PSMSL Annual Report for 2006

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 2006, the PSMSL helped to organize one of the most important sea level conferences in recent years. It 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 redoubled 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 already 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 2006

In the period since the last Annual Report (i.e. since December 2005), almost 2000 station-years of data were entered into the PSMSL database, increasing the total PSMSL data holdings to over 55000 station-years. This annual increase is significantly in excess of the norm in recent years, while the geographical coverage of the data received is much wider than normal. This reflects to some extent the enhanced levels of communication that PSMSL has been able to establish with data suppliers.

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, large data sets were also obtained from Asia, Australasia and southern Africa. Major gaps in data receipts persist in other parts of Africa which are receiving special attention through ODINAFRICA (see section 3.4 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

During 2005, the decision was made by the PSMSL and by the Chairman of GLOSS (Prof. Mark Merrifield, University of Hawaii Sea Level Center) and the GLOSS Technical Secretary (Dr. Thorkild Aarup, IOC) to separate the PSMSL and GLOSS web pages, thereby enabling the separate functions and organizational backgrounds of the two services to be more clearly identified. Therefore, during 2006 a dedicated GLOSS web site was established with the name:

http://www.gloss-sealevel.org

This web site contains an updated version of the GLOSS Handbook and revised information pages. It will continue to be maintained by the PSMSL and British Oceanographic Data Centre (BODC) on behalf of GLOSS.

The PSMSL web site will remain at http://www.pol.ac.uk/psmsl but will receive a fresh look in early 2007.

3.2 GLOSS Status from a PSMSL Viewpoint (October 2006)

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 2006 can be found at the above GLOSS web site. In brief, the overall status of the programme at the present time is modestly improved compared to that a year ago, and one expects that the improvements to the network (some originating from infrastructure installed following the Sumatra earthquake and tsunami) will feed through to status improvement during the next year.

3.3 GLOSS Training Courses

GLOSS training courses have been held in many countries since the mid-1980s. During 2006, two courses were held. The first was in Tokyo, Japan during May and included background information provided by the PSMSL. The second course, which the PSMSL took a lead in organizing, was in November at the IOC facility in Oostende, Belgium. This course was attended by participants from African countries, several of whom are to receive new tide gauges as part of GLOSS development or the ODINAFRICA programme. Training was provided in the technology of tide gauges, the software used for tidal analysis, and in the science of sea level change. Another course focused on Africa will be held in mid-2007.

3.4 New GLOSS and ODINAFRICA Tide Gauges

Two tide gauges from the GLOSS-Africa and ODINAFRICA initiatives have already been provided by IOC through PSMSL/POL for installation in Mozambique with a third at Karachi, Pakistan. Six more will be installed in the near future in Mauritania, Ghana, Cameroon, Congo, Djibouti and Yemen with up to 6 others following in 2007, again with expert assistance from PSMSL/POL. The tide gauge stations in this set consist of a radar gauge, two pressure sensors, data logger and satellite communication equipment. A dual-use approach has been adopted such that the equipment can be used for tsunami monitoring as well for sea level studies.

In May, the PSMSL hosted Lt. Cdr. Taufeeque Rauf from the Pakistan Hydrographic Department so as to provide training prior to installation of the new GLOSS tide gauge at Karachi.

3.5 IOC Manual 4

The 4th edition of the IOC Manual on Sea Level Measurement and Interpretation, which the PSMSL played a major part in writing, was finally published in 2006. Paper copies can be obtained from IOC while electronic copies can be obtained from the PSMSL training web pages.

4. BGAN Satellite Transmission

The PSMSL and POL took a major interest in 2006 in the use of the Inmarsat BGAN (Broadband Global Area Network) system for real-time transmission of tide gauge data from remote stations, and especially for data of interest for tsunami warning. This telemetry enables always-on broadband internet connections to tide gauges, providing higher bandwidth and reduced latency in data transfer than available at present by systems such as Meteosat. Inmarsat were very helpful in providing test equipment, with the result that BGAN-enabled tide gauges similar to those described above for ODINAFRICA should become available in 2007. Two papers have been submitted for publication to scientific and technical journals based on our experience with the BGAN technology.

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

Dr. Woodworth co-organised the World Climate Research Programme workshop on Understanding Sea-Level Rise and Variability, held at UNESCO in Paris, France during 6-9 June. The other co-organisers were Drs. John Church (CSIRO, Australia), Stan Wilson (NOAA, USA) and Thorkild Aarup (IOC). It was attended by Drs. Jevrejeva and Holgate and other POL staff associated with the PSMSL.

This major event attracted over 150 attendees and reviewed the entire field of past and future sea level changes (including extreme sea level as well as mean sea level), together with the reasons for change, and with methods for better monitoring and modelling them. It is intended that a book will be published in 2007 with chapters based on position papers written before the workshop and on the presentations and discussions during it.

The following other important meetings were attended during the year:

- In March, Drs. Woodworth and Rickards attended a meeting with European Sea Level Service and EuroGOOS specialists with the aim of providing improved access to real-time sea level data from the European Atlantic coastline. Since then, colleagues from the Danish Meteorological Institute have worked with POL and BODC to set up a Sea Levels along the European Atlantic Coastline (SLEAC) web site (www.sleac.org).
- Also in March, Dr. Woodworth attended the conference of the Ocean Surface Topography Science Team (OSTST) in Venice, Italy.
- In addition, in March Dr. Woodworth attended the annual meeting of FAGS Council at the Observatoire de Paris.

- In April, Dr. Woodworth and colleagues took part in a meeting at Bangor, Wales to celebrate the retirement of Professor John Simpson.
- Also in April, Dr. Horsburgh represented the PSMSL at a meeting of French sea level scientists and technologists at La Rochelle, France.
- Again in April, Dr. Jevrejeva represented the PSMSL at a GGOS Working Group meeting at the European Geophysical Union conference in Vienna, Austria.
- In addition, in April Dr. Woodworth attended the Second ODINAFRICA Seminar at Oostende, Belgium in preparation for the major investment in sea level networks in Africa.
- In May, Dr. Woodworth attended a technical meeting on BGAN held at Inmarsat's offices in London with a view to using BGAN telemetry for tide gauge data.
- Also in May, Dr. Holgate took part in outreach activities at Liverpool schools.
- In June, Prof. Willmott (Director POL) and Drs. Jevrejeva and Woodworth from PSMSL attended a meeting at the Department for International Development (DfID) in London in order to investigate DfID's interest in funding sea level networks in Africa and elsewhere. The meeting was hosted by Prof. Sir Gordon Conway FRS, DfID Chief Scientist. Possibilities for taking conclusions of the meeting forward are now being investigated.
- In September, Dr. Woodworth attended a meeting of developers of the Liverpool waterfront with the aim of including some recognition in their plans of Liverpool's historical role in sea level science. Various options exist for tidal-related themes in the developments.
- In October, Dr. Woodworth attended the first meeting of the European Union-funded TRANSFER (tsunami risk in Europe) project in Bologna, Italy.
- Also in October, Dr. Holgate visited Inmarsat in London for a technical meeting on the use of BGAN for real-time tide gauge data transmission.
- In addition, in October delegates from the National Marine Data Information Service (NMDIS) in Tianjin, China visited POL and were given a presentation on the work of the PSMSL by Dr. Holgate.
- In November, Dr. Woodworth attended the users workshop for the Gravity Field and Steady State Ocean Circulation Explorer (GOCE) mission in Frascati, Italy.
- Also in November, Drs. Jevrejeva and Holgate gave presentations to Dr. Brian Iddon MP, who serves on the UK Parliamentary Committee for Science and Technology, and Commodore David Lewis who is head of UK National Marine Facilities.

6. Staff

6.1 New Geophysicist/Geodesist

Arrangements have been made for the recruitment of a scientist at POL with geophysical or geodetic expertise to work alongside PSMSL. It is hoped that the person selected will be able to help the PSMSL play a more active role in the development of the Global Geodetic Observing System (GGOS) as well as to expand the range of scientific research at POL.

6.2 New PSMSL Director

A proposal has been put to FAGS for the retirement of Dr. Woodworth as PSMSL Director and replacement from April 2007 by Dr. Lesley Rickards (BODC) who manages presently the GLOSS Delayed Mode (DM) data bank and is chair of the International Oceanographic Data and Information Exchange (IODE) of IOC. This proposal has since been agreed to by

the International Association for the Physical Sciences of the Oceans (IAPSO), to which the PSMSL formally reports, and IOC and is expected to be endorsed by FAGS Council at its next meeting in April 2007.

Earlier in the year, the PSMSL made an application to the UK Natural Environment Research Council (the parent body of POL) for continued and modestly expanded funding for the next five years. A major aspect of that application was the merger as far as possible of the PSMSL and GLOSS DM activities (both at Liverpool and both DM, although technically one within POL and one within BODC). The proposal was graded as 'alpha-5', the highest possible, which provides a clear way forward.

7. Publications and Outreach

Appendix 2 provides a list of relevant papers published in 2006. Dr. Woodworth has continued his work as a contributing author to the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment which will be published in 2007.

In February, Dr. Woodworth took part in a BBC Radio 5 Live debate on how climate and sea level might change in the next 1000 years. In June, he contributed to an article in the Liverpool Echo newspaper on the need to raise waterfront buildings as sea level rises. In addition, he provided information in June for an article by Geoff Watts in New Scientist magazine on Captain William Hutchinson, who provided the first extended set of sea level measurements in the UK. Dr. Woodworth also took part in June in an interview on Swiss Radio concerning sea level change.

In September, Dr. Woodworth took part in filming for a programme in the BBC Coast series. This one concerned the tides, storm surges and coastal erosion along the north Norfolk coast of the UK, mentioning in particular the 1953 storm surge which resulted in large loss of life.

8. Visitors to the PSMSL in 2006

Visitors welcomed to the PSMSL during the year included Dr. Marek Ziebart (University College, London), Ross Hibbins and Gary Marshall (Bureau of Meteorology, Australia), Drs. Bob Gatliff, John Ludden and Peter Balson (British Geological Survey), Drs. Glenn Nolan and Guy Westbrook (Marine Institute, Ireland), Dr. Mark Tamisiea (Havard-Smithsonian Centre for Astrophysics, USA), Prof. Keith Tinkler (Brock University, Canada), Mr. Graham Alcock (Auckland, New Zealand), Mr. Simon Wills (OTT UK Ltd.), Dr. Thorkild Aarup (IOC) and Dr. Brian Iddon, MP.

Summary

It can be seen that 2006 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.

Finally, as this will the last PSMSL Annual Report I shall write, I would like to thank my colleagues in sea level at POL and elsewhere who have made the job of PSMSL Director so enjoyable.

P.L. Woodworth
Director PSMSL
December 2006

Appendix 1: Number of station-years entered into the databank for each country or coastline in the period mid-December 2005 to mid-December 2006 (1970 total).

SPITSBERGEN	2	JAPAN (AMAMI GUNTO)	26
RUSSIAN FEDERATION (ARCTIC)	2	JAPAN (HONSHU-JAPAN SEA)	120
SWEDEN	10	PAPUA NEW GUINEA	1
FINLAND	33	AUSTRALIA	84
GERMANY (FORMER DDR) BALTIC	8	NEW ZEALAND	83
GERMANY (FORMER FRG) BALTIC	4	GUAM	2
NETHERLANDS	22	CAROLINE IS (FED. STATES OF MICRONESIA)	5
UNITED KINGDOM	42	NAURU	1
CHANNEL ISLANDS	1	MARSHALL ISLANDS	4
SPAIN (ATLANTIC)	12	KIRIBATI	1
GIBRALTAR	1	TUVALU	1
SPAIN (MEDITERRANEAN)	70	SOLOMON ISLANDS	1
GREECE	40	VANUATU	1
RUSSIAN FED. (BLACK SEA)	2	FIJI	2
GEORGIA	62	TONGA	1
SPANISH N. AFRICA	62	AMERICAN SAMOA	2
PORTUGAL (AZORES)	43	WESTERN SAMOA	1
PORTUGAL (MADEIRA)	29	HAWAIIAN ISLANDS	12
SPAIN (CANARY ISLANDS)	4	COOK ISLANDS	1
ASCENSION	2	USA (ALEUTIAN ISLANDS)	4
NAMIBIA	2	USA (ALASKA)	30
SOUTH AFRICA	56	CANADA (PACIFIC COAST)	61
INDIA	9	USA (PACIFIC COAST)	42
THAILAND (ANDAMAN SEA)	1	ECUADOR	3
SINGAPORE	28	ARGENTINA	3
INDONESIA	97	FALKLAND ISLANDS (MALVINAS)	2
SULAWESI	10	BRAZIL	51
MALUKU	10	CUBA	21
THAILAND (GULF OF THAILAND)	4	PUERTO RICO	4
HONG KONG, CHINA	6	VIRGIN ISLANDS	4
RUSSIAN FED. (PACIFIC OCEAN)	4	USA (GULF)	39
JAPAN (HOKKAIDO)	74	BERMUDA	2
JAPAN (HONSHU-PACIFIC)	171	USA (ATLANTIC)	70
JAPAN (HONSHU-INLAND SEA)	57	CANADA (ATLANTIC AND ARCTIC)	156
JAPAN (SHIKOKU)	27	ANTARCTICA	10
JAPAN (KYUSHU)	112		

Appendix 2: Some Relevant Reports dated 2006

Woodworth, P.L. 2006. The meteorological data of William Hutchinson and a Liverpool air pressure time series spanning 1768-1999. International Journal of Climatology, 26(12), 1713-1726.

Andrew, J.A.M., Leach, H. and Woodworth, P.L. 2006. The relationships between tropical Atlantic sea level variability and major climate indices. Ocean Dynamics, doi:10.1007/s10236-006-0068-z.

Woodworth, P.L. 2006. Preface. Theme Issue 'Sea level science'. Philosophical Transactions of the Royal Society, A, 364, 783-784. doi:10.1098/rsta.2006.1755.

Woodworth, P.L. 2006. Some important issues to do with long term sea level change. Philosophical Transactions of the Royal Society, A, 364, 787-803. doi:10.1098/rsta.2006.1737.

Woodworth, P.L., Hughes, C.W., Blackman, D.L., Stepanov, V.N., Holgate, S.J., Foden, P.R., Pugh, J.P., Mack, S., Hargreaves, G.W., Meredith, M.P., Milinevsky, G. and Fierro Contreras, J.J. 2006. Antarctic peninsula sea levels: a real time system for monitoring Drake Passage transport. Antarctic Science, 18(3), 429-436.

Jevrejeva, S., Grinsted, A., Moore, J.C. and Holgate, S. 2006. Nonlinear trends and multiyear cycles in sea level records. Journal of Geophysical Research, 111, C09012, doi:10.1029/2005JC003229.

Joseph, A., Odametey, J.T., Nkebi, E.K., Pereira, A., Prabhudesai1, R.G., Mehra1, P., Rabinovich, A.B., Vijaykumar, Prabhudesai, S. and Woodworth, P.L. 2006. The 26 December 2004 Sumatra tsunami recorded on the coast of West Africa. African Journal of Marine Science (in press).

Woodworth, P.L., Flather, R.A., Williams, J.A., Wakelin, S.L. and Jevrejeva, S. 2006. The dependence of UK extreme sea levels and storm surges on the North Atlantic Oscillation. Continental Shelf Research (in press).

Holgate, S.J., Woodworth, P.L., Foden, P.R. and Pugh, J. 2006. A study of delays in making tide gauge data available to tsunami warning centres. Submitted for publication.

Holgate, S.J., Foden, P.R. and Pugh, J. 2006. Tsunami monitoring system: implementing global real time data telemetry. Submitted for publication.

Holgate, S.J. 2006. On the decadal rates of sea level change during the twentieth century. Geophysical Research Letters (in press).

Aarup, T., Merrifield, M., Perez, B., Vassie, I and Woodworth, P. 2006. Manual on sea-level measurement and interpretation. Volume 4 - An update to 2006. Intergovernmental Oceanographic Commission Manuals and Guides No. 14. IOC, Paris, 80pp.

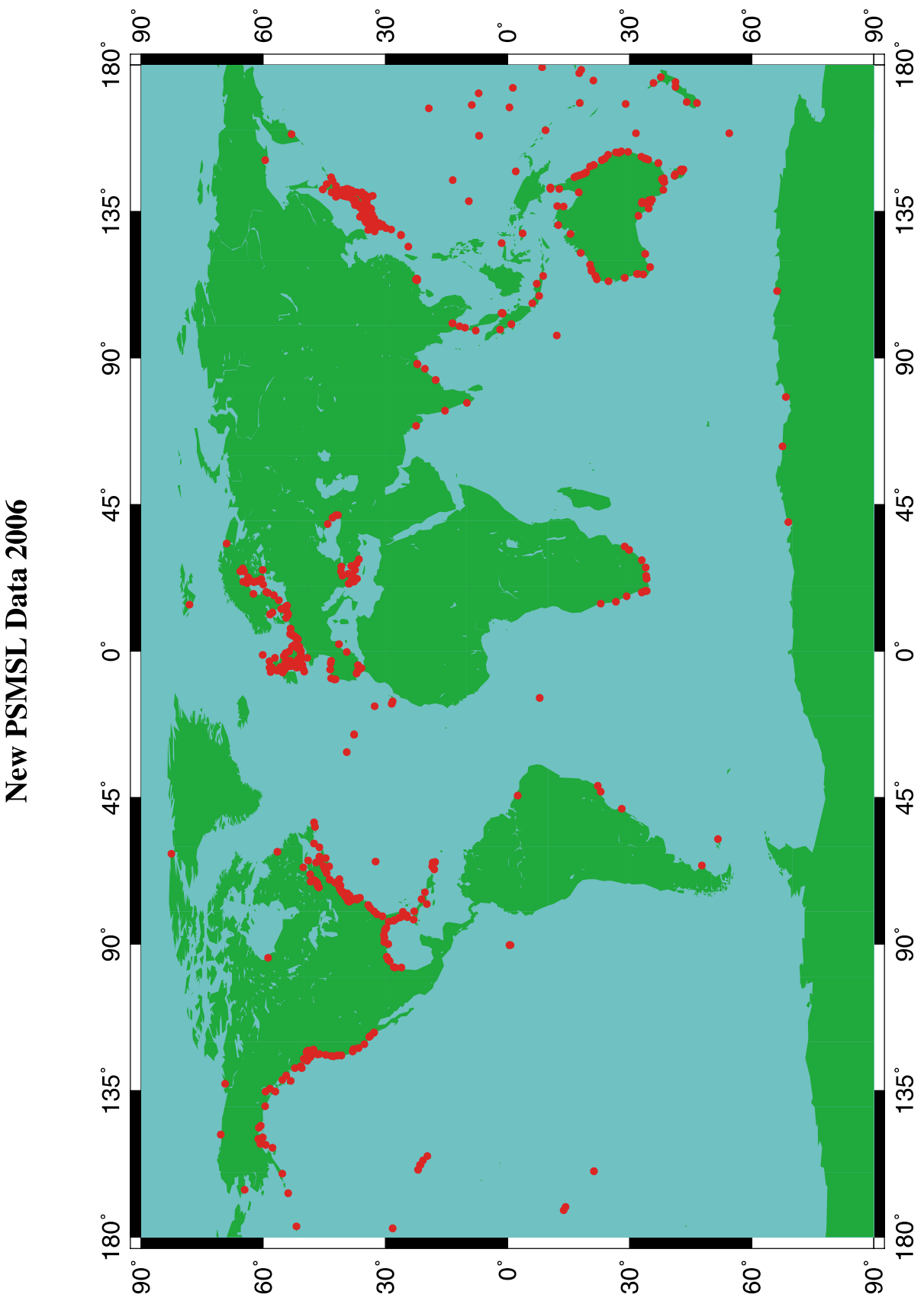
New PSMSL Data 2006
90°
60°
30°
0°
30°
60°
90°
180°
135°
90°
45°
0°
45°
90°
135°
180°

Figure 1