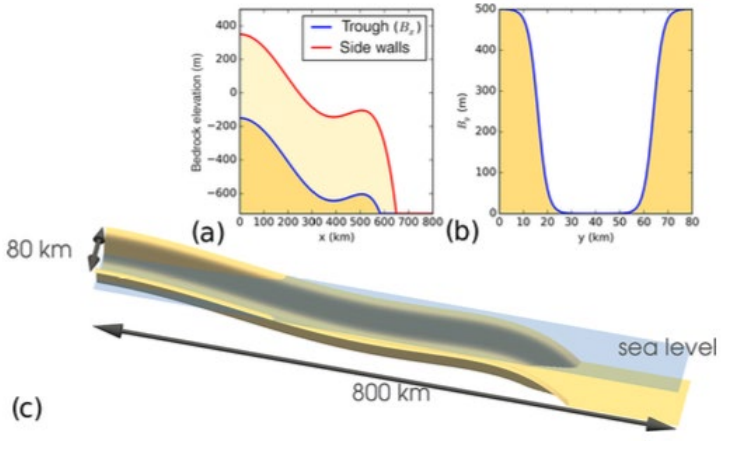
Standalone and coupled MISOMIP experiments using CISM and MOM6

Gunter Leguy, Gustavo Marques, Bill Lipscomb, Alper Altuntas,
Bill Sacks, Kate Thayer-Calder, Mariana Vertenstein

Land Ice Working Group, 4 February 2019

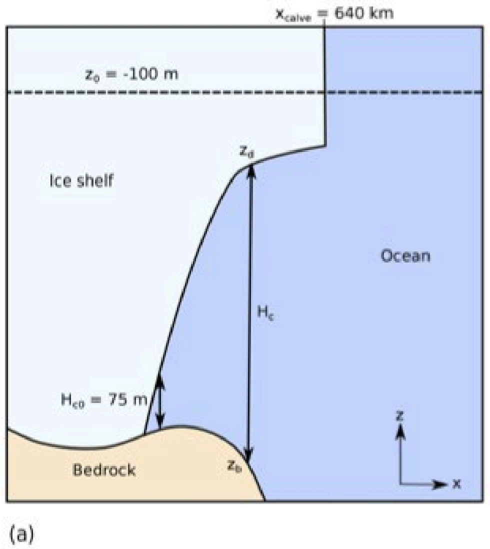
Testing CISM using MISMIP+ experimental setup

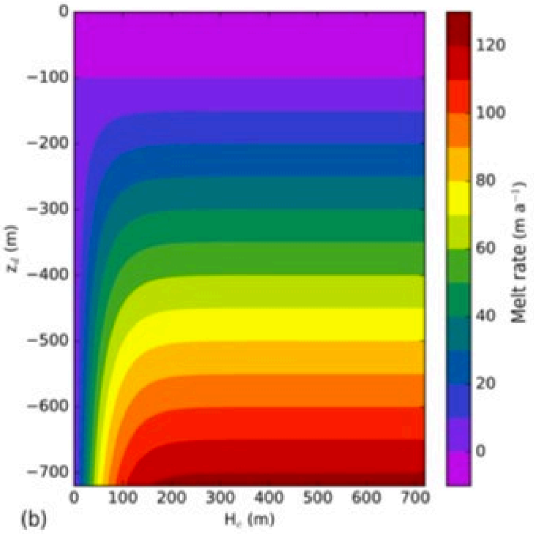
(Asay-Davis et al. 2016)



Bed topography

Mel





- Buttressing due to presence of bed topography walls.
- Experiments mimics typical ice stream flow in WAIS

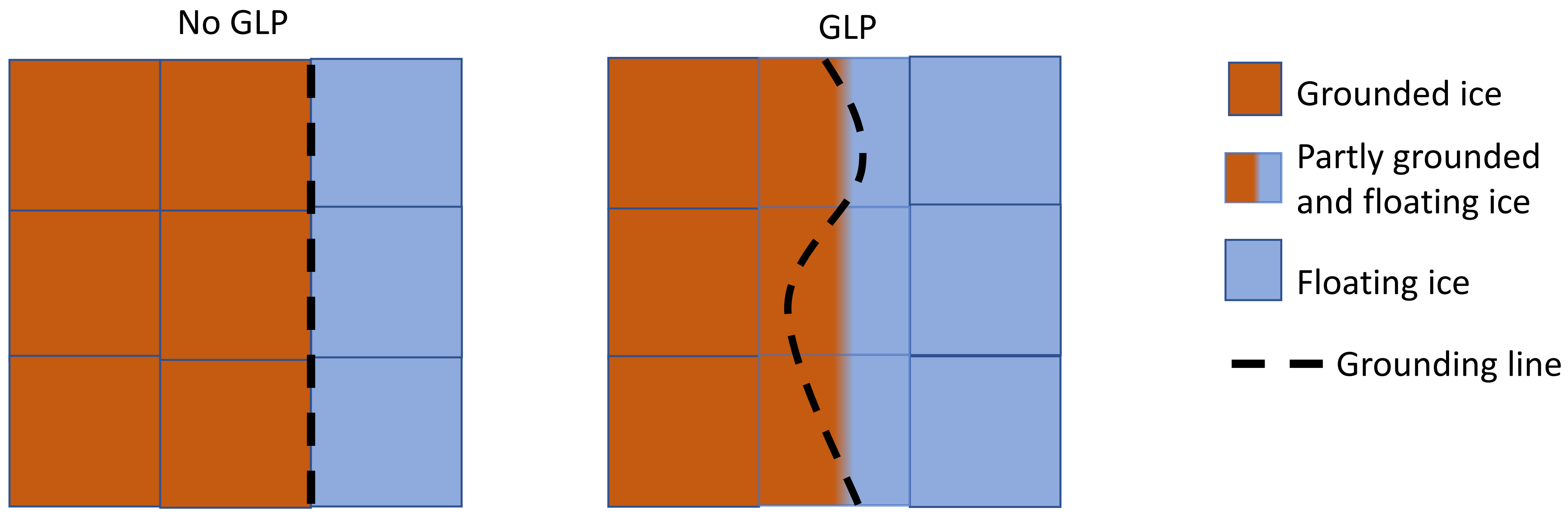
Buttressed ice shelf + Ocean warming → Thinner ice shelf + Reduced buttressing → Flux imbalance and velocity increase → Grounding line retreat (reduced grounded area)

Experimental layout

Set of 4 experiments:
1. Run to steady state (Spinup).
2. 100 year run during which melt rate is applied to steady state profile (Ice1r).
3. 100 year run after Ice1r during which melt rate is switched of and ice sheet evolves back to original profile (Ice1ra).
4. Continuing Ice1r for another 100 year (Ice1rr).

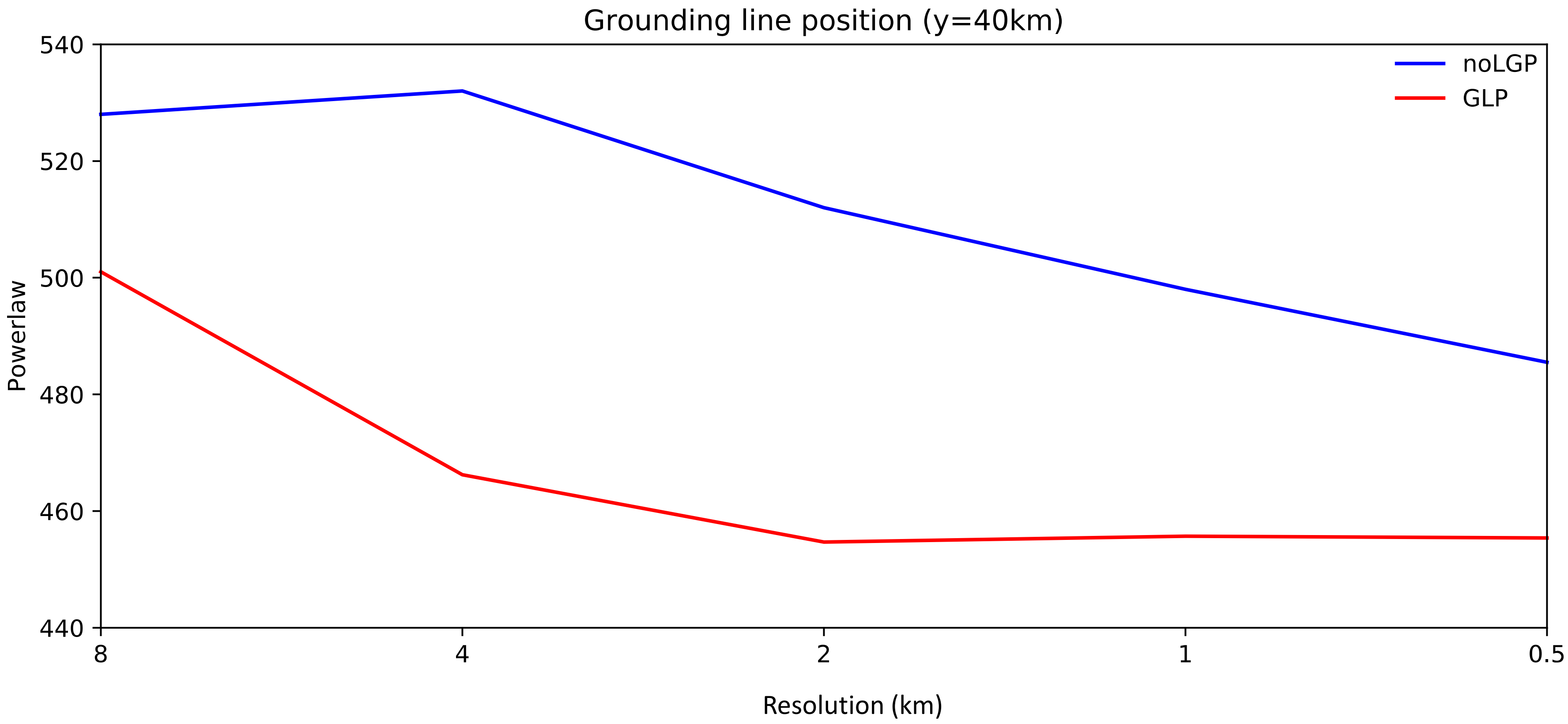
Numerical setup:
- Initial profile is a slab of uniform 100m ice thickness.
- 5 different uniform resolutions: 8, 4, 2, 1, and 0.5 km.
- Powerlaw basal sliding law.
- Stokes approximation: DIVA (Goldberg 2012, Lipscomb et al. 2019).
- Use of no GLP and GLP.
- Test of 3 basal melt parameterizations.
- ...

Grounding line (GL) refresher



- Using a GLP leads to more accurate GL representation (Gladstone et al. 2012, Leguy et al. 2014)
- Same is true for MISMIP+

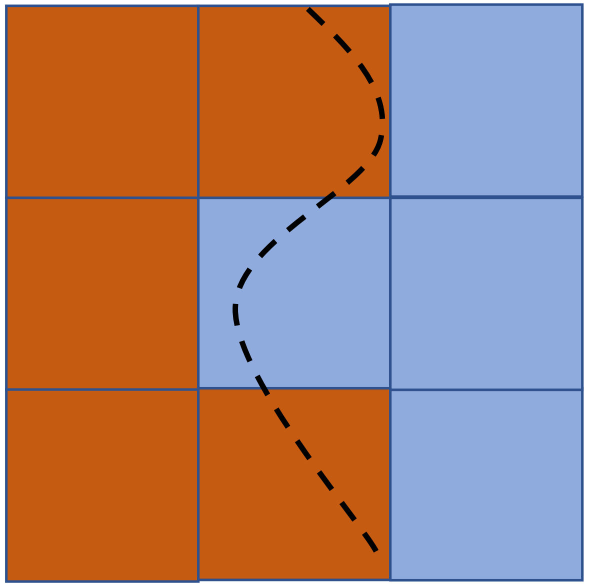
Grounding line convergence for the Spinup experiment



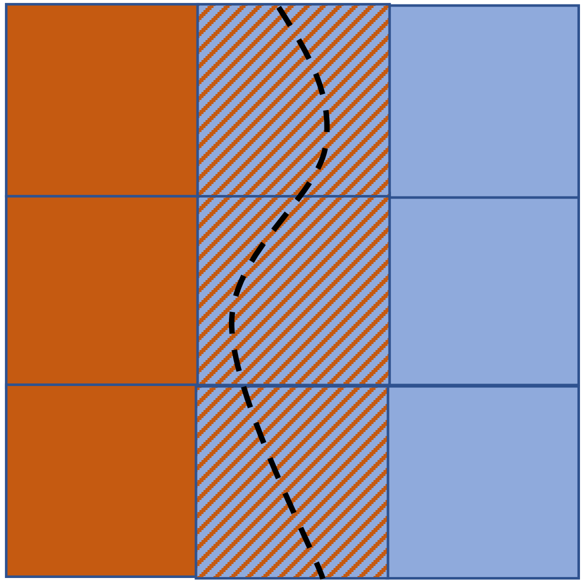
1. Running at a resolution of higher than 1 km (possibly 2 km) does not provide much benefit compared to the increased computational cost.
2. DIVA and BP show similar grounding line results (not shown but checked)

Melt parameterization options

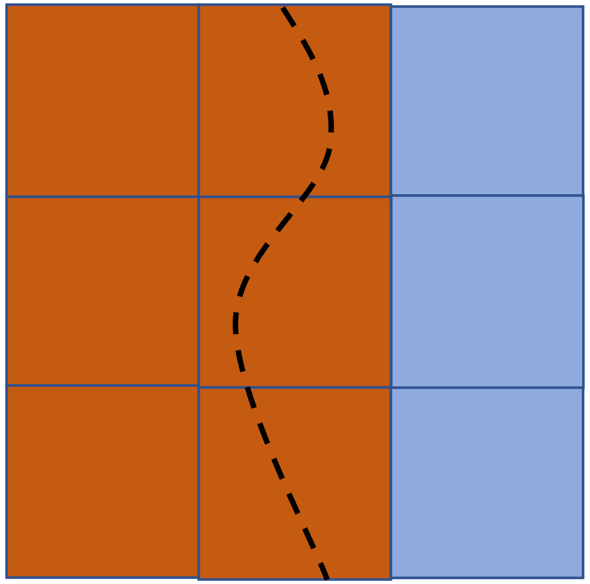
Melt parameterization specific to floatation criterion.
(bmlt_ground_0)



Subgrid melt parameterization.
(bmlt_ground_1)



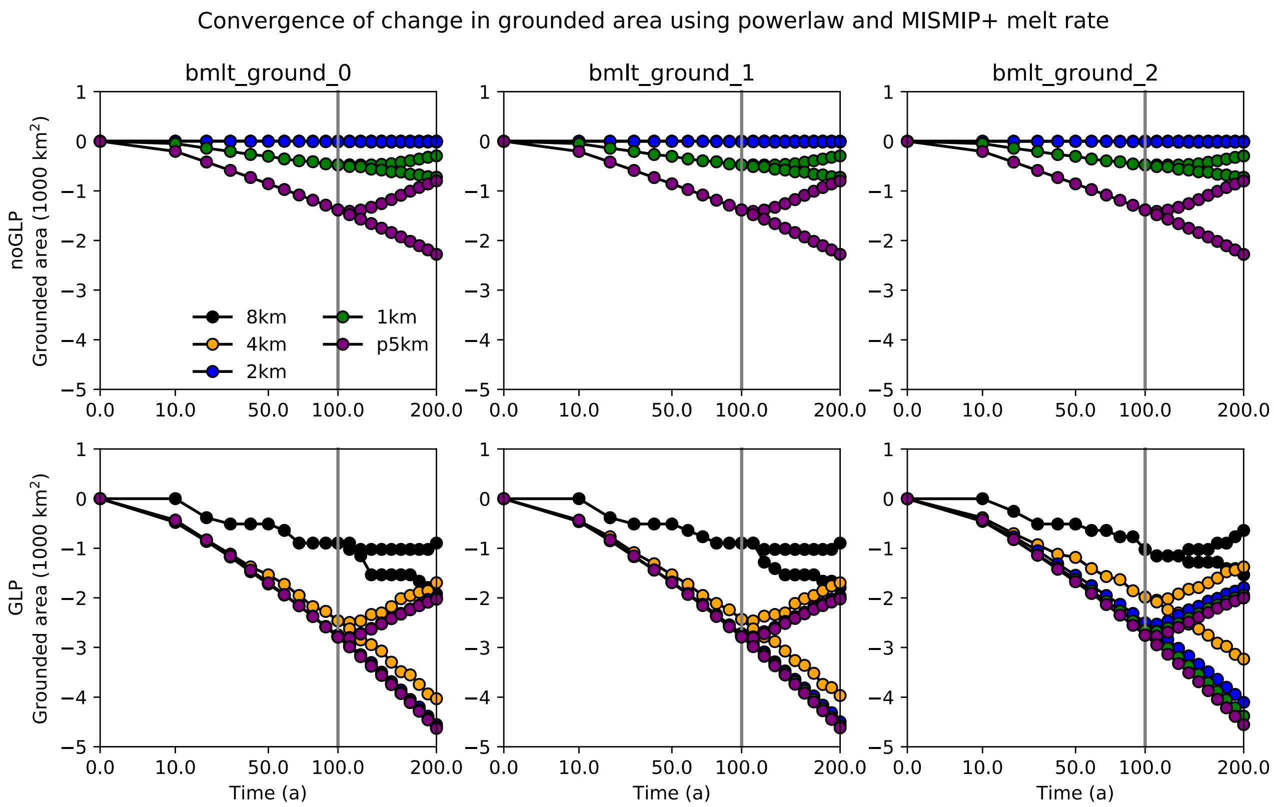
No melt parameterization.
(bmlt_ground_2)



Which option should we use?

Note: a cell could be considered fully grounded when applying the melt rate while simultaneously it can be considered partly floating and grounded when applying the GLP!

MISMIP+ transient results



Take home message:

- Not applying basal melt rate in partly grounded cell does not provide the best convergence results.
- Using a GLP remains beneficial.
- A resolution of 1 km (and 2 km in some cases) seems to be sufficient to accurately represent grounded area change.

These results shed light on necessary numerical configuration to perform coupled ice-ocean interaction

Gustavo’s turn!