**Intergovernmental Oceanographic Commission**
*Reports of Meetings of Experts and Equivalent Bodies*

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

## First Session

Proudman Oceanographic Laboratory,
Bidston, U.K., 19-23 June 1989

**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
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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

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IOC/GE-GLOSS-I/3
Paris, 2 February 1990
English only

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## 1. OPENING

1 The meeting was opened by the Chairman of the Group of Experts on GLOSS, Dr. D. Pugh.

2 Dr. Brian McCartney, Director of the Proudman Oceanographic Laboratory, welcomed the participants. He informed the participants on the programme of the Laboratory's activities, pointing out that the Laboratory, Bidston Observatory, has been dealing with the study of sea-level for a long period and the study of sea-level, ocean surface topography and tides is one of the major tasks of the Laboratory. The Proudman Oceanographic Laboratory has actively participated in international activities, particularly the GLOSS, and sea-level related activities of WOCE, and also acts as the British Oceanographic Data Centre.

3 Dr. A. Tolkachev, Senior Assistant Secretary of IOC, welcomed the participants on behalf of the Secretary of IOC and expressed thanks and appreciation to the Proudman Oceanographic Laboratory for hosting the meeting and for the support provided by the Laboratory to the IOC ativities on GLOSS, WOCE, IODE and training courses on sea-level measurements organized by the Laboratory since 1983 with support of IOC. He also referred to the decision of the Twenty-first Session of the IOC Executive Council on the establishment of the IOC Group of Experts on GLOSS, as a subsidiary body of the IOC Technical Committee on Ocean Processes and Climate.

4 The Agenda, as amended, was adopted by the Group (Annex I).

5 Dr. L. Rickards was elected as rapporteur of the meeting.

## 2. GLOSS NETWORK: RECENT DEVELOPMENTS

6 Dr. A. Tolkachev informed the Group on major GLOSS developments since the Second session of the IOC Task Team on the GLOSS, held in Honolulu, USA (19-23 October 1987). In his presentation he pointed out the following points:

(i) Preparation of the Implementation Plan for the Global Sea-level Observing System with the assistance of Dr. L. Rickards. This plan, available at the meeting, (doc. IOC-XV/8 Annex 4), will be submitted to the Third session of the IOC Committee on Ocean Processes and Climate (27-29 June 1989) and the Fifteenth session of the IOC Assembly (9-19 July 1989) for approval.

(ii) Decision of the Twenty first session of the IOC Executive Council to establish the IOC Group of Experts on GLOSS as a subsidiary body of the IOC Committee on Ocean Processes and Climate.

(iii) Recommendations of the Fifth session of the Joint IOC-WMO Committee for IGOSS (17-23 November 1988) relevant to GLOSS activities, particularly on the conversion of the IGOSS Sea-level Pilot Project in the Pacific into permanent operational programme IGOSS Sea-level Programme in the Pacific (ISLP/Pac); approval of the plan for implementation of the IGOSS Sea-Level Pilot Project in the North and Tropical Atlantic (ISLPP-NTA) and the development of the IGOSS Pilot Project on Altimetric Sea-Surface Topography Data.

(iv) Workshop on Sea-Level Measurements in Hostile Conditions (Bidston, UK, 28-31 March 1988).

(v) Proposal of the IOC Ad hoc Expert consultation on Ocean Observing Systems Development (Paris, 20-22 March 1989) on the preparation of the plan for a global operational ocean observing system that should include global sea-level variables.

(vi) Consideration of sea-level observational programmes, needed in support of TOGA and WOCE at the Second session of WMO-IOC Intergovernmental TOGA Board, (5-9 December 1987), and the International WOCE Scientific Conference (28 November - 2 December 1988).

(vii) Consideration and development of GLOSS within the framework of IOC regional activities, particularly IOCEA, IOCINCWIO, IOCINDIO, WESTPAC and IOCARIBE.

(viii) Activities of the WMO-UNEP Intergovernmental Panel on Climate Change (IPCC), particularly with regard to the activities of Working Groups on scientific assessments of climate change (which include evaluation of sea-level change) and preparations for the Second World Climate Conference to be held in November 1990.

7 **The Group noted** the progress in the development of GLOSS since 1987. It was noted, however, that some proposals of the Task Team on GLOSS had not been implemented due to financial reasons, particularly regarding the preparation of the GLOSS Newsletter, and GLOSS Brochure. **The Group also emphasised** that the growing importance of GLOSS for such programmes as TOGA, WOCE, IGBP and for climate monitoring and prediction needs more support and attention from IOC, in order to ensure the steady implementation of GLOSS.

8 This will need further strengthening and improvement of GLOSS management in the IOC Secretariat and on the regional and national levels, and consideration of a new mode of GLOSS financing. In view of the importance of sea-level monitoring for understanding and predicting climate change, IOC should look at the use of the new funds and programmes relevant to climate and global change (WMO, UNEP, UNDP etc). **The Group also noted** the need to establish contacts with the relevant Working Groups of the UNEP-WMO Intergovernmental Panel on Climate Change.

9 **The Group then reviewed** the state of implementation of the GLOSS network and determined the priorities in its implementation for the period 1990-1991. The Group requested the IOC Committee on Ocean Processes and Climate and the IOC Assembly to consider possible ways and means to implement necessary actions for it.

## 3. IGOSS SEA-LEVEL PROGRAMMES AND PROJECTS

### 3.1 IGOSS SEA-LEVEL PROGRAMME IN THE PACIFIC

10 Dr. G. Mitchum (SOC for ISLP/Pac) presented the report on the IGOSS Sea-level Programme in the Pacific (see Annex III). The IGOSS Sea-level Pilot Project was started in 1984 and since then 82 stations in the Pacific Ocean from 30 countries have provided sea-level data on a regular basis to the IGOSS Specialised Oceanographic Centre for ISLP/Pac. These data have been used to produce maps of the sea-level anomalies in the Pacific which have been given wide distribution to participating countries and interested scientists. For the period 1989-1990 it is planned to continue to produce the operational maps of the sea-level deviations in the Pacific and the maps of the atmospheric pressure-corrected sea-level anomalies. Details regarding future activities of the SOC for ISLP/Pac are contained in Annex III.

11 **The Group noted** with satisfaction the progress in the implementation of the ISLPP for the Pacific that became a permanent operational programme with effect from November 1988.

12 Under this item Prof. G. Lennon reported on the activities of Australia regarding sea-level measurements in the South Pacific, and in particular, regarding the assistance of Australia to ASEAN countries to establish sea-level stations.

13 Noting active participation of many countries of the Pacific in the ISLP/Pac, the Group requested that the IOC Secretariat invites Mexico to provide sea-level data on a regular basis to SOC/ISLP/Pac and the USSR to include additional stations for provision of sea-level data to the SOC.

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

14 The Joint IOC-WMO Committee for IGOSS at its Fifth session (November 1988) recommended to launch the IGOSS Sea-Level Pilot Project in the North and Tropical Atlantic.

15 Dr. A. Bolduc reported on the preparation of the Project. The proposal for the Project is contained in the report of the Fifth session of the Joint IOC-WMO Committee for IGOSS (doc. IOC-WMO/IGOSS-V/3 Annex VII).

16 **The Group reviewed** the progress in planning ISLPP/NTA. The objectives of the project are:

(i) identification and recruitment of tide gauges into the project;

(ii) improvement of the data communication network for tidal and sea-level applications;

(iii) evaluation and usefulness of producing synoptic mean sea-level anomaly maps for the North and Tropical Atlantic; improvement of the timeliness, quantity and quality of data flowing into the PSMSL archive.

17 The ISLPP/NTA project covers the area confined between 65°N-30°S for latitude, 100°W-20°E for longitude. The monthly mean sea-level data can be sent to MEDS via telemail, telex or by mail.

18 The Action plan for 1990-91 has been defined as:

(i) Contact all agencies from countries around the Atlantic Basin and request that monthly mean sea-level data be sent directly to MEDS each month;

(ii) Start to publish monthly mean sea-level data on a regular basis indicating the contributing countries to the project;

(iii) Complete an analysis of the correlations of sea-level changes around the North and Tropical Atlantic;

(iv) Draw monthly maps using historical data to demonstrate the usefulness of the project;

(v) Compute anomalies using historical data as a base and draw the results as operational monthly sea-level anomaly maps;

(vi) Publish and circulate all products as widely as possible to demonstrate the usefulness of the project and encourage countries to send their data as contribution to the project.

19 **The Group pointed out** the importance to initiate the project as soon as possible and urged the MEDS (Canada) to take action in this direction, taking into account the experience of the PSMSL, the ISLPP for the Pacific and the interests of TOGA Programme.

## 3.3 INITIATION OF IGOSS PILOT PROJECTS IN THE INDIAN AND SOUTHERN OCEANS

20 **The Group considered** the possible initiation of similar Pilot Projects in the Indian Ocean and the Southern Ocean.

21 With regard to the Indian Ocean the Group noted that it would be premature to initiate the operational Pilot Project, recognising that most sea-level stations have been established relatively recently and that there is a need to ensure cooperation of the countries of the Indian ocean region with regard to timely exchange of sea-level data from existing stations. This, in the opinion of the Group, will need 6-8 more years to implement the project in a similar way as the IGOSS Pilot Project in the Pacific. **The Group, however, recommended** the IOC to initiate efforts in this direction.

22 Prof. G.W. Lennon informed the Group on the feasibility study for a possible IGOSS Sea-Level Pilot Project for the Southern Ocean. The proposal for such a project was considered at the Second session of the IOC Task Team on GLOSS (October 1987) and the Fifth session of the Joint IOC-WMO Committee for IGOSS (November 1988).

23 In September 1988 the Prime Minister of Australia announced that Australia will take an initiative to monitor rising sea-level due to the greenhouse effect on behalf of the South Pacific Forum Island Countries. During March and April 1989, a group of three Australian scientists, representing both oceanographic and meteorological interests, toured the South Pacific Region in a feasibility design study of the form which such an initiative might take. At this time, June 1989, a report has been prepared

and has been submitted to the Australian Government for assessment and implementation.

24 The Studies undertaken by Flinders Institute for Atmospheric and Marine Science, Flinders University of South Australia, acknowledged the fact that the Southern Oceans plays a significant role in global oceanography. This study also demonstrated that the researchers need sea-level observations and that the most effective method to provide good quality data to the international research community would be through the establishment of regional data centres that can provide the experience and expertise in local conditions that are necessary for quality control.

25 **The Group noted**, with interest, these studies and supported the idea to initiate the IGOSS Sea-Level Pilot Project for the Southern Oceans. **The Group noted** that the functions of Centre for the Southern Oceans should be coordinated with the activities of the SOC for ISLP/Pac and future WOCE sea-level activities. The Group recommended that the Flinders University prepare the Draft Implementation Plan for the Pilot Project and submit it to the second session of the Group.

### 3.4 IGOSS PILOT PROJECT FOR GEOSAT ALTIMETRIC SEA SURFACE TOPOGRAPHY DATA.

26 Dr. A. Tolkachev informed the Group on the recommendation of the Fifth session of the Joint IOC-WMO Committee for IGOSS regarding the proposal to initiate an IGOSS Pilot Project on Altimetric Sea-Surface Topography Data (Rec. 8 (JWC-IGOSS-V)) aimed at evaluating the validity of sea-level changes derived from satellite altimeter measurements. The preliminary product to be available from this project will be maps depicting monthly departures of sea-level from a long-term mean sea-level, derived by analysis of satellite altimetry measurements. The project is expected to run for the remainder of the useful life of the US Navy GEOSAT Altimeter.

27 **The Group noted** that these maps, covering the equatorial Pacific and Indian oceans are included in the Climate Monitoring Bulletin and that the project may be of particular value for future global sea-level analysis in connection with the planned missions of ERS-1 and TOPEX/POSEIDON and the synergistic combination of these remote sensing capabilities with classical in situ measurements being implemented within the GLOSS Programme.

## 4. GLOSS DEVELOPMENT WITHIN IOC REGIONAL ACTIVITIES, AND OTHER REGIONAL PROGRAMMES

28 Dr. A. Tolkachev informed the Group on the outcome of the meetings of WESTPAC, IOCINCWIO and IOCINDIO, with regard to the development of regional components of GLOSS.

29 **The Group noted** with satisfaction that the IOCINCWIO had decided to designate Mr. Mika Odido (Kenya) as a GLOSS regional co-ordinator for IOCINCWIO.

30 The Regional Committees for WESTPAC and IOCINDIO, although recognising the importance of the implementation of GLOSS regional components, had not yet made decisions on the mechanisms for co-ordination of these activities.

31 Dr. G. A. Maul (IOCARIBE regional coordinator for GLOSS) presented the report on GLOSS development within the IOCARIBE. **The Group noted** the progress in the implementation of GLOSS in the IOCARIBE region. Five tide gauges had been donated by the NOAA to establish sites at GLOSS locations in Colombia, Mexico, Aruba and Trinidad and Tobago. The "English-Spanish Bibliography in Physical Oceanography and Ocean Climate for the Caribbean and Adjacent Seas" was published in 1988. It contains many references to sea-level studies. Proposal for an international research effort, using IOCARIBE tide-gauges and the altimeter and scatterometer aboard ESA's ERS-1 satellite, was approved by ESA.

32 **The Group noted** with satisfaction the progress in developing the IOCARIBE regional component of GLOSS. It noted the need to establish tide gauges in the Windward Passage (Cuba-Haiti). **The Group recommended** that, at the forthcoming session of the Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE, December 4-8, 1989) and preceding workshop, particular attention should be given to the implementation of the IOCARIBE regional component of GLOSS, including improvements of the mechanism for the coordination of GLOSS implementation in the region, and the financial support needed for this. **The Group also recommended** that Dr. Maul should try to establish gauges at San Salvador (Bahamas) and North Caicos (United Kingdom).

33 **Dr. G. Alcock** informed the Group of the **European sea-level project** aimed at bringing up-to-date the European Mean Sea-level (MSL) data set. The European MSL dataset will be employed in extensive climatological and geological investigations of European MSL inter-annual variability and long-term trends. This project was initiated by the Proudman Oceanographic Laboratory, in collaboration with the PSMSL, and with seven other European Laboratories with funding from the Commission of European Communities. Almost all European countries participated in the Project.

34 **The Group wished to emphasise** the need to have close co-ordination between GLOSS and European MSL project.

35 Mr. V.K. Nagar reported on the activities of Geodetic and Research Branch of the Survey of India regarding the operation of sea-level stations of India, in particular, those which participate in GLOSS and TOGA programmes. He noted that there were plans to upgrade the existing sea-level stations, which are of great importance for the study of sea-level rise and practical use for navigational purposes. Two stations, namely Minicoy and Port Blair, included in the GLOSS network, would need particular attention to install tide gauges.

36 Geodetic and Research Branch, Survey of India has a long history of over 100 years of maintaining a return of tide gauge observations on the Indian Coastline and on selected islands for the following purposes:

(i) to determine MSL for establishing the datum for vertical control of India;

(ii) to determine, update and utilise various coefficient for tidal predictions to produce tide tables.

37 Monthly MSL data of 24 ports is also being supplied to PSMSL. Out of these, data from two important tide gauge observatories viz. Port Blair (out of commission since 1965) and the other at Minicoy (out of commission since 1977) could not be recorded as the stations had been washed away.

38 The tide gauges are of old design and a lot of time is taken in data retrieval from graphical records (at Dehra Dun resulting in unavoidable delay).

39 The following tidal observation along the Indian Coast have been selected under the GLOSS programme: Cochin, Madras, Marmagao, Minicoy, Nicobar, Port Blair, Veraval and Vishakhapatnam. Data from these tide gauges are being received from port authorities and monthly means up to the year 1984 have been supplied to PSMSL. Data for 1985/86 are under scrutiny and are likely to be supplied by December 1989. Attempts are also being made to clear the backlog for the years 1987-89 within a year and a half.

40 Work has already commenced in putting the available data on magnetic tapes and, for the present, data for Cochin has been done. It will therefore be quite some time before the data for all the ports could be supplied on magnetic tape to different users.

41 The Survey of India under the modernisation plan has also taken up a project of modernisation of tide gauge network and setting up a data centre to meet the national and international requirements. In this project it is proposed to take up the activity in the following phases:

42 Phase I:

(i) Immediate construction of a tidal observatory and installation of automatic tide gauges capable of transmitting data on line to the data centre via satellite at Port Blair and Minicoy which have been out of commission since 1965 and 1977 respectively.

(ii) Establishment of a tide gauge at Indira Point in Nicobar Group of Islands.

(iii) Setting up a Data Centre at Dehra Dun for receiving data through satellite.

43 Phase II and III:

Updating of existing facilities in remaining 5 locations viz Veraval, Cochin, Madras, Vishakhapatnam, Marmagao, by installing modern tide gauges capable of collecting digital tidal records which can ultimately transform all other tide gauge observations along east and west coast. Plans are afoot to set up SLR/VLBI stations for geodetic fixing of tide gauge benchmarks.

44 **The Group expressed** appreciation to the authorities of India for provision of sea-level data from operational GLOSS stations to the PSMSL. The Group recommended that GLOSS stations of India provide sea-level data to TOGA Sea-level Centre and to make efforts to install tide gauges at Minicoy and Port Blair.

45 Dr. V. Kaliazin informed the Group on the activities of the Arctic and Antarctic's Research Institute of the USSR, regarding sea-level measurements at the Soviet Antarctic Stations. Due to severe ice conditions no permanent sea-level observations were made at Soviet Antarctic Stations. Some rough sea-level observations were made at the Stations Bellingshausen and Russkaya and, occasionally, at the Station Molodezhnaya. There are plans to organise regular sea-level observations at some Soviet Antarctic Stations in connection with the GLOSS and WOCE programmes. This will need, however, cooperation with other countries with regard to the establishment of modern tide gauges and exchange of sea-level data with other Antarctic Stations.

46 **The Group pointed** out the importance of regular sea-level measurements at some Soviet Antarctic Stations **and recommended** that soviet experts be invited to participate actively in the GLOSS programmes, particularly in the Antarctic Region.

47 Prof. G.W. Lennon reported on the ASEAN/Australia Cooperative Programme in Marine Sciences, particularly on Project I: Tides and Tidal Phenomena.

48 Phase I of this programme is due for completion on June 30, 1989. In the course of this programme some nine selected personnel from the ASEAN countries have attended a special "on-the-job" training course conducted at the Tidal Laboratory of the Flinders Institute for Atmospheric and Marine Sciences (FIAMS), Flinders University of South Australia. Seven trainees attended over a period of twelve months and two for four months. Other shorter training sessions for tide-gauge operators were held in Singapore. Topics covered included: Sea-level instrumentation; Laboratory and field calibration; Tide Generating Potential; Tidal analytical methods; Non-tidal residuals; Sea-level topography; Seasonal and secular trends; Air-sea interaction; theory and practice of hydrodynamic modelling.

49 A software package for the comprehensive treatment of sea-level time series has been produced for operation on personal computers. A two-volume report comprising the details of the training course has been prepared by the trainees.

50 Some 23 tide gauge stations have been deployed in the region within the programme so as to supplement the existing network of monitoring installations. The new stations include both analogue and digital recorders driven by both float mechanisms and by pressure sensors. The data from the region is currently being collated and assembled in a computer-based databank at the FIAMS Tidal Laboratory, and the package will be returned as a working system to each of the ASEAN countries at the conclusion of the exercise.

51 Commencing in July 1989, a second phase of the programme will begin. At the present stage it has been established that the monitoring array will be supported at least for a further three years. Other activities associated with the project are still to be defined.

## 5. COLLECTION, ANALYSIS AND EXCHANGE OF SEA-LEVEL DATA AND THE ACTIVITIES OF INTERNATIONAL SEA-LEVEL CENTRES

### 5.1 GLOSS DATA FLOW AND DATA BANKING

52 A number of issues were discussed by the Group that are most usefully linked by the fact that they all concerned the flow of data from GLOSS gauges and the banking of these data. These issues included the data frequency that had to be handled, where the datasets should be maintained, how data and information should flow between GLOSS and science programmes such as WOCE, and what steps could be taken to ensure the long-term, continuous flow of data.

53 The Group was in clear agreement that the highest priority for the GLOSS data flow was the supplying of monthly mean sea-level data to the PSMSL. Of course, this is simply an affirmation of previous GLOSS planning.

54 A new point that was discussed was the handling of the higher frequency (e.g., hourly) levels that form the basic input to the monthly mean calculations. It was decided that these data would be held at the national levels, in regional centres, and in centres associated with other programmes. It was emphasized that this need for regional/programmatic centres must be taken into account in setting up a GLOSS management structure. It is important that any structure that GLOSS implements does not interfere with the operation of these types of centres; flexibility in the management structure is the key.

55 A handbook of information about the GLOSS stations was proposed which would help to remedy information deficiencies in GLOSS. It was also proposed to include cross-referencing of the monthly mean dataset to the original data holdings at the regional or programme centres. IOC should be requested to support these efforts.

56 GLOSS can, and should, be prepared to assist science programmes such as WOCE in planning activities involving sea-level. The real strength of GLOSS lies in its completely international organization and its ability to plan and coordinate programmes crossing many national boundaries. On the other hand, GLOSS does not have permanent funding and must rely on voluntary co-operation from the data producers. Consequently, GLOSS should be viewed as a valuable organizational tool and should be prepared to fulfil such a role. The external programmes, on the other hand, must accept responsibility for assembling and distributing data other than the monthly means submitted to the PSMSL.

57 In order to fulfil this role of being an information resource to WOCE and other programmes in the future, information must be compiled and made available to planners. This information will include the status of a gauge, the agency responsible for funding and operating the gauge, the likelihood of continued funding, the type of data available from the gauge, potential problems in the record, etc. Much of this information will already be included in the GLOSS stations handbook, and it is most sensible to expand the handbook in ways appropriate to provide answers to questions such as the WOCE planners have asked. It is desirable that this handbook be maintained in close co-operation with PSMSL and the IOC should investigate methods of support.

58 Mr. J. Crease, Chairman of the International WOCE Data Management Committee, was present and participated in a discussion of how GLOSS should interrelate with other programmes. WOCE provides an excellent example of a programme that hopes to benefit from GLOSS and the questions asked by Mr. J. Crease allowed the Group to identify items that GLOSS must implement in order to effectively assist such programmes. It quickly became apparent that most of the questions concerned the operational status of gauges, and the flow of data from the gauges, the national or programmatic entities responsible for the gauges, and the likelihood of a particular installation continuing in the future. **The Group concluded** that these were entirely appropriate questions for GLOSS and learned that in fact such information was not as readily available as it should be.

## 5.2 PERMANENT SERVICE FOR MEAN SEA-LEVEL

59 Dr. P. Woodworth, Director of PSMSL, presented report on Sea-level Data Submission to the PSMSL (Annex IV). The PSMSL Sea-Level Data Bank contains sea-level data obtained from 1300 stations of 110 countries.

60 The PSMSL acts as the international centre for collection and archiving monthly and annual mean sea-level data including that from GLOSS stations. During the last three years, the data flow to PSMSL has increased considerably. For example, in late 1970s, 500 stations years per year were received; during the period of 1986-1989, 1500 s yr/yr; and in 1989, 2000 s yr/yr. This growth was due to the improvement of regular correspondence with the countries involved, development of TOGA, European Mean Sea-level Project, and a general increase of interest in future sea-level changes. Out of 306 GLOSS stations 105 are 'operational stations' for which the most recently received data is 1985 or later; 51 are considered "probably operational" for which the most recent data is within the period 1975-1984' 47 stations are "historical" stations for which the most recent data is earlier than 1975; and 103 stations for which no PSMSL data exist. The latest data entered into the PSMSL databank for each GLOSS station are shown in Annex IV. It was noted that the major problems are connected with the irregular data supply, poor worldwide communication, the use of different formats for data submission by majority of countries, and poor data quality. **The Group noted** with concern that there was still a lack of data from GLOSS Stations of China, Indonesia, Egypt and some countries of South America.

61 **The Group recommended** that the IOC Secretariat contact those countries with an invitation to provide sea-level data to PSMSL. It was also pointed out that GLOSS, WOCE and the other sea-level projects should ensure a more reliable stream of high quality mean sea-level data into the PSMSL over the next decade. The proposed "GLOSS Newsletter" will also be helpful in improving data flow as will scientific analysis of the data, good communication with the GLOSS national contacts and periodic campaigns for data, as for example with the European mean sea-level project.

62 The PSMSL responds to many enquiries for all or part of the mean sea-level data set, which are supplied on magnetic tape (in GF3 format), on floppy disk or as printouts.

5.3 TOGA SEA-LEVEL CENTRE

63 Prof. K. Wyrtki, Director of TOGA Sea-level Centre, reported on the recent activities of the Centre. Details regarding the TOGA Sea-level Network are contained in his report, reproduced as Annex V. The report also shows data submission to the TOGA Sea-level Centre from each TOGA sea-level station. Prof. K. Wyrtki noted substantial progress in the Pacific Ocean, where the TOGA network was virtually complete: 81 of the 90 stations. Desirable, missing stations are Marcus Island (Japan), Raoul (New Zealand), Lord Howe Island (Australia) and Tonga. Special efforts are needed to improve communications with Mexico.

64 In the Indian Ocean a single island-based station at Reunion, (France) existed in 1985. Since that time, 23 stations have been installed on islands and important coastal locations. Desirable, missing stations are: Salalah (Oman), Port Blair and Minicoy (India) and Bauda Atjeh and Kupang (Indonesia).

65 In the Atlantic Ocean, still little progress has been made with the establishment of a TOGA Sea-Level Network.

66 The TOGA Sea-level Centre has been established to provide the TOGA Scientific Community with daily sea-level data, with the delay of about 18 months. Experience has shown that, in order to ensure proper quality

control, hourly values are required. The Centre provided data to many scientists upon their request. The Centre plans to issue, in mid-1989, a catalogue of the quality-controlled data.

67 **The Group noted** with satisfaction the progress achieved in the implementation of TOGA network in the Pacific and Indian Oceans, with the assistance of University of Hawaii and NOAA. It will need, however, to improve timely data submission from sea-level stations in the Indian Ocean and intensify activities in the Tropical Atlantic to set up TCGA sea-level network. The Secretariat of IOC and the TOGA Project Office were requested to communicate with the countries who are not yet providing data to TOGA Centre.

68 Prof. G. W. Lennon reported that six stations have been installed by Australia in Papua New Guinea. They all transmit data to TOGA Center.

69 The Group was informed that France had installed 6 pressure type tide gauges in Lome (Togo), Dakar (Senegal), St. Peter and St. Paul Rocks, (Brazil), Pointe Noire (Congo), La Praia (Cape Verde) and Sao Tome (Sao Tome and Principe). It is planned to install satellite transmission system for these gauges within the year.

70 **The Group noted**, with satisfaction, assistance provided by NOAA in installing 7 tide gauges in the IOCARIBE region and the activities of Sweden and the Federal Republic of Germany to assist 5 countries of West Africa in setting up GLOSS Stations (Mauritania, Senegal, Ghana, Nigeria, Sierra Leonne).

## 5.4 WOCE REQUIREMENTS FOR SEA-LEVEL OBSERVATIONS

71 Mr. J. Crease, Chairman of the International WOCE Data Management Committee, informed the meeting of the conclusions of the committee regarding the progress of arrangements for acquiring, quality controlling and distributing in situ sea-level data during WOCE (see Annex VI).

72 The emphasis is on globally well distributed island stations and on the monitoring of flow through Straits. The BODC and the University of Hawaii Group were asked by the Committee to suggest appropriate arrangements, using their expertise, to implement collaboratively the arrangement for WOCE in-situ sea-level centre, based on the requirements described in section 5.3 and 3.15 of the Implementation Plan.

73 Mr. J. Crease also introduced the OCEANIC on-line information base of the US WOCE Data Management Unit. It is providing up to date information about the state of the programme, data availability, organisational structure, etc. There are also some non-WOCE components giving information on future research ship schedules of many nations and on network addresses of many oceanographers. He suggested that, at small marginal cost, GLOSS might wish to consider maintaining a database (and map) giving current status of all GLOSS gauges.

## 5.5 ABSOLUTE GEODETIC FIXING OF TIDE GAUGE BENCHMARKS (TGBMS)

74 **The Group discussed** the draft report of the Committee on Geodetic Fixing of Tide Gauge Benchmarks set up by the IAPSO Commission on Mean Sea-level and Tides. **The Group supported** the recommendations, technical

conclusions and strategy described in the report. In particular, it was agreed that the primary strategy of connecting GLOSS (and other) tide gauges with differential GPS measurements to the fundamental VLBI/SLR stations of the IERS terrestrial reference frame was very important for the various oceanographic and geophysical requirements listed in the report. Wherever possible, the vertical movements of TGBMs should be verified by absolute gravity measurements.

75 **The Group discussed** the 5 technical conclusions of the report and made the following recommendations:

(i) It is recommended that all gauges used to monitor mean sea-level must have a local network (6 to 10) of benchmarks that are resurveyed by accurate levelling or GPS at least once per year and that information on this local benchmark control should be collected by PSMSL.

(ii) Using the accuracy of differential GPS stated in the report (1cm in 1000km) and the positions of the IERS (VLBI/SLR stations), it is possible to identify those GLOSS gauges that can be fixed to within 1cm radially with respect to the IERS stations. It is recommended that the GLOSS gauges within this range and with, for example, (a) >20 years mean sea-level data and (b) >60 years mean sea-level data be identified and priority be given to geocentric location of these gauges.

(iii) It is recommended that GLOSS gauges that have >60 year mean sea-level data, and where no IERS station is within 1000km, should be identified as priority locations for either permanent VLBI/SLR stations or for mobile VLBI/SLR measurements.

(iv) It is recommended that present IERS stations with no suitable GLOSS gauges within 1000km should be identified and consideration should be given to installing suitable tide gauges within this range.

(v) It is recommended that the PSMSL would be a suitable centre to collect, archive and distribute the geodetic information for each TGBM and that the PSMSL should consult the IERS directing board with regard to the information defining the geodetic reference frame that needs to be stored.

### 5.6 NEXT GENERATION WATER LEVEL MEASUREMENT SYSTEM

76 Dr. W. Scherer reported on the progress in the installation of new generation tide gauges (based on acoustic principle) that transmit, every 3 hours, data via GOES. About 30 such tide gauges equipped with other sensors for meteorological and oceanographic observation, have been installed in the USA, including Hawaii and Alaska. It is planned to install such tide gauges in 50 locations throughout the world. Some of these stations will be linked to GPS and VLBI/SLR.

## 6. TEMA RELATED ACTIVITIES

77 Dr. A. Tolkachev presented the report on TEMA activities relating

to GLOSS, prepared with the assistance of Dr. L. Rickards (Annex VII). The report indicates that a number of countries had provided assistance in different forms to other countries in setting up GLOSS stations. Details regarding the requirements of different countries for assistance, and the assistance that had been provided by individual countries, were shown in this report. Assistance had been requested from about 30 countries.

78 Assistance had been provided by Australia, Federal Republic of Germany, Sweden, Portugal, United Kingdom and the United States. This assistance includes provision of instruments and spare parts, installation of tide gauges and their levelling, training of technicians and consultant's visits.

79 **The Group wished to express** thanks to those countries which had already assisted a number of developing countries in setting up their GLOSS Stations. **The Group also pointed out** that more assistance will be needed in future in order to develop and maintain GLOSS as a permanent global observing system. Particular efforts will be needed during the next 2-3 years in order to assist in installation of GLOSS stations and training of specialists. It was recognised that such assistance could be provided through various forms of co-operation either through bilateral cooperation (between institutions and/or governments, for example, assistance provided by USA to various countries), multilateral co-operation (for example assistance by Australia to ASEAN Countries) or through IOC (for example, UK training courses, and assistance of Sweden and FRG to countries of the IOCEA region).

80 **The Group was pleased to discuss** this matter with the specialists of Seychelles, Costa Rica, Tanzania and Nigeria, who were attending sea-level training course at the Proudman Oceanographic Laboratory. In exchanging views on this matter, the Group wished to point out that assistance, particularly with regard to provision of tide gauges and their spare parts, could be provided through different forms of collaboration. It would be however highly desirable that IOC allocate special funds for GLOSS-TEMA related activities (based on regular programmes and/or contributions of IOC member states to IOC Trust Fund) in order to organise, on a regular basis, sea-level training courses, to provide some spare parts, to provide services of consultants to advise developing countries, and to provide training/educational material. The role of IOC regional subsidiary bodies could be very important in identifying the needs for assistance and ways and means to receive such assistance. It is, however, important to draw attention of all Member States, which are committed to participate in GLOSS, that it will be their responsibility to maintain proper operation of GLOSS sea-level stations in accordance with the provisions of the GLOSS Implementation Plan.

## 7. GLOSS ORGANISATION AND PUBLICATIONS

### 7.1 GLOSS ORGANISATION

81 **The Group reviewed** the present structure of GLOSS and considered the international organisational mechanisms needed to ensure proper functioning and co-ordination of GLOSS both on national, regional and international levels. **The Group recommended** the following organisational structures for GLOSS:

82 **A GLOSS Technical Secretary**, with the primary role as GLOSS Co-ordinator should be located in the IOC Secretariat, at least for the initiation/implementation stage, with two-way communication with national and regional GLOSS management, and other international organisations such as IAPSO, UNEP.

83 The specific responsibilities of the GLOSS Technical Secretary would be to:

(i) make sure nationally-committed GLOSS gauges are operational;

(ii) service needs of Group of Experts on GLOSS;

(iii) manage IOC budget for GLOSS;

(iv) act as broker for aid, organise consultant visits, donor/recipient equipment;

(v) oversee publication and distribution of any GLOSS publications;

84 **The IOC Group of Experts on GLOSS** should review the progress in GLOSS implementation and provide advice to IOC on further actions needed.

85 **Regional GLOSS co-ordinator**: the Regional Coordinator should be active in sea-level studies and the Group of Experts on GLOSS should give advice to IOC Regional subsidiary bodies on suitable candidates. Continuing close collaboration must be maintained between the Group of Experts and the Regional bodies.

86 The specific responsibilities of GLOSS Regional Co-ordinators are:

(i) to liaise with PSMSL, national GLOSS Contacts and Technical Secretary;

(ii) to encourage the adoption of international standards for data within the region;

(iii) to organise yearly meetings of national GLOSS contacts;

(iv) to make regional member countries aware of the usefulness of GLOSS;

(v) to assist the GLOSS Technical Secretary in identifying national GLOSS contacts;

(vi) to maintain a correspondence file for the Region.

87 **The Group noted** the existence of active scientists and centres/institutes involved in regions but not presently included in IOC/GLOSS structure and recommended that information flow be improved to individual scientists or centres, through Regional Co-ordinators, National Contacts or Experts as appropriate.

88 In particular, the Group recommended to the IOCARIBE Regional Committee that assistance be given to the IOCARIBE GLOSS Regional Co-ordinator by the Universidad Nacional Heredia, Departamento de Fisica, Sección de Oceanografía, and that Mr. A. Gutierrez be added to the list of GLOSS National Contacts.

89 **The Group recognised** the problem of Southern Oceans region and recommended that consideration be given to a data/operations centre being responsible for GLOSS management in this region. The relationship of such centres to the IOC Regional Committees or Sub-commissions must be fully thought-out.

90 **National GLOSS contact**: the Group agreed that the appointment of National GLOSS Contact(s) active in sea-level studies was appropriate. **The Group recognised** the importance of personal contact in identifying such an active Contact, but noted also that national government support is crucial for a permanent GLOSS network.

91 The specific responsibilities of the National GLOSS Contacts are to:

(i) promote implementation of GLOSS at national level;

(ii) liaise with IOC and the PSMSL on all matters related to GLOSS;

(iii) act as contact points for data requests, i.e. to link between requests for data and data producers in the country;

(iv) liaise with national sea-level scientists, promote GLOSS and be aware of sea-level studies.

## 7.2 GLOSS PUBLICATIONS

92 **The Group considered** the need for GLOSS technical information, publications and recommended to prepare and publish the following material.

**A GLOSS Newsletter** should be produced in the four IOC languages, at least twice a year. However the Group recognised that if the Newsletter is to be produced in more than one language this would lead to the high costs and potential delay. The target audience would be sea-level scientists, tide gauge operators, Regional Coordinators and National Contacts, scientists and engineers in relevant Government departments, Universities and Institutes. The recommended contents should be news and information, for example:

(i) status of GLOSS stations

(ii) extreme events due to sea-level changes

(iii) reports of past sea-level meetings

(iv) details of future sea-level meetings

(v) references to major publications

(vi) reference to sea-level scientific studies and scientists

93 **GLOSS Brochure: The Group also recommended** that a multi-colour brochure be produced professionally and directed towards the general public, particularly policy decision makers. It should therefore be published in the four IOC working languages. This brochure should be produced at least before the second World Climate Conference (November 1990), with a print run

of 10,000 copies. **The Group asked** that IOC investigate the production of the first draft.

94 **The Group recommended** the production of a GLOSS Logo. The Chairman of the Group of Experts agreed to have the design drafted, based on the provisional design, with strengthened and curved letters to give a 3-d representation of the globe and therefore the technical connection. **The Group agreed** that the Logo should be incorporated into the multi-colour brochure.

95 **GLOSS Handbook**: **The Group agreed** that a comprehensive data base of information about the GLOSS stations was required, this should be centrally maintained alongside the data set, From this a GLOSS Handbook could be produced. This would enable GLOSS to serve as an information resource for other projects or programmes, for example, WOCE, in addition to providing essential information for GLOSS itself. **The Group recommended** that IOC hire a contractor to start off the data base receiving advice from existing database designers/operators.

## 8. GLOSS WORK PLAN FOR 1989, 1990 AND 1991

96 In the light of the discussion under previous agenda items the Group prepared the Work Plan for GLOSS implementation for 1989, 1990 and 1991 (Annex VIII). In order to achieve the objectives of the GLOSS Implementation Plan, i.e. to establish by 1990 an operational global network of permanent sea-level stations, the Group requested the Technical 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.

## 9. ADOPTION OF THE SUMMARY REPORT

97 **The Group adopted** the Summary Report and requested the Secretary and the Chairman to prepare the Executive Summary for submission to the Third session of the IOC Technical Committee on Ocean Processes and Climate for approval.

## 10. CLOSURE

98 The Chairman closed the session at 17:00 on 23 June 1989.

ANNEX I

**AGENDA**

1. **OPENING**

2. **GLOSS NETWORK: RECENT DEVELOPMENTS**

3. **IGOSS SEA LEVEL PROGRAMMES AND PROJECTS**

   3.1 IGOSS Sea Level Programme in the Pacific

   3.2 IGOSS Sea Level Pilot Project in the North and Tropical Atlantic

   3.3 Initiation of IGOSS Pilot Projects in the Indian and Southern Oceans

   3.4 IGOSS Pilot Project for Geosat altimetric sea-surface topography data

4. **GLOSS REGIONAL ACTIVITIES, AND OTHER REGIONAL PROGRAMMES**

5. **COLLECTION, ANALYSIS AND EXCHANGE OF SEA-LEVEL DATA AND THE ACTIVITIES OF INTERNATIONAL SEA LEVEL CENTRES**

   5.1 GLOSS data flow and banking

   5.2 Permanent Service for Mean Sea Level

   5.3 TOGA Sea Level Data Center

   5.4 WOCE requirements for sea level observations

   5.5 Absolute geodetic fixing of tide gauge benchmarks

   5.6 Next generation water level measurement system

6. **TEMA RELATED ACTIVITIES**

7. **GLOSS ORGANISATION AND PUBLICATIONS**

   7.1 GLOSS Organization

   7.2 GLOSS Publications

8. **GLOSS WORK PLAN FOR 1989, 1990 AND 1991**

9. **ADOPTION OF THE SUMMARY REPORT**

10. **CLOSURE**

# ANNEX II

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ANNEX III

THE IGOSS SEA LEVEL PROGRAMME IN THE PACIFIC

## 1. Background: The completion of the pilot project

The IGOSS Sea Level Pilot Project was established in June, 1984 for the purpose of making monthly mean sea level data available to a wide circle of users in a timely fashion, and to generate products that would be valuable for scientific analysis of climate-related processes. When the first map was produced in June of 1984, 21 stations reported data. Over the course of the pilot project we have progressed to a total of 82 stations in the Pacific Ocean and receive data from 30 countries. We have also developed the capability to exploit the availability of satellite-transmitting sea level gauges; at present 32 Pacific gauges have this capability. Of these 32 satellite-transmitting gauges, 30 are located at IGOSS stations.

Maps of the sea level deviation from the 1975 to 1981 mean sea level have been produced without fail since June, 1984. In January, 1988 we instituted several significant improvements. First, and most importantly, we now produce maps of the anomaly of sea level from the 1975 to 1986 mean annual cycle of sea level. This anomaly is also corrected for the inverted barometer effect using the atmospheric pressure fields computed at the National Meteorological Center. Second, we recomputed the mean sea level values over the time period 1975 to 1986 in order to create a more reliable reference surface. Third, we examined each of the stations for the presence of large linear trends. We found significant trends at five stations and we now routinely correct for the trends at these stations. The five stations affected are Kushimoto, Aburatsu, and Naha in Japan, Davao in the Philippines, and Seldovia in Alaska.

In addition to these expansions and improvements of our basic products, we have developed additional products during the pilot project. The new products include time series of the volume of the tropical Pacific Ocean (published quarterly) and indices of the equatorial current system (published annually). The volume time series has received much attention because of its importance for El Nino prediction and analysis. In the past year a report of the status of the pilot project was published and the monthly mean sea level data from the IGOSS stations were sent to the National Oceanographic Data Center and thus to the World Data Centers. A magnetic tape of the IGOSS dataset continues to be available at the University of Hawaii.

Reports of the progress of the IGOSS Sea Level Pilot Project have been made to the GLOSS meeting in Honolulu (October, 1987), to the U.S. IGOSS meeting in Monterey, California (February, 1988), and to the Fifth Session of the Joint IOC-WMO Working Committee for IGOSS in Paris in November, 1988. At this last meeting, the progress of the pilot project was noted and a resolution was approved making the sea level project in the Pacific a permanent effort under the name *IGOSS Sea Level Program in the Pacific.*

## 2. Activities for 1989-1990

In the coming year we will continue to produce the operational maps of the sea level deviations in the Pacific and the maps of the atmospheric pressure-corrected sea level anomalies that were developed during the pilot project. The time series of the volume of the tropical Pacific will also be continued, as will be the indices of the equatorial current systems. We will continue to provide these maps to the Climate Analysis Center for inclusion in their publications. Although our system is functioning reliably, several problems need attention in the near future.

For example, data transfer from Mexico and the Philippines is becoming uncertain. We have begun working on solutions for these problems and will continue to do so in 1989-1990.

In addition to continuing the traditional methods of disseminating the operational sea level maps mentioned in the previous paragraph, we are very excited about the possibility that modern computer networks will allow near real-time access to digital data in the near future. Up to this point, researchers and other users of the IGOSS system have received printed maps that must be digitized before further manipulations or calculations can be done. If the digitization is too large a task, then a request must be made to receive a magnetic tape. By the time such a tape is prepared and arrives, the advantage of having "operational" data has been lost. The value of the operational datasets will be greatly enhanced if they are not only available quickly, but are also available in a digital form that will encourage the *use* of the products.

In order to move towards the goal of providing operational data in digital form, we proposed to the 1989 U.S. Joint Coordination meeting of the IGOSS-IODE that a discussion of methods to implement such a system should begin. We recommended that the producers of existing IGOSS products (and the producers of products of interest to IGOSS users) should constitute the discussion group initially. This proposal met with great enthusiasm, and was included in the recommendations of the joint meeting. We have established a mailing list on the OMNET telemail system and expect that 1990 will bring progress toward supplying digital IGOSS data to users operationally.

ANNEX IV

**SEA LEVEL DATA SUBMISSION TO THE PSMSL**
(30 May 1989)

One of the main objectives of the Global Level of the Sea Surface (GLOSS) programme is to establish an operational network of permanent sea level stations reporting monthly mean values of sea level to the Permanent Service for Mean Sea Level (PSMSL). It is appropriate, therefore, to consider how the relationship between the PSMSL and its data suppliers will have to change as a result of GLOSS and to review the current degree of development of GLOSS as perceived by the PSMSL.

PSMSL Operational Methods
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Before discussing GLOSS as such, it would be as well to mention the way in which the PSMSL operates at the moment. In brief, the PSMSL Secretary (Elaine Spencer) keeps an address list of 120 authorities which operate tide gauges and which reduce the raw data either to mean sea level (MSL) or mean tide level (MTL). These authorities include the TOGA sea level centre which exists as part of an international research project; national hydrographic, geodetic, meteorological and coastal protection authorities; and individual harbour masters or university groups that may operate a single gauge. New authorities are added to the list from time to time as we become aware of them through international contacts or as data from them are published in scientific journals.

Many authorities have got into the good habit of routinely sending data to the PSMSL every year. For example, monthly and annual MTL data from Jersey were famous for many years for arriving at Bidston in the first week of the following January. However, this desirable situation is far from being the norm. Much of Elaine's time is spent in chasing backlogs of several years from authorities which are probably quite willing to satisfy their international obligations for data exchange but which simply forget from one year to the next that the PSMSL exists. For the past two years we have tried to partially overcome this difficulty by sending to all authorities, and to many individual scientists, a PSMSL New Year's Newsletter to remind them that data are still required.

At the bad end of the authority spectrum are those organisations for which we know data exist but which, for one reason or another, refuse to make the data available. Letters from the PSMSL requesting data are lost or go unanswered. The way to deal with such situations has to vary from country to country. For example, rather than uselessly writing repeat letters, the influence of the national Academy of Sciences can be requested or individual researchers can be enlisted to help. Recently, Graham Alcock, Elaine and I have been engaged in a

CEC collaborative study to bring up-to-date the European MSL dataset, search for records not hitherto held at the PSMSL, and to analyse the enhanced dataset. We have found that in many cases an effective response from authorities can be obtained from an initial letter, followed by a diplomatic but to the point telex, followed if necessary by a personal visit. Visits were made by POL/PSMSL personnel to seven countries with reasonable success; a preliminary report on this project is available. We are now considering how the lessons learned in this European project can be applied to the acquisition of data from elsewhere.

Although the pursuit of data backlogs is well worth while as a once only exercise, it is not an efficient procedure for long term data acquisition. That is why the ISLPP projects and GLOSS, with their implied routine supply of MSL data from authorities, receive the PSMSL's complete support. If the supply of data did become more regular, no major changes to the PSMSL's day to day operations would be necessary and any increased PSMSL workload arising from the installation of new GLOSS gauges would easily be offset by a removal of backlog-chasing.

This brings us to the methods and formats of MSL data exchange. At present, most monthly and annual mean values still arrive at the PSMSL on paper as tabulations. These are subsequently entered into the Oracle database by one of Elaine's co-workers. If all the required information is present, including especially the datum information, then a delay of only a few weeks will occur before it appears in Oracle and is available for export to any interested scientist. However, the information from authorities is frequently incomplete, the absence of datum information being the usual problem, or sometimes the data can simply appear inconsistent with those of previous years when subjected to a range of simple tests the PSMSL has developed. A further iteration of letter writing then takes place with an additional delay of months, or even years, before the data can finally be entered into the databank.

The GLOSS Implementation Plan and the earlier GLOSS Proposal contain the recommended format for the presentation of data to the PSMSL by the traditional method of letter mail. Elaine has also copied the format to many authorities herself. If all concerned conformed to such a format, and used it as a check list, then a major leap in efficiency would result. So far no authority has ever used it. For larger amounts of data, such as the backlogs, the PSMSL also now regularly receives data on magnetic tape and floppy discs. In principle, this is a welcome development as it removes the possibility of transcription errors in reading and re-entering the data into Oracle. However, every tape and disc sent to us is written in a different format which involves a great deal of time in once only programming, and the possibility of a different set of errors. Only one authority has ever sent data to the PSMSL using the IOC-recommended GF3 format, in spite of GF3 being the normal format in which the PSMSL exports data to scientists.

The above description of everyday PSMSL life is fairly brief but it does demonstrate that we have everything to gain from the implementation of GLOSS, even aside from the extra data to be anticipated from newly installed gauges. Also we would hope that eventually the GLOSS procedures and standards will be accepted throughout the sea level community and that they will become applicable to all the gauges the PSMSL receives data from. However, it is apparent that fundamental changes are required at each authority before this can come about and, in our opinion, someone in each country, presumably the GLOSS contact, has to take on the responsibility for the necessary actions.

GLOSS Status Within the PSMSL Dataset
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The first review of GLOSS status we have made is to determine from the GLOSS questionnaire replies (Table 1 of the Implementation Plan) if there exist historical sea level data from GLOSS sites which could be used to provide MSL information additional to that already at the PSMSL. As GLOSS stations will presumably have a more than average lifetime, we should put some effort into bringing their historical dataset as up to date as possible. Table 1 of the Plan gives details on how long each gauge has been in operation. We have compared these periods of operation with the amount of data held by the PSMSL, thereby determining if there are potential 'new' data to be found. Small differences have been ignored while recent TOGA gauges like Male have been left out of the comparison as we are concerned here with longish historical records. Table 1 of this report summarises the findings. It shows for each country the GLOSS numbers and station names, then the periods for which data are claimed in the GLOSS list and the periods for which data are with the PSMSL, if any. It is clear that the biggest discrepancies are from South America, although there are implied to be several long records from elsewhere in the world which the PSMSL does not have (Suez and Chinese sites are major examples). In each of these cases we have written to the GLOSS Contacts and national authorities to try to obtain any such 'MSL backlogs'. However, it is possible that in some cases the data exist only as charts, for example, and not as MSL. In these cases, we suggest that GLOSS makes a special effort to encourage the relevant authority to effect the reduction, or to send someone on a training course to find out how to do so.

A second review of GLOSS consisted of a definition of the 'operational status' of the network from a PSMSL viewpoint. Lesley Rickards' summary of member states' responses to the GLOSS questionnaire (IOC/GLOSS-I/8) shows that, of the 306 stations in the network, 229 are currently operating. However, not all of these stations will have been routinely reducing the tide gauge data to MSL and sending the information to the PSMSL. 'Operational' from a PSMSL viewpoint means that recent 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 306 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 1985 or later;
Category 2: 'Probably Operational' stations for which the latest data is within the period 1975-1984;
Category 3: 'Historical' stations for which the latest data is earlier than 1975;
Category 4: For which no PSMSL data exist.

Table 2 lists the number of stations which fall into each category for each 'responsible country' (as of 3 April 1989). A 'responsible country' is defined by the country which will operate the gauge, as listed in Table 1 of the Plan. This subdivision is not ideal because some countries operate gauges not only on their own coastlines but also in Antarctica, for example. In addition, some gauges are operated effectively by international projects rather than a 'responsible country'; examples would be some of the Pacific TOGA gauges. In brackets in Table 1 is shown the number of gauges for that country in each category which are 'committed to GLOSS' as listed in Table 1 of the Plan. The total number of stations in each category is shown below for all GLOSS stations and for 'committed to GLOSS':

| Category | All GLOSS | Committed to GLOSS |
|---|---|---|
| 1 | 105 | 98 |
| 2 | 51 | 45 |
| 3 | 47 | 28 |
| 4 | 103 | 44 |
| Total | 306 | 215 |

The geographical distribution of the various categories is demonstrated in Overlay 1 for GLOSS overall and Overlay 2 for 'committed to GLOSS' stations. Europe, North America, Australia, India and the Pacific can be seen to contain mostly categories 1 and 2 stations while categories 3 and 4 are mostly in Africa, South America and Antarctica.

Insofar as GLOSS is an intergovernmental exercise from IOC, Table 2 provides an at-a-glance review of which countries are contributing strongly to GLOSS and which are falling behind. For the latter, some kind of help may be required, as described in Lesley Rickards' report of TEMA activities relating to GLOSS (IOC/GLOSS-I/7), or some kind of action may be required from the GLOSS Experts.

Table 2 is also useful in demonstrating some of the points about the PSMSL operations I tried to make above. The gauges from Australia and India, for example, fall into category 2 rather than 1. We know that these gauges are operating but the start-stop nature of receiving

backlogs can often give a false impression of the overall status of global sea level recording.

Table 3 lists the latest data entered into the PSMSL databank for each GLOSS gauge. It is similar to Table 2 of the Implementation Plan but is listed in a more convenient country order rather than GLOSS number order. As regards any discussion on the establishment of new tide gauges, priority should be given to those sites in Categories 2 and 3 for which there are historical data and for which the original benchmarks may well still exist.

Role of GLOSS Contacts
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We have already described how the most difficult feature of the PSMSL's operations is maintaining regular contact with authorities in every country with tide gauges. In our opinion, GLOSS will succeed or fail on the same basis and the routine role of the GLOSS contacts will be as equally as important as the establishment of the 306 gauges themselves.

The GLOSS Contacts have to be people with an interest in the provision of high quality data, a perception of their role within a global network and a recognition that they must communicate with the nodes and other branches of that network. If a named Contact is a government functionary whose main role is to provide national communication with IOC, then he should be duplicated or replaced by another named person with scientific and communication skills. Then, given a 'network' of useful Contacts, they should be requested to play a major role in personally ensuring the regular supply of their data, or providing reasons why their data are not available. Either way, information on the status of each site should be continuously available. The project also needs a Project Manager or some kind of Secretary whose job it will be from time to time to make sure that each Contact is still functioning. My personal opinion is that this person should be based in IOC obtaining all necessary help, of course, from the sea level centres.

Regular communication with Contacts is more likely to become established rapidly if a GLOSS dataset of hourly/daily heights can be collected during the WOCE period to serve both WOCE and TOGA and to provide a dataset for the determination of the suitability of each gauge to the global network. GLOSS Contacts should also be asked to collaborate immediately in the compilation of a 'GLOSS Handbook', to be discussed at the June meeting.

It has also been suggested that Table 3 should be produced annually or semi-annually with additional columns showing the latest data received by the other sea level centres (TOGA, WOCE, ISLPP-NTA etc.). This 'GLOSS Update' would be circulated to all Contacts to act as a prompt for the latest data; exactly how is a matter for discussion at the June GLOSS meeting. Countries which fall behind might then be 'embarrassed' into providing data in much the same way gauges missing from ISLPP maps have stimulated action in certain countries.

PSMSL Future Plans
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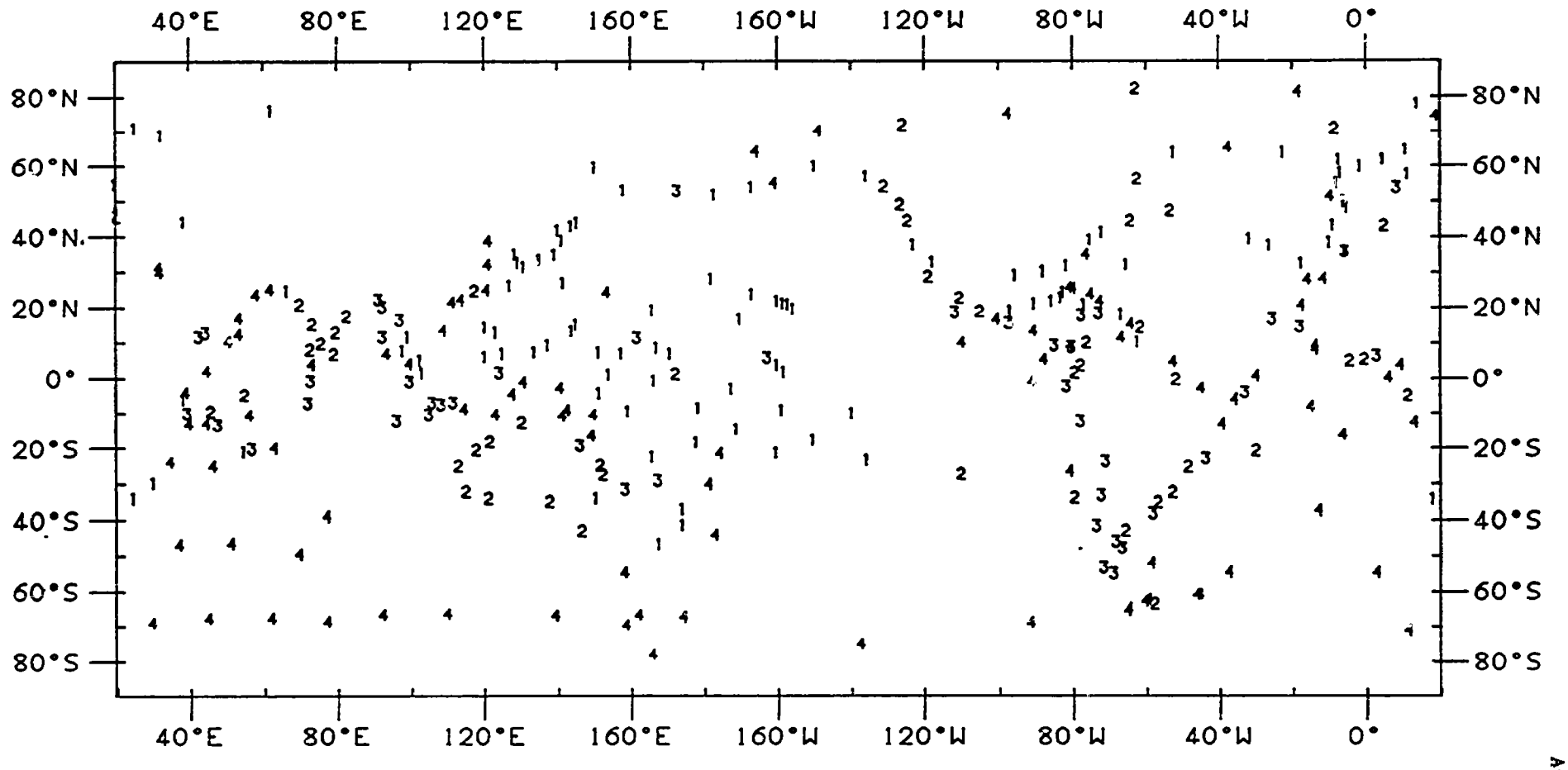
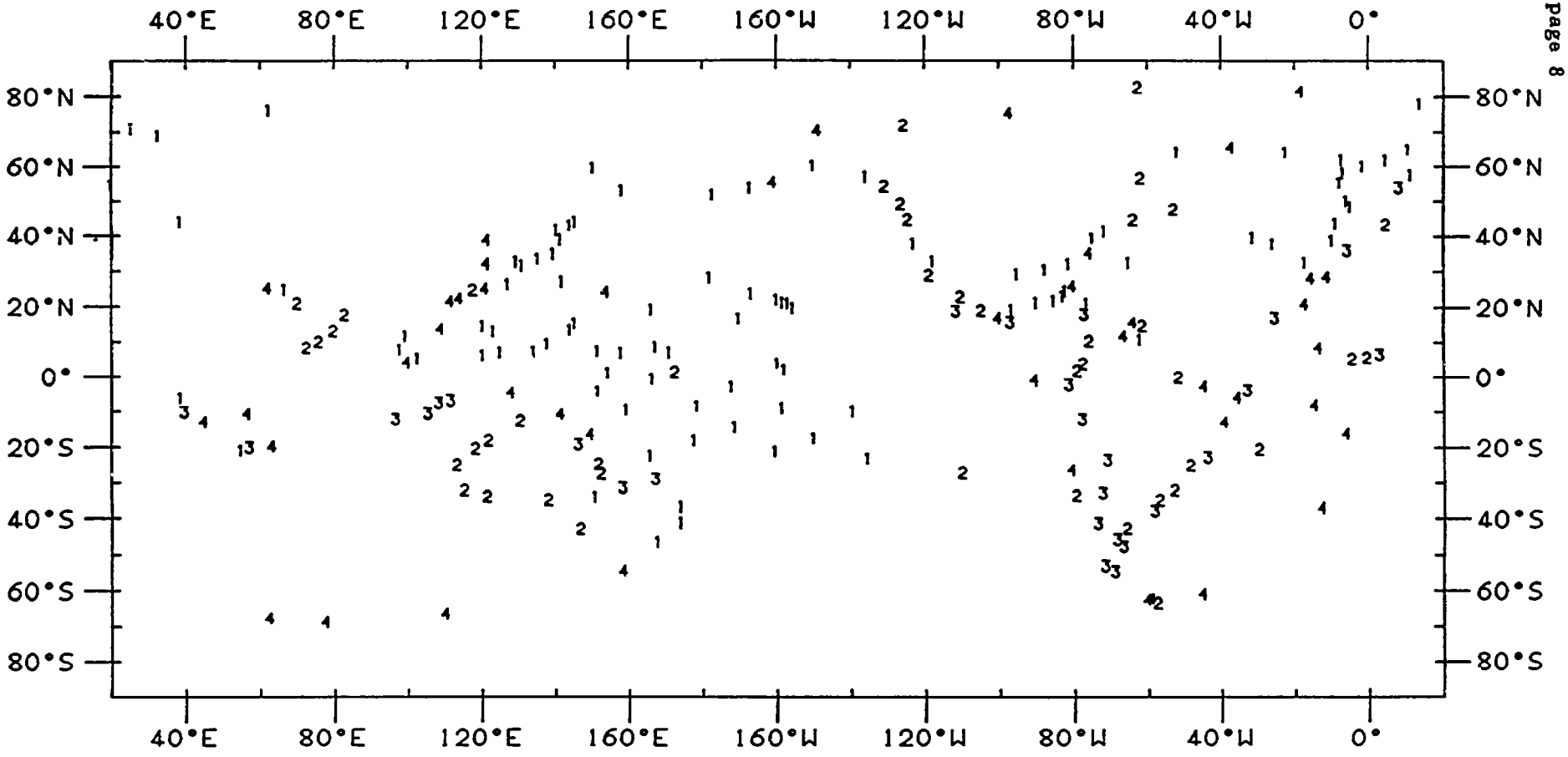
GLOSS, WOCE and the other sea level projects should ensure a more reliable stream of high quality MSL into the PSMSL over the next decade and it will obviously be important for the PSMSL to organise itself to efficiently gather in all these data and redistribute them with minimum delay. There will be a particular need to keep scientists informed of what new data are available and good interaction with the TOGA and WOCE centres will be essential. All these activities, however, are, in principle, simply a natural development of the PSMSL's traditional role.

A major new sub-activity will come from the need to databank geodetic information on vertical land movements alongside the MSL records, thereby at last enabling the measurement of 'real' and not 'relative' sea level changes. However, before we get into this to any extent it will be necessary to take advice from the GLOSS and other experts on exactly which information should be stored. As regards microgravity, it appears that a large number of meters will not be manufactured over the next few years (Private Communication from Faller), so most countries will not be making routine measurements near gauges, and I suggest that we can defer this topic to a later date. The main source of geodetic information will come from GPS and/or VLBI surveys and I would be grateful to receive suggestions on which parameters the PSMSL should store from these. Appendix 1 of this document is from a report by Boucher to the IAG on which quantities should be recorded in each set of station measurements but this seems a bit detailed and I hope that the PSMSL's purposes can be satisfied with a subset. Another factor to be considered is that there are plans for databanking of European GPS/VLBI measurements at Hannover (funded by Germany but with UELN and CEC input) and I daresay in America by NOAA. We have to be careful that our geodetic data subsets are compatible with these centres.

With GLOSS, WOCE and geodetic data to consider, the PSMSL should be fairly busy over the next few years and your advice will be much appreciated.




OVERLAY 1: ALL GLOSS STATIONS




OVERLAY 2: COMMITTED TO GLOSS

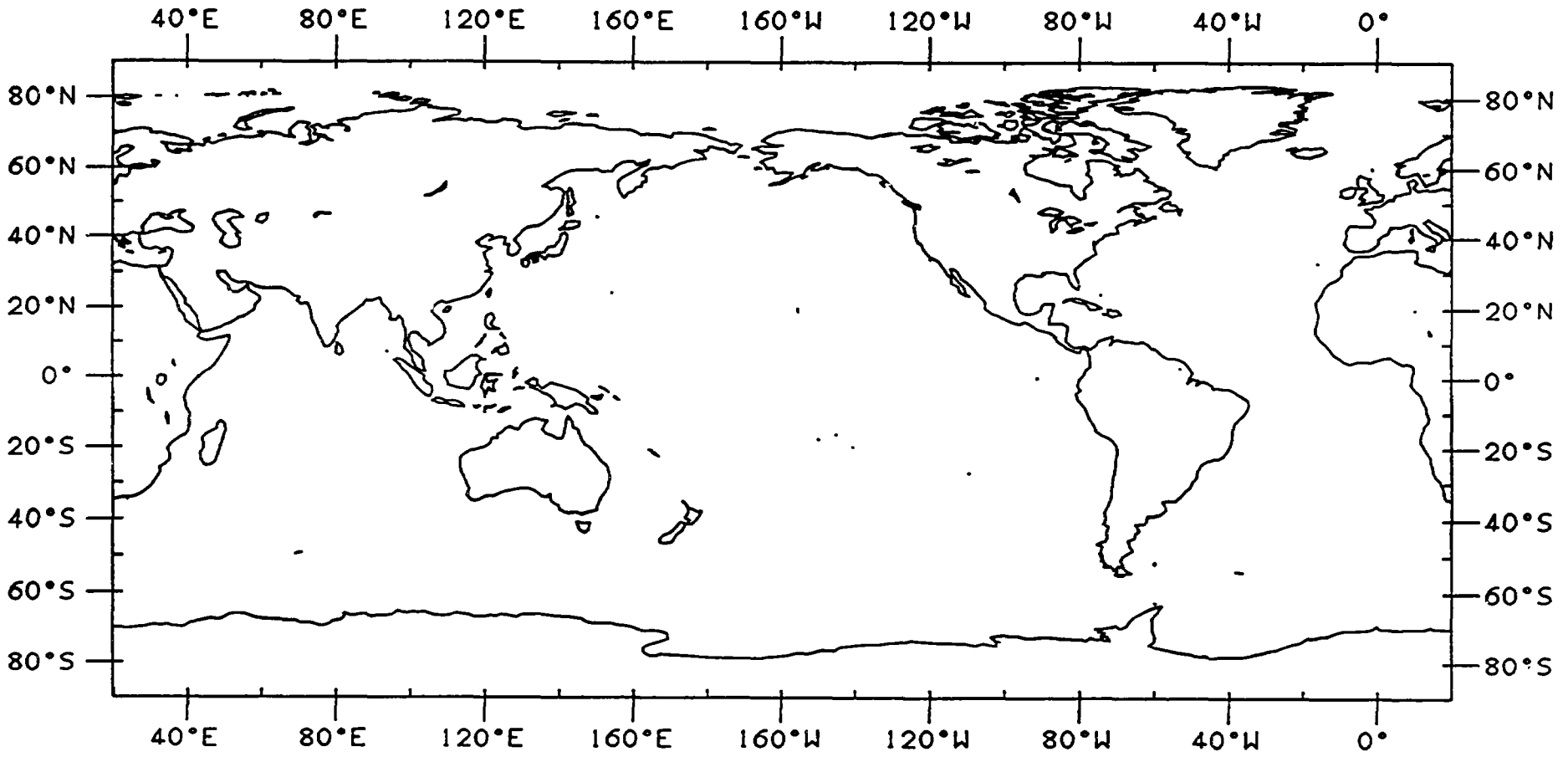

40°E
80°E
120°E
160°E
160°W
120°W
80°W
40°W
0°
80°N
60°N
40°N
20°N
0°
20°S
40°S
60°S
80°S

Table 1
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Compilation of data available from GLOSS sites ('G'), as specified in the Implementation Plan, with no corresponding data at the PSMSL.

| | | |
|---|---|---|
| **Argentina** | | |
| 190 | Puerto Deseado | 70-84 in G, only 12-37 in 860/011 |
| 185 | Esperanza(Antarctica) | 59-78 in G, only 61-78 in A/001 |
| 192 | Mar del Plata | 54- in G, 57- in 860/091 and 860/101 |
| 181 | Ushuaia | 53- in G, 57- in 860/001 |
| **Australia** | | |
| 61 | Booby Island | 71- in G, not in PSMSL (Thursday Is??) |
| 57 | Botany Bay | 81- in G, not in PSMSL (Sydney FD???) |
| 47 | Christmas Is. | 85- in G, 62-66 in 563/001 |
| 46 | Cocos Is. | 85- in G, 61-62 in 562/001 |
| 121 | Lord Howe Is. | 86- in G, 57-70 in 680/121 |
| 124 | Norfolk Is. | 85- in G, 57,59 and 65 in 680/091 |
| **Brazil** | | |
| 198 | Fernando de Noronha | 72-85 in G, 72 only in 874/141 |
| 196 | Itaparica | 85- in G, nothing in PSMSL |
| 200 | Porto de Itaqui | 85- in G, nothing in PSMSL |
| '93 | Porto de Rio Grande | 83- in G, nothing in PSMSL |
| 201 | Santana | 70- in G, 84 only in 874/171 |
| 265 | Ilha de Trinidade | 74- in G, 74-75 only in 874/101 |
| **Cameroon** | | |
| 280 | Douala | 85- in G, not in PSMSL |
| **Canada** | | |
| 153 | Little Cornwallis Is. | 57-84 in G, not in PSMSL |
| 155 | Prince Rupert | 09- in G, 1933 and 39- in 822/001 |
| 156 | Tofino | 10- in G, 1935 and 40- in 822/116 |
| **Chile** | | |
| 177 | San Felix | 84-86 in G, not in PSMSL |
| 189 | Base Antarctica Capitan Prat | 83-86 in G, not in PSMSL |
| **China** | | |
| 79 | Dalian | 75- in G, not in PSMSL |
| 78 | Zhapo | 75- in G, not in PSMSL |
| 283 | Lusi | 59- in G, not in PSMSL |
| 94 | Kanmen | 60- in G, not in PSMSL |
| **Denmark etc.** | | |
| 225 | Gothab/Nuuk | 50- in G, 65- in 980/031 |
| 237 | Torshavn | 01-07,57- in G, 57- only in 015/011 |
| **Ecuador** | | |
| 169 | Santa Cruz | 68-85 in G, 78-83 in 845/031 |

Egypt
1 Suez 1900- in G, not in PSMSL

French Islands etc.
204 Le Robert,Martinique 72-84 in G, 76- in 912/001
17 Pointe de Galets,Reunion 74- in G, 79-81 in 451/001
96 Dzaoudzi,Mayotte 81 in G, not in PSMSL
202 Cayenne, F.Guiana 77- in G, not in PSMSL
140 Papeete, Tahiti 57- in G, 75-83 in 780/011
(U.of Hawaii have recently installed a gauge at Matavai, almost same location as Papeete, that has 57-65,67,71-72 in 780/001)

Hong Kong
77 Quarry Bay 62- in G, 86- in 611/010

Kenya
8 Mombasa 86- in G, not in PSMSL (Kilindini??)

Madagascar
15 Nosy-be 58-72,85- in G, 58-72 in 440/001

Morocco
282 Tan Tan 57-59 in G, not in PSMSL (although there is 350/021 Casablanca for 57-59).

Mocambique
11 Pemba 81- in G, not in PSMSL

Pakistan
295 Gwadar 86- in G, not in PSMSL

Papua NG
63 Alotau 84- in G, not in PSMSL

Peru
173 Callao 42-86 in G, 42-55 in 848/031

El Salvador
182 Acajutla 62-85 in G, not in PSMSL

Sri Lanka
33 Colombo 34-57 in G, 34-35 in 520/001

Venezuela
298 Aves Is. 87 in G, not in PSMSL
299 La Orchila 87 in G, not in PSMSL

Table 2

Category 1: 'Operational' stations for which the latest data is 1985 or later;
Category 2: 'Probably Operational' stations for which the latest data is within the period 1975-1984;
Category 3: 'Historical' stations for which the latest data is earlier than 1975;
Category 4: For which no PSMSL data exist.

| | Cat.1 | Cat.2 | Cat.3 | Cat.4 |
|---|---|---|---|---|
| ANGOLA | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| ARGENTINA | 0 ( 0 ) | 2 ( 2 ) | 3 ( 3 ) | 2 ( 2 ) |
| AUSTRALIA | 1 ( 1 ) | 10 ( 10 ) | 5 ( 5 ) | 6 ( 6 ) |
| BAHAMAS | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 0 ) |
| BANGLADESH | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 0 ( 0 ) |
| BELAU | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| BRAZIL | 0 ( 0 ) | 4 ( 4 ) | 2 ( 2 ) | 4 ( 3 ) |
| BURMA | 0 ( 0 ) | 0 ( 0 ) | 2 ( 0 ) | 0 ( 0 ) |
| CAMEROON | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| CANADA | 0 ( 0 ) | 7 ( 7 ) | 0 ( 0 ) | 1 ( 1 ) |
| CAPE VERDE | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) |
| CHILE | 0 ( 0 ) | 2 ( 2 ) | 5 ( 5 ) | 2 ( 2 ) |
| CHINA | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) | 4 ( 4 ) |
| COLOMBIA | 0 ( 0 ) | 3 ( 3 ) | 0 ( 0 ) | 0 ( 0 ) |
| CONGO | 0 ( 0 ) | 1 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| COOK ISLANDS | 2 ( 2 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| COSTA RICA | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 1 ( 0 ) |
| COTE D'IVOIRE | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) |
| CUBA | 3 ( 3 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| DENMARK | 2 ( 2 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 2 ) |
| DJIBOUTI | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 0 ( 0 ) |
| ECUADOR | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) | 1 ( 1 ) |
| EGYPT | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 0 ) |
| EL SALVADOR | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| FED.MICRONESIA | 4 ( 4 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| FED.REP.GERMANY | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) |
| FIJI | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| FRANCE | 5 ( 5 ) | 3 ( 3 ) | 0 ( 0 ) | 7 ( 1 ) |
| GHANA | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) |
| GUINEA | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| HAITI | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 0 ( 0 ) |
| HONG KONG | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) |
| ICELAND | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| INDIA | 0 ( 0 ) | 6 ( 5 ) | 1 ( 0 ) | 1 ( 0 ) |
| INDONESIA | 0 ( 0 ) | 0 ( 0 ) | 5 ( 2 ) | 4 ( 1 ) |
| IRELAND | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| JAMAICA | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) |
| JAPAN | 9 ( 9 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 1 ) |
| KENYA | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| KIRIBATI | 3 ( 3 ) | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) |

| | | | | |
|---|---|---|---|---|
| KOREA | 1 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| MADAGASCAR | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 1 ( 0 ) |
| MALAYSIA | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) |
| MALDIVES | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 1 ( 0 ) |
| MARSHALL IS. | 1 ( 1 ) | 0 ( 0 ) | 1 ( 0 ) | 0 ( 0 ) |
| MAURITANIA | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) |
| MAURITIUS | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) | 2 ( 2 ) |
| MEXICO | 2 ( 2 ) | 3 ( 3 ) | 2 ( 2 ) | 1 ( 1 ) |
| MOROCCO | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) |
| MOZAMBIQUE | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 0 ) |
| N.MARIANA IS. | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| NAURU | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| NEW ZEALAND | 3 ( 3 ) | 0 ( 0 ) | 0 ( 0 ) | 4 ( 0 ) |
| NIGERIA | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) |
| NORWAY | 3 ( 3 ) | 1 ( 0 ) | 0 ( 0 ) | 3 ( 0 ) |
| OMAN | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 0 ) |
| P.D.R. YEMEN | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 1 ( 0 ) |
| PAKISTAN | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) |
| PANAMA | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 1 ( 0 ) |
| PAPUA NEW GUINEA | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 3 ( 0 ) |
| PERU | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) |
| PHILLIPINES | 4 ( 4 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| PORTUGAL | 4 ( 4 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| PUERTO RICO/USA | 1 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| SAO TOME/PRINCIPE | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| SENEGAL | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) | 0 ( 0 ) |
| SEYCHELLES | 0 ( 0 ) | 2 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| SIERRA LEONE | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) |
| SINGAPORE | 1 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| SOLOMON IS. | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| SOMALIA | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 0 ) |
| SOUTH AFRICA | 3 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| SPAIN | 1 ( 1 ) | 0 ( 0 ) | 1 ( 1 ) | 1 ( 1 ) |
| SRI LANKA | 0 ( 0 ) | 1 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| SWEDEN | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| TANZANIA | 1 ( 1 ) | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) |
| THAILAND | 2 ( 2 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| TONGA | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 0 ) |
| TRINIDAD AND TOBAGO | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| TUVALA | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) |
| UK | 5 ( 4 ) | 0 ( 0 ) | 1 ( 0 ) | 8 ( 3 ) |
| URUGUAY | 0 ( 0 ) | 1 ( 1 ) | 0 ( 0 ) | 0 ( 0 ) |
| USA | 23 ( 23 ) | 1 ( 1 ) | 2 ( 0 ) | 7 ( 4 ) |
| USSR | 8 ( 8 ) | 0 ( 0 ) | 0 ( 0 ) | 5 ( 0 ) |
| VENEZUELA | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 2 ( 2 ) |
| VIETNAM | 0 ( 0 ) | 0 ( 0 ) | 0 ( 0 ) | 1 ( 1 ) |
| Totals | 105 ( 98 ) | 51 ( 45 ) | 47 ( 28 ) | 103 ( 44 ) |

Table 3
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COLUMN 1 = GLOSS NUMBER
COLUMN 2 = STATION NAME
COLUMN 3 = RESPONSIBLE COUNTRY
COLUMN 4 = COMMITTED TO GLOSS FLAG
COLUMN 5/6 = PSMSL COUNTRY/STATION CODE
COLUMN 7 = LATEST DATA IN PSMSL DATABASE

| | | | | | |
|---|---|---|---|---|---|
| 262 | LOBITO | ANGOLA | | | |
| 185 | BAHIA ESPERANZA | ARGENTINA | C | A /001 | 1978 |
| 186 | BAHIA SCOTIA | ARGENTINA | C | | |
| 184 | JUBANY | ARGENTINA | C | | |
| 192 | MAR DEL PLATA | ARGENTINA | C | 860/111 | 1946 |
| 190 | PUERTO DESEADO | ARGENTINA | C | 860/011 | 1937 |
| 191 | PUERTO MADRYN | ARGENTINA | C | 860/031 | 1982 |
| 181 | USHUAIA | ARGENTINA | C | 860/001 | 1969 |
| 61 | BOOBY IS. | AUSTRALIA | C | | |
| 57 | BOTANY BAY, SYDNEY | AUSTRALIA | C | 680/141 | 1987 |
| 58 | BRISBANE | AUSTRALIA | C | 680/078 | 1984 |
| 40 | BROOME | AUSTRALIA | C | 680/486 | 1981 |
| 59 | BUNDABERG | AUSTRALIA | C | 680/073 | 1984 |
| 52 | CARNARVON | AUSTRALIA | C | 680/476 | 1984 |
| 278 | CASEY | AUSTRALIA | C | | |
| 47 | CHRISTMAS IS. | AUSTRALIA | C | 563/001 | 1966 |
| 46 | COCOS IS.(KEELING) | AUSTRALIA | C | 562/001 | 1962 |
| 62 | DARWIN | AUSTRALIA | C | 680/011 | 1981 |
| 277 | DAVIS | AUSTRALIA | C | | |
| 54 | ESPERANCE | AUSTRALIA | C | 680/446 | 1984 |
| 53 | FREMANTLE | AUSTRALIA | C | 680/471 | 1984 |
| 56 | HOBART | AUSTRALIA | C | 680/201 | 1980 |
| 148 | LORD HOWE IS. | AUSTRALIA | C | 680/121 | 1970 |
| 130 | MACQUARIE IS. | AUSTRALIA | C | | |
| 22 | MAWSON | AUSTRALIA | C | | |
| 124 | NORFOLK IS. | AUSTRALIA | C | 680/091 | 1965 |
| 55 | PORT ADELAIDE | AUSTRALIA | C | 680/301 | 1984 |
| 51 | PORT HEDLAND | AUSTRALIA | C | 680/481 | 1982 |
| 60 | TOWNSVILLE | AUSTRALIA | C | 680/052 | 1960 |
| 279 | WILLIS IS. | AUSTRALIA | C | | |
| 211 | BIMINI | BAHAMAS | | | |
| 12 | SAN SALVADOR | BAHAMAS | | | |
| 36 | CHITTAGONG | BANGLADESH | | 510/025 | 1968 |
| 120 | MALAKAL | BELAU | C | 710/021 | 1986 |
| 194 | CANANEIA | BRAZIL | C | 874/051 | 1984 |
| 198 | FERNANDA DE NORONHA | BRAZIL | C | 874/141 | 1972 |
| 196 | ITAPARICA | BRAZIL | C | | |
| 200 | PORTO DE ITAQUI | BRAZIL | C | | |
| 197 | PORTO DE NATAL | BRAZIL | C | | |
| 193 | PORTO DE RIO GRANDE | BRAZIL | C | 860/004 | 1976 |
| 201 | PORTO DE SANTANA | BRAZIL | C | 874/171 | 1984 |
| 195 | RIO DE JANEIRO | BRAZIL | C | 874/091 | 1968 |
| 199 | ST. PETER & ST. PAUL ROCKS | BRAZIL | | | |
| 265 | TRINIDADE IS. | BRAZIL | C | 874/101 | 1975 |

| | | | | | |
|---|---|---|---|---|---|
| 37 | AKYAB | BURMA | | 530/001 | 1942 |
| 141 | MOULMEIN | BURMA | | 530/021 | 1964 |
| 280 | DOUALA | CAMEROON | | | |
| 226 | ALERT | CANADA | C | 970/162 | 1977 |
| 222 | HALIFAX | CANADA | C | 970/011 | 1980 |
| 153 | LITTLE CORNWALLIS IS. | CANADA | C | | |
| 224 | NAIN | CANADA | C | 970/134 | 1980 |
| 155 | PRINCE RUPERT | CANADA | C | 822/001 | 1980 |
| 152 | SACHS HARBOUR | CANADA | C | 970/203 | 1979 |
| 223 | ST. JOHNS, NEWFLND. | CANADA | C | 970/121 | 1980 |
| 156 | TOFINO | CANADA | C | 822/116 | 1980 |
| 254 | PORTO GRANDE (ST. VICENTE) | CAPE VERDE | C | 380/001 | 1950 |
| 174 | ANTOFAGASTA | CHILE | C | 850/011 | 1970 |
| 189 | BASE ANTARCTICA (CAPT. PRAT) | CHILE | C | | |
| 176 | JUAN FERNANDEZ IS. | CHILE | C | 850/037 | 1984 |
| 137 | PASCUA IS. | CHILE | C | 810/002 | 1984 |
| 178 | PUERTO MONTT | CHILE | C | 850/051 | 1970 |
| 180 | PUERTO WILLIAMS | CHILE | C | 850/081 | 1970 |
| 179 | PUNTA ARENAS | CHILE | C | 850/061 | 1970 |
| 177 | SAN FELIX IS. | CHILE | C | | |
| 175 | VALPARISO | CHILE | C | 850/031 | 1970 |
| 79 | DALIAN | CHINA | C | | |
| 94 | KANMEN | CHINA | C | | |
| 283 | LUSI | CHINA | C | | |
| 247 | XIAMEN | CHINA | C | 610/005 | 1983 |
| 78 | ZHAPO | CHINA | C | | |
| 170 | BUENAVENTURA | COLOMBIA | C | 842/011 | 1984 |
| 207 | CARTAGENA | COLOMBIA | C | 902/021 | 1984 |
| 171 | TUMACO | COLOMBIA | C | 842/021 | 1984 |
| 261 | POINTE NOIRE | CONGO | | 424/021 | 1979 |
| 143 | PENRHYN | COOK ISLANDS | C | 775/001 | 1986 |
| 139 | RAROTONGA | COOK ISLANDS | C | 785/001 | 1986 |
| 166 | I. DEL COCO | COSTA RICA | | | |
| 167 | QUEPOS | COSTA RICA | | 836/011 | 1969 |
| 257 | ABIDJAN | COTE D'IVOIRE | C | 405/001 | 1976 |
| 214 | CABO SAN ANTONIO | CUBA | C | 930/071 | 1986 |
| 276 | GIBARA | CUBA | C | 930/031 | 1986 |
| 215 | SIBONEY | CUBA | C | 930/016 | 1987 |
| 228 | ANGMAGSSALIK, GREENLAND | DENMARK | C | | |
| 225 | GODTHAB/NUUK, GREENLAND | DENMARK | C | 980/031 | 1986 |
| 227 | NORD, GREENLAND | DENMARK | C | | |
| 237 | THORSHAVN, FAEROES | DENMARK | C | 015/011 | 1986 |
| 2 | DJIBOUTI | DJIBOUTI | | 475/001 | 1972 |
| 169 | BALTRA, GALAPAGOS IS. | ECUADOR | C | | |
| 172 | LA LIBERTAD | ECUADOR | C | 845/011 | 1969 |
| 80 | PORT SAID | EGYPT | | | |
| 1 | SUEZ | EGYPT | | | |
| 182 | ACAJUTLA | EL SALVADOR | | | |
| 117 | KAPINGAMARANGI, CAROLINE IS. | FED.MICRONESIA | C | 710/026 | 1986 |
| 115 | PONAPE, CAROLINE IS. | FED.MICRONESIA | C | 710/031 | 1986 |
| 116 | TRUK, CAROLINE IS. | FED.MICRONESIA | C | 710/001 | 1986 |
| 119 | YAP, CAROLINE IS. | FED.MICRONESIA | C | 710/011 | 1986 |
| 284 | CUXHAVEN | FED.REP.GERMANY | C | 140/011 | 1959 |
| 122 | SUVA | FIJI | C | 742/012 | 1986 |

| | | | | |
|---|---|---|---|---|
| 242 | BREST | FRANCE | C 190/091 | 1985 |
| 202 | CAYENNE, FRENCH GUIANA | FRANCE | | |
| 165 | CLIPPERTON IS. | FRANCE | | |
| 21 | CROZET IS. | FRANCE | | |
| 131 | DUMONT D'URVILLE | FRANCE | | |
| 96 | DZAOUDZI (MAYOTTE) | FRANCE | C | |
| 23 | KERGUELEN IS. | FRANCE | | |
| 204 | LE ROBERT, MARTINIQUE | FRANCE | C 912/001 | 1984 |
| 205 | MARSEILLE | FRANCE | C 230/051 | 1984 |
| 140 | MATAVAI, TAHITI | FRANCE | C 780/011 | 1986 |
| 123 | NOUMEA, NEW CALEDONIA | FRANCE | C 740/011 | 1986 |
| 142 | NUKU HIVA, MARQUESAS IS. | FRANCE | C 805/011 | 1986 |
| 17 | PTE DES GALETS, REUNION IS. | FRANCE | C 451/001 | 1981 |
| 138 | RIKITEA, GAMBIER IS. | FRANCE | C 808/001 | 1986 |
| 24 | ST. PAUL IS. | FRANCE | | |
| 258 | TEMA | GHANA | C 410/016 | 1982 |
| 255 | CONAKRY | GUINEA | | |
| 209 | PORT-AU-PRINCE/LES GAYES | HAITI | 934/011 | 1961 |
| 77 | QUARRY BAY | HONG KONG | C | |
| 229 | REYKJAVIK | ICELAND | C 010/001 | 1986 |
| 32 | COCHIN | INDIA | C 500/081 | 1982 |
| 34 | MADRAS | INDIA | C 500/091 | 1982 |
| 281 | MARMAGAO | INDIA | 500/065 | 1980 |
| 29 | MINICOY, LACCADIVE IS. | INDIA | C 455/011 | 1977 |
| 41 | NICOBAR | INDIA | | |
| 38 | PORT BLAIR, ANDAMAN IS. | INDIA | 540/001 | 1964 |
| 31 | VERAVAL | INDIA | C 500/021 | 1981 |
| 35 | VISHAKHAPATNAM | INDIA | C 500/101 | 1982 |
| 68 | AMBON | INDONESIA | C | |
| 49 | BENOA | INDONESIA | | |
| 291 | CILACAP | INDONESIA | C 560/121 | 1931 |
| 50 | KUPANG,TIMOR | INDONESIA | | |
| 69 | MANADO (BITUNG) | INDONESIA | 580/011 | 1931 |
| 45 | PADANG (TELU BAYUK) | INDONESIA | 560/031 | 1931 |
| 48 | PELABUHAN RATU | INDONESIA | 560/111 | 1931 |
| 67 | SORONG | INDONESIA | | |
| 292 | SURABAYA | INDONESIA | C 560/161 | 1931 |
| 240 | CASTLETOWNSEND | IRELAND | | |
| 239 | MALIN HEAD | IRELAND | C 175/011 | 1988 |
| 210 | PORT ROYAL, KINGSTON | JAMAICA | C 932/011 | 1969 |
| 82 | ABURATSU | JAPAN | C 645/021 | 1985 |
| 103 | CHICHIJIMA | JAPAN | C 648/001 | 1985 |
| 88 | HAKODATE | JAPAN | C 641/031 | 1985 |
| 85 | KUSHIMOTO | JAPAN | C 642/141 | 1985 |
| 89 | KUSHIRO | JAPAN | C 641/022 | 1985 |
| 86 | MERA | JAPAN | C 642/061 | 1985 |
| 104 | MINAMI-TORI-SHIMA | JAPAN | C | |
| 83 | NAGASAKI | JAPAN | C 645/064 | 1985 |
| 81 | NAHA | JAPAN | C 646/024 | 1985 |
| 87 | OFUNATO | JAPAN | C 642/022 | 1985 |
| 95 | SYOWA | JAPAN | | |
| 8 | MOMBASA | KENYA | | |
| 145 | CANTON IS. PHOENIX IS. | KIRIBATI | C 750/012 | 1986 |
| 146 | CHRISTMAS IS. LINE IS. | KIRIBATI | C 770/022 | 1986 |

| | | | | | |
|---|---|---|---|---|---|
| 147 | FANNING IS. LINE IS. | KIRIBATI | C | 770/012 | 1985 |
| 113 | TARAWA, GILBERT IS. | KIRIBATI | C | 730/006 | 1983 |
| 84 | PUSAN | KOREA | | 620/046 | 1987 |
| 271 | FORT DAUPHIN (TAOLANARO) | MADAGASCAR | | | |
| 15 | NOSY-BE | MADAGASCAR | | 440/001 | 1972 |
| 293 | CENDERING/KUALA TERENGGANU | MALAYSIA | C | 550/017 | 1986 |
| 43 | PENGKALAN/TLDM/LUMUT | MALAYSIA | C | | |
| 27 | GAN | MALDIVES | | 454/001 | 1963 |
| 28 | MALE | MALDIVES | | | |
| 110 | ENIWETOK | MARSHALL IS. | | 720/001 | 1972 |
| 112 | MAJURO | MARSHALL IS. | C | 720/016 | 1986 |
| 252 | NOUADHIBOU (CAP BLANC) | MAURITANIA | C | | |
| 16 | AGALEGA | MAURITIUS | C | | |
| 18 | PORT LOUIS | MAURITIUS | C | 450/011 | 1965 |
| 19 | RODRIGUES, PORT MATHURIN | MAURITIUS | C | | |
| 267 | ACAPULCO, GRO. | MEXICO | C | | |
| 161 | CABO SAN LUCAS | MEXICO | C | 830/020 | 1981 |
| 160 | ISLA GUADALUPE | MEXICO | C | 830/012 | 1981 |
| 163 | MANZANILLO,COL. | MEXICO | C | 830/071 | 1982 |
| 213 | PROGRESO, YUC. | MEXICO | C | 920/001 | 1985 |
| 164 | PUERTO ANGEL | MEXICO | C | 830/086 | 1966 |
| 162 | SOCORRO IS. | MEXICO | C | 830/061 | 1959 |
| 212 | VERACRUZ, VER. | MEXICO | C | 920/041 | 1985 |
| 282 | TAN TAN | MOROCCO | C | | |
| 10 | INHAMBANE | MOZAMBIQUE | | | |
| 11 | PEMBA | MOZAMBIQUE | | | |
| 118 | SAIPAN | N.MARIANA IS. | C | 700/011 | 1986 |
| 114 | NAURU, GILBERT IS. | NAURU | C | 715/001 | 1986 |
| 127 | AUCKLAND-WAITEMATA HBR. | NEW ZEALAND | C | 690/001 | 1987 |
| 132 | BALLENY IS. | NEW ZEALAND | | | |
| 129 | BLUFF HBR. | NEW ZEALAND | C | 690/041 | 1987 |
| 128 | CHATHAM IS. | NEW ZEALAND | | | |
| 126 | KERMADEC IS. (RAOUL) | NEW ZEALAND | | | |
| 133 | SCOTT IS. | NEW ZEALAND | | | |
| 101 | WELLINGTON | NEW ZEALAND | C | 690/011 | 1987 |
| 259 | LAGOS | NIGERIA | C | 420/003 | 1941 |
| 232 | BJORNOYA (BEAR ISLAND) | NORWAY | | | |
| 269 | BOUVETEYA (BOUVET IS.) | NORWAY | | | |
| 275 | HONNINGSVAG | NORWAY | C | 040/015 | 1987 |
| 230 | JAN MAYEN IS. | NORWAY | | 012/001 | 1983 |
| 235 | MALOY | NORWAY | C | 040/211 | 1987 |
| 136 | PETER IS. | NORWAY | | | |
| 234 | RORVIK | NORWAY | C | 040/136 | 1987 |
| 5 | MUSCAT (QABOOS PORT) | OMAN | | | |
| 4 | SALALAH | OMAN | | | |
| 3 | ADEN | P.D.R. YEMEN | | 485/001 | 1969 |
| 304 | SOCOTRA IS. | P.D.R. YEMEN | | | |
| 295 | GWADAR | PAKISTAN | C | | |
| 30 | KARACHI, MANORO IS. | PAKISTAN | C | 490/021 | 1985 |
| 168 | BALBOA | PANAMA | | 840/011 | 1969 |
| 208 | COCO SOLO | PANAMA | | | |
| 63 | ALOTAU | PAPUA NEW GUINEA | | | |
| 272 | DARU | PAPUA NEW GUINEA | | | |
| 65 | RABAUL | PAPUA NEW GUINEA | C | 670/021 | 1986 |

| | | | | | |
|---|---|---|---|---|---|
| 64 | VANIMO | PAPUA NEW GUINEA | | | |
| 173 | CALLAO | PERU | C | 848/031 | 1955 |
| 71 | DAVAO | PHILLIPINES | C | 660/121 | 1987 |
| 70 | JOLO | PHILLIPINES | C | 660/141 | 1987 |
| 72 | LEGASPI | PHILLIPINES | C | 660/021 | 1987 |
| 73 | MANILA | PHILLIPINES | C | 660/011 | 1987 |
| 246 | CASCAIS | PORTUGAL | C | 210/021 | 1985 |
| 244 | FLORES, AZORES | PORTUGAL | C | 360/041 | 1987 |
| 250 | FUNCHAL, MADEIRA | PORTUGAL | C | 365/001 | 1986 |
| 245 | PONTA DELGADO, AZORES | PORTUGAL | C | 360/001 | 1986 |
| 206 | SAN JUAN | PUERTO RICO/USA | | 938/021 | 1986 |
| 260 | SAO TOME | SAO TOME/PRINCIPE | | | |
| 253 | DAKAR | SENEGAL | | 390/001 | 1966 |
| 14 | ALDABRA | SEYCHELLES | | 441/001 | 1977 |
| 273 | PORT VICTORIA, HODOUL IS. | SEYCHELLES | | 442/001 | 1979 |
| 256 | ABERDEEN POINT | SIERRA LEONE | C | | |
| 44 | SINGAPORE | SINGAPORE | | 555/051 | 1987 |
| 66 | HONIARA | SOLOMON IS. | C | 734/002 | 1986 |
| 6 | HAFUN (DANTE) | SOMALIA | | | |
| 7 | MOGADISHU | SOMALIA | | | |
| 13 | DURBAN | SOUTH AFRICA | | 430/091 | 1987 |
| 20 | MARION IS. | SOUTH AFRICA | | | |
| 76 | PORT ELIZABETH | SOUTH AFRICA | | 430/088 | 1987 |
| 268 | SIMONSTOWN | SOUTH AFRICA | | 430/061 | 1987 |
| 249 | CEUTA (SPANISH N. AFRICA) | SPAIN | C | 340/001 | 1964 |
| 243 | LA CORUNA | SPAIN | C | 200/030 | 1987 |
| 251 | LAS PALMAS, CANARY IS. | SPAIN | C | | |
| 33 | COLOMBO | SRI LANKA | | 520/001 | 1979 |
| 233 | GOTEBORG | SWEDEN | C | 050/032 | 1986 |
| 9 | MTWARA | TANZANIA | C | 460/001 | 1962 |
| 297 | ZANZIBAR | TANZANIA | C | 460/016 | 1987 |
| 39 | KO LAK | THAILAND | C | 600/021 | 1986 |
| 42 | KO TAPHAO NOI | THAILAND | C | 600/001 | 1986 |
| 125 | TONGATAPU | TONGA | | | |
| 203 | PORT OF SPAIN | TRINIDAD AND TOBAGO | C | 890/001 | 1986 |
| 121 | FUNAFUTI, ELLICE IS. | TUVALA | C | 732/011 | 1986 |
| 263 | ASCENSION | UK | C | | |
| 221 | BERMUDA, ST.GEORGES IS. | UK | C | 950/011 | 1986 |
| 26 | DIEGO-GARCIA IS. | UK | | 453/001 | 1964 |
| 266 | EDINBURGH(TRISTAN DA CUNHA) | UK | C | | |
| 188 | FARADAY (ANTARCTICA) | UK | | | |
| 248 | GIBRALTAR | UK | | 215/001 | 1987 |
| 236 | LERWICK | UK | C | 170/001 | 1987 |
| 241 | NEWLYN | UK | C | 170/161 | 1985 |
| 296 | NORTH CAICOS | UK | | | |
| 306 | SIGNY, SOUTH ORKNEY ILS. | UK | | | |
| 187 | SOUTH GEORGIA (S.ATLANTIC) | UK | | | |
| 264 | ST. HELENA | UK | C | | |
| 305 | STANLEY, FALKLAND IS. | UK | | | |
| 238 | STORNOWAY | UK | C | 170/251 | 1985 |
| 300 | MONTEVIDEO | URUGUAY | C | 870/011 | 1984 |
| 302 | ADAK, ALEUTIAN IS. | USA | C | 821/003 | 1986 |
| 149 | APRA HARBOUR,GUAM,MARIANAS | USA | C | 700/001 | 1986 |
| 219 | CAPE HATTERAS, N.C. | USA | C | | |

| | | | | |
|---|---|---|---|---|
| 289 | FORT PULASKI, GA. | USA | C 960/031 | 1986 |
| 107 | FRENCH FRIGATE SHOALS, H.IS. | USA | C 760/016 | 1986 |
| 217 | GALVESTON | USA | C 940/007 | 1986 |
| 287 | HILO, HAWAII, HAW.IS. | USA | C 760/061 | 1986 |
| 108 | HONOLULU, HAWAIIAN IS. | USA | C 760/031 | 1986 |
| 109 | JOHNSTON IS. HAWAIIAN IS. | USA | C 760/011 | 1986 |
| 286 | KAHULUI HARBOR,MAUI, HAW.IS. | USA | C 760/051 | 1986 |
| 216 | KEY WEST | USA | C 940/071 | 1986 |
| 111 | KWAJALEIN, MARSHALL IS. | USA | C 720/011 | 1986 |
| 303 | MASSACRE BAY,ATTU IS.,ALASKA | USA | 820/001 | 1966 |
| 134 | MCMURDO (ANTARCTICA) | USA | | |
| 218 | MIAMI (HAULOVER PIER) | USA | C | |
| 106 | MIDWAY IS. HAWAIIAN IS. | USA | C 760/001 | 1986 |
| 285 | NAWILIWILI, KAUAI, HAW.IS. | USA | C 760/021 | 1986 |
| 290 | NEWPORT, RI. | USA | C 960/161 | 1986 |
| 74 | NOME | USA | | |
| 144 | PAGO PAGO, AMERICAN SAMOA | USA | C 745/001 | 1986 |
| 183 | PALMER (ANTARCTICA) | USA | | |
| 301 | PALMYRA IS., LINE IS. | USA | 770/001 | 1957 |
| 288 | PENSACOLA, FLORIDA | USA | C 940/041 | 1986 |
| 151 | PRUDHOE BAY, ALASKA | USA | C | |
| 159 | SAN DIEGO | USA | C 823/071 | 1986 |
| 158 | SAN FRANCISCO | USA | C 823/031 | 1986 |
| 100 | SAND POINT, ALASKA | USA | C | |
| 150 | SEWARD, ALASKA | USA | C 821/017 | 1986 |
| 154 | SITKA, ALASKA | USA | C 821/031 | 1986 |
| 157 | SOUTH BEACH,OREGON | USA | C 823/016 | 1984 |
| 102 | UNALASKA, ALEUTIAN IS. | USA | C 820/021 | 1986 |
| 220 | VENTNOR (ATLANTIC CITY),N.J. | USA | C 960/091 | 1985 |
| 105 | WAKE IS. MARSHALL IS. | USA | C 720/021 | 1986 |
| 231 | BARENTSBURG (SPITSBERGEN) | USSR | C 025/001 | 1987 |
| 97 | KALININGRAD | USSR | C 080/181 | 1987 |
| 91 | LENINGRADSKAY (ANTARCTICA) | USSR | | |
| 25 | MIRNY (ANTARCTICA) | USSR | | |
| 294 | MOLODEZHNAYA (ANTARCTICA) | USSR | | |
| 274 | MURMANSK | USSR | C 030/018 | 1987 |
| 92 | NAGAEVO BAY | USSR | C 630/011 | 1987 |
| 270 | NOVOLAZAREVSKAYA (ANTARCTIC) | USSR | | |
| 93 | PETROPAVLOVSK-KAMCHATSKY | USSR | C 630/021 | 1987 |
| 98 | PORT TUAPSE, BLACK SEA | USSR | C 300/001 | 1987 |
| 135 | RUSSKAYA | USSR | | |
| 99 | RUSSKAYA GAVAN | USSR | C 030/001 | 1987 |
| 90 | YUZHNO KURILSK | USSR | C 630/001 | 1987 |
| 298 | AVES IS. | VENEZUELA | C | |
| 209 | LA ORCHILA | VENEZUELA | C | |
| 75 | QUI NHON | VIETNAM | C | |

SUMMARY SHEET FOR THE DESCRIPTION OF THE TERRESTRIAL SYSTEM

ATTACHED TO A SET OF STATION COORDINATES

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1 - Technique :

2 - Analysis Center :

3 - Solution identifier :

4 - Software used :

5 - Relativity scale :

6 - Permanent tidal correction on station :

7 - Tectonic plate model :

8 - Velocity of light (C) =

9 - Geogravitational constant ($GM_{\oplus}$) =

10 - Reference epoch =

11 - Adjusted parameters :

12 - Definition of the origin :

13 - Definition of the orientation :

14 - Constraint for time evolution :

Contributed by C. Boucher, International Association of Geodesy,
Special Study Group 5.123.

# GUIDELINES TO FILL UP THE SUMMARY SHEET

---

1 - Technique

Select the type of technique : SLR, LLR, VLBI, GPS, DORIS, PRARE, Doppler, Combined ...

2 - Analysis Center

Name or usual acronym of the Analysis Center
Ex. : GSFC, CSR, NGS, DMA, DGFI, JPL, DUT, IFAG, GRGS, SO, CFA, MIT, BIH ...

3 - Solution identifier

Ex. : SL7.1, SSC(NGS)87R01, SV3 ...

4 - Software used

Name, such as : GEODYN, UTOPIA, CALC, MASTERFIT ...

5 - Relativity scale

SSB : solar system barycentric (usual for VLBI or LLR)
LE : local Earth (usual for SLR)

6 - Permanent tidal correction or station

This effect on coordinates is :

$$X \text{ (at epoch t)} = X_o + \Delta X_{perm} + \Delta X_{periodic} \text{ (at t)}$$

Yes will mean that both $\Delta X_{perm}$ and $\Delta X_{periodic}$ have been used, so that the output position is $X_o$.

No means that only $\Delta X_{periodic}$ is applied, or no correction at all. Then, the output position is $X_o + \Delta X_{perm}$

We recall that $\Delta X_{perm}$ is mainly a vertical effect, of :

$$\Delta h_{perm} = -0.121 \left(\frac{3}{2} \sin^2\phi - \frac{1}{2}\right) \text{ (m)}$$

7 - Tectonic plate motion model

Indicate the type of model used (if any)
Ex. : AM0-2, AM1-2 ...

8 - Velocity of light

Value used, in m/s
Currently 299 792 458
Previous value 299 792 500

9 - Geogravitational constant

Value used for $GM_\oplus$ , including the atmosphere. In SI units ($m^3 \times s^{-2}$ )

The current recent values are :

$$GM_\oplus = 3.9860\ 0440 \times 10^{14}\ m^3 s^{-2}$$

Previous value (MERIT) :

$$GM_\oplus = 3.9860\ 0443 \times 10^{14}\ m^3 s^{-2}$$

They are usually expressed in a local Earth frame. In barycentric frame, the value is different :

$$GM_\oplus^B = GM_\oplus^L (1 - 1.5 \times 10^{-8})$$

$$\simeq GM_\oplus^L - 6 \times 10^6 m^3 s^{-2}$$

10 - Reference epoch

If any, e.g. for coordinates

11 - Adjusted parameters

List of adjusted parameters in the least squares solution. They can be either free or constrained with an a priori variance.

Examples of lists :

$X_\circ\ Y_\circ\ Z_\circ$

$X_\circ\ Y_\circ\ Z_\circ\ \dot{X}\ \dot{Y}\ \dot{Z}$

$X_\circ\ Y_\circ\ Z_\circ\ \dot{\lambda}\ \dot{\phi}$

$\lambda_\circ\ \phi_\circ\ h_\circ\ \dot{\lambda}\ \dot{\phi}$

$\lambda_\circ\ \phi_\circ\ h_\circ\ \dot{\lambda}\ \dot{\phi}\ \dot{h}$

$X_\circ\ Y_\circ\ Z_\circ\ \Omega_x\ \Omega_y\ \Omega_z$

$X_\circ\ Y_\circ\ Z_\circ\ L_{X_k}\ L_{Y_k}\ L_{Z_k}$

$X_k\ Y_k\ Z_k$

We have assumed the general physical model for station positions :

$$X = X_\circ + \dot{X}(t - t_\circ) + L_k$$

with in some case $\dot{X} = \Omega \wedge X_\circ$

12 - Definition of the origin

How the origin is defined.
For instance, in dynamical techniques, this is the geocenter through $C_{10} = 0$, $C_{11} = 0$ and $S_{11} = 0$.

In VLBI, a station position is held fixed to some values (at some epoch or always).

13 - Definition of the orientation

How the orientation is defined.
For instance, by adopting at a given epoch ERP values, or equivalently two latitudes and one longitude.

14 - Evolution with time

How the system evolves with time, especially in orientation.
Examples :

- fixed plate motion model
- Tisserand condition
- constrained to an a priori model

ANNEX V

**THE TOGA SEA LEVEL NETWORK**
(Progress Report)

In the Pacific Ocean TOGA inherited an almost complete sea level network from NORPAX. Since 1985 two stations were added, Bitung on Celebes and San Felix off Chile. Thirty stations were upgraded to satellite data transmission. Australia has installed a network of 6 stations in Papua New Guinea. Malaysia has installed a network of 10 stations, half of which are on the Malacca Strait. A network of 22 stations was installed by the ASEAN project in Thailand, Malaysia, Indonesia and the Philippines during the last two years with the help of Australia. The TOGA network is virtually complete, 81 of the 90 stations listed in the implementation plan exist. Desirable missing stations are Marcus Island (Japan), Raoul (New Zealand), Lord Howe Island (Australia) and Tonga. The weakest link are the stations in Mexico, which provide very interrupted records.

Data from 72 of the 81 existing TOGA stations have been received by the TOGA Sea Level Center and are being quality controlled. Data were not yet received from Xiamen, Zhapo, Kaoshiung, Singapore, Cabo San Lucas, Puerto Angel, Manzanillo, Buenaventura and Tumaco. Data from several stations not listed in the implementation plan are also available.

In the Indian Ocean a single island based station, Reunion, existed in 1985. Since that time 23 stations have been installed on islands and important coastal locations. 17 of these stations were installed with U.S. funding or assistance. The addition of these 23 stations has improved the network considerably and 38 of the 58 stations listed in the TOGA implementation plan do exist. Desirable missing stations are: Salalah (Oman), Port Blair and Minicoy (India), and Banda Atjeh and Kupang (Indonesia). Data return from many of the stations is slow and spotty. This is chiefly due to the insufficient interest and lack of cooperation from local authorities. Increased funding and more frequent visits will help. India is still not providing sea level data for TOGA.

In the Atlantic little progress has been made with the establishment of a TOGA sea level network. The IOCCARIBE project has drawn an ambitious plan but implementation has not yet started. France has installed six pressure gauges in the tropical Atlanic. A few pressure gauges have been installed on South Atlantic islands. IOC is attempting to activate several stations along West and Central Africa as part of GLOSS. Initial attempts have been made to collect data from the few existing stations.

The TOGA SEA LEVEL CENTER has been established to provide the TOGA scientific community with daily sea level data with a delay of about 18 months. Experience has shown that daily sea level cannot be properly quality controlled, and consequently it became necessary to obtain hourly values from the originators. This has increased the workload of the center by an order of magnitude as well as the cost of processing the data. It was also decided to acquire and quality control as much of the

pre-TOGA data as possible, as long as these data were easily available on magnetic tape. We are cooperating with NODC in the acquisition and processing of these data.

The response of originators to our request for data has been outstanding. Virtually all countries located in the TOGA region have send hourly data for recent years, some have sent data for several decades. The only exceptions are India, Burma and Taiwan. Our request for data has resulted in an inflow of more than 1200 station years of hourly data from the Pacific and Indian Oceans, and our processing is lagging severely behind. So far 800 station years of data from the Pacific have been quality controlled and 30 station years from the Indian Ocean. We have not yet started to process any data from the Atlantic Ocean.

We plan to issue in mid-1989 a catalog of the quality controlled data, that are available from the TOGA Sea Level Center or from NODC. Since the establishment of the Center 113 data requests from individual scientists or organizations have been filled.

We are working closely with the Tsunami Warning Center to obtain access to the Japanese satellite so that data from the western Pacific, Indonesia and Australia can be received. We have made arrangements to relay data from the western Indian Ocean via Meteosat. All this will happen as soon as additional funding becomes available.

During the early phase of TOGA the sea level project was adequately funded. The Pacific sea level network could be upgraded to satellite transmission and a new network could be started in the Indian Ocean. It was decided to leave the establishment of a network in the Atlantic to the European nations. Plans were being made to start upgrading the Indian network to satellite transmission, after ordinary stations had been operated for about two years and local support had been assured. At that time our funding was severely curtailed and at present we are just maintaining the existing network and processing the data.

A list of the TOGA stations with station numbers and positions for each of the three oceans is enclosed as well as maps of the station locations.

Klaus Wyrtki and Gary Mitchum
TOGA SEA LEVEL CENTER

## TOGA STATIONS IN THE PACIFIC OCEAN

| TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS |
|---|---|---|---|---|---|---|
| P001 | 247 | Xiamen | China | 24-27N | 118-04E | 0000-0000 |
| P002 | 078 | Zhapo | China | 21-35N | 111-49E | 0000-0000 |
| P003 | 077 | Quarry Bay | Hong Kong | 22-18N | 114-13E | 1986-1987 |
| P003 | 077 | North Point | Hong Kong | 22-18N | 114-12E | 1962-1985 |
| P004 | 039 | Ko Lak | Thailand | 11-48N | 099-49E | 1985-1987 |
| P005 | 044 | Singapore | Singapore | 01-28N | 103-48E | 0000-0000 |
| P006 | 292 | Cendering | Malaysia | 05-16N | 103-11E | 1984-1987 |
| P007 | xxx | Bitung | Indonesia | 00-27N | 125-12E | 0000-0000 |
| P008 | 070 | Jolo | Philippines | 06-04N | 121-00E | 1984-1987 |
| P009 | 071 | Davao | Philippines | 07-05N | 125-38E | 1984-1987 |
| P010 | 072 | Legaspi | Philippines | 13-09N | 123-45E | 1984-1987 |
| P011 | 073 | Manila | Philippines | 14-35N | 120-58E | 1984-1987 |
| P012 | 081 | Naha | Japan | 26-13N | 127-40E | 1966-1986 |
| P013 | 103 | Chichijima | Japan | 27-06N | 142-11E | 1975-1986 |
| P014 | 104 | Minamitorishima | Japan | 24-18N | 153-58E | 0000-0000 |
| P015 | 118 | Saipan | N. Mariana Isl. | 15-14N | 145-45E | 1978-1987 |
| P016 | 149 | Guam | USA | 13-26N | 144-39E | 1973-1987 |
| P017 | 119 | Yap, Carolines | Fd St Micronesia | 09-31N | 138-08E | 1974-1987 |
| P018 | 120 | Malakal | Rep. of Belau | 07-20N | 134-28E | 1974-1987 |
| P019 | 067 | Sorong | Indonesia | 00-53S | 131-15E | 0000-0000 |
| P020 | xxx | Wewak | Papua New Guinea | 03-34S | 142-39E | 1984-1988 |
| P021 | xxx | Manus | Papua New Guinea | 02-02S | 147-27E | 1984-1986 |
| P022 | xxx | Kavieng | Papua New Guinea | 02-36S | 150-48E | 1984-1988 |
| P023 | xxx | Madang | Papua New Guinea | 05-09S | 145-48E | 1984-1988 |
| P024 | xxx | Port Moresby | Papua New Guinea | 09-30S | 147-10E | 1984-1988 |
| P025 | 061 | Booby | Australia | 10-36S | 141-55E | 0000-0000 |
| P026 | 060 | Townsville | Australia | 19-15S | 146-50E | 1985-1987 |
| P027 | 058 | Brisbane | Australia | 27-22S | 153-10E | 1985-1986 |
| P029 | 148 | Lord Howe | Australia | 31-31S | 159-04E | 0000-0000 |
| P030 | 124 | Norfolk | Australia | 29-04S | 167-57E | 0000-0000 |
| P031 | 123 | Noumea,New Caledonia | France | 22-18S | 166-26E | 1975-1987 |
| P032 | xxx | Lae | Papua New Guinea | 06-43S | 146-58E | 1984-1988 |
| P034 | 063 | Alotau | Papua New Guinea | 10-21S | 150-29E | 1984-1988 |
| P035 | 065 | Rabaul | Papau New Guinea | 04-12S | 152-11E | 1974-1987 |
| P036 | 066 | Honiara, Guadalcanal | Solomon Islands | 09-26S | 159-57E | 1974-1987 |
| P037 | 117 | Kapingamarangi | Fd St Micronesia | 01-06N | 154-47E | 1978-1987 |
| P038 | 116 | Truk, Carolines | Fd St Micronesia | 07-27N | 151-51E | 1973-1987 |
| P039 | 115 | Ponape | Fd St Micronesia | 06-59N | 158-15E | 1974-1987 |
| P040 | 105 | Wake | USA | 19-17N | 166-37E | 1973-1987 |
| P042 | 111 | Kwajalein | Marshall Is. | 08-44N | 167-44E | 1973-1987 |
| P043 | 112 | Majuro | Marshall Islands | 07-06N | 171-22E | 1974-1987 |
| P044 | 113 | Tarawa,Betio | Kiribati | 01-22N | 172-56E | 1974-1983 |
| P045 | 114 | Nauru | Rep. of Nauru | 00-32S | 166-54E | 1974-1987 |
| P046 | 121 | Funafuti | Tuvalu | 08-32S | 179-13E | 1977-1987 |
| P047 | 122 | Suva | Fiji | 18-08S | 178-26E | 1975-1987 |
| P048 | 126 | Raoul,Kermadec Is. | New Zealand | 29-50S | 178-15W | 0000-0000 |
| P049 | 125 | Tongatapu | Tonga | 21-10S | 175-15W | 0000-0000 |
| P050 | 144 | Pago Pago, Samoa | USA | 14-17S | 170-41W | 1973-1987 |
| P052 | 145 | Kanton | Kiribati | 02-49S | 171-43W | 1974-1987 |
| P053 | 109 | Johnston | USA | 16-45N | 169-31W | 1973-1987 |
| P054 | 106 | Midway | USA | 28-13N | 177-22W | 1974-1987 |
| P055 | 107 | French Frigate Shoals | Hawaii,USA | 23-52N | 166-17W | 1975-1987 |

| | | | | | | |
|---|---|---|---|---|---|---|
| P056 | 287 | Hilo, Hawaii | Hawaii,USA | 19-44N | 155-04W | 1973-1987 |
| P057 | 108 | Honolulu,Oahu | Hawaii,USA | 21-18N | 157-52W | 1973-1987 |
| P058 | 285 | Nawiliwili,Kauai | Hawaii,USA | 21-58N | 159-21W | 1973-1987 |
| P059 | 286 | Kahului, Maui | Hawaii,USA | 20-54N | 156-28W | 1973-1987 |
| P060 | xxx | Mokuoloe, Oahu | Hawaii,USA | 21-26N | 157-48W | 1981-1987 |
| P061 | 147 | Fanning | Kiribati | 03-54N | 159-23W | 1975-1987 |
| P062 | 146 | Christmas | Kiribati | 01-59N | 157-29W | 1975-1987 |
| P063 | 143 | Penrhyn | Cook Islands | 09-01S | 158-04W | 1977-1987 |
| P064 | 139 | Rarotonga | Cook Islands | 21-12S | 159-46W | 1977-1987 |
| P065 | 140 | Papeete | French Polynesia | 17-32S | 149-34W | 1975-1987 |
| P066 | 142 | Nuku Hiva, Marquesas Is | French Polynesia | 08-56S | 140-05W | 1982-1987 |
| P068 | 138 | Rikitea, Mangareva Isl. | French Polynesia | 23-08S | 134-57W | 1975-1987 |
| P069 | 137 | Easter | Chile | 27-09S | 109-27W | 1979-1983 |
| P070 | 165 | Clipperton | France | 10-17N | 109-13W | 0000-0000 |
| P071 | 160 | Guadalupe | Mexico | 28-53N | 118-18W | 0000-0000 |
| P072 | 161 | Cabo San Lucas | Mexico | 22-53N | 109-54W | 0000-0000 |
| P073 | 162 | Socorro | Mexico | 18-44N | 111-01W | 0000-0000 |
| P074 | 163 | Manzanillo | Mexico | 19-03N | 104-20W | 0000-0000 |
| P075 | 164 | Puerto Angel | Mexico | 15-39N | 096-30W | 0000-0000 |
| P077 | 182 | Acajutla | El Salvador | 13-35N | 089-50W | 0000-0000 |
| P078 | 167 | Puerto Quepos | Costa Rica | 09-24N | 084-10W | 1971-1987 |
| P079 | 168 | Balboa | Rep. of Panama | 08-58N | 079-34W | 1971-1985 |
| P080 | 170 | Buenaventura | Colombia | 03-53N | 077-06W | 0000-0000 |
| P081 | 172 | La Libertad | Ecuador | 02-12S | 080-55W | 1969-1988 |
| P082 | 169 | Baltra, Galapagos Isl. | Ecuador | 00-26S | 090-17W | 1985-1987 |
| P083 | 173 | Callao | Peru | 12-03S | 077-09W | 1970-1987 |
| P084 | 174 | Antofagasta | Chile | 23-39S | 070-24W | 1980-1987 |
| P085 | 177 | San Felix | Chile | 26-17S | 080-07W | 0000-0000 |
| P086 | 176 | Juan Fernandez | Chile | 33-37S | 078-50W | 1977-1984 |
| P087 | 175 | Valparaiso | Chile | 33-02S | 071-38W | 1987-1987 |
| P088 | xxx | Kao-Hsiung | Taiwan | 22-37N | 120-16E | 0000-0000 |
| P089 | xxx | Lobos | Peru | 06-56S | 080-43W | 0000-0000 |
| P091 | xxx | Caldera | Chile | 27-04S | 070-50W | 1980-1987 |
| P092 | xxx | Santa Cruz,Galapagos Is | Ecuador | 00-45S | 090-19W | 1978-1987 |
| P093 | 267 | Acapulco | Mexico | 16-50N | 099-55W | 1985-1988 |
| P094 | 059 | Bundaberg | Australia | 24-50S | 151-21E | 1985-1986 |
| P095 | 068 | Ambon | Indonesia | 04-20S | 128-12E | 0000-0000 |
| P096 | 171 | Tumaco | Colombia | 01-50N | 078 44W | 0000-0000 |
| P097 | xxx | Arica | Chile | 18-28S | 070-20W | 1982-1987 |
| Pxxx | 110 | Enewetak | Marshall Islands | 11-26N | 162-23E | 1974-1979 |
| Pxxx | xxx | Hiva Oa, Marquesas Isl. | French Polynesia | 09-49S | 139-02W | 1977-1980 |
| Pxxx | xxx | Honolulu,Kewalo,Oahu | Hawaii,USA | 21-18N | 157-52W | 1978-1986 |
| Pxxx | xxx | Hololulu,Pier 45,Oahu | Hawaii,USA | 21-19N | 157-53W | 1985-1987 |
| Pxxx | xxx | Tarawa, Bairiki | Kiribati | 01-20N | 173-01E | 1983-1987 |
| Pxxx | xxx | Miyakejima | Japan | 34-04N | 139-29E | 1965-1986 |
| Pxxx | xxx | Johor Baharu | Malaysia | 01-28N | 103-48E | 1983-1987 |
| Pxxx | xxx | Kuantan | Malaysia | 03-59N | 103-26E | 1983-1987 |
| Pxxx | xxx | Tioman | Malaysia | 02-48N | 104-08E | 1985-1987 |
| Pxxx | xxx | Kukup | Malaysia | 01-20N | 103-27E | 1985-1987 |
| Pxxx | xxx | Fort Denison | Australia | 33-51S | 151-14E | 1985-1987 |
| Pxxx | 087 | Ofunato | Japan | 39-04N | 141-43E | 1965-1986 |
| Pxxx | 086 | Mera | Japan | 34-55N | 139-50E | 1965-1986 |
| Pxxx | 085 | Kushimoto | Japan | 33-28N | 135-47E | 1961-1968 |
| Pxxx | 082 | Aburatsu | Japan | 31-34N | 131-25E | 1961-1986 |
| Pxxx | xxx | Naze | Japan | 28-23N | 129-30E | 1965-1973 |
| Pxxx | 075 | Qui Nhon | Vietnam | 13-46N | 109-13E | 0000-0000 |
| Pxxx | xxx | Ensenada, Baja Calif. | Mexico | 31-51N | 116-38W | 1986-1988 |
| Pxxx | xxx | Puerto Madero | Mexico | 14-43N | 092-26W | 1986-1988 |

## TOGA STATIONS IN THE INDIAN OCEAN

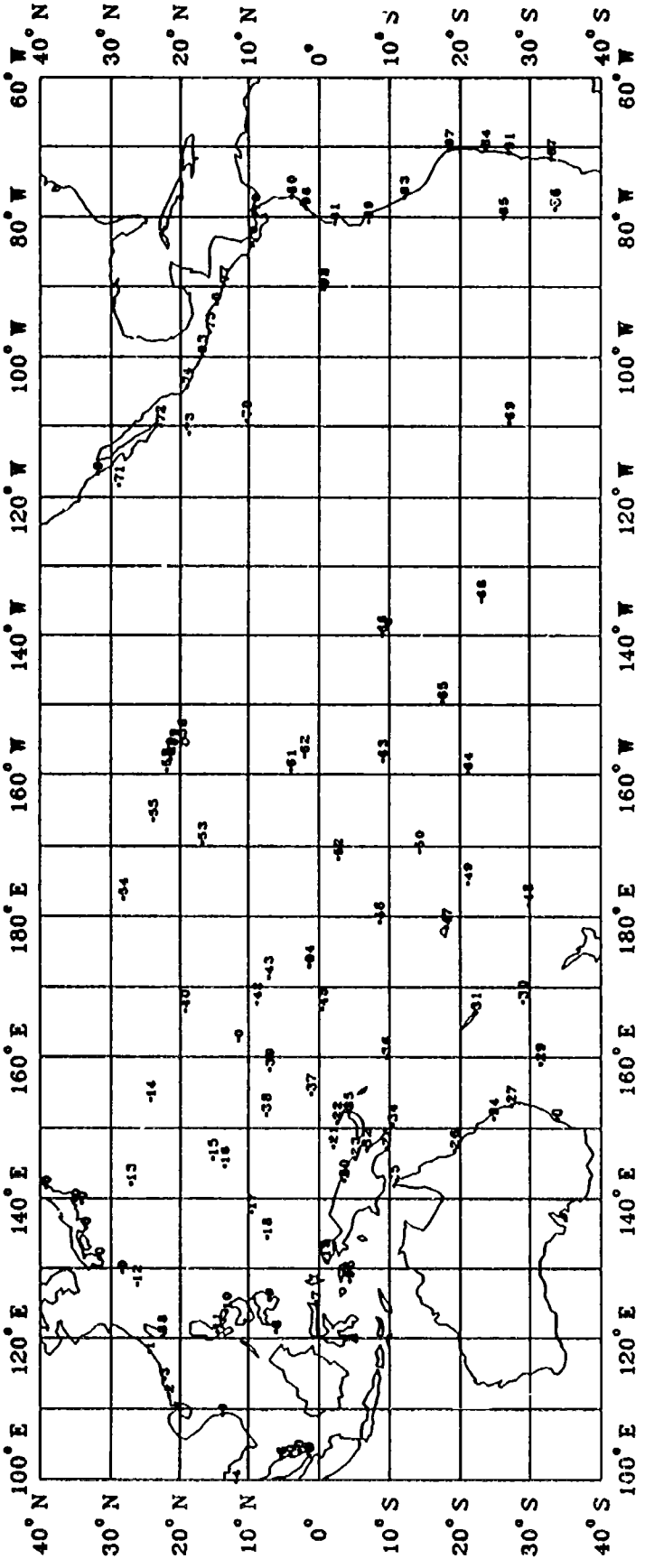
| TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS |
|---|---|---|---|---|---|---|
| I001 | 001 | Suez | Egypt | 29-55N | 032-33E | 0000-0000 |
| I002 | 002 | Djibouti | Djibouti | 11-36N | 043-09E | 0000-0000 |
| I003 | 006 | Ras Hafun | Somalia | 10- N | 051- E | 0000-0000 |
| I004 | 007 | Mogadishu | Somalia | 02-01N | 045-20E | 0000-0000 |
| I005 | 008 | Mombasa | Kenya | 04-03S | 039-40E | 0000-0000 |
| I006 | 297 | Zanzibar | Tanzania | 06-09S | 039-11E | 0000-0000 |
| I007 | xxx | Dar Es Salaam | Tanzania | 06-49S | 039-17E | 0000-0000 |
| I008 | 011 | Pemba | Mozambique | 12-58S | 040-29E | 0000-0000 |
| I009 | xxx | Mozambique | Mozambique | 15-00S | 041-30E | 0000-0000 |
| I010 | xxx | Beira | Mozambique | 20-00S | 035-00E | 0000-0000 |
| I011 | xxx | Maputo | Mozambique | 26-00S | 032-30E | 0000-0000 |
| I012 | 013 | Durban | South Africa | 29-53S | 031-00E | 0000-0000 |
| I013 | 003 | Aden | P.D.R. Yemen | 12-47N | 044-59E | 0000-0000 |
| I014 | 009 | Mtwara | Tanzania | 10-08S | 040-07E | 0000-0000 |
| I015 | 004 | Salalah | Oman | 17-00N | 054-00E | 0000-0000 |
| I016 | 005 | Muscat | Oman | 23-37N | 058-35E | 0000-0000 |
| I017 | 295 | Gwadar | Pakistan | 25-07N | 062-20E | 0000-0000 |
| I018 | 030 | Manoro (Karachi) | Pakistan | 24-48N | 066-58E | 0000-0000 |
| I019 | 031 | Veraval | India | 20-54N | 070-22E | 0000-0000 |
| I020 | 281 | Marmagao | India | 15-25N | 073-48E | 0000-0000 |
| I021 | xxx | Lakshadweep | India | 11- N | 073- E | 0000-0000 |
| I022 | 032 | Cochin | India | 09-58N | 076-16E | 0000-0000 |
| I023 | 029 | Minicoy | India | 08-17N | 073-03E | 0000-0000 |
| I024 | 034 | Madras | India | 13-06N | 080-10E | 0000-0000 |
| I025 | 035 | Vishakhapatnam | India | 17-41N | 083-17E | 0000-0000 |
| I026 | 038 | Port Blair | India | 11-41N | 092-46E | 0000-0000 |
| I027 | 041 | Great Nicobar | India | 07-00N | 093-50E | 0000-0000 |
| I028 | 141 | Moulmein | Burma | 16-29N | 097-37E | 0000-0000 |
| I029 | 037 | Akyab | Burma | 20-09N | 092-54E | 0000-0000 |
| I031 | 042 | Ko Taphao Noi (Phuket) | Thailand | 07-50N | 098-26E | 1985-1987 |
| I033 | xxx | Kelang | Malaysia | 03-03N | 101-22E | 1983-1987 |
| I034 | xxx | Lumut | Malaysia | 04-14N | 100-37E | 1984-1987 |
| I035 | 033 | Colombo | Sri Lanka | 06-56N | 079-51E | 1953-1965 |
| I036 | xxx | Banda Acheh | Indonesia | 05-30N | 095-30E | 0000-0000 |
| I037 | 045 | Padang (Telu Bayuk) | Indonesia | 00-58S | 100-20E | 0000-0000 |
| I038 | xxx | Telukbetung | Indonesia | 05-30S | 105-00E | 0000-0000 |
| I039 | 048 | Pelabuhan Ratu | Indonesia | 07-00S | 106-30E | 0000-0000 |
| I040 | 291 | Cilacap | Indonesia | 07-34S | 108-59E | 0000-0000 |
| I042 | 049 | Benoa | Indonesia | 08-46S | 115-13E | 0000-0000 |
| I043 | 050 | Kupang | Indonesia | 10-10S | 123-35E | 0000-0000 |
| I044 | 062 | Darwin | Australia | 12-28S | 130-51E | 1985-1987 |
| I045 | 040 | Broome | Australia | 18-00S | 122-13E | 0000-0000 |
| I046 | 051 | Port Hedland | Australia | 20-19S | 118-34E | 0000-0000 |
| I047 | 052 | Carnarvon | Australia | 24-54S | 113-39E | 0000-0000 |
| I048 | 046 | Cocos | Australia | 12-07S | 096-54E | 1985-1987 |
| I049 | 047 | Christmas | Australia | 10-25S | 105-40E | 1986-1987 |
| I050 | 026 | Diego Garcia | U.K. | 07-00S | 072-30E | 0000-0000 |
| I051 | 027 | Gan | Maldives | 00-41S | 074-09E | 0000-0000 |
| I052 | 028 | Male | Maldives | 04-10N | 073-30E | 0000-0000 |
| I053 | 273 | Port Victoria | Seychelles | 04-40S | 055-28E | 0000-0000 |
| I054 | 014 | Aldabra | Seychelles | 09-24S | 046-13E | 1975-1976 |
| I055 | 016 | Agalega Is. | Mauritius | 10-26S | 056-45E | 0000-0000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| I056 | 019 | Rodrigues,Mathurin | Mauritius | 19-41S | 063-25E | 0000-0000 |
| I057 | 018 | Port Louis | Mauritius | 20-09S | 057-28E | 0000-0000 |
| I058 | 017 | Pt des Galets,Reunion | France | 20-55S | 055-18E | 0000-0000 |
| I059 | 015 | Nosyybe | Madagascar | 13-24S | 048-17E | 0000-0000 |
| I060 | 271 | Fort Dauphin | Madagascar | 25- S | 047- E | 0000-0000 |
| I061 | 096 | Dzaoudzi (Mayotte) | France | 12-47S | 045-15E | 0000-0000 |
| Ixxx | xxx | Tanjung Keling | Malaysia | 02-13N | 102-09E | 1984-1987 |
| Ixxx | xxx | Langkawi | Malaysia | 06-26N | 099-46E | 1985-1987 |
| Ixxx | xxx | Penang | Malaysia | 05-25N | 100-21E | 1984-1987 |
| Ixxx | xxx | Praslin | Seychelles | 04-21S | 055-46E | 0000-0000 |
| Ixxx | xxx | Kismayo | Somalia | 00-30S | 042-30E | 0000-0000 |
| Ixxx | 292 | Surabaya | Indonesia | 06-55S | 112-14E | 0000-0000 |

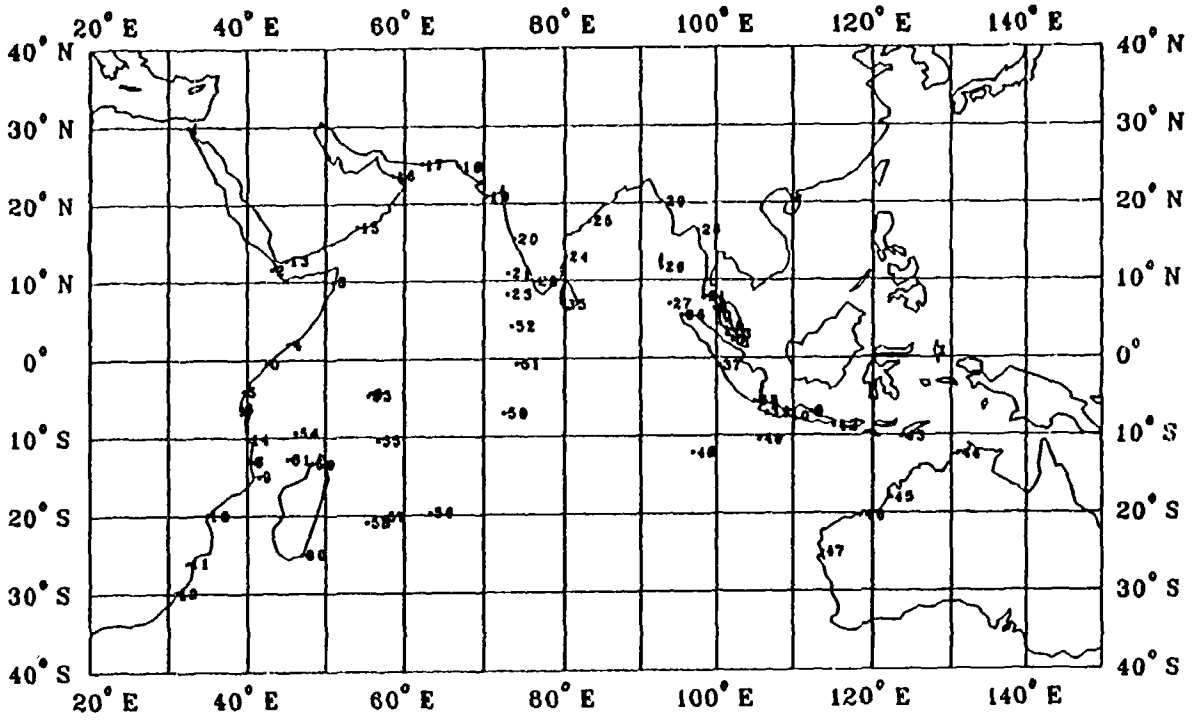
## TOGA STATIONS IN THE ATLANTIC OCEAN

| TOGA | GLOSS | STATION | COUNTRY | LAT | LONG | QC-YEARS |
|---|---|---|---|---|---|---|
| A001 | 211 | Bimini | Bahamas | 25-45N | 079-10W | 0000-0000 |
| A002 | 012 | San Salvador | Bahamas | 24-00N | 074-30W | 0000-0000 |
| A003 | 296 | North Caicos | U.K. | 22-00N | 072-00W | 0000-0000 |
| A004 | 276 | Gibara | Cuba | 21-07N | 076-07W | 0000-0000 |
| A005 | 210 | Port Royal,Kingston | Jamaica | 17-56N | 076-51W | 0000-0000 |
| A006 | 209 | Port-au-Prince | Haiti | 18-34N | 072-21W | 0000-0000 |
| A007 | 206 | San Juan | Puerto Rico | 18-27N | 066-05W | 0000-0000 |
| A008 | 204 | Le Robert,Martinique | France | 14-41N | 060-56W | 0000-0000 |
| A009 | 208 | Coco Solo | Panama | 09-22N | 079-53W | 0000-0000 |
| A010 | 207 | Cartagena | Colombia | 10-23N | 075-32W | 0000-0000 |
| A011 | xxx | La Guaira | Venzuela | 10-40N | 067-00W | 0000-0000 |
| A012 | 203 | Port of Spain | Trinidad/Tobag. | 10-39N | 061-31W | 0000-0000 |
| A013 | 202 | Cayenne | France | 05-00N | 052-00W | 0000-0000 |
| A014 | 201 | Porto de Santana | Brazil | 00-03S | 051-10W | 0000-0000 |
| A015 | 200 | Porto de Itaqui | Brazil | 02-34S | 044-22W | 0000-0000 |
| A016 | 197 | Porto de Natal | Brazil | 05-46S | 035-12W | 0000-0000 |
| A017 | 196 | Itaparica | Brazil | 12-52S | 038-41W | 0000-0000 |
| A018 | 195 | Rio de Janeiro | Brazil | 22-52S | 043-08W | 0000-0000 |
| A019 | 194 | Cananeia | Brazil | 25-01S | 047-55W | 0000-0000 |
| A020 | 265 | Trindade | Brazil | 20-30S | 029-18W | 0000-0000 |
| A021 | 198 | Fernando de Noronha | Brazil | 03-52S | 032-25W | 0000-0000 |
| A022 | 199 | St Peter/Paul Rocks | Brazil | 00-55N | 029-21W | 0000-0000 |
| A023 | 254 | Porto Grande | Cape Verde | 16-52N | 024-59W | 0000-0000 |
| A024 | 251 | Las Palmas,Canary I | Spain | 25-08N | 015-25W | 0000-0000 |
| A025 | 252 | Nouadhibou | Mauritania | 21-00N | 017-00W | 0000-0000 |
| A026 | 253 | Dakar | Senegal | 14-38N | 017-27W | 0000-0000 |
| A027 | 255 | Conakry | Guinea | 09-30N | 013-45W | 0000-0000 |
| A028 | 256 | Freetown | Sierra Leone | 08-30N | 013-15W | 0000-0000 |
| A029 | xxx | Monrovia | Liberia | 06-15N | 010-45W | 0000-0000 |
| A030 | 257 | Abidjan | Cote d'Ivoire | 05-15N | 004-00W | 0000-0000 |
| A031 | xxx | Takoradi | Ghana | 04-55N | 001-45W | 0000-0000 |
| A032 | 259 | Lagos | Nigeria | 06-25N | 003-27E | 0000-0000 |
| A033 | 280 | Douala | Cameroon | 04-03N | 009-41E | 0000-0000 |
| A034 | 260 | Sao Tome | Sao Tome/Princ. | 00-00N | 006-30E | 0000-0000 |
| A035 | 261 | Pointe-Noire | Congo | 04-47S | 011-50E | 0000-0000 |
| A036 | 263 | Ascension | U.K. | 07-55S | 014-25W | 0000-0000 |
| A037 | 264 | St Helena | U.K. | 14-55S | 005-42W | 0000-0000 |
| A038 | 262 | Lobito | Angola | 12-20S | 013-34E | 0000-0000 |
| A039 | 267 | Walvis Bay | Namibia | 22-57S | 014-30E | 0000-0000 |
| Axxx | xxx | Lome | Togo | 06-10N | 001-10E | 0000-0000 |
| Axxx | xxx | Fort de France | France | 14-36N | 061-05W | 0000-0000 |
| Axxx | xxx | Praia | Cape Verde | 15-00N | 023-30W | 0000-0000 |

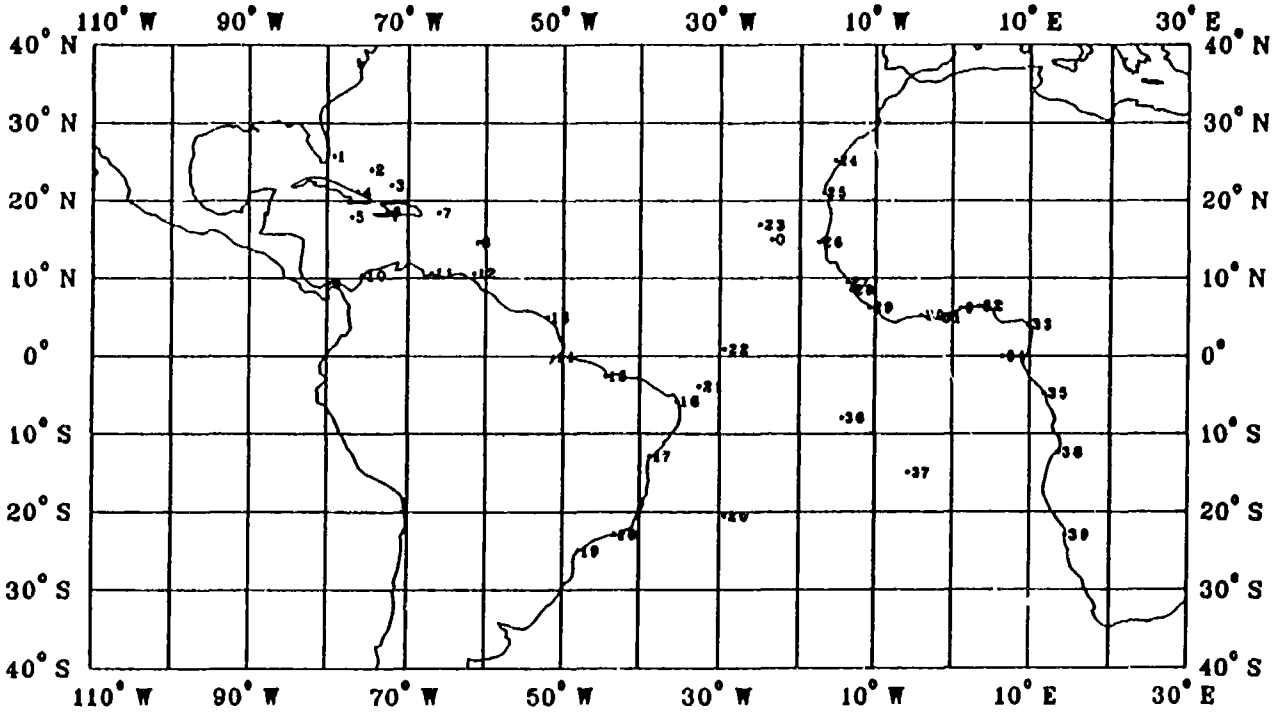
TOGA STATIONS IN THE PACIFIC OCEAN



# TOGA STATIONS IN THE INDIAN OCEAN



# TOGA STATIONS IN THE ATLANTIC OCEAN



ANNEX VI

**WOCE DATA MANAGEMENT COMMITTEE**
**Extracts of the Report of the First Meeting (27 February - 1 March 1989)**

## 5.3 Sea Level Centres

Existing plans call for two centres, one for rapid delivery to be used in orbit calibration and a second delayed mode comprehensive set for use in research mode.

Discussions at the Topex/Poseidon (T/P) meeting in February 1989 indicate a loss of interest in the T/P community in using tide gauges for orbit calibration as other methods were likely to be of higher accuracy. The need for a separate centre for the "A" set of gauges (c. 10) would then largely disappear.

The Plan states a need for 40 gauges ("B" set) and the resources document suggests that there are a sufficient number of countries willing to take part in the WOCE sea level programme. It is urgent for the scientific planning to identify where these gauges are to be located so that a sea- level centre can start work with the authorities on agreeing data flow, quality control procedures, and ancillary measurements.

The DMC suggests that in view of the requirements for sea level data as presently envisaged, only one type of sea- level DAC is now required. *SSG*

Candidate locations for the centre are the University of Hawaii and MIAS (working with the Proudman Oceanographic Laboratory) in the UK. Present Hawaii operations encompass the WOCE requirements in the tropical (±30°) Pacific and Indian Ocean. Present UK activities include the operation of a number of S Atlantic gauges and a close association with the archival activity ( global monthly mean sea level) of the PSMSL.

The DMC recommends that the two locations be requested to collaborate in operating the DAC with a formal division of responsibilities on the following lines: *SSG US,UK*

- Hawaii: acquire and QC the data for the tropical network currently operated for TOGA but extended to cover the time frame for WOCE through December 1996.

- MIAS: acquire and QC the data for the gauges in the list of circa 40 locations indicated which are not part of the Hawaii set. These additional gauges, will be more diverse in their management than the Hawaii set, so it will be a charge on MIAS to establish procedures with the managers to achieve WOCE goals.

Delivery of datasets to PIs shall, as proposed in the Implementation Plan, commence in the time frame of 6-12 months of data reception in the centre.

It is recommended that MIAS be responsible for creating the total data set for long term archival in the WDC.

If this arrangement is acceptable, Hawaii and MIAS will be requested to jointly develop a statement for inclusion in the WOCE operational documents that describes for the WOCE community the products the centre will provide.

# ANNEX VII

## TEMA RELATED ACTIVITIES

The main objective of the Global Sea Level Observing System (GLOSS) is to establish an operational network of permanent sea level stations reporting monthly mean averages to the Permanent Service for Mean Sea Level (PSMSL) by 1990. Analyses of the data products derived from this unique source of data will demonstrate the important correlation between mean sea level and climatic change. The network will be the framework for regional and scientific programs such as the Tropical Ocean & Global Atmosphere (TOGA) programme and the World Ocean Circulation Experiment (WOCE).

The GLOSS Implementation Plan indicates the stations that will constitute the GLOSS network. Member States responsible for these stations have been requested, and in majority of the cases have already made a commitment, to establish fully qualified GLOSS stations. They have also expressed their commitment towards eventually establishing fully qualified GLOSS stations, where they do not already exist and to ensure that their operation and functioning are in accordance with the provisions of the plan.

The IOC through the Group of Experts on GLOSS and the Secretariat ensures regular review of the GLOSS development, implementation and co-ordination with other international programmes.

One of the elements of GLOSS is the provision of assistance and training for establishing and maintaining sea level stations and improving national sea level networks. Member states of IOC agreeing to participate in GLOSS are required to provide assistance to other Member States on a bilateral and multilateral basis. Assistance may also be provided by Member States through the IOC Voluntary Co-operation Programme thus enabling other Member States to participate in GLOSS. The IOC has emphasised that the GLOSS would require a strong TEMA Component (TEMA is a joint UNESCO-IOC activity dealing with Training, Education and Mutual Assistance). The TEMA activities related to GLOSS, which will be co-ordinated by IOC Secretariat and the UNESCO Division of Marine Sciences, include:

(i) provision of instruments and their spare parts (shown as (ia));

(ii) assistance with improved levelling of existing tide gauges;

(iii) assistance with installation of tide gauges;

(iv) assistance in training of technicians and sea level specialists;

(v) support for attendance at international seminars and meetings;

(vi) provision of documents related to GLOSS.

(vii) provision for the visit of a consultant

Questionnaires have been distributed to Member States requesting information of the status of their tide gauges and also enquiring whether assistance could be given to other countries or if assistance was required. Member States were requested to specify what assistance was available or required in terms of (i) to (vii) above.

This short report summarises the response to the questionnaires (for TEMA activities only) and reviews the progress which has been made in providing the support requested.

Assistance has been requested from about 30 countries including Argentina, Brazil, Cameroon, Chile, Columbia, Cuba, Ecuador, Ghana, Guinea, Hong Kong, India, Indonesia, Kenya, Jamaica, Madagascar, Mauritius, Mexico, Morocco, Mozambique, Nigeria, Oman, the Philippines, the Seychelles, Senegal, Sierra Leone, Sri Lanka, Tanzania, Thailand, Trinidad & Tobago, and Turkey. The table below indicates in which of the categories (i) to (vii) assistance is required.

| | (i) | (ia) | (ii) | (iii) | (iv) | (v) | (vi) | (vii) |
|---|---|---|---|---|---|---|---|---|
| Argentina | * | | | | * | * | * | |
| Brazil | * | | | | | | | |
| Cameroon | | | | | | | | |
| Chile | * | | | | | | | |
| Columbia | * | * | | * | * | * | * | * |
| Cuba | * | * | | * | | * | * | * |
| Ecuador | * | | | | * | * | * | * |
| Ghana | * | * | * | * | * | * | * | * |
| Guinea | * | | | * | * | * | * | |
| Hong Kong | | | | | * | | * | |
| India | * | * | | | * | * | * | |
| Indonesia | * | * | | | * | * | * | * |
| Kenya | * | * | | | * | | | |
| Madagascar | * | * | | | * | * | | |
| Mauritius | * | * | | | * | * | * | |
| Mexico | | | | | | | | |
| Morocco | * | | | * | * | * | * | * |
| Mozambique | * | * | | * | * | | * | |
| Nigeria | * | | | | * | | * | |
| Oman | | | | | * | | | * |
| Philippines | * | * | | | | | | |
| Seychelles | * | * | | | * | * | * | |
| Senegal | * | | | | * | | | |
| Sierra Leone | * | * | | * | * | * | | * |
| Sri Lanka | * | | | * | * | * | | * |
| Tanzania | * | | | * | * | * | * | |
| Thailand | * | | * | * | * | * | * | * |
| Trinidad & Tobago | * | * | | * | | * | * | |
| Turkey | | | | | * | | | |
| Viet Nam | * | * | | | * | | | |

In addition to the replies tabulated above, various specific needs were identified. Cuba required technical assistance for a study of long period waves which affect their monthly mean and annual levels. Indonesia, Sierra Leone, Mozambique and Trinidad & Tobago all have a requirement for Computer Software for data processing and analysis. Training is also required for automatic digital recorders - perhaps for use in conjunction with a PC. A need for documentation in Spanish was also identified. Viet Nam has produced a proposal for the installation/construction of a tide gauge at Qui Nhon and wishes to participate in the training course at to be held in Brest. IOC requested further details of the candidate to be trained and was investigating the possibility of Viet Nam receiving a tide gauge via the IOC/VCP. India would like GLOSS to develop in its country especially because it would provide input to TOGA and WOCE and because of the major importance to climate predictions (specifically in the case of erratic monsoons resulting in drought conditions in India and the monsoon regions of SE Asia).

So far, assistance has been offered by Australia, Canada, China, France, FRG, Portugal, Sweden, the UK, and the USA. Specifically, the following actions have taken place:

AUSTRALIA

Australia has provided assistance to ASEAN countries in setting up the sea level stations and training specialists from Indonesia, Malaysia, Philippines, Singapore and Thailand. In November 1986 a two week training programme was held in Singapore for tide gauge operators from the ASEAN region. Two trainees attended from each of the 5 ASEAN countries (Thailand, Malaysia, Singapore, Indonesia and Philippines). The course content included the design of a tide gauge installation, the installation and maintenance of tide gauges, datum control, the use of specialised software and data processing on IBM PCs. The course was planned and run by Prof. G. Lennon of Flinders University. He also ran a 1 year on the job training course in Adelaide for 7 personnel from the ASEAN region (two from Thailand and the Philippines and one each from Malaysia, Singapore and Indonesia). An additional member from both Malaysia and Indonesia joined the course for 4 months. The course covers all aspects of tide and sea level data processing, time-series analysis, frequency filtering, tidal analysis, prediction power spectral techniques, meteorological perturbations of sea level and sea level phenomena from absolute levels, through sea level trends, interannual and seasonal signals, tidal frequencies and non-linear tidal harmonics. Special attention is given to large scale ocean-atmosphere coupling and the significance of water exchange through the Indonesian Straits. A tide gauge has been installed at Pelebuhan Ratu by Australia.

CANADA

The technical expertise necessary for the development of tide gauge networks, tidal data bases and data dissemination exists in Canada. Providing the required funding support can be identified, it would be possible to make this expertise available to requesting countries by sponsoring the experts travel to the requesting countries, sponsoring the training of individuals from requesting countries in Canada, or sponsoring training seminars in Canada for large groups of personnel from requesting countries. The Canadians were considering pursuing the idea of a training seminar together with the UN Department of Technical Co-operation for Development, who might provide financial support. They were also considering ways to meet equipment requirements.

CHINA

The People's Republic of China has offered two pressure-type gauges and assistance in their installation, together with all the relevant documentation. This offer has been addressed through IOC to Somalia and Sri Lanka.

In 1984 the People's Republic of China organized a sea level training course attended by 12 specialists from Pakistan, Bangladesh, Sri Lanka, Malaysia, Papua New Guinea, the Philippines, the Democratic People's Republic of Korea, Kuwait, Arab Republic of Egypt, Algeria, Guinea and Sudan. China has indicated its willingness to organise a similar course in the future if financial support is provided by IOC.

FRANCE, FEDERAL REPUBLIC OF GERMANY

France has helped Brazil to install several pressure-type tide gauges (St. Peter & St. Paul Rocks, Natal, Fernando, Trinidade) but assistance and new technology is still required.

France has offered to organize sea level training course in 1989 for French speaking countries.

The Federal Republic of Germany has expressed its readiness to offer an expert mission of long duration (half a year) to developing countries at its expense to assist in the installation, reactivation or repair of tide gauges.

The Federal Republic of Germany and Sweden have combined their efforts to help Member States in the IOCEA region to set up 5-7 GLOSS stations. The highest priority is to be given to the following : Tema (Ghana), Nouadhibou (Mauritania), Lagos (Nigeria), Dakar (Senegal) and Aberdeen Point (Sierra Leone).

Mr. B. Sharinghausen (Federal Republic of Germany), in November 1988, visited Ghana, Mauritania, Nigeria, Senegal and Sierra Leone.

PORTUGAL

Portugal has established cooperation with Cape Verde, Mozambique and Sao Tome and Principe in the installation of GLOSS stations and the training of specialists.

A mission of experts to advise on setting up national GLOSS stations was organized in 1986 with IOC support to Mozambique. Two technicians from Mozambique attended courses at the Instituto Hidrografico in Lisbon, a "Specialisation Course in Hydrography" and 3 months on the job training in Cartography and Tides. A Portuguese Consultant visited Mozambique to visit sites at Maputo, Beira, Nacala, Ihla de Mocambique and Pemba, but air connections only allowed visits to Maputo and Pemba.

The Maputo site was not considered appropriate to GLOSS. It is at the mouth of a river, and the tides differ from the neighbouring ocean tides. The gauge, a Fuess 1941, is operational but needs new parts. However, if it is well maintained it does not need replacing. Local benchmarks are well located but new ones further from the harbour should be established. The local personnel are competent to run the gauge.

The Pemba site was appropriate to GLOSS but it may be necessary to move the gauge along the pier because of silting. The gauge, an OTT, was inoperative because it required spare parts. The operator was not available. Local bench marks were well located. Data from both sites could either be sent to the Mozambique Service of Navigation, Hydrography & Buoyage for processing if software could be provided to calculate the monthly means, or the data could be processed at the Instituto Hidrografica in Lisbon.

It was suggested that Nacala might be a good site - as it is an important commercial port. There is no precise levelling network in Mozambique.

UK

Since 1983, regular annual sea level training courses have been organized by the PSMSL (Bidston Observatory, UK), with the support of IOC. These have been attended by 26 trainees from Kenya, Mauritius (2), Tanzania (2), Madagascar, People's Republic of China (2), Columbia, Ecuador, Peru, Chile, Indonesia (2), Nigeria (2), Sierra Leone, Republic of Seychelles (2), Pakistan, Somalia, Sri Lanka, Cuba, Bangladesh, Ghana and Costa Rica.

U.S.A.

Almost 20 tide gauges have been installed in the Pacific and Indian Oceans with the help of the NOAA and the University of Hawaii. In 1986-87 locations included Mombasa (Kenya), Dar-es-Salaam (Tanzania), Port Louis (Mauritius), Rodrigues (Mauritius), Male (Maldives), Gan (Maldives), Diego Garcia (UK), Muscat (Oman), Padang (Indonesia), Bitung (Indonesia), Port Victoria (Seychelles), Mogadishu (Somalia), Agalega (Mauritius) and Fort Dauphin (Madagasgar). A tide gauge will be installed in Aldabra soon. The station at Diego Garcia, which was destroyed by a hurricane in November 1987, was rebuilt in March 1988.

The University of Hawaii, with support of NOAA, has expressed willingness to assist further countries of the Indian Ocean in setting up GLOSS stations (India, Indonesia, Madagascar, Seychelles, Somalia and Oman).

A network of sea level stations has been proposed for the IOCARIBE region including 19 GLOSS stations. These gauges are distributed so as to optimise information on geostrophic surface currents, coastal erosion, storm surges, pollutant trajectories and climatic change impact. For the regional project at least 40 stations are required - many are operational already, but approximately 12 new stations will need to be established. 5 gauges have been donated by NOAA to locations in the IOCARIBE region for the stations at Puerto Morelos (Mexico), Aruba (Netherland Antilles), Charlotteville (Tobago), Cop du Mole (Haiti) and Punta Maisi (Cuba).

Other US initiatives include developing technology for use in polar regions under hostile conditions and the exploration of training needs in the Indian Ocean - particularly the provision of hands on training. As the US network gauges are updated and mechanical gauges become available these will be made available to requesting countries. Additionally, the USA is willing to develop a management mechanism for the data and to assist with products.

SUMMARY

The Pacific Ocean Network is fairly complete and the Indian Ocean will be completed soon. Effort is currently being put into the Caribbean and the Central Eastern Atlantic. When this has been done the major region remaining requiring tide gauge installation is the Southern Ocean, which has its own unique set of problems. Perhaps effort is also required to install tide gauges in Greenland (although Denmark has not requested assistance) and to reactivate those at Alert and Sach's Bay (Arctic Canada).

Although many technicians have been trained, it is often only one person from each country. Technicians from the following countries have requested training but as yet have not received training - Argentina, Hong Kong, India, Morocco, Mozambique, Oman, Senegal, Turkey and Viet Nam. There are probably also others who have not replied to the questionnaires. Many of the countries requiring assistance have also requested the provision of documents, brochures and other written information on sea level measurement.

It should be notes that although assistance was offered with improved levelling, it has not been requested in many cases. This may be because the requesting countries have good levelling networks - or it may be that they have none at all.

ANNEX VIII

GLOSS WORK PLAN FOR 1989, 1990 AND 1991

| | Actions | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| 1. | Second session of the Group of Experts on GLOSS | | X. 1990 Miami | |
| 2. | Sea Level Training Courses | | | |
| | 2.1 UK, Bidston | | VI. 1990 UK, Bidston IX.1990 | VI.1991 UK, Bidston |
| | 2.2 France, Brest | | | |
| | 2.3 Cuba (IOCARIBE) | | | |
| 3. | Missions of Consultants, GLOSS Technical Secretary and GLOSS regional co-ordinator to visit GLOSS stations and advise member states on GLOSS implementation (in IOCARIBE, IOCEA, WESTPAC, IOCINDIO and South America, etc. | | 2-3 (3 - 7 weeks) | 2-3 (3 - 7 weeks) |
| 4. | Publication of the GLOSS Implementation Plan | | Jan-Feb | |
| 5. | Preparation and publication of GLOSS Handbook (under contract) | | VI. 1990 | |
| 6. | Preparation and publication of GLOSS Newsletter | | 2 issues | 2 issues |
| 7. | Preparation and Publication of GLOSS Brochure | | 1st half | |
| 8. | Participation of GLOSS experts in the meetings of TOGA, WOCE, IGBP and meetings of IOC Regional Bodies | IOCARIBE IOCEA (2 experts) | 3-7 experts | 3-7 experts |
| 9. | Updating of GLOSS Network | XII.1989 | XII.1990 | XII.1991 |
| 10. | Consider in cooperation with SCAR and IOCSOC the development of GLOSS in the Southern Ocean (experts, Consultants) | | | |
| 11. | Assist countries of the IOCEA region in installation of 5 GLOSS Stations (Sweden, FRG) Mauritania, Senegal, Sierra Leonne, Ghana, Nigeria. | XII.1989 | | |

ANNEX IX

LIST OF DOCUMENTS *

| Document Code | Title |
|---|---|
| **WORKING DOCUMENTS** | |
| IOC/GLOSS-I/1 prov. | Provisional Agenda |
| IOC/GLOSS-I/2 prov. | Annotated Provisional Agenda |
| IOC/GLOSS-I/3 | Summary Report of the Session |
| IOC/GLOSS-I/4 prov. | Provisional List of Documents |
| IOC/GLOSS-I/5 prov. | Provisional List of Participants |
| IOC/GLOSS-I/6 | Implementation Plan for the IGOSS Sea Level Pilot Project in the North and Tropical Atlantic |
| IOC/GLOSS-I/7 | TEMA activities relating to GLOSS |
| IOC/GLOSS-I/8 | Summary of Member States' Responses to GLOSS Questionnaire |
| IOC/GLOSS-I/9 | Sea Level Data Submission to PSMSL; Sea Level Data Submission to TOGA Sea Level Center/SOC for ISLP Pac. |
| IOC/GLOSS-I/10 | Report on the activities of the IAPSO Commission on Mean Sea-Level |
| IOC-XV/8 Annex 4 | Proposed GLOSS Implementation Plan |
| IOC Workshop Report No. 54 | Summary Report of the Workshop on Sea-Level Measurements in Hostile Conditions |
| IOC/GLOSS-I/11 | GLOSS gauge technical description (example) |
| IOC/GLOSS-I/12 | IOCARIBE Regional GLOSS network |
| IOC/GLOSS-I/12 | European Mean Sea-Level Studies |
| IOC/GLOSS-I/14 | GLOSS brochure (draft) |
| IOC-WMO/IGOSS-V/3 | Summary Report of the 5th Session of the IOC-WMO Committee for IGOSS |

* For reference only. No stocks of these documents are maintained.