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Simulating the impact of Antarctic subglacial hydrology on ice sheet evolution

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While the slow moving interior of the Antarctic Ice Sheet is not prone to rapid change, the fast flowing outlet glaciers may exhibit accelerations and unstable retreat in response to ocean induced melting of the ice shelves. This rapid motion is only possible due to sliding of ice over the bed, motion which is dependent on the presence, and pressure, of liquid water under the ice sheet. This subglacial hydrologic system is fed by in-situ melting caused mainly by friction heat as ice slides over the bed, and its outflow feeds into ice shelf cavities across deep grounding lines. Two-way interactions between ice dynamics and the hydrologic system may occur due to changing sliding speeds, subsequent meltwater generation, and the responding changes in basal water pressure, which in turn impact on sliding resistance. The subglacial water system may also impact on ice shelf cavity circulation due to its very low density relative to ocean water, and this may also impact indirectly on ice dynamics due to the changing cavity circulation driving changing ice shelf melt rates, which affect ice shelf thickness and therefore backstress.

The current generation of ice sheet models used in sea level prediction do not represent the evolution of the subglacial hydrologic system. A typical approach is to spatially tune a sliding parameter in which all aspects of basal physics relating to sliding and hydrology are implicitly hidden. We will outline a modelling approach to incorporate the GLAcier Drainage System (GlaDS) model into a coupled system in which the hydrologic system can interact with both ice dynamics and cavity circulation. Ice dynamic model Elmer/Ice and the Regional Ocean Modelling System (ROMS) will be used, coupled through the Framework for Ice Sheet - Ocean Coupling (FISOC). GlaDS represents the subglacial hydrologic system as two interacting components: a distributed network of linked cavities and a network of channels. We will show preliminary simulations of these linked cavities and channels from Antarctic simulations. We will outline a plan for moving

towards fully coupling GlaDS to the ice dynamics and ice shelf cavities, along with an "accelerated forcing" approach to handle asynchronicities.