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Influence of ice-shelf collapse on Antarctic grounding-line dynamics: results from ABUMIP

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The reaction of the Antarctic ice sheet to atmospheric and ocean forcing happens to a large extent through weakening of ice shelves, concomitant reduction in ice-shelf buttressing, leading to grounding-line retreat, inland ice acceleration and loss of grounded ice mass. While the processes governing ice-shelf weakening are quite complex, due to specific interactions with atmosphere (surface melt, meltwater percolation, refreezing) and ocean (CDW circulation changes, ice-shelf- ocean interactions), uncertainties on the response of the grounded ice sheet in response to decreased buttressing is therefore harder to assess.

ABUMIP (Antarctic BUttressing Model Intercomparison Project) aims at comparing model responses to complete loss of buttressing by investigating the end-member of ice-shelf buttressing, i.e. the total loss of ice shelves. This enables gauging the sensitivity of different ice sheet models with respect to grounding-line retreat, as a function of basal sliding, isostasy, and other model parameters. The experiments are kept simple and build on existing InitMIP-Antarctica experiments within the framework of ISMIP6.

Here we present results of the exercise in which 13 different ice sheet model groups and 21 model configurations participated. Experiments involve the complete removal of ice shelves (without regrowth) as well as extreme high sub-shelf melt rates. The reaction to sudden ice-shelf removal results in large ice sheet losses in all models ranging between 2 and 10 m SLE after 500 years. This ice loss is predominantly coming from the WAIS, but larger contributions stem from losses in marine basins of the EAIS, such as Wilkes subglacial basin. The sensitivity to mass loss, hence the spread in sea-level contributions, is predominantly linked to sliding laws and approximations to the Stokes equations. Plastic sliding laws and the absence of vertical shearing (as in the Shallow-Shelf approximation) leads to a significantly larger sensitivity.