Bathymetry beneath Pine Island Glacier revealed by Autosub3 and implications for recent ice stream evolution

Adrian Jenkins1, Pierre Dutrieux1, Steve McPhail2, James Perrett2, Andy Webb2 and Dave White2 and Stan Jacobs3

1 British Antarctic Survey, Natural Environment Research Council, Cambridge, UK.
2 National Oceanography Centre, Southampton, UK.
3 Lamont-Doherty Earth Observatory of Columbia University, New York, USA.

The Antarctic ice sheet, which represents the largest of all potential contributors to sea level rise, appears to be losing mass at a rate that has accelerated over recent decades. Ice loss is focussed in a number of key drainage basins where dynamical changes in the outlet glaciers have led to increased discharge. Some of the most significant changes have been observed on Pine Island Glacier, where thinning, acceleration and grounding line retreat have all been observed, primarily through satellite remote sensing. Even during the relatively short satellite record, rates of change have been observed to increase.

Between 20th and 30th January 2009 the Natural Environment Research Council's autonomous underwater vehicle, Autosub3, was deployed on six sorties into the ocean cavity beneath Pine Island Glacier. Total track length was 887 km (taking 167 hours) of which 510 km (taking 94 hours) were beneath the glacier. One of the main aims was to map both the seabed beneath and the underside of the glacier.

Among the instruments carried by Autosub-3 were a multi-beam echosounder that could be configured to look up or down, and two Acoustic Doppler Current Profilers (ADCP's): an upward-looking 300 kHz instrument and a downward-looking 150 kHz instrument, providing a record of ice draft and seabed depth along the vehicle track. The ADCP data reveal an apparently continuous ridge with an undulating crest that extends across the cavity about 30km in from the current ice front. Swath soundings indicate that this ridge was a former grounding line, while satellite imagery from the early 1970's hints that Pine Island Glacier might still have been in contact with the ridge at that time. These findings suggest that the changes observed by satellite over the past two decades are the continuation of a longer period of grounding line retreat.