WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

DATA BUOY COOPERATION PANEL

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TWENTY-SEVENTH SESSION

ITEM: 11.4

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USER REQUIREMENTS

(Submitted by the Secretariat)

Summary and purpose of the document

This document provides information on the GOOS activities during the intersessional period in view of its contribution to meet the GOOS goals ad objectives, and provides a review of the requirements expressed by the GOOS / GCOS Ocean Observing Panel for Climate (OOPC), as required. The document also includes information on the WMO Rolling Review of Requirements and how non-climate requirements can be addressed by the Panel.

ACTION PROPOSED

The Panel will review the information contained in this report and comment and make decisions or recommendations as appropriate. See part A for the details of recommended actions.

Appendices: A. Ocean Application gaps to be considered in the new EGOS-IP

-A- DRAFT TEXT FOR INCLUSION IN THE FINAL REPORT

11.4.1 GCOS / GOOS / WCRP Ocean Observing Panel for Climate (OOPC)

11.4.1.1 Mr David Meldrum (IOC Secretariat) provided a report on behalf of the Ocean Observation Panel for Climate (OOPC). The Ocean Observations Panel for Climate (OOPC) is a scientific expert advisory group, charged with making recommendations for a sustained global ocean observing system for climate in support of the goals of its sponsors: the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), and the World Climate Research Programme (WCRP). It also reports to JCOMM on requirements; JCOMM groups including the Data Buoy Cooperation Panel (DBCP) coordinate a number of the in situ networks of the global module of GOOS, also the ocean component of GCOS. The OOPC thanked the members of the DBCP and those contributing to DBCP networks as implementers. The global ocean observing system, though incomplete in important respects, is providing essential information to users.

11.4.1.2 The OOPC has written its latest recommendations on ocean observations for climate in the GCOS 2010 Implementation Plan [1] . These reflect a mild evolution of previous recommendations, expanding the number of Essential Climate Variables for the ocean and emphasizing integration. Of note for the DBCP were the following requested actions:

- [Action O5] Complete and maintain a globally-distributed network of 30-40 surface moorings as part of the OceanSITES Reference Mooring Network.
- [Action O7] Continue the provision of best possible SST fields based on a continuous coverage-mix of polar orbiting IR and geostationary IR measurements, combined with passive microwave coverage, and appropriate linkage with the comprehensive in situ networks noted in O8.
- [Action O8] Sustain global coverage of the drifting buoy array (total array of 1250 drifting buoys equipped with ocean temperature sensors), obtain global coverage of atmospheric pressure sensors on the drifting buoys, and obtain improved ocean temperature from an enhanced VOS effort.
- [Action O11] Implement a programme to observe sea-surface salinity to include Argo profiling floats, surface drifting buoys, SOOP ships, tropical moorings, reference moorings, and research ships. Performance indicator: data availability at International Data Centres.
- [Action O16] Implement a wave measurement component as part of the Surface Reference Mooring Network.
- [Action O17] Establish an international group to assemble surface drifting buoy motion data, ship drift current estimates, current estimates based on wind stress and surface topography fields; prepare an integrated analysis of the surface current field.
- [Action O18] Plan, establish and sustain systematic in situ observations from sea-ice buoys, visual surveys (SOOP and Aircraft), and ULS in the Arctic and Antarctic.
- [Action O27] Complete implementation of the current Tropical Moored Buoy, a total network of about 120 moorings.
- [Action O29] Work with research programmes to develop autonomous capability for biogeochemical and ecological variables, for deployment on OceanSITES and in other pilot project reference sites.
- [Action O32] Develop and implement comprehensive ocean data management procedures, building on the experience of the JCOMM Pilot Project for WIGOS.
- [Action O33] Undertake a project to develop an international standard for ocean metadata.

1: Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 update), GCOS-138, GOOS-184, http://www.wmo.int/pages/ prog/gcos/Publications/gcos-138.pdf

- [Action O37] Develop enhanced and more cost-effective telecommunication capabilities, including two-way communications for dynamic control of systems, instruments and sensors.
- [Action O41] Promote and facilitate research and development (new improved technologies in particular), in support of the global ocean observing system for climate.

11.4.1.3 At its 14th session (19-22 January 2010, NOAA/AOML, Miami FL, USA), the OOPC commended the high level of effort in the XBT and Argo communities in examining error budgets for ocean temperature profiles. It decided that in 2011 it would devote its meeting to a workshop on a Deep Ocean Observing Strategy, but that in 2012 it would revisit Ocean Thermal observation requirements. The planned workshop will try to reconcile ocean heat content, sea level, and energy imbalances, and would have a focus on the error budget and sampling requirements.

11.4.1.4 The Panel took note of the points from the OOPC above, and addressed them with specific recommendations and actions during the agenda items focused on each panel.

11.4.1.5. The meeting made the following recommendations:

a. *[Rec. 1 - to be completed according to the discussion at the meeting]*

11.4.1.6. The meeting decided on the following action items:

(i) *[Action 1 (by whom; deadline) - to be completed according to the discussion at the meeting]*

11.4.2 WMO Rolling Review of Requirements update

11.4.2.1 The Panel discussed the WMO Rolling Review of Requirements (RRR) and how non-climate requirements can be addressed. In particular, Taking into account the respective Statements of Guidance, the Panel reviewed variables of interest to JCOMM that are not adequately measured *in situ* at present for the following application areas, or variables which are not properly being addressed within the existing JCOMM OPA workplan through the climate requirements:

- Seasonal to Inter-annual Forecasts
- Ocean Applications
- Global Numerical Weather Prediction
- High Resolution Numerical Weather Prediction
- Synoptic Meteorology

11.4.2.2 The Panel agreed that the DBCP could respond to those requirements for the following variables and in the following way:

- Continue to evaluate quality wave observations, and the development of cost-effective wave observations from drifters through the PP-WET and PP-WMD Pilot Project;
- Panel members are invited to make precipitation measurements from moored buoys, including coastal moorings, tropical moorings, and OceanSITES;
- Panel members are urged to install barometers on all newly deployed drifters;
- The RAMA array of tropical moored buoys in the Indian Ocean should be completed;

11.4.2.3 The Panel noted that good progress has been made in developing the new version of the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) responding to the Vision of the GOS in 2025, WIGOS needs, and GFCS requirements, with excellent engagement from some application areas. The CBS Expert Team on the Evolution of Global

Observing Systems (ET-EGOS) will ensure that all application areas with requirements for observations engage fully with the process of contributing to and reviewing drafts of the new EGOS-IP before next ET-EGOS meeting in 2012, in order to ensure that actions related to filling "key gaps" in observations for their areas are adequately captured. The ET-EGOS adopted an action plan so that the new EGOS-IP can be submitted to the CBS-XV (2012) for consideration and to EC-LXV (2013) for approval. The EGOS-IP will be a key document providing Members with clear and focused guidelines and recommended actions in order to stimulate cost-effective evolution of the observing systems to address in an integrated way the requirements of WMO programmes and co-sponsored programmes

11.4.2.4 The Panel noted with appreciation that the DBCP Chair, Mr Al Wallace (Canada) has reviewed the first draft version of the EGOS-IP, provided comments, and suggested changes. The Panel noted the key gaps, and actions proposed by JCOMM to better address the requirements of Ocean Applications. These are reflected in Appendix A. The Panel agreed that these should be included in the next version of the draft EGOS-IP.

-B- BACKGROUND INFORMATION

1. WMO Rolling Review of Requirements (RRR)

1.1. WMO, as part its Rolling Review of Requirements[2] (RRR) is addressing the following application areas:

- Global Numerical Weather Prediction
- High Resolution Numerical Weather Prediction
- Synoptic Meteorology
- Nowcasting and Very Short Range Forecasting
- Seasonal to Inter-annual Forecasts
- Aeronautical Meteorology
- Atmospheric Chemistry
- Ocean Applications
- Agricultural Meteorology
- Hydrology
- Climate Monitoring (GCOS)
- Climate Applications (Other aspects, addressed by the Commission for Climatology)

1.2. The Rolling Review of Requirements basically consists of the following steps:

1) Compiling the list of requirements for each applications area and each required variable in terms of (i) horizontal resolution, (ii) vertical resolution, (iii) observing cycle, (iv) timeliness, and (v) accuracy. For each criterion, requirements are given in terms of threshold (value below which observations are worthless), breakthrough (proposed target for significant progress, and optimal cost/benefit), and goal (value beyond which improvement gives no additional value). The list of requirements is independent from the technology being used to observe the required variables (technology free).
2) Estimating the performances of the instruments for each observing system and variable in terms of (i) horizontal resolution, (ii) vertical resolution, (iii) observing cycle, (iv) timeliness, and (v) accuracy.
3) Conducting a critical review and gap analysis based on (i) critical review charts which are objectively comparing the performances of the instruments with the requirements, and (ii) results from impact studies based mainly on Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs).

2: http://www.wmo.int/pages/prog/sat/RRR-and-SOG.html

4) The interpretation of the results from the critical review and gap analysis by experts from each of the considered application area, results in the elaboration of the Statements of Guidance[3] (SoG). The draft Statements of Guidance are then discussed, and possibly updated by the CBS Expert Team on the Evolution of global observing systems (ET-EGOS) before being formally endorsed by the Panel.
5) Based on the Statements of Guidance, the Vision for the Global Observing System (GOS) in 2025[4], cost-effectiveness of observing systems, and the assumed resources of WMO Members, the ET-EGOS proposes priorities, and updates the Implementation Plan for the Evolution of global observing systems (EGOS-IP)[5].
6) The EGOS-IP is used by WMO Members to plan the evolution of the observing systems nationally, and commit resources as appropriate.

1.3. The SoG for an application area provides for an assessment of the adequacy of the observations to fulfill requirements and suggests areas of progress towards improved use of satellite and in situ observing systems. Only the most significant variables in a given application area have been analyzed in the SOGs. SoGs are effectively gap analysis and propose priorities in terms of requirements for observations. The following terminology has been adopted. "Marginal" indicates minimum user requirements are being met, "acceptable" indicates greater than minimum but less than maximum requirements (in the useful range) are being met, and "good" means close to maximum requirements are being met.

2. Implications for JCOMM of the RRR, by application area

2.1. As far as JCOMM is concerned, only the following application areas are highly relevant:

- Seasonal to Inter-annual Forecasts
- Ocean Applications
- Global Numerical Weather Prediction
- High Resolution Numerical Weather Prediction
- Synoptic Meteorology

2.2. Based on the different Statements of Guidance, critical variables of interest to JCOMM that are not adequately measured *in situ* at present are detailed below. Other variables not listed below may also be important for those applications, but it is considered that the requirements for them are (i) either properly being addressed in the existing JCOMM OPA workplan through the climate requirements, or (ii) the observational requirements for those variables and the considered applications are currently being met adequately (e.g. through the use of satellite data).

Seasonal to Inter-annual forecasts

2.3. These requirements are already being addressed properly within the JCOMM OPA Observing System Implementation Goals taking into account the recommendations from Global Climate Observing System (GCOS) and its Ocean Observation Panel for Climate (OOPC).

Ocean Applications

2.4. Ocean Applications refer to Met-Ocean Forecasts and Services (MOFS), including marine services, marine hazards warning, and ocean mesoscale forecasting, serving the needs of maritime transportation (e.g. safety, routing), fishing, and coastal and offshore areas activities. The

3: http://www.wmo.int/pages/prog/sat/RRR-and-SOG.html#SOG
4: http://www.wmo.int/pages/prog/www/OSY/WorkingStructure/documents/CBS-2009_Vision-GOS-2025.pdf
5: The EGOS-IP corresponding to the Vision of the GOS in 2025 has been drafted and is currently being reviewed by the ET-EGOS. The previous version of the EGOS-IP responding to the Vision of the GOS in 2015 is available from http://www.wmo.int/pages/prog/www/OSY/Publications/TD1267_Impl-Plan_Evol-GOS.pdf

critical met-ocean variables that are not adequately measured (more accurate and frequent measures and better spatial/temporal resolution are required) by current or planned systems are:

- Waves parameters (significant wave height, dominant wave direction, wave period, 1-D and 2-D spectra) – noting that extreme wave and wind gusts events significantly constrain shipping and other marine operations, it is recommended the collocation of wind and wave sensors;

- Sea level – noting the wide-range of requirements for sea level data depending on the application area (since early detection of e.g., tsunamis to long-term trends of sea level rise), the requirements for this variable into the database should be carefully addressed;

- Surface pressure – noting that sea-surface pressure data from drifting and moored buoys are still limited, particularly in tropical regions where these data are vital to detect and monitor atmospheric phenomena over the oceans (e.g., tropical cyclones) that significantly constrain shipping, it is recommended the installation of barometers on all deployed drifters (1250); and

- Visibility – noting that visibility data are critical for harbours' operations and as these are still very limited, the NMHSs are encouraged to measure visibility.

Global Numerical Weather Prediction (NWP)

2.5. Observational requirements for global NWP have recently been addressed at the fourth WMO Workshop[6] on the Impact of Various Observing Systems on NWP (Geneva, Switzerland, 19-21 May 2008). The critical atmospheric variables that are not adequately measured by current or planned systems are (in order of priority):

- Wind profiles at all levels. Over most of the Earth – ocean and sparsely-inhabited land – coverage is marginal or absent. Profile data are supplemented by single-level data from aircraft along main air routes only, and by single-level satellite winds (motion vectors from cloud or humidity tracers in geostationary imagery) over low and mid-latitudes. In these areas, horizontal and temporal resolution is acceptable or good, but vertical coverage is marginal. There are very few in situ wind observations from polar regions, but recent advances have provided useful satellite winds at high latitudes from research satellite imagery (MODIS and AVHRR). In the lower stratosphere, only radiosondes provide information. Accuracy is good/acceptable for in situ systems and acceptable/marginal for satellite winds.

- Temperature and humidity profiles of adequate vertical resolution in cloudy areas. Over most of the Earth – ocean and sparsely-inhabited land – coverage is marginal or absent. Temperature profile data are supplemented by single-level data from aircraft along main air routes, where horizontal and temporal resolution and accuracy are acceptable or good. Very few aircraft currently provide humidity measurements, and these data are not generally available, but technical advances in this area are anticipated in the next decade.

- Precipitation. Surface stations measure accumulated precipitation with a temporal resolution and accuracy that is acceptable but a horizontal resolution that is marginal in some areas and missing over most of the Earth. Ground-based radars measure instantaneous precipitation with good horizontal and temporal resolution and acceptable accuracy, but over a few land areas only.

- Snow equivalent water content. Over land, surface stations measure snow cover with good temporal resolution but marginal horizontal resolution and accuracy (primarily because of

6: http://www.wmo.int/pages/prog/www/OSY/Meetings/NWP-4-Geneva2008/Summary-Conclusions.pdf

spatial sampling problems). Visible / near infra-red satellite imagery provides information of good horizontal and temporal resolution and accuracy on snow cover (but not on its equivalent water content) in the day-time in cloud-free areas. Microwave imagery offers the potential of more information on snow water content (at lower but still good resolution) but data interpretation is difficult. Snow cover over sea-ice also presents data interpretation problems.

In addition, the following can be noted:

- Surface pressure and surface wind: Over ocean, ships and buoys provide observations of acceptable frequency. Accuracy is good for pressure and acceptable/marginal for wind. Coverage is marginal or absent over large areas of the Earth.

- Surface air temperature and humidity: Over ocean, ships and buoys provide observations of acceptable frequency and acceptable accuracy (except ship temperatures during the daytime, which currently have poor accuracy). Coverage is marginal or absent over large areas of the Earth.

- Ocean sub-surface variables: In the latter part of the medium-range (~7-15 days), the role of the sub-surface layers of the ocean becomes increasingly important, and hence observations of these variables become relevant. In this respect the requirements of global NWP are similar to those of seasonal and inter-annual forecasting (see SoG on Seasonal and Inter-annual Forecasting).

- Clouds: Surface stations measure cloud cover and cloud base with a temporal resolution and accuracy that is acceptable but a horizontal resolution that is marginal in some areas and missing over most of the Earth.

- Wave height, direction, and period: Ships and buoys provide observations of acceptable frequency and acceptable/marginal accuracy. Coverage is marginal or absent over large areas of the Earth.

High Resolution[7] Numerical Weather Prediction

2.6 High resolution models are more likely to cover land areas than oceans, but oceanic buffer zones upstream from heavily populated areas are often included. The key model variables for which observations are needed are the same as for global models: 3-dimensional fields of wind, temperature and humidity, and the 2-dimensional field of surface pressure. The critical atmospheric variables that are not adequately measured by current or planned systems are (in order of priority):

- Wind profiles at all levels;
- Temperature and humidity profiles of adequate vertical resolution in cloudy and rainy areas;
- Precipitation;
- Snow equivalent water content;
- Soil moisture.

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Appendices: 1

7 : 1-5 km horizontal resolution

APPENDIX A

OCEAN APPLICATION GAPS TO BE CONSIDERED IN THE NEW EGOS-IP

(submitted by the Ocean Applications Point of contact, Mr Ali Mafimbo, Kenya)

A. Sustainability of observing systems

A large part of marine and ocean observing systems is currently maintained by research funding with limited duration. Considering the importance of continuous, long-term observations for key marine/ocean parameters for many applications, including medium-range weather and seasonal climate forecasting, WMO Members should note potential gaps that may occur *unless ongoing funding for sustained observing networks* is guaranteed. Such observing networks include (i) the tropical moored arrays, (ii) Argo, (iii) a fraction of barometer upgrades on surface drifters (for weather forecasting), and (iv) altimeter, scatterometer, microwave SST, sea ice measurements from ocean research satellite missions.

Action Gxx – Sustainability of observing systems

Action:

Ensure sustained funding for the key observing systems (e.g. tropical moorings, Arg o, surface drifters with barometers, as well as altimeter, scatterometer, microwave SST, sea ice measurements from ocean research satellite missions);

Who:

NMSs, NMHSs and partner national institutions, in collaboration with international or ganizations, WMO Technical Commissions responsible for observing system coordinati on (e.g. JCOMM, CBS, and CIMO)

Time-scale: continuous

Performance Indicator: Percentage of observing networks funded through sustained mechanism.

B. Improvement of global coverage for ocean observations

The uneven geographical coverage of the *in situ* ocean observing network is also an ongoing issue for ocean applications. Considering the regional variability in requirements as well as to ensure optimized planning for observing networks with limited resources, WMO Members should note the need for *studies on geographical variability in spatial / temporal resolution* for ocean observations.

Action Gxx – Improvement of global coverage for ocean observations

Action:

1) Improve geographical coverage of ocean observing systems, particularly for measuri ng SST, SSHA, SSS and visibility, along with higher resolution geometry;

2) Extend open-ocean and coastal wind-wave observing networks (e.g. 400 time-series reporting in open ocean), possibly developing other existing observing sites (e.g. global sea level and tsunami monitoring network) into multi-purpose stations.

Who:

NMSs, NMHSs and partner national institutions, in collaboration with WMO Technic al Commissions responsible for observing system coordination (e.g. JCOMM, CIMO, C BS) and GOOS

Time-scale: continuous

Performance Indicator: number of in situ reports on wave measurements.

C. Improvement in measurement capabilities

Sea Level: The geographic coverage of the *in situ* sea level data is acceptable for studies of long-term trends, but marginal for other applications. The existing tide gauge recording should be within

1cm accuracy in all conditions. A pressure sensor with 1 minute sampling frequency needs to be equipped at a gauge site in order to record extreme water level condition (e.g. tsunami, storm surges), and 1 second sampling frequency is required to detect wave conditions, to assimilate *in situ* sea level data into ocean circulation models, and for calibration / validation of the satellite altimeter and models. Open-ocean mooring networks for sea level monitoring (tsunameter buoys) are invaluable for tsunami early warning systems; however, geographic coverage and accuracy are still to be improved.

Sea Surface Temperature (SST): Ships and moored/drifting buoys provide SST observations of good temporal frequency and acceptable accuracy as long as required metadata are provided, while geographical coverage is still to be improved. It is a continuing challenge to ensure sustainability and high quality of global networks for drifting buoy and other in situ SST measurements. In the open ocean, SST measurements are required with accuracy < 0.1 °C on 5km spatial scale, and fast delivery (availability within 1h).

Wave Parameters (significant wave height, dominant wave direction, wave period, 1-D frequency spectral wave energy density and 2-D frequency-direction spectral wave energy density): The geographical coverage of the *in situ* wave data is still very limited, particularly with great gaps in the Southern Hemisphere. Measurements – including metadata collection – should be made in a consistent and standardized manner to enhance their value, and should be validated by globally agreed methods. Satellite altimeters provide information on significant wave height with global coverage and good accuracy, however, repeated observations by multiple altimeters are required to adequately cover cross-track spacing. SAR instruments provide information on the 2-D frequency-direction spectral wave energy density, however, horizontal/temporal resolution should be improved. *In situ* wave spectral measurements are currently too sparse in the open ocean to be of particular value, but could potentially provide higher accuracy observations to complement and correct for biases in the satellite observations that are used for global and regional wave modelling. Validation requirement is for average 1000km spacing requiring a network of around 400 buoys with minimum 10% / 25cm accuracy for wave height and 1 second for wave period.

Surface pressure: noting that sea-surface pressure data from drifting and moored buoys are still limited, particularly in tropical regions where these data are vital to detect and monitor atmospheric phenomena over the oceans (e.g., tropical cyclones) that significantly constrain shipping, it is recommended the installation of barometers on all deployed drifters (1250);

Visibility: Noting that visibility data are critical for harbour operations and as these are still very limited, NMHSs are encouraged to measure visibility.

Action Gxx – Improvement in measurement capabilities

Action:
1) Ensure state-of-art technologies be employed to improve accuracy for all measurements;
2) Extend collaboration between national/regional wave measurement networks (e.g. moored buoy networks) for validation and evaluation;
3) Install barometers on all newly deployed drifting buoys (target 1250 units);
4) Develop visibility measurement capability over the ocean (consultation needed with JCOMM experts on how to practically achieve this)

Who: NMSs, NMHSs, and national partner institutions, in collaboration with international organizations and space agencies, JCOMM, CBS, and CIMO
Time-scale: Continuous
Performance Indicator: Number of (operational) in situ reporting for each parameter.

D. Continuous measurements from satellites and Improvement in their applications

Sea Level: Horizontal / temporal coverage is marginal for the satellite products. The main limitation of the satellite altimeter in reproducing the non-long-term sea level changes is the spatial sampling because the repeat orbit cycle leads to an across-track spacing of about 300km at mid-latitudes. This sampling cannot resolve all spatial scales of mesoscale and coastal signals which have typical wavelengths of less than 100km at mid-latitude. Merging satellite data-sets can be a solution.

Sea Surface Height Anomaly (SSHA): SSHA is currently considered the most critical component of the observing system for ocean prediction systems. It is now commonly accepted that a minimum of two interleaved operational satellites is required to support ocean forecasting applications. The continuity of altimetry is the key, that can only be realized with appropriate investment to ensure an adequate timescale for scheduling satellite missions. To ensure quality ocean services for a full spectrum of applications, it is necessary to secure reliable operational observations that would enable fully coupled ocean-wave-NWP systems. SSHA observations can also be exploited in the coastal regions, however the spatial and temporal requirements in the coastal zone place greater constraints on the existing remote sensing observing system. Wider-swath observations would add significant value in this zone as well as the open ocean. Enhancing existing coastal tide gauge networks will also add significant value to ocean prediction systems in the shelf zone.

Sea Surface Temperature (SST): In coastal regions, higher density is required (accuracy < 0.1 °C on 1km spatial scale). Satellite measurements now provide high-resolution SST data, from both microwave and infrared sensors. A combination of both infra-red and microwave data is needed because they have different coverage and error properties.

Sea Surface Salinity (SSS): High-resolution and high quality SSS observations are required for ocean forecasting systems, as well as seasonal to inter-annual forecasting and NWP. The remote sensing instrumentation remains experimental and the full impact of these observations is yet to be determined. Ships and moored and other *in situ* observations provide high quality data, but coverage is marginal or worse over some areas of the ocean. There is a requirement for high quality SSS in open ocean, ideally with accuracy < 0.1-0.7 psu on 10km spatial scale, and fast delivery (availability within 1h). In coastal regions, higher density is required (accuracy < 0.1 psu on 1km spatial scale).

Coastal Geometry (Bathymetry, Coastal Topography and Shorelines): High-resolution data are required for Open Ocean and particularly coastal modelling. Satellite altimeters provide global coverage of deep-sea topography with acceptable-to-good accuracy, yet higher quality data are required for coastal zones.

Action Sxx – Continuous measurements from satellites and Improvement in their applications

Action:

1) Ensure combination of both infra-red and microwave measurements for better coverage of SST observations;

2) Improve observations in coastal regions (altimetry, SST);

2) Ensure minimum of two interleaved operational satellites providing SSHA observations to support ocean forecasting applications;

3) Develop satellite measurements of SSS on an operational basis;

Who:

NMSs, NMHSs, and national partner institutions, in collaboration with international organizations and space agencies, JCOMM, CBS, and CIMO.

Time-scale: continuous

Performance Indicator: number of satellites providing ocean parameters