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Dark Side of the Greenland Ice Sheet: How has our understanding of the ice-bed interface changed over the last decade?

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Accurately simulating the Greenland Ice Sheet's form and flow is critical for ensuring robust simulations of its future contribution to sea-level rise. In this talk, I will review how our community's understanding of four critical boundary conditions at Greenland's ice–bed interface – bed elevation, basal ice temperature, geothermal flux, and basal mass balance – has evolved over the past decade.

Firstly, the past decade saw an unprecedented proliferation of ice-thickness measurements. The assimilation of these ice-thickness measurements into ice flow models has provided a transformative improvement in our knowledge of subglacial topography. Secondly, regions of 'frozen' and 'thawed' basal states have now been inferred beneath the ice sheet, using inferences from ice flow models, ice-penetrating radar, and surface morphology. Basal thermal state remains poorly constrained beneath one-third of the ice sheet. Thirdly, in situ measurements of geothermal heat flow in Greenland have only been recently compiled for the first time. There is tremendous uncertainty in heat flow across North Greenland. On smaller scales, the topographic influence on geothermal heat flow cools subglacial ridges and warms deeply incised valley glaciers. Finally, a first estimate of basal mass balance highlights spatial heterogeneity in basal melt rates associated with differing processes. The magnitude of ice-sheet integrated basal melt has clearly been underappreciated into the recent past.

In summary, the past decade has taught us that the bed of the Greenland Ice Sheet: (1) has more rugged topography and deeply incised features than previously resolved, (2) is warmer across larger areas than previously assumed, (3) has tremendous large- and small-scale spatial variability in heat flow, and (4) has a non-trivial and increasing basal melt rate. Substantial spatial heterogeneity and uncertainty in basal conditions in critical ice-sheet regions provides strong motivations for a new generation of instruments to better probe the underside of the Greenland Ice Sheet.