Geophysical Research Abstracts
Vol. 19, EGU2017-10126, 2017
EGU General Assembly 2017

Using remote sensing to constrain regional changes in summer ice motion and subglacial evolution in western Greenland

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The impact of summer melting on the dynamic behavior of land-terminating regions of the Greenland Ice Sheet (GrIS) is controlled primarily by the state of the subglacial hydrologic system, which evolves continually as it responds to variable meltwater supply and local ice motion. Continuous observations of ice motion in land-terminating regions of the GrIS indicate that the seasonal transition from an inefficient, distributed drainage network to an efficient, channelized drainage network results in ice velocity that is insensitive to the volume of surface melt. However, such melt-season-long observations of ice velocities are spatially limited to the locations of Global Positioning System stations. To better characterize the regional impact of subglacial hydrologic evolution on ice flow, we use remotely sensed ice velocities and strain rates derived from Landsat-8 imagery to constrain seasonal changes in ice flow and subglacial evolution in the Pâkitsoq Region of Western Greenland. We find that, although basal topography plays an important role in determining the absolute magnitude of ice motion, for a given surface elevation, the proportion of ice velocity change attributed to subglacial evolution is relatively constant. We also use these remotely sensed ice velocities in conjunction with well-constrained ice thicknesses and surface mass balance models to determine the local surface evolution associated seasonal velocity perturbations. Our analysis provides insight into regional-scale variations of seasonal ice velocity and associated changes in the subglacial hydrologic system. These results contribute to our understanding of how the evolution of the subglacial hydrologic system contributes to dynamically induced GrIS mass loss.