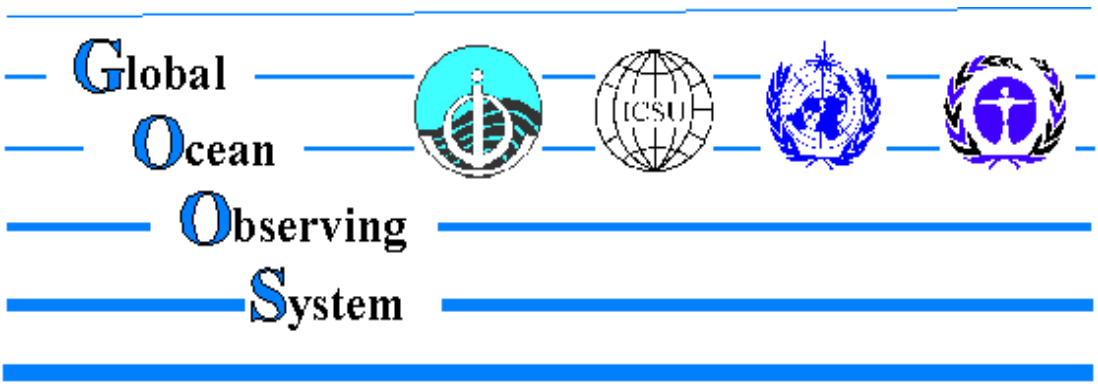

Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

IOC GROUP OF EXPERTS ON THE GLOBAL SEA LEVEL OBSERVING SYSTEM (GLOSS)

Sixth Session
Toulouse, France
12 – 14 May 1999

GOOS Report No. 71
GCOS Report No. 58

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IOC/GE-GLOSS-VI/3
Paris, 16 June 1999
English only

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1. ORGANIZATION OF THE SESSION

1.1 OPENING OF THE SESSION

Dr. Philip Woodworth, Chairman of the GLOSS Group of Experts (GGE), opened the session and welcomed all the participants. He thanked the sponsors: Intergovernmental Oceanographic Commission (IOC) of UNESCO, Centre national d'études spatiales (CNES), Observatoire du Midi Pyrennées, University of Toulouse, the French Committee for IOC, Proudman Oceanography Laboratory (POL), European Union (EU), National Ocean and Atmosphere Administration (NOAA), Commission Internationale pour l'exploration scientifique de la mer Méditerranée (CIESM) for their generous support and Dr. Christian Le Provost for enabling the meeting to be held in Toulouse.

Prior to the meeting the following workshops took place: (i) Ocean Circulation Science derived from the Atlantic, Indian and Arctic sea-level networks' organized by Dr. Gary Mitchum; (ii) GPS at tide gauge benchmarks for long-term sea-level change studies and for altimeter calibration' organized by Dr. Mike Bevis; and (iii) EOSS Work package 1 (European GPS) organized by Dr. Bernd Richter.

Dr. Woodworth welcomed the new GLOSS Technical Secretary, Dr. Thorkild Aarup and the meeting expressed their warm thanks to Ms. Janice Trotte, the Interim Technical Secretary.

1.2 ADOPTION OF THE AGENDA

The Chairman described the aims of the meeting. These were to review progress on the GLOSS implementation plan 1997 (IOC Technical Series No. 50, UNESCO), to review and encourage regional activities, to discuss geodetic fixing of tide gauge benchmarks and to facilitate contributions to the GOOS coastal module (C-GOOS). The Agenda (Annex I) was adopted by the group. The List of Participants is shown in Annex II.

1.3 DESIGNATION OF THE RAPPORTEUR

Mr. Philip Axe was elected Rapporteur of the Session.

2. & 3. REVIEW OF GLOSS ACTIVITIES

Dr. Woodworth presented the Chairman's Progress Report (Annex IV) in the light of the action items from the fifth session (GE5) of the Group held at the Jet Propulsion Laboratory, California, USA, in March 1997. Most of the actions from the fifth session had been completed satisfactorily. For example, training workshops on sea level observations and analysis, held in Bidston and Cape Town had been very successful. The GLOSS Implementation Plan had been approved at the IOC Assembly in June 1997. The outstanding action items from GE5 are included in the list of actions from GE6 in Annex VI.

Over the past two years, GLOSS training materials have been distributed widely both as printed reports and on CD-ROM. Brochures and newsletters have been published by the Proudman Oceanographic Laboratory (POL) and the Permanent Service for Mean Sea Level (PSMSL) and were presented to the meeting as examples of information products required in other languages. The importance of these in communicating GLOSS aims was emphasized. He reported on tide gauge donations to GLOSS by Sweden and Singapore, which will be shiped to use at African GLOSS sites. A possible donation of secondhand gauges from Denmark was also noted.

The GLOSS status was presented by the Chairman from the point of view of the PSMSL, and of a survey of (non-) operational gauges conducted in December 1998. In brief, two-thirds of the GLOSS stations

appear to be operational. This survey will be updated again during the GLOSS Handbook updating in 1999 (see Section 10.3). Additional information on the status of individual gauges was provided by participants during the course of the discussion of the GLOSS status which will also be incorporated into the Handbook.

4. REPORT OF THE WORKSHOP ON "OCEAN CIRCULATION SCIENCE DERIVED FROM TIDE GAUGES FROM THE ATLANTIC, INDIAN AND ARCTIC SEA-LEVEL NETWORKS"

Dr. Gary Mitchum reported on this workshop. There will be a proceedings issue which will be published later this year. The Chairman thanked Dr. Mitchum for organizing the workshop.

5. GEODETIC FIXING OF TIDE GAUGE BENCHMARKS

5.1 REPORT OF THE GPS AT TIDE GAUGES STUDY GROUP

Dr. Mike Bevis reported on the development of the training manual on the geodetic fixing of tide gauge benchmarks. He reported that there are widely differing experiences so no final standards can yet be defined. The report will have a general introduction describing common problems and minimum standards for site and data documentation. The remainder of the report will contain case studies illustrating different examples of good practice in a variety of environmental conditions. The document will be distributed *via* the Web so that it can be developed as experience is broadened.

5.2 GLOSS-ALTIMETRY STATUS

Dr. Mitchum presented an update on the analysis of drift in the TOPEX altimeter based on geodetically fixed sea level data. In the time since the last GLOSS meeting, the altimeter drift estimation that uses the global tide gauge set has been significantly improved. The improvements made were briefly summarized and described. The largest improvement has been in the reduction of the random errors due to incomplete cancellation of the ocean signals in the TOPEX/tide gauge differences.

Significant progress has also been made in reducing bias errors due to land motion at the tide gauges. The strawman set of 30 gauges proposed at the last meeting has largely been instrumented with continuous GPS measurements. Also, a set of about 250 GPS and Doppler Orbitography and Radio positioning Integrated by Satellites (DORIS) rates of vertical land movement has been incorporated into the drift analysis, so that we can report that a merged sea level, altimetry and geodesy system is now operating. Dr. Mitchum noted however that the present implementation is really a proof of concept and requires much more work before we can attribute a high degree of confidence to the analysis. The technique will be extended to evaluate the ERS-1 and ERS-2 altimeters. The panel agreed that good progress had been made in the implementation of GLOSS-ALT. This work emphasizes the importance of the availability of fast delivery sea level data. A paper on this study is in preparation.

6. REPORTS OF THE INTERNATIONAL SEA-LEVEL CENTRES, REGIONAL AND INTERNATIONAL ACTIVITIES

A number of reports were submitted to the Group which are available *via* the GLOSS Bulletin Web pages (*http://www.pol.ac.uk/psmsl/gb.html*) and in paper form from the Global Ocean Observing System (GOOS) Project Office.

6.1 PSMSL

The Permanent Service for Mean Sea Level (PSMSL) is responsible for the collection, publication, analysis and interpretation of sea-level data from the global network of tide gauges. It is based at the Proudman Oceanographic Laboratory (POL), UK. It is supported by the Federation of Astronomical and Geophysical Data Analysis Services (FAGS), by the IOC and by UK Natural Environment Research Council (NERC). As of August 1998, the database of the PSMSL contained over 45,000 station-years of monthly and annual mean values of sea level from over 1,800 tide gauge stations around the world received from almost 200 national authorities. On average, approximately 2,000 station-years of data are entered into the database each year.

Dr. Woodworth gave a brief presentation on the work of the PSMSL since GE5 and referred to a report available to the GE6 meeting (see Annex V). The Chairman noted that 1997/98 was a further very active period for the PSMSL with regard to important workshops and conferences, and a busy one with regard to data acquisition and analysis, the provision of training materials and tidal software and scientific studies.

Plans were mentioned for the merging of sea level and geodetic information within the PSMSL data set.

6.2 WOCE

The University of Hawaii Sea Level Center (UHSLC) is a research facility of the University of Hawaii/NOAA Joint Institute for Marine and Atmospheric Research (JIMAR). The mission of the UHSLC is to collect, process, distribute, and analyze *in situ* tide gauge data from around the world in support of climate research. The UHSLC is recognized as the fast mode sea level centre of the World Ocean Circulation Experiment (WOCE).

Dr. Mark Merrifield presented the work of UHSLC (report available at *http://www.pol.ac.uk/psmsl/gb7/uhslc.report*). The WOCE fast delivery data set now includes 109 stations, 89 of which are located at GLOSS sites. A major user of the fast delivery data has been the altimetry community. For 73 stations the existing time series were extended backwards to link data from the Geodetic Satellite (GEOSAT) altimeter era with the present TOPEX/POSEIDON era. UHSLC is supporting the installation of collocated continuous GPS at tide gauges in support of altimeter drift monitoring. The Group recommended that UHSLC be recognized as the GLOSS Fast Delivery Centre (FDC) and that all agencies be encouraged to send real time data to UHSLC.

Dr. L. Rickards presented a report (available at *http://www.pol.ac.uk/psmsl/gb7/wocesl.html*) on the Delayed Mode WOCE Sea-Level Centre at the British Oceanographic Data Centre (BODC) which contains data from 176 gauges (3,000 station-years). A paper, written jointly by both WOCE Centres (available at http://*www.pol.ac.uk/bodc/woce/odspaper.html*), was presented to the Ocean Data Symposium in Dublin in October 1997 on sea level data management, and a CD-ROM containing data sets from both Centres and PSMSL data had been prepared for the International WOCE Conference in Halifax, Canada in May 1998.

The Group urged the two Centres to produce combined products as far as possible.

6.3 AUSTRALIAN NTF AND SOUTHERN OCEAN

The National Tidal Facility is a self-funded marine science organization operating as a unit of the School of Earth Sciences within the Flinders University of South Australia. Under NTF the Southern Ocean Sea Level Centre (SOSLC) provides a communication forum, data bank and information service for all groups with an interest in sea-level work in the Southern Ocean.

Dr. W. Scherer presented a report summarizing the work of the Southern Ocean Sea-Level Centre

(SOSLC), the South Pacific sea-level network, the Papua New Guinea (PNG) array and the Australian baseline network. All gauges in PNG were now no longer operational due to lack of local maintenance. A conference will be organized by the NTF in April 2000 at the Cook Islands on the science of South Pacific sea levels.

6.4 AFRICAN GLOSS NETWORK

Prof. G. Brundrit presented the conclusions of the University of Cape Town GLOSS training course in November 1998 (see also section 10.1) with regard to the development of an African GLOSS network. A recommendation of the course was that coordinators be appointed for West, East and South Africa with an overall GLOSS-Africa Chairman. He noted the success of the Oceanographic Data and Information Network for Eastern Africa (ODINEA) model for a regional data centre in East Africa which should be applied also to West Africa.

The importance of West African participation in the Climate Observing System for the Tropical Atlantic programme (COSTA), including the Pilot Research Moored Array in the Tropical Atlantic (PIRATA) and remote sensing data sets, providing links to the Brazilian oceanographic programmes, was noted.

6.5 EOSS AND MedGLOSS

The European Cooperation in the field of Scientific and Technical research (COST) is a framework for scientific and technical cooperation, allowing the coordination of national research on a European level. COST Actions consist of basic and precompetitive research as well as activities of public utility. COST Action 40 is the European Sea-Level Observing System (EOSS). EOSS intends to serve as an umbrella, under which various sea-level activities can be coordinated. The most important outcome of EOSS is expected to be an "organism" that guarantees and coordinates the long-term sea-level monitoring activities and data exchange along the entire European coastline.

Dr. H-P. Plag presented the developments in the concept of EOSS including plans for tide gauge and GPS data networks and data availability and numerical modelling, within a "Service" modelled on the successful International GPS Service for Geodynamics (IGS) approach. He asked for support from the Group in addition to the International Association of Geodesy (IAG) and the International Association for the Physical Sciences of the Ocean (IAPSO) endorsement. The Group strongly recommended that the proposal be developed in collaboration with European GOOS (EuroGOOS).

The Mediterranean Global Sea-Level Observing System (MedGloss) is a long-term monitoring network system for systematic sea-level measurements in the Mediterranean and Black Seas sponsored by CIESM. Dr. Dov Rosen gave a presentation on this project and mentioned that four gauges will be put in over the summer in Tunisia, Egypt, Croatia and Romania with CIESM funding support.

6.6 INDIAN OCEAN

Dr. Somasundar presented the status of three Indian Ocean programmes including one established programme and two proposed ones:

(i) a final report was presented on the IOC-UNEP-WMO Pilot Activity on Sea Level Changes and Associated Coastal Impacts. This project was initiated in 1993 and the primary objectives were:
- to improve understanding of the processes that control sea-level variability at sites where sea

level is monitored in the Indian Ocean;
- to enhance capabilities of countries of the Indian Ocean to monitor and analyze sea-level data.

The full report is available at *http://www.pol.ac.uk/psmsl/gb7/indian.ocean.1*.

(ii) A report was given on proposals to:

- establish a sea-level observing network to acquire systematic and accurate measurements on sea-level variations in the northern Indian Ocean;
- establish a storm surge prediction system in the northern Indian Ocean, approved by the IOC Executive Council in November 1998;
see also *http://www.pol.ac.uk/psmsl/gb7/indian.ocean.2*.

The response from Member States in the region to these proposals has been rather slow. However, a workshop is planned to boost the regional corporation and support to these proposals.

A statement of the status of a proposed enhanced network of sea-level gauges for the Persian Gulf and Indian Ocean was made. A meeting is planned for June 1999 to be held in Iran to discuss the two new proposals. Dr. Somasundar presented the views of Dr. S. Shetye on elements of the Pilot Activity which should be continued.

6.7 CARIBBEAN ACTIVITIES

A major proposal for CARICOM nations through the Organization of American States to the Global Environment Fund entitled "Caribbean: Planning for Adaptation to Climate Change" (CPACC) has been funded. The plan includes installing and operating eighteen GOES-reporting sea-level/weather stations in eleven countries. The IOCARIBE GLOSS Regional Coordinator is acting as a technical expert on the project. Although these gauges are limited to CARICOM nations, CPACC will significantly modernize observations especially in the eastern Caribbean, and will act as a model for others (The full report is available at *http://www.pol.ac.uk/psmsl/gb7/carib.doc*).

In addition to sea-level monitoring, Dr. Maul expressed great interest in development of a regional tsunami warning system in the light of historical evidence for tsunamis in the region. In this context, Dr. Mitchum stressed the need for historical hourly sea-level data linked to the original benchmarks. Data from gauges in the CPACC programme are going directly to UHSLC *via* the Geostationary Operational Environmental Satellite (GOES).

Finally Dr. Maul suggested that a mission be conducted to the region to assess requirements for hardware and training and for data archaeology.

6.8 ARCTIC

At the fourth GE meeting in Bordeaux, France, 1995, a status report on Arctic tide gauges was initiated. The action item was reaffirmed at the GE5 meeting.

For the GE6 meeting Dr. Hans-Peter Plag on behalf of co-authors Don Forbes, Humfrey Melling, Palle Bo Nielsen, Steve Solomon, Ron Solvason, Phil Woodworth and Oleg Zilberstein gave a detailed report on the Arctic tide gauge data set (*http://www.pol.ac.uk/psmsl/gb7/arctic.ps*). He painted a grave picture of the current low number of recordings and recommended urgent action to remedy the situation. For example, Canada now has no operational gauges in the Arctic. On the other hand, Iceland has recently made major

efforts to develop a comprehensive network. The Group thanked Dr. Plag and co-authors for their report and asked that IOC publish the document.

Dr. O. Zilberstein provided some additional information (than was available in the draft report mentioned above) on the Russian Arctic sites and identified necessary improvements in data acquisition.

6.9 APSG AND TAIWAN MEETING REPORT

Dr. C. K. Shum gave an overview of the Asia Pacific Space Geodynamics Project (APSG), identifying possible data gaps in the region and the complementarity of tide gauge and altimeter data. A data centre for

APSG will be established at the Australian NTF. The project was encouraged to approach North-East Asian Regional GOOS (NEAR-GOOS) for collaboration.

Dr. Woodworth gave a brief report of the "miniGLOSS" meeting held in Taiwan in June 1998, the report of which can be found in the GLOSS Bulletin Web page (*http://www.pol.ac.uk/psmsl/gb6/pcs.html*).

6.10 VIET NAM

Dr. Somasundar reported on the status of the Indian shaft encoder float gauge provided to Qui Nohn, Viet Nam, which will be re-installed shortly. Dr. Woodworth mentioned that POL may help install a new gauge at the Red River Delta in Northern Viet Nam.

6.11 IAPSO TIDAL CONSTANTS DATA SET

Dr. C. Le Provost gave results from an analysis of data available from both the International Hydrographic Office (IHO) tidal constants data set and from GLOSS/WOCE data, for the purpose of providing a much expanded data set of information for the development of tidal models. Data are required in hourly form from as many GLOSS/WOCE sites as possible, in order to be subjected to tidal analysis with rigorous estimation of errors of tidal constituents. IHO tidal data from 732 sites had been found to be also potentially useful, and the advice of Mr. H-P Rohde was to make the IHO data sub-set available to the small community of tide modellers *via* the PSMSL office. The study may lead to suggestions for locations for new gauge deployments.

6.12 WEST INDIAN OCEAN REPORTS

Dr. Odido presented a report on the ongoing project to prepare a comprehensive report on the status of the sea-level network in the Western Indian Ocean region. Seven countries (Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa and Tanzania) submitted detailed reports on existing and planned gauges (*see http://www.pol.ac.uk/psmsl/gb7/windian.ocean/*). In brief, the system of GLOSS stations in the region is to a great extent installed and operational although with some remaining gaps and concerns about modernisation. The creation of a regional group of experts as recommended at the fourth meeting of IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean (IOCINCWIO) would help in improving the quality and usage of sea-level data. The region still needs assistance to complete and maintain the regional network. Six gauges in the region still receive maintenance assistance from the University of Hawaii.

6.13 NATIONAL REPORTS

National reports were presented from many countries including Argentina, Australia, Chile, Côte d'Ivoire, France, Ghana, Israel, Nigeria, Romania, Russia, Uruguay and United Kingdom. In particular, Chile was congratulated by the Group on development of a new national network. A report on some Brazilian sites was also presented by Professsors Mesquita and Marone. The fragmentation of sea-level analysis responsibilities in Brazil was noted for possible concern. Reports from several Western Indian Ocean states had been circulated prior to the meeting and formal appendices to the West Indian report of Dr. Odido were presented.

Many of these national reports can be found on the GLOSS Bulletin Web pages *http://www.pol.ac.uk/psmsl/gb7/* .

7. GGE DEVELOPMENTS

7.1 GGE STANDING MEMBERS

Dr. Woodworth invited the Group to endorse the *ex officio* right to membership of the GLOSS GE by the Directors PSMSL, UHSLC, NTF, WOCE Centres, IAPSO/Commission on Mean Sea Level and Tides (CMSLT), IGS and other future appropriate bodies. It was emphasized that this list was not exclusive or exhaustive. This extension of the GGE 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. The Group endorsed the proposal.

7.2 SUB-GROUP OF THE GGE AS A SOURCE OF SCIENCE INPUT

At the 31st Session of the Executive Council (EC), Paris, November 17-27, 1998 it had been suggested by the GOOS Steering Committee following advice from the OOPC and the Climate Variability and Predictability Programme (CLIVAR) that there was a need for a new sea-level group to work alongside the GLOSS GE to provide scientific advice on sea level to the wider community. However, at the EC meeting this proposal attracted some criticism with regard to possibly creating duplicate groups and it was decided not to put any resolution forward regarding this issue, but instead ask the GLOSS GE to examine the question.

The Group discussed an alternative proposal by the Chairman that a sub-group of the GLOSS GE be formed as a source of scientific advice, especially for climate, with the sub-group potentially a joint committee with (at present) OOPC, CLIVAR/UOP and IAPSO/CMSLT. After some debate of the relative merits of each option, which was aided by some members of the GE having attended the Executive Council meeting and therefore able to provide first-hand advice, the Group endorsed the concept of a GE sub-group, and further recommended that a second sub-group be considered in consultation with C-GOOS with regard to coastal sea-level aspects. The Chairman was requested to communicate this important development to the the Chairs of the other relevant bodies *via* the Director of the GOOS Project Office.

8. SEA-LEVEL REQUIREMENTS OF THE GOOS COASTAL MODULE

Dr. E. Marone (Vice Chairman of C-GOOS) reviewed the status of C-GOOS. A strategic design plan is being developed and it envisions parallel development of regional scale pilot projects nested in a global C-GOOS network. The global network should: (i) document the global dimensions of local to regional patterns of change in coastal waters; and (ii) provide the large scale perspective required to distinguish between locally generated patterns and those generated by regional-global scale forcings. The Regional networks should: (i) resolve patterns of variability on smaller scales relevant to problems of interest; (ii) provide larger scale context for research programmes; and (iii) incorporate selected index sites where high intensity observations provide the basis for both understanding the causes and effects of environmental variability as well as developing the models required to translate data into useful products.

Prof. K. Thompson (C-GOOS member) has been heading the C-GOOS sub-group which has drafted the part of the strategic design plan of C-GOOS which describes the global network. The report of this sub-group makes it clear that C-GOOS will depend heavily on the GLOSS network of stations for the implementation of the C-GOOS design and that additional sea-level stations may be needed.

Dr. E. Marone suggested that there could be areas where colaboration between C-GOOS and GLOSS would be possible, most notably with respect to sharing of stations, data collection and capacity building (joint courses). It was stressed that C-GOOS views GLOSS as the forum to get expert advice on sea-level issues.

9. INTERACTIONS WITH GOOS

Dr. Woodworth informed the Group of the availability of GOOS Implementation documents following the Sydney and Paris 1998 meetings of the Interim Implementation Advisory Group for GOOS (GOOS Reports No. 64 and 65; IOC-WMO-UNEP-ICSU/Impl-I and II/3, UNESCO 1998).

An IOC-WMO Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) has been proposed to replace the WMO Commission on Marine Meteorology (CMM) and the IOC-WMO Joint Commission on Integrated Global Ocean Services System (IGOSS). The objective of this merger is:

(i) to provide a coherent and cost-effective intergovernmental mechanism for coordinating and regulating marine observing systems, marine data and met-ocean services to marine users;

(ii) to provide a unified mechanism for implementing and coordinating a global ocean observing system;

(iii) to enhance involvement of IOC Member States and WMO maritime Members in this activity, and to encourage and facilitate coordination and integration at the national level between meteorological and oceanographic communities.

The proposed commission will become the parent body for GLOSS and the Data Buoy Co-operation Panel (DBCP).

The proposal was approved by the 50th WMO Congress in 1999 and it will be put forward to the 20th IOC Assembly (June-July 1999) for approval.

The first Transition Planning Meeting of the Joint Commission for Oceanography and Marine Meteorology (JCOMMTRAN) meeting will take place in St. Petersburg, Russia, in July 1999 at which GLOSS will be represented by Dr. Oleg Zilberstein, with GLOSS position papers provided by Dr. Woodworth.

10. CAPACITY BUILDING ACTIVITIES

10.1 REPORT OF THE IOC/GLOSS-GOOS TRAINING COURSE AT THE UNIVERSITY OF CAPE TOWN

Prof. G. Brundrit reviewed the conclusions of the UCT training course, which were incorporated into the Actions and Recommendations stemming from the GE6 meeting. The UCT course had been modelled closely on previous courses at Dehra Dun, India and POL, UK. Prof. Brundrit suggested that in order to maintain the momentum of sea-level training in Africa, a further course will be required in the region within the next two years, with course composition modified in the light of experience to include as much hands-on experience as possible. A UCT course report document has been printed by IOC (IOC Training Course Reports No. 51, UNESCO 1999). The Group thanked Prof. Brundrit and Dr. H.Waldron for their many efforts to enable the course to take place, and to place GLOSS-Africa on a much improved footing.

10.2 PLANS FOR A GLOSS TRAINING COURSE AT THE UNIVERSITY OF SAO PAULO

Plans for a University of Sao Paulo (USP) training course in September 1999 were announced by Prof. A.R. de Mesquita. The course will be four weeks in duration, but with the practical aspects of the course

concentrated into the first two weeks with IOC financial support. The course will be open to participants of the Spanish and Portuguese speaking countries of Central and South America and Africa.

10.3 UPDATING OF GLOSS MANUALS

Dr. Woodworth described plans for the rewriting of Manuals 1 and 2 with help from a small number of GE members. It is expected that new versions of the Manuals will be available in draft form during 1999 with final versions printed next year (see also Section 12.5).

10.4 OTHER CAPACITY BUILDING ACTIVITIES

As the provision of fellowships had been suggested by several GLOSS contacts as the best way to further capacity building within GLOSS, the Secretary was asked to investigate possibilities under the IOC Training Education and Mutual Assistance programme (TEMA).

10.5 NEWSLETTERS

The continued production of the GLOSS Bulletin by POL (Issue 7) then the NTF (Issues 8 and 9) was approved by the group. In addition, the Group endorsed a suggestion that the African-American GLOSS News (AAGN) be made more relevant to Africa by sharing the editorship between USP and UCT with mirror Web sites.

The GLOSS brochure recently produced by POL was suggested to be put on the Web as a PDF file, so it can be printed by anyone interested. A version in Portuguese was suggested to be produced by Dr. Marone and in Spanish by Dr. Valladares.

11. MORE RESOURCES FOR GLOSS

The Chairman discussed the needs to attract more resources for GLOSS. He mentioned three areas where more resources could be seeked:

(i) Donation of Secondhand Tide Gauges

The IHO will be asked to mail out another circulation letter for secondhand tide gauge equipment and will ask the Hydrographic Society to publicize the requirement. The donation by Singapore in response to a previous appeal for equipment was noted with appreciation by the Group.

(ii) Volunteering of Time

The Chairman urged the panel members to look for ways to volunteer "technician" time to areas where there may be needs for assistance in levelling and/or maintenance or installation of tide gauges. He reported that POL will volunteer a couple of weeks of technician time per year.

(iii) General Funds

The Chairman also urged members to solicit funds from off-shore companies, manufacturers of tide gauge equipment, foundations and national foreign aid programmes.

12. MEETINGS AND ACTIVITIES RELATED TO GLOSS

12.1 IPCC

The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The role of the IPCC is to assess the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change.

The IPCC completed its First Assessment Report in 1990. It played an important role in establishing the Intergovernmental Negotiating Committee for a UN Framework Convention on Climate Change (UNFCCC) by the UN General Assembly. The UNFCCC was adopted in 1992 and entered into force in 1994. It provides the overall policy framework for addressing the climate change issue.

The Second Assessment Report, Climate Change 1995, provided key input to the negotiations, which lead to the adoption of the Kyoto Protocol at the UNFCCC in 1997.

The Third Assessment Report is currently under preparation and will be a comprehensive and up-to-date assessment of the policy-relevant scientific, technical, and socio-economic dimensions of climate change. Dr. Woodworth informed the Group on the progress within Working Group I (which assesses the scientific aspects of the climate system and climate change). A draft version of the sea level chapter of that report, edited by a team headed by Dr. Jonathan Gregory from the UK Hadley Centre, Dr. John Church from the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia, and the GLOSS Chairman, has now been sent out for the first external review. A version for the general public will be available towards the end of the year.

12.2 GLOUP

There is a growing interest for Global Undersea Pressure (GLOUP) data in the sea-level community for use in tidal and space gravity studies. Bottom pressure data complement sea levels in many respects, providing tidal information in the deep ocean, and being of possible greater utility than sea level (whether from tide gauges or altimetry) for the study of ocean dynamics (see *http://www.pol.ac.uk/psmsl/gb7/gloup.report*).

GLOSS and IAPSO have been asked by Dr. Chris Hughes (POL) to endorse the formation of a GLOUP data set. One of the objectives would be to provide easy access to the historical database of *in situ* ocean bottom pressure measurements.

The Group endorsed this proposal.

12.3 ALTIMETRY

Dr. C.K. Shum informed the Group on latest developments in altimeter missions. In particular, he had been able to construct time series of quasi-global sea-level changes from the GEOSAT era through TOPEX/POSEIDON (mid-1980's to the present day), calibrated by tide gauge information, indicating evidence for increasing sea levels in the period although with large uncertainties.

12.4 DATA ARCHAEOLOGY

The Group discussed the need for data archaeology of historic sea-level records in order to possibly extend existing time series and/or gain access to observations which are not in digital form. Currently, sea-level data is not on the list of oceanographic parameters to be resuced under the Global Oceanographic Data Archaeology and Rescue (GODAR) project. However, Dr. Aarup informed the Group about the GODAR Review Conference in Silver Spring, Maryland in July 1999, where a possible extension of the parameter list will be discussed. It was decided that Dr. Aarup and/or Dr. Mitchum should represent GLOSS at this conference and suggest that sea-level data also be included in the GODAR project.

12.5 GLOSS HANDBOOK UPDATING

Drs. Woodworth and Rickards informed the group of plans to expand and enhance information in the GLOSS Handbook product. The Handbook present version is available both as a Web (*http://www.pol.ac.uk/bodc/glosshb/glosshb4.html*) and CD-ROM product, but clearly requires updating at regular intervals. The next version, which it is hoped to complete in 1999, will include as much ancillary information as possible (maps, photographs, etc.).

13. HARDWARE DEVELOPMENTS

Discussions took place on the merits of various new tide gauge technologies, including the use of simple shaft encoders for real time' stilling well operations. (Shaft encoders provide electronic digitisation of the analogue movement of floats in stilling well at relatively modest cost). Tests of newly available encoders are underway in the UK, Spain and South Africa. It was reported that a number of comparative studies of acoustic gauges are also under way at several locations, and conclusions from the separate studies should be synthesized and presented to the GE for inclusion into future training materials.

14. SURVEY OF COMPLIANCE WITH GLOSS IMPLEMENTATION PLAN 1997

The status of the GLOSS Core Network, from the viewpoint of the PSMSL, and from the viewpoint of a survey of operational/non-operational stations conducted in 1998, is described in the Chairman's report to GE6 (see Annex IV).

Dr. Lesley Rickards reported on a further survey, conducted partly during GE6 itself, into how many of the Core Network stations were making their hourly data available to the community (in addition to sending monthly means to the PSMSL), as they are required to do by Chapter 7 of the Implementation Plan. In addition, the survey attempted to estimate how many of these hourly-reporting stations were real-time. The conclusions (summarized in Annex VIII) are that approximately two-thirds of the Core Network stations now make hourly data available, and that the number of real-time sites is expected to grow significantly over the next year. These are very encouraging developments, although much work remains to be done.

15. PLAN OF ACTIONS FOR 1999-2001

Based on extensive discussions during the meeting a Plan of Action for the period 1999-2001 was constructed (Annex VII).

16. RESUME OF RECOMMENDATIONS FROM GE6

Recommendations from the Group are listed in Annex VII, divided into Assembly Recommendations which will be explicitly communicated to the IOC Assembly in June 1999, and Internal Recommendations/Endorsements which will be available to the Assembly in paper form only (i.e. this meeting report).

17. ANY OTHER BUSINESS

Mr. Viorel Malciu suggested that IOC should issue diplomas or certificates to tide gauge authorities which had made special efforts towards GLOSS. Dr. Aarup promised to look into this excellent suggestion.

18. ADOPTION OF THE REPORT

A preliminary report of the meeting was adopted.

19. DATE AND PLACE OF THE NEXT SESSION

Dr. Merrifield tentatively offered to host the GE7 meeting at the University of Hawaii with an accompanying workshop on sea level science as a tribute to the work of Prof. Klaus Wyrtki. In the event that is not possible, Dr. Wolfgang Scherer offered to host the GE7 at NTF in Australia.

20. CLOSURE

The Chairman thanked the Director of the Observatoire du Midi Pyrennées (Dr. Daniel Guedalia) and Dr. Christian Le Provost once again for their hospitality in Toulouse. He closed the Session at 13.00 on May 14 1999.

ANNEX I

AGENDA

1. ORGANIZATION OF THE SESSION

1.1 OPENING OF THE SESSION
1.2 ADOPTION OF THE AGENDA
1.3 DESIGNATION OF THE RAPPORTEUR

2. & 3. REVIEW OF GLOSS ACTIVITIES

4. REPORT OF THE WORKSHOP ON OCEAN CIRCULATION SCIENCE DERIVED FROM THE ATLANTIC, INDIAN AND ARCTIC SEA LEVEL NETWORKS

5. GEODETIC FIXING OF TIDE GAUGE BENCHMARKS

5.1 REPORT OF THE GPS AT TIDE GAUGES STUDY GROUP
5.2 GLOSS-ALTIMETRY STATUS

6. REPORTS OF THE INTERNATIONAL SEA-LEVEL CENTRES, REGIONAL AND INTERNATIONAL ACTIVITIES

6.1 PSMSL
6.2 WOCE
6.3 AUSTRALIAN NTF AND SOUTHERN OCEAN
6.4 AFRICAN GLOSS NETWORK
6.5 EOSS AND MedGLOSS
6.6 INDIAN OCEAN
6.7 CARIBBEAN ACTIVITIES
6.8 ARCTIC
6.9 APSG AND TAIWAN MEETING REPORT
6.10 VIET NAM
6.11 IAPSO TIDAL CONSTANTS DATA SET
6.12 WEST INDIAN OCEAN REPORTS
6.13 NATIONAL REPORTS

7. GGE DEVELOPMENTS

7.1 GGE STANDING MEMBERS
7.2 SUB-GROUP OF THE GGE AS A SOURCE OF SCIENCE INPUT

8. SEA-LEVEL REQUIREMENTS OF THE GOOS COASTAL MODULE

9. INTERACTIONS WITH GOOS

10. CAPACITY BUILDING ACTIVITIES

10.1 REPORT OF THE IOC/GLOSS-GOOS TRAINING COURSE AT

THE UNIVERSITY OF CAPE TOWN

10.2 PLANS FOR A GLOSS TRAINING COURSE AT UNIVERSITY OF SAO PAULO
10.3 UPDATING OF GLOSS MANUALS
10.4 OTHER CAPACITY BUILDING ACTIVITIES
10.5 NEWSLETTERS

11. MORE RESOURCES FOR GLOSS

12. MEETINGS AND ACTIVITIES RELATED TO GLOSS

12.1 IPCC
12.2 GLOUP
12.3 ALTIMETRY
12.4 DATA ARCHAEOLOGY
12.5 GLOSS HANDBOOK UPDATING

13. HARDWARE DEVELOPMENTS

14. SURVEY OF COMPLIANCE WITH GLOSS IMPLEMENTATION PLAN 1997

15. PLAN OF ACTIONS FOR 1999-2001

16. RESUME OF RECOMMENDATIONS FROM GE6

17. ANY OTHER BUSINESS

18. ADOPTION OF THE REPORT

19. DATE AND PLACE OF THE NEXT SESSION

20. CLOSURE

ANNEX II

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ANNEX III

LIST OF DOCUMENTS

(See GLOSS Bulletin Web pages *http://www.pol.ac.uk/psmsl/gb7/* for many of these reports)

LIST OF INTERNATIONAL CENTRE REPORTS

Permanent Service for Mean Sea Level
WOCE Fast and Delayed Mode Centres
Southern Ocean Sea Level Centre

LIST OF COUNTRY AND REGIONAL REPORTS

Argentina
Australia
Chile
Côte d'Ivoire
France
Ghana
Israel
Nigeria
Romania
Russia
Ukraine
United Kingdom
Uruguay

Arctic
Asia-Pacific (Space Geodynamics Project)
Caribbean
Western Indian Ocean (including Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa and Tanzania)
IOCINDIO (including Bangladesh, Iran, Iraq, Sri Lanka and India)

ANNEX IV

CHAIRMAN'S REPORT TO GE6

Chairman's Report of GLOSS Activities since the Fifth Session of the Group of Experts

P. L. Woodworth

The fifth session of the GLOSS Group of Experts was held at the Jet Propulsion Laboratory (JPL) 19-21 March 1997 at the invitation of Dr. Bill Melbourne and Dr. Ruth Neilan, Director of International GPS Service for Geodynamics (IGS) Central Bureau. This meeting was the first at which I had acted as GLOSS Chairman, having been Acting Chairman for the past year since the resignation of Dr. David Pugh. The meeting thanked Dr. Pugh and Dr. Albert Tolkatchev, the retiring GLOSS/GOOS Technical Secretary at IOC, for their many years of work for GLOSS.

This report is intended to provide a brief summary of some GLOSS-related activities since the GE5 meeting from my point of view. The list is an impressive one and I hope it will serve to stimulate consideration of further GLOSS products and projects (especially its regional activities) at the sixth session in Toulouse during 12-14 May.

POST-JPL PUBLICATIONS

Minutes of the fifth session of the group have been published (IOC/GE-GLOSS-V/3, UNESCO 1997) as has a comprehensive report on the IGS/PSMSL Workshop on GPS at tide gauges which preceded it (Neilan *et al.*, 1998). Ruth and the IGS Central Bureau are to be thanked for producing excellent paper and Web versions of this report. A draft report by the GPS Technical Committee stemming from the Workshop has been prepared by the Chairman, Dr. Mike Bevis which will be debated and enhanced at the 11 May GPS at tide gauges meeting in Toulouse.

A particularly important task for the GE5 meeting was a review of the draft new Implementation Plan for GLOSS prepared with contributions from many sea-level scientists. This was endorsed by the meeting, subject to some recommended modifications, and was subsequently presented for endorsement by the 19th Session of the IOC Assembly at UNESCO, Paris, July 1997. The Assembly also endorsed the Plan, with minor modifications, and the final version has since been printed and circulated by IOC (IOC Technical Series 50, UNESCO 1997). It is also available on the Web.

The Implementation Plan was also presented in June 1997 to international attendees at the First GOOS Forum meeting in Paris, and was discussed during the I-GOOS-III meeting following the Forum.

ACTIONS LIST

A large number of actions were generated by the GE5 meeting which can be inspected *via http://www.pol.ac.uk/psmsl/ge6/ge5actions*.

I believe this was the first time such a comprehensive list was produced at a GE meeting and it has proved to be very useful in providing stimulus to activity in between meetings. Another list will be produced during GE6.

GLOSS STATUS FROM A PSMSL VIEWPOINT (OCTOBER 1998)

For the last few years, usually coinciding with a GLOSS GE meeting, the PSMSL has provided a summary of the status of GLOSS from its viewpoint. This summary has usually been made in October so as not to bias the statistics because of the seasonal cycle of data receipts.

An operational station from a PSMSL viewpoint means that recent Mean Sea Level (MSL) monthly and annual values have been received at Bidston, have been checked as far as possible, and have been included in the databank. For each of the GLOSS stations, we have used the year of the last data entered into the databank, if any, to place the station into one of four categories:

Category 1: Operational stations for which the latest data is 1994 or later;
Category 2: Probably operational stations for which the latest data is within the period 1984-1993;
Category 3: Historical stations for which the latest data is earlier than 1984;
Category 4: For which no PSMSL data exist.

Table 1 lists the numbers of stations which fall into each category for all stations. Also shown in Table 1 are the numbers in each category reported previously with the category definitions adjusted backwards one, two, three, etc. years appropriately. Note that before 1993 we used the GLOSS90 definition of GLOSS (306 stations total), whereas 1993 onwards we have used GLOSS93 (308 stations total). We don't believe that change modified the statistics to a great extent. Also note that from 1997 we have used the GLOSS97 definition of GLOSS (287 stations total).

Overall, the statistics for 1998 are similar to those for 1997 indicating ongoing work is required to develop the network even further.

Table 1

Number of Stations in Each Category (1989-1998)

Cat	89	90	91	92	93	94	95	96	97	97	98
1	105	133	136	158	177	183	168	186	183	182	183
2	51	50	57	46	33	35	59	46	48	47	48
3	47	42	36	29	26	26	22	21	23	17	20
4	103	81	77	73	72	64	59	55	54	41	36
Total	306	306	306	306	308	308	308	308	308	287	287
using GLOSS Definition	90	90	90	90	93	93	93	93	93	97	97

GLOSS OPERATIONAL AND NON-OPERATIONAL STATIONS SURVEY (DECEMBER 1998)

In December, a detailed survey was conducted of the 287 stations of the GLOSS Core Network (GCN) to determine which gauges were operational or not as of February, the deadline for receipts of

questionnaire replies from national authorities as part of GLOSS Handbook updating. The replies were supplemented by PSMSL general knowledge in the case of non-replies.

Of the 287 sites in the GCN (defined by GLOSS97), only 42 are claimed to be non-operational. This set is listed in Appendix 1 below. It is clear that action must be taken by national authorities to instrument the sites in order to complete the network. If national resources are limited, the authorities should be endeavouring to install equipment through bi-lateral links or possibly by making requests for secondhand equipment through IOC (see GE5actions file). Alternatively, if a site cannot feasibly be instrumented, perhaps owing to environmental conditions, then IOC should be notified so that it can be reviewed for removal from the definition of the GCN at the next revision of the network.

RECONCILIATION OF THE STATISTICS OF THE PREVIOUS TWO SECTIONS

It is clear that Appendix 1 presents a more optimistic view of GLOSS status than do the statistics compiled from the PSMSL, a situation which requires investigation. One reason is that at some operational locations (e.g. Tristan da Cunha and some Antarctic sites), the gauges take the form of simple pressure transducers which provide useful information for oceanography (e.g. for the World Ocean Circulation Experiment) but which do not supply MSL data, as conventionally defined, which can subsequently be submitted to the PSMSL. This situation is understandable and tolerable if there are good environmental or technical reasons for such a choice of technology.

However, a second reason is that while an operational gauge might exist and be providing data of some kind, the expertise or facilities or manpower do not exist in order to process those data routinely and deliver them to the international community. This situation is not an acceptable one, as it clearly requires some kind of investment in hardware, software or training. The job of IOC/GLOSS is to remedy such situations as far as possible.

IOC TRAINING COURSES

A number of IOC/GLOSS training courses have been held since GE5 or are in the planning stage.

A training course for eight sea level scientists from Mediterranean and Black Sea countries, and also attended by a number of local people, was held at the Proudman Oceanographic Laboratory (Bidston Observatory) during 16-27 June. This course was organized by Mr. Graham Alcock, who was responsible for the many previous successful GLOSS courses at POL during the 1980s. The main themes of the course concerned the background science, the need for related geodetic measurements, and hands-on training sessions (HOTS)'. Invited external speakers included Drs. David Pugh and M. Tsimplis (Southampton Oceanography Centre), Dr. Albert Tolkatchev (IOC), Dr. A. Plater (Liverpool University), Dr. R. Bingley (Nottingham University) and Dr. D. Rosen (Israel Oceanographic and Limnological Research). A number of POL scientists also provided lectures and organized trips to nearby tide gauges. A presentation was made to Dr. Tolkatchev to mark his retirement.

The POL course was co-funded by the Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranée (CIESM), and was followed by a sea level summer school in Kos, Greece in July for Mediterranean scientists funded by the European Union. Mediterranean sea levels consequently received considerable attention in 1997.

A further, but larger GLOSS training course in a similar style to the Dehra Dun 1995 and POL 1997 courses was held at the University of Cape Town (UCT) during 16-27 November 1998 organized by Prof. Geoff Brundrit and Dr. Howard Waldron. This course had ten official attendees from Africa, Yemen and

Brazil and a large number of local participants. Invited external speakers included Drs. Philip Woodworth and Trevor Baker (POL) and Ms. Janice Trotte (IOC) with other lectures by UCT staff. The main themes of the course concerned background sea-level science (climate change, oceanography), the need for related geodetic measurements, and HOTS. Visits to tide gauge and geological sea level sites were also provided as were exercises in geodetic leveling. The opportunity was taken to also discuss plans for action in east, south and west Africa as part of GLOSS and of the Global Ocean Observing System (GOOS) for Africa. This was a very successful course, for which a workshop report will shortly be available containing extensive reviews of status in each participating country.

A further training course has been proposed at the University of Sao Paulo, Brazil in September 1999 following recommendations of the GE5 meeting and of the IOC Executive Council in 1998. Proposals for training courses thereafter will be discussed at the GLOSS GE6 session and will of course be subject to available funding.

TRAINING MATERIALS

The two parts of the IOC Manuals and Guides No.14 are now showing their age and their updating or replacement needs to be discussed. A Part 3 on How to Operate GPS Near a Tide Gauge is to be produced by the GPS Technical Committee with the three parts of the overall Manual published together or separately as appropriate.

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 Pat Caldwell from the University of Hawaii; this formed the basis of HOTS at Dehra Dun 1995 for example. The TASK-2000 package from POL was used at the POL 1997 and UCT 1998 courses. Either the Caldwell package or local USP software will be used at the USP 1999 course. A further package is available from the Australian NTF.

A number of GLOSS-related CD-ROMs have been produced over the last few years, primarily by the British Oceanographic Data Centre (BODC) and the National Oceanic and Atmospheric Administration (NOAA), containing GLOSS Handbook and PSMSL data sets and the World Ocean Circulation Experiment (WOCE) Sea Level Centre files, together with scanned versions of the IOC Manuals which can be read with Adobe Acrobat software. The most recent version is that produced for the International WOCE Conference in Halifax, Canada in May 1998. In preparation for that conference, BODC and the PSMSL circulated all GLOSS Contacts with a request to update and extend the information in the current version of the Handbook and that exercise will be repeated in 1999. Most of the files on the CD-ROMs are also available on the Web. The Handbook can be inspected at:

http://www.pol.ac.uk/bodc/glosshb/glosshb4.htm

and any scientist with updated information to provide, or comments to make on particular sites, is invited to contact the PSMSL.

NEWSLETTERS AND BROCHURE

There have been six issues of the GLOSS Bulletin on the Web. The PSMSL has undertaken to produce a 7th in 1999, primarily using contributions from GE6. Thereafter, a volunteer organization is required to take over production of the Bulletin. The African-American GLOSS News (AAGN) also continues to be produced regularly. This newsletter has articles mostly in Spanish and Portuguese, and is produced by the University of Sao Paulo on paper and on the Web. A special GLOSS newsletter for Africa was suggested at the UCT training course.

All sea level centres (PSMSL, BODC, UHSCL, NTF) now have good Web pages which serve to spread information to the public as well as to the science community.

An updated two page brochure advertizing GLOSS has been produced by Gillian Spencer and Robert Smith. Two thousand copies have been printed for circulation in the UK and we hope that others will be printed by UNESCO. We also hope that GLOSS National and Regional Contacts will arrange for printing in their own countries. Copies of the files which make up the brochure (Corel Draw files) may be sent to anyone interested who can edit and adapt them according to local interests.

GLOSS E-MAIL SURVEY

All GLOSS Contacts can now be reached *via* electronic mail except for those from the following countries. If e-mail addresses exist which we are not familiar with, we would be very grateful for the information:

Angola, Bangladesh, Cameroon, People's Republic of China, Congo, Djibouti, El Salvador, Fiji, Guinea, Haiti, Indonesia, Jamaica, North Korea, Madagascar, Mauritania, Mexico, Morocco, Myanmar (Burma), Panama, Sao Tome & Principe, Sierra Leone, Somalia, Sri Lanka, Tanzania, Thailand, Trinidad & Tobago, Uruguay and Yemen.

RELEVANT GLOSS-RELATED MEETINGS

Full meetings of the GLOSS Group of Experts (GGE) take place at approximately two-yearly intervals. However, it is our intention that international collaboration will be enhanced by holding regional meetings in intervening years whenever possible.

An excellent GLOSS-related workshop on different aspects of sea level studies, concentrating especially on climate and oceanographic interests, took place at the University of Hawaii, Honolulu, USA during 10-11 June 1997. This workshop considered the roles of remotely sensed and *in situ* systems for monitoring different aspects of the ocean/climate system which result in observable sea-level signals. A workshop report, edited by Dr. N.Smith (Chairman of the Ocean Observing Panel on Climate, OOPC), and a study of the global network by Dr. V.Gornitz (Goddard Institute for Space Studies), was published in 1998.

One recommendation of the meeting relates to the possibility of establishing a scientific sea-level advisory group jointly between IOC/GLOSS and other bodies (such as CLIVAR and the OOPC) to provide ongoing scientific advice to the wider GLOSS group. This will be discussed at GE6.

A regional GLOSS meeting was held on 20 July 1998 at the Academia Sinica, Taiwan hosted by Prof. Shui-Beih Yu, in association with a meeting of the sea-level group of the Asia Pacific Space Geodynamics project led by Prof. C. K.Shum from Ohio State University. The meeting benefitted from the attendance of many scientists at the Western Pacific Geophysics Meeting in Taiwan the following week. Further information on the GLOSS meeting can be found at:

http://www.pol.ac.uk/psmsl/gb6/pcs.html

This meeting followed hot on the heels of an Asia Pacific Space Geodynamics meeting in Tahiti at which C. K.Shum also took the opportunity to stimulate GLOSS-relevant activities. A report on that meeting is now available.

We also intend that there will be a GLOSS meeting at the IUGG in Birmingham in July 1999, probably held in association with the IAPSO Commission on MSL and Tides. I will be a co-convenor for one of the two main sea level sessions at the Birmingham conference.

TIDE GAUGE HARDWARE PROVISION

Four OTT tide-gauges provided by Sweden were sent by Germany to Nigeria, Guinea, Gambia and Côte d'Ivoire in 1996. A report is anticipated from Larry Awosika, the IOCEA GLOSS Regional Coordinator, on this matter. Latest news, however, is not encouraging with regard to their installation (see the GE5actions list). This stresses that the provision of training courses and/or hardware is not necessarily enough to make progress.

A request for secondhand, but serviceable, tide gauge hardware was circulated by the PSMSL in 1998, and relayed to the correspondence list of the International Hydrographic Organizsation (IHO). This resulted in the offer of 4 good Ott R20 gauges from Singapore, and the possibility of offers of others. This single kind donation from Singapore to GLOSS will result in at least two African countries (Madagascar, Ghana and one or two others) having new gauges in 1999. The PSMSL and IHO intend to repeat the request in the near future. At the present time, POL intends to add shaft encoder data loggers to at least two of the Singapore gauges. However, in general, is second hand equipment worth the effort? Experiments at POL and in South Africa suggest that the Ott encoders may be a very cost effective option (less than 2K$) for many locations as a stand-alone system and, of course, they would be new, modern equipment with a guarantee. We hope that further information will be available at GE6.

TIDE GAUGE SCIENCE (e.g., IPCC)

As normal, there have been many science meetings at which sea-level changes have been discussed. All relevant sea-level meetings which I attend each year are summarized in the PSMSL Annual Reports (*http://www.pol.ac.uk/psmsl/psmsl.info.html).*

Numerous papers have been published using GLOSS (and sea-level in general) data. The IPCC Second (1995) Scientific Assessment published in 1996 was most important in stressing the continued need for sea-level measurements. The Third Assessment has now started with a sea-level chapter led by Drs. John Church and Jonathan Gregory which all GLOSS Experts should provide input to.

CONTINUED DEVELOPMENT OF GLOSS-GOOS

Evidence that GLOSS objectives are being met (slowly maybe) can be obtained from the data holdings of the PSMSL and other centres (UHSLC, NTF/SOSLC, etc.). Statistics such as those described above have been compiled each year and are given in the PSMSL Annual Reports. Discussions at meetings in Sydney and Paris of the Interim Implementation Advisory Group (IIAG) for GOOS, which includes GLOSS, during 1998 have demonstrated the need for a whole new range of sea-level measurements for coastal applications, additional to the areas normally discussed in a GLOSS context. Consequently, there is likely to be a considerably enhanced requirement for training, advice and collaborative measurement activities in the future. How the resources for such work will be found is a major issue for discussion at GE6.

There have been a number of GLOSS regional activities started over the past decade (see Chapters 8 and 9 of the GLOSS Implementation Plan for short descriptions). However, there have not been enough of them and there is a major need for regional stimulation of GLOSS activities (see GE6 agenda). In my opinion,

this is the single most important thing which would boost GLOSS, if a sufficient number of energetic regional activists can be found.

REQUESTS FOR NEW RESOURCES FOR GLOSS

IOC funds for GLOSS are extremely limited and tend to be devoted to the costs of meetings (e.g. those of the GLOSS Group of Experts), training courses (e.g. the University of Cape Town course) and sea level products (e.g. data and training CD-ROMs). There are virtually no funds for new gauges or geodetic equipment.

A course of action was initiated in 1998 in order to try to find new resources for GLOSS. Letters have been written to international companies (e.g. oil companies, tide gauge manufacturers) with interests in certain parts of the world for which GLOSS developments are required. The letters asked if interest exists in the companies to sponsor the training and/or provision of hardware to a young scientist, perhaps *via* a master's course. At the time of writing, it is too early to judge the success of such appeals. Suggestions have been made for investigating the foreign aid budgets of various countries. Other suggestions are welcome.

GLOSS FORWARD LOOK

It is interesting that during the two years under review that the most senior of the world's politicians were evidently doing good work on our behalf. At the Fourth Session of the UN Framework Convention on Climate Change, Conference of the Parties in Buenos Aires, 2-13 November, the following recommendations of the Subsidiary Body for Scientific and Technological Advice were approved (amongst others). Such recommendations could have been written with the PSMSL and GLOSS in mind, and give the highest possible lead to national authorities to provide the international community with the sea level and other data sets which it needs for research. When considered alongside the approval of the new GLOSS Implementation Plan by the IOC Assembly in 1997, GLOSS can be seen to, in principle, have the highest level backing in which to perform its work in coming years:

The Conference **urges** parties to undertake programmes of systematic observation including the preparation of specific national plans, in response to requests from agencies participating in the Climate Agenda, based on the information developed by the Global Climate Observing System and its partner programmes;

Urges parties to undertake free and unrestricted exchange of data to meet the needs of the Convention, recognizing the various policies on data exchange of relevant international and intergovernmental organizations;

Urges parties to actively support the building of capacity in developing countries, to enable them to collect, exchange and utilize data to meet local, regional and international needs;

Urges parties to strengthen international and intergovernmental programmes assisting countries to acquire and use climate information;

Urges parties to actively support national oceanographic observing systems, to ensure that the elements of the Global Climate Observing System and Global Ocean Observing System networks in support of ocean climate observations are implemented and, to the extent possible, support an increase in the number of ocean observations, particularly in remote locations, and to establish and maintain reference stations.

GLOSS TECHNICAL SECRETARIES

Following the retirement of Dr. Tolkatchev from IOC in 1997, and the reorganization of the GOOS Office in Paris following the appointment of the new Director, Dr. Colin Summerhayes, the role of the GLOSS Technical Secretary has been occupied part-time until the end of 1998 by Ms Janice Trotte from the Directoria de Hidrografia e Navegacao (DHN) in Brazil. Her work for GLOSS was very much appreciated by the Group of Experts. In January 1999 Dr. Thorkild Aarup from Denmark was appointed Technical Secretary for GLOSS.

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Appendix 1: Non-Operational GLOSS Sites

No.	GLOSS Station	Responsible Country
262	LOBITO	ANGOLA
190	PUERTO DESEADO	ARGENTINA
47	CHRISTMAS IS.	AUSTRALIA
197	PORTO DE NATAL	BRAZIL
153	LITTLE CORNWALLIS IS.	CANADA
224	NAIN	CANADA
261	POINTE NOIRE	CONGO
166	I. DEL COCO	COSTA RICA
227	DANMARKSHAVN, GREENLAND	DENMARK
315	ITTOQQORTOORMIIT, GREENLAND	DENMARK
2	DJIBOUTI	DJIBOUTI
182	ACAJUTLA	EL SALVADOR
165	CLIPPERTON IS.	FRANCE
21	CROZET IS.	FRANCE
131	DUMONT D'URVILLE	FRANCE
204	LE ROBERT, MARTINIQUE	FRANCE
24	ST. PAUL IS	FRANCE
209	PORT-AU-PRINCE/LES GAYES	HAITI
41	NICOBAR	INDIA
67	SORONG	INDONESIA
240	CASTLETOWNSEND	IRELAND
252	NOUADHIBOU (CAP BLANC)	MAURITANIA
160	ISLA GUADALUPE	MEXICO
282	TAN TAN	MOROCCO
141	MOULMEIN	MYANMAR
128	CHATHAM IS.	NEW ZEALAND
134	SCOTT BASE	NEW ZEALAND
232	BJORNOYA (BEAR ISLAND)	NORWAY
295	GWADAR	PAKISTAN
272	DARU	PAPUA NEW GUINEA
64	VANIMO	PAPUA NEW GUINEA
25	MIRNY (ANTARCTICA)	RUSSIA
260	SAO TOME	SAO TOME/PRINCIPE
256	ABERDEEN POINT	SIERRA LEONE
6	HAFUN (DANTE)	SOMALIA
7	MOGADISHU	SOMALIA
20	MARION IS.	SOUTH AFRICA
9	MTWARA	TANZANIA
303	MASSACRE BAY	ATTU IS.,ALASKA U.S.A.
218	MIAMI (HAULOVER PIER)	U.S.A.
3	ADEN	YEMEN, P.D.R.
304	SOCOTRA IS.	YEMEN, P.D.R.

ANNEX V

PSMSL REPORT TO THE GE6 MEETING

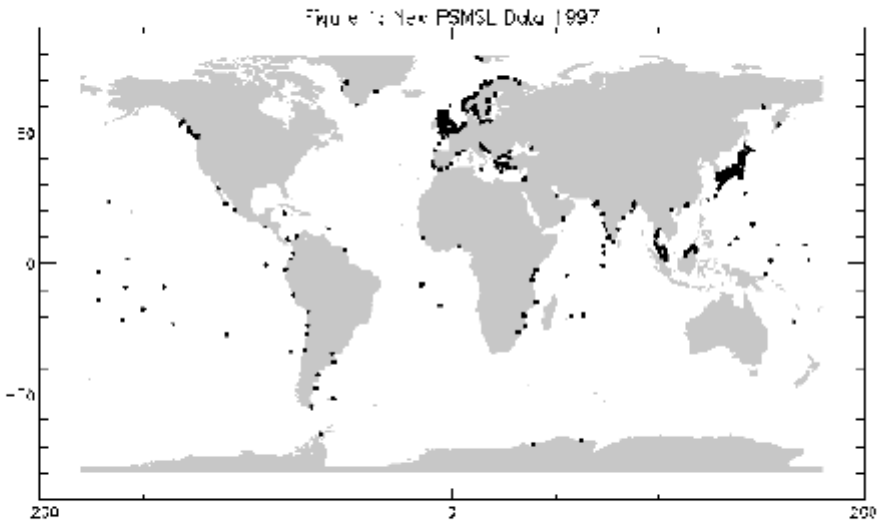
1. INTRODUCTION

This report reviews briefly the work of the Permanent Service for Mean Sea Level (PSMSL) during 1997-98. Many of the PSMSL's GLOSS-related activities in this period have already been covered in the Chairman's Report to the GE6 meeting. In this short note, other aspects of interest from the PSMSL Annual Reports of the last two years are reviewed briefly. GLOSS is important to the PSMSL in that one of the stated main aims of the programme is to improve the quantity and quality of data supplied to the Service.

2. PSMSL DATA RECEIPTS FOR 1997-98

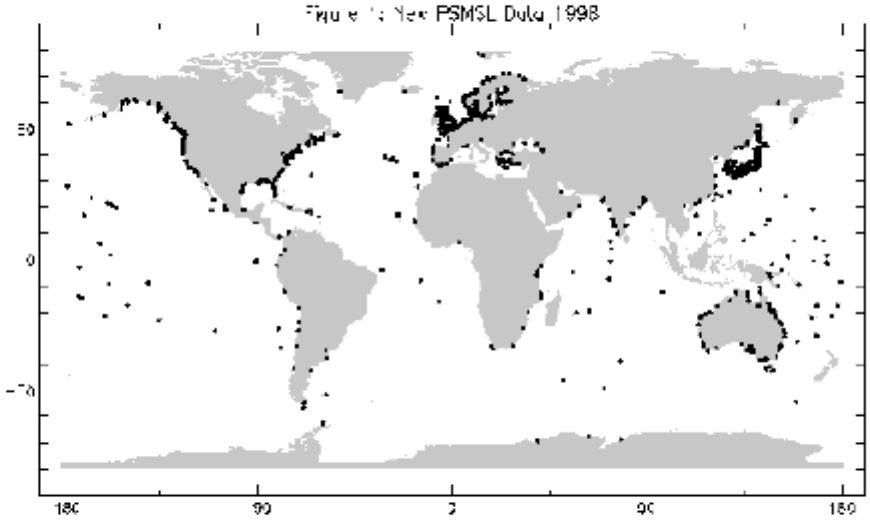
In the period 1997-98 over 3300 station-years of data were entered into the PSMSL database. This record amount of information was received from the countries shown in

http://www.pol.ac.uk/psmsl/anrep97.figure1.gif (data receipts for 1997)



and

http://www.pol.ac.uk/psmsl/anrep98.fig1.gif (data receipts for 1998)



In particular, large numbers of station-years, including several sets of national data backlogs and a number of newly acquired long time series, were obtained from Finland, Spain, Ukraine, Russia, Australia, Chile and the USA. The most gratifying aspect of the figures is the evidence that data are now received routinely from almost all parts of the world, aside from parts of Africa and South America. This agreeable development has arisen partly thanks to the availability of electronic mail and fax in almost all agencies with which the PSMSL maintains contact. Elaine Spencer, PSMSL Technical Secretary, is to be congratulated on a considerable amount of hard work in acquiring, checking and data banking the record amount of information.

3. TASK-2000

The PSMSL/POL Tidal Analysis Software Kit (TASK) has been extended and updated during 1998, particularly with regard to year 2000 compliance. The package was used intensively during the HOTS sessions at the POL 1997 and Cape Town 1998 training courses and is available free to any university or research institute scientist. A small fee will be charged to commercial users.

4. IPCC

The third scientific assessment of the Intergovernmental Panel on Climate Change (IPCC) commenced with a meeting in Bad Munstereifel, Germany at the end of the June 1998 and with a first drafting session in Paris in December. At the Bad Munstereifel meeting, there was considerable discussion as to whether there should be a dedicated sea level chapter and working group, as for the second assessment. In the end, the conclusion was that there should be, and the following people were eventually delegated to act as Lead Authors:

John Church	CSIRO Marine Research, Australia (Joint Coordinator)
Jonathan Gregory	Hadley Centre, UK (Joint Coordinator)
Philippe Huybrechts	Free University of Brussels, Belgium
Michael Kuhn	University of Innsbruck, Austria
Kurt Lambeck	Australian National University
Dahe Qin	Chinese Academy of Sciences
Philip Woodworth	Proudman Oceanographic Laboratory, UK and PSMSL

The latter's role in this is, of course, to provide some linkage to GLOSS and the PSMSL. Any input to the editing work to be performed by these Lead Authors over the next year or so will be much appreciated.

The December IPCC meeting was followed by the International CLIVAR (Climate Variability and Prediction) Conference, also held in Paris. I represented the PSMSL and was also a member of the UK delegation at this conference.

5. EOSS

The European Union EOSS project (formerly called NOSS) aims to enhance sea level (tide gauges) and land level (GPS) monitoring, and associated data exchange, in Europe primarily by sets of bilateral (i.e. no new cost) agreements. First activities in this five-year project have centred around the North Sea, where most of the countries which have so far signed up to the project commitments are located. Philip Axe from PSMSL/POL has taken the lead in informing the EOSS group of the activities in GLOSS and in leading Work Package 5 which is associated with data exchange issues. Philip has also attended all twice-yearly Management Meetings. In addition, Elaine Spencer, Trevor Baker and myself have contributed to EOSS activities during the period. It is to be hoped that EOSS will result in the more reliable provision of sea and land level information from the European region. More information on EOSS can be obtained at:

http://www.pol.ac.uk/psmsl/eoss/eoss.html

6. ALTIMETRY AND GRAVITY FIELD ACTIVITIES

Participation has continued in European and US altimeter working groups. Chris Hughes and I became Principal Investigators for the JASON (TOPEX/POSEIDON Follow On) mission during the period, while I obtained Co-Investigator status for the Envisat mission of the European Space Agency (ESA). In April-May 1998, POL and Liverpool University hosted a meeting of the British Group of Altimeter Specialists (BGAS).

A number of meetings were attended through of the Mission Advisory Group (MAG) of the ESA Gravity Field and Steady State Ocean Circulation Experiment (GOCE) mission, which is now near the end of the Phase-A development stage. The provision of a more precise model of the Earth's gravity field and geoid is of great importance to a range of oceanographic and geophysical studies.

7. AFTER GLOSS: GLOUP

Many people interested in tide gauges and altimetry will also be interested in bottom pressure measurements. Chris Hughes from POL has recently taken a lead in trying to get global bottom pressure measurements and data sets on a better footing, providing potentially a component of GOOS parallel to GLOSS. He calls this activity GLOUP. For more information, see:

http://www.pol.ac.uk/psmsl/gloup/gloup.html

A meeting connected to GLOUP will be held in April 1999 at the Royal Society organised by Chris Huges and Prof. Carl Wunsch from the Massachusetts Institute of Technology.

8. RELEVANT MEETINGS

The following relevant meetings were attended during 1997-98, in addition to those discussed above. More information on each meeting can be found in the PSMSL Annual Reports:

March 1997:	PSMSL/IGS Workshop at Jet Propulsion Laboratory, USA
April:	European Sea Level Workshop at Barcelona
May:	UK Sea Level Workshop in London
June:	International Sea Level Workshop in Hawaii, USA
July:	IAG Conference at Rio de Janeiro (PSMSL represented by Prof. A. R.de Mesquita)
October:	Ocean Data Symposium in Dublin (PSMSL represented by Dr. Lesley Rickards)
October:	TOPEX/POSEIDON and Ocean onitoring Meeting in Biarritz
December:	EOSS Management Committee at Copenhagen
Feb-March 1998:	Workshop to Develop an Implementation Action Plan for GOOS in Sydney, Australia
March:	Visit to the Australian National Tidal Facility
July:	Visit to Hong Kong Polytechnic University (for APSG)
September:	Gravity Day at ESTEC/ESA, Netherlands
October:	Symposium to mark the retirement of Prof.Vidal Ashkenazi, University of Nottingham, UK
November:	Interim Advisory Group for GOOS meeting, Metéo-France, Paris

9. TIDAL SCIENCE '96

A meeting entitled Tidal Science '96 was held at the Royal Society in October of that year. During 1998, papers stemming from the meeting were published in a special issue of Progress in Oceanography, with Richard Ray (Goddard Space Flight Center) and myself acting as editors.

10. PUBLICITY

Open Days took place at POL (including PSMSL) during 16-19 July 1998 and were attended by 2000 members of the public as well as local dignitaries and Members of Parliament. In addition, one Cabinet Minister and one Junior Minister attended at a later date.

The PSMSL/GLOSS benefitted later in 1998 from a high public exposure related to a Climate Change in the UK report issued by the Hadley Centre and University of East Anglia in which past and future sea level was discussed in some detail. (Discussion followed largely that of the second IPCC scientific assessment.) An article describing the work of the PSMSL appeared in the Liverpool Echo. Subsequently, Graham Alcock represented the PSMSL at a Climate Change in the NW England meeting in December.

In November the work of the PSMSL was featured in a programme on the second German TV network (ZDF).

11. PSMSL/WOCE CENTRE STAFFING

Philip Axe from the University of Plymouth joined the PSMSL at the beginning of 1997. He has recently finished his Ph.D studies on coastal processes in the south of England and is currently completing his thesis. His main duties at the PSMSL and WOCE Centre include updating several WOCE-related sea level data sets, overlaps with the various European and global GPS/tide gauge activities and scientific analysis of the data.

SUMMARY

It can be seen that 1997-98 has been a further active period with regard to important workshops and conferences, and a busy one with regard to data acquisition and analysis.

Particular thanks to Elaine Spencer who has been PSMSL Technical since 1974. The PSMSL is very much her data set. Unfortunately, both Elaine and her husband Bob, who will be well known to a number of GLOSS people through his deployments of tide gauges and bottom pressure recorders decided to take early retirement in May 1999. I am sure that the sincere thanks and best wishes of the GLOSS community will be extended to them both.

ANNEX VI

GLOSS PLAN OF ACTIONS 1999-2001

1. Production of GE6 report (IOC).

2. Presentation of GLOSS GE6 report and Recommendations to IOC Assembly in June 1999 (Chairman/IOC).

3. Publication of Toulouse workshop report (Mitchum/IOC).

4. Report on GLOSS and presentation at JCOMMTRAN-1 meeting in St. Petersburg in July 1999 and communication of recommendations from GE6 (Chairman/Zilberstein/Summerhayes).

5. Arrangements for GLOSS representation at IUGG and IAPSO/CMSLT in Birmingham in July 1999 including presentation on GLOSS in a Union Symposium (Chairman/Le Provost).

6. Development of new Web- and cdrom-based training materials on gauge operations including re-writing of IOC Manuals 1 and 2 (Chairman/Scherer *et al*).

7. Production of Manual 3 on operating GPS at gauges as a living document on the Web (Bevis *et al.*).

8. Attendance at IGS processing meeting June 1999 to carry forward requirements for GPS data processing from gauges as discussed at GE6 (Bevis).

9. A further round of correspondence to all GLOSS Contacts and subsequent updating of the GLOSS Handbook. Extension of the Handbook to include photographs, information on site environmental conditions (hard rock, etc.), and other metadata. Possible redefinition of the GLOSS Core Network following discussions at GE6 (Chairman/Rickards/IOC).

10. Circulation of a questionnaire in which GLOSS stations have extra channels for additional C-GOOS parameters, information to be inserted into the GLOSS Handbook (Chairman).

11. Production of summary of compliance of agencies with requirements of Chapter 7 of the GLOSS Implementation Plan (Rickards/Chairman).

12. Repeat survey of GLOSS Contacts not on email (Chairman).

13. Continuation and development of the two WOCE Sea Level Centres and Southern Ocean Sea Level Centre, the UHSLC to be recognized as the GLOSS Fast Delivery Sea Level Centre (Merrifield/Rickards/Scherer).

14. Letters to be sent to all GLOSS Contacts stressing the importance of real time data with data sent to the GLOSS FD Centre, and pointing out the possibilities of new technology (shaft encoders, etc.), (Chairman/IOC).

15. GLOSS Data Management Committee to determine ways in which the two WOCE Sea Level Centres (UHSLC and BODC) and others can work towards common products and implementation of the

Implementation Plan (Rickards/Kilonsky/others).

16. Investigation of ways in which time series data of GPS coordinates can be conveyed to data centres for merging with sea level data (Bevis/Axe).

17. Scientific review paper on the applications of sea level data collected during WOCE (Merrifield/Rickards *et al*).

18. Continued support of PSMSL activities with regard to GLOSS development (IOC).

19. Support of developments in sea level measurements in Africa including:

- implementation of recommendations from the GE6 meeting and those of the University of Cape Town training course with regard to the establishment of an African GLOSS Network and associated tasks (Brundrit/IOC);

- close contact between GE Chairman and IOC with A. Aman and A. Adekoya as the joint Regional Contacts for West Africa, M. Odido for East Africa and with G. Brundrit as GLOSS-Africa Chairman;

- organization by the African GLOSS Network of an International Conference on the scientific uses of sea level in East Africa within the next two years. Such a meeting would make use of the availability of a decade of sea level data from the region (Odido/Brundrit);

- POL installation of a gauge at Tema, Ghana and if successful at Takoradi, these gauges to consist of R20's donated by Singapore (see below) with added shaft encoders;

- follow-ups on fate of recently donated gauges to Nigeria (Escavros), Gambia, Guinea and Côte d'Ivoire (Adekoya/Aman);

- letter of support to the Director of the Nigerian Institute for Oceanography and Marine Research (NIOMAR) regarding the importance of sea level monitoring in the Lagos area and at Escavros (Chairman/IOC);

- letter to Côte d'Ivoire Government responsible person regarding lack of data flow from the Abidjan gauge (Chairman/IOC);

- review of the sea level recording situation at Dakar, where a US-supported acoustic gauge is operated alongside a French IRD gauge at Goree island, with regard to possible rationalization, transfer to local responsibility, and overall improvement in local maintenance and data flow (Merrifield/Le Provost/Diaw);

- reviews of the maintenance situations of other US-supported gauges at Cape Verde and Lagos (Merrifield/Barbosa/Adekoya);

- investigation of a possible Global Environmental Facility (GEF) bid for funds for a West African network (IOC/POL/Adekoya/Aman/Brundrit).

20. Investigation of possible support from foreign aid budgets of selected countries, and of the use of the Turner Fund at UNESCO (Aarup).

21. Completion and publication of a report on the Arctic sea level network and communication of recommendations to national authorities (Plag/IOC).

22. Installation of gauges in Viet Nam at Qui Nohn by Indian Experts and Hon Dau by POL (DoD-SOI/POL).

23. Distribution of 4 Ott R20 gauges from Singapore (POL).

24. Distribution of some of the 15 acoustic gauges offered by Denmark and possibly several from South Africa (Aarup/Brundrit/Rosen/Scherer).

25. Comparative study of new acoustic gauges (Sonar Research or MORS type) and other technologies by Perez (Spain), Waldron (South Africa), Israel (Rosen), Norway (Plag), France (Woppelmann) and Australia (Scherer).

26. Use of IOC resources for technical consultant(s) for gauge installations or leveling ties, and investigation of possible exchange programme of technical and scientific experts (Chairman/IOC).

27. Production of an IAPSO/GLOSS tidal constants data set (Le Provost/PSMSL/IHO).

28. Joint report on future sea level monitoring by means of altimetry and tide gauges for St. Raphaël meeting 1999 and possible subsequent publication (Mitchum *et al*).

29. Implementation of recommendations for continuing the work of the Pilot Phase of the Indian Ocean CMAS activity and of two proposals for sea level networks and storm surge warning systems in the Northern Indian Ocean (Somasundar/Shetye).

30. Implementation of GLOSS interests within APSG (Shum/Scherer/Chairman). Shum/Scherer to contact NEAR-GOOS regarding acquisition of sea level data from the region.

31. Survey of subsequent career paths of attendees at Sao Paulo training course in 1993, Dehra Dun course in 1995 and Buenos Aires course in 1996 (Mesquita/Shetye/Valladares).

32. Circular letter by IHO requesting secondhand tide gauges (Rohde).

33. Quality control report on Black Sea time series to agencies of region (Tsimplis/Chairman).

34. Investigate Antarctic data not in PSMSL (see Table 2 of report of Zilberstein to GE6) with data copied to the PSMSL and Southern Ocean Centre when available (Zilberstein).

35. Understanding of differences in time series for certain Russian Arctic sites in time series of sea level available from local authorities and those kept by World Ocean Data Center B or PSMSL (Zilberstein).

36. Investigation of release of data from the Association of South-East Asian Nations (ASEAN) to the community (Scherer).

37. Letter to be sent to Secretary of the EOSS COST Action in Brussels expressing GLOSS support and recommendation at GE6 (Chairman/IOC).

38. Organization of University of Sao Paulo training course 1999 (De Mesquita).

39. Mission to Central and South America to assess facilities, requirements and historical data available (Gutierrez/IOC).

40. Investigate possible subsequent training course for the Americas either in Central America (e.g. Costa Rica) or at Sao Paulo once again, building upon experience of previous courses (Gutierrez/IOC).

41. Investigate possible training course in SE Asia region with possible training support from USA and Australia (Chairman) and a further course in Africa following the Cape Town course (Chairman/Brundrit).

42. MedGLOSS proposal to be submitted under the EU Framework 5 Programme (Rosen).

43. Establishment of 4 MedGLOSS Pilot Project digital, real time gauges in Romania, Croatia, Tunisia and Egypt (Rosen).

44. Information to T. Aarup on national long-term monitoring programmes for C-GOOS monitoring (All).

45. Investigate Lascaratos time series analysis package for GLOSS training (Chairman).

46. GLOSS brochure produced at POL in 1998 to be included on Web as a PDF file (Chairman). Versions in French, Portuguese and Spanish to be investigated at IOC (Aarup) and/or translation versions to be produced by the GE group (Valladares/Marone). Printing to be investigated by UNESCO (Aarup) and NOAA (Merrifield/Johnson).

47. GLOSS Bulletin issue 7 to be edited by POL (Chairman) and issues 8 and 9 by the NTF Australia (Scherer).

48. African-American GLOSS News to be co-edited by USP and UCT on Web with mirror sites (De Mesquita/Brundrit).

49. Attendance at data archaeology conference Washington, DC July 1999 (Mitchum and/or Aarup) to argue for rescue of sea level data and for the inclusion of sea level data in the GODAR project.

50. Investigate Laserscan for chart digitizing (Rickards).

51. Discussions with C-GOOS working panels on deployment of C-GOOS sea level stations, joint training with GLOSS, etc., (Marone/Thompson/ Chairman).

52. Investigate the production of diplomas or certificates for operators of GLOSS sites as a recognition of work, possibly based upon GLOSS training course certificates (IOC).

53. Funding possibilities for GLOSS, follow-up of several ideas suggested at GE6 (Chairman/IOC).

54. Arrangements for a mini-GLOSS meeting in 2000. Note Cook Islands South Pacific meeting in early 2000 (Chairman).

55. Arrangements for GE7 in 2001, suggested location being the University of Hawaii with an accompanying workshop on sea level science as a tribute to the work of Prof. Klaus Wyrtki

(Chairman/IOC/Merrifield).

56. Responsibility for publicizing the aims and achievements of GLOSS whenever possible (All).

ANNEX VII

RECOMMENDATIONS OF THE SIXTH SESSION OF THE IOC GROUP OF EXPERTS ON GLOSS

1. RECOMMENDATIONS TO THE 20th IOC ASSEMBLY

In response to the request made at the 31st IOC Executive Council the Group recommended the establishment of a Scientific Steering Group for Climate as a joint sub-committee of the GLOSS Group of Experts and related bodies (at present OOPC, CLIVAR/USP, IAPSO/CMSLT). Further, the Group recommended that discussions with C-GOOS be conducted with regard to a joint sub-committee for coastal sea level studies.

The Group recommended the formation of an African GLOSS Network to coordinate all aspects of sea-level activities in Africa. These activities would include a tide gauge network, GPS monitoring at specific sites, altimetric coverage, data acquisition and exchange, professional training and sea-level research.

Further, the Group supported the need to take every opportunity to upgrade the sea-level instrumentation in Africa. In particular, the non-operational sites with long historical records should be revived.

In addition, the Group supported the establishment of a network of National Oceanographic Data Centres in West Africa. This will ensure that oceanographic data, including GLOSS data, collected in the region would be immediately available in that region.

Realizing the importance of the Arctic Ocean for studies of climate variability and the early detection of climate change, and taking into account that the presently available satellite altimetry observations do not cover the Arctic ocean sufficiently, the GLOSS group of experts:

- recommends that in each country bordering the Arctic Ocean efforts are made to maintain a network of tide gauges conforming to GLOSS standards;

- in particular, strongly recommends that the Canadian GLOSS tide gauges are re-established;

- urges the international funding agencies to support projects that will help to reverse the current downward trend in the maintenance of Russian Arctic tide gauges;

- urges Denmark to secure the long-term operation of the GLOSS tide gauges in Greenland;

- urges Norway to establish and operate tide gauges corresponding to GLOSS standards on Jan Mayen and Bjørnøya;

- recommends that international support is given for the continued operation and maintenance of the tide gauge in Barentsburg;

- recommends that efforts are made to co-locate an approximately equidistant subset of the Arctic tide gauges with space-geodetic techniques (GPS) and to carry out absolute gravity measurements at these gauges.

The Group endorsed efforts to expand sea-level monitoring in the Northern Indian Ocean *via* tide gauge network developments and associated storm surge warning systems. Further, the Group noted the current lack of data flow from the region.

The Group stressed the importance of access of historical sea-level time series from GLOSS sites for, amongst many other purposes as described in the GLOSS Implementation Plan, improved tidal constants. The Group also requested the International Hydrographic Organization to make use of the good offices of the Permanent Service for Mean Sea Level to provide tidal constants from the data bank at the International Hydrographic Office to relevant researchers.

The Group requested the IOC to investigate the use of GOOS TEMA programme for GLOSS-related Fellowships.

The Group recommended that the IOC be requested to make funds available for sea-level data archaeology.

2. INTERNAL RECOMMENDATIONS/ENDORSEMENTS FOR THE GROUP

The Group endorsed a proposal that the Directors of PSMSL, UHSLC, NTF, WOCE Centres, IAPSO/CMSLT, IGS, etc., be recognized as *ex officio* members of the GLOSS GE.

The Group congratulated the two WOCE Centres (Fast Delivery and Delayed Mode) on their work during the WOCE programme, and recognized that the model of two Centres working together had been a successful one. The Group recommended that the UHSLC continue and extend its work as the GLOSS Fast Delivery Centre. The Group further urged the two WOCE Centres, and other international and national sea level centres, to work towards as far as possible a seamless GLOSS scientific sea-level data set in line with Chapter 7 of the GLOSS Implementation Plan.

The Group recommended that all geodetic ties between gauges and other geodetic devices (e.g. GPS, DORIS) be accepted first as the responsibility of the gauge authorities to implement and document, with all relevant information conveyed to data centres.

The Group urged all authorities to take steps to convert all gauges to real time reporting.

The Group recommended that regular missions be conducted to all regions to assess facilities and requirements for tide gauge and geodetic equipment and training, and for the assessment of historic non-digital data for data archaeology, with Central and South America being one such priority region.

The Group endorsed the aims of the EOSS activity in Europe, in particular the establishment of a European Sea Level Service which, amongst other functions, will improve the general availability of hourly sea-level data from the region, and which will provide a test case for regional implementation of GLOSS. The Group urged EOSS to collaborate closely with programmes such as EuroGOOS.

The Group recommended that countries of the Indian Ocean with gauges provided by the University

of Hawaii make efforts to assume responsibility for all aspects of maintenance and data flow.

The Group recommended that the Uruguay station at Montevideo be re-established as soon as possible with a second GLOSS site at La Paloma to be investigated.

The Group endorsed the concept of GLOUP bottom pressure measurements towards the understanding of ocean tides and dynamics of ocean circulation and the need for a GLOUP data bank of bottom pressure data alongside sea-level information.

ANNEX VIII

REVIEW OF THE AVAILABILITY OF HOURLY (OR MORE FREQUENT) SEA-LEVEL DATA FROM THE GLOSS CORE NETWORK

As usual, at GE-GLOSS meetings a review of the status of the GLOSS Core Network (GCN) was undertaken. In the past, this has normally concentrated on whether each country's GLOSS tide gauges are operational or not, and the problems of the non-operational gauges. However, a review carried out in December 1998 indicated that of the 287 sites in the GCN (defined by GLOSS97), only 42 are claimed to be non-operational. In addition, the PSMSL report on the status of GLOSS, from their perspective, indicates that 183 stations have reported monthly and annual mean sea level data to PSMSL from at least 1994 and a further 48 for which the latest data is within the period 1984-1993.

Thus, on this occasion the review took account of the new requirement stated in the GLOSS Implementation Plan 1997 (IOC Technical Series No. 50, UNESCO 1977) to make the higher frequency (or raw data) available on-line. This requirement is noted below, and is followed by a summary of the present situation.

Chapter 7 of the GLOSS Implementation Plan states that countries committed to GLOSS should:

(i) send all monthly and annual mean sea level data, and associated documentation, to the PSMSL as previously. If possible, data should be sent by July of the year following the data year; and either

(ii) send to one or more International Centre recognized by GLOSS copies of the raw (i.e. hourly or more frequent) data sets for GLOSS stations (any one GLOSS gauge should be associated primarily with one International Centre to avoid major problems of duplicate data sets); or

(iii) provide these raw data sets on an ftp or World Wide Web server in their own organization.

Countries making the data from the GLOSS (and in some cases other) data available at their own Web sites, together with the URLs, include Australia (www.ntf.flinders.edu.au), Japan (www.jodc.jhd.go.jp/online_hydro.html), South Africa/Namibia (www.sea.uct.ac.za/tidedata), UK (www.pol.ac.uk), USA-NOS (www.opsd.nos.noaa.gov), and USA-UHSLC (www.soest.hawaii.edu/UHSLC/). The UH data collection, which has been built up over a number of years through the North Pacific Experiment (NORPAX), Tropical Oceans and Global Atmosphere (TOGA) and WOCE, includes data from Pacific Island States, some western Indian Ocean and South American countries data. Some of these are part of the UHSLC network and in addition, some countries use the UHSLC as their data archive centre.

The current EOSS project for EU member countries is encouraging tide gauge authorities in these countries to make their data available on-line. Although there are problems to overcome, the responses are quite encouraging. A number of European countries, for example, France, Germany, Iceland, Norway, Portugal, Spain, and Sweden, will hopefully make their data available in the not too distant future. Some data from these countries are available already from the WOCE Data Assembly Centres. For example, Denmark make data available to the WOCE Delayed-mode Data Centre from Godthaab/Nuuk and Torshavn, but requests for these data to be released are reviewed on a case by case basis. Denmark also provides data from Ammassalik to WOCE, and this is freely available.

Canada foresees no problem in making their data available from their Web site, and will do this in the near future. Chile has just installed a new tide gauge network which will transmit data in real time, data will

be made available *via* the UHSLC. Argentina and Uruguay will try to get their data released. Mexico has tidal predictions available on their Web site, but not data. Israel provides real-time plots of the data, but not the raw values, on the Web.
The countries or areas where little data are currently available are as follows:

Brazil	a new committee and system should improve the situation ;
India	awaiting clearance, security issue;
Indonesia	but the situation may improve through collaboration with NTF;
Russia	political/financial crisis in country ;

West African countriesa new regional data centre may help; also initiatives within Africa to work more closely together may improve the situation.

Altogether, there are approximately 200 tide gauge sites which have some form of data on-line. For some of these real-time plots of the data are available, but not the data values themselves. Most of the remainder have hourly values available on the Web from one or both of the WOCE Sea Level Data Assembly Centres (at UHSLC and BODC/PSMSL) – obviously some of these are duplicated at national sites. Eighty-five GLOSS stations report to the WOCE Fast Delivery DAC (at the UHSLC), with data usually available within one to two months of data collection.

ANNEX IX

LIST OF ACRONYMS

AAGN	African American GLOSS News
APSG	Asia Pacific Space Geodynamics Project
ASEAN	Association of South-East Asian Nations
BODC	British Oceanographic Data Centre
CIESM	Commission Internationale pour l'exploration scientifique de la mer Méditerranée
CARICOM	Caribbean Community
C-GOOS	Coastal Module of the Global Ocean Observing System
CLIVAR	Climate Variability and Predictability
CMSLT	Commission on Mean Sea Level and Tides
CNES	Centre national d'études spatiales (France)
COST	European Cooperation in the field of Scientific and Technical research
COSTA	Climate Observing System for the Tropical Atlantic
COST	Committee on Science and Technology
CPACC	Caribbean Planning for Adaptation to Climate Change
CSIRO	Commonwealth Scientific and Industrial Research Organization
DAC	Data Assembly Centre
DOD	Department of Ocean Development
DORIS	Doppler Orbitography and Radio positioning Integrated by Satellites
EOSS	European Sea-Level Observing System
EU	European Union
ERS	Earth Resources Satellite
EuroGOOS	European GOOS
FAGS	Federation of Astronomical and Geophysical Data Analysis Services
GCN	Global Core Network
GE	Group of Experts
GEF	Global Environmental Facility
GGE	GLOSS Group of Experts
GEOSAT	Geodetic Satellite (USA)
GLOSS	Global Sea-Level Observing System
GLOUP	Global Undersea Pressure
GODAR	Global Oceanographic Data Archaeology and Rescue Project
GOES	Geostationary Operational Environmental Satellite
GOOS	Global Ocean Observing System
GPS	Global Positioning System
IAG	International Association of Geodesy
IAPSO	International Association for the Physical Sciences of the Ocean
IAS	Intra American Seas
IGS	International GPS Service for Geodynamics
IHO	International Hydrographic Organization
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IOCARIBE	IOC Sub-Commission for the Caribbean and Adjacent Regions
IOCINCWIO	IOC Regional Committee for the Co-operative Investigation in the North and Central

	Western Indian Ocean
IPCC	Intergovernmental Panel on Climate Change
IRD	Institut français de recherche scientifique pour le développement en coopération (ex ORSTOM)
IUGG	International Union of Geodesy and Geophysics
MedGLOSS	Mediterranean Programme for the Global Sea-Level Observing System
NEAR-GOOS	North-East Asian Regional GOOS
NIOMAR	Nigerian Institute for Oceanography and Marine Research
NOAA	National Ocean and Atmosphere Administration (USA)
JIMAR	NOAA Joint Institute for Marine and Atmospheric Research
NOS	National Ocean Service (of NOAA)
NTF	National Tidal Facility (Australia)
ODINEA	Oceanographic Data and Information Network for Eastern Africa
OOPC	Ocean Observing Panel for Climate
PIRATA	Pilot Research Moored Array in the Tropical Atlantic
PNG	Papua New Guinea
POL	Proudman Oceanography Laboratory (UK)
PSMSL	Permanent Service for Mean Sea-Level
SOI	Southern Oscillation Index
SOSLC	Southern Ocean Sea Level Centre
TARS	Turn Around Ranging Station
TEMA	Training Education and Mutual Assistance (IOC)
TOGA	Tropical Oceans and Global Atmosphere
TOPEX	Ocean Topography Experiment
UCT	University of Cape Town
UOP	Upper Ocean Panel (CLIVAR)
UHSLC	University of Hawaii Sea-Level Centre
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
USP	University of Sao Paulo
WDC-B	World Data Centre B, Meteorology
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment