Ocean properties beneath Pine Island Glacier revealed by Autosub3 and implications for circulation and melting

Pierre Dutrieux1,, Adrian Jenkins1, Stan Jacobs2, Steve McPhail3, James Perrett3, Andy Webb3 and Dave White3*

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

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. The synchronous response of several independent glaciers, coupled with the observation that thinning is most rapid over their floating termini, is generally taken as an indicator that the changes have been driven from the ocean. The deeper parts of the Amundsen Sea continental shelf are flooded by Circumpolar Deep Water (CDW) with a temperature around 1ºC, which potentially drives rapid melting of the floating ice.
Between 20th and 30th January 2009 the Natural Environment Research Council's autonomous underwater vehicle, Autosub-3, was deployed on six sorties into the ocean cavity beneath Pine Island Glacier, totaling a track length of 510 km (taking 94 hours) in this previously unexplored environment. Some specific aims were to investigate how CDW flows beneath Pine Island Glacier and determines its melt rate.

Among the instruments carried by Autosub-3 were a Seabird CTD, with dual conductivity and temperature sensors plus a dissolved oxygen sensor and a transmissometer, and two Acoustic Doppler Current Profilers (ADCP's) providing a record of seabed depth and ice draft along the vehicle track. The ADCP data reveal an apparently continuous ridge that extends across the cavity about 30km in from the current ice front. This topographic feature blocks CDW inflow from the inner cavity and impacts the degree to which it mixes with the cooler melt water outflow. Melt water concentration derived from temperature, salinity and oxygen measurements traces the path of the outflow. High melt water concentration always corresponds to high light attenuation indicating the presence of suspended matter.