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Grounding-line flux formula applied as a flux condition in numerical simulations fails for buttressed Antarctic ice streams

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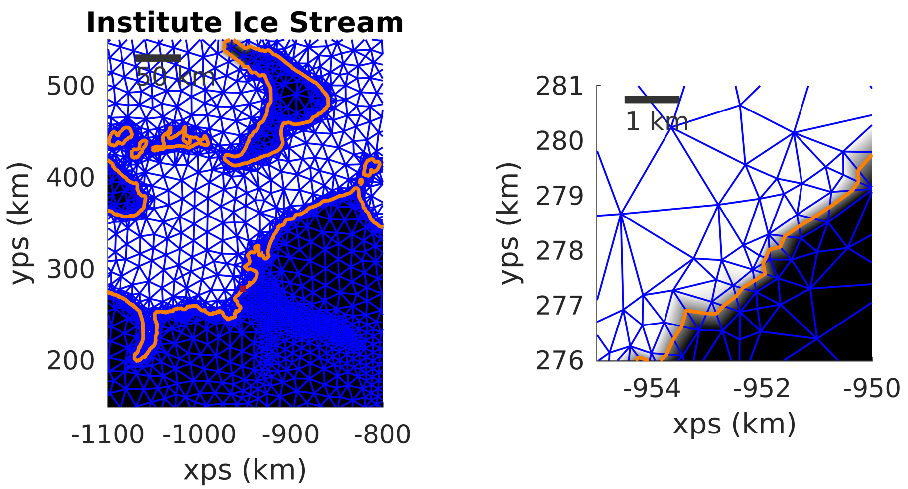

Figure S.1. Mesh elements around Institute Ice Stream are shown in blue. The grounded regions are indicated in black and the floating nodes in white. The grounding line is shown in orange. The right panel shows a zoom into the region indicated in red in the left panel.

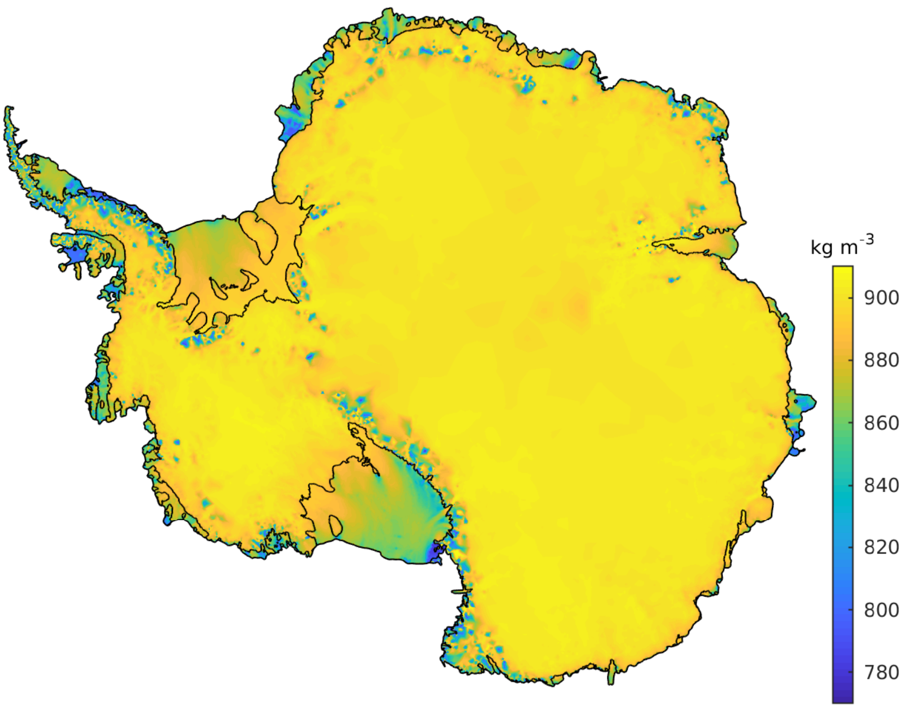

Figure S.2. The vertically averaged densities were calculated from RACMO2 firn thickness fields (Lenaerts et al., 2012) assuming an ice density of $910\ \mathrm{kg\,m^{-3}}$ and a firn density of $500\ \mathrm{kg\,m^{-3}}$.

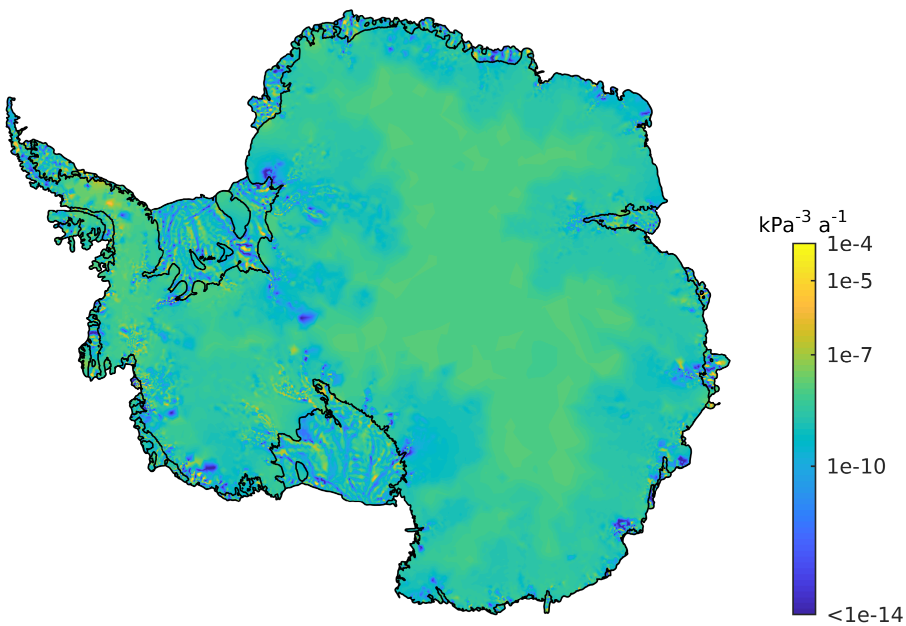

Figure S.3. The ice rate factor A in Glen's flow law is estimated by simultaneous inversion together with C, assuming the exponent in Glen's flow law to be $n = 3$. Similar to the basal slipperiness, the rate factor A is a nodal-based quantity. The patches in the continent's interior are values of single nodes.

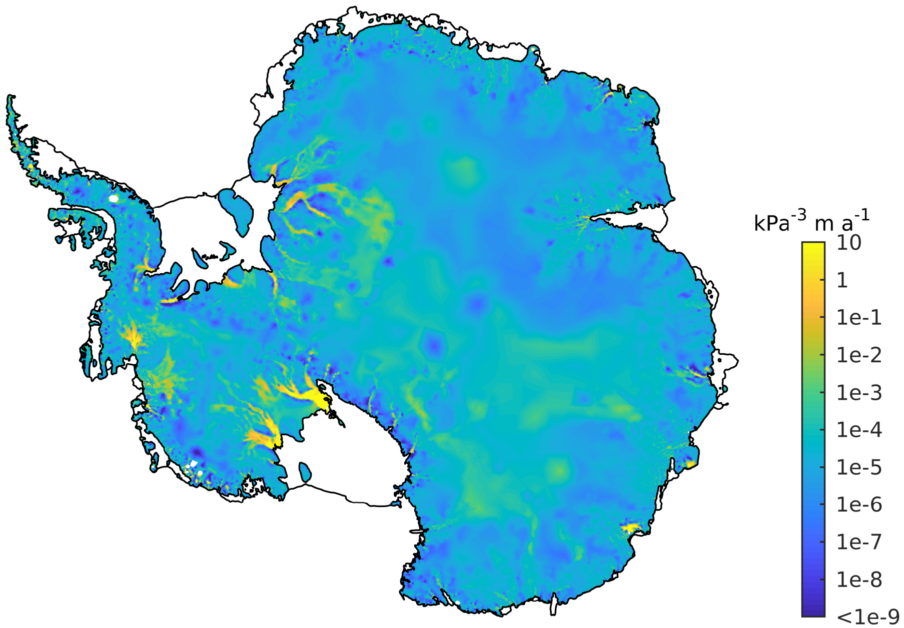

Figure S.4. The basal slipperiness distribution is obtained by inversion with the ice-flow model Úa assuming a Weertman-type sliding law with exponent $m = 3$. The slipperiness is a nodal based-value; the patches visible in the interior are values of single nodes. In the model simulations, basal drag is not applied at integration points that satisfy the flotation criterion.

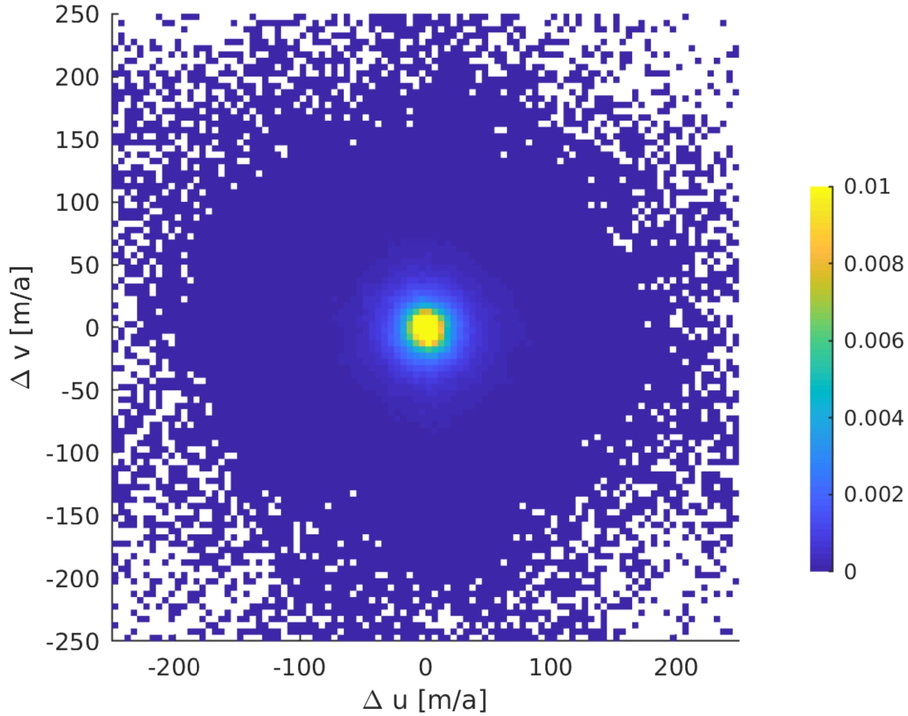

Figure S.5. Bivariate, normalized histogram of velocity residuals for all nodes of the Antarctic-wide mesh.

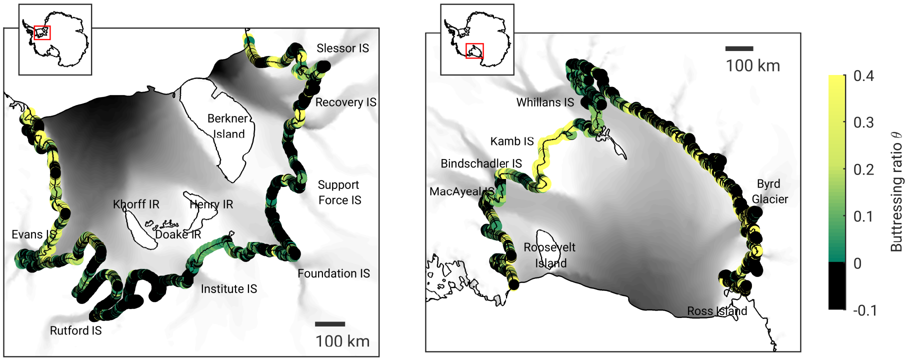

Figure S.6. Buttressing ratio θ_1 along the grounding lines of Filchner-Ronne (left panel) and Ross Ice Shelves (right panel). In comparison to Fig. 2, the model was run forward for 1.5 years, allowing ice thickness and grounding lines to relax. Insets indicate the ice shelves' locations in Antarctica, correspondingly. Regions where the grounding line is 'over-buttressed', that is, $\theta \leq 0$, are displayed in black. Modelled speed is plotted in gray ranging up to $1,500\ \mathrm{ma}^{-1}$. Grounding line and ice front locations are indicated in black. IS denotes ice streams, IR denotes ice rises or rumples.

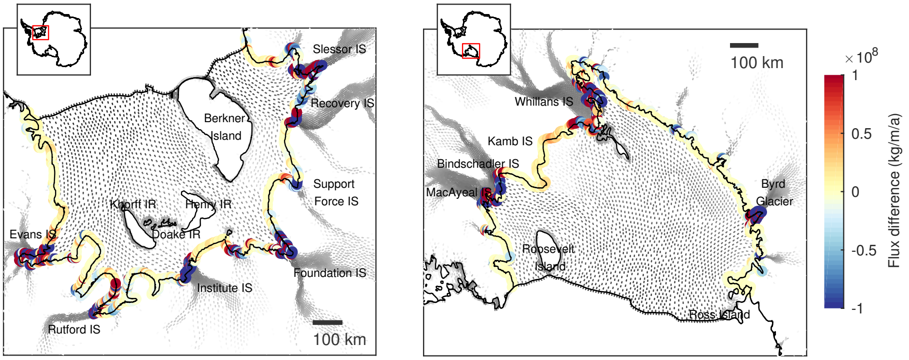

Figure S.7. Difference between the analytical and the modeled fluxes along the grounding lines of Filchner-Ronne Ice Shelf (left panel) and Ross Ice Shelf (right panel). In comparison to Fig. 5, the model was run forward for 1.5 years, allowing ice thickness and grounding lines to relax. Analytical fluxes are calculated based on θ_1 defined in Eq. 11. In locations where the formula yields unphysical results, fluxes are set to zero. Grey arrows show the modeled ice flow. IS denotes ice streams, IR denotes ice rises or rumples. Grounding line and ice front locations are indicated in black.