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Estimating the ice thickness and bed topography of Steffen and surrounding glaciers using mass conservation principles

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The majority of outlet glaciers in the Patagonian Icefields have been rapidly losing mass in recent decades. The reasons for this loss are difficult to determine, with considerable variations between glaciers. One way to understand mass loss is by modelling the icefield's mass budget and flow, which requires bed topography and ice thickness as an input. Radar measurements have been limited both spatially and temporally, with thickness observations limited to 700- 750 m as a result of high absorption and scattering due to the presence of englacial water. Therefore, the bed topography and thickness of the Patagonian Icefields is currently poorly known. However, recent measurements from helicopter-borne gravimetry suggest that the ice thickness may be greater than 700 m in some areas. Therefore, employing alternative methods based on ice dynamics can be helpful determine the ice thickness. In this study, a two-dimensional mass conservation method, coupled with an optimisation process, is applied to estimate ice thickness for Steffen Glacier and its surrounding glaciers in the Northern Patagonian Icefield. We also estimate a basal traction field, characterized by weak beds and fast sliding along the glacier trunks, and frozen beds elsewhere. This method could therefore be applied to the remainder of the ice fields, as well as other glaciers worldwide, where thickness measurements are sparse and difficult to obtain.