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Coupled modeling of ice, subglacial sediment, and glacier hydrology

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Glacier flow reshapes their beds through subglacial erosion of hard beds and deformation of soft, sedimentary beds. Past glaciations left distinct imprimints on the Earth surface, and subglacial landforms such as drumlins, grounding-zone wedges, and mega-scale glacial lineations provide clues to the coupled interplay of ice, water, and sediment within the subglacial environment. While it is speculated that grounding-zone wedges may stabilize ice sheets against sea-level rise, sedimentary deformation is typically ignored in ice-flow models. This is primarily due to lack of a suitable rheological description for the subglacial sediment.

In this presentation, I demonstrate how granular rheologies can be used to approximate sediment mechanics, in a way consistent with laboratory and field observations of till mechanics (Damsgaard et al., 2020). I couple the sediment mechanics to the ice-sheet model PISM (Bueler and Brown, 2009; Winkelmann et al., 2011), and demonstrate how sedimentation at the grounding zone can provide conditional stabilization to an ice sheet forced by rising sea level.

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