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The meltwater feedbacks on ice dynamics, elevation versus lubrication

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In recent years, temperatures over the Greenland ice sheet have been rising leading to an increase in surface melt. Projections show that this augmentation of surface melt will continue in the future and spread to higher elevations. As it increases, melt leads to two different feedbacks on the dynamic of the Greenland ice sheet. This augmentation of melt lowers the ice surface and changes its overall geometry hence impacting the ice dynamics through ice deformation. The other feedback comes into play at the base of glaciers. Here, the increase of water availability will impact the distribution of water pressure at the base of glaciers and hence their sliding velocity. The first feedback is relatively well known and relies on our knowledge of the rheology and deformation of ice. The lubrication feedback acting at the bed of glaciers is however highly uncertain on time scales longer than a season. Here we apply the Ice Sheet System Model (ISSM) to a synthetic glacier which geometry is similar to the one of a Greenland ice sheet land terminating glacier. The dynamic contributions from ice deformation and sliding are separated to study their relative evolution. This is permitted by the use of a dynamical subglacial hydrology model that allows to link the basal sliding to the meltwater production through an appropriate friction law. The model is forced through a simple temperature distribution and a Positive Degree Day model which allows to apply a large range of different forcing scenarios. Of particular interest is the evolution of the distribution of the efficient and inefficient component of the subglacial drainage system and their different response to the distribution of melt during the year which directly impact the sliding regime at the base of the glacier.