



**Proudman
Oceanographic Laboratory**
NATURAL ENVIRONMENT RESEARCH COUNCIL

Sea Level Monitoring and the GLOSS Programme

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Permanent Service for Mean Sea Level

Proudman Oceanographic Laboratory, UK

Port Meteorological Officers Meeting, IMO, 25 July 2003



The Global Sea Level Observing System

- 1. Monitoring Sea Level – Some Background**
- 2. The GLOSS Programme – Network and Activities**
- 3. Port Meteorological Officers as GLOSS Contacts**



Why Measure Sea Level?

- Scientific research – e.g. to measure long term changes in global sea level and ocean circulation
- Practical applications – e.g. to predict flood risks in coastal regions

and for PORTS ! (tide tables, extreme levels, navigation)

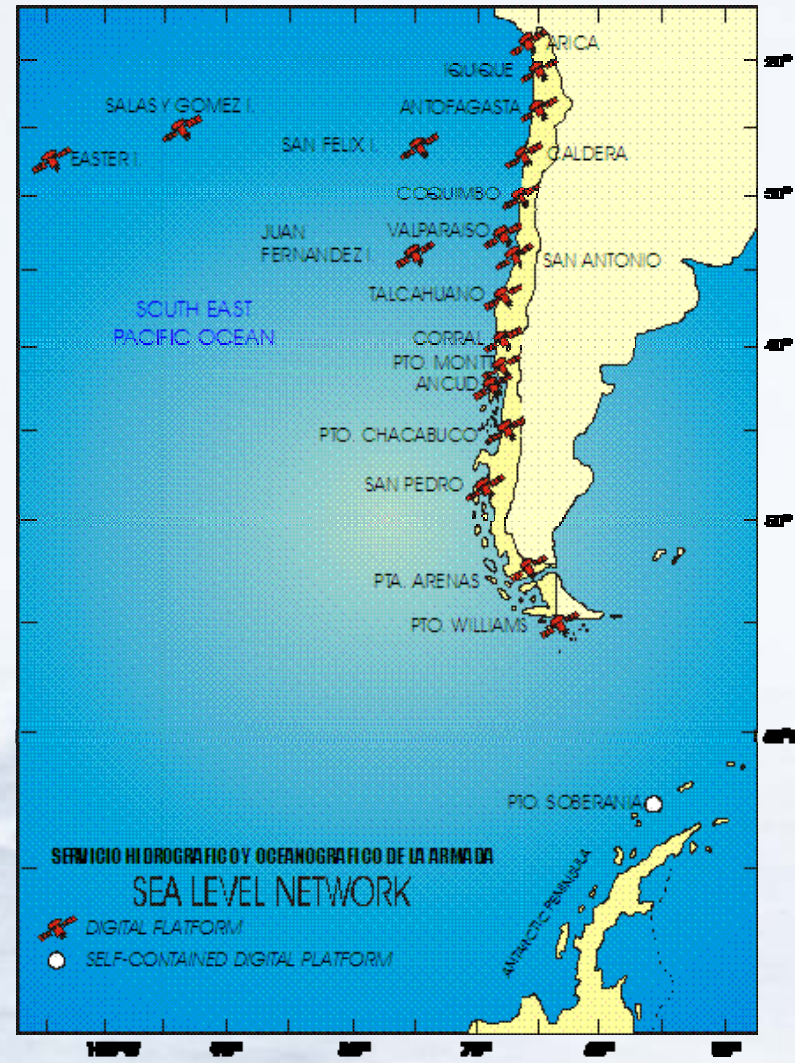
National Sea Level Networks

- UK Tide Gauge Network for both national and international scientific and practical purposes



National Sea Level Networks

- Chile Tide Gauge Network
- Another example of a network which contributes data both nationally and internationally



Classical Float Gauge

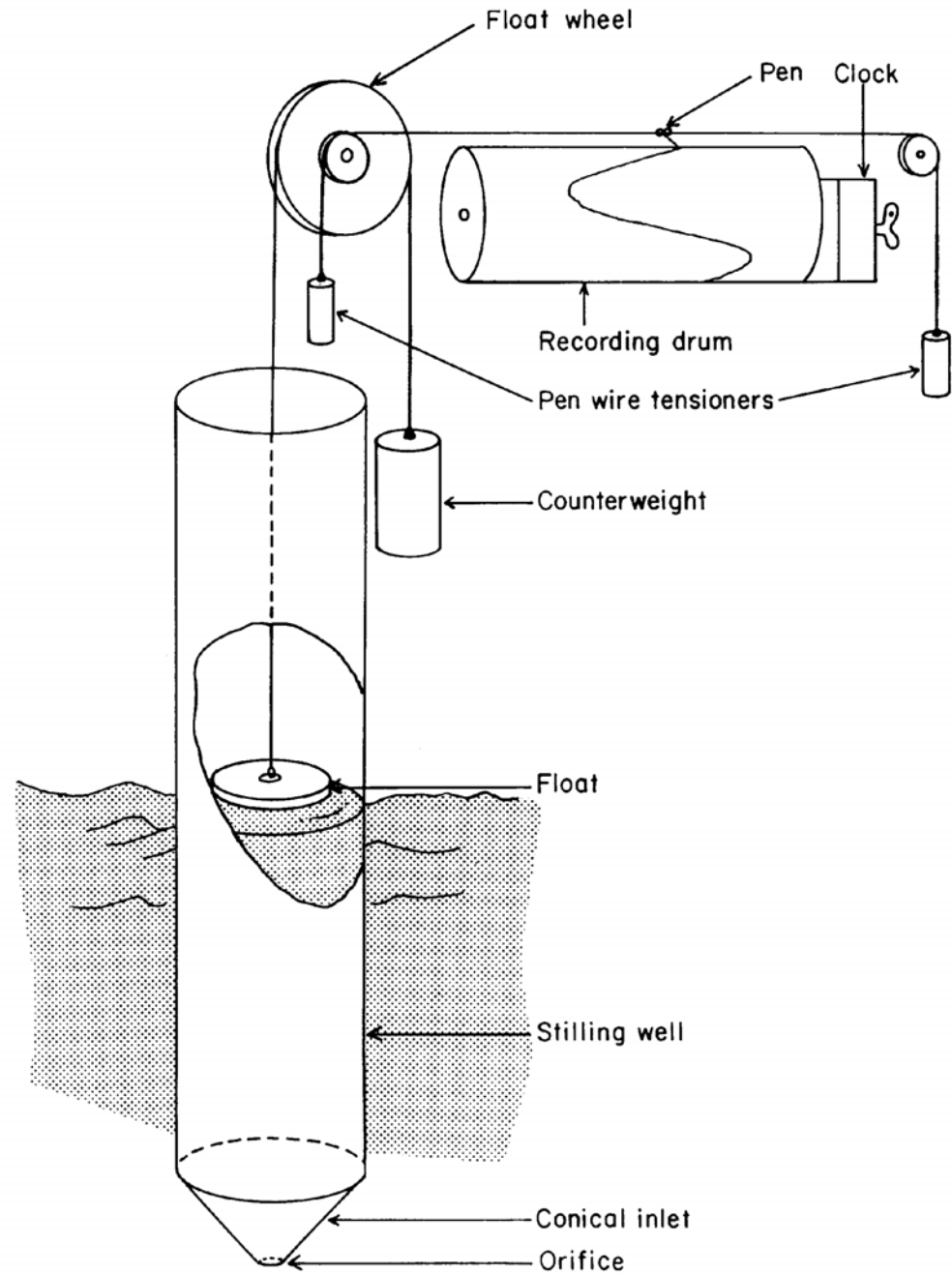


Figure 3.1



UK Float Gauge at Holyhead

Float gauges
are still important
and can be made
into digital gauges
with the use of
encoders

Acoustic SEAFRAME Gauge in Australia

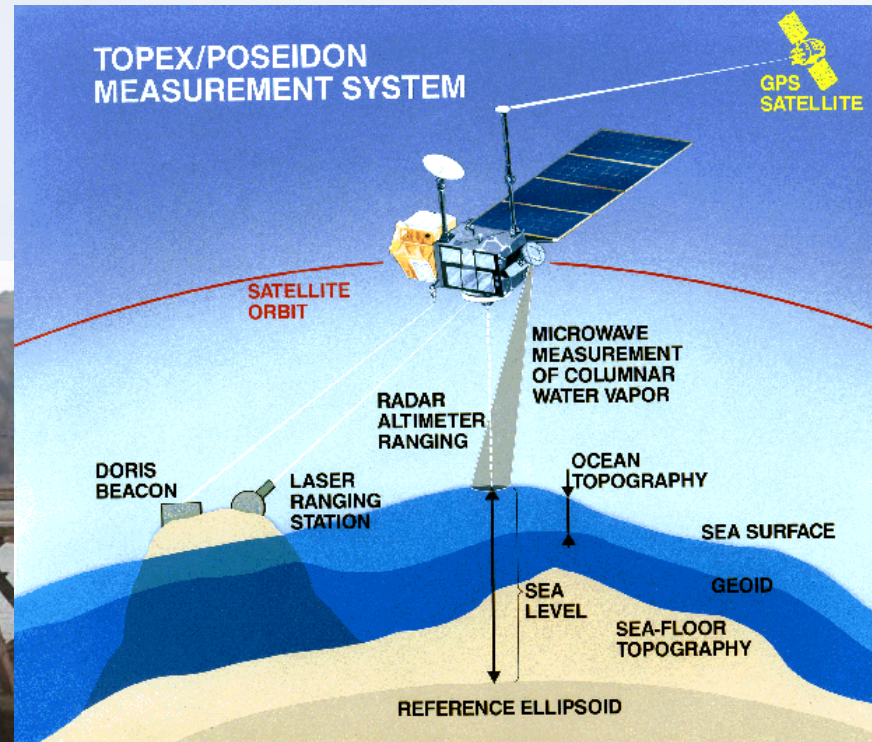
- There are also many
other types of tide
gauge



Complementary Tools for Measuring Sea Level Changes



Tide Gauges



Satellite Altimetry



Sea Floor Systems



Why Tide Gauges in the “Age of Altimetry from Space”?



Acoustic Gauge in Australia

- Principle of continuity, relative low cost of gauges
- Long records for studies relating to climate change
- Higher frequency sampling important in straits and other areas
- High latitude regions of ice coverage
- Altimeter calibrations
- Coastal applications: Hydrography, Navigation, flood warning etc. Almost too many to mention



Sea-Level Changes Impact Coasts (where people live)



Maldives Int. Airport

Different Time-Scales

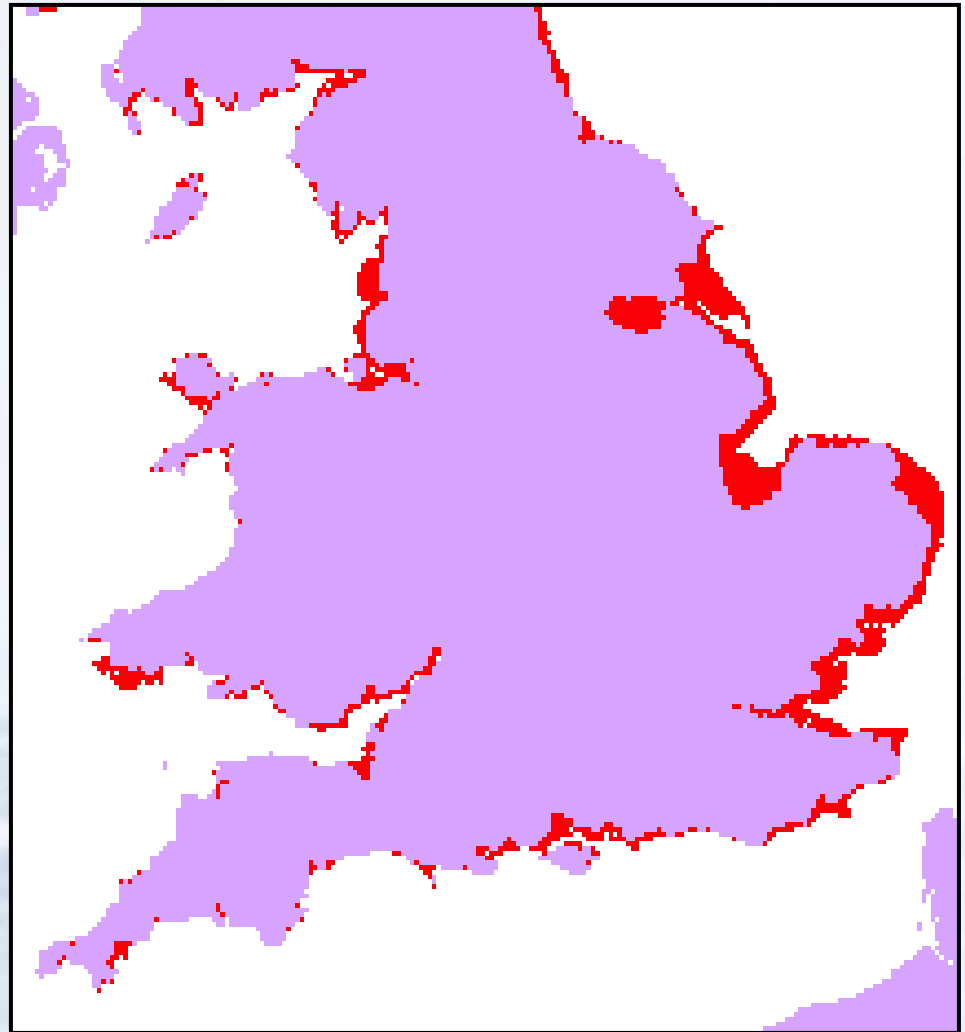
- Momentary changes due to tsunamis
- Daily changes due to tides and surges
- Seasonal changes
- Interannual changes e.g. due to ENSO
- Long term changes due to climate change

Causes of Sea Level Change

- Local processes in river/coastal regimes
- Ocean circulation changes
- Regional and global climate changes
- Geological processes

Coastal areas at risk

- Areas below 1000-year return period level
- By 2100: the **1 in 1000 year** flood level (shown here in red) may become a **1 in 100 year** level



Floods in the Irish Sea 2002

Douglas



Ramsey



"the worst in living memory"

Many \$M's damage in few hours

Pictures from
<http://www.iomonline.co.im/ftpinc/weather/febheightide.asp>.

What are we doing internationally to share data from the tide gauge networks?

(and thereby learn more about why sea level changes)

Permanent Service for Mean Sea Level

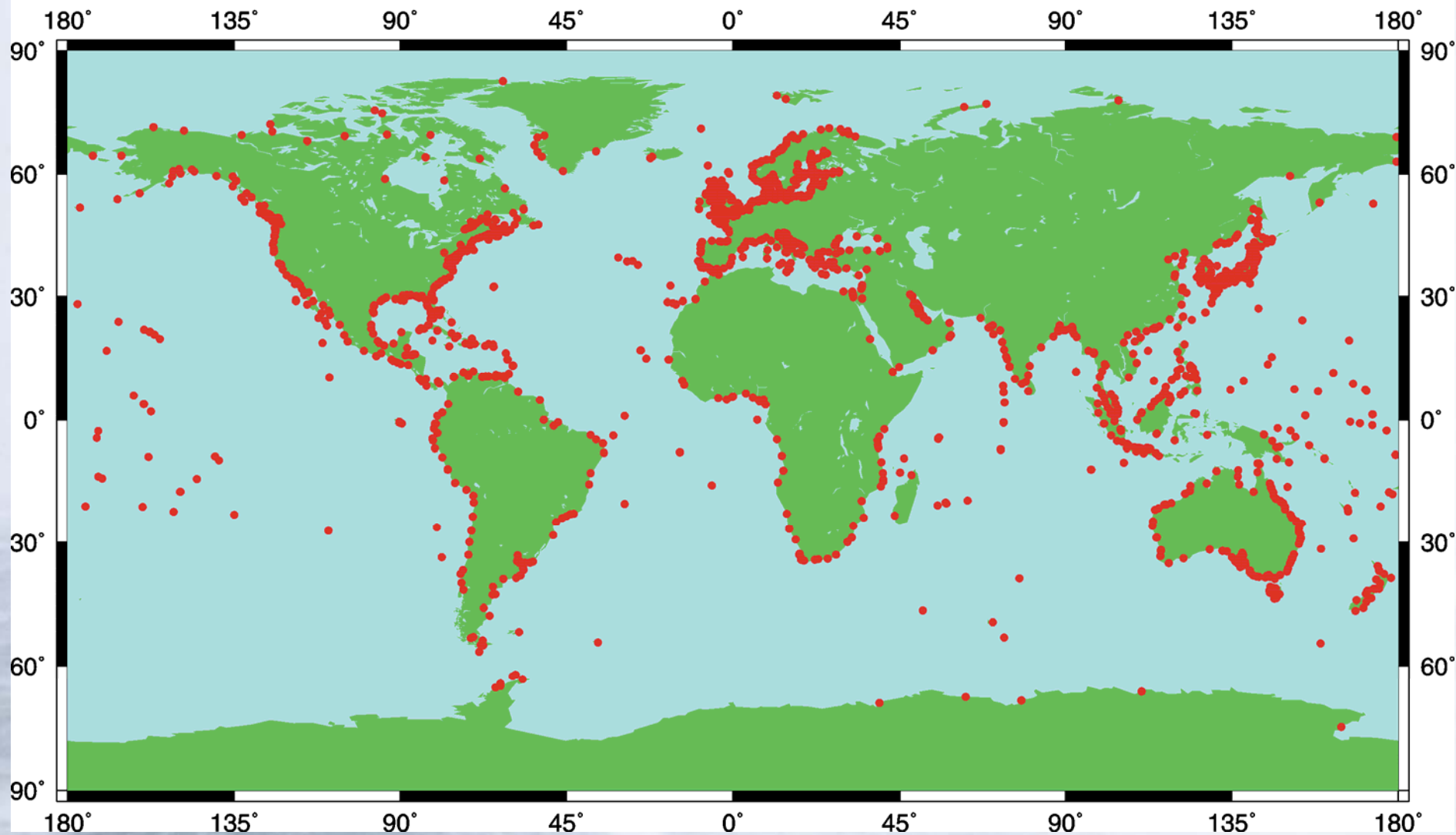
Most tide gauge agencies regularly send their monthly and annual Mean Sea Level (MSL) data to the PSMSL.

Founded in 1933 by International Council for Science.

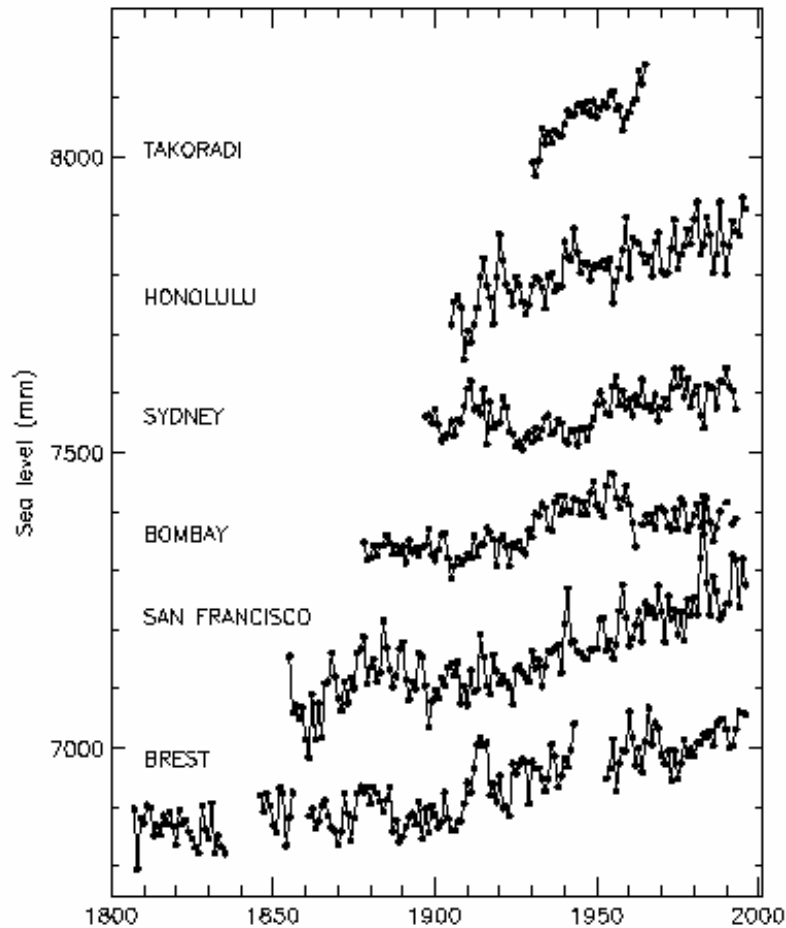
Data set contains 50,000 station-years of MSL data.

The PSMSL is more than a data bank. It attempts to provide an overall Service to the sea level community (technical and scientific advice, educational materials, FAQ web pages etc.)

Distribution of PSMSL Stations



MSL Changes in Last 100 Years

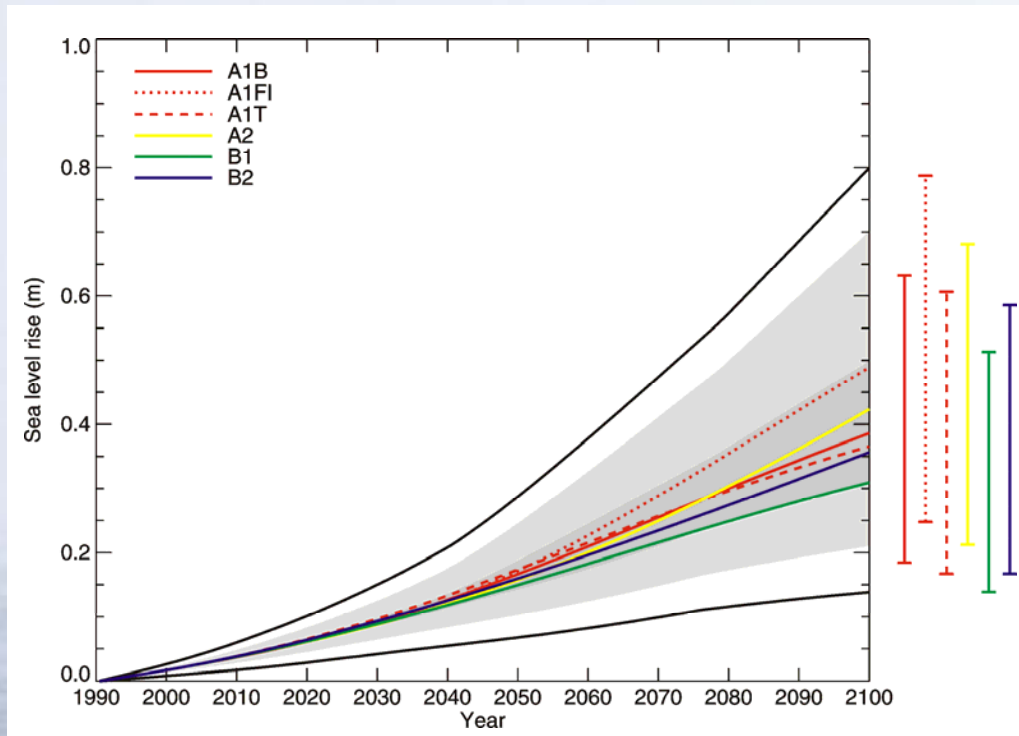


Past 100 years

- Most PSMSL records show evidence for rising sea levels during the past century
- IPCC Third Assessment Report concluded that there has been a global rise of approximately 10-20 cm during the past 100 years



Long Term Changes in Sea Level



Projected sea level rise, IPCC 2001

Next 100 years

- a rise between 9 and 88 cm
- a central value of 48 cm
- a rate of approx. 2.2 - 4.4 times that of the past 100 years

The Major Problem with the Present 'Global' PSMSL Sea Level Data Set

- Uneven geographical distribution: the PSMSL data set is under-represented in Africa, Antarctica etc. and there are no long term records from the deep ocean.

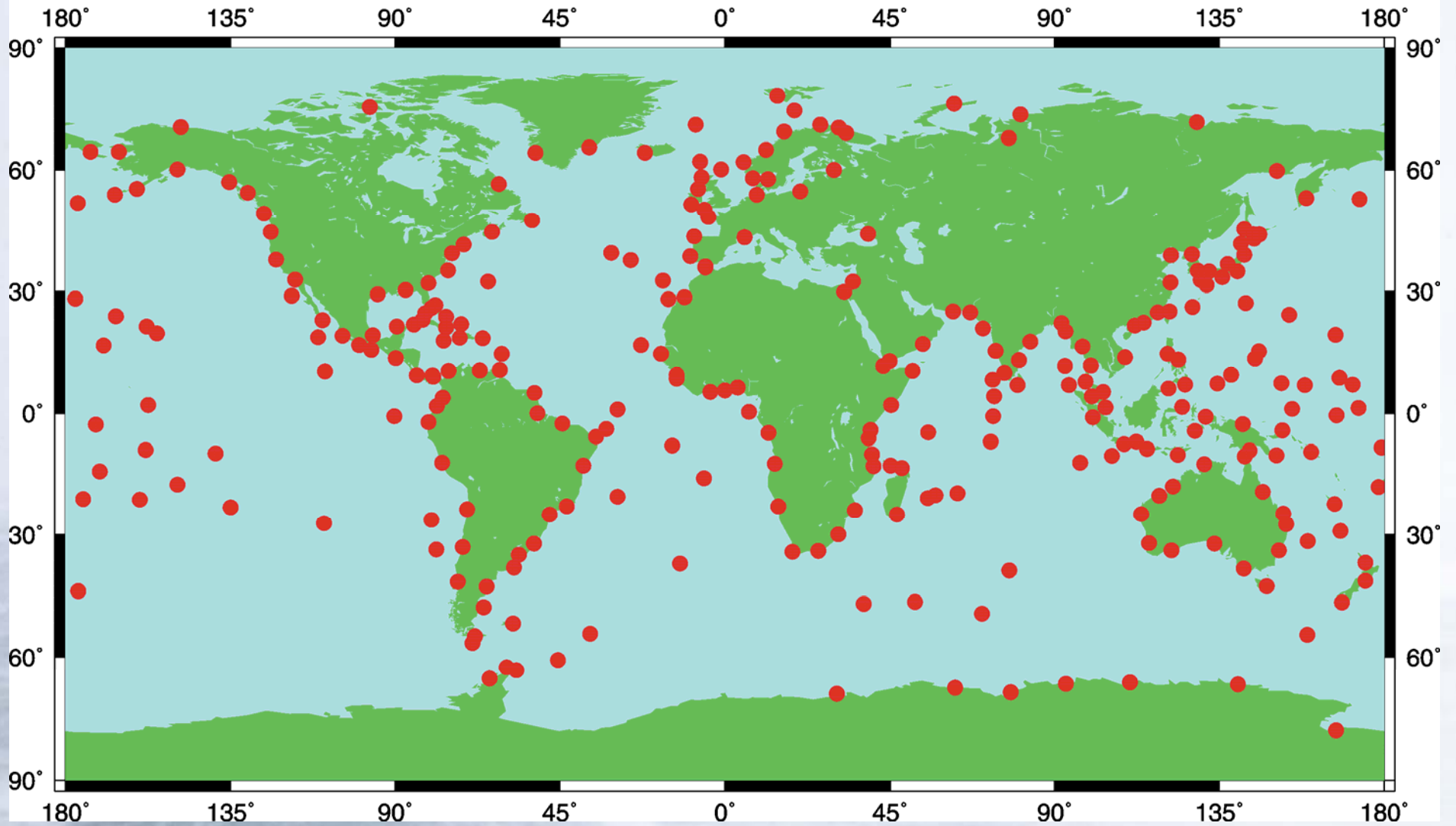
SOLUTIONS → The GLOSS programme to densify the existing tide gauge network, and programmes of satellite altimetry to measure sea levels from space. Also some deep ocean measurements.



GLOSS - The Global Sea Level Observing System

- Establishment of high quality global and regional sea level networks for application to climate, oceanographic and coastal sea level research
- Sea level stations around the world for long term climate change and oceanographic sea level monitoring
- Coordinated by the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the Intergovernmental Oceanographic Commission (IOC) and WMO
- Major contributor to JCOMM's Global Ocean Observing System (GOOS)

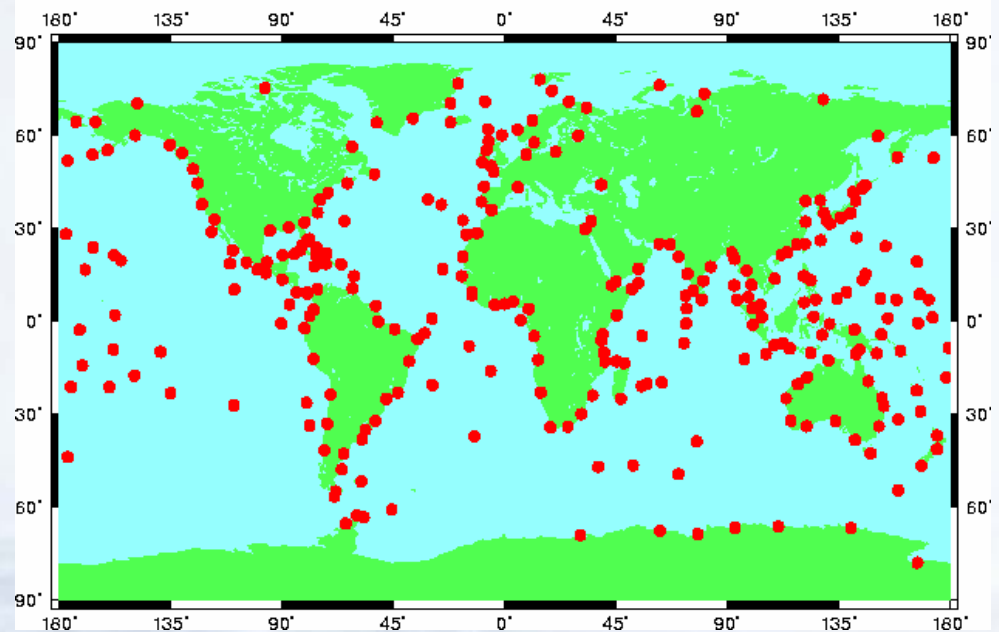
GLOSS Core Network defined by GLOSS02





The GLOSS Programme/Networks

- GLOSS Core Network (GCN)
- Regional Densifications of the GCN
- Long Term Trends (LLT)
- Altimeter calibration (GLOSS-ALT set)
- Ocean Circulation (GLOSS-OC set)



GLOSS Core Network (GCN) with approx. 280 stations



GLOSS Activities

Regional Developments

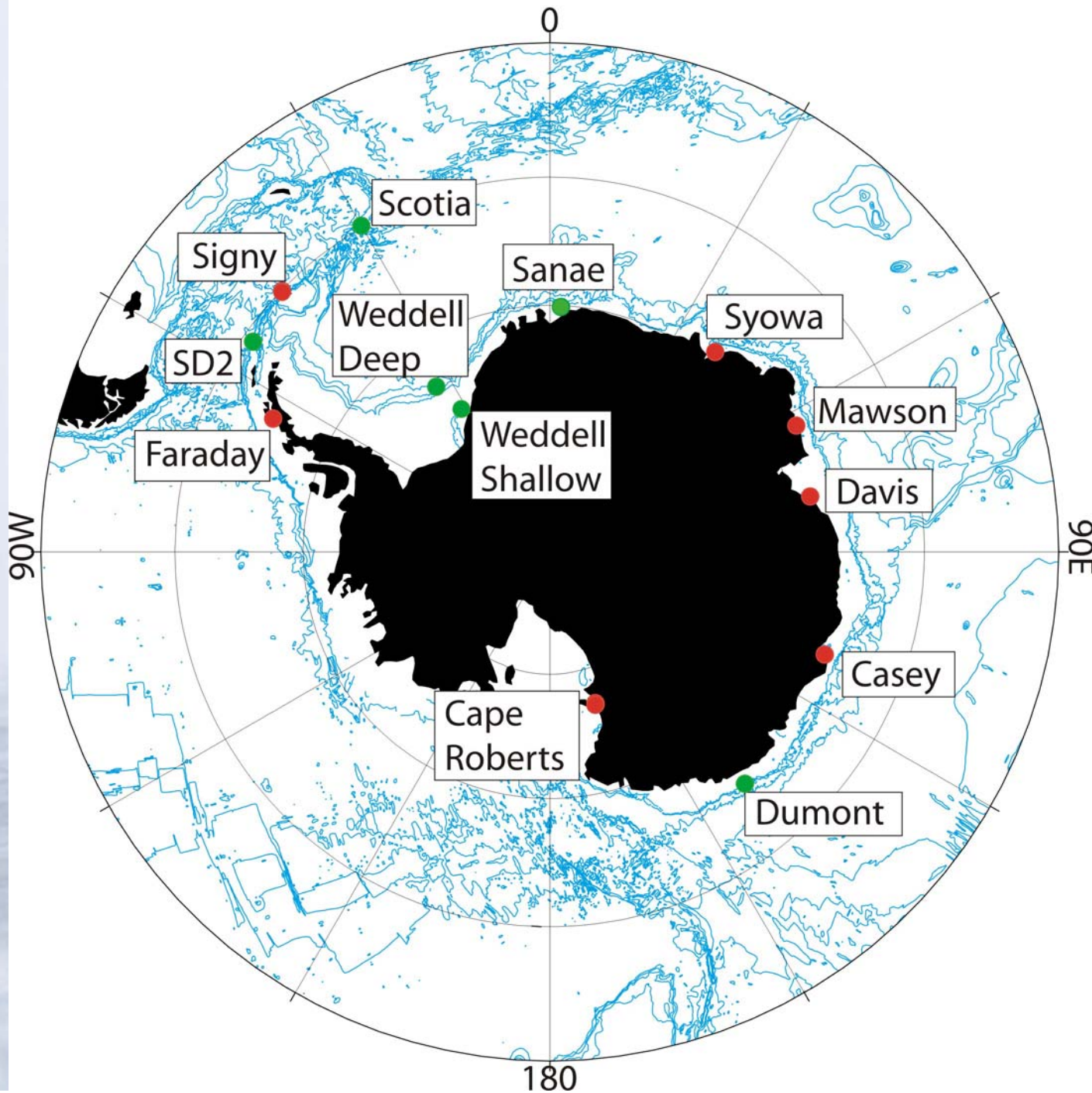
- Regional networks of gauges with greater spatial density, to serve the particular oceanographic interests of those regions - examples: IOCARIBE (Caribbean), MedGLOSS (Mediterranean & Black Seas)

National Activities

- Contribution to the activities of national agencies by improving the standards for sea level recording around the world

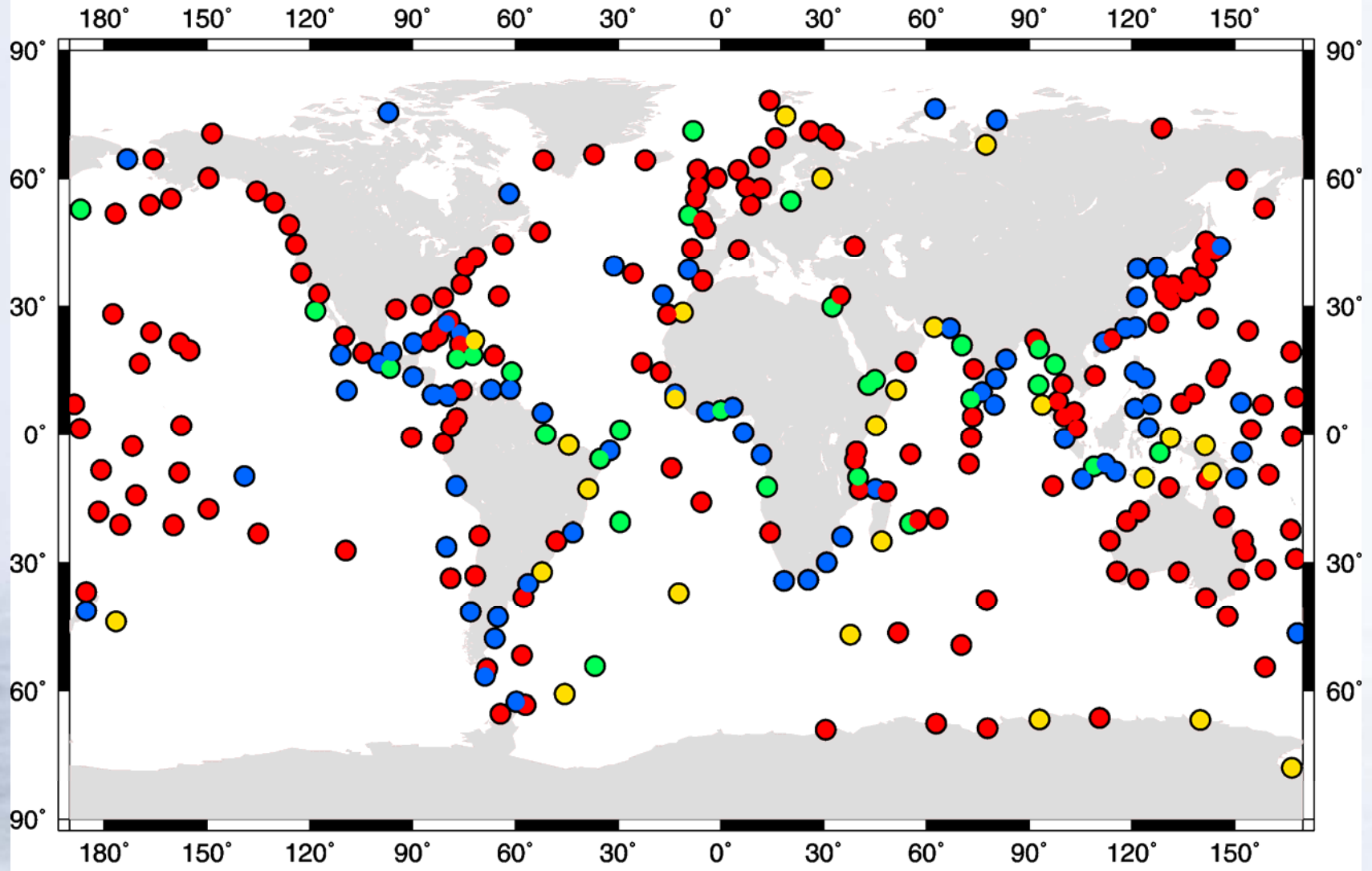
Training

- Annual training courses on the techniques of tide gauge operations, and workshops on special interests e.g. measurements in environmentally hostile areas



Southern Ocean sea levels are hard to monitor with altimetry → gauges are essential.

GLOSS status within the PSMSL dataset. October 2002



Status category: ● 1 ● 2 ● 3 ● 4

Status: GLOSS is about 50% Operational

Our Objective: To Develop a GLOSS which is 100% Operational

To do that:

- **Personal contacts are as important as hardware for monitoring systems → PMOs.**
- **Our background is primarily oceanographic or hydrographic. So PMOs provide us with a different but relevant set of personal contacts.**

What might we want you to do?

- You are ‘governmental’ so you can point us to ‘important’ people in your country e.g.**
- If a new gauge is proposed, who is the best person to contact for site selection, maintenance etc.**
- Once it is installed, there may simple things to be fixed or serious faults reported responsibly**
- Occasionally strange things happen (e.g. storms or swell events) and local insight needed into local weather.**

GLOSS has not made use of PMOs in the past which may have been a big mistake.

I hope this presentation has put this some of this omission right, and that we can occasionally rely on you in the future.

A big bonus is that, because of establishment of JCOMM, GLOSS is as much a part of the WMO as it is of IOC.

Conclusion

If all nations work together, and if all communities work together (e.g. PMOs with oceanographers), then there is more chance of GLOSS being successful in providing the global data sets this important area of work requires.



GLOSS - The Global Sea Level Observing System

Documentation

- July 1997: Second Implementation Plan for the GLOSS Program
- July 2003: GLOSS Adequacy Report
- IOC Manuals on Sea Level Measurement and Interpretation (Manuals and Guides No. 14, 3 volumes)

Further Information

GLOSS Technical Secretary
Intergovernmental Oceanographic
Commission (IOC), UNESCO
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Permanent Service for Mean Sea Level
Proudman Oceanographic Laboratory
email: psmsl@pol.ac.uk

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