

# *PSMSL Annual Report for 2005*

## **1. Introduction**

The Permanent Service for Mean Sea Level (PSMSL) has been based at the Proudman Oceanographic Laboratory (POL) at Liverpool UK, since its foundation in 1933 by Joseph Proudman who became its first Secretary. During 2005, the PSMSL has continued with its aims of providing the global data bank for long term sea level information from tide gauges, and of providing a wider Service to the sea level community. It has continued to provide strong support to the Global Sea Level Observing System (GLOSS) during the year, and to be involved in the organization of major conferences.

The importance of sea level research was emphasized last year by the Sumatra tsunami in December, followed this year by the Katrina floods in August. Considerable funds were made available in 2005 to GLOSS, so that tide gauges in the Indian Ocean can be 'tsunami enabled'. In addition, the Intergovernmental Oceanographic Commission (IOC) and other organizations held conferences and organized working groups, with the aim of devising better networks for both tsunami warning and sea level applications. Some benefits will have come from the Sumatra tsunami, if better warning systems are put in place, and if the developments eventually feed through into improvements in international data sets such as the PSMSL.

## **2. Reporting**

During November 2004, the PSMSL reported to an expert panel established by the UK Natural Environment Research Council, which was charged with reviewing the work of POL during the past six years, including that of the PSMSL. That panel graded the PSMSL work as 'alpha-5', the highest possible, which was most gratifying. The PSMSL has continued to report to the International Association for the Physical Sciences of the Ocean Commission on Mean Sea Level and Tides (IAPSO/CMSLT), of which Dr. Woodworth is now President, and has an Advisory Board consisting of scientists expert in each area of sea level research.

Annual reports on the work of the PSMSL are circulated each year to the International Association of Geodesy (IAG), the Intergovernmental Oceanographic Commission (IOC), IAPSO/CMSLT, the Federation of Astronomical and Geophysical Data Analysis Services (FAGS), and other relevant bodies and are available publicly via the PSMSL web site <http://www.pol.ac.uk/psmsl/>. It continues as a member of FAGS, working under the auspices of the International Council for Science (ICSU), and will make a further formal progress report to FAGS Council in March 2006.

## **3. PSMSL Data Receipts for 2005**

In the period since the last Annual Report (i.e. since December 2004), over 1100 station-years of data were entered into the PSMSL database, bringing the total PSMSL data holdings to almost 54000 station-years. Appendix 1 lists countries from which sea level data were obtained, while Figure 1 shows their locations. Most data originated from Europe and North America. However, there were encouraging receipts from other areas. Major gaps in data

receipts persist in Africa which are receiving special attention (see section 4.7 below).

#### **4. 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).

##### **4.1 GLOSS Status from a PSMSL Viewpoint (October 2005)**

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 2005 can be found at:

<http://www.pol.ac.uk/psmsl/programmes/gloss.info.html>

In brief, the status of the programme at the present time is similar to that in previous years with the GCN considered to be approximately two-thirds operational.

##### **4.2 GLOSS Training Courses**

GLOSS training courses have been held in many countries since the mid-1980s. A further courses is planned for 2006 in Japan. The PSMSL has committed itself to organizing one of two courses for African students at an IOC facility in Ostende, Belgium at the end of 2006.

##### **4.3 GLOSS Experts Meetings**

The 9<sup>th</sup> Meeting of the GLOSS Group of Experts took place in February 2005 with strong PSMSL participation. The meeting was dominated by discussion of outcomes from the Sumatra tsunami, although more regular topics were also covered. A report can be seen via the above web site.

##### **4.4 Tidal Analysis Software Kit (TASK) Online**

A new version of the TASK tidal analysis and prediction software became available during the year. This is called TIDE TASKS FOR WINDOWS and has been produced in collaboration with colleagues at the Israel Oceanographic and Limnological Research Institute. A web-based version of the TASK tidal analysis and prediction software continues to be made available to academic users within the GLOSS community by the UK National Tidal & Sea Level Facility. The package may be accessed via <http://www.pol.ac.uk/ntslf/task.html>.

#### **4.5 GLOSS Demonstration CD**

A 'GLOSS Demonstration CD' containing Powerpoint presentations and reports of relevance to GLOSS was produced by the POL Applications Group. Approximately 500 copies of the CD have been distributed. Colin Bell of the Group is thanked for his work on the CD.

#### **4.6 IOC Manual 4**

The PSMSL provided assistance to a consultant (Dr. Ian Vassie) to produce the 4<sup>th</sup> edition of the IOC Manual on Sea Level Measurement and Interpretation. The final draft of the manual is at the time of writing being approved by the GLOSS Technical Committee and will be circulated widely in early 2006.

#### **4.7 New Tide Gauges for GLOSS in Africa and Asia**

In 2004, POL/PSMSL was provided with IOC funds for two new gauges for Mozambique, which use Orbcomm data transmission systems. These were installed in early 2005 at Pemba and Inhambane, at the two ends of the Mozambique Channel, by the South African Hydrographic Office and have worked reasonably well since. A third gauge has been purchased for installation at Karachi, Pakistan and four more have been acquired for installation in Africa as part of the ODINAFRICA programme. All of these gauges use combinations of radar and pressure sensors. The PSMSL gave assistance to an IOC consultant (Mr. David Dixon) with regard to an expert site inspection visit to a number of African tide gauge sites.

During October 2004, the PSMSL undertook a set of correspondence concerning data archaeology as a prelude to the start of ODINAFRICA. Letters were sent to all tide gauge authorities in Africa and to selected other authorities, and receipts have since been added to those from a previous 'global' set of correspondence undertaken for IOC by Dr. Lesley Rickards of the British Oceanographic Data Centre (BODC).

#### **4.8 International Polar Year**

The PSMSL took the lead during 2005 in the preparation of a proposal for sea level measurements in the Arctic and Antarctic as part of the International Polar Year activities. The proposal was accepted enthusiastically by the international programme and can now form the basis for national bids for funding by GLOSS partners.

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

In February 2004, the PSMSL helped to organize a two day 'Celebration of UK Sea Level Science' at the Royal Society in London, which was attended by approximately 100 UK scientists. This meeting marked the establishment of the UK National Tidal & Sea Level Facility. A Theme Volume of Philosophical Transactions of the Royal Society, containing papers based on presentations at the meeting, will be published in early 2006.

The meeting was attended by Dr. Christian Le Provost, a long-standing friend of PSMSL and other colleagues at POL, and Chairman of the GLOSS Group of Experts. Christian died shortly after the Royal Society meeting and the Theme Volume will be published in his

memory. A special symposium in memory of Christian was held in Toulouse in March 2005, and a further Theme Volume will be published in Ocean Dynamics containing papers from that meeting. Dr. Woodworth spoke at the meeting and is helping with the co-editing of the volume.

The following other important meetings were also attended during the year:

- In January, Dr. Holgate attended a meeting of Japanese sea level scientists and oceanographers organised by the Japanese Meteorological Agency, and presented ideas on recent sea level rise and ocean thermal expansion.
- In March, Dr. Woodworth attended a meeting of European tsunami experts at the European Union headquarters in Brussels.
- Also in March, Dr. Horsburgh attended the IOC conference on the Indian Ocean tsunami warning system in Paris.
- Also in March, Dr. Jevrejeva attended a reception in the House of Commons for young scientists and presented a poster on her sea level research.
- In April, Dr. Jevrejeva attended the European Geosciences Union in Vienna, Austria and made oral and poster presentations.
- In May, Dr. Woodworth visited the factory of OTT in Kempten, Germany. OTT is a major supplier of tide gauge hardware.
- In August, Dr. Jevrejeva attended the Dynamic Planet (IAPSO/IAG) conference in Cairns, Australia and made oral and poster presentations.
- In October, Drs. Woodworth and Rickards and Miss Elizabeth Bradshaw attended the final meeting of the EU-funded European Sea Level Service Research Infrastructure (ESEAS-RI) project in Split, Croatia. He also attended a meeting on the future of the Antarctic ice sheet at the Royal Society, London, and a meeting of the Surface (air) Pressure Working Group of the Global Climate Observing System (GCOS) at the UK Met Office.
- In December, Dr. Williams represented the PSMSL at a meeting of the Global Geodetic Observing System (GGOS) in San Francisco.

Preparations began in 2005 with regard to a sea level workshop in IOC, Paris 6-9 June 2006 to be conducted under the auspices of the World Climate Research Programme and other sponsors. Drs. John Church (CSIRO, Australia), Stan Wilson (NOAA, USA), Thorkild Aarup (IOC) and Philip Woodworth (PSMSL) are the main leads for this meeting.

## **6. Staff**

Prof. Trevor Baker retired from POL in August 2005. Trevor has represented the PSMSL on many occasions, and lectured at GLOSS training courses, and we hope his expertise will continue to be available on an informal basis. Mrs. Kathy Gordon, formerly of the British Oceanographic Data Centre, joined the PSMSL in June as a sea level data manager. Kathy will be one of the main contacts for data suppliers in the future.

## **7. Publications and Outreach**

Appendix 2 provides a list of relevant papers published at POL/PSMSL in 2005 which have made use of PSMSL and related data. Dr. Woodworth has continued his work as a

contributing author to the Intergovernmental Panel on Climate Change (IPCC) 4<sup>th</sup> Assessment which will be published in 2006.

Various UK and international meetings were attended during the year which resulted in reports on the topic of tsunamis. For example, the UK has produced a report, to which the PSMSL contributed, on the risks to the UK coastline (see reference below).

The PSMSL actually changed the English language during 2005, by correcting an incorrect definition of 'mean sea level' in the new edition of the Oxford English Dictionary. A radio interview was given on BBC Radio Wales by Dr. Woodworth following the Katrina floods. Dr. Holgate gave a series of lectures to students from Manchester Metropolitan and Liverpool Universities, and provided a leaflet on sea level research for the public during the Mersey River Summer Festival. The PSMSL has continued to answer questions about sea level matters from members of the public, by responding to emails and letters and by providing 'Frequently Asked Questions' web pages.

## **8. Visitors to the PSMSL in 2005**

Visitors welcomed to the PSMSL during the year included Sir Keith O'Nions (Director General Research Councils UK), Prof. Philip Moore (Newcastle University), Dr. Juan Fierro (SHOA, Chile), Dr. James Martin (Schlumberger Ltd.), Dr. Jimmy Murphy (University College Cork, Ireland), Dr. Mikis Tsimplis (National Oceanography Centre, UK), Dr. David Pugh (Liverpool University, UK), Espen Isaksen (Norwegian Mapping Authority), Isabel Tang (Impossible Pictures Ltd.) and Mr. Simon Wills (OTT UK Ltd.).

### **Summary**

It can be seen that 2005 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 ever.

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.

P.L. Woodworth  
Director PSMSL  
December 2005

Appendix 1: Number of station-years entered into the databank for each country or coastline in the period mid-December 2004 to mid-December 2005 (1119 total).

|                             |     |                              |     |
|-----------------------------|-----|------------------------------|-----|
| ICELAND                     | 2   | SINGAPORE                    | 16  |
| FAEROE ISLANDS              | 11  | HONG KONG, CHINA             | 18  |
| SPITSBERGEN                 | 3   | KOREA (SOUTH)                | 100 |
| RUSSIAN FEDERATION (ARCTIC) | 1   | PHILIPPINES                  | 10  |
| NORWAY                      | 66  | NEW ZEALAND                  | 3   |
| SWEDEN                      | 10  | NORTHERN MARIANA ISLANDS     | 2   |
| DENMARK                     | 148 | GUAM                         | 1   |
| NETHERLANDS                 | 11  | CAROLINE IS (F.S.MICRONESIA) | 6   |
| BELGIUM                     | 9   | PALAU ISLANDS                | 3   |
| UNITED KINGDOM              | 42  | NAURU                        | 11  |
| CHANNEL ISLANDS             | 1   | MARSHALL ISLANDS             | 60  |
| FRANCE (ATLANTIC)           | 46  | SOLOMON ISLANDS              | 10  |
| SPAIN (ATLANTIC)            | 24  | NEW CALEDONIA                | 3   |
| SPAIN (MEDITERRANEAN)       | 20  | AMERICAN SAMOA               | 1   |
| FRANCE (MEDITERRANEAN)      | 16  | HAWAIIAN ISLANDS             | 7   |
| MALTA                       | 8   | LINE ISLANDS                 | 2   |
| ITALY (ADRIATIC)            | 4   | PENRHYN ISLAND               | 2   |
| CROATIA                     | 21  | GAMBIER ISLAND               | 2   |
| GREECE                      | 17  | USA (ALEUTIAN ISLANDS)       | 2   |
| TURKEY                      | 9   | USA (ALASKA)                 | 15  |
| PORTUGAL (AZORES)           | 5   | CANADA (PACIFIC COAST)       | 14  |
| PORTUGAL (MADEIRA)          | 24  | USA (PACIFIC COAST)          | 21  |
| SPAIN (CANARY ISLANDS)      | 8   | MEXICO (PACIFIC)             | 1   |
| SENEGAL                     | 8   | ECUADOR                      | 8   |
| ST. HELENA                  | 3   | ARGENTINA                    | 6   |
| MOZAMBIQUE                  | 4   | FALKLAND ISLANDS (MALVINAS)  | 2   |
| SEYCHELLES                  | 3   | BRAZIL                       | 69  |
| MAURITIUS                   | 4   | CUBA                         | 7   |
| MALDIVES                    | 9   | PUERTO RICO                  | 2   |
| TANZANIA                    | 3   | VIRGIN ISLANDS               | 2   |
| KENYA                       | 2   | USA (GULF)                   | 20  |
| GULF                        | 2   | BAHAMAS                      | 2   |
| MUSCAT & OMAN               | 4   | BERMUDA                      | 1   |
| IRAN                        | 42  | USA (ATLANTIC)               | 36  |
| INDIA                       | 9   | CANADA (ATLANTIC AND ARCTIC) | 29  |
| BANGLADESH                  | 5   | GREENLAND                    | 11  |
| ANDAMAN ISLANDS             | 1   | ANTARCTICA                   | 9   |

## Appendix 2: Some Relevant Reports dated 2005

Woodworth, P.L., Aarup, T. and Rummel, R. 2005. IGGOS as a potential partner in IGOS. *Journal of Geodynamics* (in press).

Jevrejeva S., Moore, J.C., Woodworth, P.L. and Grinsted, A. 2005. Influence of large scale atmospheric circulation on European sea level: results based on the wavelet transform method. *Tellus*, 57A, 183-193.

Woodworth, P.L., Pugh, D.T., Meredith, M.P. and Blackman, D.L. 2005. Sea level changes at Port Stanley, Falkland Islands. *Journal of Geophysical Research*, Vol. 110, C06013, doi:10.1029/2004JC002648.

Woodworth, P.L. 2005. Benefits to studies of global sea level changes from future space gravity missions. *Earth, Moon and Planets*, 94, 93-102. doi: 10.1007/s11038-004-5172-9.

Woodworth, P.L., Blackman, D.L., Pugh, D.T. and Vassie, J.M. 2005. A note on asymmetries in tidal probability distribution functions. *Estuarine, Coastal and Shelf Science*, 64, 235-240, doi:10.1016/j.ecss.2005.02.014.

Woodworth, P.L. 2005. Some important issues to do with long term sea level change. *Philosophical Transactions of the Royal Society* (in press).

Woodworth, P.L. 2005. Have there been large recent sea level changes in the Maldivian Islands? *Global and Planetary Change*, 49, 1-18. doi: 10.1016/j.gloplacha.2005.04.001.

Woodworth, P.L., Blackman, D.L., Foden, P., Holgate, S., Horsburgh, K., Knight, P.J., Smith, D.E., Macleod, E.A. and Bradshaw, E. 2005. Evidence for the Indonesian tsunami in British tidal records. *Weather*, 60(9), 263-267. doi: 10.1256/wea.59.05.

Woodworth, P.L. 2005. (contributor to). The threat posed by tsunami to the UK. Study commissioned by Defra Flood Management and produced by British Geological Survey, Proudman Oceanographic Laboratory, Met Office and HR Wallingford. (ed. D.Kerridge.) 167pp.

Tsimplis M.N., Woolf, D.K., Osborn, T.J., Wakelin, S., Wolf, J., Flather, R., Shaw, A.G.P., Woodworth, P., Challenor, P., Blackman, D., Pert,

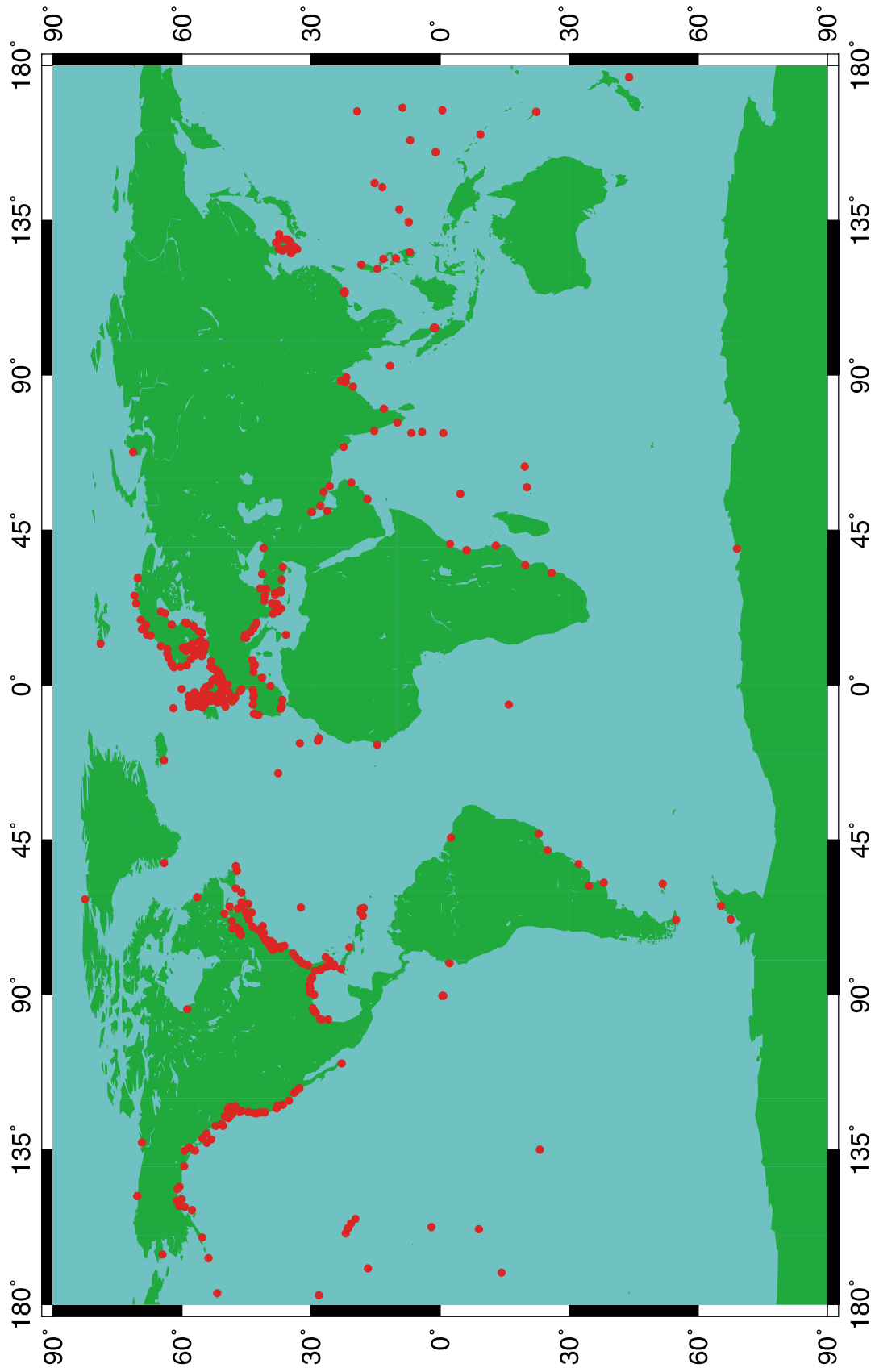
F., Yan, Z. and Jevrejeva, S. 2005. Towards a vulnerability assessment of the UK and northern European coasts: the role of regional climate variability. *Proc. Roy. Soc. London*, 363, 1329-1358, doi:10.1098/rsta.2005.1571.

Jevrejeva, S., J. C. Moore, P. L. Woodworth and A. Grinsted. 2005. Influence of large scale atmospheric circulation on European sea level: results based on the wavelet transform method. *Tellus A*, vol 57A, 129-149.

Moore, J, Grinsted, A. and S. Jevrejeva. 2005. New tools for analyzing time series relationships and trends. *EOS, VOL.*, 86, 24.

Meredith, M.P., Hughes, C.W. and Woodworth, P.L. 2005. Response of the Antarctic Circumpolar Transport to forcing by the Southern Annular Mode. *CLIVAR Exchanges*, 10(4), 20-22.

**New PSMSL Data 2005**



**Figure 1**