Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

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

Second Session

NOAA, Atlantic Oceanographic
and Meteorological Laboratory

Miami, USA, 22-26 October 1990

Unesco

In this Series, entitled

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

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

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TABLE OF CONTENTS

1. ORGANIZATION OF THE SESSION

1.1 OPENING OF THE SESSION

1 The meeting was opened by the Chairman of the Group of Experts on GLOSS, Dr. D. Pugh. He pointed out that the meeting should address 2 themes: (i) the detailed development of the GLOSS network; and (ii) the relationship between GLOSS and other programmes, particularly the Global Ocean Observing System (GOOS) and the Long-Term Global Monitoring System of Coastal and Near Shore Phenomena related to Climate Change (GCNSMS).

2 Dr. G. Maul welcomed the participants on behalf of the Director of the Atlantic Oceanographic and Meteorological Laboratory, Dr. H. Bezdek.

1.2 ADOPTION OF AGENDA AND TIMETABLE OF THE SESSION

3 The Agenda was amended and adopted by the Group as shown in Annex I. The list of participants is shown in Annex II.

1.3 DESIGNATION OF RAPPORTEUR

4 Mr. G. Alcock was elected as Rapporteur of the Session.

2. REVIEW OF ONGOING ACTIVITIES

2.1 IGOSS SEA-LEVEL PROGRAMME IN THE PACIFIC

5 Dr. G. Mitchum presented the report on the IGOSS Sea-Level Programme in the Pacific (ISLP-Pac). He informed that 82 stations were used for this Programme. Sea-level data were collected on a regular basis at the IGOSS Specialized Oceanographic Center (SOC for the ISLP-Pac) located in Honolulu. Maps of the sea-level deviation from 1975 to 1981 mean sea-level have been produced without fail since June 1984. Maps of the sea-level anomaly corrected for atmospheric pressure have been produced since January 1988. The time series of the Upper Layer Volume in the Tropical Pacific ocean (published quarterly) and indices of the equatorial current system (published annually) have continued to be updated. The monthly mean sea-level data from the IGOSS stations were sent to the National Oceanographic Data Center and to the World Data Centers and a magnetic tape of the IGOSS sea-level dataset continues to be available at the University of Hawaii. In addition to the traditional methods of dissemination the operational sea-level maps, there was a near real-time access to digital data via the INTERNET computer network and the responses of users to this new method of data access have been uniformly positive and enthusiastic.

6 The capability to exploit the availability of satellite-transmitting sea-level gauges has been developed; at present 66 Pacific gauges (including 36 gauges at IGOSS stations) have this capability.

7 A review of the performance of the IGOSS Pacific sea-level system was completed during last year and it was found that there were no major problems with the delivery of data from the participating data originators. However, additional sea-level stations have been requested from several countries: the China (along of the southern and eastern parts of China Sea), the USA (Guam) and the USSR (along the Kamchatka Peninsula). The D.P.R. of Korea has offered to provide a new station, the first from that country.

8 **The Group noted** that the major development of the programme during the last year has been the dissemination of sea-level data in real time, i.e., the provision of an operational product.

9 Under this item Prof. G. Lennon reported on the activities of Australia in setting up a network of high quality telemetered gauges at the Darwin, Broome, Hillary's, Esperance, Thevenard, Portland, Spring Bay (Tasmania), Port Kembla, Rosslyn Bay, Townsville. It was intended to maintain reference levels to existing gauges and to have an overlap of at least one year between existing and new gauges. Dr. G. Mitchum stated the particular importance of the Tasmanian station to IGOSS.

10 **The Group noted** with satisfaction the progress in the implementation of the ISLP for the Pacific, and **endorsed** the present emphasis on providing a rapid collection and dissemination of data, rather than on increasing accuracy or resolution. **The Group recognized with satisfaction** that the system was the first real-time oceanographic network for any ocean basin.

11 **The Group noted** that there would be an IGOSS Products Seminar in Tokyo (15-19 April 1991) in support of Global Change Studies. **The Group stressed** the need to submit the paper to this Seminar with description of GLOSS achievements and formulated recommendations on sea-level products needed for the Global Change studies.

2.2 IGOSS SEA-LEVEL PILOT PROJECT IN THE NORTH AND TROPICAL ATLANTIC

12 Dr. A. Bolduc reported on the present status of the IGOSS Sea-Level Pilot Project in the North and Tropical Atlantic (ISLPP/NTA), pointing out that the participating stations were not restricted to GLOSS stations. He presented initial ideas on the Project, network and data products. IOC-WMO Circular Letter No. 90-67 had been distributed to all IOC Member States in July 1990 announcing the official start of the ISLPP/NTA project, and MEDS had asked all IOC GLOSS contacts for data. Replies had been received from a few countries, and data from the U.K. More was expected soon.

13 **The Group agreed** that the base reference period should ideally be 1975-86 but in reality would be determined by data series length and the avoidance of low-frequency events such as the 1982-83 ENSO. **The Group noted** that coastal gauges were likely to be unrepresentative of the Atlantic Ocean basin and therefore these contours should not be drawn connecting individual data points (which should be given numerically on the anomaly maps). **The Group recommended** that a small advisory group be formed to assist Dr. A. Bolduc in the execution of the project. Dr. G. Mitchum, Dr. T. Murty and Dr. P. Woodworth agreed to assist in this task.

2.3 IGOSS PILOT PROJECT ON ALTIMETRIC SEA SURFACE TOPOGRAPHY DATA

14 The Joint IOC-WMO Working Committee on IGOSS at its Fifth Session (Paris, 14-23 November 1988) adopted, *inter alia*, Recommendation 8 related to implementation of IGOSS Pilot Project on Altimetric Sea Surface Topography Data funded by NOAA. Dr. B. Douglas explained that the future product from the ERS-1 altimeter data would be a sea-level time series referred to the 1985-86 base period of GEOSAT. Initially the maps would be for the tropical oceans on a monthly basis, but would later cover the global oceans. **The Group recognized** that this project should complement the classical *in situ* measurements being implemented within the GLOSS programme, with the ultimate goal of monitoring changes in global sea-level. However, **the Group pointed out** that it was not yet obvious how to synergistically combine the 2 data sets (which both have strengths and weaknesses), and that this was a current research problem likely to take a decade to resolve. For the present, both data sets should be produced independently and used for comparative studies. **The Group noted** the potential of other methods for measuring sea-level offshore, including drifting buoys using Global Positioning System (GPS) and aircraft-borne altimetry, but **also noted** the technical difficulties before such systems might become operational.

15 In connection with GPS measurements, Dr. B. Douglas informed the Group that NASA intends to install 200 permanent GPS sites, primarily to study crustal movements at plate boundaries. **The Group recognized** the potential importance of these sites and instructed the GLOSS Technical Secretary to liaise with NASA, in consultation with Dr. B. Douglas, with a view to including GLOSS Tide Gauge Bench Mark's (TGBM's) in the NASA sites (see Agenda Item 6).

2.4 PERMANENT SERVICE FOR MEAN SEA-LEVEL (PSMSL)

16 Dr. P. Woodworth, Director of PSMSL, presented the report on sea-level data submission to the PSMSL, emphasizing that the supply of data to the PSMSL had never been higher. The PSMSL Sea-Level Data Bank is currently increasing at a rate of over 2,000 station-years per year obtained from over 1000 stations in over 100 countries, i.e., with major backlogs being acquired. Following the successful review of

Europe in 1988 which resulted in an enlarged data set [1], a similar review was made in 1989 of Central and South America and in 1990 of Africa, Asia and Antarctica (in press). Chile, Ecuador and Peru remain as problems in South America. Asia, in particular, appears in good shape, although Indonesia, Myanmar and Sri Lanka remain as problems. Australia is less up to date than Asia but communications remain good with several agencies in Australia and New Zealand. Dr. P. Woodworth highlighted a potential problem of presentation of mean sea-level records becoming available through the different programmes and projects, such as TOGA, WOCE and IGOSS, and stated that it was the policy of the PSMSL to regard data received from a national authority as the "official" PSMSL version. A new issue of "Data Holdings of the PSMSL" would be produced at the end of 1990 and sent to all on the PSMSL address list.

17 Dr. P. Woodworth noted that in addition to routine procedure on reviewing data quality, the PSMSL over next couple of years would send to each authority copies of their complete historical data for checking to eliminate errors introduced by transmission, typing, etc. The future plans for data acquisition also includes the banking of geocentric co-ordinates of TGBMs. The PSMSL intends to build up an archive of parallel important data sets (i.e., geological and archaeological sea-level data sets or geodynamic models), but without accepting responsibility for their updating.

18 The PSMSL also considers how best to, or if it should, publish global and regional MSL data "products" in addition to the global data tapes distributed to scientists (this is discussed in greater detail under Agenda Item 8.2). Dr. P. Woodworth urged the Group to encourage anyone who uses the PSMSL, TOGA, etc., data sets to submit papers for the Symposium 13 on "Sea-Level Changes: Determination and Effects" at the IUGG Assembly in Vienna, August 1991.

19 Turning to the GLOSS subset of data, he indicated that out of 306 GLOSS stations 133 are "operational stations" for which the most recently acquired data is 1986 or later; 50 are considered "probably operational" for which the most recent data is within the period 1975-1985; 42 stations are "historical" stations for which the most recent data is earlier than 1975; and there are 81 stations for which no PSMSL data exist. The situation will be reviewed again when the PSMSL receive all the replies to questionnaires distributed to all GLOSS Members during the preparation of the GLOSS Handbook. Dr. P. Woodworth suggested that it may be useful then to make a special effort to encourage all historical data to be reduced to MSL for GLOSS sites.

20 **The Group noted** that the PSMSL was currently working on plans to make the data more readily accessible, using INTERNET or a similar computer system. **The Group restated** that GLOSS national contacts were very important for ensuring that their national agencies collected and sent data to the PSMSL. **The Group recognized** the need to introduce more modern methods of analyzing data to produce mean sea-level products, but a detailed discussion was left until Agenda Item 8.

2.5 GLOSS COMPONENTS IN TOGA AND WOCE PROGRAMMES

21 Prof. K. Wyrtki, Director of the TOGA Sea-Level Center, reported on the recent activities of the Center. He reminded the Group that the TOGA Programme covered the world ocean between 30°N and 30°S and was a temporary activity running from 1984 to 1994, but which also had pre-1984 data. TOGA required daily mean sea-level data, which implied access to hourly data if quality control was properly exercised. Prof. K. Wyrtki reported that the Pacific sea-level network is essentially complete, with rapid progress in converting stations to data transmission by satellite. Forty-four stations now report their data via satellite and Yap (Fed. Micronesia) is the first station to make use of the new link via the Japanese geostationary satellite. New stations have been installed at Tonga and San Felix (Chile) but important missing stations are Marcus Island (Japan), Raoul (New Zealand) and Lord Howe Island (Australia). Data flow continues to be excellent. A report containing data up to December 1987 has been issued and hourly, daily and monthly data submitted to US NODC and World Data Centre A for further distribution. Most data for 1988 have been received data for 1989 have been requested. However, no data had been received from Taiwan and Vietnam.

22 The TOGA network in the Indian Ocean is growing slowly and there are about 20 stations. New stations have been established at Colombo, (Sri Lanka) Salalah (Oman) and Fort Dauphin (Madagascar).

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[1] Woodworth P.L. *et al*, 1990. On the availability of European mean sea-level data. Intern. Hydrographic Review, 67, pp. 131-146.

The stations at Agalega (Mauritius), Kismayo (Somalia), Praslin (Seychelles) and Christmas Island (Australia) are not operating at present and the station at Reunion Island (France) has not given any useful data in recent years. No useful contacts have been made with Bangladesh, Mozambique, Myanmar and Yemen, and no progress has been made with the installation of new gauges at Port Blair and Minicoy (India).

23 The Atlantic TOGA network has grown slowly. Data has been received recently for some islands (notably from Portugal), but lack of funding means that the Atlantic network will not be developed in preference to future work in the Pacific and Indian Oceans.

24 Dr. L. Rickards and Dr. G. Mitchum presented the Group with information about the activities of the WOCE Sea-Level Data Assembly Centres at Bidston (UK) and Honolulu (USA), respectively. Dr. L. Rickards said that the BODC Work Plan was: (i) to review the status of the WOCE tide gauge network to identify gaps in the network and operational problems; (ii) to initiate correspondence with data collectors requesting data; and (iii) to set up a data tracking system to ensure that up to date information on the status of all WOCE gauges is readily available. She also described the data checking process and indicated that historical pre-WOCE data from before 1989 would be used to test the procedures.

25 Dr. G. Mitchum informed the Group that the University of Hawaii dataset was intended to support altimetry measurements, particularly for TOPEX, but no funding was available at present for this activity from US-WOCE. Dr. D. Pugh, informed the Group that the Intergovernmental WOCE Panel (IWP) was meeting in Paris now and was expecting input from the Group. **The Group decided** to remind the IWP (via Telemail) of GLOSS and its benefits to WOCE in order to stress that support for GLOSS from WOCE was crucial for the installation of gauges and data flow, and to ask that Member States help develop WOCE by making commitments to GLOSS.

3. REGIONAL AND GLOBAL COMPONENTS OF GLOSS

3.1 IOCARIBE

26 Dr. G. Maul (GLOSS Regional Co-ordinator for IOCARIBE) presented the report on GLOSS development within the IOCARIBE. The third meeting of IOCARIBE as a Sub-Commission had taken place in December 1989. During 1989-90, 5 new gauges had been installed at Puerto Morelos (Mexico), Lee Stocking Island, Exuma Key (Bahamas), Bridgetown (Barbados), Port Royal (Jamaica) and Cartagena (Colombia). Commitments to establish gauges at South Caicos (Turks and Caicos Islands) and at Charlottesville (Trinidad and Tobago) had been made and the gauges are being prepared for deployment. Information on tide gauges in Haiti had not been obtained, and a gauge designated for Saint Nicholas (Aruba) was available, but an agency willing to operate the unit had not been located.

27 **The Group confirmed** that not all gauges in IOCARIBE region needed to be GLOSS stations, but recognized that some countries wanted at least one gauge in GLOSS for various reasons. **The Group also confirmed**, referring to decisions made at the GE/GLOSS-I, that in his role as Regional Co-ordinator, Dr. Maul was responsible for assisting in developing the network, but was not the contact for data provision; that was the responsibility of GLOSS national contacts.

3.2 IOCEA

28 Mr. G. Alcock reported on the status of the GLOSS stations in the IOCEA region. A consultant from Germany, Dr. B. Scharringhausen, had installed a gauge at Lagos (Nigeria) in March 1990 and was due to install gauges at Tema (Ghana) in December 1990 and Dakar (Senegal) in December 1990 or January 1991. However, his plans to install gauges at Nouadhibou (Mauritania) and Freetown (Sierra Leone) awaited information on construction costs and required material from the countries concerned. All gauges had been donated by Sweden. Mr. G. Alcock had attended the IOCEA-II meeting in Lagos (February 1990) and reported to the Group that the Regional Committee had adopted a Recommendation: (i) welcoming Sweden's donation of gauges, but recommending IOC to ensure their continued operation by providing consumable items; (ii) urging IOC to provide equipment to the region to enable historic data to be processed; and (iii) recommending that an expert from IOCEA region be included on the GLOSS Group of Experts. The Regional Committee had reaffirmed the decision of the Fourteenth Session of IOC Assembly to establish a GLOSS Regional Team and stated that its Chairman would act as GLOSS Regional Co-ordinator.

29 **The Group welcomed** this decision and **requested** the GLOSS Technical Secretary to communicate with GLOSS contacts in the Region, verify the establishment of the Regional Team and, if it is implemented, contact GLOSS Regional co-ordinator in order to inform the Regional Team about GLOSS development and recommendations the GE/GLOSS-II.

30 **The Group noted** the intention of the USA to install NOS/NOAA new generation gauges at Dakar in 1990 and in the Cape Verde Islands later.

3.3 IOCINDIO

31 **The Group noted** progress with installation of specific gauges at Colombo (Sri Lanka) and Salalah (Oman) as part of the TOGA network, but **expressed** concern that no formal report was available for discussion.

3.4 IOCINCWIO

32 Mr. M. Odido (GLOSS Regional Co-ordinator for IOCINCWIO) informed the Group of GLOSS development within the IOCINCWIO Region. Four extra stations had been established in the Region since its Second Session in Tanzania in 1987, bringing the number of installed tide gauges to 17. However, 3 of the envisaged GLOSS stations had not been established, at Aldabra (Seychelles) Hafun (Somalia) and Mtwara (Tanzania). Stations in Agalega (Mauritius) and Port Victoria (Seychelles) are not working at present. Four stations not in the GLOSS Plan: Lamu (Kenya), Praslin (Seychelles), Kismayo (Somalia) and Dar-es-Salaam (Tanzania) should be considered for inclusion in the GLOSS network in the future. Additional stations in Madagascar and Mozambique were proposed by Mr. M. Odido for coverage of the Mozambique channel flow. He also recommended that the principal stations in the Region should be considered for automated data transmission facilities. In an effort to promote the use of sea-level data and products in the IOCINCWIO region, a workshop on "Causes and Consequences of Sea-Level Changes in the Western Indian Ocean" is proposed for the Region in 1991.

33 Prof. K. Wyrtki suggested that a technician should be based in the region for one year to assist in the operation of GLOSS stations. **The Group requested** the Secretary of IOC to consider possible ways and means to assist the IOCINCWIO region in providing technical service for GLOSS sea-level stations.

3.5 WESTPAC

34 Dr. G. Mitchum reported on the sea-level activities in the WESTPAC region. He noted that sea-level measurements in WESTPAC are basically in good shape. Prof. G. Lennon informed the Group that a Unesco Workshop on Tidal and Related Data would be held in Jakarta from 29 October to 2 November 1990. In connection with the ASEAN/Australian Programme, he reminded the Group that the ASEAN programme's main interest was technology transfer and not science. Data was being produced but was not useful for seasonal or decadal time scale studies. Dr. P. Woodworth noted that at least 6 tide gauges were operating in Indonesia, but no data have been obtained other than from Bitung gauge via the TOGA Sea-Level Centre in Hawaii. Dr. J. Hannah informed the Group that Indonesia had suggested a conference in Bali, which can be used as a good opportunity to discuss GLOSS development in the region and in particular the improvement of sea-level data submission to PSMSL. **The Group noted** that sea-level measurements in Indonesia were very important to GLOSS but recognized that communications with Indonesia were very difficult. **The Group requested** Prof. G. Lennon and Prof. K. Wyrtki to use their visits to Indonesia in October 1990 and February 1991 to try to make suitable contacts. **The Group noted** that the USA was negotiating a Memorandum of Understanding with Indonesia and hoped that consequent bi-lateral work with scientists or agencies in Indonesia would improve the situation. **The Group was encouraged** with developments in the region, but regretted that flow of data to PSMSL was not established yet. The GLOSS Technical Secretary was asked to write to the Sub-Commission Office in Bangkok and establish contact with GLOSS Regional Co-ordinator for WESTPAC.

3.6 GLOSS ACTIVITIES IN THE SOUTHERN OCEANS

35 Prof. G. Lennon reported on the IOC Workshop on Sea-Level Measurements in Antarctica, held in Leningrad (28-31 May 1990) (IOC Workshop Report No. 69). The Workshop had recognized the importance of sea-level measurements in the Southern Oceans for the WCRP and WOCE in particular; and recognized a particular need for international collaboration and co-operation in this area. The Workshop strongly

endorsed the Australian offer to establish an IGOSS Sea-Level Pilot Project for the Southern Oceans (defined as south of 30º S), and recommended the appropriate tasks for the Sea-Level Centre for the Southern Oceans.

36 **The Group reviewed and endorsed** the conclusions of the Workshop. It endorsed the observation that not all GLOSS stations located in the Antarctic are suitable for long-term installations, and the recommendation that, nevertheless, all coastal manned Antarctic bases should try to measure mean sea-level for at least a year relative to permanent shore bench marks. **The Group noted** that the SCAR questionnaire on the state of Antarctic sea-level stations had provided a lot of useful information and **recommended** that it should be repeated. **The Group recommended** that the use of numerical modeling of the Southern Oceans in defining the priority for sea-level sites should be referred for discussion to relevant IOC Southern Oceans or ICSU-IAPSO bodies. **The Group endorsed** the Workshop recommendation that there was a strong case for a permanent VLBI site at McMurdo Sound to complement those at Syowa and O' Higgins. **The Group recommended** that the USA seek collaboration with relevant countries. **The Group recognized** difficulties in measuring sea-level in Antarctica, and noted that bottom pressure measurements are likely to be the most realistic method of data measurements but **recommended** that other techniques, such as GPS, should be evaluated. **The Group endorsed** the Workshop recommendation that all recording devices be recalibrated and levelled at least annually. **The Group endorsed** the Workshop observation that there was a need to hold a workshop/training course on sea-level measurement in ice and **recommended** such a meeting be held in 1992. **The Group endorsed** the observation of the Workshop that its conclusions and recommendations could be generally applied to the sea-level programme in the Arctic Ocean.

37 Prof. G. Lennon reviewed Australian activities in the Southern Oceans, stressing the logistical problem of maintaining and recovering gauges. He informed the Group of recent theoretical studies which indicated that the mean sea-level signal in the Southern Oceans is in response to static barometric pressure, and that therefore the most useful service of satellite measurements could be in indicating barometric pressure systems. Present studies were concerned with the influence of bottom topography on sea-level variability.

38 Mr. D. Pillich informed the Group about Australian plans for installation of sea-level gauges in the Region, in collaboration with the Australian Antarctic Division and relevant experts from the USSR.

39 Prof. G. Lennon reported that funding for the Sea-Level Centre for the Southern Oceans in Australia had been provided by the Federal Government but was not yet forthcoming. **The Group recommended** that the Secretary of IOC inform Australia that the GE/GLOSS endorsed the Australian offer to establish the Sea-Level Centre for the Southern Oceans and would welcome its quick establishment.

40 **The Group confirmed** the principle that hourly sea-level data should be banked nationally, but **recognized** that the special nature of the Southern Oceans (with many countries involved) meant that such data should be collected together and banked in the Regional Centre. **The Group recognized** that during WOCE, the British Oceanographic Data Centre would act as a sea-level data assembly centre for the Southern Oceans, but **the Group however felt** that the Sea-Level Centre for the Southern Oceans in Australia would operate permanently.

41 Dr. V. Kaliazin reviewed the sea-level activities of the USSR in Antarctica and indicated that sea-level measurements have been made periodically at the Soviet Antarctic stations (Molodezhnaya, Mirny, Novolazarevskaya, Bellinsghausen and Russkaya) since the first Soviet Antarctic Expedition in 1956. Dr. V. Kaliazin informed the Group that 2 Soviet stations in the Antarctica probably would be closed. He stated that the USSR intended to re-install 2 sea-level gauges at Mirny and Molodezhnaya; the latter was close to the planned Japanese VLBI site. Dr. V. Kaliazin also informed the Group that technical problems of installing the gauges could only be solved through international collaboration; the USSR could provide all necessary support but needed modern instrumentation to be provided by co-operating partners.

42 Dr. J. Hannah informed the Group of the sea-level activities of New Zealand in the Southern Oceans. The gauge at Scott Base had been destroyed in February 1990 but would be reinstalled in November 1990 and would replace the gauge at McMurdo Sound as the GLOSS gauge. Italy is reported to have a gauge at Terra Nova. Dr. J. Hannah also informed the Group that the bench marks at Terra Nova, Scott Base and the Australian Antarctic Base would be tied-in using GPS during the next austral summer.

43 **The Group noted** with satisfaction that sea-level measurements existed in the Southern Oceans but **recommended** that this data should be analyzed as soon as possible and compared with satellite altimetry data from the 2-year repeat mission of GEOSAT.

44 **The Group noted** the need for international collaboration in the Southern Oceans and welcomed the news of intended collaboration between Australia and the USSR.

3.7 OTHER REGIONAL PROGRAMMES AND ACTIVITIES

45 Dr. D. Enfield presented a report on the status of the co-operative East Pacific Sea-Level Project which presently involves sea-level recorders at 17 stations (8 with satellite-transmitting data collection platforms [DCP's] and 9 analog-digital recorders [ADR's]). However, the project, which began under NOAA/EPOCS funding and continued through FY-1990 under US TOGA, can no longer be funded under the TOGA programme. It is intended that a reduced and streamlined programme be run under the US Climate and Global Change programme, resulting in decommissioning of a few of the DCP's and leaving the maintenance of the ADR's to the host countries. Dr. Enfield stated that it was intended to install a NOS/NOAA "new generation" gauge at Diego Ramirez Island (Chile) in early 1991, and possibly that another NOS/NOAA gauge would be installed at Valparaiso (Chile).

46 Mrs. S. Severo presented a report on the status of sea-level activities in Brazil. Of the designated GLOSS gauges, those at Cananeia and Rio de Janeiro were operational and producing good data; the one at Trindade Island was operational but historic data had to be corrected. The gauge at Natal was operational but was stolen. Next year it is planned to install gauges at Fernando de Noronha Island (a self-contained pressure gauge), Rio de Janeiro, Itaparica, Trindade and Rio Grande. A self-contained pressure gauge is to be installed in 1992 at St. Peter and St. Paul Rocks, in collaboration with France. Mrs. Severo stated that it was impossible to install a gauge at Santara because of the effects of the Amazon River. Mrs. Severo agreed to send all corrected data to the PSMSL and also agreed to review the Brazilian data holdings of the PSMSL, which would be sent to her.

47 **The Group noted** that it was intended to install a NOS/NOAA gauge at Fernando de Noronha, near to a VLBI station; and also noted a crucial VLBI site was going to be installed at Fort Alesi, near to Natal. **The Group was encouraged** to find that Brazil was so active in sea-level activities and **encouraged** co-operation between Brazil, France, USA and the PSMSL.

48 Dr. V. Kaliazin presented a report on a national programme on sea-level studies, closely connected to GLOSS. The programme includes: (i) the development of a sea-level observation network, including the Antarctic area, using modern equipment with satellite techniques for geodetic fixing of bench marks and transmission of the data; (ii) uniformed data processing to high accuracy; (iii) creation of a National Sea-Level Data Bank, and further development of data exchange in the framework of GLOSS; and (iv) development of methods for analysis and forecast of sea-level fluctuations. **The Group noted** this report with great interest and satisfaction.

49 Dr. V. Kaliazin presented the status of Soviet sea-level measurements in the Arctic, pointing out the existence of data available since 1948 and discussing the future plans for 7 operational stations.

50 The Director of the PSMSL, Dr. P. Woodworth, requested that data from the Arctic stations and from Kronstadt-Shepelevo (USSR) should be sent to the PSMSL.

51 **The Group recommended** that Dr. T. Murty, Observer at the GE/GLOSS-II Session, inform the Workshop on Implication of Climate Change and the Impact of Sea-Level Rise on the South Asian Seas Region in Bangladesh (December 1990) about GLOSS activities.

3.8 CRITERIA FOR SELECTION OF TIDE GAUGE LOCATIONS FOR THE GLOSS NETWORK

52 Prof. K. Wyrtki reviewed the original criteria for selection of the initial GLOSS network and Dr. G. Maul presented a draft set of criteria: (i) pre-existing long-term records with recoverable bench marks to re-establish original time-series; (ii) open-ocean locations that contribute both to global monitoring and to local geostrophic circulation diagnosis; straits and passages; submarine cables; (iii) wide variety of tectonic variability including tectonic plate boundaries; local subsidence; deltaic coasts; (iv) high degree of RSL change

impact on local populations; value to sustained economic development; datum control; (v) committed institutional support; (vi) proximity to VLBI/GPS/SLR sites; (vii) role in international programmes (TOGA, WOCE, WCRP); calibration of satellite altimeters; numerical model verification; and (viii) juxtaposed oceanographic serial station time series; juxtaposed weather stations.

53 **The Group recognized** that not all criteria would be fulfilled at all locations but **recommended** that criteria, listed above, should be taken into account when selecting locations for the GLOSS network. **The Group agreed** that it was necessary to have a set of procedures on how locations were added or deleted from the GLOSS network. **The Group agreed** that proposals for changes from IOC Member States should be submitted to the IOC via their Member State Representatives. Such proposals would be passed to the Group of Experts for GLOSS, for consideration at its next Session. Proposals from the Group itself or informal suggestions from scientists would also be considered by the Group, which would then instruct the GLOSS Technical Secretary to liaise with Member States on the proposed changes or recommendations to commit certain gauges to the GLOSS network.

3.9 GENERAL TRENDS OF GLOSS DEVELOPMENT

54 Dr. D. Pugh reported that he had attended Small States Conference on Sea-Level Rise in the Maldives in 1989. It had been a good opportunity to publicize GLOSS activities. The GLOSS network had been endorsed by the Conference. **The Group welcomed** the recommendations of the Conference and **affirmed** that it stood ready to support any sea-level measuring activities resulting from the Conference. **The Group also noted** that there had been no reply to Dr. D. Pugh's letter to the Maldives Government on liaison with an Action Group set up by the Small States. **The Group requested** the Secretary of IOC to assist the Chairman of GE/GLOSS in contacts with the Maldives on this matter.

55 Dr. D. Pugh stated that, at the invitation of the IOC, he had also attended a meeting of the International Federation of Surveyors in Helsinki (10-19 June 1990), which had passed a resolution encouraging governments to help in making GLOSS effective.

56 **The Group discussed** the general relationship of the regional or global GLOSS network to other regional and national sea-level networks. **The Group reaffirmed** that the GLOSS network served as a primary network to which more dense, regional or national networks could be related.

4. GLOSS INPUTS TO OTHER IOC PROGRAMMES

57 Dr. D. Pugh gave a review of GLOSS inputs to other IOC programmes: Ocean Services (e.g., IODE and IGOSS), Ocean Sciences and Living Resources (OSLR), Ocean Sciences and Non-Living Resources (OSNLR), and Training Education and Mutual Assistance (TEMA).

58 **The Group recommended** to fulfil a comprehensive analysis of the relationship between GLOSS and other IOC Programmes and **noted** that this work could be done by the relevant IOC Technical Secretaries working together.

5. GLOSS RELATIONSHIPS WITH GLOBAL LONG-TERM MONITORING SYSTEMS AND PROGRAMMES

5.1 GLOBAL OCEAN OBSERVING SYSTEM (GOOS)

59 The IOC and WMO have initiated this system in recognition that the oceans are a crucial component of the world climate system and are chronically under-observed. Dr. D. Pugh, had attended the First Session of the IOC *Ad hoc* Group of Experts on GOOS, Virginia, USA, 6-7 September 1990, as a Liaison for GLOSS, and presented the Summary Report of the Session (Doc. IOC/GOOS-I/3). The Session had recognized that initial implementation of GOOS will be facilitated by the strengthening of the existing operational systems of IOC and WMO and by improving the national and international co-ordinating mechanisms for these activities. Therefore, the Group of Experts on GOOS had urged Member States to strengthen their involvement in those systems in order to make them fully operational, through long-term commitments for data acquisition and exchange and analyses.

60 The *Ad hoc* Group of Experts on GOOS recommended that the IOC would request the Second World Climate Conference (SWCC), in November 1990, to recognize that a comprehensive ocean observing system would not be fully operational without substantial new governmental commitments. Subsequently, the IOC should initiate preparation of a protocol for the Global Ocean Observing System for adoption within the proposed draft Framework Convention on Climate Change, at the United Nations Conference on Environment and Development to be held in Brazil, in 1992.

61 Dr. D. Pugh explained that implementation of GOOS was likely therefore to have 2 phases: (i) the rationalization of existing observing systems such as GLOSS, drifting buoys, and IGOSS ships-of-opportunity programme into an embryonic GOOS; and (ii) the definition of GOOS to meet identified needs (such as potential climate change), and this would require preliminary results from global programmes such as TOGA and WOCE.

62 After a broad discussion, **the Group indicated** its willingness to participate in planning and designing of GOOS **and noted** the essential need to complement any potential space-borne observing system with an earth-based observing system. **The Group also noted** the need to develop new measuring techniques such as acoustic tomography for the ocean mid-depths. Nevertheless there was a need for GOOS now, and that phase (i) should not necessarily wait for new technology or new information. The Chairman of the Group should continue his liaison role with GOOS, and advise on suitable GLOSS statistics to be made available for the proposed GOOS inventory.

5.2 LONG-TERM GLOBAL MONITORING SYSTEM OF COASTAL AND NEAR SHORE PHENOMENA RELATED TO CLIMATE CHANGE (GCNSMS)

63 **The Group noted** that IOC, UNEP and WMO have developed a proposal for GCNSMS, recognizing the lack of a comprehensive programme for monitoring of climate-related changes relevant to the coastal and nearshore environment, and considered the document UNEP-IOC-WMO/GCNSMS-I/6, containing draft proposals.

64 Based on its identification of the factors which had enabled GLOSS to develop quickly, **the Group provided** an analysis to be brought to the attention of the UNEP-IOC-WMO Meeting of Experts on GCNSMS in December 1990. Emphasis must be on rationalizing existing systems and agreed procedures. Sea-level must be a fundamental component of a GCNSMS, but for local impact studies a much denser network than GLOSS provides would be necessary.

5.3 INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME: A STUDY OF GLOBAL CHANGE (IGBP)

65 Recognizing that sea-level was very important to the studies of the IGBP, **the Group recommended** that the programme should be based on factual sea-level information and **invited** the IGBP to make its requirements known to the Group. The GLOSS Technical Secretary should make appropriate enquiries.

5.4 WMO-UNEP INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

66 Dr. D. Pugh informed the Group that 3 working groups had been set up by the IPCC to report on science, impacts and responses to the Second World Climate Conference in November 1990. Dr. P. Woodworth gave details of the chapter on sea-level variability produced by the Working Group on Science and recommended it to the Group as a well-reviewed consensus of present knowledge and prediction of potential sea-level change in the future. Although the Group did not have access to the reports of the second and third working groups, it was understood that they gave emphasis to the need for fully operational sea-level network. **The Group indicated** its readiness to respond to these requests, provided substantial additional funds became available (see Agenda Item 10.2).

6. GEODETIC CONTROL OF SEA-LEVEL MEASUREMENTS

67 Mr. B. Douglas informed the Group of the NASA programme to install GPS stations at tectonic plate boundaries. **The Group asked** Mr. B. Douglas and the GLOSS Technical Secretary to give NASA suggestions for preferred sites at, or near to, GLOSS stations (see Agenda Item 2.3).

68 Dr. J. Hannah suggested that tide gauges within 50 to 5000 km of VLBI and SLR stations should form a primary network acting as references for regional and local gauges, which would be geodetically linked by GPS to these primary gauges.

69 The Group took note of the IAPSO Workshop on Geodetic Fixing of Tide Gauge Bench Marks held at Woods Hole in 1989 (Technical Report WHOI-89-31), which had set out the requirements needed and technology available and recognized absolute gravity as a technique independent of, and complementing, GPS and VLBI. **The Group also recognized** the need to design bench marks which are physically easily linked to GPS equipment. **The Group acknowledged** that geocentric co-ordinates of GLOSS stations bench marks would be data-banked by the PSMSL.

7. TEMA-RELATED ACTIVITIES

7.1 SEA-LEVEL TRAINING COURSES

70 Mr. G. Alcock informed the Group of the Eighth Sea-Level Training Course held at Bidston, UK, in June 1990, attended by 2 trainees from India and one each from Tanzania, Thailand and Venezuela. This course had been very successful because all trainees had an interest in and responsibility for sea-level activity in their countries. In introducing a paper analyzing all GLOSS training courses at Bidston, Mr. G. Alcock stressed that sometimes the course has been attended by people of little use to GLOSS. As the success or failure depends on the enthusiasm of the GLOSS national contacts, he explained to the Group that the present training course is not always meeting the needs of GLOSS by attracting the right people. However, overall the 8 years of the course had been generally successful, and to illustrate this, Mr. G. Alcock presented the analysis of a questionnaire sent to the 29 trainees who had attended it. Two trainees were known to have left their jobs, one was traveling overseas and 10 replied to the questionnaires. All 10 were involved in sea-level activities and claimed to have obtained some increase from the course in knowledge, expertise or realization of their responsibilities to sea-level measurement. Eight new GLOSS gauges had been installed with the help of course trainees. The main problem mentioned by trainees was the lack of spare parts and consumables such as pen and ink. There was a continuing need for training and maintenance of gauges and in the processing of data. Scientists using sea-level data were identified in 6 countries. The need for keeping the trainees informed of GLOSS activities was mentioned, and particularly the necessity of visits to countries by GLOSS experts.

71 Mr. G. Alcock proposed that in the future there continue to be a training course for technicians (with an updated manual) but also a workshop for GLOSS scientists. It was intended that the latter would discuss the science and politics of promoting GLOSS and make its operation more effective by enthusing the scientists to spread the message. The scientists may identify relevant technicians who operate the gauges and the latter can then be candidates for the technical course.

72 The Group was informed about the First Sea-Level Training Course for specialists from French speaking countries that was held in Brest (France) in September 1990. The Course was organized by IOC with financial and technical assistance of France. The training (lectures, seminars and practical exercises) was provided by the Ecole des Hydrographes, Etablissement Principal du Service Hydrographique et Oceanographique de la Marine. Nine trainees from Alger, Congo, Cote d'Ivoire, Guinea, Madagascar, Mauritania, Senegal, Togo and Tunisia participated in this Course.

73 **The Group noted** the importance of IOC arranging for the supply of spare parts and consumables donated by Member countries. The existing training manual (IOC Manual and Guides No. 14, Unesco 1985) was well received by the Group and the GLOSS Technical Secretary was instructed to send copies to every GLOSS Expert; in particular, Dr. V. Kaliazin requested 100 copies of the Russian language version to be sent to the USSR for distribution. **The Group accepted** the offer from the UK to update the Manual by including information on new methods of measurement and data transmission and filters. **The Group strongly recommended** that updated version be published in English, French, Russian, Spanish and Portuguese and **welcomed** the offers of the experts from Canada, Brazil and the USSR to translate the English version into French, Portuguese (and Spanish) and Russian, respectively.

74 **The Group recommended** that a Sea-Level Scientific Workshop be held at Bidston in 1991 if necessary funds are available. **The Group noted** the need for training courses to be held in the regions and noted that the offer of Australia to host a meeting still exist. **The Group welcomed** the offer of the USSR to

organize sea-level training course in the USSR for Russian speaking specialists and **recommended** that an appropriate Soviet specialist attend the next training course in Bidston to help prepare the appropriate training course in the USSR. **The Group welcomed** the offer of Brazil to host a Spanish and Portuguese-speaking training course for sea-level technicians, as a collaboration between the University of Sao Paulo and the Directorate of Hydrography and Navigation. **The Group noted** the importance of having further Spanish-speaking courses, particularly for South and Central American countries; it supposed that the offer from Cuba to host such a course still exist, but **instructed** the GLOSS Technical Secretary to request further details from Cuba, and to investigate potential offers from Colombia and Costa Rica.

7.2 OTHER TRAINING REQUIREMENTS

75 **The Group asked** GLOSS Experts to investigate sponsorship to provide computers for developing countries with GLOSS stations. **The Group also recognized** the need for the supply of low-level software and instructed the UK to include in updated version of the IOC Manual on Sea-Level Measurement and Interpretation (Agenda Item 7.1) references to the existence, attributes and location of suitable software packages, such as those produced by Australia (Flinders University) and the USA (University of Hawaii). **The Group recognized** the need to have specialized training in software technology and congratulated the efforts of the University of Hawaii in providing such tuition in Central and South American countries.

8. NEW TECHNOLOGY

8.1 DATA COLLECTION AND TRANSMISSION

76 **The Group noted** that the use of GPS techniques on moored buoys or small islands was a potentially valuable new technique for measuring sea-level in hostile regions such as wave-pounded regimes. It encouraged NASA to install GPS on moored buoys in ideal test-sites, such as Hawaii, for at least one year and subject the data to a full tidal analysis in order to evaluate the technique.

77 The Group emphasized that the accurate measurement of sea-level is not easy, especially over the long-term and stressed the need for frequent checks, at least several times a week and preferably daily, on the recorded sea-level using a simple independent device such as a tide pole or datum probe switch. **The Group recommended** that comparative studies of new sea-level measurement techniques be carried over the next year and the results presented at the next session of GE/GLOSS, or at separate meeting.

78 **The Group recognized** the need for regular measurements of water density and barometric pressure to be made at certain GLOSS stations, especially in mid-latitudes where decadal low-frequency, sea-level variations were mainly due to stearic and barometric pressure effects. Stearic levels computed from temperature and salinity profiles, taken over a long period could be a valuable component in the low-frequency analysis of data from GLOSS gauges, as for example, at Bermuda.

79 **The Group noted** the importance of absolute gravity measurements as a technique for checking bench mark stability, independent of GPS and VLBI techniques.

80 For studies of long-term sea-level changes, **the Group noted** the importance of measuring changes in the volume of land ice for long-term changes in sea-level, and recognized the potential of laser and radar altimetry from planes and satellites to make such measurements. **The Group strongly recommended** that bench mark monumentation at tide gauges should be ideally designed and installed to be easily coupled to GPS equipment.

8.2 GLOBAL AND REGIONAL SEA-LEVEL INDICES

81 Dr. P. Woodworth reminded the Group that the only PSMSL products currently produced were its global data tape in GF3 format, subsets of the dataset in the form of floppy disk files and printouts, and data reports. He informed the Group that the PSMSL intends to derive ongoing global and regional indices of mean sea-level, which can be used as a general guide to non-specialists, of average global and regional sea-level variability in much the same way as indices of other climate variables are produced. **The Group noted** that such an Index would be useful to indicate particularly noisy and quiet areas in terms of land movements,

and therefore would fulfil the need to raise the consciousness of scientists who use the data. Regional Indices may be more useful than the Global Index. **The Group endorsed** the PSMSL proposal to produce such indices for the IUGG Assembly in August 1991, and probably annually thereafter.

9. GLOSS PUBLICITY

82 Dr. D. Pugh showed the Group the GLOSS brochure and studies, which had been paid for by the UK, as part of its contribution to the IOC. **The Group noted with satisfaction** the effectiveness of these products in bringing GLOSS to the attention of the non-scientific community.

83 The Group asked the PSMSL to produce a poster on GLOSS at the IUGG Assembly and also asked that the PC-version of the GLOSS Handbook be displayed there. Dr. Woodworth asked Experts to encourage colleagues to submit posters on sea-level studies and GLOSS for the IUGG Inter-Association Symposium on Sea-Level Changes and the IAPSO Session on "The global heat engine", which were planned to be organized in the framework of IUGG Assembly.

84 Dr. L. Rickards presented her review of activities concerned with the GLOSS Handbook. Information sheets were distributed to about 90 GLOSS contacts in 74 countries requesting gauge information and location maps. Up to October 1990 replies had been received from 36 countries, covering 172 GLOSS gauges. Replies covering a further 40-50 GLOSS sites were expected soon. Dr. L. Rickards said that the countries who have not replied yet fall into 3 main areas: (1) South and Central America (Argentina, Brazil, Mexico), 25 gauges. (2) Africa, especially the west coast countries, 16 gauges in 11 countries. (3) Indonesia and Papua New Guinea, 13 gauges.

85 **The Group inspected** the draft GLOSS Handbook, both in computer compatible and printed form, and **warmly commended** Dr. L. Rickards on her efforts. **The Group recommended** that the computer-compatible form of Version I be ready by January 1991, incorporating all information received by December 1990. **The Group recommended** that the GLOSS Technical Secretary discusses with Dr. L. Rickards the publication of Version 1 in printed form, including maps and plots, but divided into regions. The PC diskette will be also prepared with the computer-compatible version of the whole Handbook, accompanied by a short summary description of the Handbook in printed form.

86 **The Group requested** Dr. L. Rickards to insert references to the existence of the PSMSL and its sea-level and ancillary data. **The Group decided** against including geographical/geophysical information in the Handbook, but **requested** the PSMSL to consider the feasibility of providing geophysical information about GLOSS stations on its data tape.

87 **The Group recommended** that the Handbook be updated, and possibly expanded, in about 2 years time, and that the potential of CD ROMS to store the data, including maps, be investigated.

88 **The Group requested** Dr. P. Woodworth to investigate the production of a GLOSS Newsletter, discussed at the First Session of the GE/GLOSS, and aimed at sea-level scientists, tide gauge operators, Regional Co-ordinators and National Contacts, scientists and engineers in relevant Government departments, Universities and Institutes.

89 **The Group noted** with satisfaction that the GLOSS Implementation Plan was finally prepared for publication in 1990 and sent to appropriate Unesco offices for printing.

10. OTHER ACTIVITIES RELATED TO GLOSS

10.1 IDENTIFICATION OF PRIORITY GAUGES

90 **The Group analyzed** the GLOSS primary network in detail and **identified** some GLOSS stations as priority gauges requiring special effort in clarifying their status, updating the existing installation or encouraging their installation in the next 2 years.

Notes:

"A" indicates additional station
"C" indicates committed to GLOSS
"NC" indicates not committed to GLOSS
"O" indicates no existing station
"+" indicates existing station
"U" indicates no information available on commitment or existence
"*" indicates gauge of particular importance

Station		Country		Comments
190	Puerto Deseado	Argentina	OC	WOCE New gauge needed
185	Esperanza		OC	
192	Mar del Plata		+C	
61	Booby Island	Australia	+C	"Standard gauge"
148*	Lord Howe Island		OC	TOGA, Warm core eddies
A	Twin Island		+NC	Replacement for 272 Daru
A	Settlement Point	Bahamas	+NC	Replaces 211 Bimini
A	Exuma		+NC	Replaces 12 San Salvador
36	Chittagong	Bangladesh	ONC	Additional gauges required
198*	Fernando de Noronha	Brazil	OC	
196	Itaparica		+C	
199	Penedo Sao Pedro e Sao Paul		+NC	
265*	Ilha da Trindade		+C	
254*	Porto Grande	Cape Verde	OC	Possible NOS/NOAA gauge
A*	Diego Ramirez	Chile	+NC	Replaces 179 Punta Arenas & 180 Puerto Williams
189	Capitan Prat		+C	
228	Angmagssalik	Denmark	OC	WOCE, paired with Reykjavik, Greenland
2	Djibouti	Djibouti	UNC	
80	Port Said	Egypt	ONC	
258	Tema	Ghana	+C	or Takoradi historic record
229	Reykjavik	Iceland	+C	
38	Port Blair	India	UNC	US WOCE
281	Marmagao (Goa)		+NC	Historic record
50	Kupang	Indonesia	ONC	
240	Castletownsend	Ireland	UNC	or A Galway, NOS?
104	Minamitorishima	Japan	OC	TOGA
16	Agalega Island	Mauritius	+C	Only suitable for pressure gauge
A	Puerto Morelos	Mexico	+-	Replaces 213 Progreso
282	Tan Tan	Morocco	OC	
11	Pemba	Mozambique	ONC	
10	Inhambana		ONC	
37	Akyab	Myanmar	ONC	
141	Moulmein		UNC	
A	Walvis Bay	Namibia	+-	
129*	Bluff	New Zealand	+C	NOS
126	Kermadec Island (Raoul)		ONC	TOGA
A	Scott Base		ONC	Replaces 134 McMurdo
259	Lagos	Nigeria	+C	NOS geodetic control?
A	Won San	DPR of Korea	UNC	
245	Ponta Delgado (Azores)	Portugal	+C	
260	Sao Tome	Sao Tome & Principe	ONC	TOGA, WOCE

253*	Dakar	Senegal	UNC	NOS/NOAA
14	Aldabra	Seychelles	ONC	Only suitable for bubbler or GPS
7	Mogadishu	Somalia	+NC	
249	Ceuta	Spain	OC	
9	Mtwara	Tanzania	OC	
263*	Ascension	UK	+C	TOPEX, WOCE
A	S. Caicos		OC	Replace 290 N. Caicos
188	Faraday		UNC	TOPEX, WOCE
A	Corpus Christi	USA	+NC	Replaces 217 Galveston
A	Lake Worth		+NC	Replaces 218 Miami
A	Clearwater		+NC	
A	St. Croix		+NC	
A	Fernandina Beach		+NC	Replaces 289 Ft. Puloski
303	Massacre Bay, Attu Island		ONC	
25	Mirny	USSR	OC	
A	Providenya		+NC	Bering strait couple
A	Kronstadt-Shepelevo		+NC	
A	Nahodka		+NC	or Sakhalin Island
A	Dikson		+NC	
A	Tiksi		+NC	
A	La Guaria	Venezuela	+C	Replaces 298 Aves Is and 299 Orchila
3*	Aden	P.D.R. Yemen	ONC	

91 **The Group also recommended** that the following stations be deleted from the GLOSS Network:

186	Bahia Scotia	Argentina	C	Duplicated by 306 Signy
48	Pelabuhan Ratu	Indonesia	+NC	291 Cilacop is nearby and operating
301	Palmyra Island	USA	ONC	Only local interest
285	Nawiliwili		+C	Too many Hawaiian stations
287	Hilo		+C	ditto

92 **The Group recommended** that the GLOSS Technical Secretary contact the following Member States:

Argentina, to clarify the status of Esperanza, Mar del Plata and Bahia Scotia.

Australia, to request that the existing gauge at Twin Island be committed to GLOSS as an additional Australian gauge.

Bahamas, to request that the existing gauges at Settlement Point and Exuma replace the gauges at Bimini and San Salvador as GLOSS gauges.

Bangladesh, to request information on the status of sea-level measurements.

Brazil, to propose that the committed but not existing gauge at Porto de Santara be deleted as a GLOSS gauge.

Chile, to request that a gauge be installed at Diego Ramirez and committed to GLOSS to replace the existing committed gauges at Punta Arenas and Puerto Williams.

Cuba, to encourage the installation of a gauge at Punta Maisi.

Denmark (GLOSS contact - Dr. Erik Buch, the Greenland Fisheries Research Institute), to encourage the installation of a gauge at Angmagssalik in Greenland.

Egypt (Suez Canal Authority and Alexandria University), requesting the installation of a gauge at Port Said.

France (GLOSS contact - Prof. C. Le Provost), to note and encourage the installation of gauges in the Southern Oceans.

Ghana, to seek advice on the status and desirability of gauges at Tema and Takoradi.

Haiti, to request information on the status of sea-level measurements.

Iceland, to note the importance of the committed Reykjavik gauge and request quicker data transmission.

Indonesia, to encourage the installation of a gauge at the important site of Kupang; to propose that the existing gauge at Pelabuhan Ratu be deleted, the location is covered by the existing gauge at Cilacop.

Japan, to encourage installation of a gauge at the important site at Minamitorishima.

Mexico, to request that the existing gauge at Puerto Morelos replace the existing committed gauge at Progreso, explaining that scientifically the former is a more important site.

Morocco, to seek advice on the desirability of a GLOSS gauge at Tan Tan or another site.

Mozambique, to encourage installation of gauges at Pemba and Inhambane.

Myanmar, to welcome their positive approach to installing gauges.

Namibia, to request that the existing gauge at Walvis Bay be committed to GLOSS.

New Zealand, to recommend that Scott Base replace McMurdo Sound as the GLOSS gauge.

Portugal, to note the importance of the committed gauge at Ponta Delgada (Azores) and request quicker data transmission.

Sao Tome and Principe (copied to relevant offices in Lisbon), to request a committed GLOSS gauge at Sao Tome.

Somalia, to request information on the status of the gauge at Mogadishu.

Spain, to encourage installation of the committed gauge at Cueta.

Tanzania, to encourage installation of the committed gauge at Mtwara.

United Kingdom, to encourage the modernization of existing gauges at Ascension and Faraday; and to encourage installation of a committed gauge at South Georgia.

U.S.A., to request advice on replacing existing gauges at Corpus Christi, Lake Worth and Fernandina Beach with more suitable gauges; to ask for clarification on the status of a gauge at Massacre Bay, Attu Island; to request a removal from the GLOSS main network of the gauges at Palmyra Island, Nawiliwili and Hilo.

U.S.S.R., to encourage the installation of the committed gauge at Mirny; to request that the existing gauges at Providenya, Kronstadt-Shepelevo, Nahodka, Dikson and Tiksi all be committed to GLOSS.

Venezuela, to recommend that the existing committed gauge at La Guaria replace the other 2 Venezuelan gauges.

10.2 SUPER GLOSS

93 **Assuming that a certain undefined sum of money were to become available centrally to the GLOSS organization, the Group reviewed possible moves to enhance easily GLOSS operation. An order of priorities was quickly determined. The Group expressed the general feeling that the most important part of the operation of GLOSS system should be the strengthening of the existing system. The activities were listed as follows:**

(i) Maintenance
(ii) Improvements
(iii) Data Management
(iv) Science and other global programmes
(v) Administration

94 Each of the above elements consists of several sub-sections, the order of which is set below. It has to be stressed that it was not unanimous from the beginning, and has been arrived at after some heated discussions, and thus expresses a considered opinion of the Group. All elements would benefit from increased funding.

1. Maintaining the Existing Network

A. Operate existing network of GLOSS stations including:

(1) Bench mark information.
(2) Levels.
(3) Operation and maintenance.
(4) Supply of spare parts.
(5) Observer supervision (i.e., training and instruction on site by technicians).

B. Regional co-ordination including:

(1) Technical support (mainly provision of tide gauge technician).
(2) Supervision of operation of regional network (i.e., not just primary GLOSS network).

C. TEMA - Training at individual level, including computer training; courses at a regional level.

2. Improvements of the Network

A. Completion of GLOSS network (approximately 220 now operating from 307).
B. Upgrade of existing low-quality GLOSS stations.
C. Further geodetic integration.
D. Provision of meteorological sensors.
E. Evaluation of technology and procedures.

3. Data Management

A. A GLOSS data bank at either a centralized site or distributed with central co-ordination. (Establishment and funding to provide staff and overheads for at least 5 years).
B. Banking of digital hourly heights.
C. Banking of ancillary data including:

(1) Leveling information.
(2) Meteorological data (at least atmospheric pressure).
(3) Water data (salinity, temperature, etc.)

D. P.C. software for local use (see also 5.B.(2)).
E. Preparation and propagation of sea-level products.
F. Access and process historical data.

4. Science and other global programmes

A. Scientific liaison.
B. Data analysis.
C. Workshops.

5. Administration

A. Central staff. (Project scientist and support).
B. Public relations and education.

(1) Liaison with politicians and administrators.
(2) Obtaining sponsorship from, e.g., computer companies (see also 3.D.).
(3) Publications.
(4) Talks, etc.

C. Dissemination of information on GLOSS.

95 It was envisaged that a minimum sum of $5m per annum would be required for the Member States to gain full benefit from the enhancements. Exact structure and costs for any detailed proposals (staffing etc.) would be for the Secretariat of IOC to propose, in consultation with the Chairman of the GE/GLOSS and other members.

11. GLOSS WORK PLAN FOR 1990, 1991 AND 1992-1993

96 In the light of the discussion under previous agenda items, **the Group prepared** the summary Work Plan for GLOSS implementation for 1990, 1991, and 1992-1993 (Annex IV). In order to achieve the objectives recommended by the Group of Experts on GLOSS, **the Group requested** the IOC Committee on Ocean Processes and Climate and the IOC Assembly to approve the proposed Work Plan and to consider ways and means to ensure its implementation.

97 **The Group requested** the Secretary of IOC to write letters, in consultation with the PSMSL, to those countries for which the data are lacking from the archives of the Service.

98 **The Group noted** that it would be useful to have a brief review meeting of those GLOSS Experts attending the IUGG Assembly, in Vienna in August 1991.

12. ADOPTION OF SUMMARY REPORT

99 **The Group adopted** the Summary Report and requested Dr. D. Pugh, Chairman of GE/GLOSS, to submit this Report to the Fourth session of the IOC Committee on Ocean Processes and Climate for approval. **The Group warmly applauded** the Rapporteur for his skill in preparing the draft Report, particularly as the GLOSS Technical Secretary was unable to attend. **The Group regretted** this non-attendance.

13. DATE AND PLACE OF THE NEXT SESSION

100 **The Group noted** the offer of Australia to host the Third Session of the Group of Experts on GLOSS in 1992. **The Group also discussed** the possibility of holding the Session in Paris, Singapore, Brazil or the Maldives. It would be advantageous to hold the Session with another GLOSS-related meeting.

14. CLOSURE

101 **The Chairman closed** the Session at 12:00 on 26 October 1990.

ANNEX I

AGENDA

1. ORGANIZATION OF THE SESSION
   - 1.1 OPENING OF THE SESSION
   - 1.2 ADOPTION OF AGENDA AND TIMETABLE OF THE SESSION
   - 1.3 DESIGNATION OF RAPPORTEUR
2. REVIEW OF ONGOING ACTIVITIES
   - 2.1 IGOSS SEA-LEVEL PROGRAMME IN THE PACIFIC
   - 2.2 IGOSS SEA-LEVEL PILOT PROJECT IN THE NORTH AND TROPICAL ATLANTIC
   - 2.3 IGOSS PILOT PROJECT ON ALTIMETRIC SEA-SURFACE TOPOGRAPHY DATA
   - 2.4 PERMANENT SERVICE FOR MEAN SEA-LEVEL (PSMSL)
   - 2.5 GLOSS COMPONENTS OF TOGA AND WOCE PROGRAMMES
3. REGIONAL AND GLOBAL COMPONENTS OF GLOSS
   - 3.1 IOCARIBE
   - 3.2 IOCEA
   - 3.3 IOCINDIO
   - 3.4 IOCINCWIO
   - 3.5 WESTPAC
   - 3.6 GLOSS ACTIVITIES IN THE SOUTHERN OCEANS
   - 3.7 OTHER REGIONAL PROGRAMMES AND ACTIVITIES
   - 3.8 CRITERIA FOR SELECTION OF TIDE GAUGES LOCATIONS FOR THE GLOSS NETWORK
   - 3.9 GENERAL TRENDS OF GLOSS DEVELOPMENT
4. GLOSS INPUTS TO OTHER IOC PROGRAMMES

5. GLOSS RELATIONSHIPS WITH LONG-TERM MONITORING SYSTEMS AND PROGRAMMES

5.1 GLOBAL OCEAN OBSERVING SYSTEM (GOOS)

5.2 LONG-TERM GLOBAL MONITORING SYSTEM OF COASTAL AND NEAR SHORE PHENOMENA RELATED TO CLIMATE CHANGE (GCNSMS)

5.3 INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME : A STUDY OF GLOBAL CHANGE (IGBP)

5.4 WMO-UNEP INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

6. GEODETIC CONTROL OF SEA-LEVEL MEASUREMENTS

7. TEMA RELATED ACTIVITIES

7.1 SEA-LEVEL TRAINING COURSES

7.2 OTHER TRAINING REQUIREMENTS

8. NEW TECHNOLOGY

8.1 DATA COLLECTION AND TRANSMISSION

8.2 GLOBAL AND REGIONAL SEA-LEVEL INDICES

9. GLOSS PUBLICITY

10. OTHER ACTIVITIES RELATED TO GLOSS

10.1 IDENTIFICATION OF PRIORITY GAUGES

10.2 SUPER GLOSS

11. GLOSS WORK PLAN FOR 1990, 1991 AND 1992-1993

12. ADOPTION OF SUMMARY REPORT

13. DATE AND PLACE OF THE NEXT SESSION

14. CLOSURE

ANNEX II

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ANNEX III

LIST OF DOCUMENTS[1]

Document Code	Title
IOC/GE-GLOSS-II/1 prov.	Provisional Agenda
IOC/GE-GLOSS-II/1 prov. Add.	Provisional Timetable
IOC/GE-GLOSS-II/2	Annotated Provisional Agenda
IOC/GE-GLOSS-II/3	Summary Report
IOC/GE-GLOSS-II/4 prov.	Provisional List of Documents
IOC/GE-GLOSS-II/5 prov.	Provisional List of Participants
IOC/GE-GLOSS-II/6	Progress Report on the Activities of IGOSS Sea Level Programme in the Pacific
IOC/GE-GLOSS-II/7	Progress Report on the Activities of IGOSS Sea Level Pilot Project in the North and Tropical Atlantic
IOC/GE-GLOSS-II/8	IGOSS Pilot Project on Altimetric Sea Surface Topography Data
IOC/GE-GLOSS-II/9	Recent PSMSL Activities and GLOSS Status as Perceived by the PSMSL
IOC/GE-GLOSS-II/10	IOCINCWIO Component of GLOSS
IOC/GE-GLOSS-II/11	WOCE Sea Level Data Assembly Center
IOC/GE-GLOSS-II/12	WMO-UNEP Intergovernmental Panel on Climate Change (IPCC): Overview and Conclusions Related to Impact of Sea Level Rise on Coastal Zones
IOC/GE-GLOSS-II/13	Towards Routine Global and Regional Sea Level Indices
IOC/GE-GLOSS-II/14	GLOSS Work Plan for 1990, 1991 and 1992-1993
IOC/GE-GLOSS-II/15	GLOSS Handbook: A Review of Activities
IOC/GE-GLOSS-II/16	Sea Level Training Course at Bidston
IOC/GE-GLOSS-II/17	Progress report on the TOGA Sea Level Center
IOC/GE-GLOSS-II/18	GLOSS development within the IOCARIBE

[1] For reference only. No stocks of these documents are maintained, except for the Report.

IOC/GE-GLOSS-II/19	Status of the Co-operative East Pacific Sea Level Project
IOC/GE-GLOSS-II/20	Review of the Soviet Antarctic Sea Level Activities
IOC/GE-GLOSS-II/21	Status of the Soviet Sea Level Measurements in Antarctica
IOC/GE-GLOSS-II/22	Development of the USSR Sea Level Studies in connection with GLOSS Tasks
IOC Workshop Report No. 69	Report of IOC Workshop on Sea Level Measurements in Antarctica
IOC/GOOS-I/3	Summary Report of the First Session of IOC *Ad hoc* Group of Experts on Ocean Observing System (including Strategic Plan for GOOS)
UNEP-IOC-WMO/GCNSMS-I/6	Draft Proposals for a Long Term Global Monitoring System of Coastal and Near Shore Phenomena related to Climate Change

ANNEX IV

GLOSS WORK PLAN FOR 1990, 1991 AND 1992-1993

No	Actions	1990	1991	1992	1993
1	Preparation of a report on GLOSS liaison with global programmes, such as GOOS and GCNSMS for it's presentation to the IOC-XVI	-	(Feb)	-	-
2	Regular Sessions of GE/GLOSS	2nd session Miami, USA (22-26 Oct)	-	3rd session (N/A)	-
3	Sea Level Training Courses:				
	- for English speaking trainees (Bidston, UK)	8th course (11-29 June)	-	9th course (June)	-
	- for French speaking trainees (Brest, France)	1st course (10-21 Sept)	2nd course (N/A)	?	?
	- for Spanish/ Portuguese speaking trainees (N/A)	-	-	1st course Brazil ?	?
	- for Russian speaking trainees (USSR)	-	-	-	1st course Leningrad (N/A)
4	Sea Level Scientific Workshop for Regional and National GLOSS contacts	-	1st Workshop Bidston, UK (May/June)	-	2nd Workshop (N/A)
5	Missions of GLOSS Consultants and GLOSS Regional co-ordinators to visit GLOSS stations and advice IOC Member States on GLOSS Implementation	-	2 persons (up to 4 weeks)	2 persons (up to 4 weeks)	2 persons (up to 4 weeks)

6	Technical assistance of Sweden and FRG to the countries of IOCEA region in delivery and installation of tide gauges	Nigeria Lagos (March)	Ghana Tema (Jan/Feb) Senegal Dakar (N/A) Mauritania Nouadhibou (N/A)	Sierra Leone Freetown (N/A)	-
7	Participation of GLOSS experts in the meetings of IOC Regional Bodies	SC-WESTPAC-I China (Feb) IOCEA-II Nigeria (Feb)	IOCINDIO-II India (Apr/May) IOCINCWIO-III Mauritius (N/A) IOC SOC-VI France (June)	IOCARIBE-IV Mexico (Oct)	SC-WESTPAC-II USSR ? (N/A) IOCEA-III Senegal ? (N/A)
8	Participation of GLOSS experts in the meetings of TOGA, WOCE, IGBP and other meetings relevant to GLOSS	FIG Congress Finland (10-19 June)	Antarctic Science Conf. FRG (23-28 Sept) IUGG Assembly Austria (11-24 August)	UNCED Brazil (1-12 June)	-
9	Participation of GLOSS experts in: - Workshop on Sea Level Rise in the Western Indian Ocean - Workshop on Implication of Climate Change and the Impact of Sea Level Rise on the South Asian Sea Region	- -	Kenya (N/A) Bangladesh (N/A)	- -	- -

10	Publication of GLOSS Implementation Plan	(Dec)	-	Updating (Dec)	-
11	Preparation and Publication of GLOSS Newsletter (on contract basis)	-	2 issues	2 issues	2 issues
12	Preparation, publication and updating of GLOSS Handbook	Draft (Nov)	Publication (Feb)	Updating (Dec)	-
13	Preparation and Publication of GLOSS brochure	English version (Feb)	French, Russian versions (Jan/Feb) Spanish version (March)?	-	-
14	Preparation of several copies of GLOSS Display boards	(Dec)	-	Updating (Dec)	-
15	IOC Workshop on Sea Level Measurements in Antarctica (in co-operation with SCAR and IOC SOC)	USSR Leningrad (28-31 May)	-	?	-
16	IOC Workshop on accuracy of sea level instruments	-	-	(N/A)	-
17	Annual contract IOC/Unesco with PSMSL	(May)	(Jan/Feb)	(Jan/Feb)	(Jan/Feb)
18	Publication of IGOSS/ISLPP/NTA Report	-	(Feb/March)	ongoing	ongoing