Geophysical Research Abstracts
Vol. 21, EGU2019-11946-3, 2019
EGU General Assembly 2019

Observations of Subglacial Runoff-Enhanced Melt beneath Petermann Gletscher's ice shelf, Greenland

Peter Washam (1), Andreas Mu¨nchow (1), Keith W. Nicholls (2), and Laurie Padman (3)

(1) University of Delaware, College of Earth, Ocean, and Environment, United States (pwasham@udel.edu), (2) British Antarctic Survey, Natural Environmental Research Council, Cambridge, United Kingdom (kwni@bas.ac.uk), (3) Earth & Space Research, Corvallis, OR, United States (padman@esr.org)

Fast-moving outlet glaciers transport ice from the center of the polar ice sheets to their marine margins. As these glaciers flow, geothermal and frictional heat along their base generates meltwater which then discharges across the grounding line into the ocean at their marine termini. Surface meltwater produced by above-freezing summer air temperatures further contributes to this flux when it drains down to the bed through crevasses and moulins, then discharges into the ocean. The density contrast between this fresh "subglacial runoff" and the surrounding seawater drives a buoyant circulation which efficiently moves warm, subsurface seawater towards the glacier at depth and enhances melting at the ice-ocean interface. We here present direct observations of subglacial runoff-enhanced melt beneath the floating ice shelf of Petermann Gletscher, Greenland. Moored ocean sensors recorded hydrographic properties near the ice shelf base at 3 km, 13 km, and 26 km from the grounding line. A phase-sensitive radar monitored basal melt rates at the 13 km site. Peaks in melting of $\sim$15 m yr^{-1} occurred regularly at this location and preceded cold and fresh ocean pulses that were high in subglacial runoff content, as well as ocean-generated glacial meltwater. Upper ocean data at the other sites contained similar meltwater pulses. Phase lags between these data confirm that pulses propagate seaward from the grounding line at advective speeds of about 0.23 m s^{-1}. We find that $\sim$75% of melt rate variability can be described by adjacent ocean temperature and salinity variations, with the remainder likely due to current speed fluctuations. We combine our observed melt rates and ocean temperatures with various heat transfer parameterizations to estimate current speeds. During melt peaks, estimated currents rise to 0.18 - 0.42 m s^{-1}, consistent with a buoyancy-driven flow from subglacial runoff. Maximum melt rates of 80 m yr^{-1} occur during the summer surface melt season. We estimate current speeds of 0.75 - 0.95 m s^{-1} at this time and attribute these strong currents to increased discharge of subglacial runoff from surface meltwater that has been transported down to the bed.