Helheim 2006: Integrated Geophysical Observations of Glacier Flow

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Abstract

During the summer field season, 2006, we undertook a pilot geophysical experiment at Helheim Glacier, East Greenland, in which we deployed a network of GPS instruments on and around the glacier to measure the ice deformation field as a function of time. The experiment was motivated by the discovery of a new class of earthquakes occurring at glaciers in Alaska, Antarctica, and Greenland (Ekström, Nettles, and Abers, 2003). Teleseismic analysis indicates that these glacial earthquakes may result from the rapid sliding of the glacial ice over the glacier bed, and recent evidence (Ekström, Nettles, and Tsai, 2006) suggests a link to the hydrological cycle. However, little is understood about the mechanism by which the earthquakes occur. We installed sixteen GPS receivers on Helheim glacier, in a network spanning an upglacier distance of ~25~km from a point ~10~km behind the calving front. We also installed three GPS receivers at nearby rock sites to help define a stable reference frame. The stations were deployed in late June, 2006, and retrieved in late August, 2006. The GPS receivers recorded at a rate of at least 5~samples/sec. In addition, we operated several receivers for a few days each just behind the calving front during field visits in late June, late July, and late August, and we recorded the tidal stage using a pressure sensor near the end of Helheim Fjord for ~3~weeks during the experiment. Initial results show a variation in flow speed from about 25~m/day near the calving front to about 6~m/day at a location ~35~km behind the front. The horizontal flow speeds are tidally modulated, and an abrupt spatial change in vertical displacements due to the water tide gives the probable location of the glacier grounding line. We will present our geodetic results, and combine these results with seismological and glaciological observations to place constraints on the conditions under which glacial earthquakes are generated.

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