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Feedback between ice dynamics and bedrock deformation with 3D viscosity in Antarctica

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Over glacial-interglacial cycles, the evolution of an ice sheet is influenced by Glacial isostatic adjustment (GIA) via two negative feedback loops. Firstly, vertical bedrock deformation due to a changing ice load alters ice-sheet surface elevation. For example, an increasing ice load leads to a lower bedrock elevation that lowers ice-sheet surface elevation. This will increase surface melting of the ice sheet, following an increase of atmospheric temperature at lower elevations. Secondly, bedrock deformation will change the height of the grounding line of the ice sheet. For example, a lowering bedrock height following ice-sheet advance increases the melt due to ocean water that in turn leads to a retreat of the grounding line and a slow-down of ice-sheet advance.

GIA is mainly determined by the viscosity of the interior of the solid Earth which is radially and laterally varying. Underneath the Antarctic ice sheet, there are relatively low viscosities in West Antarctica and higher viscosities in East Antarctica, in turn affecting the response time of the above mentioned feedbacks. However, most ice-dynamical models do not consider the lateral variations of the viscosity in the GIA feedback loops when simulating the evolution of the Antarctic ice sheet. The method developed by Gomez et al. (2018) includes the feedback between GIA and ice-sheet evolution and alternates between simulations of the two models where each simulation covers the full time period. We presents a different method to couple ANICE, a 3-D ice-sheet model, to a 3-D GIA finite element model. In this method the model computations alternates between the ice-sheet and GIA model until convergence of the result occurs at each timestep. We simulate the evolution of the Antarctic ice sheet from 120 000 years ago to the present. The results of the coupled simulation will be discussed and compared to results of the uncoupled ice-sheet model (using an ELRA GIA model) and the method developed by Gomez et al. (2018).