Decadal Variability of Petermann Gletscher, NW Greenland From Observations of Ice, Ocean, and Atmosphere

Laurence Padman[1], Andreas Muenchow[2], Helen Johnson[3], Humfrey Melling[4], Alan Mix[5], Roger Samelson[5], and Helen A. Fricker[6]

[1] Earth & Space Research, Corvallis OR, USA (541-753-6695; padman@esr.org)
[2] University of Delaware, Newark DE, USA
[3] University of Oxford, Oxford, United Kingdom
[4] Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney BC, Canada.
[5] Oregon State University, Corvallis OR, USA
[6] IGPP, Scripps Institution of Oceanography, La Jolla CA, USA

Petermann Gletscher drains 6% of the Greenland Ice Sheet through a large ice shelf in a deep fjord connected to Nares Strait. We describe observed variability of regional ice, ocean, and atmospheric conditions for the last decade, encompassing two large calving events (in 2010 and 2012) that reduced the ice shelf length from ~80 km to ~40 km.

Coastal air temperatures in northern Greenland and Canada indicate a warming trend of 0.1±0.05 K/yr for 1987-2012, more than four times the global rate. Moored ocean temperature observations at 300-m depth outside Petermann Fjord indicate warming of 0.06±0.02 K/yr for 2003-09. During an opportunistic cruise in 2012 we observed deep water renewal within the fjord as warm, dense waters spilled over the 400-m deep sill. Deep fjord waters also freshened, consistent with accelerated basal melting.

Surface elevation from Lidar on two repeat aircraft tracks in 2007 and 2010 reveal that hydrostatic ice thickness decreased by ~14 m along both the central melt channel and the ambient ice shelf. ICESat altimetry tracks across the fjord provide an independent assessment.

Prior mass budgets found that ~90% of the ~12 Gt/yr ice flux into the fjord is lost by ice-shelf basal melting. Observations of changing air and ocean temperatures, ice shelf thickness, and recent large calving events may indicate a transition to a new state. Support for this hypothesis requires systematic observations and models of physical processes that control ice-shelf thickness, ice-shelf coupling to grounded ice, and of system response from tidal to millennial scales.