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Modelling the basal hydrology under the Greenland Ice Sheet

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Subglacial hydrology plays an important role in the evolution of ice dynamics. Primarily, it affects basal processes such as basal sliding. Further, subglacial water exiting a calving front incites submarine melt, increasing calving, resulting in a thinning of the interior ice sheet. Knowledge of it is therefore crucial towards the development and improvement of ice sheet models. We implement a model representing the routing of subglacial water below the Greenland ice sheet in either a one, four or eight directional manner. Due to its computational efficiency, the model is suited for coupling with continental scale ice sheet models on very high resolutions (e.g. 150 m).

Routing depends on the hydraulic potential of individual grid cells which is therefore heavily dependent on accurate estimates of the ice thickness as well as the grid utilized. Sensitivity analyses brought to life that the routing exhibits artefacts resulting in significant flow diversions on high resolutions if the gradients are only considered over the distance of a single grid cell, this is overcome by incorporating a smoothing procedure.

With the basal water model in place and input of the basal melt rate from the VUB Greenland Ice Sheet Model (GISM) as well as runoff input from the Modèle Athmospherique Régional (MAR), we calculate the inflow of freshwater to several reference fjords for the last thirty years and investigate its temporal and spatial patterns. Jakobshavn Isbrae experiences by far the most freshwater inflow compared to the other reference fjords. Despite limited runoff in the northeast of Greenland, high basal melt rates and a significant catchment area provide the outlets of the Northeast Greenland Ice Stream (NEGIS) with substantial inflow too.