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Subglacial hydrology modulates basal sliding response to climate forcing of the Antarctic ice sheet

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Sliding laws determine to a large extent the sensitivity of the Antarctic ice sheet on centennial time scales (Pattyn, 2017, Bulthuis et al, 2019, Sun et al, 2020). Especially the contrast between linear and plastic sliding laws makes the latter far more responsive to changes at the grounding line. However, most studies neglect subglacial processes linked to those sliding laws. Subglacial hydrology may also play a role in modulating the amplitude of the reaction of marine ice sheets to forcing. Subglacial processes influence the effective pressure at the base. For a hard bed system, the latter can be defined by the ice overburden pressure minus the subglacial water pressure determined by routing of subglacial meltwater through a thin film. For soft-bed systems, the effective pressure is determined from till properties and physics. Here we investigate a wide range of subglacial processes and hydrology used in ice sheet models and implemented them in one ice sheet model (f.ETISh).

The subglacial hydrology models and till deformation models are coupled to different sliding and friction laws (linear, power law, Coulomb), leading to 24 different representations. The Antarctic ice sheet model was then forced by the ISMIP6 forcing in surface mass balance and ocean temperature until 2100 for different RCP scenarios (Seroussi et al., 2020). Furthermore, to sample the intrinsic sensitivity we performed the ABUMIP experiments (Sun et al., 2020) for the full set of subglacial characteristics. Results demonstrate that the type of sliding law is the most determining factor in the sensitivity of the ice sheet, modulated by the subglacial hydrology.