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ACHIEVEMENTS AND FUTURE PRIORITIES OF THE SERVICES AND FORECASTING SYSTEMS PROGRAMME AREA

BACKGROUND MATERIAL

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JCOMM-4/Doc.8.3: Safety-related Marine Meteorological Services
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JCOMM-4/Doc.8.5: Future Priority for the Services and Forecasting Systems Programme
Also see:
JCOMM-4/Doc.5.2: Operational requirements and WMO Rolling Review of Requirements
JCOMM-4/Doc.5.4: Climate Services
JCOMM-4/Doc.9: Capacity Development and Technology Transfer

REFERENCES:

- Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress (WMO-No. 1077) Resolution 24, paragraph number 4.4
- Abridged Final Reports with Resolutions of the Sixty-second (WMO-No. 1059) and Sixty-third Sessions (WMO-No. 1078) of the WMO Executive Council. paragraph number 4.2.46 to 4.2.50
- Summary Report of the Forty-third (IOC/EC-XLIII) Session of the UNESCO/IOC Executive Council, paragraph number 5.3
- Summary Report of the Twenty-sixth (IOC-XXVI) Session of the UNESCO/IOC Assembly, paragraph number 6.2
- Final Reports of the Eighth (JCOMM/MR-No.83) and Ninth (JCOMM/MR-No. 88) Sessions of the JCOMM Management Committee:
- Final Reports of the Fifth (JCOMM/MR-No.76) and Sixth (JCOMM/MR-No.89) Sessions of the Services and Forecasting Systems Coordination Group:
- JCOMM SFSPA website: http://www.jcomm.info/SFSPA

ACHIEVEMENTS AND FUTURE PRIORITIES OF THE SERVICES AND FORECASTING SYSTEMS PROGRAMME AREA (SFSPA)

1. At its third session (2009, Morocco), the Commission established the Services and Forecast Systems Program Area (SFSPA) which expanded the mandates for the previous Services Program Area by including the new focus of establishing operational ocean forecasting services. The Commission recalled the major thrust areas for the SFSPA during the current intersessional period, including:

- Ensure maritime weather and sea ice safety including the operational implementation of five (5) new Arctic Ocean METAreas by July 2011;
- Implement operational ocean forecasting capability by initially developing a Guide to Operational Ocean Forecasting;
- Reduce risks of weather hazards on coastal communities in response to expected consequences of global climate change and sea level rise by implementing recommendations from the first JCOMM storm surge symposium.

2. To make progress in these three mandate areas, the SFSPA identified a number of priority projects aimed at achieving outcomes by JCOMM-4 (http://www.jcomm.info/SPAWP). These projects have been successfully led by SFSPA Expert Teams.

Achievements/Progress during the Intersessional Period 2009-2012

3. Many SFSPA projects have been successfully completed or made significant progress, although the past intersessional period was unusually short. The responsible Teams will continue implementing those projects and activities successfully underway, during the coming intersessional period. Some significant achievements of SFSPA are briefly summarized in the following paragraphs.

Operational Ocean Forecasting (See JCOMM-4/Doc.8.1)

4. The Expert Team on Operational Ocean Forecasting Systems (ETOOFS) coordinated the implementation of operational ocean forecasting capability at several NMHSs. Operational ocean forecasting capability is achieved in Europe (Mercator-Ocean, MyOcean), Australia (Bluelink) and the United States (a Navy-NOAA partnership). ETOOFS also coordinated a framework for conducting routine performance monitoring of the operational forecasting systems among the operational centers. A strong partnership with the academic community (GODAE) enabled transition of ocean observation, modelling, and data assimilation in a research environment into operational ocean forecasting service capability at NMHSs.

5. The first Guide to Operational Ocean Forecasting is under development by ETOOFS. Significant progress is being made toward a first draft. However, given the unusually short intersessional period, the work is expected to continue into the new intersessional period. A mature document outline has been agreed upon and is being managed through collaborative tools (Google Docs). The overall strategy of the Guide is under review.

Operational Wave Forecast Verification (See JCOMM-4/Doc.8.1)

6. The wave forecast verification scheme (http://www.jcomm.info/wave), initiated in 1997, has been successfully implemented under the leadership of the Expert Team on Wind Waves and Storm Surges (ETWS) in cooperation with the European Centre for Medium-Range Weather

Forecasts (ECMWF). Contributing institutions, by disseminating their wave model data, at present include ECMWF, MetOffice, FNMOC, MSC, NCEP, MeteoFrance, DWD, BoM, SHOM, JMA, KMA, Puerto del Estado, DMI, CNR-AM, METNO and SHN-SM.

7. During the past intersessional period, ETWS and ECMWF have been successful collaborating with the European Space Agency (ESA) GlobWave project in implementing components of the wave forecast verification scheme specifically to expand the verification scheme to include additional remotely sensed data, and spatial intercomparison. It is planned to continue with the development of spectral validation of wave model outputs.

Best Practices for Wave Measurements (See JCOMM-4/Doc.6.3)

8. Through joint efforts of the Data Buoy Cooperation Panel (DBCP) and ETWS, progress has been made on the evaluation of wave measurement systems in support of a wide range of applications such as the monitoring of extreme wave events for disaster risk reduction, wave modelling, and the calibration and validation of satellite wave measurements. Following the recommendations made at the JCOMM Technical Workshop on Wave Measurements from Buoys (October 2008, USA: http://www.jcomm.info/WaveBuoys), a pilot project was launched and coordinated jointly by DBCP and ETWS to develop the basis for the continuous testing and evaluation of existing / planned wave buoy measurements, in order to establish confidence in the user community of the validity of wave measurements from the various moored buoy systems (http://www.jcomm.info/WET). Presently there are eight participants in the pilot project, following an agreed procedure for deployment, testing of prototypes, and evaluation of wave measuring instruments.

Coastal Hazard Disaster Risk Reduction (See JCOMM-4/Doc.8.2)

9. The first JCOMM Symposium on Storm Surges (2007, Republic of Korea: http://www.surgesymposium.org) initiated renewed awareness of the need to improve storm surge forecasting systems that make full use of modern techniques and observations. ETWS, in collaboration with other WMO Technical Commissions and relevant UNESCO/IOC subsidiary bodies, continues to implement the scientific/technical recommendations from this Symposium. Several activities have been successfully initiated and supported in this area, including:

- UNESCO/IOC North Indian Ocean Storm Surge Project, with an objective to improve storm surge predictability by an operational model commonly used by the NMHSs in the region,
- WMO JCOMM/CHy Coastal Inundation Forecasting Demonstration Project (CIFDP, http://www.jcomm.info/CIFDP), aiming to provide an example of cooperative work as a strategy for building improved operational forecast and warning capability for coastal inundation from combined extreme waves, surges and river flooding events, which can be sustained by the responsible national agencies,
- European Space Agency (ESA) Storm Surge Project: *eSurge* (http://www.storm-surge.info), aiming to develop a comprehensive database of storm surge events, satellite data, NWP outputs and storm surge model outputs that can be used to explore and develop new tools, techniques and understanding of storm surge forecasting.

These efforts contribute directly to the WMO Strategic Thrusts in strengthening capacity building and improving service delivery by NMHSs, especially for developing and least developed countries, to fulfil their mandates.

10. ETWS is playing the key role in developing and coordinating the CIFDP, in close

coordination with the WMO Secretariat. Significant efforts have been made to streamline the project concept and implementation plan, and to launch two national sub-projects in Bangladesh and Dominican Republic. The SFSPA workplan for the intersessional period includes continuing a focused effort to implement and conclude these two sub-projects, and to extend the concept/demonstration to other countries/region. As this project represents JCOMM's potential contribution to multi-hazard forecasting and warning, discussion has been under way with related WMO and IOC programmes including the IOC Working Group on Tsunamis and Other Hazards (TOWS WG) for cooperation in dealing with multi-hazard forecast and warning issues. It was agreed that JCOMM and TOWS WG further discuss on a set of actions to allow such collaboration to develop.

11. The JCOMM Guide to Storm Surge Forecasting (WMO-No.1076) and its Dynamic Part (http://www.jcomm.info/SSguid) have been published during the intersessional period. It is expected that this Guide will provide useful information and reference to the operational services by NMHSs. It is planned that these publications would be maintained as up-to-date as possible, under the oversight of ETWS, cross-referenced with other Manuals and Guides including the Manual of Quality Control Procedures for Validation of Oceanographic Data (UNESCO/IOC M&G No. 26).

Maritime Safety for the Arctic Ocean and Ice Navigation (See JCOMM-4/Doc.8.3)

12. The Expert Team on Maritime Safety Services (ETMSS) and Expert Team on Sea Ice (ETSI) have successfully led the completion of the operational expansion of the Global Maritime Distress and Safety System (GMDSS) to cover the Arctic Ocean. Five new Arctic Ocean METAreas became operational by 1 June 2011. A new Arctic GMDSS web-server for operational exchange of products across the Arctic Preparation Services and to ensure circumpolar continuity of products is in operation from June 2011.

13. ETSI has led the development of the elements of marine pollution emergency response support system (MPERSS) for the Arctic Ocean METAreas, along with the development of the suite of comprehensive sea-ice and met-ocean products for ice and ice-free navigation (led by ETMSS and ETSI). Progress is being made in the MPRESS capability for the Arctic Ocean on a level of national services and EU projects (mostly short-term forecast oil dispersion models) and extended suites of sea-ice, high-resolution satellite imagery and met-ocean products are being broadcast to the new METAreas supporting both ice and ice-free navigation.

14. In addition, ETMSS has made significant improvement on the GMDSS website (http://weather.gmdss.org or http://www.jcomm.info/GMDSS) which now hosts a significantly increased fraction of operational NAVTEX disseminated by issuing services.

Ice Information in Electronic Nautical Charts (See JCOMM-4/Doc.8.3)

15. Under the leadership of ETSI and through partnerships with Electronic Console Display Information System (ECDIS) manufacturers, the SFSPA has enabled the placement of sea ice objects on electronic nautical charts (ENC) and display them on the shipboard ECDIS. An integrated sea ice ENC on ECDIS is to be demonstrated at JCOMM-4. The next significant step forward is to develop the ENC/ECDIS capability both for sea-ice and met-ocean information in accordance with the new IHO S-1xx standard.

16. Telecommunication means to deliver maritime safety information to mariners at sea has always been a major challenge. WMO needs to engage IMO and IHO to address the fact of co-existence of state-of-the-art technologies (e.g., ECDIS, Internet) and "dark-age" but yet highly cost-effective technologies (e.g., radio-facsimile), a major challenge in setting Vision and directions for the future of GMDSS. An immediate step that JCOMM could take is to build on the success of (mostly vector) sea ice object display for ENC/ECDIS by expanding this capability to include

(mostly gridded) met-ocean objects in accordance with the new comprehensive IHO S-1xx standard. Under the leadership of ETMSS and ETSI, SFSPA has made noticeable progress in defining an object catalogue for met-ocean variables. The next step is to partner with the industry toward an ENC/ECDIS displaying capability for met-ocean objects. SFSPA expects to push forward in this direction for the next intersessional period, leveraging the experience from the success in sea ice information for ENC.

Implement a Framework of Quality Management System (QMS, See JCOMM-4/Doc.8.4)

17. JCOMM Members have made progress in adapting to a Quality Management System Framework. Several NMHSs including UK, Australia, France and Canada have implemented formal QMS for their marine weather services. SFSPA expects to continue to encourage NMHS of Members/Member States to establish appropriate practices under the quality management framework.

Collection and Consideration of User Requirements for Maritime Safety Information (See JCOMM-4/Doc.8.3)

18. To keep abreast of maritime user requirements for marine weather and sea ice safety information provided by JCOMM Members/Member States, ETMSS is conducting a regular user survey which is expected to be completed by JCOMM-4. Survey results will be analyzed and reported to JCOMM-4.

Update Observing Requirements for Metocean Services (See JCOMM-4/Doc.5.2 and JCOMM-4/Doc.8.1)

19. SFSPA completed its contribution and updates to the latest cycle of the RRR process including updates on observing requirements for marine meteorology and oceanography available on http://www.wmo-sat.info/db/. In particular, new observing requirements for operational ocean forecasting applications are being incorporated into the WMO database. This effort supports the WMO Strategic Thrust on advancing science and technology development to enhance access and use of Earth-and-space based observing systems. This data base along with the Statement of Guidance (SoG) is continuously under review.

20. In responding to the request made at the Management Committee (MAN-IX, September 2011, Geneva), the SFSPA Coordination Group (SCG) developed a general document on the broader ("technology free") requirements for satellite information, to be taken to the higher JCOMM level for consideration by Members / Member States including the Space Agencies – see Appendix to the JCOMM-4/Doc.5.2. It is intended to use this document as a means to communicate with high level national decision makers and with wider community.

Support for Scientific Activities (See JCOMM-4/Doc.5.4 and JCOMM-4/Doc.6.3)

21. For JCOMM to develop technical advice for Members/Member States in fulfilling their services duties, it is critical to ensure exchange of information on databases, methodologies and techniques and sharing expertise. SFSPA has been continuing its efforts in this through global scientific fora. In this context, ETWS has continued to co-sponsor and co-organize the biennial International Workshops on Wave Hindcasting and Forecasting and Coastal Hazard Symposia (http://www.waveworkshop.org), and supported several international workshops on storm surges including the Storm Surge Congress 2010 (September 2010, Germany).

22. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) identified surface wind waves as one of the key drivers in the coastal zone, on which further study of projected changes as well as on the influence of sea-level rise and inundation effects were required under future climate scenarios. The joint initiative of JCOMM and the World Climate

Research Programme (WCRP) was initiated for the Coordinated Ocean Wave Climate Projections (COWCLIP), through an expert workshop held at WMO in Geneva, 11-13 April, 2011. The outcome of this initiative would directly contribute to GFCS through the results of coordinated intercomparison on global wave projections between international research groups, and through better understanding uncertainty within the community ensemble of wave climate projections. In this context, the Commission requested the ETWCH to take a lead to this activity, with a view to include wave parameters in greater detail in the IPCC Fifth Assessment Report (AR5).

Update Manuals and Guides for Marine Meteorological Services (See JCOMM-4/Doc.8.2 and JCOMM-4/Doc.10)

23. SFSPA, with ETMSS leadership, has published the 2011 edition of the Manual on Marine Meteorological Services (WMO-No.558: http://www.jcomm.info/558), compiling all recommended and endorsed updates by JCOMM at its regular sessions and streamlining the structure of the Manual. It is planned to keep this mandatory publication updated under the SFSPA. The 2011 edition of the Guide to Marine Meteorological Services (WMO-No.471) is also being published in a consistent manner with the WMO-No.558.

24. Updating the WMO-No.471 and WMO-No.558 for Sea State in Maritime Safety Information requires the establishment of new forecast guidance on dangerous sea states. This effort is ongoing. A near term objective is to prepare a white paper by ETWS on recommendations for including hazardous seas information in GMDSS. This is expected to be completed by JCOMM-4.

25. ETSI has continued to review and update sea ice standards and associated WMO publications, Guides and Manuals, including: 1) WMO “Sea Ice Nomenclature” (No.259, 1970-2007), 2) SIGRID-3 (WMO/Td.1214, 2004), 3) Ice Chart Colour Standard (WMO/Td.1215, 2004) and “Ice Objects Catalogue” (WMO, 2007). Information on ice services for shipping is now annually tracked according to the WMO publication No.574 “Sea Ice Services in The World” (1970-2010). Updated information is communicated with the National Ice Services and the sea ice community through various means, including the series of Ice Analysis Workshops.

Capacity Building (See JCOMM-4/Doc.8.1 to 8.4, and JCOMM-4/Doc.9)

26. The training workshops sponsored and supported by SFSPA during the past intersessional period are summarized on the JCOMM web page on Capacity Building (http://www.jcomm.info/CB), in the areas of maritime safety, quality management, storm surge and operational ocean forecasting. These include:

- Maritime Safety Services Enhancement Workshop (May 2010, Australia)
- EUMETSAT/NOAA /IODE Training Course on the Use of Satellite Wind and Wave Products for Marine Forecasting (December 2009, Belgium)
- Training workshop on use of Wave Watch III model in operations (January 2010, India)
- 6th and 7th JCOMM/TCP Training Workshops on Storm Surge and Wave Forecasting (February 2011, Dominican Republic; and September 2011, Macao)
- GODAE summer school on operational ocean forecasting (January 2010, Australia)
- Ice Analysts Workshop (June 2011, Denmark)
- Training on Marine Forecasting (July 2010, Senegal)

27. A number of SFSPA activities comprise Capacity Building as their core component. For example, CIFDP put its priority to build/enhance NMHS’s capability to produce forecasting and warning information on coastal inundation. The SFSPA also focuses on supporting national institutions to obtain and share technologies on OOFS through various training and R&D initiatives.

Emerging Service Requirements and Challenges for Upcoming Intersessional Period

Global Framework for Climate Services (See JCOMM-4/Doc.5.4)

28. Implementation of a Global Framework for Climate Services (GFCS) has been identified as a top priority of WMO at the 16th Congress in 2011. A GFCS Implementation Plan is currently being developed, and JCOMM as a Technical Commission is requested to be engaged in the drafting and implementation process. SFSPA has a number of core mandate areas that directly support GFCS, including maritime weather and sea ice safety information services for the new Arctic Ocean METAREAs, and coastal natural hazard risk reduction. In addition, oceanographic observation and modeling for weather and climate monitoring and prediction is a core mandate of JCOMM. SFSPA's ocean modelling and forecasting service area through ETOOFS could provide competence in coordination of the ocean component of operational climate forecast systems.

29. JCOMM, particularly through its SFSPA, has a role not only to facilitate engagement of and interaction with the user groups and the entities to JCOMM that are interested in climate services, but also to provide scientific and technical input to the future "Climate Services Information System".

Oceanic Dispersion Modeling (Operational Ocean Forecasting and Marine Emergency Response: see JCOMM-4/Doc.8.3)

30. The Gulf of Mexico oil spell and the radioactive materials discharge from Fukushima nuclear power plant following the earthquake and tsunami illustrated the need for oceanic "dispersion modeling" capability and a coordinated global response infrastructure. Such capability would enable tracking/forecasting of hazard particles in the ocean, and assessing their potential impacts on marine life, coastal and marine ecosystems, and human health.

31. This is a potential opportunity for JCOMM to leverage on the capability of operational ocean forecasting centers to meet the new requirements, through collaboration with other UN agencies such as IAEA. The Commission should also enhance the partnership with GODAE OceanView Science Team in developing or enhancing ocean modeling capability for "dispersion modeling" and future biological and ecological impact assessment capability.

Support for Coastal Disaster Risk Reduction (See JCOMM-4/Doc.8.3 and JCOMM-4/Doc.12.4)

32. Coastal hazards associated with natural disasters such as storm surge/coastal inundation, exacerbated by expected climate change/sea level rise, are expected to rise significantly. As WMO strategically moves toward implementing a Global Framework for Climate Services (GFCS), SFSPA is expected to lead the JCOMM efforts in service provision for reduction of coastal hazard risks associated with climate variability and climate change. ETWS has been leading the JCOMM efforts for natural coastal hazard risk reduction during the past intersessional period. To further highlight the JCOMM priority in contributing to the GFCS, the Commission endorsed the SFSPA proposal to change the name of ETWS to Expert Team on Waves and Coastal Hazards forecasting systems (ETWCH).

User-oriented approach to address societal benefit

33. A major challenge in achieving the desired societal outcomes in targeted developing and least developed countries is the need to "think beyond forecasting". This includes building "storm ready" coastal communities and utilizing/enhancing available infrastructure (e.g., telecommunication) to deliver forecasts to the hands of mariners at the sea, which are major challenges. They need to be addressed in tandem with building forecasting capacity in these countries. New partnerships across traditional disciplines will be required in ocean observations, biological and radiological expertise to respond, track and assess impacts of these types of disasters on ocean, marine ecosystems, and human society.

34. Although still in its infancy, operational ocean forecasting services have already faced strong challenges in meeting societal demands for effective response to disasters such as the Gulf of Mexico Oil Spill and the radioactive discharge into the ocean resulting from the severe earthquake damage to the Fukushima nuclear power plant.

Extending the Scope of Maritime Safety Information

35. Volcanic ash floating on the sea surface has the potential to disable ship engines through ship's water intake. The Commission recognized that advisories on volcanic ash disseminated through high seas bulletins could be of value for enhanced navigation safety for mariners.

36. Severe solar magnetic storms could disrupt GPS, satellite communications and HF radio communications. Maritime transits over the open ocean rely heavily on these communication and navigation aids for their safety at sea. As the next peak solar activity period (2012-2013) is closing in, the Commission agreed to pursue the development of relevant space weather advisories for mariners through collaboration with IMO/IHO and leveraging the weather safety information generation and dissemination infrastructure of the NMHS.

SFSPA Priority and Workplan for Upcoming Intersessional Period: see JCOMM-4/Doc.8.5

37. Responding to the decisions and requests of the Governing Bodies, the proposed priorities for SFSPA should include contribution to GFCS implementation for marine and coastal communities, along with fulfilling the Commission's core service mandates in providing maritime safety services as well as supporting marine and coastal emergency responses and risk reduction.

38. Building on the achievements made by the Expert Teams of SFSPA, the proposed workplan for the upcoming intersession period includes the following:

Operational Forecasting Systems and Services

- Develop technical documentation, particularly the new Guide to Operational Ocean Forecasting Systems, and provide relevant contributions to the GDPFS manual (WMO-No.485);

- Continue implementing operational ocean forecasting services for daily to seasonal time scales, including developing performance metrics and coordinating data management and dissemination standards through close collaboration with DMPA and CBS.;

- Coordination of ocean metrics for monitoring ocean extremes in close collaboration with OOPC;

- Develop a JCOMM coordination framework to support ocean and marine requirements for operational coupled seasonal climate forecast systems, in support of the GFCS;

- Coordinate the development of oceanic dispersion modelling, prediction and impact assessment capabilities through partnerships with GODAE Ocean View Science Team, IAEA, and IMO/IHO to address the marine emergency response needs for oceanic discharge of radioactive hazards;

- Maintain and update requirements documents for ocean applications, including RRR and SoG;

- Continue leading the wave forecast verification scheme (http://www.jcomm.info/wave), and support verification/evaluation activities through the Pilot Project on Wave Evaluation and Test (PP-WET, http://www.jcomm.info/wet).

Support Disaster Risk Reduction in Coastal Zones

- Maintain and update technical documentation (and their dynamic parts), including the Guide to Storm Surge Forecasting (WMO-No.1076), Guide to Wave Analysis and Forecasting (WMO-NO.702), and relevant parts of the Global Data Processing and Forecasting System (GDPFS, WMO-NO. 485);

- Continue Supporting Members / Member States to develop and implement the regional sub-projects of the Coastal Inundation Forecasting Demonstration Project (CIFDP). This work further aims to provide advice for regional and national forecast/warning systems for coastal meteorological / oceanographic hazards;

- Support Members / Member States in establishing Extreme Wave datasets and storm surge climatologies;

- Extend cooperative activities with IOC Working Group on Tsunamis and Other Hazards related to Sea Level Warning and Mitigation Systems (TOWS-WG) for a multi-hazard approach;

- Lead research efforts for coordinated wave climate projection (COWCLIP).

Safety-related Marine Meteorological Services

- Continue supporting Maritime Safety Information services (with IMO and IHO) including ice navigation services and information on complex sea states; and enhance ENC/ Electronic Chart Display Information System (ECDIS) or other display capabilities for met-ocean safety information, under the agreed scheme for IMO e-Navigation;

- Maintain and update technical documentation, including the Manual on Marine Meteorological Services (WMO-No. 558), Guide to Marine Meteorological Services (WMO-No.471), relevant parts of the Global Data Processing and Forecasting System (GDPFS, WMO-NO. 485), and sea-ice standards and reference material;

- Assess services requirements for marine pollution emergency response, through enhanced partnerships with IAEA, IMO, IHO and other partners. This work will be conducted in parallel with the development and implementation of a JCOMM Strategy for enhanced marine pollution emergency response, with a focus on radioactive material discharge;

- Enhance interaction with marine users to keep abreast of user requirements for improvement of services, and improve the service / information interface;

- Address emerging requirements for extended maritime safety information, including marine volcanic ashfall hazard advisories and developing warnings for high impact space weather events.

Quality Management and Capacity Building

- Leverage on the successful implementation of a Quality Management System (QMS) at several advanced Services to expand the QMF/QMS approach in NMHSs in developing Members / Member States through training and pilot demonstrations;

- Support training for operational ocean forecasting;

- Continue supporting the Storm Surge Watch Scheme (SSWS), including training

workshops on storm surge and wave forecasting (JCOMM/TCP training workshop series).

- Continue supporting and harmonizing sea-ice related training (e.g. IAW, COMET, manual for ice experts – ice observers).

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