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The Impacts of Greenland Ice Sheet Basal Conditions on Regional Permafrost and Groundwater Flow

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Permafrost typically exists in regions impacted by past or present glacier and ice sheet coverage. Consequently, the thermal and physical conditions at the bed of ice masses can often form important controls on permafrost and associated groundwater flow dynamics. Here we present a conceptual overview of the Western Greenland ice sheet basal conditions, from ice divide-to-margin, with regards to regional permafrost and groundwater flow fields. Our understanding is based on ice sheet modeling combined with detailed field observations conducted along a 325 km long transect of the ice sheet as part of the "Greenland Analogue Project". We drilled 36 boreholes to the bed of the ice sheet to measure ice temperature, ice deformation and basal sliding, and subglacial water pressure and transmissivity. Simulations incorporate heat transport and higher-order physics for ice flow in three dimensions, data assimilation for constraining model results with climate and surface velocity data fields, and are forced by boundary conditions uniquely constrained by observational data. Our results suggest that between the central ice divide and the ice sheet margin, the bed transitions between four differing thermo-hydrologic regimes. Each zone has different physical conditions and plays contrasting roles in the regional groundwater flow field. We discuss the permafrost conditions beneath the ice sheet and two remaining uncertainties in transitional zones that impact permafrost and groundwater flow conditions.