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# Impact of glacial isostatic adjustment on the long-term stability of the Antarctic ice sheet

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Projections of the contribution of the Antarctic ice sheet to future sea-level rise remain highly uncertain, especially on long timescales. One of the reasons for this uncertainty lies in the uncertainty in the intensity of the feedbacks of glacial isostatic adjustment (GIA; i.e. the combination of bedrock adjustment and gravitationally-consistent sea-surface changes due to ice mass changes) on ice-sheet evolution. Indeed, the Antarctic ice sheet lies on a solid Earth that displays large spatial variations in rheological properties, with a thin lithosphere and low-viscosity upper mantle beneath West Antarctica and an opposing structure beneath East Antarctica (Morelli & Danesi, 2004; Lloyd et al., 2020). In addition to this West-East dichotomy, strong viscoelastic heterogeneities (sometimes by several orders of magnitude across relatively short spatial scales) exist within the East and West Antarctic regions (An et al., 2015). These lateral variations are known to have a significant impact on the ice-sheet grounding-line stability (Gomez et al., 2015; Konrad et al., 2015). However, large uncertainties remain in determining these viscoelastic properties with precision.

Here, we investigate the influence of GIA feedbacks on the uncertainty in assessing the long-term contribution of the Antarctic ice sheet to future sea-level rise (SLR). In this framework, we design an ensemble approach, taking advantage of the computational efficiency of the Elementary GIA model (Coulon et al., under review). The latter consists of a modified Elastic Lithosphere—Relaxing Asthenosphere model able to consider spatially-varying viscoelastic properties supplemented with an approximation of gravitationally-consistent geoid changes, allowing to approximate near-field relative sea-level changes. Using existing upper-mantle viscosity and lithosphere thickness maps, we produce a large range of plausible Antarctic viscoelastic properties by varying the level of lateral variability in the associated relaxation time and flexural rigidity. We thereby take into account (i) the important lateral variations in rheological properties observed beneath the Antarctic ice sheet as well as (ii) the strong uncertainty characterizing the estimation of Antarctic solid Earth properties. We investigate the potential stabilizing role of GIA effects as well as their influence on multi-centennial to multi-millenial SLR. In addition, we investigate whether GIA feedbacks are able to stabilize the Antarctic ice sheet on short or longer timescales for strong and intermediate mitigation climate scenarios. Preliminary results (Coulon et al., under review) show that the weak Earth structure observed beneath West Antarctica plays a significant role in

promoting the stability of the West Antarctic ice sheet (WAIS). However, WAIS collapse cannot be prevented under high-emissions climate scenarios. The highest uncertainty arises from the East Antarctic ice sheet (EAIS) where ice retreat in the Aurora Basin is highly dependent on mantle viscosity.