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Advanced ice sheet modeling: channelized basal topography in a coupled ice-shelf and ocean model

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Petermann Glacier in northwest Greenland flows into the ocean in a steep-walled fjord and forms a floating ice shelf 20km by 70km in area. Satellite altimetry and radar measurements reveal the presence of deep undulations or channels in the basal surface of the floating glacier which we show may be the result of spatially variable melting at the ice-ocean interface. We present a numerical model of this coupled dynamical system which is made up of a simplified ocean model and a dynamic ice model. The ocean model captures the dynamics of the gravity-driven flow of a buoyant melt-water plume which forms beneath the ice shelf and the ice model captures the advection of grounded ice into the floating domain and the deformations which take place as the ice is subject to boundary stresses and vigorous basal melting. We demonstrate the dominate balances in the coupled dynamics and draw conclusions about the mechanism for channel formation. We assess the sensitivity of channelization to model parameters, leading to recommendations for focused observational efforts. We also assess the stability of Petermann Glacier with respect to changes in the ambient ocean temperature.