Global Ocean Observing System

Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

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

Tenth Session
Paris, France
6–8 June 2007

GOOS Report No. 169
GCOS Report No. 120
JCOMM Report No. 58

UNESCO

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ABSTRACT

The Group of Experts reviewed the status of its actions and developed a consolidated list for the next intersessional period. After reviewing the state of the GLOSS Core Network and identifying upgrade needs globally, the Group decided to update its Implementation Plan, with particular emphasis on specific technical development of the Network, and on the impact of technological changes on station design, including data delivery. The revised Plan will be aimed at moving the GLOSS Core Network from a research-support service to an operational, multi-purpose, real-time system, especially for tsunami-warning and climate-change purposes. The revised Plan will also clarify the obligations of those Member States participating in the Network.

The Group considered the implications for GLOSS of the development of the IOC Global Tsunami and Other Ocean-related Hazards Early-Warning System. The Group declared its readiness to expand its activities to include provision of technical advice and strategic planning for water-level stations intended for hazards monitoring.

The Group reviewed the specific regional developments in the Indian Ocean, the Pacific Ocean, the Caribbean, the northeast Atlantic Ocean (including the Mediterranean and other regional seas), Africa, as well as Polar Networks. Representatives of the participating Member States informed the Group of advances in the national water-level monitoring systems.

The Group also reviewed the links between GLOSS and other relevant programmes and the updates from the GLOSS Data Centres.

Regarding its own structure and modus operandi, the Group decided to adapt its Science Sub-Group, by allowing it to form ad hoc panels to deal more effectively with specific questions.

Note*: this report is published in electronic copy only and is available on UNESDOC, the documents database of UNESCO (http://unesdoc.unesco.org/ulis/)*

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1. ORGANIZATION OF THE SESSION

1.1 OPENING OF THE SESSION

The Chairman of the GLOSS Group of Experts, Mark Merrifield, opened the Tenth Session of the JCOMM/IOC Group of Experts on the Global Sea Level Observing System at 09:00 on Wednesday 7 June 2007.

The Executive Secretary of IOC, Patricio Bernal, welcomed the participants. He noted that this tenth session of the GLOSS GE was somewhat of a “round” birthday and he was pleased to see more than 60 attendees from 30 countries indicating a growing interest in sea-level observation. He recalled the wide spectrum of institutions (i.e. port offices, geodetic, hydrographic, meteorological and marine science institutions) which now come together under GLOSS and noted this as a significant achievement. GLOSS has underpinned many developments and products in operational oceanography over the past 25 years. The sea-level observation network (in terms of observations and people) has been strengthened considerably; the number of 'category 1' GLOSS Core Network sites delivering timely mean sea-level data to the Permanent Service for Mean Sea Level has almost doubled since the start of the GLOSS programme; the number of stations in the GLOSS Core Network of stations that report data in real time has increased from 0% back in the 1980s to more than 50% of the stations now providing data in real time and contributing to regional tsunami monitoring systems; the error-bars on the altimeter products have decreased considerably through timely calibration/validation with an situ sea-level observation network; GLOSS has helped to develop a community of people interested in sea level worldwide, and approximately 300 people have received some form of training in GLOSS courses since the mid-1980s.

For the future, GLOSS remains the observation network that underpins studies of long-term sea-level rise. Increasing the number of co-located GPS stations and GLOSS Core Network stations is a priority for the scientific community (e.g. WCRP Workshop on Understanding Sea Level Rise and Variability, Paris, 6–9 June 2006). Such a development should further enhance the present collaboration between GLOSS and the geodetic community.

Real-time provision of sea-level data remains a priority particularly in the North East Atlantic and Mediterranean and Caribbean/Central America region where IOC is also coordinating the development of a tsunami warning system and where progress has not been as rapid (due to lack of funding) as seen in the Indian Ocean over the past 2–3 years. Local tsunami and hazard monitoring are also gaining priority, pushing the need to increase the frequency of data transmission further. The challenge for the GLOSS community is to recommend and determine: (i) how far to go in the efforts to upgrade existing networks; and (ii) how far it is possible to go in terms of providing sea-level observations in real time.

In closing, Patricio Bernal wished the Group of Experts a successful and productive meeting. He also acknowledged the financial support for the meeting from the National Oceanic and Atmospheric Administration (NOAA, USA).

1.2 ADOPTION OF THE AGENDA

The Chairman invited comments on the proposed Agenda. There being none, the Group accepted the Agenda for the present session (Annex I). The list of participants is provided in Annex

II. The GLOSS Plan of Actions 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.

1.3 PRACTICAL ARRANGEMENTS

The Technical Secretary for GLOSS, Thorkild Aarup, outlined the practical arrangements for the conduct of the session.

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

The Chairman of GLOSS, Mark Merrifield, introduced this item; he referred to the background documents for additional information.

In the period 2005–2007, the GLOSS community has shown considerable interest in high-frequency time-series data from GLOSS stations for tsunami, storm-surge and extreme-event research. Following the 2004 tsunami in Sumatra, many tide gauges in the GLOSS Core Network have been or are being upgraded, not only in the Indian Ocean but also in other regions. For the Indian Ocean and African regions, the IOC alone has upgraded 27 stations, through subcontracts, with the funding support of the UN International Strategy for Disaster Reduction (ISDR), the Government of Finland and IOC/ODINAfrica. GLOSS station upgrades have also been accomplished through national (Australia, Germany, Indonesia, Malaysia, Thailand, the UK, and the USA), bilateral and multilateral actions (IOC/ODINAfrica, ISDR, and Asian Disaster Preparation Centre). (See also agenda item 3).

There have been technological improvements in the GLOSS network. Radar sensors have emerged as the preferred instrumentation for primary sea-level measurement, owing to their ease of installation, reduced cost and higher reliability; 15-minute or shorter transmission cycles, via geostationary and low-earth-orbit (LEO) satellites, are becoming common. Fifty-one per cent of the GLOSS Core Network stations now report in near-real-time mode.

With the growing need to monitor the status of stations and of real-time data flow, the IOC/IODE Project Office in Ostend has developed a web-based monitoring service (see also agenda item 10), and the Pacific Tsunami Warning Centre has developed TideTool for visualizing data sent via the GTS.

Considerable progress has been made towards the completion of the GLOSS Core Network by focusing on multi-purpose stations suitable for sea-level and tsunami monitoring. The density of stations has improved, notably in Africa, thanks largely to ODINAfrica, and in Indonesia, through various partnerships with BAKOSURTANAL. The free exchange of tide-gauge data, which is a fundamental element of GLOSS policy, is being supported by more and more countries, although notable exceptions remain.

The GLOSS training activities over the last two years have comprised: training courses on sea-level observation and analysis at the Japan Meteorological Agency (Tokyo, 15–26 May 2006) and at the IODE Project Office (Ostend, 13–22 November 2006, co-sponsored by ODINAfrica); training in tide-gauge installation at the Proudman Oceanographic Laboratory (Liverpool, 22–24 May 2006, co-sponsored by POL); GLOSS technical visits to Cameroon, Comoros, Congo, Egypt, Madagascar, Mauritania, Morocco, Senegal, and Yemen.

Thorkild Aarup, Technical Secretary of GLOSS, reviewed the status of actions outstanding from GLOSS-VIII and GLOSS-IX. The following action items from the list drawn up at GLOSS-IX (UNESCO, Paris, 24–25 February 2005) are still "ongoing" or have effectively been abandoned ("no action") – more information is also available in document GLOSS-GE-X/2:

From GLOSS-VIII

1. High-frequency delayed-mode data banking at UHSLC and BODC/PSMSL
(iii) Clarify expectations of data centres to data providers (send Circular Letter) – no action
(iv) Include other parameters measured at gauges (especially meteorological) – no action

3. Undertake new survey of compliance with the Implementation Plan – partly done, as part of the update of the GLOSS Station Handbook.

From GLOSS-IX

2. SSG issues
(i) Form a new panel – no action

3. TSG issues
(ii) Provide technical advice as needed – ongoing (very low demand for technical advice)

5. COOP issues
(i) Identify GLOSS participants for Coastal GOOS Implementation Panel – no action (no new Coastal GOOS Implementation Panel has been formed yet)
(ii) Explore ways in which GLOSS can contribute to global storm-surge pilot project – no action (no global storm-surge pilot project has been developed)

6. CGPS@TG gauges and TIGA
(i) Circular letter/e-mail for people to inspect Guy Woppelmann's web site and advise – ongoing (Circular Letter sent by Thorkild Aarup to the GLOSS list of contacts; responses from China (Hong-Kong), France, Japan, Norway, The Netherlands, United Kingdom, United States)
(iii) New log file for TIGA membership to be made available – ongoing
(iv) Improve coordination between GLOSS and TIGA websites – no action status specified

7. Automatic QC information to be circulated – ongoing

9. Web sites
(i) GLOSS-Africa web site update – ongoing (Web page moved from IOC/UNESCO website to ODINAfrica site; some restructuring and addition of new information)
(ii) GLOSS-Asia web site(s) to be implemented – no action

10. Investigate training possibilities for GLOSS through Marie-Curie, POGO etc. – no action status specified

11. Greenland stations – redefine GLOSS and GCOS stations in Greenland – ongoing (Scoresbysund, Qaqortoq and Thule stations to be included in GLOSS GCN)

13. Develop user link between UHSLC and SONEL data servers – no action.

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

Mark Merrifield, Chairman of GLOSS GE introduced this item. A main component of GLOSS is the GLOSS Core Network (GCN) of 290 tide gauge stations, selected to provide an evenly distributed sampling of global coastal sea-level variations. Additional GLOSS station networks are focused on Long Term Trends (LTT), altimeter calibration (ALT), and ocean circulation (OC). GLOSS also seeks to specify land motion at tide gauges through collaboration with the International GPS Service (IGS) and the GPS Tide Gauge Benchmark Monitoring Project (TIGA).

In appreciation of the multiple uses of tide gauges, GLOSS has sought to provide water-level data that meet the standards and requirements for tsunami warning and storm-surge monitoring. Numerous GLOSS stations have contributed to the Pacific Tsunami Warning System (PTWS) and, following the 2004 Sumatra earthquake, the IOC and GLOSS have taken an active role in coordinating and implementing the water-level network for the Indian Ocean Tsunami Warning System (IOTWS).

A measure of the current status of GLOSS is the number of operational stations in the GCN. Of the 290 stations, 217 (75%) have provided data recently to one of the GLOSS Data Centres, which represents the participation of 69 nations (Figure 1). Another 32 stations are "probably operational". Approximately 50% of the GCN stations are providing data in near real-time via the Global Telecommunication System (GTS) or the Internet. Data are received in "fast-delivery" mode (that means within ~1 month) from 175 stations (60%) (Figure 2). 131 stations have continuous GPS or DORIS at or near the tide gauge.

The completion of the GCN, with each station reporting in fast-delivery mode or faster, is a priority for GLOSS. Plans are underway to upgrade or install approximately 40 stations in the next year or two (Figure 3). This will leave 60-70 stations that require special attention (Figure 4). The hope is to complete many of these remaining stations in partnership with tsunami-warning upgrades, particularly in the Caribbean/Central America region. The free exchange of tide gauge data, a fundamental policy of GLOSS, is being supported by more and more countries and agencies, although notable exceptions remain.

A detailed status report concerning the supply of mean sea-level data from the GCN can also be found in the annual report of the Permanent Service for Mean Sea Level (see document GLOSS-GE-X/9.1).

Figure 1. GLOSS delayed-mode low-frequency sea-level stations

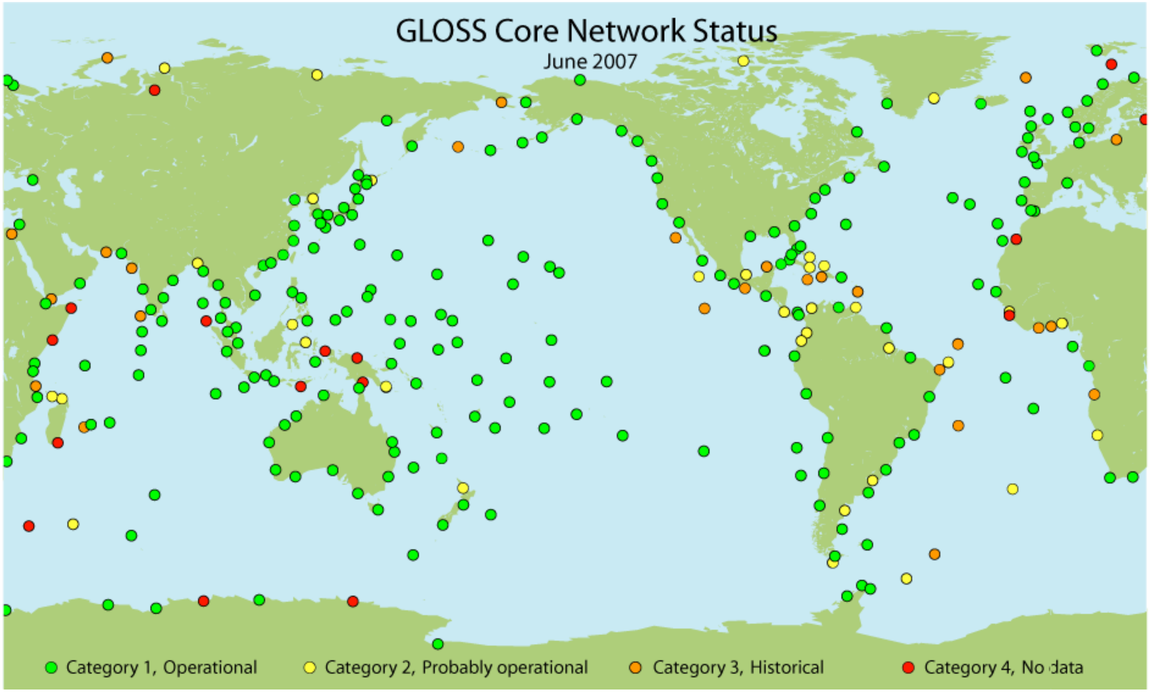


Figure 2. GLOSS high-frequency sea-level stations

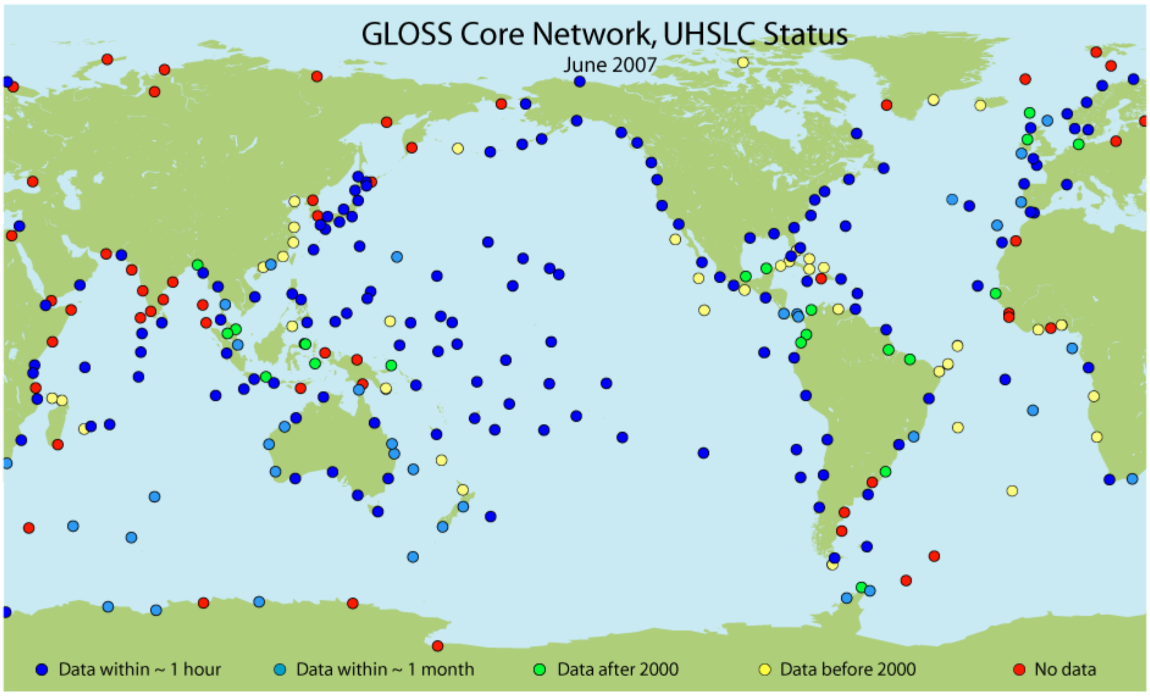


Figure 3. GLOSS stations planned for upgrades in 2007–2008

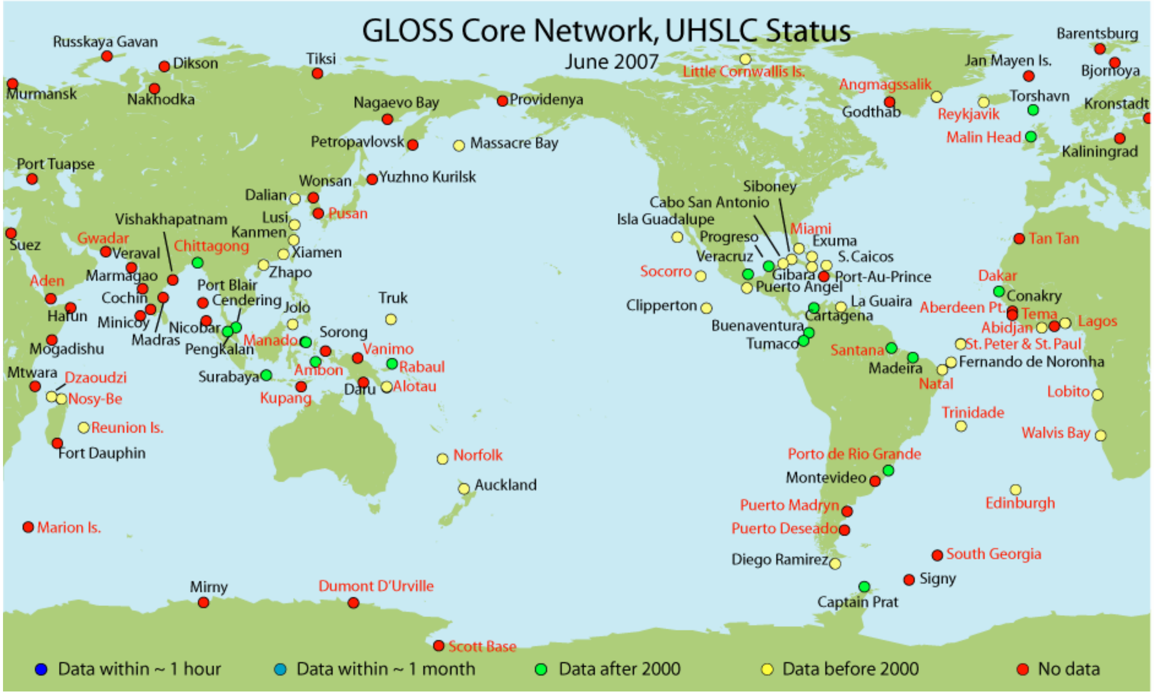
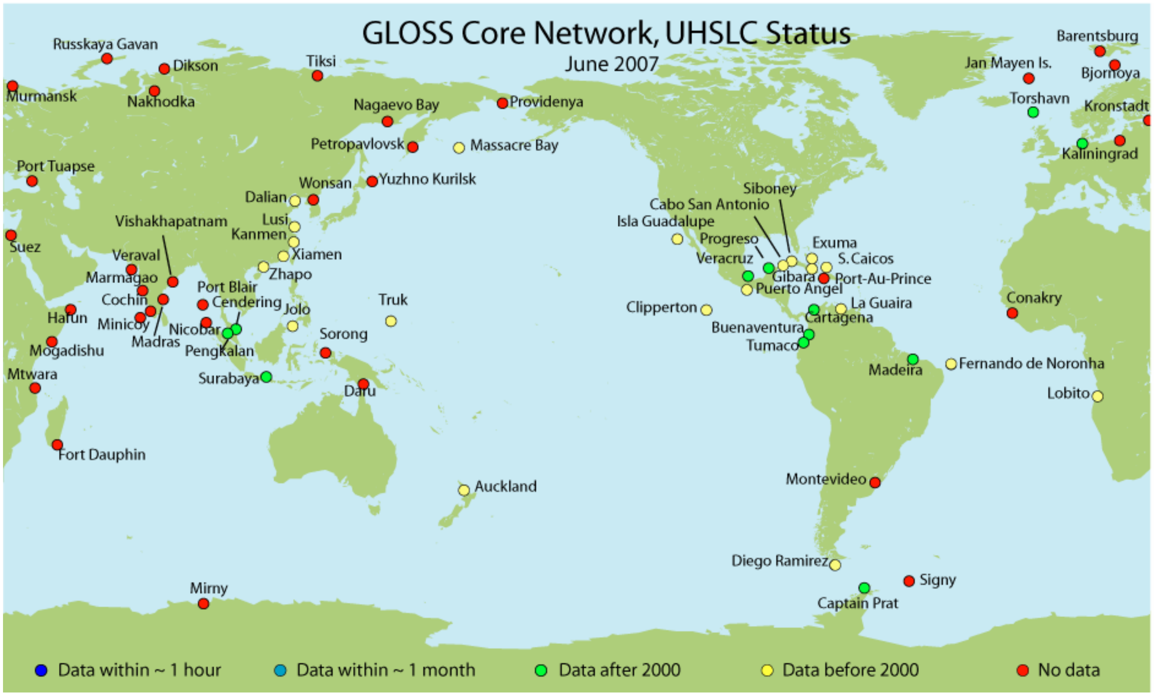


Figure 4. Stations in need of upgrading and/or with no recent provision of high-frequency data



4. UPDATE OF THE GLOSS IMPLEMENTATION PLAN

The Global Sea Level Observing System (GLOSS) has progressed over the years in a more opportunistic fashion than other components of the global ocean observing system. Because GLOSS relies on time-series data from tide gauges that, for the most part, are pre-existing components of national or regional water-level networks, there has not been a well-defined implementation plan in terms of a call for specific station installations and network milestones. Instead, the GLOSS Implementation Plan (GIP) traditionally has been a strategic plan, with recommendations on how best to achieve a globally distributed network of tide gauge stations, all reporting data suitable for scientific research. The GIP was last updated in 1997. Here we summarize briefly the updates that will be made to the GIP for a new 2007 edition that takes into account factors that have impacted GLOSS over the past decade.

The layout of the GIP will remain the same as the 1997 plan. In chapter 3, a summary will be presented of scientific and technical papers that have used GLOSS data, including studies of global and regional sea-level trends, decadal variations, mesoscale features, land-motion corrections, extreme water-level events, tsunami detection, improved tide models, and internal tides. In addition, the discussion of how GLOSS data are used for practical tsunami and storm surge monitoring will be expanded, and any changes in observing standards in response to new operational requirements (chapter 4) will be described.

In chapter 5, the present and future status of GLOSS will be examined. Of particular interest will be the level of commitment GLOSS should make to operational programmes, which is a departure from the primary emphasis on scientific research support, and a review of the high-latitude networks and how they might evolve given environmental stresses in these latitudes.

Sensor technology and communication options have changed significantly over the past 10 years. Chapter 6 will include an assessment of how these new technologies translate into optimal station configurations that satisfy multiple-user needs.

Efficient and seamless access to GLOSS station data and metadata require ongoing changes to take into account improved computer capabilities and database infrastructures (chapter 7). Updated data products and services provided by the major GLOSS data centres will also be examined (chapter 8).

Regional densification of the GLOSS network has occurred in the Indian Ocean and Africa. Efficient strategies for operating and maintaining these regional networks will be examined (chapter 9).

Ways to improve training, education and mutual assistance within GLOSS will be considered (chapter 10), as will the management and international coordination of GLOSS (chapter 11). Finally, the GIP will update the expected obligations of Member States that commit to GLOSS (chapter 12).

The Group of Experts decided to update the GLOSS Implementation Plan.

The Group decided to include the following points in the revised Implementation Plan:

- IOC data policy should apply to the GLOSS data streams and Member States should comply with that policy; and it should be stressed that GLOSS operates on a public service/public good basis.
- The revised Plan should be concrete and outline results and benchmarks.
- The Plan needs to take into consideration that GLOSS and its network addresses at least two types of sea-level community: one, research oriented, the other, non-research oriented. It has been a major achievement to bring researchers, harbour agencies, and hydrographic agencies together under the GLOSS umbrella.
- The extension of a delayed-mode research serving the GLOSS Core Network to a fully operational multi-purpose real-time GLOSS Core Network requires added funding.
- The well functioning delayed-mode low-frequency sea-level network and its associated data stream must not be damaged in the transition to a "why it is important to collect sea-level data" mode
- The revised Plan has to outline clearly why it is important to collect sea-level data, what user products can be or are generated and what the benefits are in participating and contributing data to GLOSS.
- The need for continued support to capacity development.

5. GLOSS IN THE CONTEXT OF A GLOBAL TSUNAMI AND OTHER OCEAN-RELATED HAZARDS EARLY WARNING SYSTEM

François Gérard, Chairman of the Ad hoc Working Group for the Establishment of a Framework for the Global Tsunami and Other Ocean-related Hazards Early Warning System (GOHWMS), introduced this item. He recalled the mandate given to this Working Group by the IOC in Resolution XXIII-15; it asked the Group to prepare a global coordination strategy, which is outlined in a Framework Document (GLOSS-GE-X/5 and IOC-XXIV/2 Annex 10) submitted to the 24th Session of the IOC Assembly (Paris, 19–28 June 2007). He summarized the key issues in the document and stressed that the ad hoc Working Group has confirmed an urgent need to coordinate the four regional intergovernmental tsunami warning systems globally and to ensure the involvement of other agencies and bodies in the UN system, as well as relevant NGOs, with a view to exploring synergies relative to different ocean-related hazards considered for inclusion in a common warning mechanism or system. A Draft Resolution was submitted to the IOC Assembly's 24th Session, based on the findings of the ad hoc Working Group, proposing the establishment of a permanent global working group on tsunami and other hazards related to sea level, comprising representatives of all relevant IOC subsidiary bodies and those from UN sister agencies, like ISDR and WMO, as well as representatives of relevant stakeholders and the seismic community.

François Gérard recalled that GLOSS was originally set up to deal with sea-level observations in terms of science (i.e. primarily long-term study of sea-level rise and support of altimeter calibration). At the same time he recognized that GLOSS has played an active role in the upgrading of the sea-level network as part of the Indian Ocean Tsunami Warning System and as Chairman of GOHWMS he requested the Group consider to what extent the GLOSS GE can broaden its mandate also to provide advice on sea-level monitoring for ocean hazards.

The Group thanked François Gérard for his presentation.

Several members reflected on what GLOSS has achieved so far, and how GLOSS has managed to adapt to changing requirements (for example as articulated in the second GLOSS Implementation Plan from 1997). Some also recalled national experiences and stated that national networks had become better as a consequence of serving multiple users. Some members also recognized that the GLOSS operators primarily have to serve national funders' interests which cover a wide spectrum of needs. This gives rise to an opportunistic network, so that GLOSS can influence maintenance and standards and GLOSS's job is to manage from the regional level to the global level.

Some members stated that the community is looking to GLOSS for advice, as global/regional requirements for sea-level observations are changing/expanding.

Some members stressed that GLOSS should continue to be the leader in sea-level observations and should broaden to make its Core Network both tsunami- and climate-enabled. In this evolution GLOSS should still be global and act as a demonstrator of best practice.

Some members also stressed that GLOSS is part of an integrated global observing system and should clarify what it will lead on and what should be left for others to do.

Some members stressed the importance for GLOSS of not loosing the good and well functioning delayed-mode data stream.

Finally some members stressed the importance of continuing the GLOSS GE as a forum where scientists and operators can meet.

Mark Merrifield, Chairman of GLOSS, summed up the discussion as follows:

On the recommendation of the ad hoc Working Group for the Global Ocean Hazards Warning and Mitigation System (GOHWMS), the GLOSS Group of Experts is prepared to expand its activities to include technical advice and strategic planning for water-level stations intended for hazards monitoring. The GLOSS data centres will cooperate in providing high-frequency data from the GCN in support of hazards research and planning, and will continue to provide a linkage between expertise in the global network and that required for regional operations. In addition, GLOSS will collaborate, as needed, with experts in ocean waves, tsunamis, storm-surge modelling, etc. to develop a global strategy for monitoring water-level hazards.

The Group adopted this position and asked the Technical Secretary to ensure that this position be communicated to Francois Gerard, Chairman of GOHWMS.

6. UPDATES ON REGIONAL SEA LEVEL NETWORK DEVELOPMENTS INCLUDING COORDINATION WITH TSUNAMI WARNING SYSTEM SEA LEVEL NETWORKS

6.1 INDIAN OCEAN

Mark Merrifield, Chair of GLOSS GE, reported on this item.

Since the Sumatra tsunami in 2004 there has been a considerable national and international effort to upgrade the sea-level network as part of the development of the Indian Ocean Tsunami Warning System (IOTWS). Figure 5 and Figure 6 summarize the present status of the network. In addition there are national efforts to enhance/densify national networks – notably in Indonesia, India, Thailand, Malaysia, Australia and Kenya.

Most of the GCN stations in the Indian Ocean have been upgraded or will be upgraded by the end of 2008. Exceptions are those of Somalia and Madagascar. Most of the upgraded stations in the Indian Ocean make high-frequency sea-level observations available in real time on the Global Telecommunication Network.

Figure 5. IOTWS sea level network status showing the GLOSS Core Network (GCN) of stations and non-GCN stations that make data available on the Global Telecommunication System (GTS).

6.2 PACIFIC OCEAN

Fred Stephenson, interim Chairman of the Pacific Tsunami Warning System (PTWS) Intergovernmental Coordination Group, introduced this agenda item. PTWS now comprises more than 375 sea-level stations measuring tides, storm surges and tsunamis; many of these stations can provide data in real time or near real time. The core of this network is the 74 GLOSS "fast delivery" coastal sea-level stations transmitting data at intervals between minutes and three hours. The PTWS Sea Level Network also includes 24 deep-ocean tsunami detection sensors (3 DART-I and 21 DART-II) operated by the USA and Chile, and three cabled systems operated by Japan. DART data transmission is at intervals of 12–16 minutes. Approximately half of the PTWS coastal sea-level stations have transmission rates of 1 hour or more, and are therefore of limited or no use for warning of regional or local tsunami events.

Regarding station upgrading, the IOC International Co-ordination Group for the PTWS decided that: (i) all stations used for tsunami warning and detection should have data-transmission intervals of five (5) minutes or less; (ii) those stations within 1-hour tsunami travel time of tsunami source zones should be given the highest priority; (iii) proximity to major subduction zones or strategic mid-ocean-ridge locations is an important consideration.

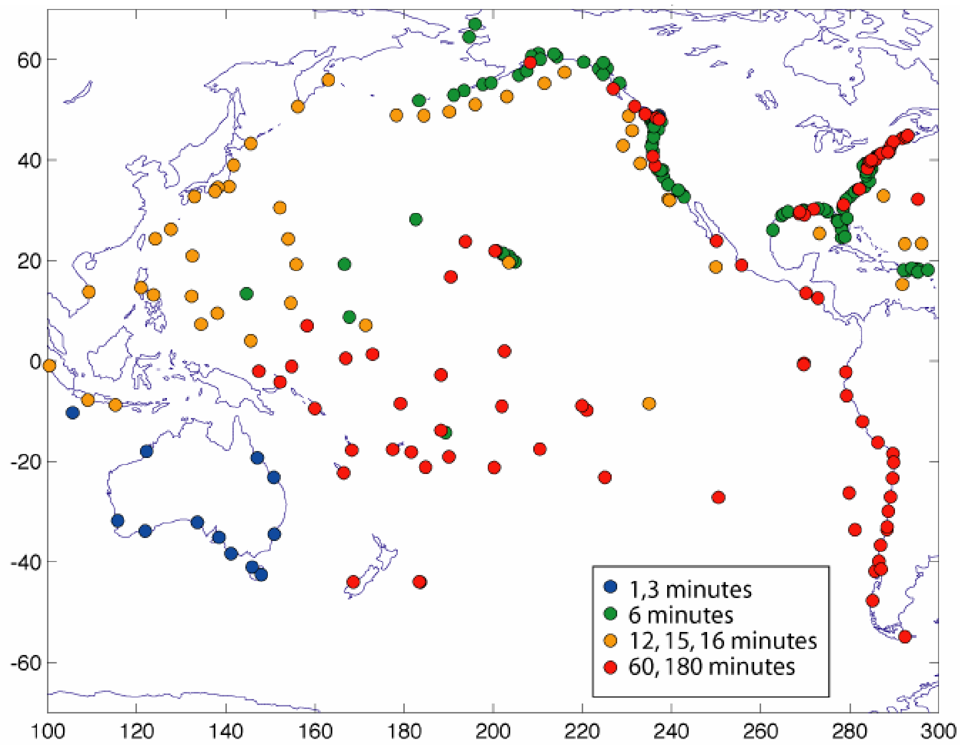
The ICG is working with GLOSS and USA NESDIS (GOES satellite) to allow for more frequent data transmission. The ICG has drawn up a preliminary list of priority stations for upgrading and is validating them.

The PTWS depends on nationally supported contributions of data in real or near-real time through the GTS, as well as stations maintained and operated by the Pacific Tsunami Warning Centre and the University of Hawaii Sea Level Centre; so upgrades will be dependent on support from a number of institutions. AUSAid (Australia) is working with many of the South Pacific Island countries to assess tsunami-prediction capability, with a view to facilitating the identification of sea-level stations for upgrading.

The ICG/PTWS considered it important to identify (and establish) new priority stations in areas where coverage is not yet adequate, and to work with GLOSS this sense.

The ICG/PTWS implementation plan for coastal sea-level stations consists basically of: (i) preparing a list of candidate stations; (ii) validating this list with a view to providing guidance on the development of the ICG/PTWS Medium-Term Strategy; (iii) calling on ICG/PTWS Member States to make the commitments necessary to ensure the sustainability of the PTWS.

Figure 6. PTWS water level stations available on the GTS.



6.3 CARIBBEAN

Bernardo Aliaga, Technical Secretary for the Tsunami and Other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions (CARIBE-EWS) introduced this agenda item.

Since 1498 there have been at least 94 tsunamis with run-ups reported in the Caribbean region causing 4,652 deaths. Most of these tsunamis were associated with submarine earthquakes, although the Caribbean Sea region has all of the potential tsunami-generating sources: submarine earthquakes, sub-aerial or submarine landslides, and underwater explosions. In addition to the 40 million people living in the region, 22 million people visit the Caribbean, making the region extremely vulnerable to tsunamis.

The Caribbean system, unlike those for other regions, has a multi-hazard approach and focuses on all coastal hazards. The ICG CARIBE-EWS met for the first time in Barbados in 2006 and its second meeting was held in March 2007 in Cumaná, Venezuela.

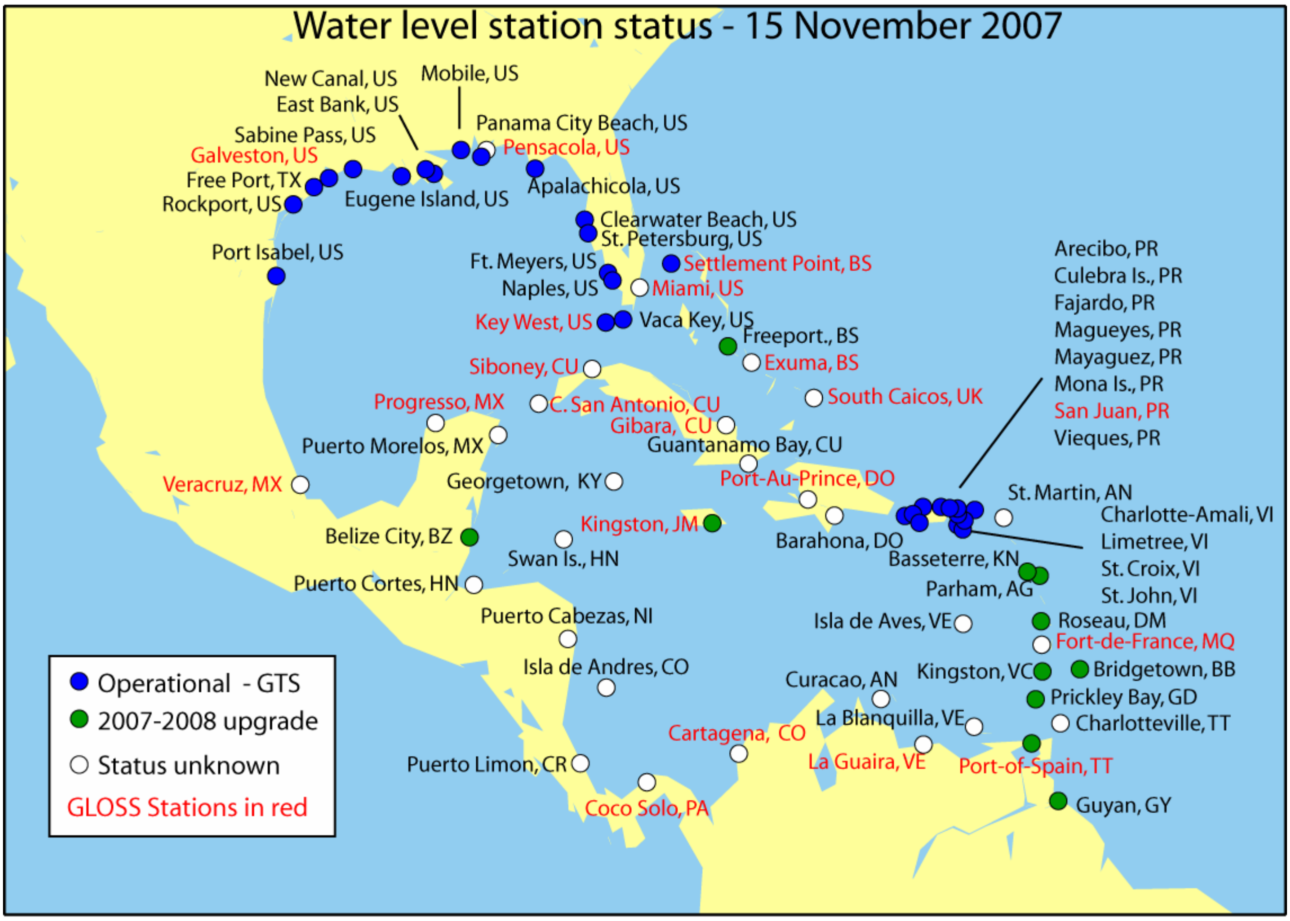
A limited interim warning system started to operate in 2005 relying almost exclusively on seismic data. The interim warning service is provided by the NOAA Richard H. Hagemeyer Pacific Tsunami Warning Centre (PTWC) located in Hawaii and hosted by the National Weather Service, United States of America.

A Communication Plan for the Interim Tsunami Advisory Information Service to the Caribbean Sea and Adjacent Regions was developed by PTWC. According to this plan:

- Currently available seismic data from the region will permit a preliminary earthquake evaluation within 10 to 20 minutes of the rupture. As additional stations become added, this response time will decrease.
- Currently available sea-level data from the region are insufficient to quickly detect whether a tsunami exists or to measure its size from all the potential source regions. However, new deep-ocean gauges have recently been deployed and new coastal gauges are planned to improve this coverage

The parties also agreed to form a consortium (network) of regional institutions interested in sea-level measurement, to be organized within the framework of IOCARIBE-GOOS, and decided that the network will be multi-use (tsunami, coastal-zone management and inundation, climate change, navigation, etc.), with parties collaborating to provide common data management and distribution resources, share operation and maintenance costs and best practices, and broaden the funding base to ensure sustainability.

Figure 7. Present status of real-time water level stations in the Caribbean. (This map has been put together based on best knowledge available concerning station upgrade plans.



6.4 NE ATLANTIC

Begoña Peréz Chairwoman of Working Group 3 on Sea Level Observation and Exchange, under the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS) introduced this agenda item.

The ICG/NEAMTWS, at its 3rd Session (Bonn, Germany, 7–9 February 2007), had approved an implementation plan for NEAMTWS. Begoña Pérez reviewed the elements of the plan pertaining to sea-level observation and data exchange.

The plan provides a list of potential sea-level stations for the initial system, based on existing stations or stations with existing upgrade plans. Begoña Pérez detailed the user requirements, namely, data sampling of 15s or 30s with transmission every 60s to stations within an hour or 100 km from the source. Concerning a survey on data transmission, she reported that only a few countries replied and suggested that an official request from ESEAS or IOC might be needed. Regarding the upgrading of sea-level stations, she reported that there were no tsunami-fit stations in operation yet. Ten sea-level stations in critical locations could be selected for the initial system. As for the buoy network, she noted that most of the buoys were in the vicinity of the coast and therefore not useful for tsunami detection; to this purpose, possible collaboration with EuroGOOS, BOOS or NOOS should be initiated.

The Recommendations from the 3rd Session of the ICG/NEAMTWS–Working Group 3 concerned:

Sea-level gauges. There is a need for: (i) a new standard to enable sea-level stations to operate in real time, with higher transmission frequency; (ii) upgrading of all key sea-level gauges to meet measurement and telecommunication requirements, standards and associated instrumentation; (iii) selected gauges (at least 10 sites) to become fully operational at the end of 2007; and (iv) the design and implementation of a comprehensive network of sea-level gauges, taking into account at-risk areas, to complement the existing system.

Offshore instrumentation for monitoring sea level. There is a need for: (i) an evaluation of existing national buoy networks and fixed offshore platforms with respect to their potential to contribute to a tsunami warning system and to their eventual upgrading; (ii) deep-ocean buoys with ocean-bottom pressure sensors and seismometers, specifically designed for tsunami monitoring; (iii) cable-based systems and sea-floor monitoring networks; (iv) instrumentation to record landslides, slumping or other events that are not detectable by seismic measurements.

Telecommunication – data transfer. There is a need for: (i) secure, redundant and earthquake-proof means to transfer data from the instrument to the operator; (ii) taking into account existing and evolving systems (e.g. WMO's proposed upgrading of the GTS according to the requirements of TWS; backup via Internet, Inmarsat/BGAN, VPN, etc.); (iii) identifying best practices in other regional systems, as the IOTWS or PTWS, taking into account the particular, more demanding requirements the NEAMTWS area may have; (iv) communicating such requirements for telecommunication standards to organizations such as ITU.

Analysis and processing centres. There is a need for: (i) the ICG/NEAMTWS to address the establishment of centres that process, validate, analyse and interpret the incoming data (Italy, through INGV, volunteered to take the lead); (ii) collaboration with existing bodies active in the coordination of deep-sea observation networks mostly for operational oceanography.

For the whole system. There is a need for: (i) immediate, free and open distribution of data in real time, in accordance with IOC data policy; (ii) enhancing the sustainability of the network, including cost effectiveness, through multi-purpose usage/approach; (iii) developing new algorithms for tsunami detection and high-frequency automatic quality control; (iv) adopting standards on data format and transmission protocols from existing systems.

Six specific tasks were identified to meet the needs expressed by the ICG/NEAMTWS Working Group 3:

Task 1: Draw up a first list of possible sea-level stations for TWS, based on: existing sea-level stations from national networks, priority given to stations with the capability of real-time data transmission; and on existing upgrading plans.

Task 2: Technical description of user requirements for NEAMTWS tide gauges, covering: (i) data sampling and transmission based on 1-minute (maximum, better 15 or 30 seconds) averages and a continuous transmission cycle of 1 minute, for stations within 1 hour tsunami travel time and/or 100 km of the tsunami source zones; (ii) communication based on WMO's GTS, with a redundant system for data transmission, like BGAN or an IP-based system; (iii) equipment based on IOC/GLOSS or equivalent proven equipment (accuracy >1 cm for multipurpose stations), with possibility of data sampling below 1 minute, in situ data-storage capacity, redundant sensors, and redundant/buffered power supply.

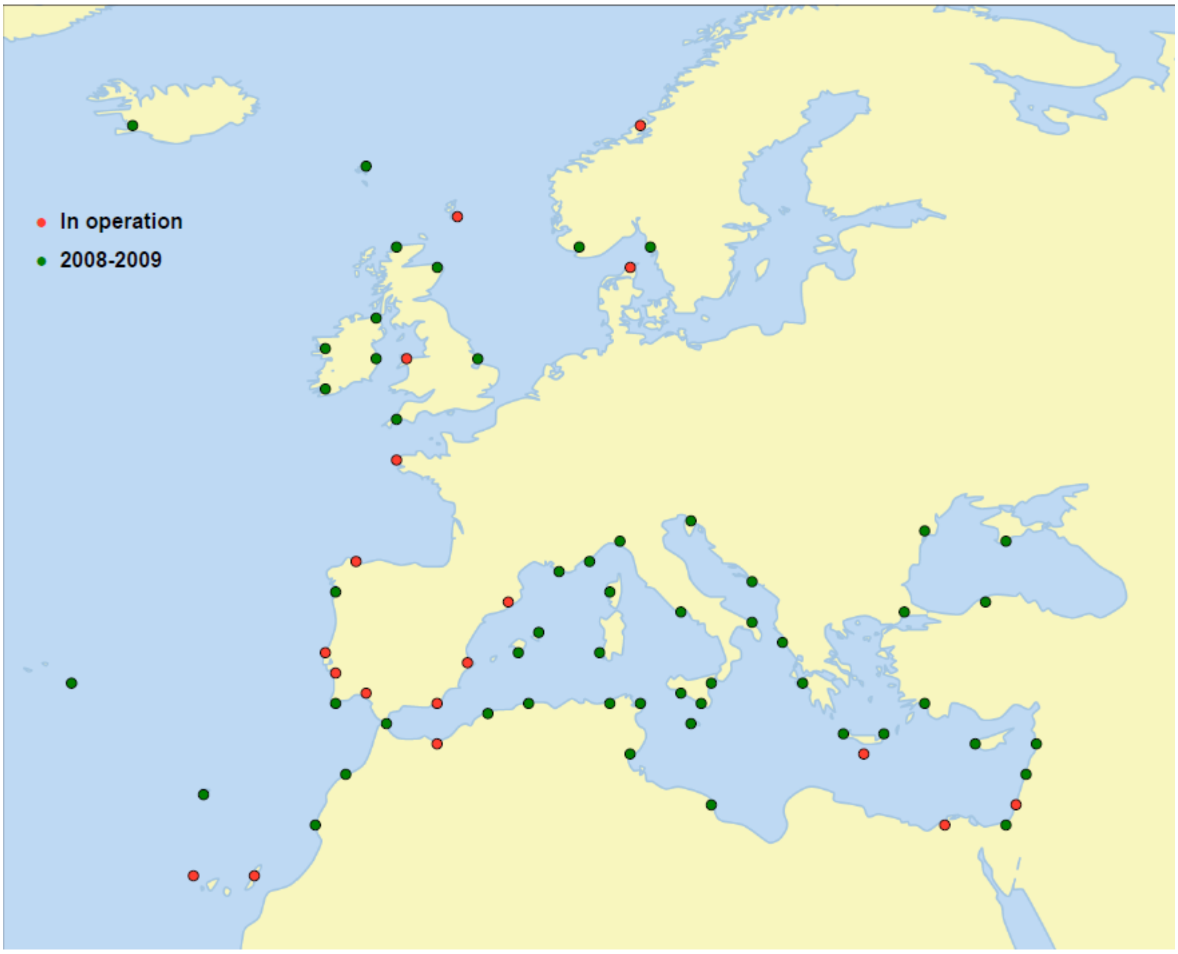
Task 3: Completion of survey on data transmission of existing sea-level stations in NEAMTWS region, with priority given to determination of the status of the stations selected under Task 1 (see Task 4).

Task 4: Report on status of initial sea-level stations and need for upgrading (the list of stations has been updated, but there are no tsunami-ready stations in the NEAMTWS region, at present).

Task 5: Final requirements on the priority of the sites (the main problem is that easy-to-upgrade stations may not be of interest for the initial system and priority sites must be decided).

Task 6: Existing offshore instrumentation report (there is a need for a detailed inventory of existing met-ocean buoys and OBS systems in order to explore the effective use of existing infrastructure; ESONET station positions should be considered).

Figure 8. Planned NEAMTWS real-time water level network.



6.4.1 SLEAC

Vibeke Huess, principal scientist at the Danish Meteorological Institute, introduced this agenda item.

The Sea Levels along the European Atlantic Coastline (SLEAC) project was started in 2006 as a way of encouraging the availability of real-time sea-level data from the European coastline. Organizations with an interest in storm surges and potential flooding have an interest in real-time data from neighbouring countries as an aid to understanding the propagation of surge events. However, such data have not been available so far from all parts of the coastline.

The SLEAC project has two immediate objectives:

1. To encourage national sea-level authorities to upgrade their tide gauge equipment so that sea-level data become available in real-time, and to make that data available to SLEAC via FTP, GTS or other exchange mechanisms.

2. To display the real-time data on a European coastline web-map, thereby indicating which tide gauge sites are currently delivering data within an acceptable delay, and providing storm-surge scientists and flood-warning centres with a first look at developing levels.

The coastline map is maintained by the Danish Meteorological Institute (DMI). The present project objectives do not include onward transfer of the real-time data received by the DMI from national sea-level authorities to third parties. Consequently, the data remain the property (and responsibility) of the national data suppliers. It is expected that, should organizations need access to real-time data from neighbouring countries other than inspection of the coastline maps (e.g. for assimilation of data into numerical models), they will enter into bilateral arrangements for access to data.

The SLEAC project is intended to complement the displays of real-time sea-level data from several regional EuroGOOS activities including NOOS, BOOS, IBIROOS as well as the displays presently provided by European coastal national authorities in Iceland, Norway, Denmark, Germany, the Netherlands, Belgium, United Kingdom, and Ireland. It is hoped that stations in the Faeroe Islands, France, Morocco and Portugal eventually can be included on the SLEAC web-site.

6.4.2 ESEAS

Bente Lilja Bye, Director of ESEAS, introduced this agenda item. ESEAS (European Sea-Level Service) is an international organization supported by European sea-level data providers and research institutions. It is a regional implementation of GLOSS, providing standardized access to sea-level data and related information for dealing with climate change, natural hazards and coastal-zone management. It also offers GLOSS training and expertise and co-operates closely with MedGLOSS (see item 6.4.3).

It is developing tsunami risk assessment and a mitigation strategy for Europe; it is seeking to ensure a real-time sea-level observing system, based on existing facilities, and to provide links to other components in an overall warning and impact-mitigation system.

ESEAS receives technical contributions from GLOSS, IODE, PSMSL, EuroGOOS, MedGLOSS, NOAA and others, and is participating in the Group on Earth Observation (GEO), Global Monitoring for Environment and Security (GMES), MedCLIVAR and EuroGOOS. It co-operates closely with I-GOOS in the promotion of GLOSS.

It conducts regional surveys of relevant sea-level observing systems and is developing standards for real-time sea-level data and data quality control; it is also proposing new standardized stations for GLOSS (for the North African Mediterranean coastline) and for the IPY (as part of the Global Geodetic Observing System).

6.4.3 MedGLOSS

Dov Rosen, Programme Coordinator for MedGLOSS, introduced this agenda item. MedGLOSS (Mediterranean Global Sea Level Observing System) is a regional component of GLOSS established by CIESM and IOC in 1997; it has a focal centre at IOLR, Haifa. The primary objectives of MedGLOSS are to detect relative and absolute regional, long-term trends in sea level, and to assess relevant plate tectonics via a long-term sea-level network in the Mediterranean and the Black Sea. In doing so, MedGLOSS is moving from a straightforward sea-level watch to a multi-hazard early warning system for tsunamis and extreme marine meteorological events. At present it provides near-real-time sea-level data for operational oceanography. MedGLOSS stations currently conform to GLOSS technical standards, but MedGLOSS is seeking to upgrade its stations, and the relevant software and instrumentation, to provide real-time data delivery and to this end is developing the necessary new standards.

MedGLOSS is co-operating with ESEAS in sea-level research and related operational activities. North African Mediterranean countries have been invited to participate in the MedGLOSS; and a MedGLOSS project – MEDALERT – has been adopted by GCOS for inclusion in its Action Plan for the Mediterranean.

6.5 AFRICA

Angora Aman, Regional Coordinator for Coastal Observing Systems GOOS-Africa and ODINAfrica, introduced this item.

The Ocean Data and Information Network for Africa (ODINAfrica), in collaboration with the Global Sea Level Observing System (GLOSS), the Benguela Large Marine Ecosystem programme and other partners have made good progress in developing a network of sea-level stations, providing data in near-real time, and addressing the key oceanographic phenomena along the African coastline.

A survey of the status of the network undertaken in 2005 revealed the existence of at least 40 operational stations spread very unevenly along the African coastline and island states. Long stretches of the coastline did not have operational tide gauges. A paper on the status of the African sea-level network has been submitted to the African Journal of Marine Research (available as a background document for this meeting).

In 2005–2007 ODINAfrica sponsored a series of technical visits to inspect the sites proposed for the installations in: Mauritania, Cameroon, Congo, Madagascar, Comoros, Senegal, and Morocco. The reports of these visits are available from the GLOSS web-page (www.gloss-sealevel.org).

ODINAfrica has, since 2005, installed new tide gauges in Congo, Djibouti, Ghana, and Mauritania. Additional stations have been installed or upgraded by the University of Hawaii Sea Level Centre (UHSLC) in Kenya, Mauritius, Senegal, Seychelles, and Tanzania, and by the Global Sea Level Observing System (GLOSS) in Mozambique and South Africa. Other countries where new gauges will be installed by ODINAfrica in 2007–2008 include Cameroon, Egypt, and Morocco.

ODINAfrica has also collaborated with the Flanders Marine Institute (VLIZ) to develop a web-based sea-level station monitoring service for Africa (for more information this topic please also see agenda item 10).

Figure 9. Status and plans for the African real time sea level network.

6.6 POLAR NETWORKS

Philip Woodworth briefly reported on this item. An expression of interest titled “Sea level and tidal science in the polar oceans” had been submitted to the International Polar Year and that it had received endorsement (IPY Activity 13; see also http://classic.ipy.org/development/eoi/proposal-details.php?id=13). Funding for proposed IPY activities will have to come from national sources. Prof. C.K. Shum (Ohio State University) and Dr Per Knudsen (Danish Space Institute) had since filed national proposals under this activity but the status of these proposals was unknown.

For the current status of sea-level networks in the polar region, see the relevant national reports under agenda item 7.

7. UPDATES ON NATIONAL SEA LEVEL ACTIVITIES

Several speakers presented updates on their respective national sea-level observing systems. These updates are only very succinctly reported here, the original reports and presentations can be found through the following link: http://www.ioc-goos.org/GLOSS-GE-X-Documents.

7.1 BRAZIL

Marcelo Cavalcante described the Implementation Plan for the GLOSS Brazil programme which involves several Brazilian institutions using sea-level observations and which are responsible for one or more tide gauges. The Diretoria de Hidrografia e Navegação (DHN) is the coordinator and has organized several training courses in tide gauge operation between 2003 and 2006. Within the framework of this programme, several stations have been upgraded and up to six radar tide gauges are planned for the next year. More information about these activities can be found at: http://www.mares.io.usp.br/aagn/ind.html.

7.2 CANADA

Fred Stephenson from the Canadian Hydrographic Service (CHS) described the Canadian tide and water-level programme and the status of active GLOSS stations in Canada. There are currently 92 tide and water-level stations which are part of the programme and deliver real time data. Amongst these, five stations contribute to GLOSS. CHS provides the predicted times and heights of high and low water for over 700 stations. There is an increasing demand for sea-level data from northern latitudes. Currently there are five Arctic tide gauge stations, co-located with GPS, and there are two more planned but awaiting funding in the framework of the 2007–2008 International Polar Year.

7.3 CHILE

Juan Fierro reported briefly on the current status of and plans for the Chilean sea-level network managed by the Servicio Hidrográfico y Oceanográfico de la Armada de Chile (SHOA). It consists of 19 sea-level stations, 8 of them contributing to GLOSS. They are equipped with differential pressure sensors. The future plans for the network include the implementation of an alternative system for real-time data transmission using a wide-area network, basically as a contribution to the National Tsunami Alarm System operation.

7.4 CHINA

Manchun Chen, of the National Marine Data and Information System, described the sea-level network in China, comprising a large number of tide gauge stations, including six registered in the GLOSS Core Network. The State Oceanic Administration has the mandate for sea-level monitoring and has recently released the “China Sea level Bulletin”. He indicated that there is an increasing concern with respect to the effects of sea-level rise and storm-surge hazards.

7.5 CÔTE D’IVOIRE

Angora Aman reviewed the current status of sea-level monitoring in Côte d’Ivoire. Four of the five national tide gauges are in the port of Abidjan; the fifth is in San Pedro. All five are float tide gauges and most of the data are in hardcopy format only. Only one of the Abidjan tide gauges is used for prediction, and this is produced by the French Hydrographic Service (Service Hydrographique de la Marine, SHOM). Angora Aman showed the relation between San Pedro sea-level data and the Gulf of Guinea upwelling signal.

7.6 ITALY

Stefano Corsini described the history of sea-level measurement in Italy. There are several institutions involved in sea-level monitoring: (i) APAT, Agency for Environmental Protection and Technical Services, Rome; (ii) Istituto Idrografico della Marina (IIM), Genoa; (iii) Comune di Venezia, Centro Segnalazioni e Previsioni Maree (CSPM), Venice; (iv) Istituto Sperimentale Talassografico (IST), Trieste; (v) Regione Calabria; (vi) Regione Abruzzo. APAT is the official national service in charge of the national tide gauge network. This network comprises 26 stations, mainly located in harbours and typically equipped with two tide gauges (acoustic and mechanical float). APAT has committed five of its tide gauge stations to the NEAMTWS monitoring system.

7.7 IRELAND

Jimmy Murphy reviewed the current status of the Irish Sea level Network. Considerable progress has been achieved in recent years; a significant effort has been made to standardize the technology. Thus, many of the existing gauges have been replaced or upgraded with OTT bubbler gauges and new sites are being established. Currently the Irish Sea Level Network consists of ten sites, two of which are part of GLOSS Core Network (Malin Head, in the North, and Castletownbere, in the South). There are plans to install a second tide gauge and a CGPS at Malin Head. All tide gauges belonging to the National Sea Level Network meet certain standards (calibration, levelling etc.) and are surveyed relative to the Ordinance Datum at Malin Head. There are other gauges operated in Ireland, but they are not included in the Networks, since they do not meet the standards. In spite of the progress in the development of the Irish Network, there are still some pending issues like the data quality control and methods for data dissemination. For the time being, information is displayed on the web page http://www.irishtides.ie.

7.8 DENMARK

Vibeke Huess presented the Danish tide gauge network, presently consisting of 84 tide gauges. The tide gauges are run by harbour authorities, the Royal Danish Administration of Navigation and Hydrography (RDANH) and the Danish Meteorological Institute (DMI). All data from these stations are sent continuously and made available on-line on the DMI web page http://www.dmi.dk/dmi/index/danmark/vandstand.htm.

Most of the tide gauges are acoustic or pressure tide gauges. There are 17 stations that contribute to PSMSL. Reference was also made to the polar network. Finally, the GLOSS station in Torshavn (Faroe Islands) is no longer operational – it has not yet been decided whether the station will be repaired.

7.9 FRANCE

Guy Wöppelmann reviewed the situation in France. There are 15 tide gauge stations worldwide committed to GLOSS. RONIM and ROSAME are the two institutional tide gauge networks, the first one managed by SHOM and the second one by LEGOS (Laboratoire d'Études en Géophysique et Océanographie). RONIM has been significantly expanded to include sites at the overseas French territories, namely in Nouméa (New Caledonia), Fort-de-France (Martinique), and the Iles du Salut (Cayenne, French Guyana); two new stations are planned in the Indian Ocean (Mayotte and La Réunion). Further information was provided on the upgrading of the RONIM network with radar sensors as well as the provision of real-time data (via Argos for ROSAME, and under development for RONIM). French tide gauge data (raw and hourly) are available at the French sea-level data centre SONEL (www.sonel.org).

7.10 GERMANY

Christoph Blasi presented the German tide gauge network, noting that this was the first time a national report had been submitted to a GLOSS GE meeting. He explained that responsibility for water-level measurements is divided among different national authorities and federal states. The WSV (Federal Waterways and Shipping Administration) operates a network of 160 gauging stations, both in coastal and inland waters. Besides, there are other tide gauges run by federal states and harbour authorities. WSV tide gauges use a float system installed in a stilling well. Tide gauge data are available at 1-minute intervals via the Internet at http://www.pegelonline.wsv.de.

7.11 GHANA

Joseph Odametey reported on the past and present of sea-level observations in Ghana. The longest time-series is from the Takoradi harbour station, which is currently part of GLOSS. In 2004 it was equipped with a new pressure tide gauge and two staff members were trained at the National Institute of Oceanography (NIO, India) in the framework of the ODINAfrica project. In 2006 the station was upgraded with a new radar sensor provided under the ODINAfrica project.

7.12 INDIA

Shri Rakesh briefly reviewed the history of sea-level measurements in India and described the modernization and expansion of the Indian sea-level network following the 2004 Tsunami. Thirty-six new digital tide gauges co-located with GPS have been installed at strategic locations. GPS data and sea-level data are transmitted via a dedicated satellite VSAT and analysed in real time at the National Tide Centre. In the event of a tsunami, the information is passed on to INCOIS (Indian National Centre for Ocean Information Services) which is responsible for issuing an alert.

7.13 INDONESIA

Parluhutan Manurung recalled the disastrous effects of the 2004 tsunami and reported developments in the Indonesia Real Time Sea Level Monitoring Network in support of tsunami warning systems (TWS), both in the Indian Ocean and for Indonesian seas. Up to 80 new tide gauges will be installed by the end of 2008 thanks to funding by Germany, USA, Indonesia, IOC and OTT. Different types of communication channels (VSAT, GTS, BGAN, GSM) will be used to ensure redundancy. As of March 2007, 11 of these tide gauges have already been put in place. The challenge is to set up a system capable of providing a very fast and reliable response in case of a local tsunami. Parluhutan Manurung also referred to the sustainability of the system: efforts must be made to increase the number of users in order to gain some revenue to cover the maintenance costs.

7.14 IRAN

Mohammad Hossein Moshiri made a brief introduction to the history of the Iranian Tide Gauge Network, which is currently under the responsibility of NCC (National Cartographic Centre). The tide gauge network consists of ten stations equipped with mechanical float gauges manufactured by OTT and installed in aluminium huts. NCC maintains an extensive levelling network along the Iranian coasts and the tide gauges are connected to this. GPS receivers have also been installed at some of the tide gauge sites. Data-gathering is centralized at the main hydrographic office in Tehran. Information regarding the Iranian tide gauge network and the available data are available at http://www.iranhydrography.org.

7.15 ISRAEL

Dov Rosen reviewed the history of tide gauge measurements since the establishment of the State of Israel. At present, there are basically two agencies involved in sea-level monitoring: the Survey of Israel (SOI) and the Israel Oceanographic and Limnological Research (IOLR). These agencies run seven tide gauge stations in the Mediterranean and two in the Red Sea. The Haifa port station, run by SOI, will shortly be equipped with a new MIROS radar sensor.

IOLR maintains the Hadera station, which is part of the GLOSS Core Network. IOLR is also involved in the establishment of the ICG/NEAMTWS pilot network of sea-level stations, with Hadera station participating in the system. IOLR is also developing software for real-time sea-level data processing and transmission over the GTS and BGAN.

7.16 SWEDEN

Thomas Hammarklint reported on the Swedish tide gauge network, which is operated by the Swedish Meteorological and Hydrological Institute (SMHI) and consists of 23 sea-level stations. There are an additional 30 sea-level stations run by the Swedish Maritime Administration. The SMHI network has undergone two important upgradings: the first in the 1980s, when digital gauges with automated data transmission were introduced; and the second, in 2005, when the stations were equipped with a new data logger to enable near-real-time data transmission. All stations are based on float gauge technology. Levelling is done every year. Real-time data can be obtained via http://www.smhi.se/weather/havsvst/sealevel.htm.

7.17 JAPAN

Keizo Sakurai reported on the Japanese sea-level programme. The Japanese tide stations are operated by several organizations, including the Japan Meteorological Agency (JMA), the Japan Coast Guard and the Geographical Survey Institute. The real-time data from about 200 tide stations operated by all these organizations are collected by the JMA. The JMA sea-level network consists of 37 stations, used primarily for storm surge and tsunami monitoring; 14 stations out of the 37 are part of the GLOSS Core Network and they were recently upgraded with acoustic tide gauges as well as co-located GPS receivers. Six JMA stations report data in real time via the GTS in support of the PTWS.

7.18 MEXICO

Jorge Zavala-Hidalgo gave an overview of the situation in Mexico. There are four institutions involved in sea-level monitoring: UNAM (Universidad Nacional Autónoma de México), CICESE (Centro de Investigación Científica y de Educación Superior de Ensenada), SEMAR (Secretaría de Marina, Armada de México) and CICATA (Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada). The first three are organized under REDDMAR (La Red Mexicana de Nivel del Mar). In Mexico, sea level has been monitored since 1952 and there is a large amount of chart data that need to be digitized. Long sea-level time-series, such as that recorded at Acapulco, clearly reflect the influence of El Niño and La Niña events as well as earthquakes and tsunamis. Local tsunamis imply a serious threat for the population, which tends to concentrate along the coasts.

UNAM is developing a proposal to upgrade its sea-level station network. Sea-level data can be found at the following websites of UNAM and CICESE (http://www.mareografico.unam.mx and http://nivelmar.cicese.mx/).

7.19 MOZAMBIQUE

Sinibaldo Canhanga presented the evolution of the tide gauge network in Mozambique, currently under the responsibility of the Instituto Nacional de Hidrografia e Navegação (INAHINA). The network consists of 14 tide gauge sites, but only 4 of them are operational. Float, pressure and radar gauges are used. Pemba and Inhambane are GLOSS stations and have two sensors (pressure and radar), and are also equipped with co-located GPS stations. Data from these two stations are retrieved every 15 min. Data from these two stations can be downloaded from the ODINAfrica sea-level display facility: http://www.vliz.be/vmdcdata/iode/blist.php?show=graph&code=pemba&period=1.5.

Sinibaldo Canhanga stressed the need to further develop national capacity in the fields of sea-level monitoring and sea-level data analysis.

7.20 NORWAY

Hanne Hodnesdal described the current status of the Norwegian tide gauge network, which consists of 23 stations and is operated by the Norwegian Hydrographic Service (NHS) under the Norwegian Mapping Authority. Five of the stations are GLOSS stations; six stations have a co-located GPS. The sampling and filtering procedures for the sea-level data were changed at the beginning of 2007. At present, the sampling frequency is 1Hz and 1-min averages are recorded and transferred to NHS every hour. NHS is working on an automatic quality control to process the 1-min data. The data are regularly sent to PSMSL, GLOSS (BODC and UHSLC), as well as ESEAS. In addition to this, data are available at the Norwegian Tidal and Sea Level Data web page: http://vannstand.statkart.no/Engelsk.

7.21 PORTUGAL

Joana Reis presented an update of the Portuguese sea-level monitoring activities. IHPT (Instituto Hidrográfico, Portugal) is responsible for a network of 19 stations and the processing of tide gauge data, as well as publication of national tide tables. The Portuguese Geographic Institute runs another 2 stations. Four stations are committed to the GLOSS Core Network, including Cascais, two sites in the Azores (Santa Cruz das Flores and Ponta Delgada) and one in Madeira (Funchal). The Cascais station was renovated and equipped with an acoustic sensor and a co-located GPS. Both stations in the Azores are going to be relocated and upgraded with acoustic gauges. Plans for the future include finishing the automatization of the network, relocation of the Lisbon tide station and the upgrading of Sines and/or Lagos stations to be part of the NEAMTWS.

7.22 SENEGAL

Bassirou Diaw provided a description of the meteorological conditions and oceanographic characteristics of Senegal before presenting the national sea-level observation system. Sea level was measured at the Dakar station by IRD (France) from 1982 to 1989 using a pressure tide gauge. The time-series is fragmented, however. From 1999 to 2003, the University of Hawaii Sea Level Centre maintained an acoustic tide gauge at the same site. The station will be upgraded with a radar water-level sensor later this year.

7.23 SPAIN

María Jesús García summarized the current status of the tide gauge networks in Spain. There are three institutions involved in sea-level monitoring with different purposes: levelling (Instituto Geográfico Nacional, IGN, 9 tide gauge stations), research (Instituto Español de Oceanografía, IEO, 12 stations) and operational (Puertos del Estado, PE, 27 stations). All tide gauges operated by IGN are co-located with GPS. The last two institutions make their data available through the following links, respectively: http://indamar.ieo.es/mareas/formulario_datos.htm, and http://www.puertos.es. These institutions are involved in the recently created National Committee for the Hazard Warning System. Since February 2005, the measurements have been improved and enable the real-time transmission of data; in particular, some of the tide gauge stations have been upgraded with radar sensors.

7.24 TUNISIA

Nahdi Saidani reviewed the activities carried out by the Tunisian Naval Hydrographic and Oceanographic Centre (TNHOC). Since 1999, TNHOC operates a tide gauge network along the Tunisian coast, mainly in the ports of Bizerte, La Goulette, Kélibia, Sousse, Sfax and Zarzis. There are five float tide gauge stations and one pressure gauge station. Hourly data are stored in a tidal data base also managed by TNHOC. Nahdi Saidani presented the results of a study undertaken in Sfax, using sea-level data collected in the period 1946–1947 by the French Hydrographic Service and comparing them with the most recent data (1999–2006). This study showed a mean sea-level rise of 17 cm in 60 years in Sfax.

7.25 TURKEY

Mehmet Simav presented the history of sea-level measurement in Turkey which dates back to 1930. The General Command for Mapping (GCM) has been responsible for the operation of tide gauges in Turkey since 1983. The tide gauge network has experienced several modifications, the most recent involving the upgrading from float to acoustic tide gauges. The Turkish National Sea-Level Monitoring System (TUDES) was established in 1999 and consists of 11 tide gauge stations. Vertical movements are controlled at all tide gauge sites by means of GPS and regular levelling. Mehmet Simav also described GCM's contribution to ESEAS and PSMSL data banks as well as its participation in ESEAS-RI. Future plans for the network include the installation of 9 new tide gauges providing real-time sea-level and ancillary meteorological data for operational oceanography and meteorology.

7.26 UNITED KINGDOM

Elizabeth Bradshaw briefly reviewed the present status of the national sea-level network. There are 44 sites around UK, most of them bubbler gauges, including 3 sites which are committed to GLOSS. The network is operated by Proudman Oceanographic Laboratory (POL) and the British Oceanographic Data Centre (BODC). As part of the UK (Environment Agency), EU (TRANSFER) and IOC (Mediterranean and NE Atlantic) tsunami warning systems, a tsunami station test site has been set up at Holyhead with a pressure gauge producing 10-Hz data averaged into 1-s packets sent via General Packet Radio Service (GPRS). The tide gauge site in Gibraltar will be equipped with a new pressure sensor along with the existing radar water-level sensor. Data are available at the UK National Tidal and Sea Level Facility (NTSLF, http://www.pol.ac.uk/ntslf/). The sea-level group at POL has provided technical assistance (including testing) in the preparation of several tide gauge installations in Africa and the NW Indian Ocean. The sea-level group also helped to organize sea-level training in Ostend (Belgium) and Liverpool (UK) during the last two years.

7.27 UNITED STATES

Mike Szabados reviewed the various ongoing National Oceanic and Atmospheric Administration (NOAA) programmes and activities related to sea level and contributing to GLOSS. A total of 117 US stations are analysed for sea-level trends and 44 non-NOAA stations are also studied and added to the website. As a part of the US Climate Change Science Programme, sea-level impact studies are being undertaken. The NOAA tide gauge network continues to expand, and GIS tools and error analysis of tidal datum accuracy are used to determine what the most suitable new sites are. The establishment of the US IOOS (Integrated Ocean Observing System) Programme in 2007 was also mentioned, sea level being one of the five core variables of the system. Important efforts have been made to enhance hurricane-proof tide gauge stations in the Gulf of Mexico. With respect to tide gauge technology, several radar sensors are being evaluated, with 16 tests being performed with MIROS equipment. Finally, in the context of the US tsunami warning programme, 140 water-level station will upgraded by the end of 2007 and operating with full tsunami capabilities. There are also plans to expand the seismic network and the DART buoy network, and there is some ongoing work to de-tide the buoy signal.

7.28 AUSTRALIA

Bill Mitchell presented the Australian National Report and the projects relative to GLOSS, such as the SEAFRAME (SEA-level Fine-Resolution Acoustic Measuring Equipment) in Australia and the southwest Pacific. In addition to this, a number of state government agencies run tide gauges and can provide real-time data if requested (for example, in case of a storm surge event). There are 95 tide gauge stations in operation in Australia. These gauges are now being accessed at least once per day and quality-controlled by operators using Australian standards. Some of the tide gauges are intended for climate-change studies, having first-order levelling, and weather sensors transmitting every minute and over the GTS. Since the 1990s, Australia also maintains an Antarctic tide gauge network with 5 stations. There are plans to install up to 20 new tsunami-enabled sea-level sites. These sites will have at least two tide gauges and will transmit data using a redundant system (INMARSAT and other).

8. UPDATES ON LINKAGES BETWEEN GLOSS AND OTHER PROGRAMMES

The corresponding written reports and presentations can be downloaded in the following link: http://www.ioc-goos.org/GLOSS-GE-X-Agenda.

8.1 CGPS STATIONS AND TIDE GAUGES

Guy Wöppelmann reported on the recent update of the inventory of permanent GPS receivers that are close to tide gauges (CGPS@TG). The main difficulty in having an answer lies in the lack of communication between the different institutions involved in each country. He noted, however, that some of the members of the GLOSS GE who should have received the letter were not aware of it. A hard copy was therefore distributed to all the participants at the present session.

The present summary shows that the number of CGPS@TG has risen from 264 to 285 stations, of which, 127 are GLOSS stations. Another 15 stations will be added in the near future. Data from 101 out of the 127 CGPS@GLOSS stations are freely accessible through the Internet. Fifty-two stations (47 in 2005) are committed to TIGA which implies that the access to their GPS data for scientific purposes is ensured by this international commitment to TIGA and therefore IGS. The complete inventory survey is available at http://www.sonel.org/stations/cgps/surv_update.html.

Tilo Schöne briefly reviewed the goals of TIGA by recalling the objectives, namely: (i) to bring the IGS expertise in GPS processing to sites at/near tide gauges; (ii) to provide consolidated and reliable time-series of vertical changes for a large number of TG sites in a delayed mode. The most important problem of the IGS solution is that they are not consistent in time; therefore the periodical reprocessing of the time-series is mandatory to obtain reliable solutions. The advantage of participating in TIGA is that it enables the analysis of the GPS data by external groups using a better, global strategy and ensuring a more homogeneous and reliable solution. However, there is still much information missing regarding the TOS (TIGA Observation Station) forms and the IGS logs.

8.2 JASON SCIENCE WORKING TEAM

Gary Mitchum, Chairman of the GLOSS Scientific Sub-Committee, introduced this item. In the past year the US NOAA and NASA agencies have funded him to create a satellite altimeter calibration facility. The products to be created are based on improvements and extensions of the calibration methods using the global tide gauge network that has developed over the past 15 years. These new products include calibrations of all past, current and future altimeters, and contributions from a wide variety of international groups are envisioned. Gary Mitchum stressed that these altimeter calibration products are based on, and completely rely on, the existence of the GLOSS Fast Delivery Dataset.

The Group of Experts was also apprised of potential problems with the continuation of the TOPEX/Poseidon/Jason series of precise-altimetry missions, due to the funding uncertainty for a Jason-3 mission. After some discussion, the GLOSS Group of Experts decided to initiate the dispatch of a letter, possibly from the IOC Executive Secretary, to the appropriate people at the various space agencies encouraging support for a Jason-3 mission. Mitchum, Merrifield and Woodworth were tasked with developing a draft of such a letter and also identifying the best list of recipients.

8.3 IHO

Steve Shipman, Technical Secretary for the Tidal Committee of the International Hydrographic Organization, reported on the IHO conferences and the Tidal Committee meetings held during the intersessional period. The Tidal Committee will cease to be a committee and become a Group Team within IHO. Steve Shipman reviewed the current list of state members and regretted the scarce presence of African members as well as many small states in the Pacific. He mentioned the recent publication of Dr. Bernard Simon's Manual on Coastal Tides (in French) and asked the GLOSS Group of Experts for help with the revision of its translation into English, which has been paid by IHO. Finally, he highlighted the importance of the formal endorsement of the IHTOC and GLOSS by the XVII IHC Assembly.

8.4 ACRE

Philip Woodworth introduced this item on behalf of Dr Rob Allan, Project Manager for the Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative. This initiative is an end-to-end project which aims to meet both the historical global weather observational data needs for "surface-observations-only" climate quality reanalyses and for the seamless feeding of 3-D weather products produced by these reanalyses into climate applications and impacts models. ACRE seeks to support the data requirements of pioneering projects, which are undertaking historical climate reanalysis based only on surface observations over the globe. This is done by linking international meteorological organizations and data-rescue infrastructure to facilitate the recovery, extension, quality control and consolidation of global historical terrestrial and marine instrumental surface data covering the last 250 years. Examples of data rescued include logbooks from the British East India Trading Company. ACRE is sponsored by the GCOS/AOPC–OOPC Surface Pressure Working Group (SPWG).

One potential source of daily to sub-daily atmospheric pressure data observations that would be invaluable to the ACRE initiative and historical reanalyses, is the meteorological/weather registers/logs kept by harbour-masters around the globe. ACRE is encouraging the digitization of harbour-masters' records of meteorological/weather observations, with efforts in Australia through the National Tidal Centre in the Bureau of Meteorology being foremost to date. Some very early records for Cape Town in South Africa (1830s) and from UK ports (e.g. Liverpool pressure data in the late 1700s have been published by Dr Phil Woodworth of POL, records from Jersey, Channel Islands, for 1936–1940 and 1946–1953) have been identified and need to be digitized and extended. The ACRE Project Manager asked the members of the Global Sea Level Observing System (GLOSS) Group of Experts if they would be prepared to investigate the existence of any harbour-master's meteorological/weather observations at ports in their own countries, especially long daily to sub-daily series going back into the 19th century. Any information on such holdings, and the possibility of having them digitized and provided to ACRE for historical reanalyses would be much appreciated. Contact coordinates: Dr Rob Allan, ACRE Project Manager, Hadley Centre for Climate Change, Met Office, FitzRoy Road, Exeter EX1 3PB, United Kingdom; tel: +44 (0)1392 886904; fax: +44 (0)1392 885681; E-mail: rob.allan@metoffice.gov.uk.

8.5 GGOS

Philip Woodworth introduced this item on behalf of Hans Peter Plag.

GGOS is the Global Geodetic Observing System of the International Association of Geodesy (IAG). It provides observations of the three fundamental geodetic observables and their variations; that is, the Earth's shape, the Earth's gravity field and the Earth's rotational motion. GGOS integrates different geodetic techniques, different models, different approaches, in order to ensure a long-term, precise monitoring of the geodetic observables in agreement with the Integrated Global Observing Strategy (IGOS). GGOS provides the observational basis to maintain a stable, accurate and global reference frame and in this function is crucial for all Earth observation and many practical applications.

Philip Woodworth also described the draft strategy and implementation plan for GGOS. The Executive Summary can be found at www.ggos.org. The full text of the draft Implementation Plan can be found at: ftp://ftp.pol.ac.uk/pub/general/plw/GGOS.pdf. He invited the Group of Experts to contribute to this document.

8.6 OOPC

Thorkild Aarup, IOC Technical Secretary for GLOSS, introduced this item on behalf of Albert Fischer, Technical Secretary for the Ocean Observations Panel for Climate.

The GCOS–GOOS–WCRP Ocean Observations Panel for Climate (OOPC) recognizes the GLOSS tide-gauge network as a key element of the global ocean-observing system for climate, and that impressive strides towards its full implementation have been made in the recent past. The OOPC highlighted some developments in the overall observing system, as well as specific points for discussion by the GLOSS Group of Experts.

The basic recommendations for the global module of GOOS, which is also the ocean module of the Global Climate Observing System (GCOS), are written into the ocean chapters of two reports to the UN Framework Convention on Climate Change (UNFCCC), published in 2003 (The Second Adequacy Report) and in late-2004 (The GCOS Implementation Plan); both reports are available at http://ioc3.unesco.org/oopc/documents/background.php). These called for full implementation of the GCOS–GLOSS Core Station Network, based on stations selected for their geographical representativity and long history of observations.

The IOC Workshop on Understanding Sea Level Rise and Variability (UNESCO, Paris, 6–9 June 2006) noted that, in order to best reduce the uncertainty in sea-level monitoring and prediction, tide gauges should have co-located geo-referencing to allow for a clear separation of sea-level variations from land movement variations. The OOPC therefore urges GLOSS to consider increasing the number of stations with co-located geo-referencing.

The publication of the Intergovernmental Panel on Climate Change (IPCC) Working Group I Report on the Physical Basis of Climate Change (2 February 2007) brought a lot of public attention to the issue of climate change; it also noted contributions from global ocean observations, including altimetry and tide gauges, as well as some of the areas where observations and research were lacking (see http://www.ioc-goos.org/content/view/81). Societal vulnerability to sea-level rise, which is one consequence of climate change, will be felt through extremes, as well as locally; therefore, improved sea-level prediction on time-scales ranging from synoptic weather systems to decadal change has a large potential social benefit. The OOPC invites GLOSS to consider how to best channel the growing societal and governmental awareness of sea-level rise into advocacy of an improved sea-level measurement network, and to help in the wide dissemination of prediction products for coastal sea-level purposes.

Near-real-time information on the status of the GLOSS Core Network (already available for most of the other networks coordinated via the JCOMM Observations Programme Area) will help in coordination and advocacy, and the OOPC urges GLOSS to reinforce its efforts to make this status compilation easily available.

The OOPC web site on the state of the ocean (http://ioc.unesco.org/oopc/state_of_the_ocean/) is gaining visibility and will be used to display new ocean climate indices as they are developed. It was designed as a tool for basic evaluation of the capabilities of the observing system, by reporting key ocean climate indices and their uncertainty; and as a tool for advocacy of the capabilities of the global module of GOOS. There are currently no sea-level indices available on the site, and the OOPC invites GLOSS to develop global and regional indices of societal relevance which can be updated on a regular (at least monthly) basis, either purely from tide gauge data or from a combination of tide gauge and altimeter data.

The current composite in situ surface and subsurface networks described in the GCOS IP are in fact a collection of independent observing networks that are coordinated through OOPC and JCOMM. Three of these networks (Argos profiling floats, DBCP surface drifters, and SOOP XBT lines) currently fund two technical coordinators at JCOMMOPS, and have found significant advantages in this cooperation. The possibilities for reinforcing and expanding this resource are a major preoccupation of the Observations Programme Area of JCOMM. The OOPC believes a reinforced centre will be a critical element in strengthening the global module of GOOS, and invites GLOSS to consider how its own coordination resources could be best integrated (virtually or physically) with a reinforced JCOMMOPS.

Beyond the specific issues for the GLOSS community outlined above, the OOPC welcomes input and feedback from GLOSS on what the Panel could do to help the GLOSS community in their work.

The Group thanked OOPC for the intervention. Several of the items raised were discussed in connection with other agenda items and have been taken up in the list of actions.

9. UPDATES FROM GLOSS DATA CENTRES

9.1 PSMSL

Leslie Richards, Director of the Permanent Service for Mean Sea Level (PSMSL), introduced this agenda item. She briefly reminded the Group of the respective responsibilities of PSMSL and UHSLC concerning archival and quality control of the various GLOSS data streams. A major goal of the two data centres remains the establishment of one place/entry point for GLOSS sea-level data. Much of the functionality for this is already in place. A new GLOSS web-site (www.gloss-sealevel.org) has been created; it is maintained by the PSMSL and the BODC on behalf of GLOSS. It contains an updated version of the GLOSS Station Handbook, with revised information pages. At present, the user can go to the Handbook and, for each station, there is a link to the data (real-time, fast-mode, delayed-mode, mean sea level, etc.). To retrieve data from more than one site is a tedious process, and retrieval could be made much more precise by including a map and a query form. Fast-mode data continues to be available via the UHSLC.

9.2 UHSLC

This matter was reported under agenda item 3.

10. THE IODE/ODINAFRICA SEA LEVEL DATA FACILITY

Francisco Hernandez, Flanders Marine Institute (VLIZ) introduced this item. VLIZ has collaborated with ODINAfrica and the Pacific Tsunami Warning Centre (PTWC) to develop a web-based sea-level station monitoring service (http://www.vliz.be/vmdcdata/iode/). The facility receives real-time sea-level data directly via the Global Telecommunication System (GTS) and provides information on: (i) status of sea-level stations; (ii) real-time data and graphs for stations; and (iii) station metadata.

The facility can provide some remedial action if a station fails, by automatically sending alerts to station operators (e-mail or SMS).

The Group thanked Franscico Hernandez for the presentation and expressed its interest in setting up a similar station status monitoring service for the whole GLOSS Core Network of stations. It asked the Chairman to explore this with VLIZ/Francisco Hernandez.

11. SEA LEVEL PRODUCTS

Phil Woodworth introduced this item. In recent years there has been an increasing call for sea-level data products in response to the increased societal awareness of sea-level rise, as well as to help improve the sea-level observing network and demonstrate its relevance to society.

Phil Woodworth recalled that the GLOSS community already produces many products and contributes scientific data that enter into products. Examples include:

IGOSS maps for the Pacific
Anomaly maps
Various NOAA sea-level products
Antarctic current index

There is a range of products that could be added, ranging from policy products to global/regional data analysis products to broader public outreach products. Phil Woodworth invited suggestions for other products and how they could be brought together.

It will be necessary to establish a more formal process for production of high-level products. Other products could be more readily compiled and added under the GLOSS web-site.

The Group decided that Phil Woodworth, Svetlana Jevrejeva and Gary Mitchum should develop a more comprehensive product list which should address multiple users. The list should be circulated for further comments within the GLOSS GE, with a view to establishing a sea-level product web-portal in the intersessional period.

12. REPORT FROM THE GLOSS SCIENTIFIC SUB-GROUP

At the IXth meeting of the GLOSS Group of Experts, the GLOSS Scientific Sub-Group (SSG) was tasked with providing support for the World Climate Research Programme Workshop on Understanding Sea Level Rise and Variability, which took place at the IOC headquarters in Paris in June of 2007. A number of the SSG members participated in this Workshop in various roles. Notably, the Chairmen of the GLOSS Group of Experts (Merrifield) and of its SSG (Mitchum) served on the organizing committee and also chaired the session on the 20th century record (i.e., the tide gauge and satellite altimetry records) of sea-level rise. Also, SSG member Woodworth was one of the three co-chairs for the meeting, and another SSG member (Sturges) was invited to participate in the Workshop to provide an overall assessment of the outcome.

The GLOSS SSG Chairman (Mitchum) also suggested a change in the composition and the operating model for the SSG. He noted that, since the inception of the SSG, most of the questions put to it had been dealt with either by himself or by consultation with one, or at most a few, of the

SSG members. Most of the members were never actually called upon to contribute. Given this experience, Mitchum asked that the GLOSS Group of Experts consider to reorient the present SSG in favour of a smaller group whose main task would be to help the SSG Chairperson to identify appropriate expertise for whatever questions might be put to the SSG, thus allowing the formation of ad hoc groups to address specific questions.

The Group of Experts invited the Chairman of the SSG to approach Philip Woodworth, Anny Cazenave, and Richard Ray about being members of the revised group and Mitchum himself to remain as the SSG's Chairperson. It also decided that the Chair and the GLOSS Technical Secretary should be ex-officio members of the reorient the SSG. This reoriented group will provide international expertise spanning tide gauge sea levels, satellite altimetry, oceanography and geodesy, and variations on time-scales from tides to sea-level rise. Mitchum was tasked with contacting the former SSG members as well as the proposed new SSG members about the proposed changes.

13. REPORT FROM THE GLOSS TECHNICAL SUB COMMITTEE AND TECHNICAL DEVELOPMENTS IN RELATION TO GLOSS

Begoña Peréz, Chairwoman of the GLOSS Techncial Sub-Committee, informed the Group of Experts that the Sub-Committee had assisted with the updating of the IOC Manual on Sea Level Observations and Interpretation (vol 4) and had helped organize the Workshop on Real-time Transmission and Processing Techniques: Improving the Global Sea Level Observing System's Contribution to Multi-Hazard Warning Systems (Paris, France, 5 June 2007).

14. GLOSS TRAINING ACTIVITIES FOR 2007-2009

Thorkild Aarup informed the Group about early plans for a GLOSS training course on sea-level observation and data analysis. This course will be held at a location (yet to be decided) in the NW Indian Ocean.

15. INTERSESSIONAL ACTIONS FOR 2007–2009

Mark Merrifield and Thorkild Aarup presented a list of actions to be undertaken during the forthcoming intersessional period, based on the discussions of the present session of the Group of Experts and on any necessary follow-up of actions decided at the previous session.

The Group endorsed the list.

16. ANY OTHER BUSINESS

No additional items were put forward for discussion.

17. DATE AND PLACE OF THE NEXT SESSION

The Group of Experts decided that its Eleventh Session would be held in IOC, UNESCO, in 2007, dates to be decided in due course. The Chairman invited suggestions for a theme for a technical workshop in association with the Group of Experts' Eleventh Session.

18. CLOSURE

The Chairman closed the Tenth Session of the Group of Experts on the Global Sea Level Observing System at 12:30 h on 9 June 2007.

ANNEX I

AGENDA

1. ORGANIZATION OF THE SESSION

1.1 OPENING OF THE SESSION (welcome by Patricio Bernal)
1.2 ADOPTION OF THE AGENDA
1.3 PRACTICAL ARRANGEMENTS (Aarup)

2. REVIEW OF GLOSS ACTIVITIES AND STATUS FOR ACTIONS FROM GE-IX (Aarup, Merrifield)

3. REVIEW OF GLOSS CORE NETWORK STATUS (LOW FREQUENCY & HIGH FREQUENCY, DELAYED MODE & FAST MODE) (Merrifield, Rickards)

4. UPDATE OF THE GLOSS IMPLEMENTATION PLAN (Merrifield, Woodworth, Mitchum)

5. GLOSS IN THE CONTEXT OF A GLOBAL TSUNAMI AND OTHER OCEAN-RELATED HAZARDS EARLY WARNING SYSTEM (Gérard)

6. UPDATES ON REGIONAL SEA LEVEL NETWORK DEVELOPMENTS INCLUDING COORDINATION WITH TSUNAMI WARNING SYSTEMS SEA LEVEL NETWORKS

6.1 Indian Ocean (Merrifield)
6.2 Pacific Ocean (Stephenson)
6.3 Caribbean (Aliaga, Mitchum)
6.4 NE Atlantic & Mediterranean (Perez/Wolf)
6.4.1 SLEAC (Huess/Woodworth)
6.4.2 ESEAS (Bye)
6.4.3 MedGLOSS (Rosen)
6.5 Africa (Aman, Woodworth)
6.6 Polar networks (IPY, Woodworth)

7. UPDATES ON NATIONAL SEA LEVEL ACTIVITIES

8. UPDATES ON LINKAGES BETWEEN GLOSS AND OTHER PROGRAMMES (Merrifield, Aarup)
OOPC (Fischer)
CLIVAR (Merrifield)
Continuous GPS stations and tide-gauges (Wöppelmann/Schoene)
GGOS (Woodworth)
Jason Science Working Team/Alt-Cal (Mitchum)
IHO (Shipman)
JCOMMOPS Developments (TBA)
Atmospheric Circulation Reconstructions over the Earth (ACRE) (Woodworth)

9. UPDATES FROM GLOSS DATA CENTRES

9.1 PSMSL (Rickards)
9.2 UHSLC (Merrifield)

10. THE IODE/ODINAFRICA SEA LEVEL DATA FACILITY (Hernandez)

11. SEA LEVEL PRODUCTS (Woodworth, Merrifield)

12. REPORT FROM THE GLOSS SCIENTIFIC SUB-COMMITTEE

13. REPORT FROM THE GLOSS TECHNICAL SUB-COMMITTEE AND TECHNICAL DEVELOPMENTS IN RELATION TO GLOSS

14. GLOSS TRAINING ACTIVITIES FOR 2007–2009

15. INTERSESSIONAL ACTIONS FOR 2007–2009

16. ANY OTHER BUSINESS

17. DATE AND PLACE OF THE NEXT SESSION

18. CLOSURE

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ANNEX III

GLOSS PLAN OF ACTIONS 2007–2009

GE-X Action Items

1. Complete GE-X meeting report, draft to be circulated to meeting attendees for comment [Aarup/Merrifield].

2. GLOSS Technical Workshop 5 June 2007: Powerpoint presentations to be made available at GLOSS website [Aarup/Martin].

3. High-frequency delayed-mode data banking at BODC/PSMSL and UHSLC/JASL:
   (i) Data centres will provide delayed-mode data in two formats: a version at the highest sample rate possible with QC flags and ancillary datasets, and hourly averages with QC notes included in metadata files. The datasets will be accessible through the GLOSS website [Rickards/Merrifield].
   (ii) Clarify data centre expectations regarding data transfer and quality-assessment procedures for delayed-mode data: Circular Letter to data providers [Rickards/Merrifield].

4. High-frequency fast-mode data banking at UHSLC:
   (i) UHSLC will seek fast-mode (within 1 month) high-frequency data from all GCN station operators that are not currently contributing to the data bank [Merrifield].
   (ii) Clarify data centre expectations regarding data transfer and quality-assessment procedures for fast-mode data: Circular Letter to data providers [Merrifield/Rickards].

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 [Merrifield].

6. Letter to appropriate agencies from Executive Secretary IOC advocating continued precision-altimeter missions [Mitchum/Woodworth/Aarup].

7. Contact Francisco Hernandez regarding the feasibility of hosting GLOSS network status and near-real-time plots at the IOC/IODE Office in Ostend [Aarup/Merrifield].

8. Expand GCN status map at the GLOSS website to include high-frequency delayed-mode and fast-mode datasets [Merrifield/Rickards].

9. GPS vertical rates and TIGA:
   (i) Contact tide gauge station operators to ask that they inspect Guy Woppelmann's web site and advise on GPS near gauges not included at present, and encourage them to sign up to TIGA [Aarup/Woppelmann/Schoene].
   (ii) Letter to John Dow (John.Dow@esa.int, cc Ruth Neilan) stating importance of TIGA to GLOSS and requesting continued operation [Merrifield/Aarup].

(iii) Devise an implementation strategy to install and maintain CGPS receivers at 50–100 GCN stations, identify an appropriate funding agency, and submit a proposal on behalf of GLOSS by the next GE meeting [Schoene/Mitchum /Mitchell/Manurung/Fernandes/Woppelmann/Zavala-Hidalgo/ Merrifield].

10. Update GLOSS Implementation Plan by the end of 2007 [Merrifield/Mitchum/Woodworth].

11. GLOSS products – prepare a list of potential products and circulate it amongst the GE members for comment [Woodworth, Jevrejeva]

12. Hazards issues:

(i) Offer GLOSS GE assistance, in response to Francois Gerard's presentation on the GOHWMS, in coordinating global and regional tide gauge networks for hazard monitoring [Chairperson, IOC].

(ii) Serve sub-hourly average GCN data at BODC in support of hazard community [Rickards].

13. Training courses

(i) NW Indian Ocean

(ii) Additional?

14. Circular Letter to National GLOSS Contacts seeking regular updates of all leveling data [Merrifield/Rickards].

15. Finalize revised GCN station list (300 stations – GLOSS07) and update data banks, maps, etc. at data centres [Merrifield/Rickards].

ANNEX IV

LIST OF DOCUMENTS

(Available from http://www.ioc-goos.org/glossge10)

Document Code	Title	Agenda Items
Working documents		
GLOSS-GE-X / 1.3	GLOSS-GE-X Agenda 6–8 June 2007	1.3
GLOSS-GE-X / 2	The history of GLOSS (presentation)	2
GLOSS-GE-X / 2	Review of GLOSS activities (report)	2
GLOSS-GE-X / 2	Review of list of Action Items from GLOSS-GE-IX (report)	2
GLOSS-GE-X / 3	Review of GLOSS Core Network status (presentation)	3
GLOSS-GE-X / 4	GLOSS Implementation Plan 1997–2007 (presentation)	4
GLOSS-GE-X / 5	Ocean Hazard Warning and Mitigation Systems, a perspective for GLOSS (presentation)	5
GLOSS-GE-X / 5	GLOSS in the context of a global tsunami and other ocean-related hazards (report)	5
GLOSS-GE-X /6.1	Updates on regional sea level networks developments: Indian Ocean (presentation)	6.1
GLOSS-GE-X / 6.2	Updates in regional sea level network developments: Pacific Ocean (report)	6.2
GLOSS-GE-X /6.2	Updates on regional sea level networks developments: Pacific Ocean (presentation)	6.2
GLOSS-GE-X/ 6.2	Updates in regional sea level network developments: Pacific Ocean (table.xls)	6.2
GLOSS-GE-X / 6.3	Updates on regional sea level network developments: Caribbean (presentation)	6.3
GLOSS-GE-X / 6.4	Updates on regional sea level network developments: NE Atlantic and Mediterranean (presentation)**(?)**	6.4
GLOSS-GE-X /6.4.1	Updates on regional sea level network developments: SLEAC/NOOS/BOOS (presentation)	6.4.1
GLOSS-GE-X /6.4.2	Updates on regional sea level network developments: ESEAS (presentation)	6.4.2
GLOSS-GE-X / 6.4.3	Updates on regional sea level network developments: MedGLOSS (presentation)	6.4.3
GLOSS-GE-X / 6.4.3	Updates in regional sea level network developments: MedGLOSS (report)	6.4.3
GLOSS-GE-X / 6.5	Updates in regional sea level network developments: Sea level monitoring in Africa (presentation)	6.5

Document Code	Title	Agenda Items
GLOSS-GE-X / 6.5	Updates in regional sea level network developments: ODINAfrica (presentation)	6.5
GLOSS-GE-X / 6.5	Updates in regional sea level network developments: Sea level monitoring in Africa (report)	6.5
GLOSS-GE-X / 7	GLOSS National Reports 2007 A–I (size 15MB) (presentations)	7
GLOSS-GE-X / 7	GLOSS National Reports 2007 J–Z (size 11MB) (presentations)	7
GLOSS-GE-X /7	GLOSS National Reports 2007 (all reports)	7
GLOSS-GE-X / 8	Linkages GLOSS and other programmes: GGOS (presentation)	8
GLOSS-GE-X / 8	Linkages between GLOSS and other programmes: ACRE (report)	8
GLOSS-GE-X / 8	Linkages between GLOSS and other programmes: ACRE (presentation)	8
GLOSS-GE-X / 8	Linkages between GLOSS and other programmes: OOPC (report)	8
GLOSS-GE-X / 8	Linkages between GLOSS and other programmes: JASON (presentation)	8
GLOSS-GE-X / 8	Linkages between GLOSS and other programmes: CGPS@TG (presentation)	8
GLOSS-GE-X / 8	Linkages GLOSS and other programmes: TIGA (presentation)	8
GLOSS-GE-X/ 8	Linkages between GLOSS and other programmes: IHO (presentation)	8
GLOSS-GE-X / 9	Updates from GLOSS data centres: PSMSL and UHSLC (presentation)	9
GLOSS-GE-X /9.1	Updates from GLOSS data centres: PSMSL (report)	9
GLOSS-GE-X / 10	The IODE/ODINAfrica sea level data facility (presentation)	10
GLOSS-GE-X / 15	List of Action Items 2007–2009	15

INFORMATION AND OTHER REFERENCE DOCUMENTS

Workshop and GLOSS GE X timetable

Brazil GLOSS National Report 2007

Canada GLOSS National Report 2007

Chile GLOSS National Report 2007

China GLOSS National Report 2007

Côte d'Ivoire GLOSS National Report 2007

Denmark GLOSS National Report 2007

France GLOSS National Report 2007

Italy GLOSS National Report 2007

Germany GLOSS National Report 2007

Ghana GLOSS National Report 2007

India GLOSS National Report 2007

Indonesia GLOSS National Report 2007

Iran GLOSS National Report 2007

Ireland GLOSS National Report 2007

Israel GLOSS National Report 2007

Japan GLOSS National Report 2007

Kenya GLOSS National Report 2007

Mexico GLOSS National Report 2007

Morocco GLOSS National Report 2007

Mozambique GLOSS National Report 2007

New Zealand GLOSS National Report 2007

Norway GLOSS National Report 2007

Portugal GLOSS National Report 2007

Russia GLOSS National Report 2007

Senegal GLOSS National Report 2007

South Africa GLOSS National Report 2007

Spain GLOSS National Report 2007

Sweden GLOSS National Report 2007

Tanzania GLOSS National Report 2007

Tunisia GLOSS National Report 2007

Turkey GLOSS National Report 2007

United Kingdom GLOSS National Report 2007

United States GLOSS National Report 2007

ANNEX V

ACRONYMS

ACRE	Atmospheric Circulation Reconstruction over the Earth
ALT	Altimeter calibration
AOPC	Atmospheric Observation Panel Climate (GCOS)
APAT	Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici (Agency for Enviromental Protection and Technical Services) (Italy)
BAKOSURTANAL	National Coordinating Agency for Surveys and Mapping (Indonesia)
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
CGPS	Continuous Global Positioning System
CGPS@TG	Continuous Global Positioning System at Tide Gauges
CHS	Canadian Hydrographic Service
CICATA	Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada (Mexico)
CICESE	Centro de Investigación Científica y de Educación Superior de Ensenada (Mexico)
CIESM	Commission Internationale pour l'Exploration Scientifique de la Mer Mediterrannée (International Commission for the Scientific Exploration of the Mediterranean Sea)
CLIVAR	Climate Variability and Predictability Programme (WCRP)
COOP	Coastal Ocean Observations Panel (GOOS)
CSPM	Centro Segnalazioni e Previsioni Maree (Italy)
DART	Deep-ocean Assessment and Reporting of Tsunamis)
DBCP	Drifting Buoy Cooperation Panel
DHN	Diretoria de Hidrografia e Navegação (Brazil)
DMI	Danish Meteorological Institute
DORIS	Détermination d'Orbite et Radiopositionnement Intégré par Satellite
ESEAS	European Sea Level Service
ESEAS-RI	ESEAS Research Infrastructure
EU	European Union
FTP	File transfer protocol (Internet)
EuroGOOS	European Global Ocean Observing System
GCM	General Command for Mapping (Turkey)
GCN	GLOSS Core Network
GCOS	Global Climate Observing System (WMO–ICSU–IOC–UNEP)
GE	Group of Experts
GEO	Group on Earth Observation
GGOS	Global Geodetic Observing System (IAG)
GIP	GLOSS Implementation Plan
GIS	Geographical Information System
GLOSS	Global Sea Level Observing System (JCOMM)
GMES	Global Monitoring for Environment and Security (EU)
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)
GOOS-Africa	Global Ocean Observing System in Africa
GPRS	General Packet Radio Service (GPRS)
GPS	Global Positioning System
GPS@TG	GPS at Tide Gauge
GSM	Groupe Spécial Mobile (Global System for Mobile Communications)
GTS	Global Telecommunication System
IAG	International Association of Geodesy (ICSU)
IBIROOS	Iberian–Biscay–Ireland Operational Oceanography System
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
ICSU	International Council for Science
IEO	Instituto Español de Oceanografía
IGN	Instituto Geográfico Nacional (Spain)
I-GOOS	Intergovernmental Committee for the Global Ocean Observing System
IGOS	Integrated Global Observing System (GGOS)
IGS	International GNSS Service
IHO	International Hydrographic Organization
IHPT	Instituto Hidrografico (Portugal)
INAHINA	Instituto Nacional de Hidrografia e Navegação (Mozambique)
INCOIS	Indian National Centre for Ocean Information Services
INGV	Istituto Nazionale di Geofisica e Vulcanologia (Italy)
INMARSAT	International Marine Satellite Organization
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IOCARIBE-GOOS	Caribbean and Adjacent Regions Global Ocean Observing System
IODE	International Oceanographic Data and Information Exchange
IOLR	Israel Oceanographic and Limnological Research Ltd.
IOOS	Integrated Ocean Observing System (USA)
IOTWS	Indian Ocean Tsunami Warning System
IP	Internet protocol
IPCC	Intergovernmental Panel on Climate Change (UN)
IPY	International Polar Year
IRD	Institut de Recherche pour le Développement (France)
ISDR	International Strategy for Disaster Reduction (UN)
IST	Istituto Sperimentale Talassografico (Italy)
ITU	International Telecommunication Union (UN
JCOMM	Joint Commission for Oceanography and Marine Meteorology (WMO–IOC)
JCOMMOPS	JCOMM Observing Platform Support
JMA	Japan Meteorological Agency
LEGOS	Laboratoire d'Etudes en Géophysique et Océanographie (France)
LEO	Low Earth orbit
LTT	Long-term trend
MedCLIVAR	Mediterranean Climate Variability and Prediction (WMO/WCRP)
MedGLOSS	Mediterranean Programme for the Global Sea-Level Observing System
NASA	National Aeronautics and Space Administration (USA)

NCC	National Cartographic Centre (Iran)
NEAMTWS	North East Atlantic, Mediterranean and Connected Seas Tsunami Warning System
NESDIS	National Environmental Satellite, Data, and Information Service (USA)
NGO	Non-Governmental Organization
NHS	Norwegian Hydrographic Service
NIO	National Institute of Oceanography (India)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOOS	North-West Shelf Operational Oceanographic System
NTSLF	National Tidal and Sea Level Facility (UK)
OBS	(Indicator for paid data/information service)
OC	Ocean Circulation
ODINAfrica	Oceanographic Data and Information Network for Africa
OOPC	Ocean Observations Panel for Climate (GOOS)
POGO	Partnership for Observing the Global Oceans
POL	Proudman Oceanography Laboratory (UK)
PSMSL	Permanent Service for Mean Sea Level (UK)
PTWC	Pacific Tsunami Warning Centre
QC	Quality Control
RDANH	Royal Danish Administration of Navigation and Hydrography
REDDMAR	La Red Mexicana de Nivel del Mar (Mexico)
RONIM	Réseau d'Observation du Niveau de la Mer (France)
ROSAME	Réseau d'Observation Subantarctique et Antarctique du niveau de la Mer (France)
SEAFRAME	Sea-Level Fine-Resolution Acoustic Measuring System (Australia)
SEMAR	Secretaría de Marina (Mexico)
SHOA	Servicio Hidrográfico y Oceanográfico de la Armada (Chile)
SHOM	Service Hydrographique de la Marine (France)
SLEAC	Sea Levels along the European Atlantic Coastline
SMHI	Swedish Meteorological and Hydrological Institute
SMS	Short message service (Internet)
SPWG	Surface Pressure Working Group (GCOS)
SOI	Survey of Israel
SONEL	Système d'Observation du Niveau des Eaux Littorales (France)
SOOP	Ship of Opportunity Programme
SSG	Scientific Sub-Group of GLOSS GE
TG	Tide Gauge
TIGA	GPS Tide Gauge Benchmark Monitoring Project
TNHOC	Tunisian Naval Hydrographic and Oceanographic Centre
TOPEX–Poseidon	Ocean Topography Experiment/Poseidon Satellite
TOS	TIGA Observation Station
TRANSFER	Tsunami Risk ANd Strategies For European Region (EU Framework Project)
TUDES	Turkish National Sea Level Monitoring System
TWS	Tsunami Warning System
UHSLC	University of Hawaii Sea Level Center
UN	United Nations
UNAM	Universidad Nacional Autónoma de México
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

UNFCCC	United Nations Framework Convention on Climate Change
VLIZ	Flanders Marine Institute (Belgium)
VPN	Virtual private network
VSAT	Very small aperture terminal
WCRP	World Climate Research Programme (WMO–ICSU–IOC)
WMO	World Meteorological Organization
XBT	Expendable bathythermograph