

FIRST SESSION

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ITEMS 4, 8.4, 11

AKUREYRI, ICELAND, 19 TO 29 JUNE 2001

Original: ENGLISH

## SEA LEVEL

### Reports by the Chairmen of the Major Subsidiary and Reporting Bodies

#### Report by the chairman of the GLOSS Group of Experts

*(Submitted by Dr Philip Woodworth, chairman of the GLOSS Group of Experts)*

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#### Summary and Purpose of Document

This report provides a summary of the status of the Global Sea Level Observing System (GLOSS) and of activities taken in support of GLOSS during the past four years. It also raises a number of issues requiring the attention of the Commission.

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#### ACTION PROPOSED

The Commission is invited to:

- (a) Note the information given in the report and comment as appropriate;
- (b) Approve the draft text in Appendix B for inclusion in the general summary of JCOMM-I;
- (c) Adopt the draft recommendation in Appendix C.

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- References:**
- 1. Final report, sixth session of the GLOSS Group of Experts, Toulouse, 1999
  - 2. Final report, seventh session of the GLOSS Group of Experts, Hawaii, 2001

- Appendices:**
- A. Report by the chairman of the GLOSS Group of Experts
  - B. Draft text for inclusion in the general summary of JCOMM-I
  - C. Draft Recommendation 8.4/1 (JCOMM-I) – Global Sea Level Observing System (GLOSS).

## REPORT BY THE CHAIRMAN OF THE GLOSS GROUP OF EXPERTS

1. This report gives a summary of the status of the Global Sea Level Observing System (GLOSS). The list of achievements during the past four years, following the acceptance of the GLOSS Implementation Plan (GIP) by the IOC Assembly in 1997, is an impressive one, although much remains to be done. The GIP called for the development of a GLOSS Core Network (GCN) of 287 stations; a network of several tens of sites for on-going satellite altimeter calibration (GLOSS-ALT); a programme of investment in gauges with geodetic equipment (especially GPS) at sites with long records (the LTT, or long term trends, set); and the use of gauges at straits and other strategic locations for ocean circulation monitoring (the OC set).

### GCN Status from a PSMSL Viewpoint

2. For several years, the Permanent Service for Mean Sea Level (PSMSL) has provided a regular summary of GLOSS Core Network (GCN) status. A review as of October 2000 can be found at:

<http://www.pol.ac.uk/psmsl/gloss.html>

In brief, the status of the GCN has been essentially unchanged for several years. It can be considered to be approximately two-thirds operational, using data receipts by the PSMSL as a guide to operational status, or somewhat better if additional factors are considered. These include the fact that at some locations the gauges take the form of simple pressure transducers, which provide useful information for oceanography, even if they do not provide MSL data for the PSMSL. However, these status summaries hide major problems in several regions, with expenditure in new tide gauge equipment in a number of countries, and the network improvements which result, balanced against the fact that many GLOSS stations in other countries are being terminated or require major upgrades. In addition, the investments made in gauges for international programmes (notably WOCE) are unlikely to be repeated in future. Consequently, it is possible that GLOSS status, measured in terms of PSMSL receipts, may have reached a plateau.

3. This pessimism is contradicted to some extent by the stated requirements for investment in regional networks of coastal tide gauges by, for example, the GOOS COOP (Coastal Oceans Observations Panel). Therefore, GLOSS status may receive a boost in the long term from 'coastal', rather than 'climate' or 'oceanographic', applications. Whatever the scientific emphasis, investment in equipment and training is a necessity in many countries.

### GLOSS GE and Subgroup Developments

4. At the sixth meeting of the GLOSS Group of Experts (GE6) in 1999, the Group endorsed the 'ex officio' right to membership of the GE by the Directors PSMSL, UHSLC, NTF, WOCE Centres, IAPSO/CMSLT, IGS and other future appropriate bodies. It was emphasized, however, that this list was not exclusive or exhaustive. This extension of the GE could have the benefit of increasing the number of people well briefed about GLOSS who will be able to represent the programme at international meetings.

5. In addition, discussion took place on a proposal that a subgroup of the GE be formed as a source of scientific advice, especially for climate but possibly also for coastal matters, with the subgroup potentially a joint committee with (at present) OOPC, CLIVAR/UOP and IAPSO/CMSLT. The Group endorsed the concept, and the subgroup has since been established.

### Regional GLOSS Activities

6. A number of regional GLOSS activities have taken place in 1999-2000 including the Arctic and Europe (for which Professor Hans-Peter Plag is to be thanked for taking a major lead) and Asia-Pacific (thanks to Professor C.K. Shum and Dr Wolfgang Scherer). Another example concerns MedGLOSS, which is a joint programme of the International Commission for the Scientific

Exploration of the Mediterranean Sea (CIESM) and IOC, with the aim of installing and coordinating a network of gauges for the Mediterranean and Black Seas. Coordination meetings have commenced, led by Dr Dov Rosen.

### **GOOS Coastal Module/COOP**

7. This year has seen the publication of several GOOS documents which refer to the need for sea level measurements for coastal GOOS applications. At the GE6 meeting, the status of (what was then called) C-GOOS was reviewed together with its needs for hardware and training. Joint training was suggested. In addition, the need for real-time data was emphasized, together with the possible use of tide gauge data transmission platforms for delivery of other data types. The scope for collaboration between programmes needs to be more firmly resolved.

### **GLOSS-ALT**

8. GLOSS-ALT is the name given in the GLOSS Implementation Plan 1997 to the use of a number of tide gauges distributed worldwide, primarily on islands, for on-going altimeter calibration. This topic has been led in particular by Dr Gary Mitchum, with contributions from several other groups. As reported at GE6, the developments in this field, in demonstrating the important symbiosis between altimetry and gauges, are so significant that to a great extent GLOSS-ALT may be called operational.

### **GLOSS Handbook, Fast WOCE/GLOSS and Delayed Mode WOCE Data Sets**

9. The GLOSS Handbook product, available on the web, was edited by Dr Lesley Rickards of the British Oceanographic Data Centre (BODC). The Handbook was updated and extended during 1999 by means of rounds of correspondence with GLOSS contacts and a survey conducted at the GE6 meeting in May 1999. Major updates have now started towards a 2000-01 version. GLOSS contacts will be asked to provide information. The GLOSS Handbook web pages at:

<http://www.bodc.ac.uk/services/glosshb/>

now provide links to 'Fast-Delivery' and 'Delayed Mode' WOCE high-frequency (typically hourly) data (HFD) sets. A survey conducted at GE6 suggested that HFD were available from approximately 200 of GLOSS Core Network sites from various national and international centres. Not all of these are available from the GLOSS Handbook pages, but an important start has been made.

10. For people without good web access, Version 2.0 of the WOCE sea level data set is now available on CD-ROM. In addition to the 'Fast-Delivery' and 'Delayed-Mode' WOCE sea level data sets, the CD-ROM contains tidal constants from the WOCE sea level data set, PSMSL monthly and annual mean sea level data set, and the GLOSS Station Handbook (Version 4.1). Copies are available from PSMSL, BODC or the University of Hawaii Sea Level Center. The Sea Level CD-ROM is a contribution to the WOCE Global Data (Version 2.0) CD-ROM set (15 CDs). Copies of the complete set are available from the US National Oceanographic Data Center, Silver Spring.

11. It has been agreed that the 'Fast WOCE' activity will be expanded as far as possible into a 'Fast GLOSS' activity, for the benefit of a different set of sea level data users, and also as an aid to more efficient data quality control.

### **GLOSS Training Courses**

12. IOC/GLOSS training courses have been held each year since GE6. A course took place at the University of Sao Paulo, Brazil in September 1999 organized by Professor Afranio de Mesquita and with Drs Baker and Vassie from POL as guest lecturers. As with previous courses, the Sao Paulo agenda was concerned with background sea level science (climate change, oceanography), the need for related geodetic measurements, and 'hands on training sessions' (HOTS). A further course took place during 15-19 April 2000 in Jeddah, Saudi Arabia, funded by the Programme for the

Environment of the Red Sea and Gulf of Aden (PERSGA) and IOC. The local organization was led by Dr Dirar Nasr of PERSGA and Mr David Dixon (Plymouth, UK) provided lectures on background sea level science (climate change, oceanography), the need for related geodetic measurements, and (HOTS), using many training materials from previous courses. Workshop reports are available for both of these courses. At the time of preparation of this report, suggestions for new courses are awaiting discussion at GE7 in April 2001.

### **Training Materials and Training Web Page**

13. An updated version of the third volume of the IOC Manuals and Guides No.14 on sea level measurement and interpretation has been completed and can be down-loaded from the PSMSL training web page:

<http://www.pol.ac.uk/psmsl/training/training.html>

This is a typical example of the set of sea-level related information which, it is hoped, such a training page will eventually contain. Several sets of tidal analysis software continue to be widely distributed and play a major role in improving data quality and timely delivery. The most used is that of the University of Hawaii. The TASK-2000 package from POL was used at recent GLOSS training courses. A further package is available from the Australian National Tidal Facility.

### **Newsletters and Brochures**

14. There have been seven issues of the GLOSS Bulletin on the web, of which the last was produced by the PSMSL in 1999 using contributions from GE6. However, a volunteer is required to take over production of the Bulletin from now on. Several issues of the Afro-American GLOSS News (AAGN) have been produced by the University of Sao Paulo, with recent editions on the web. At GE6, it was suggested that the AAGN be produced in future jointly by the Universities of Sao Paulo and Cape Town, thereby widening the geographical scope of the Newsletter. However, this has not yet happened. All sea level centres (PSMSL, BODC, UHSLC, NTF) now have good web pages which serve to spread information to the public as well as the science community. Two-page brochures advertising GLOSS are now available in English, Portuguese, Spanish and (shortly) French and can be downloaded from the PSMSL training web page.

### **Proposal for a Sea Level Data Archaeology Project**

15. At the IOC International Oceanographic Data and Information Exchange (IODE) Committee's sixteenth meeting in 2000, extensions to the Global Ocean Data Archaeology and Rescue (GODAR) project were suggested. A GLOSS proposal concerned a data archaeology project for historical sea level records with the aim of extending existing time series and gaining access to observations which are not in digital form. In many countries there are considerable amounts of historical sea level data in paper form such as charts or tabulations. These need to be computerized to provide electronic access, as backup for data security, and so that they can be subject to modern quality control and analysis. The original records would not be destroyed, as they may contain further information which is not captured by the computerized version (for example, charts digitized to hourly values might miss tsunami or seiche information) and also, in some cases, they are historic documents. The IODE Committee supported the proposal and recommended that the sea level archaeology project should be coordinated by GLOSS, with the GODAR Project Leader acting as advisor to the project. The GLOSS Secretariat will now encourage all countries to assess their holdings of historical tide gauge data which can potentially be rescued. Following on from this, GLOSS will aim to put countries in touch with each other and with sea level organizations with regard to collaborative data rescue.

### **IHB Tidal Constants Data Set**

16. At the GE6 meeting, there was a proposal (suggested by the representative of the IHB) for the PSMSL to act as a source of the complete IHB tidal constants data bank, from which bona fide

tidal researchers (and no others) would have access. However, this proposal was overtaken by events in 2000, when the IHB decided not to continue with the data bank in Canada. Anyone requiring constants in future will have to apply to a large number of national hydrographic offices. During 2000, correspondence was exchanged between IOC, IHB and the Canadian Hydrographic Office as to whether they would rethink their decision and continue with the data bank as a Canadian contribution to GLOSS. However, that appeal was unsuccessful as confirmed in a letter from the IHB in October. If the community now feels that such a data set is useful, based on GLOSS/WOCE data, then joint action needs to be taken between the GE and IAPSO/CMSLT.

### **Sea Level Science**

17. Numerous papers have been published using GLOSS (and sea level in general) data. However, perhaps one of the most important sets of publications is the set of reviews of the Intergovernmental Panel on Climate Change (IPCC). The Third Assessment Report (TAR) of the IPCC has continued under development in 1999-2000 with Chapter 11 on sea level changes led by Dr J. Church (Australia) and Dr J. Gregory (UK) and with the GLOSS Chairman as a lead author. Chapter meetings took place in New Zealand in February and Canada in July 2000 with final publication of the TAR in January 2001.

18. Other notable sea level publications during the past two years include a book on the history of tidal research by David Cartwright, and a book on sea level changes edited by Bruce Douglas, Steve Leatherman and M.S. Kearney. A review of global and European regional sea level changes has also been published by David Smith and colleagues.

### **Other Relevant GLOSS-related Meetings**

19. Full meetings of the GLOSS Group of Experts (GE) take place at approximately two-yearly intervals. Reports are available in paper and electronic form for the most recent GE6 at Toulouse, France, in May 1999 and GE7 2001 in Hawaii, USA. Important GLOSS-related meetings also take place in the intervening periods. Examples include the four-yearly conference of the International Union of Geodesy and Geophysics (IUGG) and those of its associations (IAPSO and IAG) and, at a regional level, of the Asia Pacific Space Geodynamics (APSG) Project. In April 2000, an important sea level conference on Climate Change, Climate Variability and Sea Level Rise took place at Rarotonga, Cook Islands, organized by the Australian National Tidal Facility and others. Technical workshops (e.g. on the use of Global Positioning System equipment at tide gauges) have taken place alongside GE meetings. The GLOSS Chairman and Secretary have also participated fully in JCOMMTRAN activities.

### **New Resources for GLOSS**

20. Regular Secretariat budget funds for GLOSS are extremely limited and tend to be devoted to the cost of meetings, training courses and sea level products (e.g. data and training CD-ROMs). There are virtually no funds for new gauges or geodetic equipment. During the past year, the GLOSS Chairman and Secretariat have been investigating possibilities for obtaining additional funding for the programme, with many letters asking for support having been sent to national and international funding agencies and IOC national focal points. Results in this area will be reported to the GE7 and JCOMM-I meetings.

### **Publications and Outreach**

21. Various activities have been made on behalf of PSMSL and GLOSS including TV, radio and press interviews, Open Days and presentations to politicians and national delegations. In addition, presentations have been made to the IOC community at Assembly and Executive Council sessions.

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**DRAFT TEXT FOR INCLUSION IN THE GENERAL SUMMARY OF JCOMM-I**

**8.4 Sea Level** (*agenda item 8.4*)

8.4.1 The Commission recognized the major importance of the Global Sea Level Observing System (GLOSS), both to a variety of operational activities in Members/Member States and also to global climate studies. It therefore noted with interest and appreciation the report by the Chairman of the GLOSS Group of Experts, Dr Philip Woodworth, reviewing the achievements of, and deficiencies in, the programme.

8.4.2 The Commission noted progress made in elements of GLOSS such as the GLOSS Core Network (GCN) development; certain regional GLOSS networks; use of tide gauges for on-going altimeter calibration (GLOSS-ALT); provision of data and information to international scientific study groups such as the Intergovernmental Panel on Climate Change (IPCC); and enhancement of materials for training, outreach and research. At the same time, it also noted the requirement for significantly increased resources for programme development in many parts of the world, for both 'climate/oceanographic' and 'coastal' applications.

8.4.3 The Commission recognized the need for investment world-wide resulting from increasing requirements for real time sea level data (as opposed to the 'delayed mode' data available so far) and the use of tide gauge data transmission platforms for other oceanographic parameters. It further recognized the potential value to both the meteorological and oceanographic communities of making the products of GLOSS-related Sea Level Centres (such as the Permanent Service for Mean Sea Level, UK, and the Hawaii Sea Level Center, USA) more widely known through existing WMO information services. It therefore adopted Recommendation 8.4/1 (JCOMM-I) on this general topic.

8.4.4 The Commission approved the changes made to the organization of the GLOSS programme with regard to the establishment of a subgroup capable of providing on-going scientific input on sea level matters to the Group of Experts and to the wider community.

8.4.5 The Commission requested its Management Committee to provide advice to, and to coordinate with, the GLOSS Technical Secretariat at IOC with regard to obtaining funds necessary to ensure the modernization and extension of the programme.

**Draft recommendation**

**Rec. 8.4/1 (JCOMM-I) – THE GLOBAL SEA LEVEL OBSERVING SYSTEM (GLOSS)**

**THE JOINT WMO/IOC TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY,**

**NOTING:**

- (1) The considerable achievements of GLOSS in establishing a global system to monitor sea level changes;
- (2) That over two thirds of the GLOSS Core Network stations, as defined in accordance with the 1997 Implementation Plan for GLOSS, are operational and that this number has remained essentially unchanged over the past few years;

**CONSIDERING:**

- (1) The importance of long-term sea level measurements to many WMO Programmes concerned with climate change, hydrology, storm surges and tropical cyclones;
- (2) The importance of sea level measurements for operational oceanography, coastal engineering and defence applications and in the wider implementation of GOOS;
- (3) The potential for station sharing and use of tide gauge data transmission platforms for delivery of other data types;

**RECOMMENDS** to Members/Member States and national agencies to:

- (1) Continue and strengthen the support for GLOSS: (a) at the national level through maintenance of GLOSS-designated tide gauges; and (b) at the international level through support to the IOC Trust Fund or through bilateral and/or multilateral assistance for GLOSS activities by, for example, collaborative support for maintaining/upgrading GLOSS gauges in accordance with the GLOSS Implementation Plan;
- (2) Provide in-situ sea level data from GLOSS stations to the international data centres without delay in accordance with the provisions of the Implementation Plan;
- (3) Consider local and regional observation platform sharing for data acquisition of other important parameters at GLOSS sites, especially by providing the necessary upgrades for real time data acquisition;

**RECOMMENDS FURTHER** that the products of GLOSS-related Sea Level Centres (such as the Permanent Service for Mean Sea Level, UK and the Hawaii Sea Level Center, USA) should be made more widely known to the WMO/IOC communities through existing WMO information services, in order to promote enhanced knowledge and understanding in this important field;

**REQUESTS** the Secretary-General of WMO and the Executive Secretary IOC to provide assistance to Members/Member States, as appropriate and within the available budgetary resources, in the implementation of this recommendation.

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