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Investigating basal thaw as a potential driver of ice flow acceleration in Antarctica

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Glacial thermal processes exert a fundamental control on ice flow, governing viscosity and frozen-to-thawed transitions at the ice-bed interface. Across Antarctica, frozen bed regions characterized by numerical models and geophysical observations, can also reduce ice flow by increasing basal traction. Some frozen bed regions can separate or confine fast-flowing glaciers and ice streams. Others separate inland catchments with thawed beds from the grounding zone of marine ice-sheet sectors. If regions with frozen bed experienced thawing, such a transition may lead to ice-sheet acceleration, reconfiguration, or retreat. To investigate the potential impact of such a thermal transition, we use the JPL/UCI Ice Sheet System Model (ISSM) to identify vulnerable regions across Antarctica that are close to the basal melting point. We assess the impact of thawing these regions by quantifying resulting volume changes and surface expressions. This allows us to identify the areas of the ice sheet where the thermal regime at the ice-bed interface has the largest potential impact on ice-sheet stability and sea-level contribution. We also examine the potential basal temperature and thaw-propagation thresholds governing this process. We then compare the ISSM results to a selection of ice-penetrating radar sounding observations to refine our constraints of the configuration, distribution, and extent of these thermally critical areas.