Geophysical Research Abstracts
Vol. 19, EGU2017-8811, 2017
EGU General Assembly 2017

Vertical displacements of circum-Arctic lithosphere caused by glacial erosion

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The Arctic, as many other places, is affected by complex geodynamic features, including the effects of plumes, heat, basin formation etc. In contrast with other places, however, effects of complex features in the Arctic are masked by the last, and in many ways obvious, geodynamic effects of ice and erosion. We aim to resolve this overriding geodynamic event and quantify its effects before older and more complex processes are debated. During the Quaternary, the northern hemisphere was intensely sculptured by thick icecaps, and ice-streams. In some areas, like central East Greenland, or NE Canada, huge fjords and inlets are carved more than 3 km below the summit surface. This erosion cause major unloading, and thus uplift which we model by numerically placing back eroded material, and calculating the flexural isostatic response (vertical motion) repeatedly backwards in time until eroded features are filled to the summit surface. Model results show that Late Cenozoic (mostly glacial) erosion has caused dramatic vertical motions and tilts. Regions such as greater Ellesmere-NW Greenland and central East Greenland have experienced regional erosional uplift in excess of 1 km, which is of the scale of the vertical displacement (down) induced by the load of the Greenland icecap. Interestingly, this erosional uplift solves long-standing enigmas of the occurrence of marine sediments above 1 km altitude in tectonically quiet areas like East Greenland and some islands of Canadian Arctic archipelago and adds systematics between regional AFT ages and elevation. In some areas, like Svalbard and Iceland, modelled erosional uplift and associated down flexing are highly influenced by the assumed effective elastic thickness, and the results thus give direct input to our understanding of the Earth's interior.