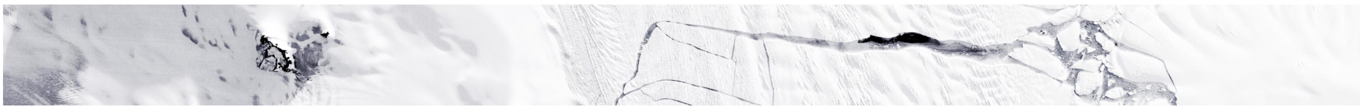
ABUMIP Antarctica

Goals

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.

The ABUMIP experiments were led by Frank Pattyn and Sainan Sun. The group publication is Sun et al. (2020).



Standard Experiments

Ice-shelf removal or ‘float-kill’ (*abuk*)

The first standard experiment starts from an initialized present-day state of the Antarctic ice sheet, as defined in initMIP-Antarctica and which represents the present-day Antarctic ice sheet either obtained through a spin-up or by optimization of unknown fields (basal friction, rheology). The experiments run for **500 years**, but should be at least **200 years** for models that have difficulties to cope with multi-centennial runs. At the start of the experiment, all floating ice (shelves) surrounding the ice sheet are removed and kept removed during the run (so-called ‘float-kill’). In other words, the calving front coincides during the whole run with the grounding line position. The present-day surface mass balance (SMB) and temperatures are used as boundary condition and kept constant during the run. As in initMIP, experimenters are free in their choice of SMB field. Isostasy and sub-shelf melting (upstream of the grounding line) are not considered. A similar experiment has been done by Golledge et al. (2017; supplementary material) and Pattyn (2017). The experiment aims at global Antarctic models, although regional experiments may be considered for high-resolution models. The same conventions as initMIP-Antartica applies to those models.

Extreme sub-shelf melt (*abum*)

The second experiment applies a constant melt rate of **400 m^{-1}** underneath the floating ice (shelves) for a period of **500 years**. It is always possible that some models will have difficulties with the sudden removal of ice shelves (Experiment 1). Therefore, the second experiment should be feasible for all Antarctic models.

Control (*abuc*)

An optional third experiment performs a simple control run using a non-evolving present-day parameterization, to ensure that ice shelves remain close to present-day extents for the duration of the experiment period. Setup should be as for the initMIP Antarctica ‘‘ctrl‘’ run, but extended to span the same length as ***abuk*** and ***abum*** (ideally 500 years).

Additional experiments

Repeat the standard experiments with:

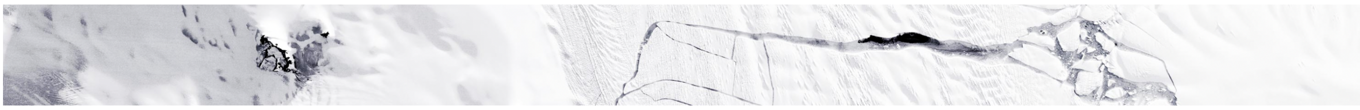
- Addition of isostasy during the same period (***abukiso*** and ***abumiso***)
- Different sliding/friction laws (***abuksx*** and ***abumsx***, where x = 1, 2, ...)

Note that, according to initMIP-Antarctica conventions, each additional experiment implies a different model name. Supplied documentation should give sufficient details on the model and its settings.

Output

Similar output as for the initMIP-Antarctica experiments is considered, with the experiment names as listed above (*abuk*, *abum*, *abuc*, *abukiso*, *abumiso*, …).

However, given the longer time series, output fields of 2d variables should be given **every 10 years** instead of every 5 years in order to keep output volume reduced. Output as time series should be given **every year**. The same convention applies, and time series, such as grounded ice volume, will therefore be 501 elements long whereby the value at t = 0 is the initialized value.



ABUMIP-Antarctica Standalone Ice Sheet Modeling Initial Participants

Contributors	Model	Group ID	Group
Nick Golledge	PISM	ARC	Antarctic Research Centre, Victoria University of Wellington, NZ
Thomas Kleiner, Johannes Sutter, Angelika Humbert	PISMPal	AWI	Alfred Wegener Institute for Polar and Marine Research, DE/University of Bremen, DE
Stephen Cornford	BISICLES	CPOM	University of Bristol, Centre for Polar Observation and Modelling, UK
Fabien Gillet-Chaulet	ELMER	IGE	Laboratoire de Glaciologie et Géophysique de l'Environnement, FR
Ralf Greve	SICOPOLIS	ILTS	Institute of Low Temperature Science, Hokkaido University, Sapporo, JP
Heiko Goelzer, Roderik van de Wal, Thomas Reerink	IMAUICE32	IMAU	Utrecht University, Institute for Marine and Atmospheric Research (IMAU), Utrecht, NL
Helene Seroussi	ISSM	JPL	NASA Jet Propulsion Laboratory, Pasadena, USA
William Lipscomb	MALI	LANL	Los Alamos National Laboratory, Los Alamos, USA
Aurélien Quiquet, Christophe Dumas	GRISLI	LSCE	Laboratoire des Sciences du Climat et de l'Environnement,Université Paris-Saclay, France
William Lipscomb	CISM	NCAR	National Center for Atmospheric Research, Boulder, CO, USA
David Pollard	HC, NOHC	PSU	Pennsylvania State University EMS Earth and Environmental Systems Institute, Pennsylvania, USA
Sainan Sun, Frank	FETISH	ULB	Laboratoire de

Pattyn

Glaciologie, Université Libre de Bruxelles, Brussels, BE

Reference

Sun S, Pattyn F, Simon EG, et al. Antarctic ice sheet response to sudden and sustained ice-shelf collapse (ABUMIP). Journal of Glaciology. 2020;66(260):891-904. doi:10.1017/jog.2020.67