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Outstanding Student & PhD candidate Presentation contest

Reversibility experiments of present-day Antarctic grounding lines

EGU General Assembly 2022

Benoît Urruty*, Ronja Reese*, Emily Hill*, Julius Garbe, Olivier Gagliardini, Gael Durand, Fabien Gillet-Chaulet, G. Hilmar Gudmundsson, Ricarda Winkelmann, Mondher Chekki, David Chandler, and Petra Langebroek

*Equal contribution

Stability of the current grounding line

What is the current stability of the grounding lines around Antarctica ?

A. Are the grounding lines of Antarctica stable in their current geometry?

B. Are the grounding lines committed to retreat under constant present-day climate forcing?

- MISI not only controlled by the retrograde slope => the **stability is complex** to determine
- There has not yet been a systematic numerical stability analysis to assess if antarctica is under stable/unstable condition.
- Reversibility of perturbation experiments

Common Approach

	elmer/ice	PISM PARALLEL ICE SHEET MODEL	Úa
Numerical method	FE	FD	FE
Stress Balance	SSA	SSA + SIA	SSA
Grid Resolution	Unstructured grid 1 - 50 km	8 km	1 km - 200 km
Rheology	Glen's flow law	Glen's flow law (Glen-Paterson-Budd-Lliboutry-Duval)	Glen's flow law
Friction Law	Coulomb regularized (Joughin et al., 2019)	Power-law with Mohr-Coulomb	Coulomb regularized (Asay-Davis et al., 2016)
Initialisation Method	Data assimilation with relaxation	Spin-up	Data assimilation with relaxation

Common Approach

Measure how sensitive the perturbations are to the ice-sheet model itself
Use as many common features during the initialisation of each model

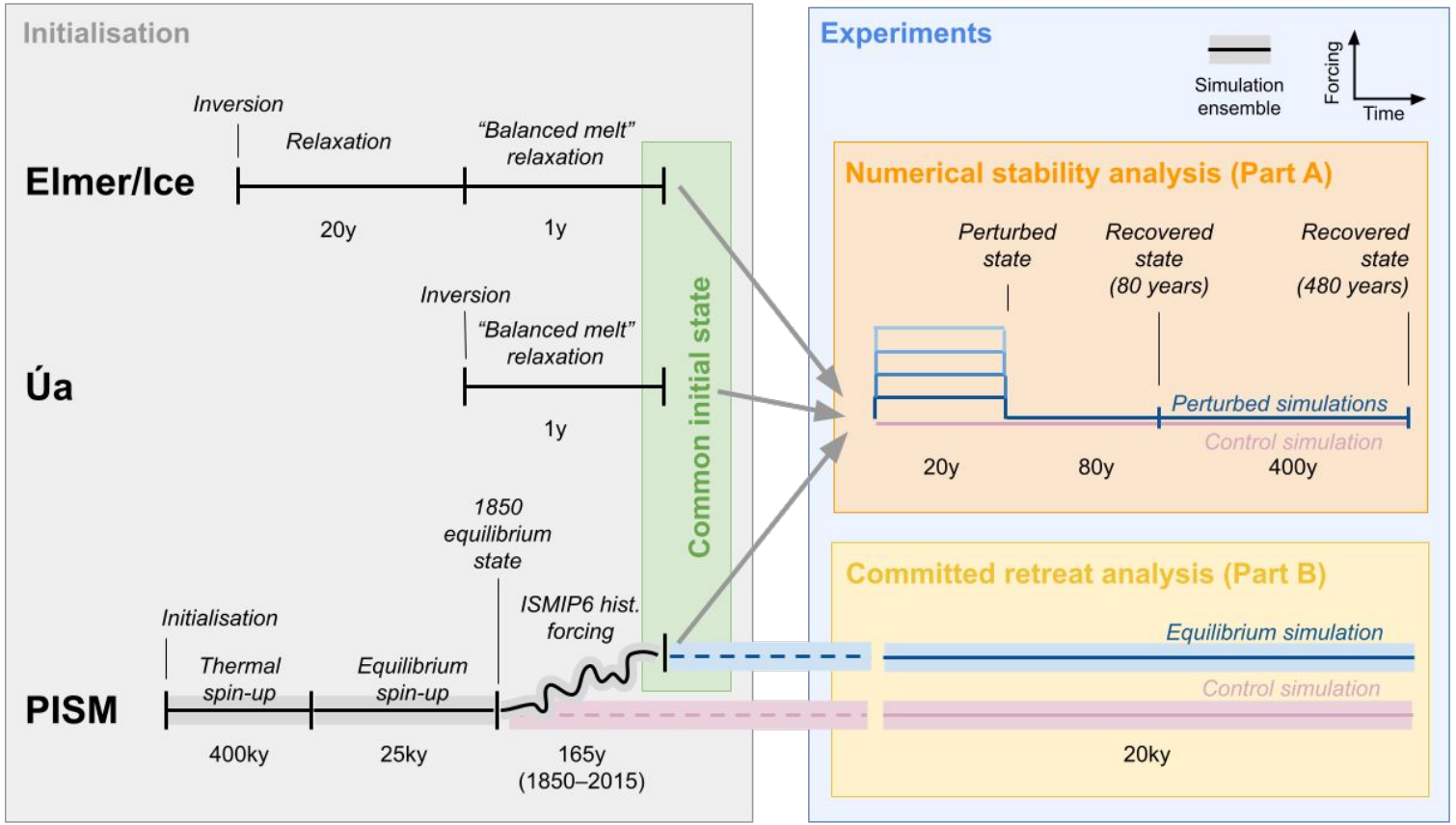
Datasets

- Geometry from BedMachine v2
- Surface velocity from MEaSUREs Annual Antarctic Ice Velocity v1 2015/2016
- Constant surface mass balance from RACMO averaged from 01/1995 to 12/2014
- Basal melt from PICO model

Approach

- “Come as you are” approach as each model is initialised differently
- Aim to replicate the current configuration of the Antarctic ice sheet prior to a perturbation
- Score initial states with respect to observations (similar to ISMIP/initMIP)

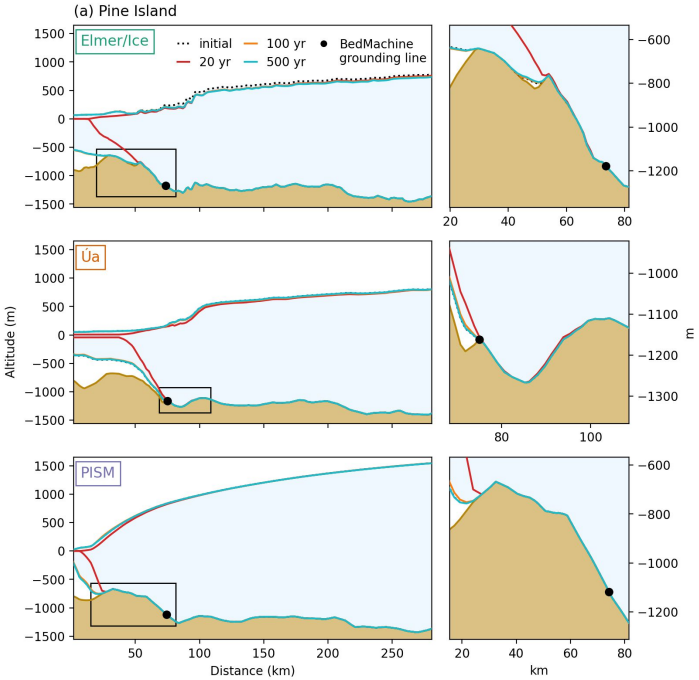
Workflow


Initialisation
Inversion
Relaxation
"Balanced melt" relaxation
Elmer/Ice
20y
1y
Inversion
"Balanced melt" relaxation
Úa
1y
1850 equilibrium state
ISMIP6 hist. forcing
Initialisation
Thermal spin-up
Equilibrium spin-up
PISM
400ky
25ky
165y (1850–2015)
Common initial state
Experiments
Simulation ensemble
Forcing
Time
Numerical stability analysis (Part A)
Perturbed state
Recovered state (80 years)
Recovered state (480 years)
Perturbed simulations
Control simulation
20y
80y
400y
Committed retreat analysis (Part B)
Equilibrium simulation
Control simulation
20ky

Result

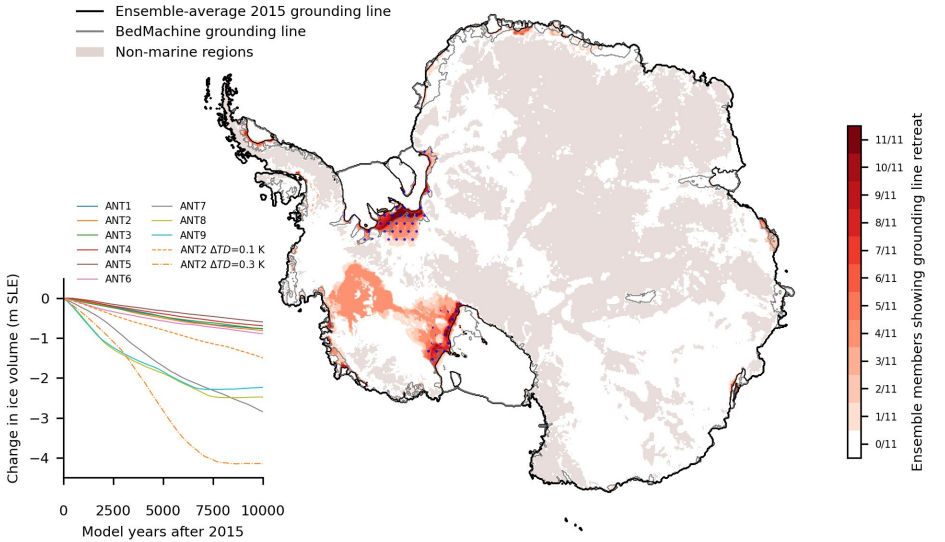
Part A : Numerical stability analysis

- GL are **stable** at their current position **under controlled mass balance**



Part B : Committed retreat analysis

- **Current climate conditions** can force a retreat of glaciers in the Amundsen Sea



Conclusion

No MISI at present (Part A), but WAIS collapse could eventually occur under present-day conditions (Part B)

Tomorrow :

Emily Hill will present CR1.4: Reversibility experiments of present-day Antarctic grounding lines: the short-term perspective (17h21) EGU22-7802

Ronja Reese will present CR1.4: Reversibility experiments of present-day Antarctic grounding lines: the long-term perspective (17h28) EGU22-7802

Both papers have been submitted to The Cryosphere

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TiPACCs

Tipping Points in Antarctic Climate Components

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The TiPACCs project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 820575

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