MISMIP+ summary of GLE_SSA_SCHOOF2005_1km

G.R. Leguy[1] and W.H. Lipscomb[2]

[1]University of New Mexico, Albuquerque, New Mexico, USA
[2]Los Alamos National Laboratory, Los Alamos, New Mexico, USA

1 Model Detail

- Model: CISM 2.1 [Lipscomb et al., 2013, Price et al., 2015]
- Version not yet publicly released
- Englacial stresses: SSA, Glen's law, $n = 3$, $A = 2.0 \times 10^{-17}$ Pa^{-3}a^{-1}
- Basal traction: second modified law [Schoof, 2005], $\tau_b = \dfrac{\beta^2 u_b^{1/m} \alpha^2 N}{\left[\beta^{2m} u_b + (\alpha^2 N)^m\right]^{1/m}} u_b^{-1} u_{t_i}$, β^2 =10^4 Pa m$^{-1/3}y^{1/3}$, $\alpha^2 = 0.5$, $m = 3$
- Space discretization: Finite element, uniform grid, square cells $0.5 < \Delta x < 4.0$ km (submitted convergence results with all these resolutions but only sent converged results at $\Delta x = 1$ km).
- Time stepping: incremental remapping [Dukowicz and Baumgardner, 2000, Lipscomb and Hunke, 2004], explicit, $\Delta t < \dfrac{\Delta x}{max\left(|u|\right)}$
- Grounding line: Use of a grounding line parameterization. We use the Pattyn function [Pattyn et al., 2006] to diagnose the grounding line position and compute the fractional grounded area in the staggered grid cell containing the grounding line. (A staggered grid cell has a velocity point at its center.) The basal traction is scaled by that fraction in that cell. (More detail is available upon request).

- MISMIP3d name: GLE2 (did not participate in MISMIP3d but assume this would have been the name).

2 Mesh resolution

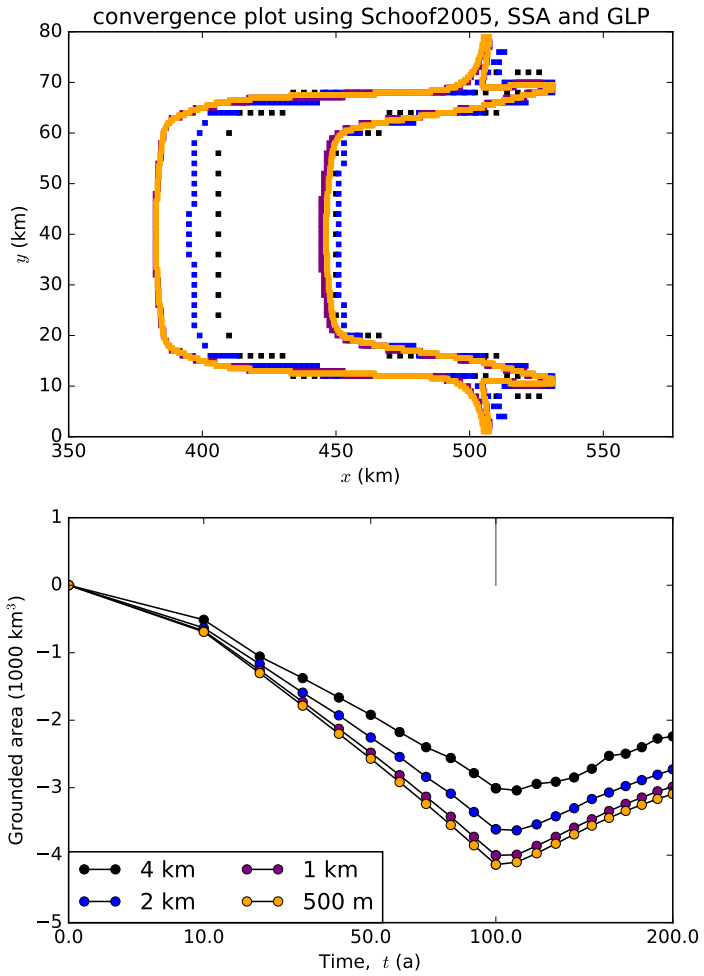

Figure 1: Mesh resolution convergence study. The mesh spacings are $\Delta x = 4$ (black), 2 (blue), 1 (purple), and 0.5 (orange) km. The models were evolved for 20,000 years starting from a uniform 100 m ice thickness prior to running experiment Ice1r. The top panel shows the grounding line positions at the beginning and end of experiment Ice1r. The initial grounding lines are close together (within 7 km from each other). At the end of the experiment the grounding lines are closer to one another as the mesh spacing decreases. The two grounding lines with finest resolution are 0.25 km apart along the center line of the domain (y = 40 km). The bottom panel shows the volume above flotation change during experiments Ice1r and Ice1ra. The curves lie progressively closer together with increasing resolution. The curves with the two highest resolutions show the smallest difference in volume above flotation compared to the total change. Given the top and bottom panels, we believe the difference between the 1 km and 0.5 km resolution results to be small enough to state that the model using a resolution of 1 km is sufficiently converged.

References

W. H. Lipscomb, J. G. Fyke, M. Vizcaino, W. J. Sacks, J. Wolfe, M. Vertenstein, A. Craig, E. Kluzek, and D. M. Lawrence. Implementation and initial evaluation of the Glimmer Community Ice Sheet Model in the Community Earth System Model. *J. Climate*, 2013. doi: 10.1175/JCLI-D-12-00557.1. in press.

S Price, W Lipscomb, M Hoffman, M Hagdorn, I Rutt, T Payne, and F Hebeler. Cism 2.0. 0 documentation, Los Alamos National Laboratory, 2015.

C. Schoof. The effect of cavitation on glacier sliding. *Proc. R. Soc. A*, 461(2055): 609, 2005.

John K Dukowicz and John R Baumgardner. Incremental remapping as a transport/advection algorithm. *Journal of Computational Physics*, 160(1):318–335, 2000.

William H Lipscomb and Elizabeth C Hunke. Modeling sea ice transport using incremental remapping. *Monthly Weather Review*, 132(6):1341–1354, 2004.

Frank Pattyn, Ann Huyghe, Sang De Brabander, and Bert De Smedt. Role of transition zones in marine ice sheet dynamics. *Journal of Geophysical Research: Earth Surface*, 111(F2), 2006.