

PSMSL Annual Report for 2003

1. Introduction

Since 1933, the Permanent Service for Mean Sea Level (PSMSL) has been operated at Bidston Observatory (now the Proudman Oceanographic Laboratory, POL) with the 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 is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) and works under the auspices of the International Council for Science (ICSU).

The PSMSL reports to the International Association for the Physical Sciences of the Ocean Commission on Mean Sea Level and Tides (IAPSO/CMSLT) 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, FAGS, and other relevant bodies and are available publicly via the web at:

<http://www.pol.ac.uk/psmsl/>

The same web page also serves as a source of PSMSL data and ancillary information.

This year has been an unusual one in several respects. First, we expected the PSMSL to move with the rest of POL to new premises at the Joseph Proudman Building on the University of Liverpool campus. That move has now been delayed until February 2004. The uncertainties associated with the move have caused some disruption which we have had to work around. Second, while the PSMSL has continued with its primary task of assembly of the global data set of sea level change information and its dissemination to the research community, the amount of data collected this year has been very large and has been dominated by mean sea level values from the Russian Arctic. Third, there have been a number of important conferences this year and a large number of visitors to Bidston. In between times, the PSMSL has conducted scientific investigations of the data set and related information, and it has continued to contribute strongly to the further development of the Global Sea Level Observing System (GLOSS). These and other activities are reviewed briefly in the following report.

2. PSMSL Data Receipts for 2003

In the period since the last Annual Report (i.e. since mid-December 2002), over 3500 station-years of data were entered into the PSMSL database. These were dominated by over 2700 station-years for the Arctic coast of Russia provided to the PSMSL by the Arctic and Antarctic Research Institute via Professor Andrey Proshutinsky of the Woods Hole Oceanographic Institution. This data set contains approximately 70 locations with record lengths of 10-50 years and appears to be of very good quality. Approximately 800 station-years were added from elsewhere, which is in itself a respectable number. Appendix 1 lists countries from which sea level data were obtained, while Figure 1 shows their locations. Major gaps in data receipts persist in South America, Africa and parts of Asia which are

receiving special attention through recent initiatives (see 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 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 GLOSS Status from a PSMSL Viewpoint (October 2003)

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 2003 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 slightly improved over earlier years with the GCN considered to be approximately two-thirds operational.

3.2 GLOSS Training Courses

GLOSS training courses have been held in many countries since the mid-1980s. In April 2003, a most successful course was held at the Hydrographic and Oceanographic Service of the Navy (SHOA) in Valparaiso, Chile in which the PSMSL (Dr. Woodworth) gave several lectures on sea level science and technology. A further course was planned for almost the same time in Malaysia. However, that had to be postponed to February 2004 owing to the SARS epidemic. That course will be attended by Dr. Williams from POL. A possible three courses are at present in planning for 2004, each of which will have PSMSL representation.

3.3 Maps of Holocene Sea Level Changes

During 2002, the PSMSL with some support from GLOSS funded the production of maps of sea level change through the Holocene period (last 10,000 years), showing the changes in coastlines which resulted. The maps form part of the PSMSL and GLOSS training materials and have been produced by Dr. Glenn Milne and colleagues at the University of Durham. They are accessible from the PSMSL web pages.

3.4 GLOSS Adequacy Report

During the first part of 2003, the PSMSL took the lead in the preparation of the GLOSS Adequacy Report (<http://unesdoc.unesco.org/images/0013/001302/130292e.pdf>). This document contains a review of the status of the GLOSS programme, together with a proposal for modest funding for taking the programme forward. This document was discussed at the IOC Assembly in June 2003 and was endorsed unanimously. While the Assembly has itself no funds to initiate a programme of the size suggested, the exercise was a useful one in

providing the background information for construction of the proposals to funding agencies later in the year mentioned below.

3.5 Eighth Meeting of the GLOSS Group of Experts

Meetings of the GLOSS Group of Experts (GE) usually take place at intervals of two years. The last (GE7) took place at the University of Hawaii during April 2001. GE8 was held 13-17 October at IOC in Paris and included a two and a half day Technical Workshop on new technologies for sea and land level measurements. This very successful workshop will result in a useful workshop report in early 2004. The week also included 'sideline workshops' of the European Sea Level Service (ESEAS) and of the proposed International Altimeter Service.

There is insufficient space in this Annual Report to note the many items discussed in the Technical Workshop and during GE8 itself. However, one important topic was the election of Dr. Christian Le Provost (Toulouse, France) as the new GLOSS Chairman, in place of Dr. Woodworth who held that position for the last 5 years. However, Dr. Woodworth will remain closely associated with the programme through his PSMSL and other sea level activities.

At the time of writing, the Workshop and GE8 reports are not yet available. However, presentations made during the Workshop can be inspected via

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

4. Proposals for Enhanced Sea Level Networks

During 2003, the PSMSL took the lead in two major proposals to the European Union for funds to enhance the sea level networks in Africa, South America and certain Island States. Both proposals are called GAINS (GLOSS development in the Atlantic and Indian oceans) and have been submitted under the 'international cooperation' and 'global change and ecosystems' themes. In addition, the PSMSL provided similar input to a proposal for enhancement to environmental monitoring systems (not only sea level) in Africa submitted to the Government of Flanders by the ODINAFRICA group. At the time of writing, the fate of these proposals is unknown.

In October, Dr. Woodworth took part in the construction of a bid for funding to the UK Natural Environment Research Council for a programme called FREE (Forecasting the Risk of Extreme Events). This proposal is concerned with methods for better protecting against the 'extreme events' in European weather (rainfall, river and coastal floods) which seem to be becoming more common.

Most recently, the PSMSL and other POL scientists have been engaged in proposals for the construction of a sea level network in Ireland, which would provide that country's contribution to GLOSS, and for enhancements to the UK National Network. Reports on both of these activities will be available in early 2004.

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

The following important meetings, study groups and events were attended during the year:

- A most pleasant PhD examination of Dr. Cecile Cabanes in Toulouse, France in January attended by Dr. Woodworth.
- A workshop on future space gravity and its relevance for sea level studies held in Bern, Switzerland in January and attended by Drs. Hughes and Woodworth.
- Several study groups held in January and throughout the year as part of the UK Tyndall Centre sea level activities and attended by Drs. Wakelin, Jevrejeva, Wolf, Flather and Woodworth.
- A hosting of a large number of colleagues within the European Sea Level Service (ESEAS) at Bidston in March. The PSMSL has been represented during the year in the ESEAS Governing Board and in several work packages of the programme.
- In March Dr. Jevrejeva made a special visit to the Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg to discuss data exchange issues.
- A presentation on tracking coastal boundary waves using PSMSL data was given at the European Geophysical Society conference in April by Dr. Holgate. A presentation on the influence of the large-scale atmospheric circulation on European sea level was given by Dr. Jevrejeva at the same conference.
- A training course for sea level specialists in Valparaiso, Chile in April and attended by Dr. Woodworth.
- A presentation on sea level science to the Royal Society of Chemistry in May by Dr. Woodworth.
- Several study groups held in May and throughout the year as part of the UK Foresight flooding activity and attended by Dr. Woodworth.
- Representation of the PSMSL and GLOSS by Dr. Baker at the EUREF (European Reference Frame) and ECGN (European Combined Geodetic Network) meeting in Toledo, Spain. The new ECGN network aims to combine the geodetic information provided by Absolute Gravity, Superconducting Gravity, Continuous GPS and tide gauges.
- A consultation with advisors from the European Union on possible funding for the global sea level network in Brussels in June and attended by Dr. Woodworth.
- A presentation on GLOSS to the IOC Assembly in June by Dr. Woodworth.
- The 4-yearly conference of the International Union of Geodesy and Geophysics (IUGG) in Sapporo, Japan in June/July attended by Dr. Jevrejeva. This conference included a meeting of representatives of the FAGS Services. Dr. Woodworth acted as convenor for 2 scientific sessions but could not attend the conference itself. Dr. Jevrejeva presented European sea level variability findings.
- A presentation on PSMSL and GLOSS to Port Meteorological Officers at the International Maritime Organisation (IMO) in London in July by Dr. Woodworth.
- Presentations on global sea level change to the Royal Geographical Society, Royal Meteorological Society and British Association for the Advancement of Science in September by Dr. Woodworth.
- Representation of the PSMSL and GLOSS at the Global Climate Observing System (GCOS) Regional Conference in Santiago, Chile in October by Dr. Carlos Franca of the University of São Paulo, Brazil.
- A presentation on the global tide gauge network at the JASON/GAMBLE conference in Arles, France in November and attended by Drs. Hughes and Woodworth.
- Representation of the PSMSL at the ESEAS meeting in Slovenia in November by Miss Elizabeth Bradshaw.
- A briefing meeting on sea level measurements and science to Dr. Howard Dalton, Chief

Scientist of the UK Department for the Environment, Food and Rural Affairs (Defra) in December attended by Drs. Woodworth, Flather and Hill.

Plans are already underway for an important meeting at the Royal Society in February 2004 which will mark the establishment of the UK National Tidal & Sea Level Facility (NTSLF) and which will be a 'celebration of UK sea level science'. The PSMSL will be well-represented at this important meeting which will include presentations from several sea level experts from Europe and USA.

6. Publications

Appendix 2 provides a list of relevant papers published in 2002-3 which have made use of PSMSL and related data. Of particular note, the paper by Woodworth and Player in the Journal of Coastal Research includes an update on the work of the PSMSL.

Outlines of the work of the PSMSL and other FAGS Services can be found in the latest edition of the International Association of Geodesy (IAG) Geodesists Handbook. Outlines in PDF format can be found at <http://www.gfy.ku.dk/~iag/HB2004/newsum.htm> while a printed version will be available in early 2004.

7. Outreach

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.

On two occasions Dr. Holgate from the PSMSL organised aspects of local SETPOINT training, which is a partnership between education and industry and which operates throughout the UK. Dr. Holgate worked with children of about 11 years of age with the aim of encouraging them, by means of stimulating, enjoyable activities, to take science and engineering as a future career.

8. Visitors to the PSMSL in 2003

A large number of visitors were welcomed to the PSMSL during the year. Dr. A.S. Unnikrishnan of the National Institute of Oceanography, India visited for several weeks. Other visitors included Dr. Alan Wall and Mr. Paul Hughes (Liverpool John Moores University), Dr. David Pugh (Southampton Oceanography Centre), Prof. Keith Tinkler (Brock University, Canada), Dr. Stan Wilson (NOAA, USA), Dr. Thorkild Aarup (IOC, Paris), Mr. Lawrence Holden (Liverpool), Dr. Derek Goring (NIWA, New Zealand), Dr. Paul Cruddace (Ordnance Survey), Dr. Ruth Adams (UK Hydrographic Office), Dr. Lucy Mathers (De Montfort University, UK), Dr. Mikis Tsimplis (Southampton Oceanography Centre), Drs. Jonathan Gregory and Jason Lowe (Hadley Centre), Dr. Marek Ziebart (University College London), Dr. John Hunter (University of Tasmania, Australia) and Mr. Roger Fraser (University of Melbourne, Australia).

9. Relocation of POL to Liverpool University

There are now plans to relocate POL from Bidston Observatory to a new building on the campus of Liverpool University in February 2004. This will include the relocation of the PSMSL. Our new postal address and phone and fax numbers will be advertised on the PSMSL web pages but our email and web addresses will be unchanged. We expect that any disruption to the work of the PSMSL will be temporary.

Summary

It can be seen that 2003 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, S. Jevrejeva and S. Holgate
December 2003

Appendix 1: Number of station-years entered into the databank for each country or coastline in the period mid-December 2002 to mid-December 2003 (3524 total).

SPITSBERGEN	47	NEW ZEALAND	303
RUSSIAN FEDERATION (ARCTIC)	2741	GUAM	1
GERMANY (FORMER DDR) BALTIC	8	MARSHALL ISLANDS	2
GERMANY (FORMER FRG) BALTIC	4	AMERICAN SAMOA	1
GERMANY (NORTH SEA)	3	HAWAIIAN ISLANDS	7
NETHERLANDS	11	ILES DE LA SOCIETE	1
UNITED KINGDOM	42	USA (ALEUTIAN ISLANDS)	2
CHANNEL ISLANDS	1	USA (ALASKA)	15
GREECE	1	CANADA (PACIFIC COAST)	6
RUSSIAN FEDERATION (BLACK SEA)	1	USA (PACIFIC COAST)	21
GEORGIA	1	PANAMA (PACIFIC)	16
TURKEY	7	PERU	9
INDIA	27	ARGENTINA	14
THAILAND (ANDAMAN SEA)	2	GUYANA	1
THAILAND (GULF OF THAILAND)	10	TRINIDAD & TOBAGO	2
CHINA	45	ST. VINCENT	1
RUSSIAN FED. (PACIFIC OCEAN)	2	ST. LUCIA	1
JAPAN (HOKKAIDO)	5	CUBA	7
JAPAN (HONSHU-PACIFIC)	18	JAMAICA	2
JAPAN (HONSHU-INLAND SEA)	7	ST. KITTS	1
JAPAN (SHIKOKU)	7	PUERTO RICO	2
JAPAN (KYUSHU)	8	VIRGIN ISLANDS	2
JAPAN (AMAMI GUNTO)	2	USA (GULF)	20
JAPAN (HONSHU-JAPAN SEA)	7	BAHAMAS	1
JAPAN (OGASAWARA GUNTO)	1	BERMUDA	1
JAPAN (MINAMI-TORI-SHIMA)	1	USA (ATLANTIC)	36
PHILIPPINES	31	CANADA (ATLANTIC AND ARCTIC)	9

Appendix 2: Some Relevant Reports dated 2003

- Dong, X., Huang, C., Woodworth, P., Moore, P. and Bingley, R. 2003. Absolute calibration of the ERS-2 altimeter using UK tide gauges, in, *Satellite Altimetry for Geodesy, Geophysics and Oceanography* (C. Hwang, C.K. Shum and J.C. Li, eds.), IAG Symposium 126, pp. 91-98, Springer, Berlin.
- Flather, R., Williams, J., Blackman, D., Woodworth, P., Smith, D. and Bell, C. 2003. Investigation into forecast errors at Sheerness during 2002. Proudman Oceanographic Laboratory Internal Document No.151, 46pp.
- Hughes, C.W., Woodworth, P.L., Meredith, M.P., Stepanov, V., Whitworth, T. and Pyne A.R. 2003. Coherence of Antarctic sea levels, Southern Hemisphere Annular Mode, and flow through Drake Passage. *Geophysical Research Letters*, 30(9), 1464, doi:10.1029/2003GL017240.
- Johannessen, J.A., Balmino, G., Le Provost, C., Rummel, R., Sabadini, R., Sünkel, H., Tschering, C.C., Visser, P., Woodworth, P., Hughes, C., LeGrand, P., Sneeuw, N., Perosanz, F., Aguirre-Martinez, M., Rebhan, H. and Drinkwater, M. 2003. The European Gravity Field and Steady-State Ocean Circulation Explorer satellite mission: its impact on geophysics. *Surveys in Geophysics*, 24(4), 339-386.
- Mathers, E.L. and Woodworth, P.L. 2003. A study of departures from the inverse barometer response of sea level to air pressure forcing at a period of 5 days. *Quarterly Journal of the Royal Meteorological Society* (in press).
- Vassie, J.M., Woodworth, P.L. and Holt, M.W. 2003. An example of North Atlantic deep ocean swell impacting Ascension and St. Helena islands in the central South Atlantic. *Journal of Atmospheric and Oceanic Technology* (in press).
- Wakelin, S.L., Woodworth, P.L. Flather, R.A. and Williams, J.A. 2003. Sea-level dependence on the NAO over the NW European Continental Shelf, *Geophysical Research Letters*, 30(7), 1403, doi:10.1029/2003GL017041, 2003.
- Woodworth, P.L. and Gregory, J.M. 2003. Benefits of GRACE and GOCE to sea level studies. *Space Science Reviews*, 108, 307-317.
- Woodworth, P.L. 2003. Some comments on the long sea level records from the northern Mediterranean. *Journal of Coastal Research*, 19, 212-217.
- Woodworth, P.L. and Player, R. 2003. The Permanent Service for Mean Sea Level: an update to the 21st century. *Journal of Coastal Research*, 19, 287-295.
- Woodworth, P.L. and Blackman, D.L. 2003. Evidence for systematic changes in extreme high waters since the mid-1970s. *Journal of Climate* (in press).
- Woodworth, P.L., Gregory, J.M. and Nicholls, R.J. 2003. Long term sea level changes and their impacts. To be published in Vols. 12/13 of *The Sea*.
- Woodworth, P.L. 2003. Some further biographical details of the Holden tide table makers. Proudman Oceanographic Laboratory Report No. 58. 20pp.
- Woodworth, P.L. and Aarup, T. 2003. A report on the status of the GLOSS programme and a proposal for taking the programme forward. Intergovernmental Oceanographic Commission report IOC/INF-1190. 41pp.
- Woodworth, P.L. and Smith, D.E. 2003. A one year comparison of radar and bubbler tide gauges at Liverpool. *International Hydrographic Review*, 4(3), December 2003 (in press).
- Woodworth, P.L., Aarup, T. and Rummel, R. 2003. IGGOS as a potential partner in IGOS. *Journal of Geodynamics* (submitted).
- Woodworth, P.L., Aarup, T., Merrifield, M., Mitchum, G.T. and Le Provost, C. 2003. The status of the Global Sea Level Observing System. EOS, *Transactions of the American Geophysical Union* (in press).

Figure 1 New PSMSL Data 2003

