighted the work being undertaken by GOOS to identify, and track, value chains within the ocean observing systems which underpin a wide range of applications. Ocean information increasingly finds uses in a wide range of public policy arenas and in supporting commercial activities, bringing new efficiencies, productivity gains, or cost avoidances. Collecting, distributing, and archiving public marine data provides benefits to society at large. However, knowledge of the economic value of the services it enables is scattered and not well defined.

In this regard Dr. Heslop drew the Team's attention to an Organisation for Economic Co-operation and Development (OECD) working paper entitled "*Value Chains of Public Marine Data: A UK Case Study"*[74]. This working paper is the result of close cooperation between experts from

[73] https://www.coastpredict.org
[74] https://www.oecd.org/fr/numerique/value-chains-in-public-marine-data-d8bbdcfa-en.htm

GOOS, the OECD Ocean Economy Group of the OECD's Directorate of Science, Technology and Innovation, and the UK Marine Environmental Data and Information Network (MEDIN). Based on an original survey of UK marine data users, the paper explores pathways through which marine data are used and transformed into actionable information, creating systemised value chains for the first time. The paper lays the foundations for further OECD work with the marine data community.

The study helped to identify and map data type use across various sectors e.g., academia, commercial, governmental, environmental etc., and showed that the main observations being used across these sectors fell into the chemical/biological/physical oceanography, marine geology, and human activity data types. Furthermore, it helped to identify differences in the types of action (e.g., analyse policies, analyse risk, conduct research/development, inform marine planning decisions, inform operations, raise awareness and education, etc.) that the data is informing across each sector.

Role of the OCG

Dr. Heslop reminded members that OCG works to efficiently operate, maintain, coordinate, and integrate a comprehensive in-situ global ocean observing system and now targets eight foci:

1. Requirements
2. Observing Advances
3. Standards and Best Practices
4. Data Management
5. OceanOPS
6. Metrics
7. Environmental Stewardship
8. Capacity Development

The Team noted that arising from the OCG-12 session there are several priority action areas that interface with the work of SOT. These include:

- Advancing the integrated global ocean observing design (increase focus around EOVs and ECVs) and identify opportunities.
  (One action is for DBCP and SOT (Mr. Henry Kleta) to interface to GBON and report back on the engagement of OCG).
- Best practice development in networks and GOOS best practice "endorsement" process:
  (*Involves some SOOP developments and also reaching out to ASAP).*
- OCG Data Strategy/Data and Metadata work:
  (SOT contacts are involved in Data and Metadata work, VOS, SOOP, ASAP Maps data flow, Open-GTS WIS 2.0).
- EOV views of ocean observing:
  (*OceanOPS work with WMO to provide EOV / ECV views of ocean GBON – this would have connection with the SOT's work on KPIs).*
- OCG revised Terms of Reference.
  (These are under review by the GOOS SC now, SOT reviewed).
- OCG, GOOS, networks and the Ocean Decade:
  (OCG Roundtable to look at potential to work across OCG / GOOS).
- Boundary Currents: workshop group to work on regional pilot/s - scoping needs with stakeholders/modelling, looking at from EOV perspective, working on optimal design/trade-offs. Connect to OOPC and report back to OCG roundtable.
  (SOOP lead Tammy Morris is the lead).

Finally, Dr. Heslop reported on a WMO initiative that involves the IOC Secretariat together with SOT and DBCP members. The Study Group on Ocean Observations and Infrastructure Systems (SG-OOIS) which was established by INFCOM and reports to the INFCOM Management Group. Its general goal is to propose "*optimal functional connections between the WMO and IOC-GOOS bodies, programs, and systems to ensure the objectives defined by WMO Members".*

Following the discontinuance of JCOMM the SG-OOIS is developing a comprehensive view of the functional and strategic connections between WMO and GOOS structures, including the networks. The synthesis of the work has not been completed yet, although when done this should provide recommendations to WMO (and by extension GOOS) on optimal connections, for effective partnership.

14.3 Next SOT Session

The Team recalled that at its previous SOT-10 session, the Australian Bureau of Meteorology had offered to host SOT-11 in Melbourne, Australia. An alternate option was also proposed for the session to be held at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Hobart, Australia. However, this SOT-11 meeting was eventually held virtually due to the impact of the COVID pandemic.

The Team invited the members from Australia to approve their willingness to host SOT-12 with the exact location to be determined and provided it can be held with some in-person attendance. Should Australia be unable to host SOT-12 it was suggested that Miami might be a backup location for the session, subject to United States approval.

It is currently expected that SOT-12, and future SOT meetings, will incorporate a combination of in-person and virtual attendance. This will enable maximum attendance at any SOT meeting. It will also afford the person-to-person discussions which are so important for building and maintaining relationships among the Team, and with new Team members. Timing the SOT-12 the meeting to coincide with OCG was also recognised as being important.

To encourage continuity of involvement in the work of the Team it was suggested that the SOT Executive Board should consider the possibility of holding annual intersessional virtual SOT meetings. However, it was recognised that focused webinars may help to bridge the gap between sessions.

The Team extended a standing invitation to all PMOs to attend future SOT sessions, either in person or virtually, as appropriate.

Actions:

A14.3/1 — *With the approval of the members of Australia, with no unforeseen issues, and provided it can be held with some in-person attendance, approve Australia as host of SOT-12.*

14.4 Any Other Business / Closing Remarks

Mr. Henry Kleta, supported by the Team, thanked Mr. Figurskey for his excellent Chairmanship of the session, and for his outstanding efforts on behalf of the SOT community.

There being no other business to discuss, Mr. Figurskey thanked everyone for their active participation in the session, and for their ongoing commitment to the SOT. He particularly thanked those members for whom, due to large time differences, the meeting had taken place during unsociable hours.

Mr. Figurskey concluded by recalling all the challenges Team members had faced during the intersessional period and, going forward, he wished all members, teams and families to stay well and to be able to continue the fine work of the SOT. He concluded by offering his thanks to the Executive Board, the Executive Committee, the SOT Technical Coordinator and to the Secretariat for the preparatory work that had helped to make the meeting such a success.

CLOSURE OF THE SESSION

At 1155 UTC on the 19 September 2021 the SOT Chair struck the gavel to bring the session to a close.

Annex I - Participants List

The following delegates participated in the virtual SOT-11 Session. Additional contact details and profile information for each participant is available on the OceanExpert website at https://oceanexpert.org/event/3065#participants

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Annex II – Final Agenda

Agenda

DAY 1 - MONDAY 13 SEPTEMBER 2021 CLICK HERE TO JOIN PLENARY SESSION	TIME UTC
1. OPENING OF THE SOT SESSION 1.1. Opening Remarks from SOT Chair 1.1.1 Adoption of the Agenda 1.1.2 Report from the SOT Chairperson 1.2. Opening Remarks from IOC Secretariat 1.3. Opening Remarks from WMO Secretariat 1.4. Virtual meeting instructions	09:00 – 9:15
2. NATIONAL REPORTS	09:15 – 11:00
3. INDUSTRY/PARTNER PRESENTATIONS 3.1 Kongsberg 3.2 SubCtech 3.3 Science RoCs 3.4 International Research Ship Operators (IRSO)	11:15 – 11:30 11:30 – 11:45 11:45 – 12:00 12:00 – 12:15 End of first Day

DAY 2 - TUESDAY 14 SEPTEMBER 2021 - OPEN BY SOT CHAIR AT 0900 UTC CLICK HERE TO JOIN PLENARY SESSION	
4. METADATA 4.1 Metadata/ID Numbers 4.1.1 SOT – ID / WIGOS – ID 4.1.2 Report of the Task Team on Unique ID Observation Scheme 4.2 Metadata/Pub 47 – Including Report of the Task Team on Metadata	09:05 – 10:00 10:15 – 10:30
5. KEY PERFORMANCE INDICATORS (KPI) - Including Report of the Task Team on KPI	10:30 – 11:00
6. BUFR STATUS	11:15 – 11:30
7. OPEN-GTS/THIRD PARTY	11:30 – 12:00 End of second Day

DAY 3 - WEDNESDAY 15 SEPTEMBER 2021 - OPEN BY SOT CHAIR AT 0900 UTC **CLICK HERE TO JOIN PLENARY SESSION**	
8. OceanOPS	**09:05 – 09:30**
9. BREAKOUT SESSIONS (***Parallel sessions***) **9.1 VOS and ASAP Breakout Sessions** **CLICK HERE TO JOIN VOS AND ASAP BREAKOUT** **9.1.1 VOS Panel - including** **9.1.1.1 VOS Report,** **9.1.1.2 E-SURFMAR Report** **9.1.1.3 E-SURFMAR QC Tools** **9.1.1.4 VOS GDAC Report (incl. Delayed Mode IMMT data)** **9.1.1.5 PMO 6 Review** **9.1.1.6 Other relevant VOS topics & Recommendations** **9.1.2 ASAP - including Report of the ASAP Task Team** **9.2 SOOP Breakout Session** **CLICK HERE TO JOIN SOOP BREAKOUT** **9.2.1 SOOPIP Status Report – including** **9.2.1.1 XBT Science Team: Updates and Recommendations** **9.2.1.2 XBT Best Practices: Progress and call for contributions** **9.2.1.3 Environmental Stewardship: XBT Environmental Impact** **9.2.1.4 pCO2 Operations Status Report** **9.2.1.5 CPR Operations Status Report** **9.2.1.6 Other relevant SOOP topics & Recommendations**	**09:45 – 11:15** **09:45 – 11:15**
BREAKOUT SESSION REPORTS	**11:15 – 11:45**
10. EXECUTIVE BOARD STATUS ***(Including Election of SOT and Panel chairs, vice- and co-chairs, SOT and SOT-EB Terms of Reference)*** **10.1 SOT Financial Report** **10.2 SOT Implementation Strategy** **10.3 SOT-ASAP: From Task Team to Panel**	**11:45 – 12:00** **End of third day**

DAY 4 - THURSDAY 16 SEPTEMBER 2021 - OPEN BY SOT CHAIR AT 0900 UTC **CLICK HERE TO JOIN PLENARY SESSION**	
11. OCEAN DECADE **11.1 Discussion of U.N. Decade of Ocean Science for Sustainable Development** **11.2 OceanOPS "Odyssey" Program submission**	 **09:05 – 09:15** **09:15 – 09:30**
12. CAPACITY DEVELOPMENT **12.1 Report of the Task Team on Recruitment, Promotion and Training**	 **09:30 – 10:00**
13. OCEAN BEST PRACTICES **13.1 Best Practices** **13.2 Task Team on Instrument Standards and Satellite Communication Systems, including Review of WMO Pub No 8**	 **10:15 – 10:30** **10:30 – 10:45**
14. SECRETARIAT UPDATE AND ADJOURN **14.1 WMO Secretariat Report** **14.1.1 SOT Focal Points / PMO & TT Lists** **14.2 IOC Secretariat Report** **14.3 Next SOT session** **14.4 Any Other Business / Closing remarks**	 **11:00 – 11:20** **11:20 – 11:40** **11:40 – 12:00** **End of the Session**

Annex III - Universally Unique Identifiers for VOS Observations

Introduction

Duplicated weather observations from Voluntary Observing Ships have been a long-standing problem for users of the observations within both the operational and research communities. The detection of duplicates, whilst conceptually simple, is often complicated by corrections and unit conversions applied to individual elements within the weather reports and the masking of callsigns. At every processing step and whenever the data are forwarded small differences can be introduced, leading to increased effort to correctly identify those reports that have been duplicated. In order to aid the identification of such duplicated observations it was proposed at SOT-8 to add an additional field to store a unique identifier for each weather report to the BUFR template for VOS that was under development. The template was subsequently modified, validated and approved for operational use from November 2016 onwards. However, within the template (and WMO manual on codes) there is little guidance on how to set the unique identifier field. This short document attempts to rectify that.

UUIDs

Following discussion within the ad-hoc Task Team on Unique Identifiers [75] it was agreed to recommend version 4 of the Universally Unique Identifier (UUID) standard (e.g., IETF, 2005[76]) for the generation of the unique identifiers. UUIDs generated following this standard can be represented textually as a 32-character hexadecimal string split into 5 groups, e.g.

50d42ffc-c95c-4383-86b6-30d05dd5d57c

This choice was made as the generation of UUIDs is supported by most modern computing platforms and languages[77] and are widely used in other fields. More importantly, due to the method in which UUIDs are generated the likelihood of collision between UUIDs is very small or negligible. As a result, UUIDs can be generated independently within different centres with minimal risk of duplication.

VOS BUFR Sequence 3-08-014 and UUIDs

BUFR Table B 01 (BUFR/CREX Identification) contains a descriptor for reporting unique identifiers (0 01 079, unique identifier for the profile). Whilst initially for profile measurements this descriptor can be used for other unique identifiers and has been included in the current / recommended VOS sequence (3 08 014) but expanded from the default 8 characters to 32 characters to store the full UUID. For practical purposes the hyphens can be dropped, i.e., the example UUID above becomes:

50d42ffcc95c438386b630d05dd5d57c

Implementation

The purpose of the UUIDs in the VOS BUFR sequence is to aid the identification of duplicate observations within the different data streams. To avoid the same observation being given multiple different UUIDs only the centre that receives the observation directly from the vessels and performs the BUFR encoding should generate the UUIDs. Any other centre processing the observations should leave the UUID field (0 01 079) unmodified, including leaving it blank or missing when not set by the original encoding centre.

[75] E.g., https://goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=23690
[76] https://tools.ietf.org/html/rfc4122
[77] E.g., see https://www.uuidgenerator.net/dev-corner for examples in different languages.

Annex IV – Terms of Reference

The following revised Terms of Reference were agreed by the Team and were subsequently approved by the SOT Executive Board at its meeting on 26 October 2021. Terms of Reference for the Ship Observations Team and all its sub-groups are maintained on the OceanExpert dashboard at **https://oceanexpert.org/group/106**

Task Team on Instrument Standards and Satellite Communications Systems (TT—ISSC)

Terms of Reference

The Task Team will:

1. Compile information and provide guidance on existing activities, procedures and practices within SOT relating to instrument testing, standardization and intercalibration, as well as the standardization of observation practices and procedures;
2. Using guidance contained in existing guides, including the WMO Guides on Instruments and Methods of Observation (WMO-No.8), communicate with manufacturers regarding new technologies and recognized equipment problems when requested;
3. Prepare dedicated Webpages containing this information, to be made widely available through the SOT web site and linked from other relevant websites;
4. Organise inter-comparisons as required by SOT sessions;
5. Review and comment on relevant WMO Publications, when requested, to make sure they are kept up to date;
6. Evaluate the operational and cost-effective use of satellite data telecommunication systems for the real-time collection of VOS and SOOP data in support of the World Weather Watch, GOOS, and GCOS;
7. Evaluate and propose new communication systems for conventional VOS to substitute Code 41 and continue to monitor the cost implications of Code 41;
8. Liaise with international organizations (IMO, IMSO) and with telecom providers to take into account expected evolutions relevant to SOT;
9. Monitor UUIDs within VOS reports encoded using BUFR sequence 308014;
10. Verify Task Team Membership on an annual basis and advise SOT EB and SOT TC of any changes.

Members

Jean-Baptiste COHUET (TT Chair) (France)
Martin KRAMP (ex officio, SOT TC)
Christophe BILLON (France)
Francis BRINGAS (United States)
Joel CABRIE (Australia)
Mardené DE VILLIERS
Darin FIGURSKEY (United States)
Henry KLETA (Germany)
Rudolf KROCKAUER (Germany)
James LUCIANI (United States)
Balakrishnan NAIR (India)
Emma STEVENTON (United Kingdom)
Michael POTOCHNEY (United States)
Peter ROUX (South Africa)
Rene ROZEBOOM (Netherlands)
Adam RYAN (United Kingdom)
Shawn SMITH (United States)
Joaquin TRINANES (United States)
Mayu YAMAMOTO (Japan)

Task Team on Metadata (TT-Metadata)

Terms of Reference

The Task Team will:

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. 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

Members

Emma STEVENTON (TT Chair) (United Kingdom)
Henry KLETA (Acting Chair) (Germany)
Vice Chair: Vacant
Martin KRAMP (Ex officio, SOT TC)
Anthonin LIZÉ (France)
Jean-Baptiste COHUET (France)
Joel CABRIE (Australia)
Eric FREEMAN (United States)
Venkat Shesu REDDEM (India)
Matthias HOIGT (Germany)
Rudolf KROCKAUER (Germany)
Rebecca COWLEY (Australia)
Tamaryn MORRIS (South Africa)
Richard CORNES (United Kingdom)
Puneet JASWAL (Canada)

Task Team on Key Performance Indicators (TT-KPI)

Terms of Reference

The Task Team will:

1. Considering the User requirements for observations (OSCAR/Requirements);

2. Considering the existing leading programs in each panel of the SOT, with their existing Key Performance Indicators;

3. The Task Team shall derive Key Performance Indicators for the various panels of the SOT;

4. Noting that such Key Performance Indicators shall inform about current situation and progress regarding

   i. Implementation,
   ii. Data Flow,
   iii. Instrumentation,
   iv. Operations,
   v. Data Uptake and
   vi. International Cooperation (as relevant);

5. Such Key Performance Indicators shall be implemented on OceanOPS website;

6. Further develop SOT-wide metrics on spatiotemporal coverage, relating those metrics to the requirements as specified in the WMO Rolling Review of Requirements (RRR) and in coordination with the GOOS OCG/networks, GCOS AOPC and OOPC, and other relevant groups;

7. Review existing KPI's and make recommendations to the SOT EB for the development of an extended range of metrics for the monitoring of data flow for quality and completeness of reports;

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

Members

Elizabeth KENT (Chair) (United Kingdom)
David BERRY (ex-lead)
Axel ANDERSSON (Germany)
Darin FIGURSKEY (Ex officio – SOT Chair)
Henry KLETA (Ex officio – VOSP Chair)
Martin KRAMP (Ex officio – SOT TC)
Rudolf KROCKAUER (Germany)
Shawn SMITH (United States)
Janet SPRINTALL (United States)
Callum STONE (United Kingdom)
Rik WANNINKHOF (United States)

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

Terms of Reference

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,
    f. and recommend new promotional aids or initiatives (e.g., social media), where appropriate;
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 VOS Operators, PMOs and observers and propose new documents where appropriate;
6. Provide advice to Nautical Colleges about training syllabuses for observers;
7. Encourage initiatives to increase VOS recruitment, particularly in data sparse areas such as the Polar regions;
8. Propose initiatives to assist member countries seeking to establish new national VOS networks;
9. Review relevant GOOS publications to ensure they are up to date with respect to VOS Classes, 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.

Members

Joel CABRIE (Chair) Australia
Mardené de VILLIERS (Vice-Chair) (South Africa)
Martin KRAMP Ex officio (SOT TC) OceanOPS
Francis BRINGAS (United States)
Jean-Baptiste COHUET (France)
Michael FUNNELL (Australia)
Marie Jose GUERRERO (Spain)
Robert NIEMEYER (United States)
Larry Hubble (United States)
Michael POTOCHNEY (United States)
Susanne RIPKE (Germany
Emma STEVENTON (United Kingdom)
Philippe GAUTIER (France)

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

Terms of Reference

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

Members:

Darin FIGURSKEY (SOT Chair) (United States)
Jean-Baptiste COHUET (France)
Kevin O'BRIEN (United States)
Chris PAVER (United States)
Shawn SMITH (United States)
Brian TETREAULT (United States)
Henry KLETA Ex-officio, VOS Panel Chair (Germany)
Martin KRAMP Ex-officio, (SOT TC) OceanOPS

Yvonne SCHAVEMAKER (contact only) (Netherlands)

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

Terms of Reference

The Ad hoc Task Team will:

1. Check the current status of the IMMT data format;
2. Analyse the implications of changing the IMMT data format on existing VOS dataflows and tools;
3. Collect requirements for marine meteorological data exchange (in the MCDS);
4. Identify elements that need to be added to a new format and / or are no longer needed;
5. Specify a new delayed mode data format;
6. Discuss technical implementation issues;
7. Adapt MQC standards to the new data format;
8. Liaise with other working groups (e.g., within the WMO commissions) when necessary;
9. Encourage the development of common procedures for producing IMMT formatted observations from Automatic Weather Stations (AWS);
10. Verify Task Team Membership on an annual basis and advise SOT EB and SOT TC of any changes.

Members

Axel ANDERSSON (Chair) (Germany)
Vice-Chair: Vacant
Henry KLETA (VOSP Chair, ex officio)
Martin KRAMP (SOT-TC, ex officio)
Hildrun OTTEN_BALLACCANU (VOS-GDAC) (Germany)
Callum STONE (VOS-GDAC) United Kingdom
Eric FREEMAN (United States)
Shawn SMITH (United States)
Elizabeth KENT (SOT Vice Chair) (United Kingdom)
Fraser CUNNINGHAM (United Kingdom)
Jean-Baptiste COHUET (France)

.....

ASAP (Automated Shipboard Aerological Programme) Panel

(Previously Task Team on ASAP)

Terms of Reference

1. Coordinate and encourage the overall implementation of the ASAP, including recommending routes and monitoring the overall performance of the programme, both operationally and in respect of the quality of the ASAP system data processing;

2. Coordinate the exchange of technical information on relevant meteorological equipment and expendables, development, functionality, reliability and accuracy, and survey new developments in instrumentation technology and recommended practices;

3. Review all relevant publications to make sure they are kept up to date and comply with Quality Management terminology;

4. Prepare annually a report on the status of ASAP operations, data availability and data quality.

VOS Panel

Terms of Reference

The Voluntary Observing Ship (VOS) Panel shall:

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

2. Support the development and maintenance of new pilot projects;

3. 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);

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

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

SOOP Implementation Panel

Terms of Reference

The Ship-of-Opportunity Implementation Panel (SOOPIP) coordinates the installation and deployment of instrumentation from Ships of Opportunity that travel in fixed transects, and in particular coordinates the implementation of regional and basin-wide instrumentation that measure physical, chemical and biological parameters, such as XBTs, TSGs, pCO_2 and CPR.

Its terms of reference are to:

1. Implement, maintain, and monitor specialized shipboard instrumentation and observing practices relevant to the SOOPIP;

2. Coordinate the exchange of recommended practices, and technical and developmental information about oceanographic instrumentation relevant to the SOOPIP;

3. Ensure the distribution of available programme resources to ships to meet the recommended sampling network in the most efficient way;

4. Ensure the transmission of SOOP data to the GTS and relevant data centres is carried out according to operational and scientific requirements;

5. Provide guidance and assistance to the SOT Chairperson and SOT Technical Coordinator to produce, appropriate inventories, monitoring reports and analyses, performance indicators, implementation plans and information exchange facilities;

6. Where relevant, serve as a platform for other observational programmes;

7. Maintain close communications with the scientific community and periodically meet and discuss ongoing research performed with observations relevant to SOOPIP.

Annex V - New SOT Metadata Format

explanation:

- M² Mandatory to request an SOT-ID (NB: IMO# or ICES code are required, not both)
- M Mandatory metadata that is required to register a station at OceanOPS
- C Shall be delivered if available
- O Optional

Metadata		Name	M / O / C	content of field	remarks	Example
SHIP		Ship Name	M²	free text		Sonne
		IMO#	M²	9 digits (ready for extension)	if available, else NIL	9633927
		ICES code	M²	4 char	if available, else NIL	NIL
		Country of registration	C	ISO 2	Flagstate of vessel	DE
		Call Sign	C	min 4 max 7 char		DBBE
		MMSI	C	8 digits		21162740
		Hide Ship Metadata Option	M²	boolean	1 (Yes) / 0 (No)	0
		Vessel type	C	ref table		RV
		vessel length	C	real, . decimal meters		118.42
		vessel breadth	C	real, . decimal meters		20.6
		freeboard	C	real, . decimal meters		NIL
		draft	C	real, . decimal meters		6.4
		cargo height	C	real, . decimal meters		NIL

		distance bridge bow	C	real, . decimal meters		NIL
		max speed	C	real, . decimal knots		15.0
		Shipping Company	O	free text		Briese
not public		Ship Contact Shore Name	O	free text	e.g. shipping company	Briese Research
not public		Ship Contact Shore eMail	O	eMail address	eMail address of PIC	not public
not public		Ship Contact Sea eMail	O	eMail address	eMail adddress of ship	not public
STATION		GTS-ID	M²	min 4 max 7 char	call sign, MASK, SOT-ID	BLSFV3U
		Class-Category	M²	ref table	VOS: new VOS class	NMHS operated
		Programme	M²	ref table	based on operator	VOS-DE
		Additional Programme Affiliation	O	ref table		E-SURFMAR
		Schedule of Observation	M	ref table		hourly
		Area of Operation	O	ref table	e.g. target XBT line	NIL
		Target Inspection Interval	O	ref table		annual
		start date	M	YYYY-MM-DD	installation date	2014-02-10
		stop date	O	YYYY-MM-DD		NIL
		Observing Height	O	real, . decimal meters	visual observing height	14.0
		Observing system main device	M/O	ref table	e.g. AWS or XBT Recorder	EUCAWS
		main device serial number	O	ref table		00367462
		main device version number	O	ref table		0.4.2
		Observing system ancillary device	M/O	ref table	e.g. TBW or XBT Launcher	TurboWin
		ancillary device serial number	O	ref table		NIL
		ancillary device version number	O	ref table		5.0
		Maintenance activity	O			NIL
		Telecom Service	M	ref table		ISDB
		Telecom Type	O	ref table	can be unknown	Iridium
		Latency	M	ref table		less than 1 hour
		Ship2Shore dataformat	M	ref table		#100

SENSOR		parameter:make_model	M:M	ref table:ref table	ID ref table	ATM:Vaisala_PTB330
[1..n]		serial	O	serial number of sensor		1234
		start date	M	YYYY-MM-DD		2020-04-29
		stop date	O	YYYY-MM-DD		NIL
		configuration	O	ref table		vented to the outside
		configuration - location	O	ref table		Technical room
		configuration - sideindicator	O	ref table	STB;PB,NIL	NIL
		measurement unit	O	autogenerate or overwrite		NIL
		vertical distance from SLL	O	real, . decimal meters		14.0
		height of sensor above deck	O	real, . decimal meters		1.8
		distance from bow	O	real, . decimal meters		NIL
		distance from center line	O	real, . decimal meters		NIL
		date of last calibration	O	YYYY-MM-DD		2021-05-01
		next calibration due date	O	YYYY-MM-DD		2023-05-01
		instrument operating status	O	autogenerate		NIL
		instrument specs: range	O	autogenerate or overwrite		NIL
		instrument specs: resolution	O	autogenerate or overwrite		NIL
		instrument specs: precision	O	autogenerate or overwrite		NIL
		instrument specs: accuracy	O	autogenerate or overwrite		NIL
		sensor sampling period	O	ref table	sensor specific	9sec
		total sampling period	O	ref table	observation specific	1min
		data processing algorithms	O	ref table		mean
		instrument control schedule	O	ref table		annually

Annex VI - Report of the VOS-GDACs to the ELEVENTH SESSION of SOT

1. VOS Data

The Marine Climatological Summaries Scheme (MCSS) was established by the WMO Commission for Marine Meteorology in 1963. In an effort to improve data flow and quality of global marine data two Global Collecting Centres (GCCs) were created in 1994.

In 2017, at the Fifth session of JCOMM, the MCSS was declared obsolete and officially replaced by the Marine Climate Data System (MCDS). The VOS-GDACs (Voluntary Observing Ship Global Data Assembly Centres) operate in the structure of the new MCDS.

The 2020 VOS-GDAC report marks the 27th year of operation. The main highlights from the report are:

- 1,562,377 observations from 14 countries were received and processed by the VOS-GDACs, with an increasing number of observations from automatic weather stations (AWS).
- In 2020 the VOS-GDACs received observations from 558 VOS.
- 62% of the data were observed in the last two years, 2019 and 2020 (see Figure 1).
- 55% of the received observations were coded in the most IMMT-5 format and 43% in the IMMT-4 format. 1% of the received observations were coded in the older IMMT-3 format and 1% in the very old IMMT-1 format.

The full report is available from https://dwd.de/vos-gdac

Number of Contributed Observations 2020

Country Name	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
Argentina					0
Australia	1.644	2.328	562		4.534
Brazil					0
Canada				227.274	227.274
Croatia				18.845	18.845
France	50.614	48.812	33.622	51.473	184.521
Germany	167.753	45.490	89.441	91.235	393.919
Greece					0
Hong Kong, China	3.001	3.000	3.000	3.000	12.001
India					0
Ireland					0
Israel					0
Italy					0
Japan	1.598	2.481	2.736	4.138	10.953
Kenya					0
Malaysia					0
Netherlands				8.147	8.147
New Zealand	1.929	1.487			3.416
Nigeria					0
Norway	9.966	8.066		21.518	39.550
Poland	388				388
Russian Federation	1.531	1.961	1.470	1.921	6.883
Singapore					0
South Africa				801	801
Sweden					0
United Kingdom	9.886		54.144	587.115	651.145
USA					0
14 of 27 Contributing Countries	**248.310**	**113.625**	**184.975**	**1.015.467**	**1.562.377**

Table 1: Number of contributed observations for each quarter of 2020 (Countries without any contribution in 2020 are marked in red)

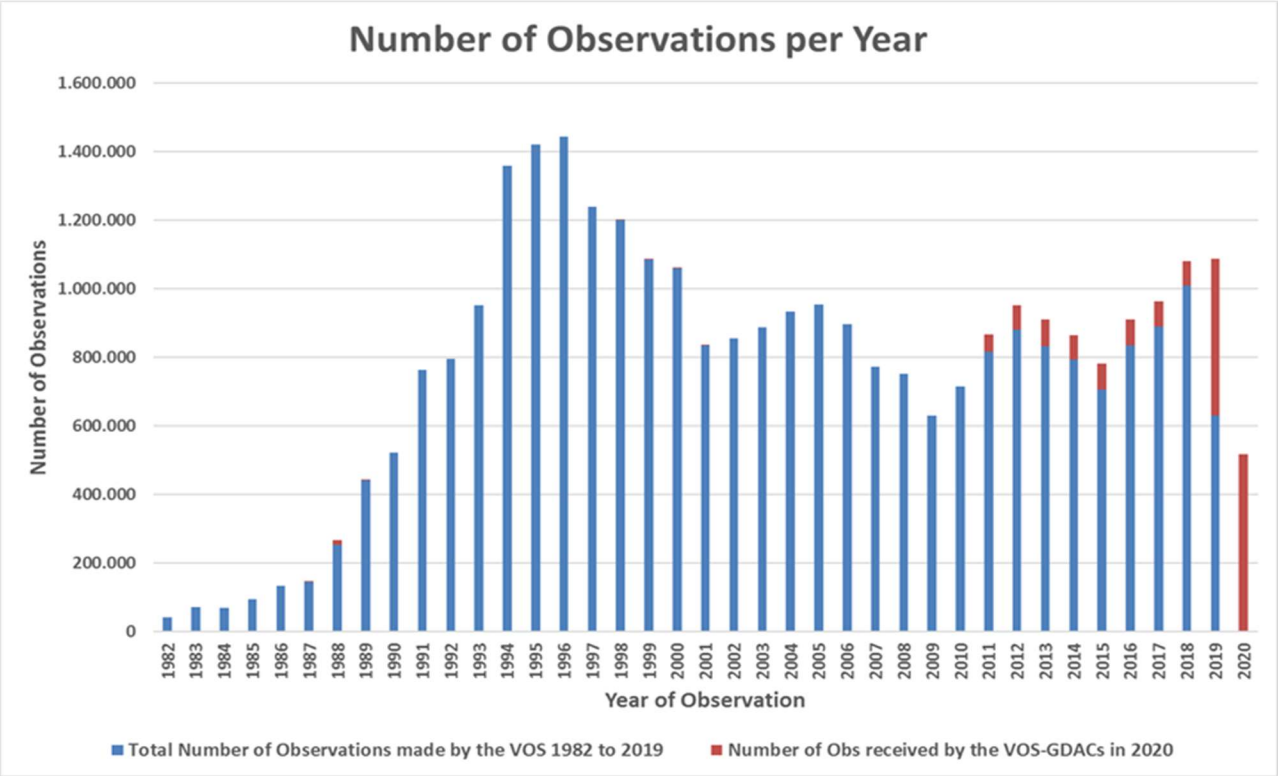

Figure 1: Total number of observations per year

- When evaluated against the MQCS, the majority of the reported elements were again found to be of good quality. Such elements were assigned a QC Flag of '1' meaning 'element appears correct'. For example, frequently reported elements such as air pressure, wind direction, wind speed, and sea surface temperature were flagged with a '1' in over 99% and the air temperature in 97% of cases.
- There were 3216 observations (0.2%) showing on-land positions. These are plotted as red dots in Figure 2.

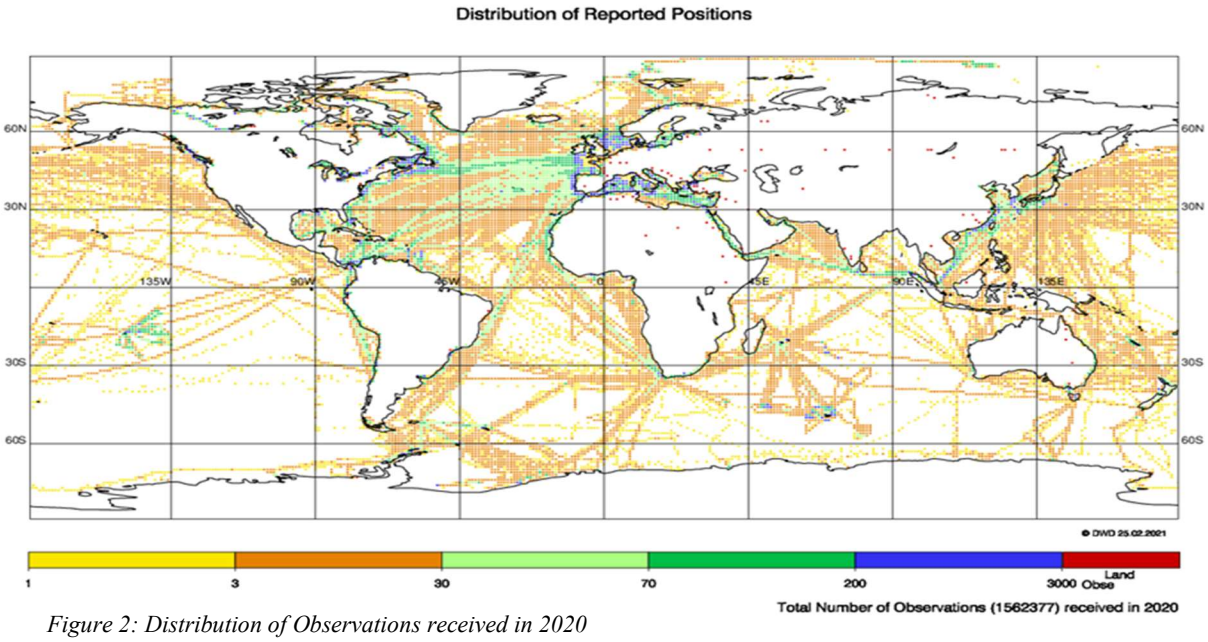

Figure 2: Distribution of Observations received in 2020

2. VOSClim Data

The VOSClim Project aimed at providing a high-quality subset of marine meteorological data with detailed information on how data have been obtained. These data are available in delayed mode and are of great value to both operational marine forecasting and global climate studies. The VOSClim ship list is produced by OceanOPS (WMO-IOC Joint Centre for Oceanography and Meteorology in situ Observations Programmes Support (previously JCOMMOPS)).

Total Number of Observations from VOSClim-Ships / Number of Observations with VOSClim-Elements from VOSClim-Ships / Number of Observations with VOSClim-Elements from not listed ships 2020

Country Name	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter			Total		
Australia	1.091	1.090	147	699	696	557	0	0	524	0	0	0	1.790	1.786	1.228
Canada	0	0	0	0	0	0	0	0	0	216.130	0	0	216.130	0	0
France	46.615	46.615	3.980	44.685	44.685	3.225	30.974	30.974	2.430	47.709	47.709	3.435	169.983	169.983	13.070
Germany	12.248	5.107	903	1.482	0	0	2.242	0	0	2.830	0	0	18.802	5.107	903
Hong Kong, China	2.364	0	0	2.147	0	0	2.007	0	0	2.660	0	0	9.178	0	0
India	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Japan	0	0	0	0	0	0	0	0	0	2.865	2.865	0	2.865	2.865	0
Netherlands	0	0	0	0	0	0	0	0	0	6.043	5.911	1.393	6.043	5.911	1.393
New Zealand	542	0	0	0	0	449	0	0	0	0	0	0	542	0	449
South Africa	0	0	0	0	0	0	0	0	0	801	0	0	801	0	0
United Kingdom	9.032	7.363	669	0	0	0	54.144	0	0	0	0	0	63.176	7.363	669
USA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 of 12 countries	71.892	60.175	5.699	49.013	45.381	4.231	89.367	30.974	2.954	279.038	56.485	4.828	**489.310**	**193.015**	**17.712**

Table 2 : VOSClim class observations submitted for each quarter of 2020

During 2020:

- 489,310 observations were received and processed from VOSClim registered ships.
- This represents 31% of data received by the VOS-GDACs from the VOS fleet.
- 10 of the 12 countries with registered VOSClim ships submitted observations (see Figure 5).
- The VOS-GDACs received data from over 226 ships listed as VOSClim.
- 193,015 of the VOSClim observations (39%) contain the VOSClim defined additional elements.
- Nearly 100% of the data from VOSClim registered ships provided by France, Japan, Australia, and the Netherlands contain the VOSClim defined additional elements.

3. Call Sign Masking

- In 2019 and 2020 the VOS-GDACs received only unmasked call signs from the DACs.

4. Developments and Future Changes

- Formats and Standards: IMMT-5 and MQCS-7 were adopted at JCOMM-4 in May, 2012 and were in effect from June, 2012. These include only minor updates of wording and QC limits (see links for the full IMMT-5 & MQCS-7).
  The IMMT-format should be expanded to accommodate the extra resolution that BUFR provides for certain elements, for example, the date/time group should include minutes and positions and temperatures should be expanded to take the resolution of one-hundredth of a degree rather than one-tenth. More incompatibilities may exist between BUFR and IMMT and should be investigated to avoid data loss by incorrect conversion procedures.

- MCDS: The new Marine Climate Data System (MCDS) encompasses a generic data flow structure with defined roles and tasks to be applied to all marine data types for the management of climate data. Further information about the MCDS is provided in the respective sections of the VOS-GDAC annual report 2020. The full terms of reference for MCDS data centres, data formats and Quality Control Standards are included in WMO Manual 558 (2012 Edition, updated in 2018) and WMO Guide 471 (2018 Edition).

- WIS DCPC: Both VOS-GDACs have been identified as "Data Collection and Production Centres" (DCPCs) for the WMO Information System (WIS) and are able to provide more than 30 million MQCS-checked and flagged observations received by the VOS-GDACs from 1996 up to now. Additionally, all contributed original records are saved and free available at https://gisc.dwd.de/wisportal/ by entering "gcc*" in the search field.

- HQCS: New Higher Quality Control Standard (HQCS) developed by DWD is proposed to be used as the basis for a software package for automatic quality checks within the new MCDS VOS-GDACs.

- Problems uncovered: During the first quarter of 2013 the VOS-GDACs discovered problems with coding of relative humidity in TurboWin version 5. Both VOS-GDACs worked to resolve the issues. The bug has been fixed since TurboWin Version 5.6 and NMHS should update the TurboWin Software to eliminate the bug in relative humidity reports of IMMT.
  Investigated and proposed changes to IMMT and MQCS to the new three VOS classes:
  NMHS Operated
  NMHS Cooperative
  Independent

Annex VII – E-ASAP Fleet

Station SOT ID	Service	Sounding equipment
ASEU01 LRYQE3U	Northern Europe – East coast US	Equipped with a manual launcher and GRAW GS-E on the bridge. Most crew members involved in launching operations.
ASEU02 JNKN7JF	Northern Europe – East coast US	Equipped with a manual launcher and GRAW GS-E on the bridge. Most crew members involved in launching operations.
ASEU03 7JUNA4N	Northern Europe – East coast US	Equipped with a manual launcher and GRAW GS-E on the bridge. Most crew members involved in launching operations.
ASEU04 YLV96WM	Northern Europe – East coast US	Equipped with a manual launcher and GRAW GS-E on the bridge. Most crew members involved in launching operations.
ASEU05 KMPLHPW	Northern Europe – East coast US	Equipped with a manual launcher and GRAW GS-E on the bridge. Most crew members involved in launching operations.
ASEU06 WDK38HS	No regular service, Research ship	Equipped with a 10' container launcher and Vaisala MW41 inside the container. Launches usually carried out by the electronic engineer.
ASDE01 FPUW5GN	No regular service, Research ship	Equipped with a 10' container launcher and Vaisala MW41 in the ship. Launches usually carried out by the electronic engineer (system administrator). The old container launcher was replaced by a new container in 2021.
ASDE02 ZVQEQCM	No regular service, Research ship	The 20' container launcher is equipped with a Vaisala MW41. Launches are carried out by a professional observer of Deutscher Wetterdienst DWD.
ASDE03 VKB4L5Q	Mediterranean – Montreal	Equipped with a manual launcher and Vaisala MW41 on the bridge. Launches usually carried out by the ship's officers.
ASDE04 XQFJRGX	Northern Europe – Montreal	Equipped with two manual launchers (starboard and portside) and Vaisala MW41 on the bridge. Launches usually carried out by two cadets on board.
ASDK01 ATGU3FT	Denmark – West coast Greenland	This station (formerly ID FHM5UJH) was inactive since Jan-2020. Reinstallation on board new ship in July 2021. Equipment: manual launcher and MODEM SR10.
ASDK02 HTXUH4H	Denmark – West coast Greenland	The launcher is integrated in the ship. The Vaisala MW41 sounding system is installed on the bridge. The station has to be transferred to another ship in 2021.
ASDK03 -/-	Denmark – West coast Greenland	Inactive since May 2020. The station shall be transferred to new host ship by end of 2021.
ASFR1 UXK5JTU	North West Europe – French West Indies	Inactive from May 2019 – Aug 2020. Equipped with an open deck launcher and MODEM SR10 on the bridge. Launches usually carried out by the electricians.
ASFR2 KJJF9XN	North West Europe – French West Indies	Equipped with an open deck launcher and MODEM SR10 on the bridge. Launches usually carried out by the electricians.
ASFR3 2EERVTP	North West Europe – French West Indies	Inactive from July 2019 – Jul 2021 (former ID QCY3TGN). Equipped with an open deck launcher and MODEM SR10 on the bridge. Launches usually carried out by the electricians.
ASFR4 BPMWB2N	North West Europe – French West Indies	This station was transferred to new host ship in Oct 2019 (former ID 7HCPVTB). The ship is equipped with an open deck launcher and MODEM SR2K sounding system in the wheelhouse. Launches usually carried out by the electricians.
ASES01 XKQLWQB	No regular service, Hospital ship	The 10' container launcher is equipped with a Vaisala MW21. Launches usually carried out by the 1st officer. The old container will be replaced by a new container by end of 2021.

Annex VIII – Financial Status Reports

WMO OMM
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Trust Fund for JCOMM support - Sub award no. A101189
Trust Fund 421306
Final Statement of income and expenditure
From inception to 30 June 2020
(amounts in US Dollars)

	2020	Cumulative
1. Balance of fund at 1 January 2019	47,442.10	-
1.1 Voluntary contribution	-	2,596,931.00
1.2 Gain in currency exchange	-	369.06
1.3 Interest	-	792.41
1.4 Total Income	47,442.10	2,598,092.47
2. Expenditure		
2.1 Direct project costs		
2.1.1 Technical Coordinator, OOPC - Ms Hill	-	788,985.38
2.1.2 Technical Coordinator: Argo Information Centre, Mr M. Belbeoch	-	711,239.50
2.1.3 JCOMMOPS IT Hosting	-	187,419.52
2.1.4 Technical Coordinator: DBCP, Mr Long Jiang	-	271,330.19
2.1.5 JCOMMOPS Development in 2015	-	102,041.45
2.1.6 Technical Coordinator, Ship time, Mr Kramp	44,338.41	218,448.97
2.1.7 Technical Coordinator: DBCP-SOT, Ms Gallage Dona	-	53,175.58
2.1.8 Administrative Assistant, SOT, Ms Magali Krieger	-	33,949.14
2.1.9 Technical Coordinator: DBCP-SOT, Mr Martin Kramp	-	27,833.63
2.1.10 Consultant, SOT, Ms Sarah North	-	7,907.11
2.1.11 Contribution to GCOS activities	-	28,492.31
2.1.13 Total Direct project costs	44,338.41	2,430,822.78
2.2 Indirect project costs		
2.2.1 WMO overhead (7%)	3,103.69	170,157.59
2.2.2 Loss in currency exchange	-	(3,528.23)
2.2.3 Bank charges	-	640.33
2.2.4 Total indirect costs	3,103.69	167,269.69
2.3 Total expenditure	47,442.10	2,598,092.47
3. Balance of fund at 30 June 2020	**0.00**	**0.00**

Certified correct:

Brian Cover
Chief, Finance Division
30 July 2020

Certified correct:

Lars Peter Riishojgaard, PhD
Director, Earth System Branch
Infrastructure Department

WHOI Trust Fund- 2020 Financial Statement

WMO OMM

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WHOI Trust Fund
Trust Fund 421398
Final Statement of income and expenditure
For the period inception to 31 December 2020
(Amounts in Swiss Francs)

1. Income			
1.1 Contributions a/			649,698.65
2. Total available funds during reporting period			649,698.65
3. Expenditure			
3.1 Direct project costs			
3.1.1 Salaries and Wages	342,041.46		
3.1.2 Contributions to GCOS	163,531.31		
3.1.3 IT costs	50,812.18		
3.1.4 Total direct costs		556,384.95	
4.2 Indirect project costs			
4.2.1 Support costs at 7%	38,946.95		
4.2.4 Total indirect costs		38,946.95	
4.3 Total project expenditure			595,331.90
5. Balance of fund at 31 December 2020			**54,366.75**

a/

Contributions	
Woods Hole Oceanographic Institution (USD 650,349)	649,698.65
Total contributions	**649,698.65**

Certified correct:

Brian Cover
Chief, Finance Division
30 April 2021

Certified correct:

Champika Gallage
Project Manager
30 April 2021

ASAP Trust Fund – Final Statement

WMO OMM

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ASAP Trust Fund

Final Statement of income and expenditure
For the period 1 January 2019 to 29 March 2021
Amounts in Swiss Francs

1. Balance of fund at 1 January 2019	**12,906**
2. Transfer balance to DBCP Trust Fund, SOT Project	(12,906)
3. Balance of fund at 29 March 2021	-

Certified correct:

Brian Cover
Chief, Finance Division
29 March 2021

Certified correct:

Champika Gallage
Project Manager
29 March 2021

DBCP Trust Fund Financial Report - 2020

WMO OMM

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DATA BUOY CO-OPERATION PANEL
Trust Fund 421309
Final Statement of Income and expenditure
For the period 1 January to 31 December 2020
Amounts in United States dollars

1. Balance brought forward , 1 January 2020			155.327
2. Income			
2.1 Contributions a/			276.198
2.2 Return of Argos Joint Tariff Agreements funds to CLS			(28.633)
2.3 Gain in exchange currency			1.817
3. Total available funds during reporting period			404.709
4. Expenditure			
4.1 Direct project costs			
4.1.1 JCOMMOPS			
4.1.1.1 IT Contract	64.637		
4.1.1.2 JCOMMOPS Logistical Support	55.730		
4.1.1.3 Other JCOMMOPS Expenses	13.315		
4.1.1.4 JCOMMOPS - General Activity	1.595		
4.1.1.5 ARGO-TC Travel	1.595		
4.1.1.6 DBCP-TC Travel	(318)		
4.1.1.7 JCOMMOPS Total		136.554	
4.1.2 OceanOPS - EuroSea			
4.1.2.1 OceanOPS Staff Direct Personnel Costs	53.982		
4.1.2.2 OceanOPS - EuroSea Total		53.982	
4.1.3 OceanOPS - Euro-Argo RISE			
4.1.3.1 OceanOPS Direct Costs for Subcontracting	31.214		
4.1.3.2 OceanOPS Direct Personnel Costs	6.883		
4.1.3.3 OceanOPS Travel	1.575		
4.1.3.4 OceanOPS - Euro-Argo RISE Total		39.672	
4.1.4 SOT			
4.1.4.1 SOT Chair and Other Travel	1.551		
4.1.4.2 SOT Total		1.551	
4.1.5 DBCP			
4.1.5.1 DBCP Chair Travel	976		
4.1.5.2 DBCP Total		976	
4.1.6 Total direct costs		232.735	
4.2 Indirect project costs			
4.2.1 Support costs at 3%	6.982		
4.2.2 Bank charges	326		
4.2.3 Total indirect costs		7.308	
4.3 Total project expenditure			240.043
5. Balance of fund at 31 December 2020			**164.666**
6. Balance comprised of the following projects:			
6.1 DBCP			108.896
6.2 JCOMMOPS			51.852 b/
6.3 SOT			31.695
6.4 WMO			18.563
6.5 OceanOPS - SeaDataCloud			8.550 b/
6.6 OceanOPS - Euro-Argo RISE			405 b/
6.7 JTA			-
6.8 OceanOPS - EuroSea			(55.255) b/
6.9 Total			**164.666**

a/

Contributions	
Météo France (EUR 55,000)	65.706
GEOMAR Germany	57.049
Ifremer, France	42.750
Euro-Argo ERIC, France	41.926
Environment Canada (CAD 39,500)	30.866
Australian Bureau of Meteorology (EUR 23,400)	26.807
National Institute of Ocean Technology, India	5.000
South African Weather Service (EUR 4,000)	4.578
BSH M22/SCOP, Germany (EUR 3,600)	4.301
Meteorological Services of New Zealand (EUR 1,800)	2.115
Total contributions	**275.198**

b/ *Amount excludes USD 116,013 of revenues that are deferred in compliance with IPSAS.*

The financial statement has been prepared on the accrual basis of accounting in accordance with the International Public Sector Accounting Standards (IPSAS). Therefore, the amount of contributions shown above excludes those that are deferred in accordance with IPSAS.

Certified correct:
Brian Cover
Chief, Finance Division
19 July 2021

Certified correct:
Champika Gallage
Project Manager
19 July 2021

DBCP Trust Fund Financial Report – 1 January to 15 July 2021

WMO OMM

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DATA BUOY CO-OPERATION PANEL
Trust Fund 421309
Interim Statement of income and expenditure
For the period 1 January to 15 July 2021
Amounts in United States dollars

1. Balance brought forward , 1 January 2021			164.665
2. Income			
2.1 Contributions a/			66.748
2.2 Transfer from ASAP Trust Fund			14.534
3. Total available funds during reporting period			245.947
4. Expenditure			
4.1 Direct project costs			
4.1.1 JCOMMOPS			
4.1.1.1 IT Contract	18.458		
4.1.1.7 JCOMMOPS Total		18.458	
4.1.2 OceanOPS - EuroSea			
4.1.2.1 OceanOPS Staff Direct Personnel Costs	62.172		
4.1.2.2 OceanOPS - EuroSea Total		62.172	
4.1.3 Total direct costs		80.629	
4.2 Indirect project costs			
4.2.1 Support costs at 3%	2.419		
4.2.2 Loss in currency exchange	9.419		
4.2.3 Bank charges	8		
4.2.4 Total indirect costs		11.845	
4.3 Total project expenditure			92.475
5. Balance of fund at 15 July 2021			**153.472**
6. Balance comprised of the following projects:			
6.1 DBCP			118.909
6.2 JCOMMOPS			28.905 b/
6.3 SOT			56.200
6.4 WMO			18.563
6.5 OceanOPS - SeaDataCloud			- b/
6.6 OceanOPS - Euro-Argo RISE			405 b/
6.7 JTA			-
6.8 OceanOPS - EuroSea			(69.511) b/
6.9 Total			**153.472**

a/

Contributions	
Météo France (EUR 55,000)	66.748
Total contributions	**66.748**

b/ *Amount excludes USD 116,013 of revenues that are deferred in compliance with IPSAS.*

The financial statement has been prepared on the accrual basis of accounting in accordance with the International Public Sector Accounting Standards (IPSAS). Therefore, the amount of contributions shown above excludes those that are deferred in accordance with IPSAS.

Certified correct:

Brian Cover
Chief, Finance Division
15 July 2021

Certified correct:

Champika Gallage
Project Manager
15 July 2021

Annex IX - SOT Implementation Strategy

NOTES
WMO DISCLAIMER

Regulation 42
Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43
In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

IOC (OF UNESCO) DISCLAIMER
The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariats of UNESCO and IOC concerning the legal status of any country or territory, or its authorities, or concerning the delimitation of the frontiers of any country or territory.

SOT Implementation Strategy – Version 2.1, December, 2021
CONTENTS

SOT Implementation Strategy – Version 2.1, December, 2021
RECORD OF CHANGES

Date	Page(s) affected	Reason for change	Author
December, 2021	Various	Removal of JCOMM and JCOMMOPS references, web link updates, added references to WMO Technical Commissions, transition of ASAP from a task team to a panel, and other miscellaneous updates and wording changes.	David Berry, S.T. Chan, Rebecca Cowley, Darin Figurskey, Champika Gallage, Henry Kleta, Martin Kramp, Lisa Krummel, Sarah North, Emma Steventon

SOT Implementation Strategy – Version 2.1, December, 2021

FOREWORD

The Ship Observations Team (SOT) was established in 2001, jointly by the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, to build on synergies between the three Panels involved in coordinating global ship-based observing programmes, i.e. the Voluntary Observing Ship (VOS) Scheme, the Ship-of-Opportunity Programme (SOOP), and the Automated Shipboard Aerological Programme (ASAP), with a view to a possible full-integration of ship-based observing systems on commercial and research vessels.

In recognition of these developments and expanded requirements, and in the context also of the implementation plans and requirements of the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS), the WMO Integrated Global Observing System (WIGOS), and the Global Framework for Climate Services (GFCS), the SOT agreed in 2011 at its sixth Session on the need for an SOT Implementation Strategy, which would provide an overall framework for the Team's work, and at the same time enable it and its members to react appropriately to future developments. The first SOT Implementation Strategy was published in JCOMM Technical Report No. 61 in March, 2014.

This Implementation Strategy continues to provide the rationale for the SOT mission, along with the vision, structure, and work flow of SOT and its core panels. The SOT terms of reference (Annex I) express the mission of the SOT to respond to requirements for ship-based observation data/metadata, coordinate actions among associated programs, liaise and coordinate as necessary with other program areas and expert teams, seek opportunities to improve the quality and quantity of data/metadata, assess the work of the SOT, perform outreach and capacity development as agreed by participating members and member states, develop improved real-time feedback, and promote greater Port Meteorological Officer (PMO) collaboration including support of other networks. The SOT will regularly review its mission and terms of reference, both for the entire SOT and its task teams, making updates to this implementation strategy as appropriate. This implementation strategy is meant to provide a succinct view of the strategic objectives of the SOT, through which the SOT will foster greater international coordination between entities involved in marine observing programs.

Darin Figurskey
(United States of America)
(Chairperson of the SOT)

1. IMPLEMENTATION STRATEGY

1.1 Structure

1.1.1 The Ship Observations Team (SOT) consists of a group of enduring and successful observing and data collection programmes under the GOOS Observations Coordination Group (OCG), comprising:

1.1.1.1 The Voluntary Observing Ship (VOS) scheme;

1.1.1.2 The Ship of Opportunity Programme (SOOP); and,

1.1.1.3 The Automated Shipboard Aerological Programme (ASAP).

1.1.2 The SOT has a governance structure of an Executive Board. Terms of reference for the Executive Board are found in Annex II.

1.2 Objectives

1.2.1 To manage, coordinate and, wherever possible, integrate these programmes to support a range of well-defined operational and research applications, with a priority to maintain and increase the quantity and quality of ship-based environmental observations.

1.2.2 To participate in, liaise and coordinate as necessary with GOOS expert groups and expert teams and the Joint WMO-IOC Collaborative Board (JCB), especially but not limited to the OCG, along with WMO Technical Commissions and their Standing Committees, Study Groups and Expert Teams, the WMO Research Board and Regional Associations, the Global Climate Observing System (GCOS), interested parties such as the International Maritime Organization (IMO), other relevant international organizations, and industry and manufacturers as appropriate, to provide increased maritime observational opportunities.

1.2.3 To foster greater national and international coordination between agencies involved in similar or related marine observing programmes to leverage resources, technology, and innovation, and to maintain and increase the quantity and quality of ship observations, along with reducing the number of visitors to ships with sampling programme requests.

1.2.4 To establish greater cooperation with groups that use ships as observing stations / platforms and/or for deploying autonomous instruments, to raise the awareness of:

1.2.4.1 Data and metadata standards;

1.2.4.2 Station / platform identification standards;

1.2.4.3 Minimum observational metadata;

1.2.4.4 Equipment and communications standards;

1.2.4.5 Equipment calibration;

1.2.4.6 Data processing methods, including quality control and quality monitoring;

1.2.4.7 Data reporting methods; and,

1.2.4.8 The need for comprehensive observer/operator training and retraining.

1.3 Working Arrangements

1.3.1 SOT meets approximately every 2 years and incorporates separate, but plenary sessions of:
1.3.1.1 The Voluntary Observing Ship Panel (VOSP);
1.3.1.2 The Ship-of-Opportunity Programme Implementation Panel (SOOPIP); and,
1.3.1.3 The Automated Shipboard Aerological Programme (ASAP) Panel.

1.3.2 Issues and reports that are of interest to all programmes are addressed during the Common Session of SOT.

1.3.3 The Common Session of SOT is presided over by the chairperson of SOT.

1.3.4 Issues and reports that are relevant to a particular programme or special project are addressed during the appropriate Panel Session.

1.3.5 The Panel Sessions are presided over by the chairpersons of VOSP, SOOPIP, and ASAP as appropriate.

1.3.6 Much of the work of SOT is achieved during the intersessional period by the SOT Executive Board (SOT-EB), and the task teams established to examine and make recommendations about specific issues. Task Teams work predominantly by email and report at SOT sessions. Contributions by the entire SOT are encouraged. SOT-EB meeting notes can be found at https://www.ocean-ops.org/sot/index.html

1.3.7 Scientific advice and guidance to SOT is provided by panels and bodies for climate and operational meteorology including, but not limited to, national meteorological and hydrological services (NMHS), the WMO Scientific Advisory Panel, the Atmospheric Observation Panel for Climate (AOPC), the Ocean Observations Physics and Climate Panel (OOPC), etc. (Also reference section 3).

1.4 Vision

The mission of the Ship Observations Team is to:

1.4.1 Promote the free and unrestricted exchange of quality ship-based weather and ocean observations for a better understanding and prediction of the marine environment and to support safety of life at sea.

1.4.2 Develop and maintain a process for ships from commercial, private, and research fleets to register their instrumentation.

1.4.3 Improve the coordination of observations between nations, standardize and advance observational and metadata methods and quality assurance and quality control, and ensure consistent data management.

1.4.4 Increase sampling in under-sampled regions of the world oceans, increase the frequency of observations even along well-travelled shipping lanes, and measure multiple parameters simultaneously on a single ship.

1.4.5 In cooperation with other networks and the OCG, develop a unified data management for shipboard observations and metadata, with real-time and delayed-mode delivery approaches, that meets the needs of a diverse user community.

1.4.6 Foster greater international capacity for the VOS programme, SOOP, and ASAP, including, but not limited to, developing nations.

1.4.7 Foster regional and gender balance among the SOT leadership.

1.4.8 Raise the technology readiness level of automated sensors for autonomous shipboard observation and ship-to-shore data communications.

1.4.9 Ensure adequate representation of SOT programmes in GOOS panels, WMO Technical Commissions, and expert task teams such as the OCG.

1.4.10 Work among the OCG networks to harmonize metadata, develop performance indicators, and coordinate recruitment, promotion, and training activities.

1.4.11 Ensure financial planning and budgetary situational awareness meets the SOT vision.

2. BACKGROUND

2.1 The Ship Observations Team (SOT) was established by the former WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) at its first session (JCOMM-I, Akureyri, Iceland, June, 2001). It was created to build on synergies between the panels involved in coordinating global ship-based observing programmes addressing observational requirements of WMO and IOC applications, with a view to an eventual possible full-integration of ship-based observing systems on commercial and research vessels. The panels include the Voluntary Observing Ship (VOS) Scheme, the Ship-of-Opportunity Programme (SOOP), and the Automated Shipboard Aerological Programme (ASAP).

2.2 Ships participating in the VOS volunteer to take surface meteorological and surface oceanographic observations while ASAP vessels acquire upper air observations over ocean areas by means of radiosonde systems. Similarly, the SOOP involves volunteer merchant and scientific ships that acquire oceanographic measurements using one or more scientific instruments such as Expendable Bathythermographs (XBTs) and thermosalinographs.

2.3 Membership to the Team is open, and comprises operators of VOS, SOOP and ASAP, as well as representatives from other groups (hereafter called SOT associated programmes) using ships to host observing stations / platforms. It also includes representatives from: monitoring centres; data management centres and bodies; operators of satellite communication systems; ship, observing systems, or communications systems manufacturers; scientific advisory bodies; and, other interested parties as appropriate.

2.4 The terms of reference of the SOT are given in Annex I. Subsequent annexes contain the terms of reference of the SOT panels, and links to terms of reference for task teams.

2.5 The SOT will regularly review its mission in the light of changing research, new technology and innovation, and organizational and operational imperatives, and will update this document and terms of reference as appropriate. The SOT will continue to explore ways to expand its membership, in particular through enhanced links with countries operating ship observing fleets supporting WMO and IOC applications.

3. RATIONALE AND USER REQUIREMENTS

3.1 Neither global programmes such as the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS), the IOC-WMO-UNEP-ISC sponsored Global Ocean Observing System (GOOS), or the WMO World Weather Watch (WWW), nor the SOT and its panels (i.e. the VOS Panel – VOSP–, the SOOP Implementation Panel – SOOPIP, and the Automated Shipboard Aerological Programme Panel (ASAP), currently operate as funding bodies for observational networks. Instead, all commitments for the implementation of these networks are made nationally to address the requirements of these global programmes, including through the VOSP, SOOPIP, ASAP and SOT associated programmes. SOT must attempt to reconcile the needs and aspirations of the global programmes with those of the ship-based observation operators and funders, and align with the WMO and IOC Strategic Planning.

3.2 Although this strategy is restricted to ship-based observations, the SOT recognizes that drifting buoys, moored buoys, sub-surface floats and profilers also play a fundamental role as in situ stations / platforms in any observing network. The SOT assists in the coordination between different observational programmes to help ensure multiple requests do not adversely impact the core mission of any vessel. The SOT also assists in cross-network coordination for standardizing observational methods and quality assessment/control, and ensuring consistent data management.

3.3 There are six major met-ocean application areas that critically depend on highly accurate observations of met-ocean parameters: (a) Safety of Life at Sea (SOLAS); (b) Numerical Weather Prediction (NWP); (c) Climate monitoring (such as undertaken through GCOS); (d) Seasonal to Inter-annual Forecasts (SIAF); (e) Met-Ocean forecasts and services (MOFS), including marine services and ocean mesoscale forecasting; and, (f) Marine and ocean research.

3.4 Climate monitoring requirements have been endorsed and developed by GCOS and the United Nations Framework Convention on Climate Change (UNFCCC) and fall within the remit of the Group on Earth Observations (GEO), established by the Earth Observation Summit in 2003. Climate aspects are detailed in the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (GCOS-92, October, 2004), and its 2010 update (GCOS-138).

3.5 By addressing climate monitoring requirements while at the same time recognizing the need of operational applications for real-time data, it is believed that most of the requirements of targeted WMO and IOC applications, along with consideration of additional requirements, are derived from the WMO Rolling Review of Requirements (RRR).

3.5.1 The WMO RRR is an exercise to develop a consensus view on the design and implementation of composite observing systems, in particular where the need and implementation occur on global or regional scales.

3.6 The WMO Integrated Global Observing System (WIGOS) is a major contribution of the World Meteorological Organization (WMO) to address the need for more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members must continue their legacy of contributions by taking full advantage of advances in observation and telecommunication technologies and to increase our science-based understanding of Earth and its environment. The end result will be better prediction and assessment of potential impacts of weather and climate-related events to provide the required information for the public and policy and decision makers.

3.7 The WMO Fifteenth Congress (Cg-XV, Geneva, Switzerland, 7-25 May 2007) therefore decided that the enhanced integration of the WMO observing system should be pursued as a strategic objective of the WMO. Through Resolution 50 (Cg-XVI), the WMO Sixteenth Congress (Cg-XVI, Geneva, Switzerland, 16 May – 3 June 2011) decided to implement WIGOS during the period 2012 to 2015. WIGOS will establish an integrated, comprehensive and coordinated observing system to satisfy in a cost-effective and sustained manner the evolving observing requirements of WMO Members and will enhance coordination of WMO observing systems with those of partner organizations, such as the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), for the benefit of society.

3.8 Following the legacy recommendations of the JCOMM Pilot Project for WIGOS, the SOT agreed to support the WIGOS Implementation Phase (2012-2015), and continued WIGOS implementation activities, to achieve better integration of marine meteorological and other appropriate oceanographic observations into WIGOS.

4. SHIP FLEETS

4.1 In general, most current operational ship fleets contributing marine meteorological and oceanographic observations to WMO and IOC applications fall within the scope of the Voluntary Observing Ship (VOS) Panel (VOSP), the Ship of Opportunity Programme (SOOP) Implementation Panel (SOOPIP), or the Automated Shipboard Aerological Programme (ASAP) Panel.

4.2 Appropriate spatial distribution of ship observations over the global ocean must be achieved in complement to other types of observing stations / platforms and requires smart and coordinated vessel recruitment strategies.

4.3 The SOT will support ship recruitment strategies which optimize the expenditure of available resources, and which allow accurate and credible prediction of future resource requirements, and their relation to declared objectives.

4.4 The SOT will support technology developments to increase the impact, amount, and cost effectiveness of ship observations.

4.5 The Voluntary Observing Ship (VOS) Scheme's primary responsibility is to fulfill marine meteorological and climate data requirements expressed by the World Weather Watch (WWW) and the Global Climate Observing System (AOPC and OOPC), respectively, and to contribute to the WMO Earth System Monitoring in terms of observational marine data that can be obtained from voluntary observing ships.

4.6 The Ship of Opportunity Programme's (SOOP) primary responsibility is to fulfill upper ocean data requirements expressed by the Ocean Observations Physics and Climate Panel (OOPC) of GOOS and GCOS in terms of observational oceanographic data that can be obtained from ships of opportunity.

4.7 The Automated Shipboard Aerological Programme (ASAP) provides data that are of vital importance to numerical weather prediction and is a cost-effective source of baseline upper-air data from the ocean. As part of the global observing system, ASAP data can be used to support many applications, including global climate studies.

5. DATA FLOW

5.1 The SOT promotes the free and unrestricted exchange of the ship-based observations collected through the VOS, ASAP, and SOOP, in compliance with the WMO data policy (Res. 40 – Cg-XII) and/or the IOC oceanographic data exchange policy (Resolution IOC-XXII-630). The SOT works with the associated programmes to make their data available to the WMO and IOC applications in both real-time and delayed-mode.

5.2 More details can be found in "An Oceanographer's and Marine Meteorologist's Cookbook for Submitting Data and Metadata in Realtime and Delayed-Mode", JCOMM Technical Report No. 72. This document is in the process of being updated.

Data flow diagrams, the cookbook, and other related background documents are available from the SOT documents section at: https://www.ocean-ops.org/sot/documents.html

6. METADATA

6.1 The SOT is committed to collect and share station/platform metadata concerning observations made from ships.

6.2 The SOT promotes observational metadata and a sophisticated metadata catalog that allows for detailed and standardized quality monitoring of individual vessels and instruments, as well as the health of the networks and vessels.

6.3 The SOT advocates for a central metadata repository, such as that provided by OceanOPS, to maintain historical vessel/station/platform metadata and lineage, and to allow data users to assess data usefulness for their operational or research goals.

6.4 The SOT recognizes the need for the archival of both observations and metadata, which are critical for real-time and delayed-mode applications of the observations, and collaborates with the MCDS, its functionally connected bodies, and responsible world data centers.

6.5 The SOT emphasizes the importance of the rescue of historical metadata, which may be at risk of permanent loss due to such things as media degradation and organizational changes, to support marine climate research and services, and invites its members and other networks to make sure that metadata are properly rescued.

ANNEX I
SOT Terms of Reference

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 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 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 in the view to enhance the collection of data from ships;

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

(m) The SOT Executive Board (EB) executes SOT business during SOT intersessional period.

ANNEX II
SOT Executive Board Terms of Reference

The Terms of Reference of the SOT EB shall be:

a. 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;

b. 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;

c. 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;

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

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

f. 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;

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

h. To conduct regular team meetings biennially, following an agenda developed by the SOT EB;

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

j. 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:

a. The SOT Chair;

b. The SOT vice-Chair;

c. The VOS Panel Chair(s);

d. The VOS Panel vice-Chair(s);

e. The SOOP Implementation Panel Chair(s);

f. The SOOP Implementation Panel vice-Chair(s);

g. The SOT Technical Coordinator (ex officio);

h. A representative from the IOC Secretariat (ex officio); and,

i. A representative from the WMO Secretariat (ex officio).

Working procedures

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

b. 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.

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

d. 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.

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

f. 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 III
VOSP Terms of Reference

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 new 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);

(d) Develop and implement activities to optimize ship inspections and recruitment, including promotional material;

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

ANNEX IV
SOOPIP Terms of Reference

The Ship-of-Opportunity Implementation Panel (SOOPIP) coordinates the installation and deployment of instrumentation from Ships of Opportunity that travel in fixed transects, and in particular coordinates the implementation of regional and basin-wide instrumentation that measure physical, chemical and biological parameters, such as XBTs, TSGs, and CPR. Its terms of reference are to:

(a) Implement, maintain, and monitor specialized shipboard instrumentation and observing practices relevant to the SOOPIP;

(b) Coordinate the exchange of recommended practices, and technical and developmental information about oceanographic instrumentation relevant to the SOOPIP;

(c) Ensure the distribution of available programme resources to ships to meet the recommended sampling network in the most efficient way;

(d) Ensure the transmission of SOOP data to the GTS and relevant data centres is carried out according to operational and scientific requirements;

(e) Provide guidance and assistance to the SOT chairperson and SOT Technical Coordinator to produce, appropriate inventories, monitoring reports and analyses, performance indicators, implementation plans and information exchange facilities;

(f) Where relevant, serve as a platform for other observational programmes;

(g) Maintain close communications with the scientific community and periodically meet and discuss ongoing research performed with observations relevant to SOOPIP.

ANNEX V
ASAP Panel Terms of Reference

The Automated Shipboard Aerological Programme (ASAP) Panel shall:

(a) Coordinate and encourage the overall implementation of the ASAP, including recommending routes and monitoring the overall performance of the programme, both operationally and in respect of the quality of the ASAP system data processing
(b) Coordinate the exchange of technical information on relevant meteorological equipment and expendables, development, functionality, reliability and accuracy, and survey new developments in instrumentation technology and recommended practices;
(d) Review all relevant publications to make sure they are kept up to date and comply with Quality Management terminology;
(e) Prepare annually a report on the status of ASAP operations, data availability and data quality.

ANNEX VI
Task Team Terms of Reference

Terms of reference for the SOT Task Teams can be found with the individual task team links at:

https://goosocean.org/index.php?option=com_oe&task=viewGroupRecord&groupID=106

ANNEX VII
List of Acronyms

AODN	Australian Ocean Data Network
AOPC	Atmospheric Observation Panel for Climate
ASAP	Automated Shipboard Aerological Programme
ASCII	American Standard Code for Information Interchange
BUFR	Binary Universal Form for the Representation of meteorological data
CM	Contributing Member
CMOC	Centre for Marine. Meteorological and Oceanographic Climate Data
CPR	Continuous Plankton Recorder
DAC	Data Assembly Center
EB	Executive Board
ECMWF	European Centre for Medium-Range Weather Forecasts
E-SURFMAR	Surface Marine programme of the Network of European Meteorological Services
GCC	Global Collecting Centre
GCOS	Global Climate Observing System
GDAC	Global Data Assembly Centre
GEO	Group on Earth Observations
GFCS	Global Framework for Climate Services
GOOS	Global Ocean Observing System
GTS	Global Telecommunication System
GTSPP	Global Temperature-Salinity Profile Program
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
ICSU	International Council for Science
IGRA	Integrated Global Radiosonde Archive
IHO	International Hydrographic Organization
IMMT	International Maritime Meteorological Tape
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
ISC	International Science Council
JCB	Joint WMO-IOC Collaborative Board
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
MCDS	Marine Climate Data System
MOFS	Met-Ocean Forecasts and Services
NetCDF	Network Common Data Form
NMHS	National Meteorological and Hydrological Services
NWP	Numerical Weather Prediction
OCG	Observations Coordination Group
OOPC	Ocean Observations Physics and Climate Panel
PMO	Port Meteorological Officer
RSMC	Regional Specialized Meteorological Centre
RTMC	Real-Time Monitoring Centre
SAC	Special Access Code
SIAF	Seasonal to Inter-annual Forecasts
SOLAS	Safety of Life at Sea
SOOP	Ship of Opportunity Programme
SOOPIP	Ship of Opportunity Programme Implementation Panel
SOT	Ship Observations Team
SOT-EB	SOT Executive Board
TSG	Thermosalinograph
UNEP	United Nations Environment Program

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VOS	Voluntary Observing Ship
VOSP	Voluntary Observing Ship Panel
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
RRR	WMO Rolling Review of Requirements
WOD	World Ocean Database (United States)
WWW	WMO World Weather Watch
XBT	Expendable Bathythermograph
XCTD	Expendable Conductivity/Temperature/Depth

Annex X – VOS Donation Program- Expression of Interest

Call for Expression of Interest as Recipients

in the VOS Donation Program

The Voluntary Observing Ship (VOS) Scheme, as a core observing program of the Ship Observations Team (SOT) of the Global Ocean Observing System (GOOS), is an international program comprising members of the World Meteorological Organization (WMO) that recruit ships to take, record and transmit weather observations whilst at sea. Meteorological and oceanographic data are required from the seas and oceans for a number of purposes:

- For the preparation of marine forecasts and warnings;
- for the preparation of forecasts and warnings for offshore industries;
- for marine consultancy;
- for global computer models of the future state of the atmosphere;
- to monitor the state of the oceans using delayed-mode data in weekly and monthly analyses;
- for climatological data banks for many purposes, e.g. design of ships and structures at sea, determination of economic shipping routes; and
- to build long-term records to monitor changes in the climate of the earth.

Turbowin+ is a user-friendly electronic logbook software developed as freeware by the Royal Netherlands Meteorological Institute (KNMI). The software is endorsed by the World Meteorological Organization (WMO) for use on voluntary observing ships and is developed with contributions from WMO and many national meteorological services. The user-friendly software automatically codes observations and contains over 200 built-in quality checks to minimise errors before transmission.

Recent technology developments now allow for Turbowin+ to interface directly with some sensors, such as a digital barometer and GPS in addition to the collection of manually observed parameters. The system can operate from a voluntary observing ship's bridge PC, with data transmitted via the ship's email system.

As a capacity building effort to encourage the development of new national VOS networks, the SOT is calling for expressions of interest from National Meteorological and Hydrological Services (NMHSs) as recipients in the VOS Donation Program. The program aims to provide selected groups with one or more digital barometer and GPS units to be interfaced with Turbowin+ as a semi-automated weather station for use on a VOS ship for an initial period of 1 year. The program will be dependent on the availability of funds.

Guidance and training will be provided by the SOT for the duration of the capacity building effort to assist the recipients to implement the systems successfully.

Once the capacity building effort is concluded, and the recipient has demonstrated that the equipment has been deployed successfully, it is expected that the recipient will then take responsibility for maintaining and operating the assets.

The SOT is inviting expressions of interest that should explain:

1. Why you are interested (scientific/technical motivations, gaps in the nation's networks, etc.).
2. What impact and value this new unit will bring to your national and regional services?
3. Your logistic capacity to recruit voluntary observing ships, perform regular maintenance, provide observer training & perform return to service ship visits as required.

Annex XI – Instrument Standards and Practices

Instrument Standards Guidance Documents

VOS

- **WMO**

Guide To Meteorological Instruments and Methods of Observation (WMO-No. 8) Edition 2018
TurboWin User guides: https://www.ocean-ops.org/sot/vos/resources.html

- **NMS**

Australia
Port Meteorological Agents Guide
TurboWin User Guide
TurboWin Setup Manual

Germany
Port Met Officers Work Instruction
Marine Observers Guide
TurboWin manual (+ DWD own help doc to TurboWin)

Hong Kong, China
Guidance Notes on Port Meteorological Services
Marine Observers Handbook
UK Met.O.740

Japan
Guide to Weather Observations for Ships (JMA)
Guide to Ships Weather Reports (JMA)
Manual on Port Meteorological Services (JMA, in Japanese)

United Kingdom
Marine Observers Handbook
TurboWin user/installation guideline
UK Met.O.740 (Only provided on request from ship)

United States of America
Military Specification MIL-B-17089
National Weather Service NWS G101 – SP004
National Weather Service NWS G222 – SP002
NWS Instruction 10-201 (Feb 24, 2012)
http://www.nws.noaa.gov/directives/sym/pd01002001curr.pdf

SOOP

- **IOC**

Guide to IGOSS (now JCOMM) Data Archives and Exchange (BATHY and TESAC) - IOC Manual and Guides No.1
Guide to Operational Procedures for the Collection and Exchange of IGOSS (now JCOMM) Data - IOC Manual and Guides No.3
IGOSS (now JCOMM) Plan and Implementation Programme - IOC Technical Series No. 43
Best Guide and Principles Manual For The Ships Of Opportunity Program (SOOP) and Expendable Bathythermograph (XBT) Operations
GO-SHIP Repeat Hydrography Manual

http://www.go-ship.org/HydroMan.html

- **NMS**

Australia
Devil XBT User Manual

ASAP

- **WMO**

No guidance available at this time.

E-ASAP
No guidance available at this time.

Germany
ASAP-Manual for sounding procedures

Japan
Guide to Upper-Air Observation (JMA; in Japanese)

Instrument Standards Equipment Status Report
Conventional VOS

Barometers

BAROMETERS ON CONVENTIONAL VOS				
National VOS	**Barometer**	**Barometer Type**	**Barometer Setting**	**Type of Correction Tables Used**
Argentina	CS100 Setra. Model 278	Digital Digital	Station Level Station Level	Height
Australia	Vaisala PTB220 Vaisala PTB330	Digital Digital	Station Level Station Level	Height Height
Croatia	Barigo Fisher SUNDO	Ship's Aneroid Ship's Aneroid Ship's Aneroid	MSL MSL MSL	NIL NIL NIL
Ecuador		Aneroid	MSL	NIL
France	Vaisala PTB220	Digital	Station Level	Height
Germany	Fuess Vaisala PTB330	15PM Digital	MSL MSL	NIL NIL
Greece	Belfort	Aneroid	Station Level	Height / Temperature
Hong Kong, China	Hisamatsu Mintaka Duo	Precision Aneroid Ship's Aneroid Digital	Station Level Station Level Station Level	U.K. Met. O. 740 U.K. Met. O. 740 Temp/Height (TurboWin)
Iceland	Fuess Vaisala PA11	Ship's Aneroid Digital	MSL MSL	Air Pressure Dependent
Ireland		Ship's Aneroid Aneroid	MSL MSL	NIL NIL
Japan		Aneroid	Station Level	Pressure/Temperature

		Digital	Station Level	Height Pressure/Temperature Height
Netherlands	Fuess Vaisala PTB220 Vaisala PTB330	Aneroid Digital Digital	Station Level Station Level Station Level	Temp / Height (TurboWin) Temp / Height (TurboWin) Temp / Height (TurboWin)
New Zealand	Fuess Vaisala PTB330 Vaisala PTB220	Aneroid Precision Aneroid Digital Digital	MSL Station Level Station Level Station Level	NIL Instrument & Height Height Height
Norway	Vaisala PTB220	Digital	MSL	NIL
Singapore	PAB MK2 M2236		MSL	U.K. Met. O. 740
South Africa	Fuess Viking	Aneroid Aneroid	MSL MSL	NIL NIL
Sweden	Vaisala PTB220	Digital	Station Level	Height or TurboWin
United Kingdom	Negretti & Zambra PAB MK2 Vaisala PTB330	Precision Aneroid Barometer Digital	Station Level Station Level	NIL Temp / Height (TurboWin)
United States	Belfort Fischer Meteograf Aquatech DBX1 Mintaka Duo	Aneroid Aneroid Digital Digital Digital	MSL MSL MSL MSL Station Level	NIL NIL NIL NIL NIL
NOTE: For Ships using TurboWin, the Height correction is applied by the software.				

Barographs

BAROGRAPHS ON CONVENTIONAL VOS			
National VOS	**Barograph**	**Barograph Type**	**Barograph Setting**
Australia	Negretti & Zambra Vaisala PTB220 Vaisala PTB330	Open Scale (7 Day) Digital Digital	Station Level Station Level Station Level
Croatia	KOMPAS	Open Scale	MSL
Ecuador		Micro-Barograph	MSL
France	None		
Germany	Mueller 78A Lambrecht 290 Vaisala PTB330	Small Scale Small Scale Digital	MSL MSL MSL
Greece	Belfort	Open Scale (4 Day)	Station Level
Hong Kong, China	Fischer Sato Hisamatsu Isuzu Seisakusho OTA Mintaka Duo	Small Scale Small Scale Small Scale Small Scale Small Scale Digital	Station Level Station Level Station Level Station Level Station Level Station Level
Iceland	None		
Ireland		Open Scale (7 Day)	MSL
Japan		Open Scale (1 Day) Open Scale (7 Day)	Station Level Station Level
Netherlands	Fuess	Aneroid	Station Level

	Vaisala PTB220 Vaisala PTB330	Digital Digital	Station Level Station Level
New Zealand	 Vaisala PTB330	Open Scale Digital Display	MSL Station Level
Norway	Vaisala PTB220	Digital Display	MSL
Singapore		Open Scale MK3	MSL
South Africa	Mason		MSL
United Kingdom	CASELLA MK2Fischer MK3 Vaisala PTB330	 Open Scale (7 Day) Small Scale Digital	Station Level Station Level Station Level
United States	Aquatech DBX1 Meteograf Mintaka Duo	Digital Digital Digital	MSL MSL Station Level

Transfer Barometers

VOS TRANSFER STANDARD BAROMETERS ON CONVENTIONAL VOS		
National VOS	**Barometer**	**Frequency of Barometer comparison**
Australia	Vaisala PTB220B	4 monthly
Equador	OACI mercury	6 monthly
France	None	
Germany	Vaisala PTB330 Druck DPI 740	6 monthly 6 monthly
Greece	Belfort Aneroid	3 - 6 monthly
Hong Kong, China	Vaisala PTB330	9 monthly
Japan	Vaisala Digital Barometer Paroscientific	6 monthly
Netherlands	Fuess Aneroid Vaisala PTB220 Vaisala PTB330	12 monthly 12 monthly 12 monthly
New Zealand	Vaisala PTB220	12 monthly
Norway	Digiquartz	12 monthly
South Africa	Vaisala PA11 & Precision Aneroid	3 - 6 monthly
Sweden	Vaisala PA11A	12 monthly
United Kingdom	Vaisala PTB330TS (includes temp/humidity with handheld device)	12 monthly
United States	Digiquartz	6 monthly

Air thermometers

THERMOMETERS ON CONVENTIONAL VOS			
National VOS	**Thermometer**	**Thermometer Type**	**Thermometer Fluid**
Australia	AMA Zeal PT100	Liquid-in-glass Liquid-in-glass Digital	Hg Hg
Germany	Sling Eigenbrodt	Liquid-in-glass Digital	Hg

	Rotronic Hygropalm		
Greece	Schneider	Liquid-in-glass	Hg
Hong Kong, China		Liquid-in-glass	Alcohol
France	Vaisala HMP34	Digital	
Netherlands	Schneider	Liquid-in-glass	Alcohol
Norway	PT100		
Sweden	PT100 Testo 950		
United Kingdom	Zeal 2C Rotronic Hygropalm	Liquid-in-glass Digital	Alcohol
United States	Zeal P2505 Extech RH300 PHT-771	Mason Hygrometer Digital Digital	Glycol

Sea Surface temperature sensors

SEA SURFACE TEMPERATURE ON CONVENTIONAL VOS			
National VOS	**Sensor**	**Sensor Type**	**Sensor Scale C/F**
Australia	Sea thermometer	Ship's intake Bucket (UK) Hull contact sensor	C C C
Germany	Sea thermometer	Bucket Ship's intake Hull contact sensor	C C C
Greece	Sea thermometer	Ship's intake	C
Hong Kong, China	Sea thermometer	Ship's intake	C
Netherlands	Sea thermometer	Ship's intake Bucket (alcohol or mercury)	C
Norway	Sea thermometer	Hull contact	C
United Kingdom	Sea thermometer	Bucket Ship's intake Hull contact sensor	C C C
United States	Sea thermometer	Bucket Model 2170-TX	Either (ship Dependent)

Automatic Weather Stations on VOS			
National VOS	**Type of AWS**	**Communication Method**	**Manual Entry Facility**
Argentina	Campbell Scientific	Inmarsat C	
Australia	Vaisala Milos 500 AWS Techsas	Inmarsat C (Data Mode) Inmarsat C (Data Mode	Yes No
Brasil	VAISALA MAWS410 VAISALA MAWS430	HF Radio/Satellite HF Radio/Satellite	Yes Yes

Canada	AVOS – AXYS Technologies	Inmarsat C Iridium	Yes
China	XZC6-1 XZC2-2SA DJQ-1	Inmarsat C CDMA	Yes
France	BATOS MERCURY EUCAWS	Inmarsat C (Data Mode) & Iridium SBD Iridium SBD Iridium SBD	Yes Yes Yes
Germany	Vaisala Milos 500 AWS Ship's own datalogger SCAWS EUCAWS	eMail / Meteosat Inmarsat / Iridium eMail Iridium SBD	Some Yes No Yes
Hong Kong, China	AMOS MetOcean drifting buoy onboard VOS	Iridium Iridium	No No
Indonesia	BATOS	Iridium SBD	Yes
Ireland	Vaisala Milos AWS	Meteosat	No
Japan	Koshin Denki Kogyo Co., Ltd (Japan) Surface Meteorological observation (SMet) system	Email Email	Yes Yes
Netherland	EUCAWS	Iridium SBD	Yes
New Zealand	iSTAR mSTAR-SHIP	Inmarsat GPRS Cell	Yes No
Norway	PC with QLC50 EUCAWS	VSAT with Iridium	Yes
Portugal	EUCAWS	Iridium SBD	Yes
Russia	GM6	Inmarsat C	Yes
South Africa	Vaisala Milos 520	Inmarsat C	Yes
Spain	Vaisala MAWS 410 EUCAWS Campbell Scientific CR1000X	Inmarsat C by email Iridium VSat X-band	No Yes No
South Africa	Homdade from Campbell	eMail	Yes/No
United Kingdom	AMOS AMOS2X	Iridium Iridium	No No
United States	SEAS-AutoImet Ship's own datalogger	SEAS eMail	Some No

SENSORS FOR VOS AUTOMATED SYSTEMS

National VOS	Parameter	Sensor	Calibration interval
Argentina	Pressure Combined Humidity and Temp Wind	CS100 Setra. Model 278 Campbell HC2S3 Campbell 05108-L	
Australia	Pressure Air temperature	Vaisala PTB220 Rosemount ST2401	6 months 6 months

	Humidity	Vaisala HMP45D Vaisala HMP155	6 months
	Wind	Vaisala WAV151 & WAA151	24 months
	SST	Seabird SBE48	24 months
China	Pressure	R.M.Young 61302 Setra278	
	Combined Humidity and Temp	R.M.Young 41382 Vaisala HMP155A	
	Wind	Hydrowise XFY3-1 R.M.Young 05103 Vaisala WMT702	
	SST	Everst Interscience 4000.3ZL TRDI TS-N	
France	Pressure	Vaisala PTB210 Vaisala PTB220 Vaisala PTU200 Vaisala PTB330	2 years
	Air temperature	PT100 HMP110 HMP45D	
	Humidity	Vaisala HMP35DE Vaisala HMP45D Vaisala HMP110	12 months 12 months 12 months
	Wind	Gill Windsonic WS2 Vaisala WMT52	
	SST	PT100 intake Hull contact PT100	
Germany	Pressure	Vaisala PTB (220 + 330)	18 months
	Air temperature	PT100	5 years
	Humidity	Vaisala HMP45D	12 months
	Combined Humidity and Temp	E+E33	12 months
	Wind	Lufft Ventus (ultrasonic) Thies Cup and Vane	24 months 24 months
	SST	PT100	10 years
Hong Kong, China	Pressure	PTB110	12 months
	Air temperature	Build in temperature sensor of MetOcean drifting buoy	

Indonesia	Pressure Air temperature Humidity Wind SST	Vaisala PTB330 Vaisala HMP155 Vaisala HMP155 Gill Windsonic WS2 Hull contact PT100	
Japan	Pressure Air temperature Humidity Wind SST	Vaisala PTB 220 Setra Systems MODEL 370 CHINO CORPORATION R005-341 Vaisala HMP155 Vaisala HMT3303 JM Vaisala HMP155 Koshin KVS-400-J Koshin KS-5900 CHINO CORPORATION RFN1-0 Koshin RFN2-0	10 years 12 months 12 months 5 years 12 months
Netherlands	Pressure Combined Humidity and Temp Wind	Vaisala PTB 220 / 330 E+E33 OMC-116	38 months 8 months
New Zealand	Pressure Air temperature Humidity Wind	Vaisala PTB330 Vaisala HMP155 Vaisala HMP155 Vaisala WAA151 &WAV151 Vaisala WMT702	
Spain	Pressure Air Temperature Humidity Wind SST	Vaisala PTB220 Vaisala PTB330 Setra CS100 Vaisala HMP155 Vaisala HMP155 Vaisala WMT700 Vaisala WMT702 MetSENS200 Hull contact Vaisala Hull contact DWD	
South Africa	Pressure Air temperature	Vaisala PTB110 Vaisala HMP155	

	Humidity Wind	Vaisala HMP155 Gill Observer 2	
United Kingdom	Pressure Combined Humidity and Temp	Vaisala PTB110 Vaisala HMP110	~3 years ~1 year from installation
United States	Pressure Air temperature Wind SST	Young 61201 Vaisala PTB330 Young 26800 Young 41372VC Young Vaisala WMT700 IMET Wind sensor Integrated Seabird	

SOOP

Expendable BathyThermograph (XBT)

XBT Probe	
National SOOP	**Equipment Type**
Australia	Sippican
France	Sippican (Deep Blue, T7 and Fast Deep)
Italy	Sippican (T4, T5, T7, T10, DeepBlue)
Japan	TSK(T-7)
United States	Sippican (DeepBlue and FastDeep)

XBT Recorder	
National SOOP	**Equipment Type**
Australia- BOM Australia- CSIRO	Quoll XBT Quoll XBT
France	Devil XBT Sippican MK21 USB (DAQ)
Italy	Sippican MK21 USB (DAQ) Sippican MK21 USB (Ethernet)
Japan	TSK (MK150)
United States	Sippican MK21 ISA Sippican MK21 USB (DAQ) Sippican MK21 USB (Ethernet)

XBT Launcher	
National SOOP	**Equipment Type**
Australia	Sippican Hand Launcher (modified LM3A)
France	Sippican Hand Launcher (LM3A)
Italy	Sippican Hand Launcher (LM3A)

Japan	TSK (Hand-held Launcher)
United States	Sippican Hand Launcher (LM3A) AOML Autolauncher (AOML) Scripps Autolauncher (SIO)

XBT Transmission	
National SOOP	**Equipment Type**
Australia-BOM Australia-CSIRO	Iridium
France	Argos
Japan	email
United States	T&T Sailor 403026S Mini-C transceiver Iridium NAL SAF4070-IG Iridium NAL A3LA-XG Iridium NAL A3LA-RG Garmin GPS 18X PC Furuno GPS Navigator GP-32

ThermoSalinoGraph (TSG)

Thermosalinograph (TSG)	
National SOOP	**Equipment Type**
France	Seabird 21 TSG
Japan	Seabird 38 Remote Temperature Sensor Seabird 45 Micro TSG
United States	Seabird 21 TSG Seabird 38 Remote Temperature Sensor Seabird 45 MicroTSG

TSG Transmission	
National SOOP	**Equipment Type**
France	Inmarsat C
United States	Iridium NAL A3LA-RG Garmin GPS 18X PC

Conductivity, Temperature, and Depth (CTD)

Conductivity, Temperature, and Depth (CTD)	
National SOOP	**Equipment Type**
Japan	Seabird 911+
United States	Seabird 19 Seabird 25 Seabird 911+

Expandable Conductivity, Temperature, and Depth (XCTD)

Expandable Conductivity, Temperature, and Depth (XCTD)	
National SOOP	**Equipment Type**
Italy	TSK XCTD-1
United States	Sippican XCTD-1 Sippican XCTD-3

Acoustic Doppler Current Profile (ADCP)

Acoustic Doppler Current Profile (ADCP)	
National SOOP	**Equipment Type**
Japan	RD Instruments
United Stated	RD Instruments

Partial Pressure of CO_2 (pCO_2)

Partial Pressure of CO_2 (pCO_2)	
National SOOP	**Equipment Type**
Australia	CSIRO
France	Craig Neil General Oceanics 8050
Japan	Nihon ANS system (LI-COR LI700) Los Gatos Research (Off-Axis ICOS)
United States	General Oceanics 8050

Moving Vessel Profiler

Moving Vessel Profiler	
National SOOP	**Equipment Type**
United States	Brooke
United States	Scripps

ASAP

ASAP TYPES and COMMUNICATIONS				
National ASAP		**Container**	**Sounding Equipment**	**SATELLITE TRANSCEIVER**
E-ASAP	Denmark	10ft container Built-In launcher 10ft container	Vaisala MW41 Vaisala MW41 Vaisala MW41	A3LA-RM Iridium A3LA-RM Iridium A3LA-RM Iridium
	E-ASAP	Deck launcher Deck launcher Deck launcher Deck launcher Deck launcher 10ft container	Graw GS-E Graw GS-E Graw GS-E Graw GS-E Graw GS-E Vaisala MW41	A3LA-RM Iridium A3LA-RM Iridium A3LA-RM Iridium A3LA-RM Iridium A3LA-RM Iridium A3LA-RM Iridium
	France	Deck launcher Deck launcher Deck launcher	MODEM SR10 MODEM SR10 MODEM SR10	 A3LA-RM Iridium A3LA-RM Iridium

		Deck launcher	MODEM SR10	A3LA-RM Iridium A3LA-RM Iridium
	Germany	10ft container 20ft container Deck launcher Deck launcher	Vaisala MW41 Vaisala MW41 Vaisala MW41 Vaisala MW41	A3LA-RM Iridium A3LA-RM Iridium A3LA-RM Iridium A3LA-RM Iridium
	Spain	10ft Container	Vaisala MW21	A3LA-RM Iridium
Germany (AWI)		Built-in (manual)	Vaisala MW31	email (ship system)
Japan		10ft Container 20ft Container	Vaisala MW41 Vaisala MW41	Email Email

Land Earth Station list

Satellite	SAC	Operator	Name of station	CCCC	LES Id	Costs incurred by	country	Remark
AOR-E	41	Inmarsat (Stratos)	Goonhilly	EGRR	102	Metoffice	United Kingdom	
AOR-E	41	COMSAT	Southbury	KWBC	101	NOAA	USA	
AOR-E	41	Marlink	Eik	KWBC	104	NOAA	USA	
AOR-E	41	Inmarsat (Stratos)	Station 12	LFPW	112	KNMI	The Netherlands	Messages pushed to Météo-France by KNMI
AOR-E	41	Otesat	Thermopylae	LGAT	120	HNMS	Greece	
AOR-E	41	Marlink	Aussaguel	LFPW	121	Météo France	France	
AOR-W	41	Inmarsat (Stratos)	Goonhilly	EGRR	002	Metoffice	United Kingdom	
AOR-W	41	COMSAT	Southbury	KWBC	001	NOAA	USA	
AOR-W	41	Marlink	Eik	KWBC	004	NOAA	USA	
AOR-W	41	Inmarsat (Stratos)	Station 12	LFPW	012	KNMI	The Netherlands	Messages pushed to Météo-France by KNMI
AOR-W	41	Marlink	Aussaguel	LFPW	021	Météo France	France	
IOR	41	KDDI	Yamaguchi	RJTD	303	JMA	Japan	
IOR	41	COMSAT	Southbury	KWBC	301	NOAA	USA	
IOR	41	Marlink	Eik	KWBC	304	NOAA	USA	
IOR	41	Otesat	Thermopylae	LGAT	305	HNMS	Greece	
IOR	41	Tata Communications	Pune	DEMS	306	IMD	India	Accepted if reported from within Metarea VIII (N) only
IOR	41	Inmarsat (Stratos)	Station 12	LFPW	312	KNMI	The Netherlands	Messages pushed to Météo-France by KNMI
IOR	1241	Inmarsat (Stratos)	Station 12	AMMC	312	BOM	Australia	
IOR	41	Marlink	Aussaguel	LFPW	321	Météo France	France	
IOR	141	Singapore Telecom	Goonhilly	WSSS	302	NEA	Singapore	
POR	41	KDDI	Yamaguchi	RJTD	203	JMA	Japan	
POR	41	COMSAT	Santa Paula	KWBC	201	NOAA	USA	
POR	41	Marlink	Eik	KWBC	204	NOAA	USA	
POR	141	Singapore Telecom	Goonhilly	WSSS	202	NEA	Singapore	
POR	1241	Inmarsat (Stratos)	Station 12	AMMC	212	BOM	Australia	
POR	41	Marlink	Aussaguel	LFPW	221	Météo France	France	

GTS headers list

The GTS headers are now available on SOT Website : https://www.ocean-ops.org/sot/ in the headers/dataflows document.

VOS

Source of observation	GTS header for FM 13 SHIP	BUFR template	GTS header for BUFR
Code41 sent to LES Aussaguel (FR)	No	TM 308009	ISS[A-L]02 LFPW
FM13 data flow sent from KNMI to MF (among them Code41 sent to LES Burum (NL),	No	TM 308009	ISS[A-L]04 LFPW
Code41 sent to LES Goonillhy (UK) UK VOS (Turbowin via email)	SXVX88 EGRR	TM 308009	ISS[A-L]ii EGRR
Code41 sent to LES Southbury (US)	S[MIN]V[A-X] ii 01-19 KWBC	TM 308009	ISS[A-L]01-19 KWBC
Code 41 sent to Thermopylae (GR)	no	TM 308009	ISSF01 LGAT ISSF20 LGAT
Australian VOS (AWS, Turbowin)	SMV[A-J]01 AMMC S[I,N]V[A-J]21 AMMC	No	No
Canadian VOS (AWS, Turbowin)	SNVD01 KWBC	No	No
French AWS (Batos, Baros) + Half compressed (APR, email, Obs2server) from ESURFMAR VOS	No	TM 308009	ISS[A-L]01 LFPW
French Mercury AWS	No	TM 308009	ISS[A-L]03 LFPW
EUCAWS stations collected by MF	No	TM 308009	ISS[A-L]05 LFPW
German VOS	No	TM 308009	ISS[A-L]01 EDZW
Hong Kong VOS	SIV[B,E,X]20 VHHH SMV[B,E,X]01 VHHH	TM 308009	ISS[A-D,I-L,X]01 VHHH
Indian AWS	SMVX02 DEMS	No	No
Japanese VOS (Obsjma, Turbowin, AWS)	S[MIN]V[BDEX]ii RJTD	TM 308009	ISS[A-D,I-L]01-02 RJTD

Spanish AWS (Esperanza del mar)	No	TM 308009	ISSA01 LEMM (SHIPs 00, 06, 12 and 18UTC), ISSA22 LEMM (SHIPs 03, 09, 15 and 21UTC), ISSA21 LEMM (hourly SHIPs)
Spanish AWS (Hesperides)	No	TM 308009	ISSX01 LEEM
Sweden	No	TM 308009	ISS[A-L]01ESWI
UK Vos (AMOS, Turbowin to server)	S[MIN]V[A..X] ii EGRR	TM 308009	ISS[A-L]ii EGRR
Irish Turbowin VOS	No	TM 308009	ISSA[20]1 EIDB
US VOS (Turbowin, Anverseas)	S[MIN]V[A-X] ii 01-19 KWBC	TM 308009	ISS[A-L]01-19 KWBC
US VOS (Turbowin, Anverseas)	S[MIN]V[A-X] ii 01-19 PANC	TM 308009	ISS[A-L]01-19 PANC

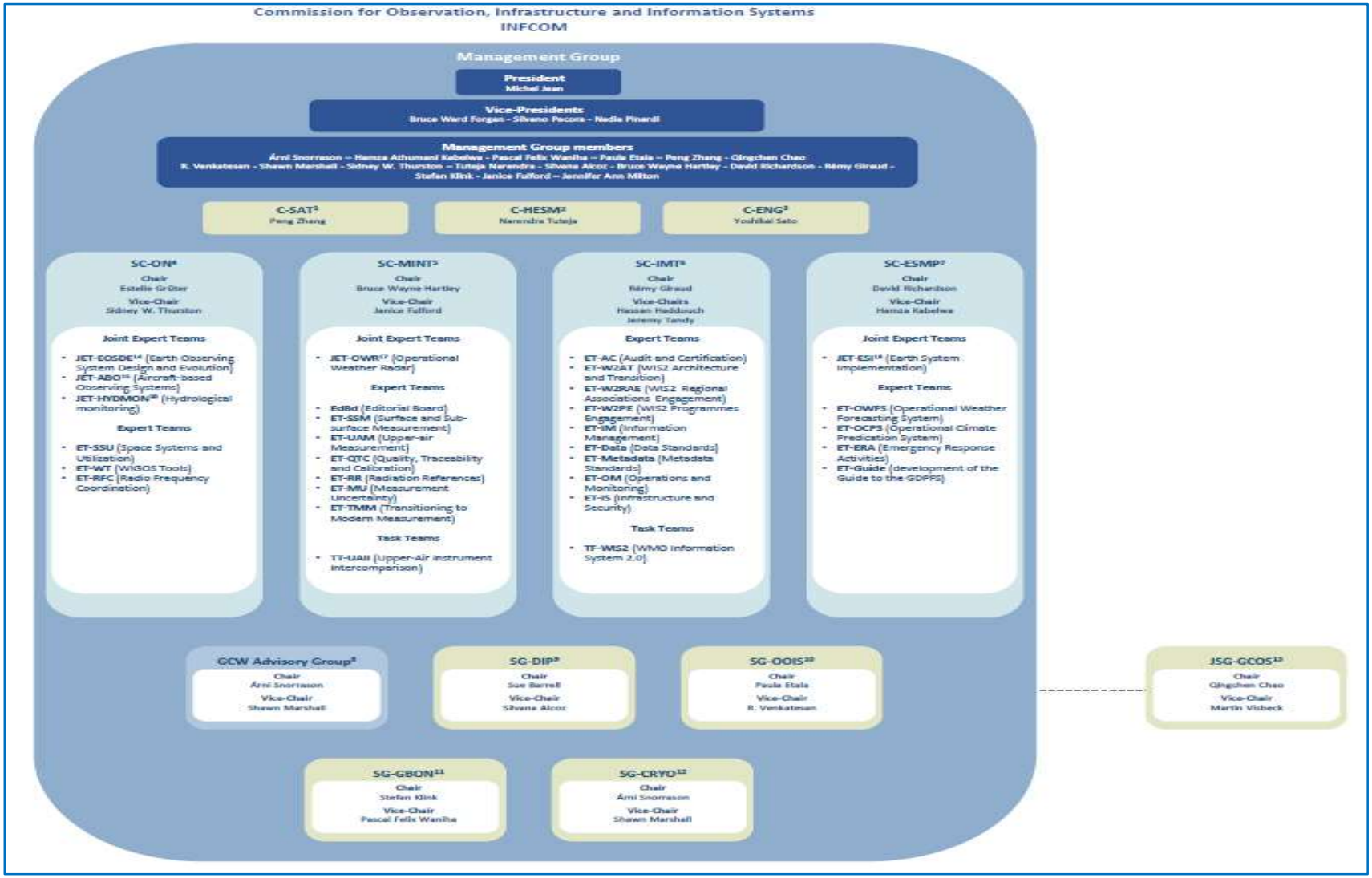
ASAP

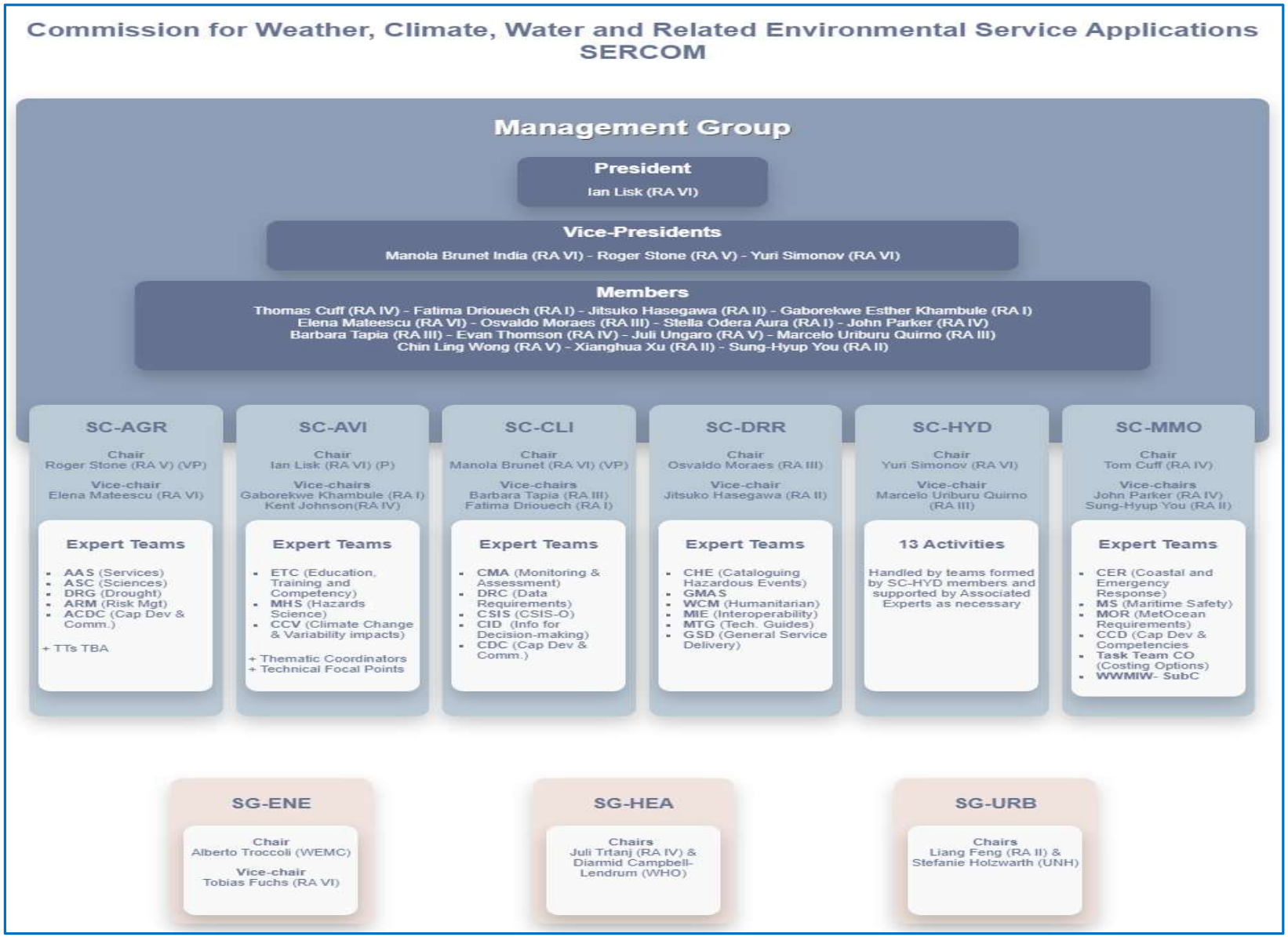
Source of observation	BUFR template	GTS header for BUFR
E-ASAP	309052	IUKX40/IUSX40 EDZW
DE-ASAP	309052	IUKX40/IUSX40 EDZW
FR-ASAP	309052	IUKX40/IUSX40 LFPW
DK-ASAP	309052	IUKX40/IUSX40 EKMI
ES-ASAP	309052	IUKX40/IUSX40 EDZW

SOOP

Source of observation	System	TAC message	TAC Header	BUFR template	GTS header for BUFR
Australia (BOM, CSIRO, RAN)	XBT	BATHY	SOV[A-F,J]01 AMMC	TM 315004	IOS[N/S]01 AMMC
Brazil	XBT	BATHY	SOV[A, C, D, J]01 SBBR		
Canada	CTD	TESAC	SOVD02 CWOW		
Canada	XBT	BATHY	SOVD02 CWOW		
France (IFREMER)	XBT	TESAC	SOVX05 LFPW	TM 315004	IOSX01 LFVX
France (IFREMER)	CTD	TESAC	SOVX06 LFPW	TM 315007	IOSX01 LFVX
France (IFREMER)	TSG	TRACKOB	SOVX06 LFPW		
France (IFREMER)	Minilogg ers			TM 315002	IOSX01 LFVX
Japan	CTD	TESAC	SOVX02 RJTD	TM 315007	IOS[A-D,I-L]nn RJTD
Japan	XBT	BATHY	SOVX01 RJTD	TM 315004	IOS[A-D,I-L]nn RJTD
Japan	TSG	TRACKOB	SOVX12 RJTD	TM 308010	IORX01-03
USA (NOAA/AOML, SIO)	XBT	BATHY	SOVX01 KWBC	TM 315004	IOSX01 KWBC

Annex XII – WMO Commission Organigrams





Annex XIII – Actions and Recommendations Agreed at SOT-11

As agreed by the SOT Executive Board meeting held on 20 October 2021 "Actions" have some level of SOT (including OceanOPS and DAC) involvement, whilst "Recommendations" are those actions that are placed solely on a body outside of the SOT sphere of involvement.

ACTIONS:

No	Ref. Item	Action	By	Deadline	*Update*
1	***A3.1/01***	Open discussions with Kongsberg regarding demonstration projects using Blue Insight.	SOT Chair	November 2021	
2	***A3.3/01***	Review planned RoCS activities and open dialog between RoCS, OceanOPS, and appropriate SOT Panels and Task Teams to leverage these activities to support SOT members	SOT Chair &, VOSP Chair, SOOP Chair, TC, and SOT TTs	SOT-12	
3	***A3.3/02***	Provide 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	VOSP Chair, SOOP Chair	November 2021	
4	***A3.3/03***	SOT/OCG to engage with Science RoCS regarding the possible development of a unified global shipboard ADCP program	SOT Chair, SOT-EB & OCG	December 2021	
5	***A4.1.1/01***	Use SOT-IDs for all new stations and phase out the use of masking schemes; migration to SOT-IDs is strongly recommended for existing stations	SOT Members	Ongoing	
6	***A4.1.2/01***	Merge the monitoring function of TT-UID with that of the TT-ISSC and discontinue the TT-UIDs.	SOT EB & TT-ISSC	SOT-11	Done
7	***A4.1.2/02***	WMO Secretariat, in liaison with SOT EB, to consider the need to send a letter to NFPs advising of the need to implement UUIDs	WMO Secretariat & SOT EB	SOT-12	

8	***A4.2/01***	Metadata providers and users are requested to adapt their dataflows to the new SOT metadata format	Operators, data archives, etc	SOT-12	
9	***A4.2/02***	Agree the revised Terms of Reference for the Task Team on Metadata	SOT Members	SOT-11	Done
10	***A5.0/01***	Promote the ad-hoc Task Team on KPI to a full Task Team and confirm its Terms of Reference	SOT & SOT EB	SOT-11	Done
11	***A5.0/02***	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	SOT-12	
12	***A5.0/03***	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 Meteo-France 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	SOT-12	
13	***A5.0/04***	Review monthly OceanOPS products, including static maps, in liaison with the TT-KPI	SOT-TC, TT-KPI	By September 2022	
14	***A5.0/05***	Consider the development of a single, integrated, KPI for all SOT (and OCG) networks	TT-KPI, SOT-TC, (& OCG)	SOT-12	
15	***A6.0/01***	SOT NFPs, who haven't already done so, to advise their future plans to migrate to BUFR, and all data producers to transition to TDC's	SOT Members, SOT NFPs, National data processing centres	SOT12	
16	***A6.0/02***	Investigate which producers intend to use the new BUFR template 308014 in the near future, and set up a test procedure with data users	TT-ISSC, data users, National data processing centres	Ongoing	

17	***A7.0/01***	Approve creation of a new TT on Expansion of Independent Class Observations and agree appropriate Terms of Reference	SOT members and SOT EB	October 2021	Done
18	***A8.0/01***	In liaison with the Open-GTS Project and industry partners who have GTS access (e.g., CLS), develop a strategy on how the expected increase in third party data, metadata/instruments could be managed	SOT EB, TT-EICO, & TC/OceanOPS	SOT12	
19	***A8.0/02***	Based on MAERSK success foster further company-wide recruitments, with focus on ship-side funded and maintained AWS systems	TT-RPT, TT-EICO, TC	Ongoing	
20	***A8.0/03***	Review content of the VOS brochure, with a view to developing a lighter and broader (SOT, OCG) document.	TT RPT & TC VOSP Chair, SOOP Chair, OCG	SOT-12	
21	***A8.0/04***	OceanOPS to maintain and make available contact information and user groups for Task Teams and other SOT groups (SOT NFPs, PMO Lists, etc), which list membership and TORs, and act as the primary repository for such information (replacing the OceanExpert repository).	OceanOPS	SOT-12	
22	***A8.0/05***	Clear specifications for GUI development to be provided for review/comment by mid-October, with the aim to fully exploit the SOT-funded web-designer resources	TT-Metadata, SOT TC, OceanOPS web designer	Mid-October 2021	
23	***A8.0/06***	Review existing monthly statistics, indicators and maps computed by OceanOPS, and suggest improvements, including OCG wide EOV/ECV analysis.	TT-KPI	Dec-21	
24	***A8.0/07***	SOT operators, including new SOOP network operators (e.g., TSG/GOSUD, pCO_2, CPR…), to implement the SOT-ID management and new metadata format, and end all remaining masking schemes	SOT Operators	SOT12	

25	***A8.0/08***	SOT operators to compare their observation numbers and station metadata availability at OceanOPS and report any issues back to the TC, in particular regarding transition to new SOT-IDs and metadata format.	SOT Operators, SOT-TC	Ongoing	
26	***A8.0/09***	Members who do not share data publicly or unmasked (GTS or elsewhere) to investigate if national data policies or technical protocols could be improved and report to the SOT-EB, and SOT TC	SOT Members, SOT EB & SOT-TC	April 2022	
27	***A8.0/10***	TC to update and circulate a revised SOT certificate with new IOC-UNESCO logo.	SOT-TC	October 2021	Done
28	***A8.0/11***	Operators to only use the revised SOT Certificate and send copies to certificate@jcommops.org	SOT Operators	Ongoing	
29	***A8.0/12***	SOT Members to attend OCG Data and Metadata Workshop and assist with review of IOC driven data flow charts	SOT Members	Oct-21	Done
30	***A8.0/13***	In liaison with OCG, as appropriate, establish closer cooperation with IRSO with a view to ensuring that all IRSO RVs are contributing to SOT activities.	SOT Chair, SOT TC, OCG,	SOT-12	
31	***A9.1.1/01***	All VOS operators and / or PMOs are requested to arrange provision of SOT annual reports via their National Focal Point	VOS Operators, PMOs, SOT NFPs	Annually	
32	***A9.1.1/02***	VOS operators are requested to keep their VOS metadata up to date in the relevant metadata database.	VOS Operators	Ongoing	
33	***A9.1.1/03***	OceanOPS to implement functionality to allow output of information on number of observations (observation counters per selected station/stations/fleet) for a specified period of time (month/year and to generate maps showing only those observations (using VOS terminology).	OceanOPS	asap	

34	***A9.1.1/04***	VOS operators are requested to provide quarterly delayed mode data to the VOS GDACs.	VOS Operators	Quarterly	
35	***A9.1.1/05***	VOS operators are invited to compare their observation counts with those from OceanOPS in order to identify missing data and / or duplicates.	VOS Operators	Ongoing	
36	***A9.1.1.4/01***	VOS operators to review the content of the 2020 GDAC Report to ensure their national data is being correctly submitted and processed	VOS Operators, DACs	end of 2021	
37	***A9.1.1.4/02***	Data Acquisition Centres (DACs) that did not submit data during 2020 should do so in 2021, or alternatively contact a VOS-GDAC for advice;	DACs	end of 2021	
38	***A9.1.1.4/03***	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 2021	
39	***A9.1.1.4/04***	VOS Operating countries that have not already done so are encouraged to register as a DAC and contribute their data to the GDACs.	VOS Operators, SOT NFPs	asap/end 2021	
40	***A9.1.1.4/05***	Former Contributing Members (CMs) that have not already done so should migrate to VOS-DACs within the new MCDS	SOT & Former CMs	SOT-12	
41	***A9.1.1.4/06***	DACs should submit their observations only once. If there is a requirement to resubmit data (e.g., due to quality improvements) then the VOS-GDACs should be made aware of this	DACs	Ongoing	
42	***A9.1.1.4/07***	DACs should submit data files in one IMMT format only – preferably IMMT-5 quality checked to MQCS-7 making use of its increased coding capabilities	DACs	Ongoing	
43	***A9.1.1.4/08***	DACs not able to submit their data because of issues e.g., with digitizing or converting into the IMMT format, should contact VOS-GDACs for advice	DACs. VOS-GDAC	Ongoing	

44	***A9.1.1.4/09***	DACs should apply MQCS to data prior to submission, so that the VOS-DACs can assist in identifying and solving significant problems (in particular issues concerning date/time/position)	DACs. VOS-GDAC	Ongoing	
45	***A9.1.1.4/10***	To avoid data losses, common procedures should be developed for producing IMMT formatted observations directly from Automatic Weather Stations (AWS), or for converting such automated observations into IMMT format at a later stage.	SOT, TT-VOS DMD, DACs and VOS-GDAC	SOT-12	
46	***A9.1.1.4/11***	To avoid TurboWin coding problems resulting in erroneous relative humidity values being submitted (in IMMT-4 and IMMT-5 files) VOS Operators and SOT members should update to TurboWin Version 5.6 software or newer	VOS Operators, SOT members, PMOs	asap	
47	***A9.1.1.4/12***	All VOS-observations should include the additional climate elements that were previously required for VOSClim class ships	VOS Operators and VOS-DACs	asap	
48	***A9.1.1.4/13***	Whenever possible, DACs should ensure all masked call signs (e.g., 'SHIP') are converted back to the original ID prior to submission	DACs	Ongoing	
49	***A9.1.1.4/14***	Observations should contain the same call sign as transmitted on the GTS i.e., the SOT-ID should be used as the call sign in IMMT submissions if it is used for GTS real time data	DACs	Ongoing	
50	***A9.1.1.4/15***	The IMMT and MQCS formats need to be revised in order to: a. be compatible with parameters, flags and accuracies provided in the BUFR format, b. be flexible for future changes in other fields such as the IMO-number, c. maintain compatibility with OceanOPS meta data structure (e.g., new VOS Classes), d. provide accurate quality flags for all relevant parameters,	VOS GDAC & TT-VOS DMD	SOT-12	

51	***A9.1.1.4/16***	An (ad-hoc) Task Team should be set up to investigate and propose changes or alternatives to IMMT and MQCS. VOS-DACs should stay up to date with MCDS developments	SOT-EB, VOS-DACs, TT-VOS DMD	October 2021	Done
52	***A9.1.2/01***	Recognising that scientific studies confirm the positive impact of upper air soundings in data sparse regions SOT NFPs should encourage their NMHS to participate in global ASAP observations by installing and operating ASAP stations on board ships.	SOT NFPs, SOT EB, ASAP Panel,	Ongoing	
53	***A9.2.1/01***	SOOPIP Chairs, in liaison with the Technical Coordinator, to create a SOOP Bibliography on the SOOP/SOT website	SOOPIP Chairs & SOT-TC	SOT-12	
54	***A9.2.1.2/01***	SOOPIP Chairs, in liaison with Technical Coordinator, to flesh-out SOT/SOOP website.	SOOPIP Chairs & SOT-TC	Start 2022 - Complete before SOT-12.	
55	***A9.2.1.2/02***	In liaison with SOT-EB agree the format for presenting standards and best practices on the SOT/SOOP website. Consider a Table of Contents document with standardized formatting for each chapter (similar to the GO-SHIP hydrography manual).	SOT-EB, SOOPIP Chairs/Members	SOT-12	
56	***A9.2.1.2/03***	Complete "XBT Observational Best Practices for Quality Assurance" and post on https://www.oceanbestpractices.org/ with GOOS endorsement.	Justine Parks	By end 2021.	
57	***A9.2.1.2/04***	Continue to promote completion of S&BPs for all measurement parameters under SOOP umbrella, including posting on https://www.oceanbestpractices.org/ with GOOS endorsement, especially for pCO_2, TSG and CPR.	SOOPIP Chairs/members	Significant progress by SOT-12.	
58	***A9.2.1.2/05***	Work with the SOT community to complete "SOT Vessel Recruitment and on-Board Conduct" and post on https://www.oceanbestpractices.org/ with GOOS endorsement.	SOOPIP with interested SOT-EC members, TT-RPT	complete by end of 2022.	

59	***A9.2.1.2/06***	Continue testing and implementation of ship and platform metadata templates leading to best practices document's specific to each measurement parameter. *(The first will be "XBT Metadata Content and Format" because it is closest to finalization, but expand this for pCO_2, TSG, and CPR).*	SOOPIP with SOT-TC,	by SOT-12	
60	***A9.2.1.3/01***	Create an XBT environmental impact pamphlet, and make available via the SOOP website to communities and especially vessel Master's deploying XBT's.	SOOPIP TT-RPT SOT-TC	complete by mid-2022	
61	***A9.2.1.4/01***	Work with the pCO_2 network to recruit more vessels to have underway pCO_2 systems.	SOOPIP Chairs/members	Ongoing	
62	***A10.0/01***	Approval of the volunteers for membership of the SOT EB, and the current members of the SOT EB that wish to remain as members of the SOT EB, for term one (as per the SOT EB Terms of Reference)	SOT	SOT-11	Done
63	***A10.0/02***	Approve revised Terms of Reference for all SOT Task Teams and Panels, and notify OCG as necessary	SOT & SOT EB	October 2021	Done
64	***A 10.1/01***	Approval of the SOT financial report and estimated budget for next intersessional period.	SOT	SOT11	Done
65	***A10.1/02***	Members to consider contributing to the DBCP-TF towards SOT activities	SOT Members & Permanent Representatives	Ongoing	
66	***A10.2/01***	Approval of the SOT Implementation Strategy, Version 2.1	SOT	SOT-11	Done
67	***A10.2/02***	Review and further refine the SOT Implementation Strategy as an even more strategic document, to be labelled version 3	SOT EB/SOT Members	by SOT-12	

68	***A10.2/03***	Coordinate with the Observations Coordination Group for the update of "An Oceanographer's and Marine Meteorologist's Cookbook for Submitting Data and Metadata in Realtime and Delayed-Mode"	OCG / SOT	Complete by SOT-12	
69	***A10.3/01***	Recognise ASAP as a separate SOT Programme and approve changing ASAP Task Team into an SOT Panel with appropriate new Terms of Reference	SOT EB & OCG	November 2021	
70	***A11.2/01***	Exploit synergies with the Odyssey project	TT RPT	SOT 12	
71	***A12.1/01***	Create a series of Turbowin+ videos (setup, use, download log files, etc.)	TT-RPT	June 2022	
72	***A12.1/02***	Review the feedback from the PMO-6 survey to better inform the structure and delivery of the next PMO workshop	TT-RPT	SOT-12	
73	***A12.1/03***	Arrange targeted 6-monthly PMO webinars to focus on individual topics of interest. The first of which to be scheduled within 6 months of SOT-11	TT-RPT	March 2022	
74	***A13.2/01***	Participate in the writing of the new marine volume of WMO Pub No 8, which should also include JCOMM TR 63 documentation.	TT-ISSC	SOT-12	
75	***A13.2/02***	Work closely with Iridium to implement a Code 41 system on Iridium GMDSS	TT-ISSC	SOT-12	
76	***A13.2/03***	Update observing systems, sensors, and telecommunication metadata in OceanOPS database.	SOT NFP	SOT-12	
77	***A13.2/04***	Agree the new TT-ISSC Terms of Reference	SOT & SOT EB	October 2021	Done
78	***A14.1/01***	SOT members are requested to support the implementation of GBON requirements for SST and SLP observations identified in the WMO NO 1160 (section 3.2.2.10) and provide input to further develop GBON to include fuller range of marine/ocean EOVs and ECVs.	SOT members	Ongoing	

79	***A14.1.1/01***	SOT Website(s) to be reviewed and amended to include links to current membership lists (SOT NFPs, PMO's, TT's and SOOP/VOS Panel lists) and to also include a link to the latest version 2.1 of the SOT Implementation Strategy	TT-RPT, SOT-TC, WMO/IOC Secretariats	by end 2021	
80	***A14.1.1/02***	Task Team Chairs to review and confirm TT membership on annual basis and, accordingly, advise SOT-Technical Coordinator of any changes	TT Chairs	January each year	
81	***A14.1.1/03***	Task Team ToR's and VOS/SOOP/ASAP Panel ToR's to be amended to include a requirement to verify membership annually	TT & VOS/SOOP/ASAP Chairs & SOT EC	October 2021	Done
82	***A14.1.1/04***	Task Team membership be added to the SOT Annual Report	SOT TC, WMO Secretariat	Dec-21	
83	***A14.1.1/05***	WMO & IOC Secretariats to consider need to review Circular Letter 2666 to reflect future collection of SOT contact information via OceanOPS	WMO/IOC Secretariats (in liaison with SOT-TC)	Dec-22	
84	***A14.1.1/06***	OceanOPS to liaise with WMO Secretariat regarding future revised procedures and instructions for requesting submission of SOT Annual Reports via OceanOPS database/user groups	WMO Secretariat, SOT- TC	2022	
85	***A14.1.1/07***	IOC Secretariat to ensure that online SOT NFP legacy lists cannot be confused with current SOT NFP lists on the OceanExpert dashboard.	IOC Secretariat	end 2021	
86	***A14.3/01***	With the approval of the members of Australia, with no unforeseen issues, and provided it can be held with some in-person attendance, approve Australia as the host of SOT-12.	Australian BoM, SOT Chair	SOT-12	

RECOMMENDATIONS:

No	Ref. Item	Recommendation	By	Deadline	*Update*
1	***R6.0/01***	Populate all metadata fields available in GTS ingested data	Data Producers National data processing centres	Ongoing	
2	***R9.1.1/01***	If data is drawn from GTS and re-ingested, the use of special headers should be considered to make it clear that they are duplicates or compilations i.e., to allow easier identification of duplicates and / or original format data or conversions made from the original observations.	GTS data Centres/Nodes	Ongoing	
3	***R9.1.1/02***	Secretariats to provide easy access to NFP and PMO lists (with input from WMO and IOC members) and keep them up-to-date, and link to them from relevant websites.	WMO/IOC Secretariats	asap/Ongoing	
4	***R9.1.1/03***	WMO Secretariat to organise appointment of a contributor to ISO&TC 8/SC 13/WG 2. (to replace outgoing VOSP VC)	WMO Secretariat	asap	
5	***R9.1.1/04***	Secretariats to ensure that the ToRs are stated correctly on all relevant websites and documents are kept up to date.	WMO/IOC Secretariats	asap /Ongoing	
6	***R14.1.1/01***	E-SURFMAR to strongly encourage its participating EUMETNET members to submit individual national SOT Annual Reports to future SOT sessions	E-SURFMAR VOS Chair & Members	annually	

Annex XIV – List of Acronyms

ADCP	Acoustic Doppler Current Profiler
AIS	Automatic Identification System
AMOS	Autonomous Marine Observing System
AOML	NOAA Atlantic Oceanographic and Meteorological Laboratory (USA)
AOPC	Atmospheric Observations Panel for Climate (of GCOS)
API	Application programming interface
APTR	Automated pressure and temperature recording
ASAP	Automated Shipboard Aerological Programme
AtlantECO	Atlantic Ecosystems Assessment, Forecasting, and Sustainability
AWS	Automatic Weather Station
BGC	Biogeochemical
BoM	Bureau of Meteorology (Australia)
BUFR	Binary Universal Form for Representation of meteorological data
CBS	Commission for Basic Systems
CDR	Carbon dioxide removal
Cg	WMO Congress
CIMO	Commission on Instruments and Methods of Observation (WMO)
CLIMAR	Workshops on Advances of Marine Climatology
CLS	Collecte Localisation Satellites (France)
CMD	Continuously Managed Database
CMEMS	European Copernicus Marine Environment Monitoring Service
CMM	Commission for Marine Meteorology
CMOC	Centre for Marine Meteorological and Oceanographic Climate Data
CO2	Carbon dioxide
COVID	Coronavirus disease
CPR	Continuous plankton recorder
CREX	Character form for the Representation and EXchange of data
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSV	Comma Separated Values format
CTD	Conductivity, Temperature, Depth
DAC	Data Assembly Centre
DBCP	Data Buoy Co-operation Panel (WMO-IOC)
DCPC	Data Collection and Production Centre
DWD	Deutscher Wetterdienst
E-ASAP	ASAP Programme of EUMETNET
EB	Executive Board
EC	Executive Council
EC-PHORS	Experts on Polar and High Mountain Observations, Research and Services
ECV	Essential Climate Variable
EEZ	Exclusive Economic Zone
EMOS	Enhanced Manual Observing System
EOV	Essential Ocean Variable
ERDDAP	Environmental Research Division's Data Access Program
ERVO	European Research Vessel Operators
E-SURFMAR	Surface Marine programme of the Network of EUMETNET
ETMC	Expert Team on Marine Climatology (JCOMM)
EU	European Union
EUCAWS	EUropean common Automatic Weather Station

EUMETNET	Network of European Meteorological Services
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FTE	Full Time Employee
FTP	File Transfer Protocol
FSU	Florida State University
GBON	Global Basic Observing Network
GCC	Global Collecting Centre (of MCSS)
GCOS	Global Climate Observing System
GCW	Global Cryosphere Watch
GDAC	Global Data Assembly / Acquisition Centre
GLOSS	Global Sea Level Observing System
GMDSS	Global Maritime Distress and Safety System
GOMO	Global Ocean Monitoring and Observing Program
GOOS	Global Ocean Observing System
GO-SHIP	Global Ocean Ship-Based Hydrographic Investigations Programme
GOSUD	Global Ocean Surface Underway Data Pilot Project
GTS	Global Telecommunication System
GTSPP	Global Temperature and Salinity Profile Programme
GUI	Graphical User Interface
HKO	Hong Kong Observatory
HQCS	Higher Quality Control Standard
HRMM	High Resolution Marine Meteorology
ICES	International Council for the Exploration of the Sea
IETF	Internet Engineering Task Force
ICOADS	International Comprehensive Ocean-Atmosphere Data Set (USA)
IFREMER	Institute Français pour la Recherche et l'Exploration de la Mer
IHO	International Hydrographic Organization
IMMT	International Maritime Meteorological Tape
IMO	International Maritime Organization
INFCOM	Commission for Observation, Infrastructure and Information Systems
IOC	International Oceanographic Commission
IOCCP	International Ocean Carbon Coordination Project
IODE	International Oceanographic Data and Information Exchange (IOC)
IQuOD	International Quality-controlled Ocean Database
IRD	Institut de Recherche pour le Developpment
IRSO	International Research Ship Operators
ISC	International Science Council
IT	Information technology
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JCOMMOPS	JCOMM in situ Observations Programme Support Centre
JMA	Japan Meteorological Agency
KM	Kongsberg Maritime
KNMI	The Royal Netherlands Meteorological Institute
KPI	Key Performance Indicators
MCDS	Marine Climate Data System
MCSS	Marine Climatological Summaries Scheme
MEDS	Marine Environmental Data Section
MFP	Marine Facilities Planning
MOSAiC	Multidisciplinary Drifting Observatory for the Study of Arctic Climate
MoU	Memorandum of Understanding
MQCS	Minimum Quality Control Standards
NASA	National Aeronautics and Space Administration (USA)
NCEI	National Centers for Environmental Information (NOAA-USA)

NCSR	Navigation, Communications, Search & Rescue
NERC	Natural Environment Research Council
netCDF	Network Common Data Form
NFPs	National Focal Points
NMEA	National Marine Electronics Association
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration (USA)
NODC	IODE National Oceanographic Data Centre
NWP	Numerical Weather Prediction
NWS	NOAA's National Weather Service
NSF	National Science Foundation
OBP	Ocean Best Practices
OceanOPS	WMO-IOC in situ Ocean Observing System Monitoring and Coordination Centre
OCG	Observation Coordination Group
OECD	Organisation for Economic Co-operation and Development
OFEG	Ocean Facilities Exchange Group
OOMD	Ocean Observation and Monitoring Division (NOAA-USA)
OOPC	Ocean Observations Panel for Climate
OPA	Observations Programme Area
OSCAR	Observing System Capability Analysis and Review
PMO	Port Meteorological Officer
QC	Quality Control
RAN	Royal Australian Navy
RRR	Rolling Review of Requirements (WMO)
RSMC	Regional Specialized Meteorological Centre
RSV	Research Survey Vessel
RTMC	Real-Time Monitoring Centre
SAMOS	Shipboard Automated Meteorological and Oceanographic System
S-AWS	Ship-borne Automatic Weather Stations
SBD	Short-Burst Data
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SERCOM	Commission for Weather, Climate, Water and Related Environmental Services and Applications
SGDs	Sustainable Development Goals
SHOM	French Naval Hydrographic and Oceanographic Service
SOCAT	Surface Ocean Carbon Atlas
SOCIB	Balearic Islands Coastal Observing and Forecasting System
SO-CPR	Southern Ocean Continuous Plankton Recorder
SOLAS	Safety of Life at Sea
SOOP	Ship Of Opportunity Program
SOOP-IP	SOOP Implementation Panel
SOS	Sustainable Ocean Summit
SOT	Ship Observations Team
SOT-ID	SOT Identifier Scheme
SSS	Sea Surface Salinity
SST	Sea Surface Temperature
TAC	Traditional Alphanumeric Codes
TBTO	Tributyltin oxide
TC	Technical Coordinator
TDC	Table Driven Code
TF	Trust fund
THREDDS	Thematic Real-time Environmental Distributed Data Services

ToR	Terms of Reference
TPOS	Tropical Pacific Observing System
TSG	Thermosalinograph
TT	Task Team
TT-HRMM	Task Team on High Resolution Marine Meteorology
TT-IS	Task Team on Instrument Standards
TT-ISSC	Task Team on Instrument Standards and Satellite Communications
TT-KPI	Task Team on Key Performance Indicators
TT-RPT	Task Team on Recruitment, Program Promotion and Training
TT-Satcom	Task Team on Satellite Communication Systems
TT-TDC	Task Team on Table driven Code
TT-VRPP	Task Team on VOS Recruitment and Programme Promotion
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNOLS	University-National Oceanographic Laboratory System
USV	Uncrewed surface vehicle
UTC	Universal Time Coordinated
VOS	Voluntary Observing Ship
VOSP	Voluntary Observing Ship Panel
WCRP	World Climate Research Programme
WHOI	Woods Hole Oceanographic Institution
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
WOC	World Ocean Council
WOW	Weather Observations Website
WRAP	Worldwide Recurring ASAP Project
XBT	Expendable Bathy Thermograph
XCTD	Expendable Conductivity/Temperature/Depth
XML	Extensible Markup Language