The Proudman Oceanographic Laboratory and Southern Ocean Sea Levels:  
Summary of activities prepared for the POGO-4 Meeting  
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1. Antarctic Sea Levels  
The history of sea level measurements at Antarctic bases extends for almost a century. Early recording was usually by tide pole or temporary summer stilling well, over a short period of a fortnight or so, for the purpose of determining tidal constants. Not until the establishment of the UK Faraday (now Ukrainian Vernadsky) station in 1958, as part of the International Geophysical Year activities, did Antarctica have a truly long-term sea level station. Faraday had (and still has) a heated well with a chart recording float gauge using ‘wrong size’ charts, provided first by the National Institute of Oceanography, then the British Antarctic Survey (BAS) and now the Proudman Oceanographic Laboratory (POL) in collaboration with the Ukrainian Antarctic Expedition. Faraday also now has a pressure gauge provided by POL.

Other stations with long records include Syowa (Japan) and, more recently, Mawson, Davis and Casey (Australia) which are of high quality, and which were subject to an external review by POL in 2002. Antarctic gauges are of many types (float, pressure and acoustic) with pressure gauges being the most used. Figure 1 shows a network of coastal stations which provided data in the period 1995-6, together with bottom pressure recorders (BPRs) available near the coast at this time. Other stations, such as Rothera (UK, gauge operated by BAS/POL), Dumont D’Urville (France) and Scott Base (NZ) are being added at present.

Most long Antarctic sea level records are represented in the Permanent Service for Mean Sea Level (PSMSL) data set (http://www.pol.ac.uk/psmsl/) while catalogues of historical records can be found in reports of the Scientific Committee on Antarctic Research (SCAR) (http://www.scar.org). In addition, the Australian National Tidal Facility (ANTF) operates a prototype Southern Ocean Sea Level Centre on behalf of the Global Sea Level Observing System (GLOSS) of the Intergovernmental Oceanographic Commission (IOC) and maintains a catalogue of available data.

The GLOSS programme has held several workshops on the operation of gauges in ‘environmentally hostile areas’ in the last decade (see above PSMSL web page for references). A main factor in operations is that the ‘best’ sea level measurements are not always possible in such difficult conditions, and that ‘second best’ is always better than nothing. Also, it is always desirable to have parallel, redundant systems as one never had enough data and all records from Antarctica contain gaps.
GLOSS has three data streams: delayed mode MSL data; delayed mode higher frequency data (typically hourly values); and ‘fast’ (or quasi real-time) data. Data from the fast stream are required to go to the GLOSS Fast Centre at the University of Hawaii. Partly because of the environmental conditions and partly because of the need for modernization of equipment, fast data from only a few Antarctic gauges are available so far.

Antarctic recording has received a boost in recent years because of concerns of long term sea level rise and consequent interest in how Southern Ocean sea (and land) levels are changing. As yet, few sites, apart from the Australian ones, have Continuous GPS (CGPS) receivers alongside the gauges to conduct essential monitoring of vertical land movements, as is now becoming routine at lower latitudes.

Antarctic sea level recording has been recognized as being important for monitoring the Antarctic Circumpolar Current (ACC), with ‘south side’ ACC gauges being more useful for monitoring flows than ‘north side’ ones (owing to the presence of other oceanographic processes on the north side), and year-round altimetry not being accessible throughout the whole Southern Ocean. The Southern Ocean constituted ‘Core Project 2’ of the World Ocean Circulation Experiment, and several POL papers are in preparation on the use of Antarctic gauges for ACC monitoring.

2. ‘North Side’ Sea Levels
POL has contributed to the development of GLOSS on the ‘north side’ of the ACC, with gauges at Port Stanley and Tristan da Cunha (http://www.pol.ac.uk/psmsl/programmes/acclaim.info.html). In addition, it has for a decade operated BPRs across the Drake Passage (following the classic work of Wearn and Baker in the 1970s) and, in the late 1980s and early 1990s, between Kerguelen and Amsterdam Islands in the Indian Ocean. Data are available via http://www.pol.ac.uk/psmsl/programmes/gloup.html which also contains BPR data from other groups.

3. Bottom Pressure Recorder (BPR) Developments
It is likely that the POL Drake Passage BPR activities will be scaled down in the next two years, as the use of coastal gauges for ACC monitoring becomes established and as BPRs are required for other programmes (e.g. the UK Rapid Climate Change programme). However, BPRs will continue to be used in the Southern Ocean in process studies (e.g. SHAGEX project in the SW Atlantic) and potentially ‘disposable’ deployments from aircraft or submarines. The scientific interest in such work includes under-ice tidal information, required to tune barotropic tide models and to understand mixing processes.

4. Reviews of Southern Ocean Sea Level Research
5. Collaboration

Finally, we wish to stress the importance of collaboration in Southern Ocean (and especially Antarctic) sea level research, and the need to exchange relatively sparse sea level data, which is far more valuable within a network. POL is grateful for especially stimulating cooperation with Ukrainian, Japanese, French, US, Australian and New Zealand colleagues.

*Figure 1*: An example of the available Antarctic network, in this case for data from 1995-6. Red points are coastal stations and blue points are BPRs.