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Fun at Antarctic grounding lines: Ice-shelf channels and sediment transport

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Meltwater beneath the polar ice sheets drains, in part, through subglacial conduits. Landforms created by such drainages are abundant in areas formerly covered by ice sheets during the last glacial maximum. However, observations of subglacial conduit dynamics under a contemporary ice sheet are lacking. We present results from ice-penetrating radar to infer the existence of subglacial conduits upstream of the grounding line of Roi Baudouin Ice Shelf, Antarctica. The conduits are aligned with ice-shelf channels, and underlain by esker ridges formed from sediment deposition due to reduced water outflow speed near the grounding line. In turn, the eskers modify local ice flow to initiate the bottom topography of the ice-shelf channels, and create small surface ridges extending onto the shelf. Relict features on the shelf are interpreted to indicate a history of these interactions and variability of past subglacial drainages. Because ice-shelf channels are loci where intense melting occurs to thin an ice shelf, these findings expose a novel link between subglacial drainage, sedimentation, and ice-shelf stability.

To investigate the role of sediment transport beneath ice sheets further, we model the sheet-shelf system of the Ekstömisen catchment, Antarctica. A 3D finite element model (Elmer/ICE) is used to solve the transients full Stokes equation for isotropic, isothermal ice with a dynamic grounding line. We initialize the model with surface topography from the TanDEM-X satellites and by inverting simultaneously for ice viscosity and basal drag using present-day surface velocities. Results produce a flow field which is consitent with sattelite and on-site observations. Solving the age-depth relationship allows comparison with radar isochrones from airborne data, and gives information about the atmospheric/dynamic history of this sector. The flow field will eventually be used to identify potential sediment sources and sinks which we compare with more than 400 km of seismic profiles collected over the floating ice shelves and the grounded ice sheet.