

# *PSMSL Annual Report for 2007*

## **1. Introduction**

The Permanent Service for Mean Sea Level (PSMSL) is based at the Proudman Oceanographic Laboratory (POL) on the campus of Liverpool University. It is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) and operates under the auspices of the International Council for Science (ICSU).

During 2007, the PSMSL continued to provide strong support to the Global Sea Level Observing System (GLOSS) and to related projects such as the Ocean Data and Information Network for Africa (ODINAfrica). It provided advice and assistance to a large number of people with interests in Sea Level Science, thereby fulfilling its overall obligations as a FAGS Service. Finally, and most importantly, it continued its efforts in its primary aim of providing the global data bank for long term sea level information from tide gauges.

The PSMSL has been based at POL (which was located at Bidston Observatory until December 2004, on the other side of the River Mersey from its present position in Liverpool) for many years, having been established in 1933 by Joseph Proudman who became its first Secretary. The functions provided by the PSMSL are in as much demand as ever, and plans are in place to celebrate the 75th anniversary of the Service in 2008, when Liverpool will itself be celebrating its recognition as European Capital of Culture.

## **2. PSMSL Data Receipts for 2007**

In the period since the last Annual Report (i.e. since December 2006), almost 1000 station-years of data were entered into the PSMSL database, increasing the total PSMSL data holdings to over 56000 station-years. Appendix 1 lists countries from which sea level data were obtained, while Figure 1 shows their locations. Although the number of station years was less than in 2006 some significant data series were received. Most originated from Europe and North America. Some large data sets were also obtained from Asia, New Zealand and South America. Effort to improve data flow will be stepped up in the coming year and PSMSL will endeavour to increase levels of communication with data suppliers. Major gaps in data receipts persist in other parts of Africa which are receiving special attention through ODINAfrica (see section 4.3 below).

## **3. GLOSS Activities**

The Global Sea Level Observing System (GLOSS) is a project of the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the Intergovernmental Oceanographic Commission (IOC) and the World Meteorological Organisation (WMO). One of the main aims of GLOSS is to improve the quality and quantity of data supplied to the PSMSL. GLOSS has been one of the first components of the Global Ocean Observing System (GOOS).

### **3.1 New GLOSS and PSMSL Web Sites**

The GLOSS web pages ([www.gloss-sealevel.org](http://www.gloss-sealevel.org)) have been completely modernised and updated. The GLOSS Handbook has also been revised and updated during the year and is being merged with the GLOSS web-site. New material has been added to the GLOSS web pages including training material and national reports from the GE/GLOSS-X meeting. Much of the information text has been reviewed and revised. It continues to be maintained by the PSMSL and British Oceanographic Data Centre (BODC) on behalf of GLOSS.

The 'new look' PSMSL web site ([www.pol.ac.uk/psmsl](http://www.pol.ac.uk/psmsl)) was launched in 2007 with a revised home page and the addition of a section with commentaries on the interpretation of long sea level records.

### **3.2 GLOSS Status from a PSMSL Viewpoint (October 2007)**

For several years, the PSMSL has provided a summary of the status of the GLOSS Core Network (GCN) from its viewpoint. A review of its status as of October 2007 can be found at the above GLOSS web site. Overall, the statistics for 2007 are similar to those for recent previous years, and they continue to indicate that ongoing work is required to develop the network further so that all stations can be Category 1 ('Operational' stations for which the latest data is 2003 or more recent). It is to be hoped that the considerable investments being put into sea level recording in Africa and in the Indian Ocean following the Sumatra tsunami will eventually be represented in these statistics.

### **3.3 GLOSS Delayed-mode high frequency data centre**

Alongside the monthly mean sea level data collection, the PSMSL together with BODC is responsible for an archive of delayed-mode higher-frequency sea level data (e.g. hourly values) from the GLOSS network. Approximately 726 site years of high-frequency delayed-mode were received during the period 2003-2007 (see Figure 2). Data are being added from new tide gauge installations in poor coverage areas, such as the data from the ODINAfrica tide gauges. There have also been important datasets received from other data sparse regions, such as Indonesia, and South America (a large amount of data was submitted for Venezuela). Significant historic datasets have also been included. Data have been received from Norway, extending back to 1927 in one case, from the gauge at Tregde. Long time series have also been acquired for two of the French GLOSS sites, with the record from Brest beginning in 1860. These data are being added to the high-frequency delayed-mode databank.

## **4. International projects**

The PSMSL was closely involved during the year in a number of international projects. These included:

### **4.1 Tsunami Projects**

PSMSL staff are contributing to UK-organised tsunami warning activities (e.g. for the UK Defra ministry), European Union ones (TRANSFER) and those coordinated under the auspices of the Intergovernmental Oceanographic Commission (IOC) (e.g. IOTWS,

NEAMTWS). These activities include studies of optimum networks and hardware and modelling of tsunami propagation.

#### **4.2 European Projects**

The PSMSL took the lead, with the Danish Meteorological Institute (DMI), in initiating a web page for real time sea level data from the European Atlantic coastline ([www.sleac.org](http://www.sleac.org)). In addition, it took part in an IOC study group on access to real time data from across Europe. It has also contributed proposals to the chair of the European Sea Level Service (ESEAS) Governing Board through which the delivery of delayed mode sea level data from the region can be placed on a more reliable basis.

#### **4.3 ODINAfrica and IOTWS Activities**

The PSMSL has been closely involved in the delivery of sea level hardware for a number of stations in Africa and the western Indian Ocean. Equipment for the 6 stations mentioned in the 2006 report were delivered, installed and are now operational. The most recent deliveries have been to Aden, Yemen (installed by German colleagues from GFZ in mid-2007) and Alexandria, Egypt (to be installed in early 2008). A small number of further installations might take place under the ODINAfrica programme. However, PSMSL will now move to devising effective methods for maintenance and assurance of data flow from the newly installed sites.

In May, the PSMSL provided a technical training course at POL for specialists from Iran, Egypt and Germany which was most useful preparation for the recent installations.

In September, Dr. E.M.S. Wijeratne from the National Aquatic Resources Research and Development Agency (NARA) in Sri Lanka arrived at POL for a 3 month stay under an IOC Indian Ocean Tsunami Warning System (IOTWS) fellowship. This visit proved most useful and has in turn led to proposals for further activities. In October, Mr. D. Sundar from the National Institute of Oceanography in India arrived for a 6 week stay under an IOTWS fellowship which covered aspects of data management and data quality control.

In December, Dr. Woodworth attended a ceremony at Inmarsat headquarters in London which included the signing of an agreement between IOC and Inmarsat for the use of the Inmarsat Broadband Global Area Network (BGAN) system in the IOTWS. The use of BGAN in this way had been suggested by PSMSL and other POL staff (notably Dr. Holgate, Mr. Peter Foden and Mr. Jeff Pugh) and subsequently demonstrated in a series of tests. BGAN has the potential to improve the speed of tsunami warnings, and therefore to save lives.

### **5. PSMSL-Related Scientific Meetings, Study Groups and Events**

During the year the following important meetings were attended:

- In January, Drs. Holgate, Jevrejeva and Woodworth attended the Marine Science Symposium at Liverpool

- In February, Dr. Woodworth represented the PSMSL at a retreat of the Global Geodetic Observing System (GGOS) in Oxnard, California. In addition, he was present at the UK launch of the International Polar Year at the Royal Society in London attended by the Princess Royal. He also presented a seminar on sea level changes at Plymouth University.
- In March, Dr. Woodworth attended the Ocean Surface Topography Science Team (OSTST) meeting in Hobart, Australia. Dr. Jevrejeva attended a launch meeting for the publication of the 4th Intergovernmental Panel on Climate Change (IPCC) research assessment; Drs. Woodworth and Tamisiea had been Contributing Authors for the Ocean Climate and Sea Level chapter of that assessment.
- In April, Dr. Jevrejeva represented the PSMSL at the European Geophysical Union conference in Vienna, Austria. Dr. Woodworth presented a seminar on sea level changes at Newcastle University.
- In June, a number of PSMSL staff attended the 10th meeting of the GLOSS Group of Experts at IOC in Paris. Dr. Jevrejeva chaired the morning session of the technical workshop “Real-time Transmission and Processing Techniques” held in conjunction with the GLOSS meeting. Dr. Tamisiea gave an invited talk on sea level at the “Interior of the Earth” Gordon Conference in Massachusetts.
- In July, Drs. Holgate, Jevrejeva and Woodworth attended the 24th General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Perugia, Italy. The assembly included a meeting of the IAPSO Commission on MSL and Tides, and a meeting of the FAGS Service Directors.
- In September, Drs. Holgate, Jevrejeva and Woodworth attended the 2007 Science Festival of the British Association in York, in preparation for the sea level session to be organised by the PSMSL at the 2008 Festival in Liverpool.
- In November, Dr. Woodworth took part in a study of real time sea level data for Europe held at IOC in Paris.
- In December, Dr. Tamisiea represented PSMSL at the Unified Analysis Workshop and the GGOS steering committee meeting and attended the American Geophysical Union Fall meeting, all in California.

## **6. Staff Changes**

As mentioned in the 2006 PSMSL Annual Report, the International Association for the Physical Sciences of the Oceans (IAPSO) and IOC had agreed to the change of PSMSL Director from Dr. Philip Woodworth to Dr. Lesley Rickards and approval was awaited from the FAGS Council. That approval was subsequently obtained at a meeting of the

Council in Paris in April this year. Dr. Woodworth accepted at the same Council meeting the role of Secretary of FAGS.

In April, Dr. Mark Tamisiea joined the PSMSL. He will contribute primarily to links between PSMSL and geodetic and geophysical programmes (e.g. GGOS), to the provision of geophysical information in PSMSL web pages, and to analysis of sea level data which requires geophysical insight.

As highlighted in last year's report, the PSMSL proposal to the UK Natural Environment Research Council (the parent body of POL) for continued and modestly expanded funding for the next five years was graded as 'alpha-5', the highest possible, providing a clear way forward. The funding began in April 2007 and has allowed recruitment of a new member of staff. One of the priority areas of work will be the merger as far as possible of the PSMSL and GLOSS delayed mode activities (both at Liverpool and both delayed mode although technically one within POL and one within BODC).

## **7. Publications and Outreach**

Appendix 2 provides a list of relevant papers published in 2007.

In October, Dr. Woodworth presented a lecture on climate change to local school teachers in Liverpool. He also appeared on the BBC Coast TV programme describing the major floods in the UK in 1953.

## **8. Visitors to the PSMSL in 2007**

Visitors welcomed to the PSMSL during the year included David Dixon (Plymouth, UK), Dr. Hans von Storch (GKSS, Germany), Dr. Rolf Weisse (GKSS, Germany), Dr. Thorkild Aarup (IOC), Dr. Rui Manuel da Silva Fernandez (Portugal), Dr. Norman Teferle (University of Nottingham, UK), Sir David Wallace (Isaac Newton Institute, Cambridge, UK), Prof. Afranio Rubens de Mesquita (University of Sao Paulo, Brazil), Prof. Roland Gehrels (Plymouth University, UK), Drs. Marta Marcos and Mikis Tsimplis (National Oceanography Centre, Southampton, UK), Drs. Carl Wainman and Sanette Gildenhuis (Institute for Maritime Technology, South Africa), Dr. Siobhan O'Farrell (Bureau of Meteorology, Australia) and representatives of the Miros tide gauge company.

## **9. Plans for PSMSL in 2008**

The next year should see several major developments:

- (i) The PSMSL has this year started a 'Commentaries' web page by which informal introductions to PSMSL data holdings in particular regions can be used to inform new users. We hope to expand that in 2008.
- (ii) We intend to build upon the Bulletin of the American Meteorological Society report we published last year in collaboration with the University of Hawaii Sea Level Center on sea level in the past year.

- (iii) A new staff member will join PSMSL early in 2008 tasked explicitly with addressing the backlogs in the higher frequency delayed-mode holdings for GLOSS sites which the PSMSL is charged with maintaining.
- (iv) Finally, we will be organising (at least) two major symposia in 2008 to mark the 75th anniversary of the PSMSL. One will be at the EGU 2008 conference in Vienna in April and a second will be at the British Association Science Festival in September. In addition, PSMSL will partially sponsor The Geological Society of London's William Smith meeting "Observations and Causes of Sea-Level Changes on Millennial to Decadal Timescales". Dr. Tamisiea is on the organising committee, and Dr. Woodworth will be one of the keynote speakers. More details on these activities can be found in the PSMSL web pages.

## **10. Summary**

It can be seen that 2007 has been a further active year with regard to important workshops, international conferences and working groups. Scientific outputs, represented by the number of POL publications in sea level and related fields, are as high as they ever have been.

Particular thanks as usual go to PSMSL staff and to colleagues at the Proudman Oceanographic Laboratory and British Oceanographic Data Centre who contribute part of their time to PSMSL activities.

L.J. Rickards  
Director PSMSL  
February 2008

**Appendix 1: Number of station-years entered into the databank for each country or coastline in the period mid-December 2006 to mid-December 2007 (864 total).**

|                                    |    |                              |    |
|------------------------------------|----|------------------------------|----|
| ICELAND                            | 1  | JAPAN (HOKKAIDO)             | 15 |
| FAEROE ISLANDS                     | 7  | JAPAN (HONSHU-PACIFIC)       | 33 |
| SPITSBERGEN                        | 3  | JAPAN (HONSHU-INLAND SEA)    | 11 |
| RUSSIAN FEDERATION (ARCTIC)        | 1  | JAPAN (SHIKOKU)              | 8  |
| NORWAY                             | 44 | JAPAN (KYUSHU)               | 18 |
| SWEDEN                             | 10 | JAPAN (AMAMI GUNTO)          | 5  |
| FINLAND                            | 27 | JAPAN (HONSHU-JAPAN SEA)     | 21 |
| GERMANY (NORTH SEA)                | 12 | JAPAN (OGASAWARA GUNTO)      | 4  |
| NETHERLANDS                        | 11 | JAPAN (MINAMI-TORI-SHIMA)    | 4  |
| UNITED KINGDOM                     | 42 | PHILIPPINES                  | 7  |
| CHANNEL ISLANDS                    | 1  | NEW ZEALAND                  | 40 |
| FRANCE (ATLANTIC)                  | 34 | GUAM                         | 1  |
| SPAIN (ATLANTIC)                   | 5  | MARSHALL ISLANDS             | 2  |
| FRANCE (MEDITERRANEAN)             | 7  | AMERICAN SAMOA               | 1  |
| CORSICA                            | 3  | HAWAIIAN ISLANDS             | 6  |
| ITALY (ADRIATIC)                   | 2  | EASTER ISLAND                | 4  |
| SLOVENIA                           | 1  | USA (ALEUTIAN ISLANDS)       | 2  |
| CROATIA                            | 14 | USA (ALASKA)                 | 15 |
| GREECE                             | 40 | CANADA (PACIFIC COAST)       | 13 |
| RUSSIAN FEDERATION (BLACK SEA)     | 1  | USA (PACIFIC COAST)          | 21 |
| ISRAEL (MEDITERRANEAN)             | 7  | MEXICO (PACIFIC)             | 6  |
| SPANISH N. AFRICA                  | 1  | CHILE                        | 20 |
| SPAIN (CANARY ISLANDS)             | 5  | ARGENTINA                    | 6  |
| GULF                               | 1  | BRAZIL                       | 63 |
| IRAN                               | 18 | CUBA                         | 17 |
| INDIA                              | 5  | CAYMAN ISLANDS               | 2  |
| THAILAND (ANDAMAN SEA)             | 2  | PUERTO RICO                  | 2  |
| THAILAND (GULF OF THAILAND)        | 8  | VIRGIN ISLANDS               | 2  |
| VIET NAM                           | 5  | USA (GULF)                   | 19 |
| CHINA                              | 26 | BERMUDA                      | 1  |
| HONG KONG, CHINA                   | 6  | USA (ATLANTIC)               | 35 |
| KOREA (SOUTH)                      | 69 | CANADA (ATLANTIC AND ARCTIC) | 34 |
| RUSSIAN FEDERATION (PACIFIC OCEAN) | 2  | ANTARCTICA                   | 5  |

## Appendix 2: Some Relevant Reports dated 2007

- Bindoff, N. and Willebrand, J. 2007. Chapter 5: Observations: Oceanic Climate Change and Sea Level. pp.385-432 in, IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (eds. Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L.) Cambridge: Cambridge University Press, 996pp.
- Church, J.A., Aarup, T., Wilson, W.S. and Woodworth, P.L. 2007. Sea-level rise and vulnerable coastal populations. To be published in The Full Picture. A publication for the GEO Ministerial Summit, 'Earth Observation for Sustainable Growth and Development' Cape Town, 30 November 2007.
- Church, J.A., White, N.J., Aarup, T., Wilson, W.S., Woodworth, P.L., Domingues, C.M., Hunter, J.R. and Lambeck, K. 2007. Understanding global sea levels: past, present and future. Sustainability Science (in press).
- Church, J., Wilson, S., Woodworth, P. and Aarup, T. 2007. Understanding sea level rise and variability. Meeting report. EOS, Transactions of the American Geophysical Union, 88(4), 23 January 2007, p43.
- Church, J., Wilson, S., Woodworth, P. and Aarup, T. 2007. Understanding sea level rise and variability. Ocean Challenge, 15(1), p12.
- Holgate, S., Jevrejeva, S., Woodworth, P. and Brewer, S. 2007. Comment on "A semi-empirical approach to projecting future sea-level rise". Science 317, (5846), 1866b. (28 September 2007). doi:10.1126/science.1140942.
- Holgate, S.J., Woodworth, P.L., Foden, P.R. and Pugh, J. 2007. A study of delays in making tide gauge data available to tsunami warning centres. Journal of Atmospheric and Oceanic Technology (in press).
- Jenkins, G., Perry, M. and Prior, J. 2007. (P.L. Woodworth as contributor.) UKCIP08: the climate of the United Kingdom and recent trends. Met Office and UK Climate Impacts Programme report to DEFRA. 119pp.
- Merrifield, M., Mitchum, G.T., Gill, S. and Woodworth, P. 2007. Sea Level, in State of the Climate in 2006 (Arguez, A., ed.). Bulletin of the American Meteorological Society, 88, S1-S135, doi:10.1175/bams-88-6-929.
- Woodworth, P.L. 2007. The reporting of sea level information. The Remote Sensing and Photogrammetry Society Newsletter, No. 26, October 2007, 27-28.
- Woodworth, P.L., Aman, A. and Aarup, T. 2007. Sea level monitoring in Africa. African Journal of Marine Science (in press).
- Woodworth, P.L., Flather, R.A., Williams, J.A., Wakelin, S.L. and Jevrejeva, S. 2007. The dependence of UK extreme sea levels and storm surges on the North Atlantic Oscillation. Continental Shelf Research, 27, 935-946. doi:10.1016/j.csr.2006.12.007.
- Woodworth, P.L., Holgate, S., Foden, P. and Pugh, J. 2007. New sea level stations for Africa and the North Western Indian Ocean. Planet Earth, summer 2007 edition, 24-25. Swindon: Natural Environment Research Council.



Figure 1 New PSMSL Data for 2007

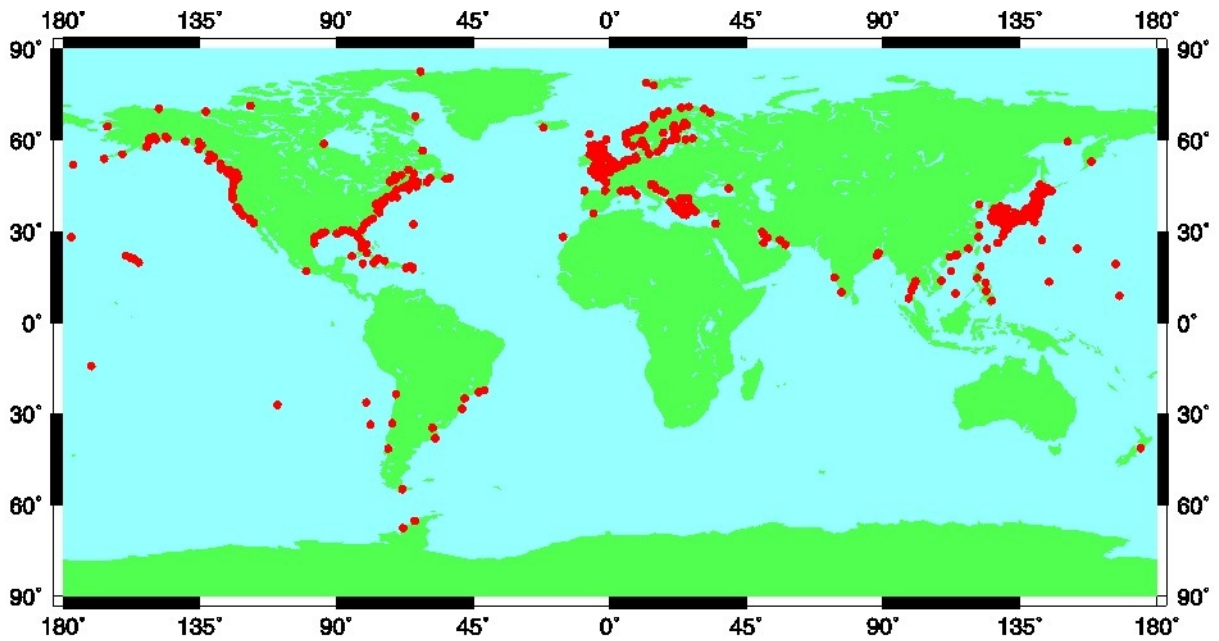


Figure 2 New HF DM data received between 2003 and 2007

