Antarctic MIP results using CISM

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InitMIP and ABUMIP

• Aim to be a precursor to ISMIP6 (Ice Sheet Model Intercomparison Project for CMIP6)

• **InitMIP**: INITialization for Model Intercomparison Project
  • 2 experiments:
  • asmb: applying SMB anomaly to spun up model and evolve for 100 yr. SMB evolves as: 
    \[ \text{SMB}(t) = \text{SMB}_{\text{initialization}} + \text{SMB}_{\text{anomaly}} \times (\text{floor}(t) / 40); \text{for } 0 < t < 40 \text{ in years} \]
  • abmb: applying BMB anomaly to spun up model and evolve for 100 yr. BMB evolves in a similar fashion as SMB.

• **ABUMIP**: Antarctic Buttressing Model Intercomparison Project
  • 4 experiments:
  • abum: apply a uniform basal melt rate under ice shelves or 400 m/yr and run for 500 yr
  • abuk: remove all ice shelves throughout the experiment and run for 500 yr
  • abumiso = abum + adding isostatic adjustment (not shown here)
  • Abukiso = abuk + adding isostatic adjustment (not shown. Here)
initMIP: asmb (4km Res)

- Thickness evolution follows closely SMB anomalies.
- The thickness changes are mainly on the coast.
- Negative thickness in Ross (and other places with non-negative SMB anomaly) are due to an unbalanced spin up transient behavior.

Applied SMB anomaly (m/yr), data from RACMO2.3

Difference (m) in ice thickness between time 100 yr and control
**initMIP: abmb (4km Res)**

- Ice overall thins.
- Grounding line retreats for many ice streams.
- Grounded ice loss most important in Amundsen sea sector, which has the largest melt rates along with reverse-sloping beds that favor retreat.
Both experiments lead to strong thinning mainly in West Antarctica Ice Sheet. Pine Island Glacier is affected the most. Removing all ice shelves has a greater consequences on WAIS than the strong applied melt rate. A short lived buttressing can delay the retreat of marine ice.
Some time series

- Experiment abmb shows an s.l.e increase of about 40 mm/yr at the end of 100 year which is within the error bounds of past estimations.
- A short lived buttressing can delay the retreat of marine ice over century time scale.
- Under strong melt scenario, 0.5 m of s.l.e happens after 100 yr. This number doubles if ice streams lose buttressing.

- Limited impact of model resolution with asmb, in contrast with the 3 other experiments.
- Higher model resolution favors more retreat.
• **Conclusion:**
  • CISM can simulate realistic Antarctic perturbation scenario.
  • The Amundsen sea and in particular PIG is very sensitive to SMB and BMB perturbation.
  • Buttressing strongly delays the retreat of marine ice.
  • Model is very sensitive to horizontal grid resolution.

• **Future work:**
  • Redo these simulations at higher model resolution (2km).
  • Replace schematic melt rates with sub-shelf melt rates spatially and temporally varying.
  • Couple CISM to ocean model for improve physical representation (MISOMIP).

• **Question:**
  • Can we compensate the ice loss due to increase melting via an increase in precipitation and simultaneously stabilize the Antarctic ice sheet? If so how much do we need?
Kink in the abuk s.l.e curve: an explanation

Thickness at time 200

Thickness at time 210