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Moulin density controls subglacial drainage development under the Greenland Ice Sheet

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Uncertainty remains about how the surface hydrology of the Greenland Ice Sheet (GrIS) influences its subglacial drainage system, affecting basal water pressures and ice velocities, particularly over intra- and inter-seasonal timescales. Given this, several recent field-based geophysical studies have attempted to infer the behaviour of the GrIS's subglacial drainage system from measurements of meteorology, surface velocity and uplift, and borehole water pressures, while various catchment-scale subglacial modelling approaches have also emerged. Here, we apply a high spatial (200 m) and temporal (1 h) resolution subglacial hydrological model to Paakitsoq, a marginal (extending $\sim$25 km inland), land-terminating region of W. Greenland. The model is based on that discussed by Hewitt [2013], but is adapted for functionality with both the real boundary conditions and realistically modeled water inputs from Banwell et al. [2013]. These water inputs are moulin hydrographs, which are calculated by a surface routing and lake-filling model, combined with a surface lake drainage model, and forced with distributed hourly melt runoff calculated by a surface energy balance model. Sensitivity tests show that the lake volume threshold parameter, which controls where and when surface lakes drain (determining, therefore the overall density of moulins, and when they open during the melt season), strongly affects the rate at which the subglacial drainage system develops, and thus the extent of channelisation across the catchment by the end of the melt season. In turn, this has a strong control on spatial and temporal variations in basal water pressures within the catchment, which will influence basal sliding rates, and thus surface ice velocities.