

The Mass Budget of the Lambert Glacier-Amery Ice Shelf system

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Introduction

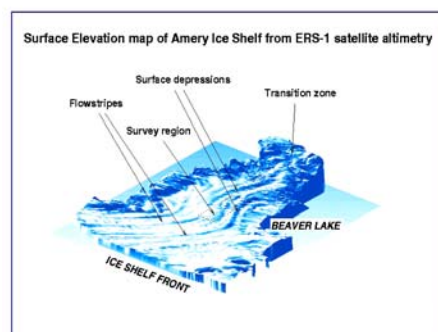
- ❖ The Lambert Glacier-Amery Ice Shelf (AIS) system drains approximately 11% of Antarctica and its mass budget could potentially have a great influence on global sea-level change
- ❖ The AIS is of particular interest due to its ice-ocean interface it will respond to changes in ocean temperatures as well as those occurring in the atmosphere
- ❖ Since 1968, geodetic quality measurements have been made on the AIS in order to determine its velocity, surface elevation and tidal characteristics. Recent GPS and satellite-based measurements extend this time series to the present day (37 years)
- ❖ A direct estimation of the mass budget of the AIS could in theory be derived from AIS elevation measurements since changes in ice shelf thickness may be determined from elevation changes given a density model of the ice shelf. Multi-decade observations increase observation precision and reduce the effects of short-period thickness variations. However, until recently, the older levelling data could not be related accurately to the more recent measurements since they were in different reference systems; accurate geoid and ocean tide models were required to make this connection which are now available (e.g., geoid from GRACE data, Antarctic regional ocean tide models)
- ❖ In this project, we seek to combine all surface elevation data in an attempt to determine the ice mass balance of the Lambert Glacier-Amery Ice Shelf system. CryoSat data are vital in extending the time series further, especially in the steep grounding zone regions of the system. Substantial modelling will be required to determine the driving mechanism(s) for any observed change

Current Data Sets



1968 Levelling Data

Approximately 300 km of geodetic levelling (route shown above) connected to instantaneous sea level in NE AIS [Budd et al, 1982]. To compare with GPS and altimeter data, geoid-ellipsoid separations, ocean tides, the inverse barometer effect, sea level rise, post-glacial rebound and sea surface topography need to be accounted for. For removing the tidal signal we propose to use the CADA00.10 ocean tide model [Padman et al, 2002] which has AIS GPS tidal data [King, 2001] assimilated. We will use a GRACE-derived geoid for the geoid-ellipsoid correction. The levelling data has a relative accuracy of approximately 0.05 m

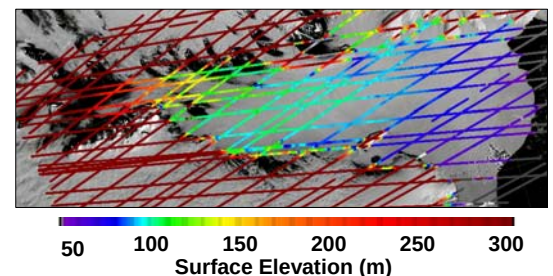


RADAR Altimeter Data

ERS-1&2 (1990s) and Envisat RA-2 (2002-) data at both cross-over and along-track locations. The DEM shown above was produced in a previous study using ERS-1 data only [Fricker et al, 2000]. Conventional RADAR altimeter data have problems in regions of high slope, and consequently the AIS margins are not well sampled using these data

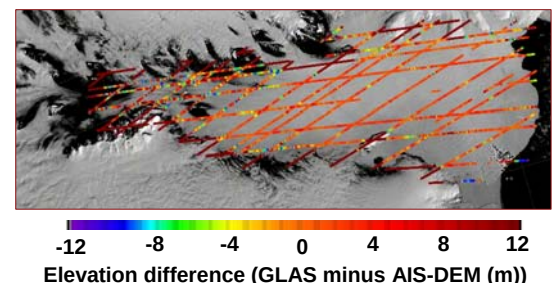
GPS Surface Profiles

The ERS-1 DEM was validated using kinematic GPS profiles (shown as 'survey region' above) measured in 1995 and found to have a mean error of 0.0 m and an RMS of 0.8 m [Phillips et al, 1998]. Further kinematic GPS profiles (all in the northern AIS) have been surveyed during 1998-99, 1999-00 and 2001-2 [unpublished data]. The GPS profiles have a relative accuracy of approximately 0.05 m



Laser Altimeter Data

The Geoscience Laser Altimeter System (GLAS) onboard the Ice, Cloud and land Elevation Satellite (launched 2003) provides surface elevations at unprecedented horizontal resolution and accuracy (65 m footprint of ~2-3km for ERS-1) and 175m track spacing (cf 330m for ERS-1) (above). Initial comparison with the ERS DEM (below), or at cross-over points, show close agreement. The narrow footprint and precise pointing of ICESat will allow accurate comparison of the levelling and GPS profiles



CryoSat

- ❖ CryoSat will add important new data to this time series, especially in the steeper regions where data are presently lacking. These steep regions are near the ice margins, especially at the southern grounding zone of the AIS
- ❖ Over the northern AIS we expect to be able to determine elevation change rates at the level of a ~1 cm/yr, equivalent to thickness change rates of ~10cm/yr. Where no historic levelling data are available, the precision will be lower
- ❖ Over the remainder of the Lambert Glacier-Amery Ice Shelf basin, elevation change rates should have similar precision even with a shorter time series, since grounded ice does not require tide corrections, nor do we need to apply a geoid-ellipsoid correction

References

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