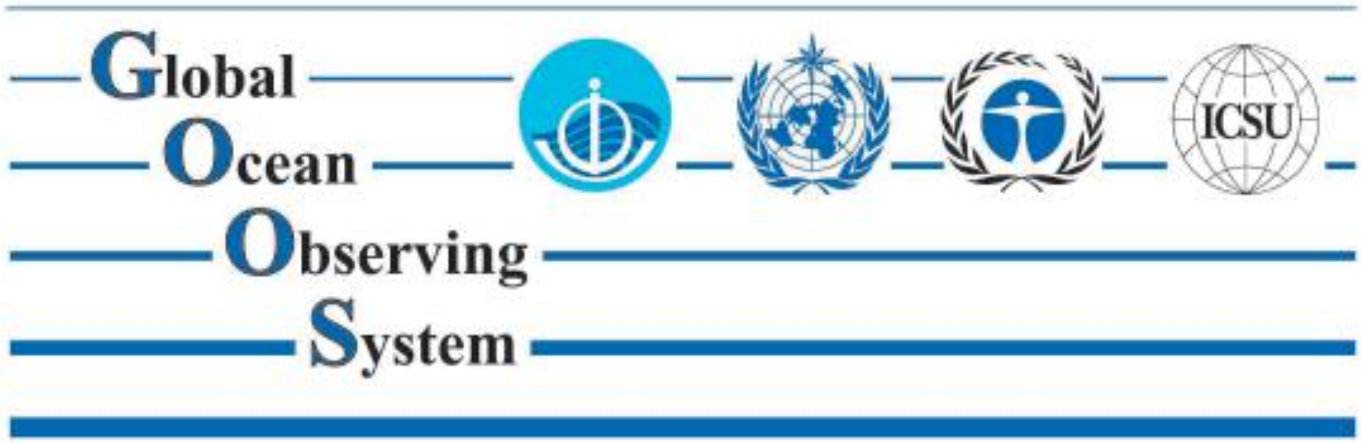

Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

IOC Group of Experts on the Global Sea Level Observing System (GLOSS)

Eleventh Session
Paris, France
13−15 May 2009

Electronic copy only

GOOS Report No. 181
GCOS Report No. 139
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ABSTRACT

This report presents a summary of the topics discussed at the Eleventh Session of the Group of Experts on the Global Sea Level Observing System (GLOSS-GE). The Group of Experts evaluated the status of its GLOSS station networks.

Regarding the GLOSS Core Network, it recognized the need for a clear policy on the meaning of "fast delivery" and to have the necessary capacity to handle fast-delivery data. The sub-networks of co-located and near-co-located GPS stations need to be improved and completed, including the infrastructure to ensure data processing and products.

The Group of Experts accepted that all GPS stations should, if possible, be tied to the corresponding tide gauge benchmarks; it also stressed the importance of improving cooperation between the sea level and the geodetic communities and of relating the sea level station data to the TOPEX/Poseidon–Jason satellite data. It accepted the main conclusions and recommendations of the Workshop on Precision Observations of Vertical Land Motion at Tide Gauges (May 2009).

The Group of Experts reviewed recent research based on tide gauge observations which is currently addressing the main factors determining mean sea level: thermal expansion; changes in glaciers, ice fields and ice caps; the considerable differences between the periods 1961–1993 and 1993–2003 are not easy to explain (to reduce the error requires a global data set, but there has been a decline in data submission, especially in the northern hemisphere, since about 1997).

The Group addressed the question of whether and how to exploit tide gauge stations in the context of tsunami and other ocean hazards warning systems, particularly on a regional level. This may require expanding the field of expertise of GLOSS and revision of its own Terms of Reference.

The Group of Experts examined the real-time station network and the work of the Sea Level Station Monitoring Facility, in Ostend (Belgium) and acknowledged the important service it provides to many sea level institutions without access to the GTS. The Group of Experts also recognized the Facility as the GLOSS designated centre for real time sea level data.

The Group adopted the GLOSS Manual and Technical Report on Quality Control of Sea Level Data. It reviewed the sea level products now available on the World-Wide Web and updates on regional and national sea level activities were provided.

The Group reviewed present links between GLOSS and other relevant programmes. It also received information on the latest technical developments regarding radar gauge intercomparison and BGAN- based tide gauges.

The Group identified issues or actions to be addressed to its parent body, JCOMM, at its third session (November 2009) and drew up a list of its own intersessional activities for 2009–2011.

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ANNEXES

1. ORGANIZATION OF THE SESSION

1.1 OPENING OF THE SESSION

The Chairman of the GLOSS Group of Experts, Mark Merrifield, opened the Eleventh Session of the GLOSS Group of Experts on 13 May 2009. He welcomed the participants.

Speaking on behalf of the Executive Secretary of IOC, Patricio Bernal, who was attending a World Oceanography Conference in Indonesia, the IOC Technical Secretary for the GLOSS Group of Experts, Mr. Thorkild Aarup, also welcomed the participants. He was pleased to see the high level of attendance and he stressed the growing importance of sea level monitoring to the Member States in terms of their socio-economic development. He thanked the U.S. National Oceanic and Atmospheric Administration's Office for Global Programmes for having supported the travel of certain participants.

1.2 PRACTICAL ARRANGEMENTS

The Technical Secretary for GLOSS outlined the practical arrangements for the conduct of the session. He informed the Group of Experts that all the meeting documentation was available on the GLOSS GE XI meeting website (http://ioc-goos.org/glossgexi).

1.3 ADOPTION OF THE AGENDA

The Chairman briefly reviewed the proposed Agenda and invited comments; there being none, he declared the proposed Agenda as being agreed. The Agenda for the present session is in Annex I to the present Summary Report. The List of Participants is in Annex II. The GLOSS Plan of Actions 2009–2011 adopted by the Group following its deliberations at the present session is in Annex III, the List of Documents is in Annex IV and the List of Acronyms is in Annex V.

2. REVIEW OF GLOSS ACTIVITIES AND STATUS OF ACTIONS FROM GE-X

The Chairman of GLOSS introduced this item. He reviewed the status of the Actions adopted by the Group of Experts at its Tenth Session for the period 2007–2009. The actions and their current status are summarized here below.

Action agreed at GLOSS GE-X	Current status
1. Complete GE-X meeting report, draft to be circulated to meeting attendees for comment	Done
2. GLOSS Technical Workshop 5 June 2007: Powerpoint presentations to be made available at GLOSS website	Done, including the report
3. High-frequency delayed-mode data banking at BODC/PSMSL and UHSLC/JASL	Lesley Rickard will give presentation on PSMSL at the present session; JASL data now available on the web
4. High-frequency fast-mode data banking at UHSLC	Some progress made, but more still to be done

Action agreed at GLOSS GE-X	Current status
5. Requests to NOAA/NESDIS for 5-minute transmission slots on GOES satellites for GLOSS satellite transmitting stations within 1 hour of tsunami genesis locations.	Done
6. Letter to appropriate agencies from Patricio Bernal advocating continued precision altimeter missions.	Done
7. Contact Francisco Hernandez regarding the feasibility of hosting GLOSS network status and near-real-time plots at the IODE office at Ostend	Done
8. Expand GCN status map at the GLOSS website to include high-frequency delayed-mode and fast-mode datasets	Partly done
9. GPS vertical rates and TIGA	Ongoing
10. Update GLOSS Implementation Plan by the end of 2007	In progress
11. GLOSS Products – Prepare a list of potential products and circulate amongst the GE for comment	See agenda item 12
12. Hazards Issues: (i) Offer GLOSS GE assistance, in response to François Gerard's presentation on the GOHWMS, in coordinating global and regional tide gauge networks for hazards monitoring (ii) Serve sub-hourly average GCN data at BODC in support of hazards community	François Gérard will give presentation at the present session
13. Training Courses (i) NW Indian Ocean (ii) Additional?	Training course organized in the Caribbean region (University of Puerto Rico, 23-27 June 2008); short-term practical training has been organized by the Proudman Oceanographic Laboratory for participants from Congo and Nigeria; in collaboration with the IOC Tsunami Coordination Unit 30 visiting fellowship in sea level science and applications had been awarded to participants from Indian Ocean countries
14. Circular Letter to GLOSS members seeking regular updates of all levelling data	No progress
15. Finalize revised GCN station list (300 stations – GLOSS07) and update data banks, maps, etc. at data centres	In progress and under review

In the discussion, the possibility of creating subsets of the GLOSS Core Network for different purposes (e.g. for GCOS, climate research, altimetric calibration etc.) was raised. The Group of Experts agreed that this needed further study.

3. GLOSS STATION NETWORKS

3.1 REVIEW OF GLOSS CORE NETWORK STATUS (LOW FREQUENCY AND HIGH FREQUENCY, DELAYED MODE AND FAST MODE)

The Chairman of GLOSS GE introduced this item. He invited Lesley Rickard, Director of the Permanent Service for Mean Sea Level (PSMSL) to report on the activities of the PSMSL and on the GLOSS Delayed-Mode Archive Centre housed by the British Oceanographic Data Centre. She briefly reviewed its main responsibilities. Referring to the implications of ICSU's reorganization of the Federation of Astronomical and Geophysical Services (FAGS) (to which PSMSL reports) and the ICSU World Data Centres, she believed that there would be little change in function, as far as PSMSL is concerned.

Dr. Rickards noted that ~750 site-years of high-frequency delayed-mode data were received in 2007–2009, including data from important data-sparse regions (e.g. ODINAfrica, polar regions). The historic South African tide gauge dataset was revised, and Portugal submitted the fifty-year-long time-series from Funchal (Madeira). PSMSL has also updated the GLOSS Station Handbook.

Nevertheless, there remains much to be done:

- improve the monitoring of vertical land movements at tide gauge sites (PSMSL works closely with the International GNSS Service (IGS) and the Global Geodetic Observing System (GGOS)
- the provision of geophysical information in PSMSL web pages
- analysis of sea level data which requires geophysical insight
- merge various data sets (e.g. traditional MSL and delayed-mode collection of raw data), including metadata as far as possible
- continue collaboration with and advice to the community in general (e.g. scientific input to IPCC etc., knowledge transfer to the public)
- improve access to the overall data set available (e.g. through GLOSS web pages and the Station Handbook).

PSMSL is promoting the concept of seamless one-stop provision of GLOSS sea level data (low frequency and high frequency quality controlled data); to retrieve data from more than one site is tedious. Much of the functionality required is already in place; for example, a user can go to the GLOSS Handbook and for each station there is a link to the data (fast, delayed, mean sea level, etc.).

Dr. Rickards also discussed the question of delivery speeds. The University of Hawaii Sea Level Center (UHSLC) maintains the GLOSS Fast Delivery data base. These data are used for model calibration/validation and altimeter calibration. PSMSL asks that data be provided to UHSLC at regular intervals, preferably within 10 days of data collection, although up to 30 days is acceptable. IOC has established the Sea Level Station Monitoring Facility (www.ioc-sealevelmonitoring.org) hosted by the Flanders Marine Institute (VLIZ). PSMSL asks that real-time high-frequency data from all GLOSS stations be included at this site. These data will be used primarily for tsunami warning and operational oceanography purposes. PSMSL and BODC maintain the GLOSS delayed-mode data base, which consists of the final quality-assured data as determined by the data originator. PSMSL asks that quality-assured, high-frequency data (e.g. hourly or higher), be sent annually, preferably prior to June in the year following the collection of

the data. Ancillary information, such as benchmark levelling surveys and atmospheric pressure measurements at or near the gauge, should also be provided. And finally, monthly and annual mean sea level values for all tide gauges (not just GLOSS) should continue to be sent to the PSMSL.

In the subsequent discussion, the need for a clear policy on the meaning of "fast delivery" was broached, and the capacity of the data centres (e.g. BODC) to handle fast-delivery data was queried. And there is still a lot of data that has not yet been digitized. The evolution of the GCN was also queried, particularly as regards the maintenance of the high standard required of a GCN station and the firm obligation to make the data available to all bona fide users; this requires a strong national commitment. Some participants asked that a GLOSS sea level station network for hazard monitoring be defined with the understanding that requirements for geo-referencing at those stations be relaxed in comparison with the requirements for GLOSS Core Network Stations (as specified in the IOC Manuals and Guides No. 14, volume IV, 2006).

It was also pointed out that the Sea Level Station Monitoring Facility was not a 24/7 operation and has no clear quality-control function (see also section 8). Moreover, in some regions, quality control of data is still a major challenge.

The Chairman and the Technical Secretary provided responses to these and other queries. Regarding data rescue (digitization of hand-recorded data), the GLOSS data centres (UHSLC and PSMSL) can provide such a service, if requested. As to the definition of a GLOSS or a GCN station, it is clear that there is no intention to incorporate all sea level stations into GLOSS stations. The GCN was aimed at a 300 limit determined also by such considerations as accuracy and frequency of the data delivered, the assurance of a good geographical coverage, sustainability and "usefulness" in a research or a warning system context. GCN stations that cease to provide data should also cease to be GLOSS designated stations, so the GCN is evolutive. The Group of Experts should also give further consideration to such aspects as quality control of the data (how strong, for what purpose, at what level – originator, data centres etc.), but the overall aim should be to provide the final data within one year of collection. It should also be the Group of Experts' aim to ensure that all GLOSS stations eventually provide at least hourly data, although some applications (e.g. tsunami warning systems) require even shorter delays.

The Chairman invited Pat Caldwell (NOAA) to inform the Group of Experts on NOAA's procedures for delayed-mode data management and, in particular, the Joint Archive for Sea Level (JASL). JASL originally grew out of the Tropical Ocean Global Atmosphere programme within the WCRP. NOAA global sites support TOGA, GLOSS, WOCE, TOPEX-Poseidon, Jason, and CLIVAR; i.e. it is science driven. Hourly, daily and monthly quality-controlled data are submitted to the Word Data Center – Oceanography (Silver Spring, Maryland) and to the Permanent Service for Mean Sea Level at the British Oceanographic Data Centre; it operates an open data policy with the BODC. The submissions to the WDC have increased greatly since the early 1990s. The JASL is supported by more than 60 agencies (70 countries) and collaborates closely with the University of Hawaii Sea Level Center.

JASL does not pursue data at the highest resolution or the fastest recorded interval or from every station of every coast; this is pursued by the U.S. National Geophysical Data Center (Paula Dunbar).

JASL future aims are to: harmonize its submission schedule with that of PSMSL; request data providers to update annually, preferably by 1 June and in verified hourly data; improve management of metadata; strive for consistency; increase the number of stations per given coast;

and to handle only hourly and daily values of research quality. JASL is not, however, ready to take on a tsunami warning system function.

In the discussion the question of how to resolve inconsistencies in similar data sets from different sources was raised. JASL operates basic quality control and NOAA files comprise only final (i.e. quality-controlled) JASL data.

The Group of Experts thanked both Lesley Rickard and Pat Caldwell for their presentations.

3.2 REVIEW OF COLLOCATED AND NEARLY COLLOCATED CGPS STATIONS

The Chairman invited Guy Wöppelmann to introduce this Agenda Item. GLOSS gauges to be used for the study of long-term sea level trends, ocean circulation and altimeter calibration need to be equipped with GPS receivers as close to the gauge as possible. The main issues are to:

- improve and complete the network
- make the data available to GLOSS/TIGA data centres
- consider designating an institution as a coordinator of the network of continuous GPS stations near tide gauges
- seek support from geodetic colleagues
- link the GPS antenna to the tide gauge benchmark (TGBM)
- include GPS in the TGBM network when separation is <500m
- undertake differential GPS campaigns (24 hours) when separation is >500m
- repeat observations to monitor relative motions (yearly…)
- maintain and, where necessary, change equipment
- limit the discontinuities in the data record to the strict minimum, and inform the data (analysis) centres
- seek the accuracy now needed for sea level applications
- develop the TIGA/IGS infrastructure to ensure data processing and products.

The Group of Experts accepted that all GPS stations should, if possible, be tied to the corresponding tide gauge benchmarks; this was discussed at the GLOSS Workshop (see Agenda Item 4). It also stressed the importance of geodetic data, hence of improving cooperation between the sea level and the geodetic communities. Nevertheless, it also recognized that it might be necessary to accept a latency of two months or more in the geodetic data set; the implication of such a latency would depend on the application concerned. It agreed that it would also be useful to relate the sea level station data to the TOPEX/Poseidon–Jason satellite data.

4. REPORT ON THE WORKSHOP ON PRECISION OBSERVATIONS OF VERTICAL LAND MOTION AT TIDE GAUGES, 11–12 MAY 2009

The Chairman invited Gary Mitchum to report on the GLOSS Workshop on Precision Observations of Vertical Land Motion at Tide Gauges held (UNESCO, 11–12 May 2009) immediately prior to the present session of GLOSS GE.

The principal themes discussed at the Workshop were:

- Why put continuous global positioning system (CGPS) equipment near tide gauges?
- What is the present geodetic network status?
- What are the current geodetic issues with respect to sea level monitoring?
- What are the technical issues for operators and users?
- What processing and data centres are needed for GPS data and products?
- What should the future network be?
- What future actions are needed?

Taking these themes in the order, the main conclusions of the Workshop were as follows:

Equipping selected GLOSS Core Network tide gauges with CGPS facilitates: altimeter calibration and consequently a view of global sea level; determination of sea level trends at a single point; comparison of geometric and orthometric frames of reference; wet troposphere/ionosphere applications; and assessment of earthquake impact on sea level data.

Regarding the present geodetic network status, there is a need to: establish guidelines for co-location definitions and to explain the pros and cons to operators; consider the use of InSAR as a new tool; measure absolute gravity in order to connect the respective heights of the reference geoid and ellipsoid heights.

The current geodetic issues with respect to sea level monitoring are: uncertainties of 0.5–1.0 mm/year in the reference frame; in some cases, there are large differential motions (3–5 mm/year) between tide gauge and GPS sites; what should the location of GPS sites be based on?; can campaign GPS be used to establish local ties between continuous GPS and tide gauges?; although InSAR can achieve better than 1 mm/year precision for local ties, there is a question about what is being imaged and measured within a 10–50-m footprint; GPS processing needs state-of-the-art processing models, techniques and parameters, so it is better to use global or regional networks for optimal precision.

The technical issues for operators and users are to: avoid any unnecessary changes to GPS stations and to monitor the multi-path environment; use quality deep-braced monumentation wherever possible; encourage co-located geodetic monitoring systems, to understand the differences and the problems between systems (this co-location requires good levelling links; carry out high-quality levelling for a number of benchmarks, ideally on an annual basis – a larger number of benchmarks should be maintained for redundancy in case of BM destruction); ensure sufficient redundancy in measuring systems and communications, as data are often lost due to poor communications, especially from remote locations (local storage of data that can be downloaded and processed in delayed mode is preferable to lost data); consider appropriate systems, sampling and transmission rates for each situation (not all sites need to report in real time or near-real time).

Regarding the processing and data centres needed for GPS data and products, there is a need to reprocess when new IGS combined products become available (annually is likely acceptable for TIGA). It is preferable to have at least three global solutions to connect to the IGS frame. A combination centre is needed to produce a combined product; and data sets should be made public. The CGPS stations should be tied to tide gauge stations, but the needed information is currently

very weak; the information on available CGPS sites also needs updating. For TIGA to operate effectively, a Network Coordinator is needed.

Regarding the future network, the Workshop emphasized the need to provide quantitative, application-specific metrics that could help prioritize the implementation of new stations and the augmentation of present stations, in time for OceanObs '09 (September 2009), if possible. Although funding is important, it does not always ensure the success of stations, especially in developing countries. Support in the form of training and data management, as well as data sharing, and help in real-time data transmission are important for developing nations. GLOSS should convene a small technical group, with a view to preparing a white paper summarizing the status of the current stations and the impacts on various applications of expanding the collocated network.

The Group of Experts thanked Gary Mitchum for his summary of the Workshop and accepted its main conclusions and recommendations.

5. SUMMARY OF RECENT RESEARCH BASED ON TIDE GAUGE OBSERVATIONS

The Chairman invited Svetlana Jerevjeva (PSMSL) to present this agenda item. There is a growing interest in sea level measurement and research in the general public, governments and the scientific community. The results are of particular interest to the Intergovernmental Panel on Climate Change (IPCC) as it prepares its 5th Assessment Report.

Sea level science is currently addressing the main factors that determine mean sea level: thermal expansion; changes in glaciers and the ice caps and in the ice fields of Greenland and Antarctica. The considerable differences between the periods 1961–1993 and 1993–2003 are not easy to explain, and the error bars are large; to reduce them requires a global data set, but there has been a decline in data submission, especially in the northern hemisphere, since about 1997.

Some of scientific questions that are now challenging researchers are:

- What are the relative rates of global and regional sea level rise?
- Can the present uncertainties in estimates of sea level rise be reduced?
- Are there changes in the characteristics and frequency of extreme events in climate change?
- Is the coastal mean sea level rising faster than the global mean?

Some doubt was expressed about the reliability of altimetric data close to the coast, but the Group of Experts agreed that such data were in better agreement with tide gauge data than with open-ocean altimetric data. It recognized that the estimation of ice melting was still not adequate; so far, the IPCC has only provided a rough estimate and has acknowledged the considerable uncertainty in this , and some models exclude the cryosphere altogether.

The Group of Experts expressed its concern over the decrease in data submission in recent years, but it also recognized that there was possibly a number of long sea level time-series that could be made available with the application of data archaeology.

6. WORKING GROUP ON TSUNAMIS AND OTHER OCEAN HAZARDS WARNING AND MITIGATION SYSTEMS (TOWS-2)

The Chairman invited Mr François Gérard, Chairman of the WMO–IOC Intergovernmental Commission on the Global Ocean Observing System, to present this Agenda Item. Mr Gérard first reported on the outcome, in relation to GLOSS, of the Second Session of the IOC Working Group on Tsunamis and Other Ocean Hazards Warning and Mitigation Systems (TOWS-II) on 27 March 2009. The Working Group, which met in conjunction with a meeting of the Chairpersons of the International Coordination Groups for the tsunami warning systems in the Indian Ocean (IOTWS), the Pacific Ocean (PTWS), the North Atlantic, Mediterranean and Connected Seas (NEAMTWS), and the Caribbean (Caribe-EWS), recommended to the IOC the establishment of an inter-ICG task team on sea level as it relates to tsunami warning systems, and invited the participation of GLOSS.

Regarding the collection and exchange of real-time sea level data for tsunami warning purposes, the Working Group urged the inclusion of such requirements in the work programmes of JCOMM/GLOSS and JCOMM/DBCP and a possible review of the GLOSS Terms of Reference to reflect the operational requirements of the tsunami warning centres. It also recommended an assessment of the IOC Oceanographic Data Exchange Policy with respect to its application to tsunami warning systems and the monitoring of its implementation; it also urged the open, free, and unrestricted sharing of tsunami-relevant observational data needed for timely and effective ocean-related hazard detection, analysis, and warning for coastal communities.

Mr Gérard reminded the Group of Experts that GOOS was the ocean-observing component of the Global Earth Observations System of Systems (GEOSS), as are the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS), but GEOSS does not have a component for coastal hazards; however, GOOS could ensure that GLOSS data are made available to GEOSS.

The Group of Experts recognized its own responsibility with respect to tsunami warning and other ocean hazard warning in terms of implementation and that this may require expanding the field of expertise of GLOSS and a corresponding revision of its own Terms of Reference. It also recognized a possible need to define a reference sea level station network for the warning systems.

7. UPDATES ON REGIONAL SEA LEVEL NETWORK DEVELOPMENTS, INCLUDING COORDINATION WITH TSUNAMIS WARNING SYSTEMS

7.1 INDIAN OCEAN

Dr. Parluhutan Manurung (Indonesia) briefly reviewed the progress in the development of the Indian Ocean Tsunami Warning System (IOTWS). The coastal tide gauge network comprises pressure, float and radar gauges, with a reliable power supply, mostly as solar cells, with power grid back-up, and the use of multiple and independent communication channels for data transmission. The development of the Sunda Trench coastal gauge network has progressed: Indonesia has 58 gauges of the 80 planned now in place; India, 26 out of 50; and Malaysia, 6 out of 21. Instrument standards and operating guidelines have been set. And data exchange norms have been established (GTS, 15 minutes; BGAN and VSAT, 1 minute). The tide gauge system is supported by a buoy network.

The question of the accessibility of the Regional Tsunami Watch Providers (RTWPs) to the relevant sea level data is also being addressed.

Dr. Manurung stressed the need to ensure the sustainability of the IOTWS. It is the warning capability, not just a network, that needs to be sustained. There are national and regional interests to take account of with regard to network optimization; present technology and funding donors will not be permanently present; and there are possible problems of changing priority and availability of expertise and funding that may lead to some relaxation of requirements of the system.

The action plans envisaged are:

- Coastal gauges (continuing installation of new real-time stations; BGAN upgrade of some near-source station communications; GLOSS training – Indonesia has shown an interest in hosting courses)
- Buoy network (continuing deployment of buoys; recovery and redeployment of non-operational stations)
- Data exchange (GTS buoy data exchange trial; data exchange among coastal gauges; publication of "complete" network resources map; determination of reporting and delivery latency)
- Data depositories (contribution to requirements – TOWS Working Group).

The Group of Experts recognized the difficulty of passing from the research/development phase to the full operational phase of a regional warning system and welcomed the progress in the IOTWS.

7.2 PACIFIC OCEAN

Dr. Rick Bailey (Australia) reported on the Pacific Tsunami Warning System (PTWS). The International Coordination Group for the PTWS, at its Twenty-third Session (ICG/PTWS-XXIII, Samoa, 16-18 February 2009) reviewed progress and the potential for rationalization of the System.

Sea level data are required for the following tsunami applications (in order of priority):

- Warning (detection/verification; cancellation)
- Monitoring (impact/situation reports; local response)
- Research (tsunami behaviour; inundation).

The ICG considered that an integrated sea level network should comprise:

- Coastal sea level stations to ensure detection and promote local response
- Deep ocean tsunami monitoring buoys (tsunameters) to allow: detection and verification; assimilation; and scenario review.

With regard to tsunami warning, the system presently based on earthquake magnitude and subsequent tsunami travel time is soon to be replaced by a system based on forecasting/scenario evaluation/threat assessment. This will require the collaboration of National Tsunami Warning Centres (NTWCs) and the establishment of Regional Tsunami Watch Providers (RTWPs). This new approach will require the establishment of design criteria and of siting guidelines, allowing for some fundamental differences between climate and tsunami requirements. There will also be a need for some ongoing coordination of new installations.

Regarding data exchange, the CREX code for transmission of coastal sea data via the GTS has been approved in principle by the WMO Commission on Basic Systems (CBS) and CREX tables for sea level data are under development. The CREX code for transmission of deep ocean tsunameter data is nearing completion. However, the adoption of the CREX code is still limited.

There is a need for a global archive for all high-frequency data.

The principal problems to be addressed are:

- Too slow transmission frequencies for many stations
- Difficulty of GTS "access" for some countries
- Non-compliance in the use of the standard CREX code on GTS
- Need for improved consultation and 24/7 support for data visualisation systems.

The recommendations of the TOWS Working Group relevant to the PTWS were discussed under Agenda Item 6.

The Group of Experts welcomed the developments in the Pacific Tsunami Warning System; it recognized that the new data exchange format, CREX, would guarantee the processing of the data, but that WMO had undertaken no commitment so far to increase the speed of data exchange. It believed there was a need to improve the quality-control aspects and the automation of data exchange and suggested the usefulness of putting a quality-control "flag" on each station in the network. As to the archiving of the tsunameter data, the Group of Experts noted that this would be the responsibility of national geophysical data centres and would eventually call for close collaboration between the sea level and the geophysical communities.

7.3 CARIBBEAN

Ms Christa von Hillebrandt-Andrade (Puerto Rico, USA) reported on developments in the Caribbean region. This region is distinguished by some special features:

- Events are short-fused and generated by local earthquakes, submarine and subareal landslides and volcanic eruptions
- Events are of low frequency, but high impact
- So very fast response is required: a regional tsunami warning system should issue a first product within 5 minutes of an event; tsunami-ready sea level stations need to transmit within at least 15 minutes
- Interim tsunami warning guidance is currently provided by the Pacific Tsunami Warning Centre (PTWC) and the WCATWC; there is a recommendation for the establishment of a Caribbean Tsunami Warning Centre (CTWC) by 2010; these Warning Centres also address other coastal hazards from hurricanes, storms and sea level rise.

Currently there are 44 operational sea level stations in the region, but only 17 of these are contributing sea level data within 15 minutes, through GOES/GTS. IOCARIBE–GOOS has made the re-development of a regional multi-use sea level system its top priority.

The ICG for Caribe-EWS has made several recommendations on sea level:

- that sea level data be made available through the GTS
- that data from stations be sent via the GOES satellite (NESDIS has provided 30 5-minute slots for the stations in the region)
- that visualization of the data be facilitated, since it is critical for station operators to remain engaged
- that the minimum requirements for station specification be based on the needs of the Caribe-EWS, including tsunami, weather and climate change considerations.

The ICG also decided to prepare an inventory of continuous GPS stations in the region; there is considerable concern related to meeting the levelling requirements for GLOSS Core Network stations, as well as the limited equipment and trained resources.

It also believed that buoys are necessary for a complete sea level monitoring network; and the sea level station operators recognize that, in addition to the necessity of timely and accurate sea level data, there is also a need for local emergency preparedness, education, mitigation, mapping and other monitoring efforts to achieve an end-to-end tsunami and other coastal hazards warning system.

The IOCARIBE–GOOS coordination network is a mechanism that will engage the sea level network operators and monitor the state of health of the sea level network in the Caribbean to: leverage national and programmatic resources region-wide; enhance sustainability; encourage multi-purpose installations; support common standards, information exchange, and applications; work by strengthening existing programmes.

The Group of Experts raised the question as to whether the development of the Caribe-EWS would produce any specific costs to GLOSS. To which, the answer was no: five stations have been identified as meeting network requirements and expansion is presently based on NOAA funding. Twelve stations have been upgraded using World Bank funding. France will establish two stations in Guadeloupe in 2009.

7.4 NE ATLANTIC AND MEDITERRANEAN

Ms Begoña Pérez (Spain) reviewed the situation in the Tsunami Early Warning and Mitigation System for the North Eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS). The ICG for the NEAMTWS accepted several recommendations from its Working Group 3 regarding:

- Sea level gauges – establish a new standard to enhance sea level stations to operate in real time and at a higher frequency; upgrade all required sea level gauges in order to meet new measurement and telecommunication requirements and standards; design a more comprehensive network of sea level gauges for the consideration of at-risk areas, to complement the existing system
- Offshore instrumentation for monitoring sea level – review and evaluate existing buoys in national networks and existing fixed offshore platforms with respect to their potential for contributing to a tsunami early warning system and, as necessary, upgraded to address the needs for tsunami monitoring and tsunami early warning; establish deep ocean buoys with ocean bottom-pressure sensors and seismometers, specifically designed for tsunami monitoring; explore cable-based systems and sea-

floor monitoring networks (these measurements are important for slumping events, landslides or other events that are not seen in seismic measurements)

- Other instrumentation – GPS data, which are useful for quick determination of earthquake characteristics, should be part of the tsunami warning system; CGPS stations close to existing sea level gauges should provide data in real time to the seismological data-processing centres
- Telecommunications – guarantee secure and redundant transfer of data from the instrument to the operators; ensure that communication links remain operational after earthquakes, floods, etc.; take advantage of existing and evolving systems (e.g. WMO GTS, which WMO has offered to upgrade taking into account the requirements of the NEAMTWS), IP networks, satellite communications, VPN internet, etc.; identify best practices in other systems (e.g. IOTWS, PTWS); communicate such requirements to telecommunication standards organizations, such as ITU
- Analysis and processing centres – address the establishment of centres that process, validate, analyse and interpret incoming data, on a 24/7 operational basis; explore the regional components of GLOSS and EuroGOOS in the area (e.g. MedGLOSS, ESEAS, SLEAC); collaborate with existing bodies active in the coordination of deep-sea observation networks mostly for operational oceanography, such as MedGOOS, IBIROOS, NOOS, BOOS (regional components of GOOS in the Euro-Mediterranean region) and MOON
- For the whole system – acknowledge immediate, free and open distribution of raw data from the observing systems in real time as a founding principle for all national, regional and global tsunami warning systems; develop the NEAMTWS as a multi-purpose system addressing several hazards with the same infrastructure, and delivering other types of routine operational and long-term products; develop new algorithms for tsunami detection and for automatic quality control of high-frequency data; adopt standards for data format and data transmission protocols based on existing systems (e.g. XML, GTS).

There are years of near-real-time sea level data available for storm-surge forecasts in the North Sea and the Atlantic coast, but practically none for the Mediterranean. Moreover, tsunami requirements in respect of data sampling and data transmission are much more restrictive than for the storm-surge application, which implies a necessary upgrading of existing stations.

The installation of a core network of coastal sea level stations is underway; it will comprise around 70 stations by the end of 2011 and will meet the 1-min sampling/latency requirements. The IOC Sea Level Monitoring Facility (Ostend, Belgium) offers a real-time display of data from the NEAMTWS coastal sea level network, as an interim solution until regional/national warning centres are established. The design and implementation of a network of deep-ocean sea level monitoring stations is also under way and is expected to be in operation by the end of 2011. The selection of the core network was primarily based on: existing stations already transmitting data in real or near-real time with a multi-hazard approach; the location of the more important tsunamigenic sources in the region; and the national offers during ICG/NEAMTWS meetings. The objective is a core network of 70 stations, of which, about 12 would be completely new, especially along the North African coast.

Regarding data sampling and transmission: 1-min data sampling will be enough for the initial system, but for the future system a frequency in the seconds range is recommended at those stations

closer to tsunamigenic zones, with a view also to detecting tsunamis due to landslides and to ensuring a continuous transmission cycle of 1 min for stations within 1 hour of travel and/or 100 km of tsunami-generation areas.

Quality control is not recommended; raw data should be transmitted to and interpreted by experts at the warning centre (to be defined).

Data communication will be based on system redundancy using BGAN, ADSL, GPRS or Internet and data will be transmitted every minute to the warning centre and will be integrated into the WMO GTS; training in access and use of the GTS may be required.

The equipment should have an accuracy of <1 cm to be useful for multipurpose stations, as for the GLOSS sea level stations. It should also be capable of measuring higher and lower water levels than normally experienced by a GLOSS sea level station and should be fitted with an adequate in situ data storage capacity. The data sampling rate should be less than 1 min (seconds). Equipment redundancy, including power supply (batteries, solar panels, etc) is desirable.

The IOC Sea Level Monitoring Facility ensures the possibility of sea level data exchange in real time for the whole NEAMTWS region and can monitor the operational status of the NEAMTWS network.

The NEAMTWS core network now comprises 41 stations, but only 26 of them have been upgraded to a 1-min or less data sampling and transmission rate (to meet tsunami requirements) and only 2 of them are in North Africa (Ceuta and Melilla); there are still none in the eastern Mediterranean. About 30 stations remain to be installed or upgraded for this minimum core network.

A design for the offshore instrumentation for Europe remains to be carried out. Owing to the short time propagation for tsunami events in the NEAMTWS region, offshore instrumentation is very important for an efficient warning system; seven priority sites have been proposed, taking into account the risk areas

The Group of Experts welcomed the progress in the development of the NEAMTWS and recognized that it did not require any specific action by GLOSS at this time.

8. REAL-TIME NETWORK: REPORT OF THE SEA LEVEL STATION MONITORING FACILITY

Francisco Hernández (Belgium) briefly reviewed the work of this Facility. The Facility focuses on monitoring gauge status, for which purpose it maintains real-time data and a corresponding data base. It can notify station operators of the status by e-mail and/or SMS. The relevant websites are: http://www.ioc-sealevelmonitoring.org/; http://www.vliz.be/vmdcdata/iode/; http://www.vliz.be/gauges/.

The Facility, which is located in the Flanders Marine Institute (VLIZ), in Ostend, replicates a more limited web-service originally developed for the ODINAfrica project. The Facility covers all oceans and provides services to GLOSS and tsunami warning centres. It is progressively incorporating more stations in all oceans. It is enhancing its metadata holdings with a view to including all station details (for which, an online entry form is made available), GTS message parsing simulation, a table of data providers and contacts, and an improved map showing station options.

The station status monitoring is checked at every webpage refresh; the station list is maintained up to date. The Facility provides performance reports and can mail notifications (system health check), among other things.

Observational data are mainly provided to the Facility via GTS or Internet FTP transfer. The GTS link is based on a Belnet connection between VLIZ and the Royal Meteorological Institute (KMI; Belgium). The Facility receives GTS messages from KMI and provides several services (ftp upload, 1-minute batch jobs, upload to the data base, message logging) and adjusts station status. The FTP set-up is similar; the Facility also reads a considerable number of stations from NOAA's 1-minute-data web service.

The main applications of the Facility are the servicing of the ODINAfrica and the IOC-sea level monitoring websites as well as the provision of web services, graphics and data, analysis, and the monitoring of specific stations.

There are areas where the Facility can develop further. It needs to:

- acquire more metadata
- improve its communications
- determine the cause when a gauge stops sending data
- react to a change of message format
- plan and develop a notification system, hence
- decide to whom messages need to be sent, hence
- develop e-mail, postal address and mobile phone number lists

Possible enhancements of the Facility include:

- better documentation and information material about the Facility
- wider gauge coverage
- better gauge monitoring
- produce a weekly status report
- develop a station start-up notification system
- increase functionality
- work with a metadata web-service project
- generate message logs for Tidetool
- improve reliability
- set up mirror sites
- undertake self health check
- develop online QC procedure

Mr. Hernández informed the Group of Experts that the Facility can push data received via the Internet (e-mail, ftp, web services) onto the GTS. Regarding most of the problems with the data, it may be better to go back to their source. Station operators should check the associated metadata for their stations. The Facility tries to get to know the providers, but there is a need for someone to maintain the metadata at the Facility. Station operators, left to themselves, tend not to keep the metadata up to date. For observations delivered via ftp-box Mr. Hernández informed that the Facility updates its data displays every 5 minutes. Mr. Hernández stressed that presently the system is not guaranteed to run on a 24/7 basis (as is also acknowledged on the web page). However, considerable efforts are made to keep the system operational outside regular work hours. It is expected that a mirror site can be established over the next year which should lead to increased reliability of the site.

The Group of Experts acknowledged that the Facility provided a very useful service for many sea level operator institutions without access to the GTS. The Group of Experts expressed its thanks to VLIZ for hosting this Facility. The Group of Experts acknowledged that the Facility has been developed considerably from its interim stage since the GLOSS GE X meeting, and the Group of Experts decided to recognize the Facility as the GLOSS designated centre for real time sea level data.

While the service of the Facility centre will focus on operational real time sea level stations, the VLIZ centre will work together with the existing GLOSS datacentres, i.e. the Permanent Service for Mean Sea Level (PSMSL), the British Oceanographic Data Center (BODC) and the University of Hawaii Sea Level Center (UHSLC) which serve as archives for low frequency and high frequency research quality sea level data (delayed mode and “fast” mode).

The Group of Experts, though accepting that site mirroring was useful, stressed the need to make sure that parallel, "overlapping" data sets do not become established. It was also concerned about how to provide access to data by the general public and the press before the data were reviewed by experts; this would allow, for example, the removal of outlier data. In that respect it agreed that it would be useful also to have a tide forecasts available (or overlapped) against actual sea level observation values.

9. THE FUTURE ROLE OF GLOSS IN REGARD TO TSUNAMI/HAZARD MONITORING

The Chairman introduced this Agenda Item. The question before the Group of Experts was whether it should do more, in the domain of tsunami/hazard monitoring, than simply cooperate; and if so, decide what GLOSS could really do. Full operational support for the IOC Working Group on Tsunamis and Other Ocean Hazards Warning and Mitigation Systems (TOWS) would require changes to the GLOSS Terms of Reference. The present commitment by GLOSS was stated in the Communiqué (adopted at the 9th session of the GLOSS Group of Experts), in 2005, when some of the new demands were not so apparent.

The Group of Experts recognized that it should aim at making the GLOSS Core Network (GCN) multi-capable/multi-purpose (for tsunami and storm-surge warning and for monitoring climate change), but that the implications of this system-wide upgrading needed careful evaluation; the additional demands would therefore need to be reflected in the Terms of Reference.

The Group of Experts agreed that the standards required for tsunami warning were not the same as those for climate-change monitoring or storm-surge warning. It recognized that, in the pursuit of multi-capability, it will not be feasible to establish (GLOSS quality) stations in some places even though desirable from a system standpoint; and some stations will probably never be made more fully capable. In some regions where tsunamis are rare events, for example, the pressure to upgrade stations to become tsunami-warning-capable may be weak. It also recognized the danger of requiring making stations measure with high accuracy (as for instance needed for climate studies) at the expense of the fundamental tide gauge function; it therefore stressed the importance of protecting the GCN's basic identity.

It agreed that the search for multi-capability may require the definition of subsets of GCN specifically adapted to the different purposes involving sea level monitoring. It also recognized that,

while the cost of adapting tide gauges to full GLOSS capability would not be enormous, there may be a need to adopt a new operational model, with appropriate staffing and funding on a sustainable basis.

The Group of Experts noted the proliferation of secondary Subsidiary Bodies (mainly in the form of Working Groups, Task Teams) of the ICGs for the various regional tsunami warning systems (each has several Working Groups) which may have an adverse impact, in terms of coordination, on the development of a multi-capable sea level network for tsunami warning purposes.

The Chairman reminded the participants that the future of GLOSS Core Network would have to be tied to the move to full-hazard capability in order to attract governmental backing and funding, without which, the sustainability of GLOSS would be compromised. He also stressed the fact that tsunamis have a greater importance than climate change at the local level, so the user communities for these two factors would be different, whereas the sea level stations would be the same.

10. REVIEW OF THE DRAFT GLOSS IMPLEMENTATION PLAN

The Chairman presented the draft GLOSS Implementation Plan for 2009. The cornerstones were:

- The GLOSS Core Network – which is aimed at: comprising some 300 stations, though presently comprising about 150; real-time data sampling, fast- and delayed-mode data exchange; supporting hazard warning applications
- The GLOSS Climate Network (GCOS) – which is aimed at: altimeter calibration; global sea level reconstruction, taking land motion into account (replaces GLOSS/ALT); a redefinition of the climate component of GLOSS
- GLOSS Long-Term Trends (LTT) – assessment of time-series, taking land motion into account
- GLOSS Data Centres – PSMSL/BODC: delayed-mode data delivery; UHSLC: fast-mode data delivery; SLSMF/VLIZ: real-time data management; TIGA: land motion considerations

The Group of Experts noted the need to define the term "long time-series" in terms of climate change considerations vis-à-vis sea level monitoring considerations; it also noted that the definition presently tended to vary from one region to another. It recognized the need to confront the needs of tsunami and other hazard warning systems with the other tide gauge functions in terms of objectives and the means available.

Another question was the meaning of "real time"; for tsunami and storm-surge warning purposes, it should be transmission of data within 15 minutes or better.

Regarding the possible setting-up of subsets of the GCN to deal with different applications, the Group of Experts recognized that it would be necessary to optimize the number of stations in each subset for a given consideration, and that the corresponding data accessibility and delivery should be ensured.

The Group of Experts agreed to the proposed Implementation Plan.

11. REVIEW AND ADOPTION OF THE GLOSS MANUAL/TECHNICAL REPORT ON QUALITY CONTROL OF SEA LEVEL DATA

Lesley Rickard introduced this Agenda Item. Data quality control ensures data consistency within a single data set or collection of data sets so as to ensure that the quality and errors of the data are apparent to the user. It also helps to maintain data standards, consistency and reliability. Information on the quality control of tide gauge data is in the IOC Manuals and Guides No. 14 on Sea Level Measurement and Interpretation (Volumes I–IV), but the GLOSS Quality Manual represents the first time that detailed information on quality-control procedures has been assembled in one document. Other relevant documents are: the EOSS Position Paper; and the ESEAS Quality Control Manual. The objective is to establish a set of recommended standards for quality control of tide gauge data, with a view to producing sea level data sets that have been acquired and processed to agreed standards and eventually to making available a GLOSS data-quality endorsement.

The scope of GLOSS data quality control also comprises: the production of metadata (information) to accompany data; automatic checks; "scientific" quality control; flagging of data quality; and the assembly of other relevant documentation.

Regarding quality control of historical data, when information is not available to perform a confident quality check on the reference level, standard tests may be applied, such as: correlations; standard normal homogeneity test (SNHT); EOF analysis.

The data subject to quality control are: the traditional hourly values of sea level (digitized from paper chart records; from the mid-1980s, digital records of 15-, 10-, 6- and 5-minute sampling intervals, which are better for storm-surge detection and other extreme events; and now, a 1-minute sampling interval, for tsunami detection. Bottom-pressure and water level recorder data should also be subject to quality control. The QC requirements may be different depending on sampling interval, latency and the use to which data are put.

The Group of Experts raised a number of questions. Regarding instrument drift, relevant information may be a component of the metadata. As to the distinction between "real-time" and "delayed-mode" quality control, it reminded operators that these two categories corresponded to levels 1 and 2 in the Manual. The Group of Experts also recognized that, if buyers of data undertake a quality control, this would be acceptable, but such control would not be likely to override the GLOSS quality-control label. It recommended operators to discourage the use of tide gauge data for commercial purposes, since the appropriate quality control would not be assured.

The Group of Experts welcomed the suggestion that a Spanish version of the GLOSS Manual was desirable and called on the Technical Secretary to determine the feasibility of producing such a version.

It accepted the view that radar gauges are very sensitive to wave action, but agreed that this was not a significant factor in the production of monthly averages.

Lesley Rickard reminded the Group of Experts that a draft of the GLOSS Quality Control Manual was on the website and invited them to send her their comments/corrections, preferably before 30 June 2009.

12. OVERVIEW OF SEA LEVEL PRODUCTS ON THE WEB

Ms Allison Allen (NOAA) presented this agenda item. The GLOSS website (www.gloss-sealevel.org) needs to be broadened and improved. At present, GLOSS is very effective at providing access to data and some links to existing sea level resources, but has no specific products on offer. The GLOSS website should be updated to reflect the new components of the Global Sea Level Observing System, and to provide more products and tools. Ms Allen recommended the addition of a "Research" page and the inclusion of figures and of links to cutting-edge research sites. She gave numerous examples of relevant research and operational websites that should be on the GLOSS website. The principal examples (institutional first, programmatic, second; both sets in alphabetical order) were:

British Oceanographic Data Centre
Bulletin of the American Meteorological Society
Center for Satellite Applications and Research (USA)
Fisheries & Oceans Canada
International Tsunami Information Centre (ITIC)
Japan Oceanographic Data Centre
JCOMM
National Aeronautics and Space Administration (U.S.A.)
National Oceanic and Atmospheric Administration (U.S.A.)
Permanent Service for Mean Sea Level (U.K.)
Proudman Oceanographic Laboratory (U.K.)
Puertos del Estado (Spain)
University of Hawaii Sea Level Center
University of South Florida

Australian Baseline Sea Level Monitoring Project
Aviso
Climate Variability and Prediction (CLIVAR)
Global Ocean Data Assimilation Experiment
GPS Tide Gauge Benchmark Monitoring Project (TIGA)
IODE–GLOSSAfrica (IOC)
MedGLOSS
Ocean Observations Panel for Climate (OOPC)
Sea Level Stations Monitoring Facility (VLIZ)
U.S. Climate Change Science Programme
World Ocean Circulation Experiment (WOCE)

Ms Allen suggested compiling existing data and analysis products on one page on the GLOSS website, but also to consider the development of new products. She recommended enhancing linkages to all national, regional, and GLOSS data bases through a central web-based portal. And links to new technology and tools should be established to support the technical aspects of sea level monitoring and analysis.

Ms Allen also recommended: the identification of the components of a new GLOSS in accordance with the elements of the 2009 Implementation Plan; a more comprehensive assessment of existing web products; the use of the current and/or expanded GLOSS Scientific Sub-Committee to assess and potentially endorse new web sites and products; the creation of new pages and links through GLOSS to relevant programmes and products; the development of new products where

gaps exist; and the continual maintenance of the GLOSS website. These proposed activities would require the identification of the experts who should be involved in them and of the required resources.

The Group of Experts stressed the importance of improved understanding by the general public of the value of sea level monitoring. It agreed that this would involve: standardization of the GLOSS tool for the visualization of the data for sea level as well as for the tsunami warning systems. This would imply a greater attention to the regional level and to sources not in English (Google is noticeably biased towards sources in English). It recognized that, while there was a need to improve such links, there was also a need to ensure that this would not be considered as being automatically synonymous with a GLOSS endorsement of any particular data set or product. Hence there was a need to develop a list of GLOSS-approved products.

The Group of Experts recognized that a number of improvements were necessary:

- Maintain all relevant websites up to date and, where necessary, improve the presentation
- Maintain a specific GLOSS identity by defining GLOSS web pages and reviewing all Internet links to and from the GLOSS web pages, with a view to avoiding duplication of information (e.g. GLOSS and PSMSL)

The Group of Experts accepted that it needed some guidance on setting the content of its website, defining its fundamental purpose, management and sustainability, and recognized that the shortcomings observed were often due to a lack of financial and human resources, particularly in the search for relevant websites and data sources (in all languages).

Some participants warned that an abundance of websites might not enhance the status of GLOSS, which would possibly tend to become "lost" in the plethora, particularly in view of the perceived importance of providing data and information useful to the non-scientific user. On the other hand, there was also a danger that GLOSS alone would be useless, given the growing focus on multi-hazard warning systems based on sea level monitoring. There was a good case for placing GLOSS under a bigger banner, such as UNESCO, and perhaps with a change of domain name.

The Group of Experts recognized that it was in the process of becoming a "public-interest" body, with many major operational implications at the national, regional and international levels.

13. UPDATES ON REGIONAL AND NATIONAL SEA LEVEL ACTIVITIES

13.1 EUROPEAN SEA LEVEL SERVICE (ESEAS)

Dr. Per Knudsen, of the Danish National Space Institute, briefly reviewed the status of this service, which comprises 27 institutions and ~200 tide gauge stations. The ESEAS data archives and portals comprise a portal for delayed-mode tide gauge data (BODC/POL/PSMSL) and another portal with a display of real-time tide gauge data (DMI); and an archive for GPS data from GPS@TG stations (NMA). The main objective is to provide a standardized access to quality-assured sea level data and information in Europe to a broad range of scientific and non-scientific users, based on: national sea-level monitoring and data; quality-assured high-level products derived from the tide gauges, GPS and satellite altimetry. ESEAS is the regional implementation of GLOSS.

Ms Liz Bradshaw (BODC) presented a demonstration of the ESEAS data service.

The Group of Experts noted that all ESEAS member countries will quality-control their own data before posting them on the website; moreover, full freedom of access to all is a condition of such posting, although the delay may vary from country to country and from one month to maybe one year.

13.2 MedGLOSS

Dr. Dov Rosen reviewed the progress in MedGLOSS. All MedGLOSS stations conform to GLOSS standards; new standards have been developed for real-time stations. An effort is being made to have the benchmarks of all the near-real-time stations monitored by GPS. While the NRT stations usually collect sea level data with a low latency, they can be upgraded to true real-time mode using new software and transmission equipment. The MedGLOSS website (http://medgloss.ocean.org.il/) provides near-real-time data, statistical and software tools, with download capabilities.

MedGLOSS continues to cooperate with the European Sea Level Service (ESEAS) in sea level research and operational activities. The quality control and dissemination of near-real-time data and real-time data are also available on the MedGLOSS website. A new version (TT4W ver.2) of the software, Tide Tasks for Windows, for tidal analysis and forecasting has been developed to process observations with up to 1-minute data intervals. A programme for upgrading selected MedGLOSS stations has been recently completed, with the collaboration of ICSEM, for the stations at Portomaso (Malta), Paphos (Cyprus), Constanta (Romania) and Kacively (Ukraine), to enable them to provide real-time data for tsunami-warning purposes.

The transmission of real-time data is expected to start in July 2009, following a training workshop for the station operators on the operation of the upgrade equipment and software. The MedGLOSS Focal Centre will also upgrade the stations at Hadera and Ashdod in the Mediterranean and at Eilat in the Gulf of Aqaba (Red Sea). One-minute ASCII files, containing four 15-second averages will initially be sent via Internet FTP, and at a later stage also via GTS or BGAN, to the IOC Sea Level Monitoring Facility in Ostend and, later, to the NEAMTWS Regional Tsunami Watch Centres.

The Group of Experts welcomed the developments in MedGLOSS and expressed the hope that candidate stations in North Africa could eventually be incorporated into MedGLOSS.

13.3 ODINAfrica

Dr. Angora Aman briefly described developments in the IOC/IODE ODINAfrica project. At present, not all existing gauges in Africa region are operational (especially in the Gulf of Guinea) and not all stations are GLOSS stations. There is also a wide variety of tide gauges in the region, and basic meteorological parameters (especially air pressure) are not often measured. The main difficulties are: the poor or non-existent communication facilities for data transmission and exchange and a low capacity for station maintenance. On the other hand, there is a considerable amount of tide gauge data in hard copy format. Regarding the collocation of GPS stations, three GNSS receivers were installed in 2008 at: Takoradi (Ghana); Pemba and Inhambane (both in Mozambique).

Although 22 sea level stations have been installed/upgraded during phase III of ODINAfrica, there is a clear need to upgrade and expand the African Sea Level Network to provide in situ measurement and monitoring of ocean variables in near real time. This will require building an

adequate capacity for the collection, analysis and management of sea-state data through training and the procurement of equipment; and to work with the IOC Sea Level Station Monitoring Facility in Ostend.

Some experts from African countries have used ODINAfrica-III training to analyse data from the sea level stations around Africa and prepare tidal predictions: www.iode.org/glossafrica. Dr. Aman gave an example of ODINAfrica sea level data processing (harmonic analysis and tide prediction), which was supported by the Western Indian Ocean Marine Science Association (WIOMSA).

ODINAfrica has identified future needs for the full development of the Africa Sea Level Network: data capture via GTS and archival in a relational data base; website display (plots and raw data provision) of an alert for tide gauge operators in case of equipment malfunction; semi-automatic data quality control; the possibility of communication with a technical consultant, as necessary.

Dr. Aman noted that, if the African Sea Level Network can be consolidated and if all the stations function well and contribute to GLOSS, as well as to the understanding of global climate change, ODINAfrica would be in a very good situation. However, the maintenance of the equipment after the end of ODINAFRICA-III has not yet been clearly planned. Moreover, the sustainable development of the Network will continue to require: the strengthening of the scientists' capability in sea level data analysis and interpretation; the addition of meteorological sensors (for temperature, wind speed and direction) to the stations. And GLOSS would benefit from finding the best way to rescue the historical sea level data and digitized charts.

The Group of Experts welcomed the advances achieved in the development of the African Sea Level Network and the work under ODINAfrica on sea level monitoring and ocean hazard warning. It recognized that the long-term maintenance of tide gauge stations in Africa was still problematical, but believed that, nevertheless, each country must assume responsibility for its tide gauge stations. It also recognized that it must continue to help in the resolution of this problem.

The Group of Experts noted that, although the sea level stations in Alexandria and Suez were of good quality, there is a need to take into account the fact that the flow of water through the Suez Canal had increased in recent years and that the monitoring of sea level in the region should be adjusted accordingly.

13.4 IOC REGIONAL COMMITTEE FOR THE WESTERN INDIAN OCEAN (IOCWIO)

Dr. Charles Magori described the recent work of this IOC Regional Subsidiary Body (formerly known by the acronym IOCINCWIO). He reviewed the present status of the WIO network. IOCWIO has firmly recommended the implementation of GLOSS in its region and the establishment of a regional sea level programme addressing, in particular, repair and maintenance of tide gauges and the installation of new tide gauges. A joint IOCWIO–WIOMSA tidal analysis workshop was held in Mombasa, 1–5 April 2008; it discussed, among other topics, tidal analysis for a number of newly installed tide gauges under the ODINAfrica III project.

Regarding data availability in the western Indian Ocean, Dr. Magori noted that the data for most stations are available in the Joint Archive for Sea Level (JASL); real-time access is via the GTS. As in western Africa, there are many analog data charts that need to be digitized. IOCWIO collaborates closely with the UHSLC and with the Sea Level Station Monitoring Facility in Ostend. Other sea level data are available from non-GLOSS stations. The information available from national reports has improved considerably since the installation of UHSLC gauges (since 1986).

The scientific capability available in the region for analysis and interpretation is adequate, but the technical capacity needs to be strengthened, particularly as regards tide gauge installation and maintenance, benchmarking and quality control of data. The development of the necessary capability is being pursued through: regional training workshops; internships to specialized centres (UHSLC, PSMSL, NIO); Indian Ocean Tsunami Warning System (IOTWS) fellowships in sea level measurement; and on-site training during field visits.

The Group of Experts welcomed the active participation of the WIO region in GLOSS and noted that many WIO tide gauges are dedicated components of IOTWS. It also noted that the consistency and reliability of data delivery has improved in recent years. There remains, however, an urgent need to: strengthen technical capacity in: tide gauge installation and maintenance; GPS benchmarking; the use of satellite altimetry data; and the assimilation of data into numerical models for weather and ocean forecasting. This effort should be supported by developing and strengthening institutional linkages.

The Group of Experts welcomed the collaboration with WIOMSA in the region.

13.5 REGIONAL ORGANIZATION FOR THE CONSERVATION OF THE ENVIRONMENT OF THE RED SEA AND THE GULF OF ADEN (PERSGA)

Dr. Mohammad Badran briefly reviewed developments in the work programme of PERSGA. It is still mainly a regional marine environmental body which emerged from the UN Regional Seas Programme, but has not so far developed significant sea level monitoring activities. It operates a Marine Emergency Mutual Aid Centre (Hurghada, Egypt).

The Group of Experts thanked Dr. Mohammad Badran for his presentation. It expressed its hope that PERSGA would look into the possibility of restarting the Port Sudan sea level station.

13.6 NATIONAL REPORTS

Several speakers presented updates on their respective national sea level networks. These presentations can be found at: http://ioc-goos.org/glossgexi. Many of the presenters had also provided updated national reports. These are available at http://ioc-goos.org/glossgexi and http://www.gloss-sealevel.org/publications/national_reports.html .

Australia/Bill Mitchell (National Tidal Centre, Bureau of Meteorology, Kent Town, SA)
Brazil/Rosuita Helena Roso (Navy Hydrography Centre, Rio de Janeiro)
Canada/Phillip McAulay (Canadian Hydrographic Service, Ottawa)
China/Manchun Chen (National Marine Data and Information System, Tianjin)
Côte d'Ivoire/Angora Aman (University of Cocody, Abidjan)
Colombia/Luís Otero Díaz (Centro de Investigaciones Oceanográficas e Hidrográficas, Cartagena)
Denmark/Vibeke Huess (The Danish Meteorological Institute, Copenhagen)
Ecuador/Edwin Pinto (Instituto Oceanografico e la Armada, Guayaquil)
France/Guy Wöppelmann (Université de la Rochelle); Lydie Sichoix (University of French Polynesia) reported on the French Polynesian Geodetic Network
Germany/Christoph Blasi (Federal Institute of Hydrology, Koblenz)
India/Thomas Babi (National Institute of Oceanography, Goa)
Indonesia/Parluhutan Manurung (National Coordinating Agency for Survey and Mapping, Cibinong)
Israel/Dov Rosen (Israel Oceanographic and Limnological Research, Haifa)
Japan/Hironori Hayashibara (Japan Meteorological Agency, Tokyo)
Kenya/Charles Magori (Kenya Marine and Fisheries Research Institute, Mombasa)

Mexico/Jorge Zavala-Hidalgo (Universidad Nacional Autónoma de México, Coyoacán)
Norway/Hanne Hodnesdal (Norwegian Hydrographic Service, Stavanger)
Portugal/Joana Reis (Instituto Hidrográfico, Lisbon)
Russian Federation/(Arctic and Antarctic Research Institute, Saint Petersburg)
Sweden/Thomas Hammarklint (Swedish Meteorological and Hydrological Institute, Norrköping)
Thailand/Sommart Niemnil (Royal Thai Naval Academy, Bangkok)
United Kingdom/Liz Bradshaw (British Oceanographic Data Centre, Liverpool)
United States of America/Mike Szabados (NOAA National Ocean Service, Silver Spring, MD)

14. UPDATES ON LINKAGES BETWEEN GLOSS AND OTHER PROGRAMMES

14.1 GLOSS WHITE PAPER TO OCEANOBS '09

The Chairman informed the Group of Experts that this paper was still in preparation; he stressed the need to improve the regional networks, for which more details were needed. He invited the members of Group of Experts to provide additional input following the present session. The whitepaper is available at: http://www.pol.ac.uk/psmsl/training/gloss.pub.html .

14.2 WORLD CLIMATE RESEARCH PROGRAMME (WCRP)

Luís Valdés (Head, IOC Sciences Section) recalled that the WCRP is cosponsored by ICSU, IOC and WMO. IOC cooperates with the WCRP through CLIVAR (the WMO Climate Variability and Prediction programme), and through the organization of a WCRP Workshop on Understanding Sea Level Rise and Variability (Paris, 6–9 June 2006) and the planning of a workshop on the impacts of sea level rise on coasts and islands. The WCRP was also represented on the Scientific Committee of the ICES–PICES–IOC International Symposium on the Effects of Climate Change on the World's Oceans. (Gijón, Spain, 19–23 May 2008). The WCRP Joint Scientific Committee invited the IOC (in April 2009) to cosponsor a WCRP–IOC Task Force on Sea Level Rise.

The Group of Experts thanked Dr. Valdés for his presentation.

14.3 OCEAN OBSERVATIONS PANEL FOR CLIMATE (OOPC)

Albert Fischer (IOC Technical Secretary for OOPC) reminded the Group of Experts that GLOSS is a component of the Global Climate Observing System (GCOS), the main goals of which are to: provide data and information products for climate monitoring and forecasting, assessment and research; meet the growing interest in understanding climate impacts, in order to support decision-making in adaptation to climate change; and serve as the foundation for global operational oceanography.

Coordination of the technical implementation of GCOS is largely done via the Joint WMO–IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) – Observations Coordination Group; it covers: the status of observing networks; standards for metadata and telecommunications; the JCOMM in situ Observing Platform Support Centre (JCOMMOPS), as well as technical coordination for surface drifters, ship observations (meteo and XBT), Argo floats, OceanSITES moored reference stations; and other common issues.

Among the users of the GCOS/OOPC products are: IOC/GOOS; the UN Framework Convention on Climate Change (UNFCCC) and ultimately the IPCC. There is particular interest in: reports on the adequacy of the global system (via GCOS); implementation plans and status reports; access to higher levels of national representation; explaining the importance of ocean observations (including GLOSS); tracking the evolution of the entire global system; and generating political pressure for free and open data exchange.

With respect to GLOSS reporting, the GCOS, GOOS and JCOMM need clear, regularly updated indicators of the status of the observing networks, such as system status and data-flow maps, as well as statistics on national contributions and identification of problem areas. Nevertheless, there remains some confusion over the specifics of the GLOSS Core Network, the GCOS subset of GCN, the altimeter calibration subset, and the geolocated/referenced stations. GCOS/OOPC would like to work with the GLOSS community to improve these indicators.

The OOPC's vision for the OceanObs '09 Conference (Venice, 21–25 September 2009) is to strengthen and enhance the international framework under GCOS, GOOS, WCRP, IGBP and other international programmes for sustained world ocean observing and information systems to help meet the needs of society regarding ocean weather, climate, ecosystems, carbon and chemistry. The goals for the Conference and its follow-up are to ensure the further development and sustainability of the present system and to realize the fullest possible benefits for all stakeholders and participating nations. The long-term aim is to extend the present system to include comprehensive observation, analysis and forecasting of the biogeochemical state of the ocean and the status of marine ecosystems.

This will require consideration of all the goals of the GLOSS network: determination of the global sea level rise and regional/relative sea level changes; supporting hazard warning systems (tsunami, improving storm-surge forecasts); setting standards for regional densification of the GLOSS network and deciding what should be counted as a part of GLOSS.

The Group of Experts welcomed Albert Fischer's presentation. It recognized the need to monitor the changes affecting observing systems, such as GLOSS and GCOS; not only are stations added or withdrawn by the operating agencies for various reasons (such as lack of sufficient human and financial resources), but there are losses due to vandalism, beaching of drifting buoys and occasional operational breakdown, for example. It therefore urged station operators to keep the relevant metadata up to date and to inform the GLOSS data centres.

14.4 JASON-2 SCIENCE WORKING TEAM

Gary Mitchum summarized progress in the Jason-2 mission. The Science Working Team (SWT) considers tide gauge calibration important and has found the GLOSS data set very helpful. He reminded the Group of Experts that the TOPEX/Poseidon satellite was put into orbit in 1992 with an expected life of three years, but lasted for nearly fifteen years. It was replaced by Jason-1 in 2001, which, after a six-month intercalibration period, was manoeuvred into an orbit close to the TOPEX/Poseidon orbit, with a doubling of the ground coverage. Similarly, Jason-2 replaced Jason-1 in June 2008, with similar coverage and data quality.

The Group of Experts thanked Gary Mitchum for his presentation.

14.5 INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO)

Steve Shipman (IHO) informed the Group of Experts of the progress made by his organization in the intersessional period. The IHO now has 80 Member States (Haiti, Ireland and Montenegro being the latest to join). The longstanding IHO Tidal Committee was disbanded after its eighth and final meeting (Halifax, Canada, 23–27 October 2007). Its work was taken on by the Tidal and Water Level Working Group (TWLWG), which first met in Rio de Janeiro, Brazil, 30 March–1 April 2009.

Volume 1, on Coastal Tides, of the IHO Manual on Tides was published by the Institut Océanographique; volume 2, on Oceanic Tides, is in preparation. Regular communication between the IHO and GLOSS Secretariats is ensuring good liaison and mutual attendance at IHO and GLOSS meetings. There is also increasing common membership.

The Group of Experts thanked Steve Shipman for his presentation, and reaffirmed its commitment to close cooperation with the IHO and its Secretariat (the International Hydrographic Bureau).

14.6 ATMOSPHERIC CIRCULATION RECONSTRUCTIONS OVER THE EARTH (ACRE)

Philip Woodworth presented the ACRE project. An interest in sea level changes compels an interest in air pressures and winds and long sea level records of these and other meteorological and sea level parameters in particular. ACRE is an international collaborative initiative led by a consortium of the Queensland (Australia) Climate Change Centre of Excellence (QCCCE), the Met Office Hadley Centre (UK), and the U.S. National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (ESRL) and Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado. ACRE is a project of the GCOS OOPC/AOPC Surface Pressure Working Group (SPWG).

The main purposes of ACRE are: the recovery of historical instrumental surface terrestrial and marine global weather observations to underpin 4-D weather reconstructions (reanalyses) over the last 200–250 years and to serve studies of climate and impacts needing worldwide historical meteorological (air pressure) data. Data from conventional meteorological sources, as well as unconventional ones, such as ships' logbooks, are used to reconstruct sea level air pressure back to 1750.

The main products of ACRE are: dynamically consistent, high-resolution global historical 4-D weather reconstructions at a spatial resolution of 2^{o} latitude by 2^{o} longitude every 6 hours using state-of-the-art scientific capabilities (in the future, a $1/2^{o}$ spatial resolution will be achieved); a baseline of such weather reconstructions that can be tailored to regional/local climate applications (e.g., agricultural, environmental, societal, physical), climate impact studies (e.g., risk of high-impact phenomena), and direct weather input into biophysical and production models. ACRE also aims to provide a historical baseline of global weather that can be used to constrain global climate models, putting them in a much stronger position to look into the future at possible implications and impacts of climate change.

Dr. Woodworth recalled the fact that GLOSS had agreed to be an ACRE project sponsor and that he was the oceanography member on the SPWG. The Working Group has identified its requirements of GLOSS. It noted that air pressure measurements started in the $17^{th}/18^{th}$ centuries, at about the same time as tide gauges, so it is possible that the same archives and libraries that hold sea level records also hold air pressure records. The SPWG requested the members of GLOSS to:

inform ACRE (Rob Allan, ACRE Project Manager, Met Office Hadley Centre, U.K.) of any interesting records, computerized if possible; for countries with a colonial history, investigate where relevant records are now; check out possible non-conventional sources (e.g., ships' logbooks; port operators). He stressed that, although ACRE ideally needs long, continuous records, even short records are of interest. Sea level research can only benefit from 'data archaeology' of related variables, such as air pressure.

Dr. Woodworth recognized that the members of the Group of Experts were well occupied with GLOSS, but stressed that, in return, the members can use the ACRE products in their research (see web site: http://www.met-acre.org/).

The Group of Experts thanked Dr. Woodworth for his presentation and affirmed its continued interest in collaborating with the ACRE project.

15. ISSUES OR ACTIONS FOR JCOMM-III

The Chairman invited Ms Candyce Clark (Chair of the JCOMM Observations Programme Area Group) to identify the issues/actions that the Group of Experts wished to see submitted to JCOMM at its upcoming Third Session (Marrakech, 4–11 November 2009). Ms Clark informed the Group of Experts that a report similar to the White Paper to be submitted to the OceanObs '09 conference (see Agenda Item 14.1) will be submitted to JCOMM for its consideration at its Third Session. She reminded the members that six global in situ implementation programmes (DBCP, Ship Observations Team, GLOSS, Argo, OceanSITES, and the International Ocean Carbon Coordination Project) are linked internationally through the WMO–IOC JCOMM Observations Coordination Group, with a view to building a global ocean observing system.

The Group of Experts thanked Ms Clark for her presentation.

16. TECHNICAL DEVELOPMENTS

16.1 RADAR GAUGE INTERCOMPARISON

Dr. Robert Heitsenrether (NOAA) gave a presentation on the testing of microwave radio sensors. As measurement technology evolves, it is important to provide the most up-to-date water level products and services available. When introducing new technology into a pre-existing operational observatory, it is critical to conduct rigorous testing in order to fully understand sensor functioning and performance, especially with respect to the confirmation of sensor accuracy, the impact of environmental variability and the design of optimal processing.

Four MW sensors (Miros, Design Analysis, Ohmart/Vega, Sutron) were selected and subjected to various laboratory and field tests. The test plan was primarily driven by NWLON's multiple applications and stringent requirements, so the test stations were located in many different types of coastal environments: impact of open-ocean environment and large surface waves (station at Duck, N.C.); performance in the presence of a large tidal signal (Port Townsend, Wash.); and impact of enclosed well, wave-guide effects (Fort Gratiot, Mich. – on Lake Huron).

The field tests were aimed at the collection of long-term measurements at multiple locations near NWLON reference stations, to capture a broad range of environmental variability. Two signal

types were used: "pulse" and "frequency-modulated continuous wave." The mounting plate and the DCP/battery enclosure were common to all lab and field tests. The data were used to monitor many different physical processes, covering a broad range of time-scales. The results of the ongoing field tests are used to further optimize set-ups and to design optimal processing techniques to obtain the most accurate water levels possible. Further analysis of field data will provide information on sensor accuracy and the impacts of various environmental conditions on performance.

The lab tests were aimed at a basic target range, using wave tanks and environmental chambers. Wave tank test results show short, regular waves cause a water-level offset in all sensors that scale to surface wavelength; the results are used to optimize sensor configuration. Environmental chamber temperature tests indicate that the microwave sensors remain extremely stable.

Significant progress has been made in the NOAA Microwave Water Level Test project, leading to several valuable and unique data sets. A NOAA draft report documenting the first ~ 8 months of testing is now available. Many potential benefits of using microwave range sensors to monitor sea level have been identified.

The Group of Experts thanked Dr. Szabados for his presentation. It stressed the overall value of such testing to the development of GLOSS.

16.2 BGAN-BASED TIDE GAUGES

Dr Simon Holgate (PSMSL) gave an update on real-time sea level data transmission from tide gauges using BGAN (INMARSAT). High-frequency real-time data transmission is a particular need for tide gauges near tsunamigenic sources (i.e. typically 100-km travel distance or less than 1-hour travel time) and in particular at remote sites where there is no other access to the internet. BGAN offers a way to transmit sea level observations more frequently than what presently can be achieved via the public meteorological geostationary satellites (i.e. transmission every 15 minutes via GOES, Meteosat or MTSAT). In addition BGAN offers two-way communication to stations which can be used for troubleshooting and testing.

Over the past two years GFZ, POL, and UHSLC have experimented with the use of BGAN to transmit both continuous GPS and tide gauge measurements. Some 15 stations are presently in operation among the three organizations and GFZ also use the BGAN technology on two buoys. Simon Holgate described aspects of the use including: (i) how a BGAN transmission terminal communicates with the tide gauge equipment; (ii) transmission issues and overhead; (iii) what to consider in selecting a BGAN transmission terminal; and (iv) transmission format issues (including transmission overhead).

The BGAN stations that so far have been set up work in parallel with existing transmission equipment (i.e. double redundancy). The typical transmission frequency is sending 1-minute data every 5 minutes with double redundancy (i.e. sending the last 10 minutes of data). With that transmission frequency, data latency is typically 7 minutes. If needed, BGAN transmitted observations can be pushed on to the GTS via the IOC Sea Level Monitoring Facility (hosted at VLIZ) which is connected to the GTS.

The Group of Experts thanked Simon Holgate for his presentation.

17. INTERSESSIONAL ACTIONS FOR 2009–2011

The Group of Experts adopted the list of intersessional actions for the period 2009–2011; it is in Annex III.

18. ANY OTHER BUSINESS

No other business was presented to the Group of Experts.

19. DATE AND PLACE OF THE NEXT SESSION

The Technical Secretary reminded the Group of Experts that, if any institution proposed a venue outside Paris, the IOC would require a financial contribution to cover costs. There was no proposal and the Group of Experts requested the Chairman and the Technical Secretary to determine the dates of the Twelfth Session in due course.

20. CLOSURE

The Chairman thanked the Technical Secretary and his colleagues for the excellent arrangements made for the present session. He closed the Eleventh Session of the GLOSS Group of Experts at 13:00 on Friday 15 June 2009.

ANNEX I

AGENDA

1. ORGANIZATION OF THE SESSION

1.1 OPENING OF THE SESSION

1.2 PRACTICAL ARRANGEMENTS

1.3 ADOPTION OF THE AGENDA

2. REVIEW OF GLOSS ACTIVITIES AND STATUS OF ACTIONS FROM GE-X

3. GLOSS STATION NETWORKS

3.1 REVIEW OF GLOSS CORE NETWORK STATUS (LOW FREQUENCY AND HIGH FREQUENCY, DELAYED MODE AND FAST MODE)

3.2 REVIEW OF COLLOCATED AND NEARLY COLLOCATED CGPS STATIONS

4. REPORT ON THE WORKSHOP ON PRECISION OBSERVATIONS OF VERTICAL LAND MOTION AT TIDE GAUGES, 11–12 MAY 2009

5. SUMMARY OF RECENT RESEARCH BASED ON TIDE GAUGE OBSERVATIONS

6. WORKING GROUP ON TSUNAMIS AND OTHER OCEAN HAZARDS WARNING AND MITIGATION SYSTEMS (TOWS-2)

7. UPDATES ON REGIONAL SEA LEVEL NETWORK DEVELOPMENTS, INCLUDING COORDINATION WITH TSUNAMIS WARNING SYSTEMS

7.1 INDIAN OCEAN

7.2 PACIFIC OCEAN

7.3 CARIBBEAN

7.4 NE ATLANTIC AND MEDITERRANEAN

8. REAL-TIME NETWORK: REPORT OF THE SEA LEVEL STATION MONITORING FACILITY

9. THE FUTURE ROLE OF GLOSS IN REGARD TO TSUNAMI/HAZARD MONITORING

10. REVIEW OF THE DRAFT GLOSS IMPLEMENTATION PLAN

11. REVIEW AND ADOPTION OF THE GLOSS MANUAL/TECHNICAL REPORT ON QUALITY CONTROL OF SEA LEVEL DATA

12. OVERVIEW OF SEA LEVEL PRODUCTS ON THE WEB

13. UPDATES ON REGIONAL AND NATIONAL SEA LEVEL ACTIVITIES

13.1 EUROPEAN SEA LEVEL SERVICE (ESEAS)

13.2 MEDGLOSS

13.3 ODINAFRICA

13.4 IOC REGIONAL COMMITTEE FOR THE WESTERN INDIAN OCEAN (IOCWIO)

13.5 REGIONAL ORGANIZATION FOR THE CONSERVATION OF THE ENVIRONMENT OF THE RED SEA AND THE GULF OF ADEN (PERSGA)

13.6 NATIONAL REPORTS

14. UPDATES ON LINKAGES BETWEEN GLOSS AND OTHER PROGRAMMES

14.1 GLOSS WHITE PAPER TO OCEANOBS '09

14.2 WORLD CLIMATE RESEARCH PROGRAMME (WCRP)

14.3 OCEAN OBSERVATIONS PANEL FOR CLIMATE (OOPC)

14.4 JASON-2 SCIENCE WORKING TEAM

14.5 INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO)

14.6 ATMOSPHERIC CIRCULATION RECONSTRUCTIONS OVER THE EARTH (ACRE)

15. ISSUES OR ACTIONS FOR JCOMM-III

16. TECHNICAL DEVELOPMENTS

16.1 RADAR GAUGE INTERCOMPARISON

16.2 BGAN-BASED TIDE GAUGES

17. INTERSESSIONAL ACTIONS FOR 2009–2011

18. ANY OTHER BUSINESS

19. DATE AND PLACE OF THE NEXT SESSION

20. CLOSURE

ANNEX II

LIST OF PARTICIPANTS

Allison ALLEN
Oceanographer
NOAA National Ocean Service
SSMC4, Station 6525
1305 East West Highway
Silver Spring, MD 20910
United States
Tel: +1 301 713 2897 Ext. 161
Email: allison.allen@noaa.gov

Angora AMAN
Université de Cocody
UFR SSMT
22 BP 582
Abidjan
Cote d'Ivoire
Tel: +225 078 277 ext. 52
Email: aman_angora@hotmail.com

Igor ASHIK
Arctic and Antarctic Research Institute (AARI)
Oceanology Department (Head)
38 Bering Street
Saint Petersburg 199397
Russian Federation
Tel: +7 812 352 1922
Email: ashik@aari.nw.ru

Madavana Thomas BABU
Physical Oceanography, NIO
Dona Paula
Goa 403004
India
Tel: +91 832 240 542
Fax: +91 20 164 169
Email: mtbabu@nio.org

Mohammad BADRAN
Director, Project Management, Scientific Research and Development
Regional Organization for Conservation of the Environment of the Red Sea and Gulf of Aden "PERSGA"
PO Box 53662
Jeddah 21583
Saudi Arabia
Tel: +966 2 657 3224 ext. 204
Fax: +966 2 652 1901
Email: mohammed.badran@persga.org

Rick BAILEY
Project Director
Bureau of Meteorology
700 Collins Street
Docklands
GPO Box 1289
Melbourne VIC 3001
Australia
Tel: +61 3 9669 4103
Fax: +61 3 9669 4660
Email: R.Bailey@bom.gov.au

Christoph BLASI
Federal Institute of Hydrology
Am Mainzer Tor 1
56002 Koblenz
Germany
Tel: +49 261 1306 5246
Fax: +49 261 1306 5280
Email: blasi@bafg.de

Elizabeth BRADSHAW
British Oceanographic Data Centre
Joseph Proudman Building
6 Brownlow Street
Liverpool L3 5DA
United Kingdom
Tel: +44 151 795 4871
Fax: +44 151 795 4912
Email: elizb@bodc.ac.uk

Patrick CALDWELL
NOAA
1000 Pope Road Marine Science Bldg. Rm 316
University of Hawaii at Manoa
Honolulu HI 96822
United States
Tel: 808-956-4105
Email: Patrick.Caldwell@noaa.gov

Manchun CHEN
National Marine Data and Information Service (NMDIS)/SOA
93 Liuwei Road, Hedong District,
Tianjin, 300171
China
Tel: +86 22 2401 0845
Fax: +86 22 2401 0926
Email: cmc@mail.nmdis.gov.cn

Candyce CLARK
NOAA/Climate Program Office (CPO)
Climate Observation Division
1100 Wayne Avenue, suite 1202
Silver Spring MD 20910
United States
Tel: +1 301 427 2463
Fax: +1 301 427 0033
Email: candyce.clark@noaa.gov

Ronan CRÉACH
Service Hydrographique et Océanographique de la Marine (SHOM)
13 Rue du Châtellier - CS 92803
29228 Brest Cedex 2
France
Tel: +33 2 9822 1589
Fax: +33 2 9822 0899
Email: creach@shom.fr

Rui Manuel Da Silva FERNANDES
University of Beira Interior
Rua Marques d'Avila e Bolama
Colvilha
Portugal
Tel: +351 91 999 9300
Email: rmanuel@di.ubi.pt

Albert FISCHER
Technical Secretary of OOPC
Intergovernmental Oceanographic Commission of UNESCO
1 rue Miollis
75732 Paris cedex 15
France
Tel: +33 1 4568 4040
Fax: +33 1 4568 5813
Email: a.fischer@unesco.org

François GÉRARD
MEDDAT-CGEDD-S1
Tour Pascal B
92055 La Défense Cédex
France
Tel: +33 1 4081 2388
Email: francois.gerard@developpement-durable.gouv.fr

Kathy GORDON
Permanent Service for Mean Sea Level
Proudman Oceanographic Laboratory
Joseph Proudman Building
6 Brownlow St.
Liverpool L3 5DA
United Kingdom
Email: psmsl1@pol.ac.uk

Mikaël GUICHARD
Bâtiment ILE
2, rue Olympe de Gouges
17 000 La Rochelle
France
Tel: +33 5 4645 7205
Email: mguichar@sonel.org

Thomas HAMMARKLINT
Swedish Meteorological and Hydrological Institute
SMHI Core Services Observations
SE-60176 Norrköping
Sweden
Tel: +46 11 495 8435
Fax: +46 11 495 8001
Email: Thomas.Hammarklint@smhi.se

Hironori HAYASHIBARA
Tide Unit
Office of Marine Prediction
Global Environment & Marine Department
Japan Meteorological Agency
Otemachi l-3-4
Chiyoda-ku
Tokyo 100-8122
Japan
Tel: +81 3 3212 8341 ext.5139
Fax: +81 3 3211 3047
Email: tide@climar.kishou.go.jp

Robert HEITSENRETHER
NOAA National Ocean Service
672 Independence Parkway
Chesapeake VA 23452
United States
Email: Robert.Heitsenrether@noaa.gov

Francisco HERNANDEZ
Manager Datacentre
Belgium
Tel: +32 59 342 130
Fax: +32 59 342 130
Email: francher@vliz.be

Hanne HODNESDAL
Norwegian Mapping Authority
Norwegian Hydrographic Service
P.O. Box 60
4001 Stavanger
Norway
Tel: +47 51 858 823
Fax: +47 51 858 701
Email: hanne.hodnesdal@statkart.no

Simon HOLGATE
Permanent Service for Mean Sea Level
Proudman Oceanographic Laboratory
Joseph Proudman Building
6 Brownlow St.
Liverpool L3 5DA
United Kingdom
Tel: +44 151 795 4900
Fax: +44 151 795 4912
Email: simonh@pol.ac.uk

Vibeke HUESS
Center for Ocean and Ice
Danish Meteorological Institute
Lyngbyvej 100
2100 Copenhagen
Denmark
Tel: +45 3915 7205
Email: vh@dmi.dk

Svetlana JEVREJEVA
Permanent Service for Mean Sea Level
Proudman Oceanographic Laboratory
Joseph Proudman Building
6 Brownlow St.
Liverpool L3 5DA
United Kingdom
Tel: +44 151 795 4900
Fax: +44 151 795 4912
Email: sveta@pol.ac.uk

Minghai JIA
Senior Geodesist, Earth Monitoring Group
Geospatial & Earth Monitoring Division
Cnr Jerrabomberra Ave and Hindmarsh Drive
Symonston ACT 2609
GPO Box 378
Canberra ACT 2601
Australia
Tel: +61 2 6249 9045
Fax: Fax: +61 2 6249 9929
Email: Minghai.Jia@ga.gov.au

Mikhail KARPYTCHEV
Université de La Rochelle
Pôle Sciences et Technologie
Centre Littoral de Géophysique (C.L.D.G.)
Avenue Michel Crépeau
17042 La Rochelle Cedex 01
France
Tel: +33 5 4645 7206
Fax: +33 5 4645 8249
Email: mikhail.karpytchev@univ-lr.fr

Matt KING
Newcastle University
Newcastle-upon-Tyne
NE1 7RU
United Kingdom
Tel: +44 191 222 7833
Email: m.a.king@ncl.ac.uk

Per KNUDSEN
National Space Institute
Technical University of Denmark
Department of Geodesy
Juliane Maries Vej 30
DK-2100 Copenhagen
Denmark
Tel: +45 3532 5718
Fax: +45 3536 2475
Email: pk@space.dtu.dk

Oddgeir KRISTIANSEN
Norwegian Mapping and Cadastre Authority
Geodetic Institute
NO-3507 Hönefoss
Norway
Tel: +47 3211 8299
Fax: +47 3211 8101
Email: oddgeir.kristiansen@statkart.no

Camille LETETREL
LIttoral ENvironnement et Sociétés
LIENSs,
UMR 6250 CNRS-Université de La Rochelle
2, rue Olympe de Gouges
17042 La Rochelle cedex
France
Tel: +33 5 4645 7224
Fax: +33 5 4645 8249
Email: camille.letetrel@univ-lr.fr

Gunter LIEBSCH
Bundesamt für Kartographie und Geodäsie
Germany
Tel: +49 341 563 4415
Email: gunter.liebsch@bkg.bund.de

Prof Shao Hua LIN
Director Honorary
National Marine Data & Information Service
93 Tianjin City Rd., Liu Wei Rd.
P.O. Box 74, Hedong District
300171 Tianjin
China
Tel: +86 22 2401 0803
Fax: +86 22 2401 0926/+86 22 2401 0820
Email: shlin@mail.nmdis.gov.cn

Phillip MACAULAY
Canadian Hydrographic Service
Canada
Email: macaulayp@mar.dfo-mpo.gc.ca

Charles MAGORI
Research Scientist, KMFRI
Silos Rd. English Point - Mkomani
P. O. Box 81651
Mombasa 80100
Kenya
Tel: +254 722 985 303
Fax: +254 20 235 3226
Email: cmagori@yahoo.com;cmagori@kmfri.co.ke

Parluhutan MANURUNG
Head of Division for Gravity and Tide
Program Manager for Indonesia Coastal Sea Level Monitoring
National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL)
Jl. Raya Jakarta-Bogor Km 46
Cibinong 16911
Indonesia
Tel: +62 21 8790 7730
Fax: +62 21 8790 7730
Email: parluhutan@bakosurtanal.go.id

Juan José MARTINEZ-BENJAMIN
Technical University of Catalonia
Dpt. Geotechnical Engineering and Geosciences ETS Ingenieros de Caminos Canales y Puertos South Campus
Av. Doctor Marañón, 44-50
08028 Barcelona
Spain
Tel: +34 93 401 7057
Fax: +34 93 401 5712
Email: jj.benjamin@upc.edu

Marina MARTINEZ-GARCIA
Technical University of Catalonia,
Av. Dr Marañón 44-50
08028 Barcelona
Spain
Email: marina.martinez@ideg.es

Andrew MATTHEWS
Data Scientist
Permanent Service for Mean Sea Level
Proudman Oceanographic Laboratory
Joseph Proudman Building
6 Brownlow Street
Liverpool L3 5DA
United Kingdom
Tel: +44 151 795 4800
Email: antt@pol.ac.uk

Mark MERRIFIELD
Chairman, GLOSS Group of Experts
University of Hawaii Sea Level Center
Department of Oceanography
1000 Pope Road, MSB 317
Honolulu HI 96822
United States
Tel: +1 808 956 6161
Fax: +1 808 956 2352
Email: markm@soest.hawaii.edu

Bill MITCHELL
National Tidal Centre
Bureau of Meteorology
PO Box 421
25 College Road
Kent Town SA 5071
Australia
Tel: +61 8 8366 2710
Fax: +61 8 8366 2651
Email: b.mitchell@bom.gov.au

Gary MITCHUM
College of Marine Science
University of South Florida
140 Seventh Avenue
St. Petersburg FL 33701
United States
Tel: +1 727 553 3941
Fax: +1 729 553 1189
Email: mitchum@marine.usf.edu

Captain Sommart NIEMNIL, RTN
Royal Thai Naval Academy
204 Sukumvith Rd. Paknam
Muang District
Samutprakan 10270
Thailand
Tel: +66 2 475 3986/ (mob) +66 89 775 7432
Email: sniemnil@gmail.com

Luís Jesús OTERO DIAZ
Centro de Investigaciones Oceanográficas e Hidrográficas (CIOH)
Dirección General Marítima (DIMAR)
Cartagena de Indias D.T. y C.
Colombia
Tel: +57 5 669 4465 ext. 132
Email: loterodiaz@hotmail.com

Begoña PEREZ GOMEZ
Puertos del Estado
Avda. del Partenón 10
Campo de las Naciones
28042 Madrid
Spain
Email: bego@puertos.es

Edwin PINTO
Head of the Department
Instituto Oceanográfico de la Armada
INOCAR
Avenida 25 de Julio Via a Pto. Marítimo
(Base Naval Sur) Casilla de Correos 5940
Guayaquil
Ecuador
Tel: +593 4 248 1300/248 1105
Fax: +593 4 248 5166
Email: ccmar@inocar.mil.ec

Fabio RAICICH
CNR - Istituto di Scienze Marine
viale Romolo Gessi, 2
34123 Trieste
Italy
Tel: +39 040 305 312 ext. 532
Fax: +39 040 308 941
Email: fabio.raicich@ts.ismar.cnr.it

Joana REIS
Instituto Hidrográfico
Divisão de Oceanografia
Secção de Marés
Rua das Trinas 49
1249-093 Lisboa
Portugal
Tel: +351 21 094 3052
Email: joana.reis@hidrografico.pt

Lesley RICKARDS
Permanent Service for Mean Sea Level (PSMSL)
British Oceanographic Data Centre (BODC)
6 Brownlow Street
Liverpool L3 5DA
United Kingdom
Tel: +44 151 795 4897
Fax: +44 151 795 4912
Email: ljr@bodc.ac.uk

Dov S. ROSEN
Head, Dept of Marine Geology & Coastal Processes
Israel Oceanographic & Limnological Research
MedGLOSS Coordinator & GLOSS National Contact
Tel Shikmona PO Box 8030
Haifa 31080
Israel
Tel: +972 4 856 5241 / (mob) 5 0727 0867
Fax: +972 4 851 1911
Email: rosen@ocean.org.il

Rosuita Helena ROSO
Centro de Hidrografia da Marinha
Seccão de Marés (Tidal Section)
Rua Barão de Jaceguai S/N
Ponta d´Areia
Niteroi - RJ, CEP 24048-900
Brazil
Email: rosuita@chm.mar.mil.br

Álvaro SANTAMARÍA-GÓMEZ
Subdirección General de Astronomía
Geodesia y Geofísica
Instituto Geográfico Nacional
General Ibañez de Ibero, 3
28003 Madrid
Spain
Email: asantamaria@fomento.es

Tilo SCHÖNE
GeoForschungsZentrum Potsdam (GFZ)
Department 1, Section 1.2
D-14473 Potsdam
Germany
Tel: +49 331 288 1739
Fax: +49 331 288 1775
Email: tschoene@gfz-potsdam.de

Steve SHIPMAN
International Hydrographic Bureau
4 Quai Antoine 1er
BP 445
MC-98011 Monaco
Monaco
Tel: (dir) +377 9310 8106 / +377 9310 8100
Fax: +377 9310 8140
Email: sshipman@ihb.mc

Lydie SICHOIX
University of French Polynesia
B.P. 6570 Faa'a
98702 Tahiti
French Polynesia
Tel: +689 803 884
Fax: +689 803 804
Email: lydie.sichoix@upf.pf

Derrick SNOWDEN
Program Manager
Climate Observation Division
1100 Wayne Ave, Suite 1202
Silver Spring MD 20910
United States
Tel: +1 301 427 2464
Fax: +1 301 427 0033
Email: Derrick.Snowden@noaa.gov

Cecep SUBARYA
Center for Geodesy and Geodynamics
BAKOSURTANAL
Jl. Raya Jakarta-Bogor Km.46,
Cibinong
16911 BOGOR
Indonesia
Email: csubarya@bakosurtanal.go.id

Mike SZABADOS
NOAA National Ocean Service
1305 East-West Highway
Silver Spring, MD 20910
United States
Tel: +1 301 713 2981
Fax: +1 301 713 4435
Email: Mike.Szabados@noaa.gov

Laurent TESTUT
Laboratoire d'Océanographie et de
Géophysique Spatiale
GRGS/Observatoire Midi-Pyrénées
14, Avenue Edouard Belin
31400 Toulouse
France
Tel: +33 5 6133 2785
Fax: +33 5 6125 3205
Email: laurent.testut@legos.obs-mip.fr

Luís VALDES
Chief of Section for Ocean Science (IOC/OSS)
Intergovernmental Oceanographic
Commission of UNESCO
1 rue Miollis
75732 Paris cedex 15
France
Email: jl.valdes@unesco.org

Bart VANHOORNE
Flanders Marine Institute
(Vlaams Instituut voor de Zee, VLIZ)
Vismijn Pakhuizen 45-52
8400 Oostende
Belgium
Tel: +32 59 340 159
Fax: +32 59 342 131
Email: bart.vanhoorne@vliz.be

Anna VON GYLDENFELDT
Bundesamt fuer Seeschifffahrt und
Hydrographie
(Federal Maritime and Hydrographic Agency)
Bernhard-Nocht Straße 78
20359 Hamburg
Germany
Tel: +49 40 3190 3111
Fax: +49 40 3190 5032
Email: anna.gyldenfeldt@bsh.de

Jorge Luis VALDES
Chief of Section for Ocean Science (IOC/OSS)
Intergovernmental Oceanographic
Commission of UNESCO
1 rue Miollis
75732 Paris cedex 15
France
Tel: +33 1 4568 4011
Fax: +33 1 4568 5812
Email: jl.valdes@unesco.org

Christa VON HILLEBRANDT-ANDRADE
Director and Researcher
Mayaguez
Puerto Rico 00680
United States
Tel: +1 787 833 8433
Fax: +1 787 265 1684
Email: christa@prsn.uprm.edu

Robert WEIß
Bundesanstalt für Gewässerkunde
Referat Geodäsie
Federal Institute of Hydrology
Department Geodesy
Am Mainzer Tor 1
56068 Koblenz
Germany
Tel: +49 261 1306 5289
Email: Weiss@bafg.de

Philip WOODWORTH
Proudman Oceanographic Laboratory,
Liverpool L3 5DA, UK
United Kingdom
Tel: +44 151 795 4800
Fax: +44 151 795 4801
Email: plw@pol.ac.uk

Guy WOPPELMANN
LIttoral ENvironnement et Sociétés, LIENSs,
UMR 6250 CNRS-Université de La Rochelle
2, rue Olympe de Gouges
17042 La Rochelle cedex
France
Tel: +33 5 4645 8613
Fax: +33 5 4645 8249
Email: gwoppelm@univ-lr.fr

Jorge ZAVALA-HIDALGO
Centro de Ciencias de la Atmósfera
Universidad Nacional Autónoma de México
Circuito Exterior s/n, Ciudad Universitaria
Coyoacán
04510 México D.F
Mexico
Tel: +52 55 5622 4048
Fax: +52 55 5616 0789
Email: jzavala@atmosfera.unam.mx

IOC Secretariat

Thorkild AARUP
Intergovernmental Oceanographic
Commission of UNESCO
1 rue Miollis
75732 Paris cedex 15
France
Tel: +33 1 4568 4019
Fax: +33 1 4568 5812
Email: t.aarup@unesco.org

Laurence FERRY
Intergovernmental Oceanographic
Commission of UNESCO
1 rue Miollis
75732 Paris cedex 15
France
Tel: +33 1 4568 4022
Fax: +33 1 4568 5812
Email: l.ferry@unesco.org

Belen MARTIN MIGUEZ
Intergovernmental Oceanographic
Commission of UNESCO
1 rue Miollis
75732 Paris cedex 15
France
Tel: +33 1 4568 3990
Fax: +33 1 4568 5812
Email: b.martin-miguez@unesco.org

ANNEX III

GLOSS PLAN OF ACTIONS 2009–2011

Actions	Members Responsible for Action
Reports	
Complete report from GLOSS GE XI	Merrifield, Aarup
Revision, consolidation of GCN and subsets of the GCN for different purposes (e.g. for GCOS, CC, ALT,)	Merrifield (with input from GLOSS Community)
Complete GLOSS Implementation Plan	Merrifield
Complete OceanObs '09 White Paper Incl "Matrix station list from GPS@TG workshop"	Merrifield, co-authors
Complete Technical Report for the Workshop on Precision Observations of Vertical Land Motion at Tide Gauges	Workshop Steering Group
Finalize the GLOSS quality-control manual	Rickards with input from community by 1 August 2009
GLOSS & Sea Level Observations & Advice in Regard to Tsunami Monitoring Systems	
Note draft TOWS requests to IOC Assembly • Expand GLOSS GE with expertise in tsunami sea level monitoring • Participate in inter-ICG Task Team on sea level requirements of GLOSS and its network • Based on requirements from Task Team and in consultation with PICO/Coastal GOOS define reference SL network in regard to tsunamis • Ensure free/unrestricted data exchange Determine more precisely the desiderata for GLOSS stations and particularly for the GCN stations to enable them to contribute effectively to tsunami and other ocean hazards warning and mitigation systems	Chair to act on requests (when formally established)
Data Management	
Delayed-mode data banking at BODC/PSMSL and UHSLC/JASL – continue efforts for a joint portal access to sea level data records	Continuing from GE-X (Rickards,)
High-frequency fast-mode data banking at UHSLC – establish clear policy on the meaning of "fast delivery"	Merrifield

Actions	Members Responsible for Action
Reports	
Establish formal arrangements for exchange of station status information from the different data streams GLOSS Core Network station status information (delayed mode, fast mode, real time, TIGA)	(Merrifield, Rickards, Hernandez, Wöppleman)
GLOSS Products & Web Sites	
Identify sea level indices in regard to GCOS/OOPC web-site Consider/evaluate global/regional products and content for GLOSS web-site with a view to further increasing outreach and visibility. Ensure frequent updating of GLOSS regional websites	Ongoing (Allen, Szabados, Mitchell, Perez)

ANNEX IV

LIST OF DOCUMENTS

(Documents and presentations are available from http://www.ioc-goos.org/glossge11)

Agenda Item	
2.	Chairman's Report GLOSS GE XI 2009
3.1	PSMSL Report GLOSS GE XI 2009
3.1	UHSLC Report GLOSS GE XI 2009
7.3	ICG/Caribe-EWS Report
11.	GLOSS QC Manual (Draft) GLOSS GE XI 2009 (Draft)
13.	Israel National Report GLOSS GE XI 2009
13.	MedGLOSS Report GLOSS GE XI 2009
13.	PERSGA Report GLOSS GE XI 2009
13.	France National Report GLOSS GE XI 2009
13.	French Polynesia Report GLOSS GE XI 2009
13.	Colombia National Report GLOSS GE XI 2009
13.	Canada National Report GLOSS GE XI 2009
13.	India NIO National Report GLOSS GE XI 2009
13.	New Zealand National Report GLOSS GE XI 2009
13.	Côte d'Ivoire National Report GLOSS GE XI 2009
13.	Kenya National Report GLOSS GE XI 2009
13.	US National Report GLOSS GE XI 2009
13.	Australia National Report GLOSS GE XI 2009
13.	UK National Report GLOSS GE XI 2009
13.	Ecuador National Report GLOSS GE XI 2009
13.	Japan National Report GLOSS GE XI 2009 25/04/09
13.	Portugal National Report GLOSS GE XI 2009
13.	Odinafrica Report GLOSS GE XI 2009
13.	WIO Report GLOSS GE XI 2009
13.	South Africa National Report GLOSS GE XI 2009
13.	Sweden National Report GLOSS GE XI 2009
13.	Indonesia National Report GLOSS GE XI 2009
13.	Norway National Report GLOSS GE XI 2009
13.	Italy National Report GLOSS GE XI 2009
13.	Mexico National Report GLOSS GE XI 2009
13.	Brazil National Report GLOSS GE XI 2009
13.	Germany National Report GLOSS GE 2009
13.	Denmark National Report GLOSS GE XI 2009
13.	China National Report GLOSS GE XI 2009
14.1	GLOSS White Paper to OCEANOBS '09
16.1	NOAA Microwave Water Level Sensor Interim Report

Other Documents	Background for Workshop
	Workshop Agenda on Precision Observations of Vertical Land Motion at Tide Gauges, 11–12 May 2009 (Draft)
	OOS-169 Report of the Tenth Session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Paris, France, 6–8 June 2007
	GLOSS GE XI-Timetable
	GLOSS GE XI- Annotated Agenda
	TIGA Splinter meeting, Analysis Center and Combination
	Splinter Meeting: Science Application

ANNEX V

LIST OF ACRONYMS

ASCII	American Standard Coded Information Interchange
ACRE	Atmospheric Circulation Reconstructions over the Earth
ADSL	Asymmetric Digital Subscriber Line
ALT	Altimeter calibration
AOPC	Atmospheric Observing Panel for Climate (GCOS)
BGAN	Broadband Global Area Network (INMARSAT)
BODC	British Oceanographic Data Centre (UK)
BOOS	Baltic GOOS
Caribe-EWS	Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
CBS	Commission for Basic Systems (WMO)
CGPS	Continuous Global Positioning System
CIRES	Cooperative Institute for Research in Environmental Sciences (University of Colorado)
CLIVAR	Climate Variability and Prediction (WCRP)
CTWC	Caribbean Tsunami Warning Centre
DBCP	Drifting Buoy Cooperation Panel (WMO–IOC)
DCP	Data collection platform
DMI	Danish Meteorological Institute
EOF	End of file
EOSS	European Sea-level Observing System (EU)
ESEAS	European Sea Level Service
EU	European Union
FTP	File transfer protocol (Internet)
EuroGOOS	European Global Ocean Observing System
FAGS	Federation of Astronomical and Geophysical Services (ICSU)
GCN	GLOSS Core Network
GCOS	Global Climate Observing System (WMO–ICSU–IOC–UNEP)
GE	Group of Experts
GEOSS	Global Earth Observations System of Systems
GFZ	GeoForschungsZentrum (Germany)

GGOS	Global Geodetic Observing System (IAG)
GLOSS	Global Sea Level Observing System (JCOMM)
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellite
GOHWMS	Ad hoc Working Group for the Establishment of a Framework for the Global Tsunami and Other Ocean-related Hazards Early Warning System
GOOS	Global Ocean Observing System (WMO–ICSU–IOC–UNEP)
GPRS	General Packet Radio Service
GPS	Global Positioning System
GPS@TG	GPS at Tide Gauge
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System
IAG	International Association of Geodesy (ICSU)
IBIROOS	Iberian–Biscay–Ireland Operational Oceanography System
ICES	International Council for the Exploration of the Sea
ICG	International Coordination Group
ICG/NEAMTWS	International Coordination Group for the North East Atlantic, Mediterranean and Connected Seas Tsunami Warning System
ICG/PTWS	International Coordination Group for the Pacific Tsunami Warning System
ICSEM	International Commission for the Scientific Exploration of the Mediterranean Sea
ICSU	International Council for Science
IGBP	International Geosphere–Biosphere Programme (ICSU)
IGS	International GNSS Service
IHO	International Hydrographic Organization
INMARSAT	International Marine Satellite Organization
InSAR	Interferometric Synthetic Aperture Radar
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IOCARIBE–GOOS	Caribbean and Adjacent Regions Global Ocean Observing System
IOCWIO	IOC Regional Committee for the Western Indian Ocean
IODE	International Oceanographic Data and Information Exchange
IOTWS	Indian Ocean Tsunami Warning System
IP	Internet protocol
IPCC	Intergovernmental Panel on Climate Change (UN)

ITIC	International Tsunami Information System
ITU	International Telecommunication Union (UN)
JASL	Joint Archive for Sea Level
JCOMM	Joint Commission for Oceanography and Marine Meteorology (WMO–IOC)
JCOMMOPS	JCOMM Observing Platform Support
KMI	Koninklijk Meterologisch Instituut/Royal Meteorological Institute (Belgium)
LTT	Long-term trend
MedGLOSS	Mediterranean Programme for the Global Sea-Level Observing System
MedGOOS	Mediterranean Programme for the Global Ocean Observing System
MOON	Mediterranean Operational Oceanography Network
MSL	Mean sea level
MTSAT	Multi-functional Transport Satellite (Japan)
NEAMTWS	North East Atlantic, Mediterranean and Connected Seas Tsunami Warning System
NESDIS	National Environmental Satellite, Data, and Information Service (USA)
NIO	National Institute of Oceanography (India)
NMA	Norwegian Mapping Agency
NOAA	National Oceanic and Atmospheric Administration (USA)
NOOS	North-West Shelf Operational Oceanographic System
NRT	Near real time
NTWC	National Tsunami Warning Centre
NWLON	National Water Level Observing Network (USA)
ODINAfrica	Oceanographic Data and Information Network for Africa
OOPC	Ocean Observations Panel for Climate (GOOS)
PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and the Gulf of Aden
PICES	North Pacific Marine Sciences Organization
POL	Proudman Oceanography Laboratory (UK)
PSMSL	Permanent Service for Mean Sea Level (UK)
PTWC	Pacific Tsunami Warning Centre
PTWS	Pacific Tsunami Warning System
QC	Quality control
QCCCE	Queensland Climate Change Centre of Excellence (Australia)

RTWP	Regional Tsunami Watch Provider
SLSMF	Sea Level Station Monitoring Facility
SMS	Short message service (Internet)
SNHT	Standard normal homogeneity test
SPWG	Surface Pressure Working Group (GCOS)
SWT	Science Working Team
TG	Tide gauge
TGBM	Tide gauge benchmark
TIGA	GPS Tide Gauge Benchmark Monitoring Project
TOGA	Tropical Ocean Global Atmosphere (WCRP)
TOPEX–Poseidon	Ocean Topography Experiment/Poseidon Satellite
TOWS	Tsunamis and Other Ocean Hazards Warning and Mitigation Systems
TWLWG	Tidal and Water Level Working Group (Brazil)
UHSLC	University of Hawaii Sea Level Center
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VLIZ	Vlaams Instituut voor de Zee/Flanders Marine Institute (Belgium)
WCATWC	West Coast/Alaska Tsunami Warning Center (USA)
WCRP	World Climate Research Programme (WMO–ICSU–IOC)
WIO	Western Indian Ocean
WIOMSA	Western Indian Ocean Marine Science Association
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
XBT	Expendable bathythermograph
XML	Extensible Mark-up Language

In this Series, entitled

Reports of Meetings of Experts and Equivalent Bodies, which was initiated in 1984 and which is published in English only, unless otherwise specified, the reports of the following meetings have already been issued:

1. Third Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
2. Fourth Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans S. Fourth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Also printed in Spanish)***
4. First Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
5. First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
6. First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
7. First Session of the Joint CCOP(SOPAC)-IOC Working Group on South Pacific Tectonics and Resources
8. First Session of the IODE Group of Experts on Marine Information Management
9. Tenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies in East Asian Tectonics and Resources
10. Sixth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
11. First Session of the IOC Consultative Group on Ocean Mapping ***(Also printed in French and Spanish)***
12. Joint 100-WMO Meeting for Implementation of IGOSS XBT Ships-of-Opportunity Programmes
13. Second Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
14. Third Session of the Group of Experts on Format Development
15. Eleventh Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
16. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
17. Seventh Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
18. Second Session of the IOC Group of Experts on Effects of Pollutants
19. Primera Reunión del Comité Editorial de la COI para la Carta Batimétrica lnternacional del Mar Caribe y Parte del Océano Pacífico frente a Centroamérica ***(Spanish only)***
20. Third Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
21. Twelfth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
22. Second Session of the IODE Group of Experts on Marine Information Management
23. First Session of the IOC Group of Experts on Marine Geology and Geophysics in the Western Pacific
24. Second Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources ***(Also printed in French and Spanish)***
25. Third Session of the IOC Group of Experts on Effects of Pollutants
26. Eighth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
27. Eleventh Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
28. Second Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
29. First Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
30. First Session of the IOCARIBE Group of Experts on Recruitment in Tropical Coastal Demersal Communities ***(Also printed in Spanish)***
31. Second IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
32. Thirteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asia Tectonics and Resources
33. Second Session of the IOC Task Team on the Global Sea-Level Observing System
34. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
35. Fourth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
36. First Consultative Meeting on RNODCs and Climate Data Services
37. Second Joint IOC-WMO Meeting of Experts on IGOSS-IODE Data Flow
38. Fourth Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
39. Fourth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
40. Fourteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
41. Third Session of the IOC Consultative Group on Ocean Mapping
42. Sixth Session of the Joint IOC-WMO-CCPS Working Group on the Investigations of 'El Niño' (***Also printed in Spanish)***
43. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
44. Third Session of the IOC-UN(OALOS) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
45. Ninth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
46. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
47. Cancelled
48. Twelfth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
49. Fifteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
50. Third Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
51. First Session of the IOC Group of Experts on the Global Sea-Level Observing System
52. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean
53. First Session of the IOC Editorial Board for the International Chart of the Central Eastern Atlantic ***(Also printed in French)***
54. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
55. Fifth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
56. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
57. First Meeting of the IOC *ad hoc* Group of Experts on Ocean Mapping in the WESTPAC Area
58. Fourth Session of the IOC Consultative Group on Ocean Mapping
59. Second Session of the IOC-WMO/IGOSS Group of Experts on Operations and Technical Applications

60. Second Session of the IOC Group of Experts on the Global Sea-Level Observing System
61. UNEP-IOC-WMO Meeting of Experts on Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change
62. Third Session of the IOC-FAO Group of Experts on the Programme of Ocean Science in Relation to Living Resources
63. Second Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
64. Joint Meeting of the Group of Experts on Pollutants and the Group of Experts on Methods, Standards and Intercalibration
65. First Meeting of the Working Group on Oceanographic Co-operation in the ROPME Sea Area
66. Fifth Session of the Editorial Board for the International Bathymetric and its Geological/Geophysical Series
67. Thirteenth Session of the IOC-IHO Joint Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
68. International Meeting of Scientific and Technical Experts on Climate Change and Oceans
69. UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System
70. Fourth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
71. ROPME-IOC Meeting of the Steering Committee on Oceanographic Co-operation in the ROPME Sea Area
72. Seventh Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Spanish only)***
73. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
74. UNEP-IOC-ASPEI Global Task Team on the Implications of Climate Change on Coral Reefs
75. Third Session of the IODE Group of Experts on Marine Information Management
76. Fifth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
77. ROPME-IOC Meeting of the Steering Committee for the Integrated Project Plan for the Coastal and Marine Environment of the ROPME Sea Area
78. Third Session of the IOC Group of Experts on the Global Sea-level Observing System
79. Third Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
80. Fourteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
81. Fifth Joint IOG-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
82. Second Meeting of the UNEP-IOC-ASPEI Global Task Team on the Implications of climate Change on Coral Reefs
83. Seventh Session of the JSC Ocean Observing System Development Panel
84. Fourth Session of the IODE Group of Experts on Marine Information Management
85. Sixth Session of the IOC Editorial Board for the International Bathymetric chart of the Mediterranean and its Geological/Geophysical Series
86. Fourth Session of the Joint IOC-JGOFS Panel on Carbon Dioxide
87. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Pacific
88. Eighth Session of the JSC Ocean Observing System Development Panel
89. Ninth Session of the JSC Ocean Observing System Development Panel
90. Sixth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
91. First Session of the IOC-FAO Group of Experts on OSLR for the IOCINCWIO Region
92. Fifth Session of the Joint IOC-JGOFS CO, Advisory Panel Meeting
93. Tenth Session of the JSC Ocean Observing System Development Panel
94. First Session of the Joint CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing
95. Third Session of the IOC Editorial Board for the International Chart of the Western Indian Ocean
96. Fourth Session of the IOC Group of Experts on the Global Sea Level Observing System
97. Joint Meeting of GEMSI and GEEP Core Groups
98. First Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
99. Second International Meeting of Scientific and Technical Experts on Climate Change and the Oceans
100. First Meeting of the Officers of the Editorial Board for the International Bathymetric Chart of the Western Pacific
101. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
102. Second Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
103. Fifteenth Session of the Joint IOC-IHO Committee for the General Bathymetric Chart of the Oceans
104. Fifth Session of the IOC Consultative Group on Ocean Mapping
105. Fifth Session of the IODE Group of Experts on Marine Information Management
106. IOC-NOAA *Ad hoc* Consultation on Marine Biodiversity
107. Sixth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
108. Third Session of the Health of the Oceans (HOTO) Panel of the Joint Scientific and Technical Committee for GLOSS
109. Second Session of the Strategy Subcommittee (SSC) of the IOC-WMO-UNEP Intergovernmental Committee for the Global Ocean Observing System
110. Third Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
111. First Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate
112. Sixth Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting
113. First Meeting of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS)
114. Eighth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of "El Niño" ***(Spanish only)***
115. Second Session of the IOC Editorial Board of the International Bathymetric Chart of the Central Eastern Atlantic ***(Also printed in French)***
116. Tenth Session of the Officers Committee for the Joint IOC-IHO General Bathymetric Chart of the Oceans (GEBCO), USA, 1996
117. IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Fifth Session, USA, 1997
118. Joint Scientific Technical Committee for Global Ocean Observing System (J-GOOS), Fourth Session, USA, 1997
199 First Session of the Joint 100-WMO IGOSS Ship-of-Opportunity Programme Implementation Panel, South Africa, 1997
120. Report of Ocean Climate Time-Series Workshop, Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate, USA, 1997
121. IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional Global Ocean Observing System (NEAR-GOOS), Second Session, Thailand, 1997

122. First Session of the IOC-IUCN-NOAA *Ad hoc* Consultative Meeting on Large Marine Ecosystems (LME), France, 1997

123. Second Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), South Africa, 1997

124. Sixth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico, Colombia, 1996 ***(also printed in Spanish)***

125. Seventh Session of the IODE Group of Experts on Technical Aspects of Data Exchange, Ireland, 1997

126. IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), First Session, France, 1997

127. Second Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 1998

128. Sixth Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1997

129. Sixth Session of the Tropical Atmosphere - Ocean Array (TAO) Implementation Panel, United Kingdom, 1997

130. First Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 1998

131. Fourth Session of the Health of the Oceans (HOTO) Panel of the Global Ocean Observing System (GOOS), Singapore, 1997

132. Sixteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), United Kingdom, 1997

133. First Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1998

134. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IOC/EB-IBCWIO-IW3), South Africa, 1997

135. Third Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), France, 1998

136. Seventh Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting, Germany, 1997

137. Implementation of Global Ocean Observations for GOOS/GCOS, First Session, Australia, 1998

138. Implementation of Global Ocean Observations for GOOS/GCOS, Second Session, France, 1998

139. Second Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Brazil, 1998

140. Third Session of IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), China, 1998

141. Ninth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Ecuador, 1998 ***(Spanish only)***

142. Seventh Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Croatia, 1998

143. Seventh Session of the Tropical Atmosphere-Ocean Array (TAO) Implementation Panel, Abidjan, Côte d'Ivoire, 1998

144. Sixth Session of the IODE Group of Experts on Marine Information Management (GEMIM), USA, 1999

145. Second Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), China, 1999

146. Third Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Ghana, 1999

147. Fourth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC); Fourth Session of the WCRP CLIVAR Upper Ocean Panel (UOP); Special Joint Session of OOPC and UOP, USA, 1999

148. Second Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1999

149. Eighth Session of the Joint IOC-JGOFS CO2 Advisory Panel Meeting, Japan, 1999

150. Fourth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Japan, 1999

151. Seventh Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1999

152. Sixth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 1999

153. Seventeenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), Canada, 1999

154. Comité Editorial de la COI para la Carta Batimétrica Internacional del Mar Caribe y el Golfo de Mexico (IBCCA), Septima Reunión, Mexico, 1998

IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico (IBCCA), Seventh Session, Mexico, 1998

155. Initial Global Ocean Observing System (GOOS) Commitments Meeting, IOC-WMO-UNEP-ICSU/Impl-III/3, France, 1999

156. First Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Venezuela, 1999 ***(also printed in Spanish and French)***

157. Fourth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), China, 1999

158. Eighth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Russian Federation, 1999

159. Third Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), Chile, 1999

160. Fourth Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS). Hawaii, 2000

161. Eighth Session of the IODE Group of Experts on Technical Aspects of Data Exchange, USA, 2000

162. Third Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 2000

163. Fifth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Poland, 2000

164. Third Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 2000

165. Second Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Cuba, 2000 ***(also printed in Spanish and French)***

166. First Session of the Coastal Ocean Observations Panel, Costa Rica, 2000

167. First GOOS Users' Forum, 2000

168. Seventh Session of the Group of Experts on the Global Sea Level Observing System, Honolulu, 2001

169. First Session of the Advisory Body of Experts on the Law of the Sea (ABE-LOS), France, 2001 ***(also printed in French)***

170. Fourth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, Chile, 2001

171. First Session of the IOC-SCOR Ocean CO_2 Advisory Panel, France, 2000

172. Fifth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Norway, 2000 ***(electronic copy only)***

173. Third Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, USA, 2001 ***(also printed in Spanish and French)***

174. Second Session of the Coastal Ocean Observations Panel and GOOS Users' Forum, Italy, 2001

175. Second Session of the Black Sea GOOS Workshop, Georgia, 2001

176. Fifth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Republic of Korea, 2000

177. Second Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Morocco, 2002 ***(also printed in French)***

178. Sixth Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Australia, 2001 ***(electronic copy only)***

179. *Cancelled*

180. Second Session of the IOC-SCOR Ocean CO_2 Advisory Panel, Honolulu, Hawaii, U.S.A, 2002 ***(electronic copy only)***

181. IOC Workshop on the Establishment of SEAGOOS in the Wider Southeast Asian Region, Seoul, Republic of Korea, 2001 (SEAGOOS preparatory workshop) ***(electronic copy only)***

182. First Session of the IODE Steering Group for the Resource Kit, USA, 19–21 March 2001

183. Fourth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), France, 2002

184. Seventh Session of the IODE Group of Experts on Marine Information Management (GEMIM), France, 2002 ***(electronic copy only)***

185. Sixth Session of IOC/WESTPAC Coordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), Republic of Korea, 2001 ***(electronic copy only)***

186. First Session of the Global Ocean Observing System (GOOS) Capacity Building Panel, Switzerland, 2002 ***(electronic copy only)***

187. Fourth Session of the ad hoc Advisory Group for IOCARIBE-GOOS, 2002, Mexico ***(also printed in French and Spanish)***

188. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IBCWIO), Mauritius, 2000

189. Third session of the Editorial Board for the International Bathymetric Chart of the Western Pacific, Chine, 2000

190. Third Session of the Coastal Ocean Observations Panel and GOOS Users' Forum, Vietnam, 2002

191. Eighth Session of the IOC Consultative Group on Ocean Mapping, Russian Federation, 2001

192. Third Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Lisbon, 2003 ***(also printed in French)***

193. Extraordinary Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Chile, 1999 ***(Spanish only; electronic copy only)***

194. Fifth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, France, 2002

195. Sixth Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System, South Africa, 2003

196. Fourth Session of the Coastal Ocean Observations Panel, South Africa, 2002 ***(electronic copy only)***

197. First Session of the JCOMM/IODE Expert Team On Data Management Practices, Belgium, 2003 *(also JCOMM Meeting Report No. 25)*

198. Fifth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2003

199. Ninth Session of the IOC Consultative Group on Ocean Mapping, Monaco, 2003 ***(Recommendations in English, French, Russian and Spanish included)***

200. Eighth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2003 ***(electronic copy only)***

201. Fourth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Greece, 2004 ***(also printed in French)***

202. Sixth Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2004 ***(electronic copy only)***

203. Fifth Session of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Argentina, 2005 ***(also printed in French)***

204. Ninth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 2005 ***(electronic copy only)***

205. Eighth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), China, 2003 ***(electronic copy only)***

206. Sixth Meeting of the Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Spain, 2006 ***(also printed in French)***

207. Third Session of the Regional Forum of the Global Ocean Observing System, South Africa, 2006 ***(electronic copy only)***

208. Seventh Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2005 ***(electronic copy only)***

209. Eighth Session of the IOC-UNEP-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs), Paris, 2006 ***(electronic copy only)***

210. Seventh Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Gabon, 2007 ***(bilingual English/French)***

211. First Meeting of the IOC Working Group on the Future of IOC, Paris, 2008 ***(Executive Summary in English, French, Russian and Spanish included)***

212. First meeting of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 3–4 April 2008 ***(Executive Summary in English, French, Russian and Spanish included)***

213. First Session of the Panel for Integrated Coastal Observation (PICO-I), Paris, 10–11 April 2008 ***(electronic copy only)***

214. Tenth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 6–8 June 2007 ***(electronic copy only)***

215. Eighth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 21–25 April 2008 ***(bilingual English/French)***

216. Fourth Session of the Global Ocean Observing System (GOOS) Regional Alliances Forum (GRF), Guayaquil, Ecuador, 25–27 November 2008 ***(electronic copy only)***

217. Second Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Paris, 27 March 2009 ***(Executive Summary in English, French, Russian and Spanish included)***

218. Ninth Meeting of the IOC Advisory Body of Experts on the Law of the Sea (IOC/ABE-LOS), Paris, 30 March–3 April 2009 ***(bilingual English/French)***

219. First Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 3), Broomfield, Colorado, U.S.A., 1 October 2005 ***(electronic copy only)***

220. Second Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 6), Paris, France, 20 April 2007 ***(electronic copy only)***

221. Third Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 10), Villefranche-sur-mer, France, 3–4 October 2008 ***(electronic copy only)***

222. Fourth Session of the IOC-SCOR International Ocean Carbon Coordination Project (IOCCP) Scientific Steering Group (also IOCCP Reports, 15), Jena, Germany, 14 September 2009 ***(electronic copy only)***

223. First Meeting of the joint IOC-ICES Study Group on Nutrient Standards (SGONS) (also IOCCP Reports, 20), Paris, France, 23–24 March 2010 *(Executive Summary in E, F, R, S included)*

224. Third Session of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG), Lisbon, Portugal, 5–6 May 2010 ***(Executive Summary in English, French, Russian and Spanish included)***

225. Eleventh Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), Paris, 13–15 May 2009 ***(electronic copy only)***