Overview of the GLOSS System
(July 1996)
Overview of the GLOSS System
by
A. Tolkatchev (*), P.L. Woodworth (**) & L.J. Rickards (***)

July 1996
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to the Global Sea Level Observing System (GLOSS)</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>The GLOSS Station Handbook</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Status of the GLOSS Network as of October 1995</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Information about GLOSS Newsletters</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Contact points for International sea level programmes, projects and centres</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>Training activities within the Global Sea Level Observing System (GLOSS)</td>
<td>21</td>
</tr>
<tr>
<td>7</td>
<td>Publications Relevant to the PSMSL and GLOSS (Updated 15 May 1996)</td>
<td>25</td>
</tr>
</tbody>
</table>
Section 1. Introduction to the Global Sea Level Observing System (GLOSS)

The Intergovernmental Oceanographic Commission (IOC) was founded in 1960 within UNESCO. The Commission has functional autonomy within UNESCO and serves the members of the UN family in their implementation of joint programmes relating to ocean research and observations. 125 countries are Members of the Commission.

In 1985 IOC initiated the development of a Global Sea Level Observing System - an international system to provide high quality standardised sea level data from a global network of sea level stations. The measuring system has become known as GLOSS because it provides data for deriving the Global Level of the Sea Surface, a smooth level after averaging out waves, tides and short-period meteorological events. The GLOSS network has been designed to observe large-scale sea level variations of global implications, and stations were identified at intervals of approximately 1000 km along the continental coasts and on islands, but generally not closer than 500 km. In selecting individual sites, priority is given to gauges which have been functioning for a long period. All gauges are required to aim for an accuracy of 10 mm in level, and 1 minute in time. All must be linked to bench marks against which their datum is checked regularly.

This network monitors sea level changes which could be indicative of global warming, ocean circulation patterns, climate variability, etc., and contributes data to global climate research within the World Climate Research Programme (WCRP) including the Tropical Ocean-Global Atmosphere (TOGA) project, the World Ocean Circulation Experiment (WOCE), Climate Variability and Predictability (CLIVAR) and recent vertical crustal movements studies conducted by the International Union of Geodesy and Geophysics (IUGG) of the International Council of Scientific Unions (ICSU) and UNESCO (International Geological Correlation Programme (IGCP)). It also provides high quality data for practical applications of national importance. The measurements by GLOSS gauges complement satellite altimetry measurements. GLOSS is considered as an important potential element of the Global Ocean Observing System (GOOS) initiated by IOC in co-operation with the World Meteorological Organisation (WMO), the UN Environment Programme (UNEP) and ICSU.

The elements of GLOSS are:

- A global network of permanent sea level stations to obtain standardised sea level observations; this forms the primary network to which regional and national sea level networks can be related;
- Data collection for international exchange with unified formats and standard procedures which includes both near-real-time as well as delayed mode data collection;
- Data analysis and product preparation for scientific and/or practical applications;
- Assistance and training for establishing and maintaining sea level stations as part of GLOSS and improving national sea level networks;
- A selected set of GLOSS tide-gauge bench marks accurately connected to a global geodetic reference system (i.e., the conventional terrestrial frame established by the International Earth Rotation Service).
The Permanent Service for Mean Sea Level (PSMSL) collects and archives data from GLOSS stations in the form of monthly mean values, but hourly and daily values are also expected to be made available from all stations by the originators. The GLOSS network consists of 308 sea level stations (Figure 1) which are operated and maintained by 87 countries.

The Implementation Plan for GLOSS (IOC Technical series No. 35, 1990) provides details regarding the GLOSS structure and implementation. Member States participating in GLOSS have designated national GLOSS contacts. Regional GLOSS co-ordinators have been designated for some IOC regional bodies, in particular for the Caribbean & Adjacent Regions (IOCARIBE), the Central East Atlantic (IOCEA) and the North & Central Western Indian Ocean (IOCINCWIO). The IOC Group of Experts on GLOSS provides advice to IOC on the implementation of GLOSS. International co-ordination of GLOSS is carried out by the GLOSS Technical Secretary at the IOC Secretariat (UNESCO, Paris, France).

Since the initiation of GLOSS almost 70 specialists have been trained in sea level measurements, interpretation and analysis at IOC sea-level training courses/workshops organised and hosted by Brazil, China, France, India and United Kingdom. Further details of the training courses which have been held are given in Section 6. The Manual on Sea Level Measurement and Interpretation (IOC Manuals and Guides No. 14, Volumes I and II) provides recommended procedural guides for sea-level measurements, their analysis and for assisting those Member States who wish to install or reactivate their sea-level stations.

A number of regional sea-level programmes closely associated with GLOSS has been launched or planned in the Pacific and Indian Oceans, the Southern Ocean, North and Tropical Atlantic, the Caribbean and Adjacent Seas, and the Mediterranean. Contact points for these and other international projects, programmes and centres are given in Section 5.

One such international programme which is making major efforts to collect sea level data (typically hourly values) is WOCE. This is in order to provide an in-situ data set, primarily for comparison with and validation of sea level data obtained from satellite radar altimetry. The collection of sites designated as the WOCE tide gauge network is comprised mostly of GLOSS island sites and pairs of gauges across straits and totals about 100 stations.

There are two WOCE Sea Level Data Assembly Centres. The first is at the University of Hawaii alongside the TOGA Sea Level Centre. This is the so-called ‘fast centre’ and is charged with the provision of as fully controlled as possible a WOCE sea level dataset within a timescale similar to that of altimeter data availability (i.e. several months). The second is at the British Oceanographic Data Centre (BODC) at Bidston Observatory alongside the PSMSL. This is the so-called ‘delayed-mode’ centre and is charged with the provision of the fully quality controlled and complete WOCE sea level dataset within 12-18 months of data availability.

Data are made available from both centres via both the World Wide Web and ftp, as follows:

For the ‘fast centre’ the URL for access via the Web is:

http://www.soest.hawaii.edu/kilonsky/uhslc.html

and the ftp site is: kia.soest.hawaii.edu

(choose the directory ‘woce’ and read the README)
Figure 1
The GLOSS tide gauge network
(1993 definition)
For the ‘delayed-mode centre’ the URL for access via the Web is:

http://www.nbi.ac.uk/bodc/woce/dmsldac.html

and the ftp site is bisag.nbi.ac.uk

(choose the directory ‘pub/woce/wocesl’ and read the WOCESL.readme)

As part of the GLOSS programme, the GLOSS Station Handbook, a comprehensive database of information about GLOSS stations, has been compiled. The GLOSS Station Handbook includes detailed information about the approximately 300 sea level sites in the GLOSS network. The Handbook serves as a resource for other projects and programmes in addition to those of GLOSS. A full description of each gauge in the network is provided including tide gauge details, benchmark information, data delivery systems and the GLOSS national contact point. This is described in more detail in the next section.
Section 2. The GLOSS Station Handbook

The GLOSS Station Handbook comprises a comprehensive database of information about GLOSS sea level stations. The Handbook serves as an information resource for other projects and programmes such as WOCE, TOGA and IGBP and, in addition, will provide essential information for GLOSS itself. A full description of each gauge in the network is provided including tide gauge details, benchmark information, data delivery systems and the GLOSS national contact point. The Handbook on this CD-ROM contains GLOSS Station Information for the 308 stations of the GLOSS network (GLOSS93 definition). The information has been compiled with the kind co-operation of national and international GLOSS Contacts in IOC Member States. It is intended to continuously update and amend the master copy of the database and to issue updates at 1-2 year intervals. Any inaccuracies, omissions or amendments to the information contained in the database should be sent to the GLOSS Handbook Co-ordinator at the PSMSL.

At the first meeting of the IOC Group of Experts on GLOSS, held in June 1989, it was agreed, at the suggestion of the PSMSL, to produce a handbook of information about GLOSS tide gauge stations. The Station Handbook comprises several pages devoted to each GLOSS station, and where available, mean sea level plots of the data held by PSMSL will be included. Each entry also includes location maps, on various scales firstly showing the position of the tide gauge within the country, and then larger scale maps and diagrams showing major roads, the tide gauge site and tide gauge benchmarks.

At this stage much information had already been compiled by IOC prior to the production of the GLOSS Implementation Plan. This was supplied mainly by the GLOSS National Contacts. The next stage of the process was to draw up a Station Information Sheet including all the information that was needed for the database.

The first section covers the name and location of the gauge including ocean and local time meridian. In addition to the country or territory where the gauge is situated, the country responsible for the tide gauge is given. This is because some countries, notably the USA, operate gauges on behalf of others. One or two national contacts are given for each gauge - usually these contacts will provide the primary link for the country in question - and any queries about the gauges or the data should, in the first instance, be directed to that person. However, in addition, the name and address of the authority responsible for the operation of the gauge is listed.

The second section of the Station Information Sheet is given over to details of the tide gauge. For example, the type of gauge - whether it is a float and stilling well, a pressure gauge or an acoustic gauge and if more than one gauge is operating at the site. In addition to the gauge type, the periods during which measurements have been recorded are noted. The method of data transmission is also included in this section, for example, whether the data are transmitted by satellite, or if any other near-real-time data transmission is available. This will be useful for planning new projects; tide gauges in strategic locations can then be upgraded to real-time transmission as required. The rate of data acquisition from the tide gauge (i.e. hourly, 15 minute interval, 6 minute interval) and the availability of the data in computer compatible form is noted - some gauges record on charts which subsequently require digitisation. Also included in this section are other parameters recorded at the site (for example, barometric pressure, sea temperature, etc.) and the nearest meteorological station to the tide gauge.
The third section relates to the PSMSL and includes the PSMSL code (for tide gauges where data have been sent to PSMSL) and the periods for which the PSMSL hold monthly and annual mean sea level values. Where these data have been reduced to PSMSL’s Revised Local Reference (RLR), they can be plotted on screen. The PSMSL have compared the periods of observation with their data holdings and are actively seeking out missing data. The method used to determine mean sea level (for example, arithmetic mean, Doodson X0 filter, etc.) is also included. If the data have been sent to national or project (for example, TOGA or WOCE) data centres, the volumes of data and their location are given. If the GLOSS station is participating in other international projects, this is also indicated.

The next section of the Station Information Sheet provides details of the local benchmarks. It is essential to link the recorded tidal levels to a benchmark, they are of little value without this. The benchmark in turn needs to be related to the National Datum. A description of the Tide Gauge Benchmark is given together with benchmark relationships - for example, Tide Gauge Zero relative to Admiralty Chart Datum, Tide Gauge Zero to the Tide Gauge Benchmark. Where possible the dates for these relations should be included. Details of auxiliary benchmarks, a guard against the movement or destruction of the main Tide Gauge Benchmark, are also requested. (If there is insufficient space in the appropriate section of the form, the information can be included in the 'Other relevant information' section.) In the future, the PSMSL intend to databank the geocentric co-ordinates of tide gauge benchmarks, primarily from Global Positioning System (GPS) and Very Long Baseline Interferometry (VLBI) measurements, hence information on geocentric measurement is included and the nearest IERS 'Fundamental Point' is listed if it is within 1000km of the tide gauge.

Extra space is also provided for the inclusion of any other additional relevant information, for example, other tide gauges at the site - either now or in the past, data transmission methods, problems associated with the gauge or site, reasons why gauge is out of action or when a gauge is likely to be installed.

Where possible, tide gauge location maps have been compiled for inclusion in the Handbook. At this stage location maps from approximately 100 sites have been electronically scanned and stored and are accessible via the GLOSS Station Handbook software. Maps from other sites are available, but at present they are only available in hardcopy. Ideally three maps should accompany each GLOSS Station Information Sheet; the first showing the approximate position of the gauge in the country, and the second and third showing major roads and towns and the location of the tide gauge, the tide gauge benchmark and auxiliary benchmarks.

The GLOSS Station Handbook together with software to search and select information from the Handbook is included on the CD-ROM. If further information is required this can be requested from the IOC Secretariat.

2.1 How to use the GLOSS Station Handbook (Windows version)

To start running the GLOSS Station Handbook software, click on the Handbook icon. This brings you to the main index of GLOSS Stations. This index can be browsed; individual stations can be marked in order to view detailed information about the station on the screen, or sent to a printer. In addition, where RLR monthly and annual sea level data are held by PSMSL, these may be plotted on screen or sent to a printer. For approximately 100 stations, maps are also available showing the location of the gauge and benchmarks. These can be displayed and sent to a printer. Selection of stations can also be made via a world map.
The following options are available from the GLOSS Station Index page:

Individual stations can be selected using the left mouse button. To select more than one station from the index page, use ctrl and the left mouse button. To select a series of stations, use the shift key and the left mouse button.

**File:**

Options are available for setting up and saving setup information, printing the index information and exiting from the software package.

**View:**

This is used to change the index information displayed on the screen. Click on the list items to switch the information on or off. Note that either Country/Territory or Responsible Country can be displayed.

**Search/Sort:**

Various options are available for searching and selecting the tide gauge stations of interest. These are as follows:

- **World Map:** A world map is displayed showing the GLOSS Stations. Further details are given in the map section below.
- **Number of Stations:** This will re-order the GLOSS Station Index into ascending numerical order using the GLOSS Station Number.
- **Station Name:** This will re-order the GLOSS Station Index alphabetically, using the GLOSS Station Name.
- **Country/Territory:** This option re-orders the GLOSS Station Index alphabetically, by the Country/Territory. The Country/Territory refers to the country or territory in which the tide gauge is located. This may differ from the country responsible for the operation and maintenance of the gauge.
- **Latitude & Longitude:** This allows sorting of the GLOSS Station Index by Latitude and Longitude. Several options are available; these are Latitude, Longitude, 1 degree square, 5 degree square and 10 degree square.
- **Ocean:** This will re-order the GLOSS Station Index alphabetically, by Ocean.
- **Responsible Country:** This option re-orders the GLOSS Station Index alphabetically, by the Responsible Country. The responsible country is the country responsible for the maintenance of the tide gauge, and may not be the same as the country/territory in which the gauge is situated.
- **Select All:** This option allows selection of all of the GLOSS Stations in the index.
Geographic Area: This option allows the user to specify a rectangular geographic area to be searched. The index entries for any GLOSS Stations located within that area are automatically selected.

Show:
This option shows on-screen the detailed information about each GLOSS Station, the plots of monthly and annual mean sea level and the location site maps.

The following options are available from the World Map page to allow site selection:

Select Site:
Individual stations can be selected/deselected by clicking near the required site(s).

Select Area:
This option allows stations in an area to be selected/deselected. Click on Select area; then click at the top left of the required area and drag the cursor to the required bottom right corner of the box; click again.

Clear Selection:
Clears the current selection of stations.

Note: Clicking on the right mouse button on a tide gauge site will display the site name.

The following options are available after selecting Show. These allow the Station Information Sheets (Info), Mean Sea Level Plots (Plot) and Site Location Maps (Map) to be displayed on screen. Click on Info, Plot or Map to bring that information to the top.

Info:
- **File:** Options are available for setting up and saving setup information, printing and returning to the index page.
- **First:** Moves to the first of the selected stations.
- **Previous:** Returns to the immediately preceding selected station.
- **Next:** Moves on to the next of the selected stations.
- **Last:** Moves to the last of the selected stations.

Plot:
- **File:** Options are available for setting up and saving setup information, printing and returning to the index page.
- **First:** Moves to the first of the selected stations.
- **Previous:** Returns to the immediately preceding selected station.
- **Next:** Moves on to the next of the selected stations.
Last: Moves to the last of the selected stations.

Plot: Allows the selection of monthly or annual (or both) RLR mean sea level data, where these are held by PSMSL. Note: Where more than one data series is available from a station, information indicating the number of series is given towards the top left of the screen. Clicking with the mouse will move between series. In addition, it is possible to choose the colours that that are used for plotting the data, the axes, the background and the title. There is also a black and white option for printing. Some grey scale printers will attempt to use dithering for output. Since only lines are being drawn, this may not be required and a better result will be obtained by printing in black and white.

Map:

File: Options are available for setting up and saving setup information, printing and returning to the index page.

First: Moves to the first of the selected stations.

Previous: Returns to the immediately preceding selected station.

Next: Moves on to the next of the selected stations.

Last: Moves to the last of the selected stations.

Zoom: Allows zooming in/out of site location map.

Note: Where more than one map is available for a tide gauge site, information indicating the number of maps is given towards the top left of the screen. Clicking with the mouse will move between maps.
Section 3. Status of the GLOSS Network as of October 1995

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

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

Category 1: 'Operational' stations for which the latest data is 1991 or later;

Category 2: 'Probably operational' stations for which the latest data is within the period 1981-90;

Category 3: 'Historical' stations for which the latest data is earlier than 1981;

Category 4: For which no PSMSL data exist.

Table 1 lists the number of stations which fall into each category for all stations, then for the subset which have been ‘committed to GLOSS’. (‘Committed to GLOSS’ means that formal commitments have been made by national authorities to IOC to keep gauges operational). Also shown are the numbers in each category reported at previous GLOSS meetings with the category definitions adjusted backwards one, two, three etc. years appropriately.

Note that before 1993 we used the 'GLOSS90' definition of GLOSS (306 stations total), whereas 1993 onwards we have used 'GLOSS93' (308 stations total). However, PSMSL does not believe that this modifies the statistics to a great extent.

It can be seen that, following the gradual improvements in the number of Category 1 stations for many years, this year saw a decline which is very disappointing. This can be traced largely to the fact that for several countries with large numbers of GLOSS stations, the latest data available is from 1990. Consequently, those stations have been Category 1 for the last couple of years but have now fallen into Category 2. The two main countries in this set are Australia and Indonesia.

This reversal is so large as to hide definite progress in other areas. For example, several stations have moved from Category 4 into 1 (e.g. South African stations), as can be seen from the number of Category 4's dropping to 59 from 64. This is partly a consequence of the on-going installation of new gauges as part of GLOSS, WOCE etc. The number of Category 3's has also been reduced. The overall result is that there is now a vast number of Category 2 stations (more than there ever been, about a third of the number of Category 1 stations), which implies that there is a lot of data out there which is not finding its way into the data banks.

Note that GLOSS will again be redefined slightly in 1996, removing from the official list some stations which are unlikely ever to be installed.
Table 1

Number of Stations in Each Category (All Stations)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>105</td>
<td>133</td>
<td>136</td>
<td>158</td>
<td>177</td>
</tr>
<tr>
<td>2</td>
<td>51</td>
<td>50</td>
<td>57</td>
<td>46</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
<td>42</td>
<td>36</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>103</td>
<td>81</td>
<td>77</td>
<td>73</td>
<td>72</td>
</tr>
<tr>
<td>Total</td>
<td>306</td>
<td>306</td>
<td>306</td>
<td>306</td>
<td>308</td>
</tr>
</tbody>
</table>

Number of Stations in Each Category (Committed to GLOSS)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>98</td>
<td>122</td>
<td>118</td>
<td>135</td>
<td>151</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
<td>40</td>
<td>47</td>
<td>38</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>25</td>
<td>21</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>44</td>
<td>28</td>
<td>29</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>215</td>
<td>215</td>
<td>215</td>
<td>217</td>
</tr>
<tr>
<td>using 'GLOSS Definition'</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>93</td>
</tr>
</tbody>
</table>

A full breakdown of the status of each of the 308 GLOSS gauges is available from the PSMSL.
Section 4. Information about GLOSS Newsletters

The following GLOSS newsletters are available:

- "Afro-America GLOSS News" published approximately twice a year on paper. For copies contact:
  
  Prof. A.R. De Mesquita  
  Instituto Oceanografico Da Universidade De Sao Paulo  
  Cidade Universataria Butanta  
  05508 Sao Paulo S.P.  
  Brazil  
  E-mail: ardmesqu@fox.cce.usp.br


The contents list for the first three editions of the GLOSS Bulletin are given below:

GLOSS Bulletin

Newsletter of the Global Sea Level Community - edited by PSMSL

Contents of Issue 3 (April 1996)

- Editorial

GLOSS Reports

- GLOSS-GOOS Sea Level Training Course at Dehra Dun (Satish Shetye)
- The Malaysian Sea Level Monitoring Network (Teh Seng Hoe)
- The MedGLOSS Proposal (Aldo Drago and Dov Rosen)
- New Director of the Univ. of Hawaii Sea Level Center (Mark Merrifield)

Climate and Global Sea Level Change

- IPCC Second Scientific Assessment: Chapter 7 Summary (Dick Warrick et. al.)
- Global Sea Rise: a Redetermination (Bruce Douglas)

GPS and Absolute Gravity

- PSMSL/IGS Joint Letter (Ruth Neilan and Philip Woodworth)
- Absolute Gravity Research at POL (Bob Edge et al.)

The Southern Ocean

- The Southern Ocean Sea Level Centre (Marion Tait)
- Sea Surface Height Variations of the Antarctic Circumpolar Wave (Gregg Jacobs)

Ocean Tides

- The IAPSO Compilation of Pelagic Tidal Constants (Mike Smithson)
- Tidal Science 1996 Meeting Announcement (Richard Ray et al.)

Software News

- The MeteOcean Info Software System ISRAMAR (Dov Rosen and Isaac Gertman)
Contents of Issue 2 (October 1995)

- Editorial

Software News

- The EDTEVA Data Processing Package (Steve Loch)

Hardware News

- Precise Datum Control for Pressure Tide Gauges (Philip Woodworth et al.)

GLOSS Status News

- GLOSS Status October 1995 (Philip Woodworth)

News of Regional Projects

- IOC-UNEP-WMO Indian Ocean Pilot Project (Satish Shetye)
- The Australian Antarctic and Southern Ocean Sea Level Network (Rupert Summerson)

News of Particular Sites

- A King Makes His Mark (Bjorn Engen and David Pugh)

News of Scientific Analyses

- The EUROGAUGE Project (Richard Bingley et al.)
- Temporal Variability of the Transport Through Drake Passage (Mike Meredith et al.)
- Tide Poles for TOPEX (Gary Mitchum)

News of Sea Level Working Groups

- Caspian Sea-Level Rise: An Environmental Emergency (Albert Tolkatchev)
- Report on the Second LOICZ Open Science Meeting (Bill Carter)

News of Ocean Tide Working Groups

- Recommendation of TOPEX/POSEIDON Ocean Tide Model (Philip Woodworth, C.K. Shum and Christian Le Provost) This note summarises the present status of global tide models derived from TOPEX/POSEIDON and gives recommendations on which ones are "best" as of May 1995.

Meeting Reports

- Report of the Boulder IUGG Conference (David Pugh)
- Report of the Hawaii IAPSO Conference (Afranio Rubens de Mesquita)

Upcoming Meetings

- Miami Sea Level Workshop November 15-17 1995
Contents of Issue 1 (April 1995)

- Editorial

Hardware News
- NOAA's Next Generation Tide Gauges (Steve Gill)

Software News
- Sea Level Processing Software (Pat Caldwell)

GLOSS Status News
- GLOSS Station Status and Handbook Update (Lesley Rickards)
- Report of the Bordeaux Meeting of GLOSS Experts (Albert Tolkatchev)
- New Southern Ocean Sea Level Centre (Bill Mitchell)

News of Regional Projects
- SELF Project in the Mediterranean (Susanna Zerbini)

News of Particular Sites
- Sea Level Observations at Syowa Station, Antarctica (Minoru Odamaki and Katsuziro Oka)
- Gauges Needed in West Africa (Larry Awosika)

News of Scientific Analyses
- Wind Forcing of Sea Level in the North Atlantic: Comparison at Bermuda (Tony Sturges and B.G. Hong)
- The Anomalous North Sea Pole Tide Revisited (Mickey Tsimplis)
- Satellite Altimeter Calibration using Tide Gauge Data and Local Models (Chris Murphy)

News of Sea Level Working Groups
- Report of the IAPSO Surrey Meeting on Tide Gauge Bench Mark Fixing (Bill Carter)
- Status of the Sea Level Part of the IPCC 1995 Scientific Assessment (Philip Woodworth)

News of Ocean Tide Working Groups
- Interim Recommendation of TOPEX/POSEIDON Ocean Tide Model (Philip Woodworth, C.K. Shum and Christian Le Provost) This report summarises the present status of tide models derived from the TOPEX/POSEIDON project and gives recommendations on which ones are "best" as of February 1995.

Debating Points
- Tide Gauges vs. Altimetry

Upcoming Meetings
- Sea Level and Ice as Geophysical Indicators 10-11 July 1995
- Ocean and Atmosphere Pacific 23-27 October 1995
Section 5. Contact points for International sea level programmes, projects and centres

1. The Permanent Service for Mean Sea Level (PSMSL)
   Dr. Philip Woodworth, Director, PSMSL,
   Proudman Oceanographic Laboratory,
   Bidston Observatory, Birkenhead,
   Merseyside L43 7RA,
   UNITED KINGDOM.
   Tel: (+44) (151) 653 86 33
   Fax: (+44) (151) 653 62 69
   E-mail: plw@pol.ac.uk

2. Tropical Ocean and Global Atmosphere (TOGA) Programme Sea Level Centre (TSLC)
   Dr. Mark Merrifield, Director, UH Sea Level Centre,
   University of Hawaii, 1000 Pope Road, MSB 307,
   Honolulu, Hawaii 96822-2336,
   UNITED STATES OF AMERICA.
   Tel: (+1) 808 956 61 61
   Fax: (+1) 808 956 23 52
   E-mail: markm@soest.hawaii.edu

3. World Ocean Circulation Experiment (WOCE)

3.1 WOCE Sea Level Data Assembly Centre - Fast Delivery Centre (WOCE-DAC)
   Dr. Mark Merrifield, UH Sea Level Centre,
   University of Hawaii, 1000 Pope Road, MSB 307,
   Honolulu, Hawaii 96822-2336,
   UNITED STATES OF AMERICA.
   Tel: (+1) 808 956 61 61
   Fax: (+1) 808 956 23 52
   E-mail: markm@soest.hawaii.edu

3.2 WOCE Sea Level Data Assembly Centre - Delayed Mode Delivery (WOCE-DAC)
   Dr. Lesley Rickards, British Oceanographic Data Centre,
   Proudman Oceanographic Laboratory,
   Bidston Observatory, Birkenhead,
   Merseyside L43 7RA,
   UNITED KINGDOM.
   Tel: (+44) (151) 653 86 33
   Fax: (+44) (151) 652 39 50
   E-mail: ljr@pol.ac.uk
4. IGOSS Sea-Level Programme in the Pacific (ISLP-Pac) Specialised Oceanographic Centre (SOC) for Mean Sea Level in the Pacific

Dr. Mark A. Merrifield and Mr. Bernard J. Kilonsky,
Department of Oceanography,
University of Hawaii at Manoa,
1000 Pope Road, MSB 307,
Honolulu, Hawaii 96822-2336,
UNITED STATES OF AMERICA.
Tel: (+1) 808 956 61 61
Fax: (+1) 808 956 23 52
E-mail: markm@soest.hawaii.edu

5. IGOSS Sea-Level Pilot Project in the North and Tropical Atlantic (ISLPP-NTA) Specialised Oceanographic Centre for ISLPP-NTA

Mr. Andre Bolduc,
MEDS, Dept. of Fisheries & Oceans,
12th Floor, 200 Kent Street,
Ottawa, Ontario K1A OE6,
CANADA
Tel: (+1) 613 990 02 31
Fax: (+1) 613 990 55 10
E-mail: bolduc@ottmed.meds.dfo.ca

6. Sea-Level Pilot Project for the Southern Ocean (SLP-SO)

Ms Marion Tait,
Southern Ocean Analysis Assistant,
National Tidal Facility,
The Flinders University of South Australia,
GPO Box 2100, Adelaide,
South Australia 5001,
AUSTRALIA.
Tel: (+61 8) 201 7532
Fax: (+61 8) 201 7523
E-mail: marion@pacific.ntf.flinders.edu.au

7. Pilot Monitoring Activity on Sea Level Changes and Associated Coastal Impacts in the Indian Ocean (SLP-IO)

Dr. Satish Shetye, Project Co-ordinator,
Physical Oceanography Division,
National Institute of Oceanography (NIO),
Dona Paula, Goa 403-004,
INDIA.
Tel: (+91)(832) 22 62 53-56 ext. 224/310
Tlx: 194-216 NIO IN or 194-316 MGG IN
Fax: (+91)(832) 22 33 40/1360
E-mail: shetye@bcgoa.ernet.in or shetye@csnio.ren.nic.in
8. European Primary Tide Gauge Network Proposal-"EuroGLOSS"

Dr. Philip Woodworth, Director, PSMSL,
Proudman Oceanographic Laboratory,
Bidston Observatory, Birkenhead,
Merseyside L43 7RA,
UNITED KINGDOM.
Tel: (+44) (151) 653 86 33
Fax: (+44) (151) 653 62 69
E-mail: plw@pol.ac.uk


Dr. Dov Rosen, Project Co-ordinator,
Israel Oceanographic and Limnological Research Ltd.(IOLR),
Tel Shikmona-P.O.Box 8030,
Haifa,
ISRAEL.
Tel: (+972) 485 15202
Fax: (+972) 485 11911
E-mail: rosen@ocean.org.il

Prof. Frederic Briand,
Commission Internationale Pour L'Exploration Scientifique
de la Mer Mediterranee (CIESM),
16, Bd.de Suisse,
MC 98000,
MONACO.
Tel: (+33) 93 30 38 79
Fax: (+33) 92 16 11 95
E-mail: ciesm@unice.fr

10. South Pacific Sea Level and Climate Monitoring Project

Project Co-ordinator,
National Tidal Facility,
The Flinders University of South Australia,
GPO Box 2100,
Adelaide 5001,
AUSTRALIA.
Tel: (+61 8) 201 7611
Fax: (+61 8) 201 7523
E-mail: mota@flinders.edu.au
11. Height Investigations to Broaden Information both on mean Sea Level Changes and Understanding of Surface vertical movements in the Caribbean and adjacent regions (HIBISCUS Project)

Prof. Susanna Zerbini,
Dipartimento di Fisica,
Settore di Geofisica,
Università degli Studi di Bologna,
Viale C. Berti Pichat, 8, 40127 Bologna,
ITALY.
Tel: (+39) 51 630 50 01
Fax: (+39) 51 25 01 06
Tlx: 520634 INFNBO I
E-mail: zerbini@astbol.bo.cnr.it

12. IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE)
GLOSS Regional Co-ordinator for IOCARIBE

Prof. George Maul, Director,
Division of Marine and Environmental Systems,
Florida Institute of Technology,
150 West University Boulevard,
Melbourne, Florida 32901-6988,
UNITED STATES OF AMERICA.
Tel: (+1) 407-768-8000
Fax: (+1) 407-984-8461
E-Mail: gmaul@pelican.marine.fit.edu

13. IOC Regional Committee for the Central Eastern Atlantic (IOCEA)
GLOSS Regional Co-ordinator for IOCEA

Dr. Larry Awosika,
Nigerian Institute for Oceanography & Marine Research (NIOMR),
Federal Ministry of Agriculture & Natural Resources Development,
P.M.B. 12729 Victoria Island, Lagos,
NIGERIA.
Tel: (+234) (1) 61 95 17
Fax: (+234) (1) 61 95 17
Tlx: OCEANOGRAF

14. IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean (IOCINCWIO) - GLOSS Regional Co-ordinator for IOCINCWIO

Mr. Mike O. Odido,
Kenya Marine & Fisheries Research Institute (KMFRI),
P.O. Box 81651, Mombasa,
KENYA.
Tel: (+254)(11) 47 55 70 74
Fax: (+254)(11) 47 22 15
Tlx: 21151 PUBLIC MBSA Attn:KMFRI
E-mail: sngete@main.bib.uia.ac.be
15. Sea Level Fluctuations: Geophysical Interpretation and Environmental Impact project-SELF Project (The Mediterranean and Black Seas)

Prof. Susanna Zerbini,
Dipartimento di Fisica,
Settore di Geofisica,
Universita Delgli Studi di Bologna,
Viale C.Berti Pichat, 8, 40127 Bologna,
ITALY.
Tel: (+39) 51 630 50 01
Fax: (+39) 51 25 01 06
Tlx: 520634 INFNBO I
E-mail: zerbini@astbo1.bo.cnr.it

16. Intergovernmental Oceanographic Commission (IOC)

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

Chairman,
Dr. Philip Woodworth,
(address as 1. above)

16.2 GLOSS Technical Secretary

Dr. A. Tolkatchev,
Intergovernmental Oceanographic,
Commission (IOC), UNESCO,
1 rue Miollis, 75732 Paris Cedex 15,
FRANCE.
Tel: (+33) (1) 45 68 39 78
Fax: (+33) (1) 40 56 93 16
E-mail: a.tolkatchev@unesco.org

17. International Hydrographic Organization (IHO)

Mr. Hans-Peter Rohde - Professional Assistant (Hydrography),
International Hydrographic Bureau,
7, Avenue President J.F. Kennedy,
MC-98011 Monaco Cedex,
PRINCIPALITY OF MONACO.
Tel: (+33) 93 50 65 87
Fax: (+33) 93 25 20 03
Internet: ihb@unice.fr

Tidal Constituent Bank,
Canadian Hydrographic Service,
615 Booth Street,
Ottawa, Ontario,
CANADA K1A OE6
Tel: (+1) 613 995 44 13
Fax: (+1) 613 996 90 53
18. International Association for the Physical Sciences of the Ocean (IAPSO) of the International Union of Geodesy and Geophysics (IUGG of ICSU) Commission on Sea-Level and Tides

Dr. Christian Le Provost,
Directeur de Recherche,
Insitut de Mecanique de Grenoble,
B.P. S3X,
38402 St. Martin d'Heres Cedex,
FRANCE.
Tel: (+33) 76 82 50 65
Fax: (+33) 76 82 50 01 or 76 82 52 71
E-mail: clp@img.fr

19. Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee (CIESM)

Prof. Frederic Briand, Director General,
16, Bd de Suisse,
MC 98000,
MONACO.
Tel: (+33) 93 30 38 79
Fax: (+33) 92 16 11 95
E-mail: ciesm@unice.fr

20. Scientific Committee on Oceanic Research (SCOR of ICSU) Working Group on Sea Levels and Erosion of the World's Coastline

Prof. P.D. Komar, Chairman,
College of Oceanography,
Oregon State University,
Oceanography Administration,
Building 104,
Corvallis, OR 97331-5503,
UNITED STATES OF AMERICA.

21. International GPS Service for Geodynamics (IGS)

IGS Central Bureau,
Director: Mrs. Ruth E. Neilan,
Jet Propulsion Laboratory,
4800 Oak Grove Drive,
Pasadena, CA 91109,
UNITED STATES OF AMERICA.
Tel: (+1) 818 354 83 30
Fax: (+1) 818 393 66 86
E-mail: igscb@igscb.jpl.nasa.gov
Section 6. Training activities within the Global Sea Level Observing System (GLOSS)

The GLOSS is implemented by Member States which have accepted certain responsibility for maintenance of GLOSS stations, their proper operation according to international standards and for provision of high quality data for international exchange. The success of GLOSS depends on the enthusiasm and expertise of the people responsible for the operation and maintenance of each GLOSS gauge, and for the reduction of data and supply of mean sea levels to the data centres. The role of training is crucial, in order to instil and maintain common, high standards throughout the GLOSS network.

Training in sea-level interpretation and analysis is also of great importance for specialists to enable them to use fully and efficiently data resulting from GLOSS for national scientific and practical applications, for independent assessment of sea-level data and likely impact.

Up to 1995, training courses have been held with the co-ordination and support of IOC in Brazil (1993), France (1990), the People's Republic of China (1984), the United Kingdom, 9 courses (1983-1991) and India (1995). Almost 70 specialists from countries of Africa, Central and South America and Asia have been trained in tide gauge installation, operation, maintenance, sea level data reduction and data interpretation and analysis. Many of them are actively involved in GLOSS activities in their countries.

IOC Training courses 1983 - 1995

First Sea-Level Training Course, Bidston Observatory, UK; 12 - 30 September 1983
1. Mr. M.O. Odido, Kenya Marine & Fisheries Research Institute, Mombasa, Kenya
2. Mr. S. Ragoonaden, Meteorological Services Headquarters, Vacoas, Mauritius

Second Sea-Level Training Course, Bidston Observatory, UK; 25 June - 13 July 1984
1. Mr. A.T. Shannugan, Tanzania Harbours Authority, Dar-es-Salaam, Tanzania
2. Mr. R.M.L. Ranaivoson, Centre National de Recherches Oceanographiques (CNRO), Nosy-Be, Madagascar
3. Mr. Soorramania, Meteorological Services Headquarters, Vacoas, Mauritius
4. Mr. Zhao Xucai, Institute of Marine Scientific & Technological Information, National Bureau of Oceanography, Tianjin, China
5. Mr. Wang Ji (the same address as 4), China

Sea-Level Training Seminar, National Bureau of Oceanography, Tianjin, China; 23 August - 27 September 1984

Trainees:
1. Mr. Arshad Ali, National Institute of Oceanography, Karachi, Pakistan
2. Mr. Ali Ahmed, Bangladesh Meteorological Department, Dhaka, Bangladesh
3. Mr. P.V. Wijayaratna, Department of Coast Conservation, Colombo, Sri Lanka
4. Mr. Chongyan Lee, Universiti Sains Malaysia, Penang, Malaysia
5. Mr. Pekou Chakumai, Department of Transport & Civil Aviation, Konedobu, Papua New Guinea
7. Mr. Kang Gil U, Oceanographic Research Institute, Nampor City, Korea (DPR of)
8. Mr. Abdullah Al-Salem, Kuwait Institute for Scientific Research, Safat, Kuwait
9. Mr. Tarek Helmy Mohamed Omran, Suez Canal Authority, Ismailia, Egypt
10. Mr. Mejdoub Benzoehra, Institut des Sciences de la Mer & de l'Amenagement du Littoral, Alger-Bourse, Algeria
11. Mr. Toumany Camara, Centre de Recherche Scientifique de Conakry, Conakry, Guinea
12. Mr. Ibrahim Elsayed Elbeshir, Institute of Oceanography, Khartoum, Sudan

Third Sea-Level Training Course, Bidston Observatory, UK; 24 June - 12 July 1985
1. Dr. Margarita Astralaga, Centro de Investigaciones Oceanograficas e Hidrograficas, Bogota, Colombia
2. Mr. Julio Falconeri Rosero Pincay, Instituto Oceanografico de la Armada, Guayaquil, Ecuador
3. Dr. Francisco Vasquez Pita, Instituto del Mar Peruano, Peru,
4. Mr. Ariel Eduardo Vera, Instituto Hidrografico de la Armada, Valparaiso, Chile

Fourth Sea-Level Training Course, Bidston Observatory, UK; 23 June - 11 July 1986
1. Mr. Rochman Djaja, National Co-ordinating Agency for Surveys & Mapping, Jakarta, Indonesia
2. Dr. Chidi Ibe, Institute for Oceanography & Marine Research, Lagos, Nigeria
3. Mr. Charles Mustapha, Institute of Marine Biology and Oceanography, Freetown, Sierra Leone
4. Mr. Gaetan Sauzier, Directorate of Civil Aviation, Seychelles, Rep. of

Fifth Sea-Level Training Course, Bidston Observatory, UK; 22 June - 10 July 1987
1. Mr. Asif Lakhani, National Institute of Oceanography, Karachi, Pakistan
2. Mr. Yusuf Ismail Araleh, Somali Port Authority, Mogadishu, Somalia
3. Dr. W. Shanti Wickremeratne, National Aquatic Resources Authority, Colombo, Sri Lanka

Sixth Sea-Level Training Course, Bidston Observatory, UK; 13 June - 1 July 1988
1. Mr. Joseph T. Odametey, Survey Department, Accra, Ghana
2. Mrs. Georgina Diaz Lianes, Institute of Oceanology, Havana, Cuba
3. Mr. Rachmat, Hydro-Oceanographic Service, Jakarta, Indonesia
4. Capt. Kazi Ali Iman, Bangladesh Shipping Corporation, Chittagong, Bangladesh

Seventh Training Course on Mean Sea Level, Bidston Observatory, UK; 12 - 30 June 1989
1. Mr. P.J. Horeau, Meteorological Office, P.O. Box 181, Mahe, Seychelles Republic
3. Mr. A.B. Gutierrez, Dept. de Fisica, Univ. Nacional, Apartado Postal 492, Heredia 3000, Costa Rica
4. Mr. A. Ngusaru, Inst. of Marine Sciences, Univ. of Dar es Salaam, PO Box 668, Zanzibar, Tanzania

22
Eighth Training Course on Mean Sea Level Measurement Techniques, Bidston Observatory, UK; 11 - 29 June 1990

1. Mr. Mario Capaldo Mena, Direccion de Hydrografia y Navegacion, Caracas, Venezuela.
2. Mr. Winai Maneeprag, Hydrographic Department, Bangkok, Thailand
3. Mr. Danoradan Sundar, NIO, Dona Paula, India
4. Mr. Shri C.S. Negi, Survey of India, Dehra Dun, India
5. Mr. Mussa Mohamed Abdalla, Department of Lands and Surveys, Zanzibar, Tanzania

First Sea-Level Training Course for French speaking trainees, Ecole des Hydrographes, L'Etablissement Principal du Service Hydrographique et Oceanographique de la Marine, Brest, France; 10- 21 September 1990

1. Camara Mamadouba Morlaye, CERESCOR, Conacry, Guinee
2. Mohamed Ouid El Mahfoudh, CNROP, Nouhdhibou, Mauritanie
3. Affian Kouadio, Universite d'Abidjan, Abidjan, Cote d'Ivoire
4. Baritse Lardja, Universite de Benin, Lome, Togo
5. Makaya Jean-Francois, Centre ORSTOM, Pointe Noire, Congo
6. Ranaivoson LaLao Roger, CNRO, Nosy Be, Madagascar
7. Tili Mohamed Alall, Service Hydrographique, Bordj Elbahri, Algerie
8. Louhaichi Jaouhar, Service Hydrographique et Oceanographique, Bizerte, Tunisie
9. Bassirou Diaw, Centre de Recherches Oceanographique, Dakar, Senegal

Sea Level Training Course for Spanish and Portuguese speaking countries (1 - 20 February 1993), Instituto Oceanografico da Universidade def Sao Paulo, Brazil

1. Kivuna Mkiamby, Instituto de Investigacao Pesqueira, Lobito, Angola
2. Monica M.E. Fiore, Servicio de Hidrografia, Bienes Aires, Argentina
3. Emmanuel Giarolla, Instituto Oceanografico da USP, Sao Paulo, Brazil
4. Marco Antonio Correa, IO da USP, Sao Paulo, Brazil
5. Ana Claudia De Paula, Diretoria de Hidrofia e Navegacao, Ponta da Areia, Brazil
6. Geraldo Nogueira Da Silva (the same address as 5), Brazil
7. Mauricio Magalhaes Mata, Depto. de Fisica/Oceanografia Fisica, Fundacao Universidade do Rio Grande, Rio Grande, Brazil
8. Roberto Teixeira Luz, Instituto Brasileiro de Geografia e Estatistica, Rio de Janeiro, Brazil
9. Valeria Mendonca Guimaraes (the same address as 8) Brazil
10. Victor Manoel Da Matta (the same address as 8), Brazil
11. Juan Jose Fierro Contreras, Servicio Hidrigrafico y Oceanografico de la Armada, Valparaiso, Chile
12. Jafar M.C. Ruby, Instituto Nacional de Hidrografia e Navegacao, Maputo, Mocambique
13. Manuel Teixeira, Direccao das Pescas, Sao Tome, Sao Tome e Principe (R.D.of)
IOC (GLOSS-GOOS) Training Workshop on Sea Level Data Analysis, Survey of India, Dehra Dun, India; 21 November - 1 December 1995

1. Mr. Abdul Matin Mondal, Department of Hydrography, BIWTA Ministry of Shipping, Dhaka, Bangladesh
2. Mr. Lalita Prasad, Geodetic and Research Branch Survey of India, Dehara Dun, India
3. Mr. Charles Magori, Kenya Marine & Fisheries Research Institute, Mombasa, Kenya
4. Mr. N.T. Razakafoniaina, Department d'Oceanographie Physique et Chemique Centre National de Recherches Oceanographique (CNRO), Nosy Be, Madagascar
5. Mr. Teh Seng Hoe, Department of Survey and Mapping, Kuala Lampur, Malaysia
6. Mr. S. Ragoonaden, Meteorological Service, Vacoas, Mauritius
7. Mr. O.U. Mwaipopo, Institute of Marine Sciences, University of Dar Es Salaam, Zanzibar, Tanzania,
8. Mr. Ahmed Saleem, Environment Research Unit, MPHRE, Male, Republic of Maldives
Section 7. Publications Relevant to the PSMSL and GLOSS (Updated 15 May 1996)

The following file contains a list of major publications relevant to the Permanent Service for Mean Sea Level (PSMSL) and the Intergovernmental Oceanographic Commission (IOC) co-ordinated Global Sea Level Observing System (GLOSS) programme.

IOC. 1985.


Data holdings of the Permanent Service for Mean Sea Level. Bidston, Birkenhead: Permanent Service for Mean Sea Level. 156pp.


Global Sea-Level Observing System (GLOSS) development in support of the TOGA programme. Tropical Ocean-Atmosphere Newsletter, No. 43, 10-11.


(This report lists values of annual mean sea level for a number of stations for which the corresponding monthly values are not available and are therefore not in the PSMSL dataset itself. The station-years are usually very old and should be used only with great caution).

World Ocean Circulation Experiment implementation plan. Volume 1: Detailed requirements. WMO World Climate Programme Research, WCRP-11, 63pp. (WMO/TD-No.242).


Sea level: the rising tide. UNESCO Sources, No.6 (July/August 1989).

IOC. 1990.

IOC. 1990.
GLOSS. (Global Sea Level Observing System) Paris: Intergovernmental Oceanographic Commission. 6pp. (foldout).

IOC. 1990.


On the availability of European mean sea level data. International Hydrographic Review, 67(1), 131-146.


First satellite-reported sea level data in the Indian Ocean. TOGA Notes, No.6, p.15.


WOODWORTH, P.L. 1992


Two new satellite-reporting sea level stations in the Indian Ocean. TOGA Notes, No.7, p.25.


Pelagic tidal constants - 3. IAPSO Publication Scientifique No.35. Published by the International Association for the Physical Sciences of the Ocean (IAPSO) of the International Union of Geodesy and Geophysics. 191pp.
(Recent updates of this report are available from Dr. Smithson via the PSMSL).

IOC. 1993.


The ACCLAIM programme in the South Atlantic and Southern Oceans. International Hydrographic Review, 70, 7-21.

Sea level changes: determination and effects. IUGG Geophysical Monograph Series, Vol.69.


Data holdings of the Permanent Service for Mean Sea Level (November 1993). Bidston, Birkenhead: Permanent Service for Mean Sea Level. 81pp.


IOC. 1993.
IOC training course for the Global Sea Level Observing System (GLOSS) directed to the African and South American Portuguese and Spanish-speaking countries, Instituto Oceanografico da Universidade de Sao Paulo, Sao Paulo, Brazil, 1-19 February 1993. Intergovernmental Oceanographic Commission, Training Course Reports No. 20, 9pp. & annexes.

WOCE data management. WOCE Data Report 104/93. 40pp.


UNESCO. 1994.

IOC. 1994.
IOC. 1994.

Precise datum control for pressure tide gauges. To be published in Marine Geodesy.


IOC. 1995.

IOC. 1995.


TOLKATCHEV, A. 1996.

IOC. 1996.

IOC. 1996.