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Fault slip during a glacial cycle

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Areas affected by glacial isostatic adjustment (GIA) generally show uplift after deglaciation. These regions are also characterized by a moderate past and present-day seismicity, at seismic moment release rates that exceed those expected under stable tectonic conditions. Several faults have been found in North America and Europe, which have been activated during or after the last deglaciation. Large-magnitude earthquakes have generated fault offsets of up to 120 m. Due to the recent melting of Greenland and Antarctic ice sheets, an understanding of the occurrence of these earthquakes is important.
With a new finite-element model, we are able to estimate, for the first time, fault slip during a glacial cycle for continental ice sheets. A two-dimensional earth model based on former GIA studies is developed, which is loaded with a hyperbolic ice sheet. The fault is able to move in a stress field consisting of rebound stress, tectonic background stress, and lithostatic stress. The sensitivity of this fault is tested regarding lithospheric and crustal thickness, viscosity structure of upper and lower mantle, ice-sheet thickness and width, and fault parameters including coefficient of friction, depth, angle and location. Fault throws of up to 30 m are obtained using a fault of 45° dipping below the ice sheet centre. The thickness of the crust is one of the major parameters affecting the total fault throw, e.g. higher values for a thinner crust. Most faults start to move close to the end of deglaciation, and movement stops after one thrusting/reverse earthquake. However, certain conditions may also lead to several fault movements after the end of glaciations.