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Investigating the role of subglacial geology on ice sheet dynamics

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Basal boundary conditions, such as basal geology, the presence of unconsolidated sediments, and hydrology, play a dominant role in the dynamics of ice sheets. One problem when studying existing ice sheets in Greenland and Antarctica is the lack of direct observations of these basal conditions. Studying paleo-ice sheet behaviour is advantageous in this respect, because these conditions are preserved in glacial landforms and sediments. By studying past ice sheet behaviour, we can provide analogues for modern behaviour. We investigate the role of basal geological conditions and hydrology on ice sheet dynamics using the ice sheet model PISM. We specifically focus on the North American ice sheet complex. We present datasets for this region that can be used in ice sheet models to investigate basal conditions including information on bedrock geology, the distribution of unconsolidated sediments, and the dominant grain size of the sediments. We use these datasets to investigate how they impact ice sheet dynamics with simulations over the last glacial cycle. We include a simple hydrology model that includes meltwater derived from the surface, and property changes depending on the basal geology from our datasets. Our results show that the behaviour of the ice sheet changes when there is a transition from regions with sparse sediment cover to complete sediment cover. One impact is that because ice can flow faster in regions like Hudson Bay, it can cause the Laurentide Ice Sheet to stabilize into a single continent-wide ice sheet faster than in a situation where sediments are not present. We also investigate the role of changes in basal geological conditions have in causing unstable behaviour in ice sheets.