

**gmdd-2015-228** "Experimental design for three interrelated Marine Ice-Sheet and Ocean Model Intercomparison Projects" - Asay-Davis et al.

This paper describes in detail 3 new model intercomparison projects, MISMIP+, ISOMIP+ and MISOMIP1 for marine ice sheet and regional ocean models. MISMIP+ is dedicated to the marine ice sheet models, ISOMIP+ to the ocean models incorporating an ice-shelf cavity and MISOMIP1 to the coupling of both type of models. This paper is well written, clear and it is an important contribution for the ice-sheet/ocean community. I have only one main concern regarding the diffusion of the setups through different canals (this paper and a web site) and few minor remarks listed below. I will mostly comment on the ice part of the experiments, being not an oceanographer.

My main concern is the existence of more than one place to find the description of the experiments, which might be confusing and source of errors for the participants. It should be stated clearly with which document participants should be working, both on the GMD paper and on the CLIC webpages hosting the description of the MISOMIP experiments. This is also true for supplement material, part of it being attached as a supplement of this paper and an other part being located on the webpage. I suggest that if this GMD paper is the reference for these experiments that all the needed material (input files, examples of model description, etc) is provided as a supplement of this paper. The GMD being the reference, it questions the way changes or updates (which might be necessary when participants will start running the experiments and find some ambiguities in the experiments description, because it is always difficult to think about all possible configurations in advance) will be provided to the community. The strategy for setup update after the GMD paper is accepted should be clearly stated in the GMD paper itself (a link to an update webpage on the MISOMIP website for example).

## Other remarks

page 9865, line 13: performed simulations used offline ... → performed offline coupled simulations ... (?)

page 9869, first equations and all over in the paper. Some of the notations are not homogeneous through all the paper. For example, the bed (which is also the bathymetry) is written  $B$  here,  $z_b$  after Eq. (8) and (13). Then when a quantity is evaluated at the bed (in fact the bottom ice surface) it is noted  $b$  ( $\tau_{nt}|_b$  in Eq. (6)). I would suggest to adopt the same notations as in the previous ISMIP and ISMIP3d experiments for the geometry:  $b$  for the bedrock (and bathymetry),  $z_s$  for the ice upper surface and  $z_b$  for the ice bottom surface, this latter being equal to  $b$  when the ice is grounded and describes the ice-ocean interface (ice draft for the ocean model) when ice is floating. The same apply for the coordinates which are sometime written using lowercase (ice part) and sometime uppercase (ocean part). Legend of figures will have to be updated accordingly.

page 9869, line 20: the fact that either  $A$  and  $\beta^2$  (or both) should be modified is repeated at different places, but I would suggest to write it as a preamble of how the steady state is obtained. This is an important point and the strategy of doing it this way should be explained. Also, it should be stated more clearly if  $A$  and  $\beta^2$  should only be one single scalar for the whole domain (or the whole bedrock) or if participants are free to have space evolving  $A$  and/or  $\beta^2$ .

page 9870, line 1: The tangential component ... → Where the ice is grounded, the tangential component ...

Eq. (7): I have two points here: the first is on how the Tsai friction law, and its dependency to water pressure, is written. The second is on the use of Tsai and others (2015) friction law instead of the  $C^1$  Coulomb-type friction law proposed by Schoof (2005) and Gagliardini and others (2007).

First, I would suggest to really make the distinction between the friction law itself and the way the effective pressure entering the friction law is estimated. I would suggest to write the Tsai and others (2015) friction law as:

$$\tau_{nt}|_b = \min(fN, \beta^2 u_b^{1/m}) u_b^{-1} \mathbf{u}_t \quad (1)$$

and then explain how the effective pressure is estimated:  $N = -\sigma_{nn} - \rho_{sw} g z_b$  (assuming that sea level is 0). It should be stated clearly (more clearly than in the Tsai and others (2015) paper at least) that the water pressure is assumed over all the bed to be given by the ocean hydrostatic pressure, which can be seen as a zero order hydrology model assuming a perfect connection of all the bedrock interface to the ocean (which is certainly a good approximation in the close vicinity of the GL but might give too large water pressure far inland if bedrock elevation decrease again). Then you might want to explain that  $N$  can be expressed using the floatation thickness as  $N = \rho_i g (h - h_f)$ .

Second, I would suggest that the participants can choose between Tsai and others (2015) friction law and the most commonly used so far Coulomb-type friction proposed by Schoof (2005) and Gagliardini and others (2007):

$$\tau_{nt}|_b = CN \left( \frac{u_b^{1-m}}{u_b + A_s C^m N^m} \right)^{1/m} \mathbf{u}_t \quad (2)$$

which depends on the same number of parameter than the Tsai and others (2015) friction law. Moreover, if  $C = f$  and  $A_s = (\beta^2)^{-m}$ , both law are very similar, but the latter is  $C^1$  and always bijective, whereas the former might conduct to numerical difficulties when the plateau is reached. I would suggest that at least the participants have the choice between both effective pressure dependent friction laws.

Eqs. (6) and (7):  $\mathbf{u}$  should be  $u_t$  (only the tangential part to the bed of the velocity vector) and one should define the norm of the tangential velocity (noted  $u_b$  above) instead of  $|u|$ .

page 9870, line 18: computing basal melt by balancing ... → computing basal melt bellow the ice-shelf by balancing ...

page 9871, line 2:  $u_*$  is the friction velocity ... →  $u_*$  is the ocean water friction velocity ...

the elevation of the bedrock is already defined before. thickness, and where  $u_{*,0}$  ... → thickness, and  $u_{*,0}$  ...

page 9872, line 14: in units definition, "yr" should be written "a" all over the manuscript.

page 9875, line 23: in a. pdf file ... → in a pdf file ...

page 9876, points 2 and 3: if  $A$  and/or  $\beta^2$  are not uniform, how should they be given?

page 9877, line 4: of ice, not water equivalent) ... → of ice (not water equivalent) ...

page 9877, line 9: what is expected here is the basal traction at the bottom interface, so using your notation it should be  $\tau_{nt}|_{z_d}$ , but adopting what I have suggested it should write  $\tau_{nt}|_{z_b}$  (this should be corrected at many other places in the manuscript).

page 9879, line 15: Ocean2 has a fixed geometry?

page 9879, line 27: the web site address is given at different places in the manuscript. I would suggest to give it once at a judicious place where you should also explain which document is the reference document for the experiences and what can be found in the MISOMIP website (see my main comment).

page 9880, line 12: why it is important should be stated more clearly? Also, are the ocean models supposed to account for the iceberg melting. I guess not, but it should be stated that when calved, iceberg are simply removed from the system and don't induce any fresh water flux to the ocean model.

page 9881, Eqs. (15) and (16): would suggest to replace = ... by  $\approx$ . Coordinates are now in uppercase. Should keep this homogeneous through the manuscript.

page 9881, line 14:  $T_{bot}$  should be  $T_b$  (using my notation suggestion), but then in Eqs. (21)-(24), it should be  $T_{z_b}$ ,  $S_{z_b}$  and  $p_{z_b}$  ...

3.2 to 3.5: would suppress "experiment i": ISOMIP+ experiment 1 (Ocean1): ... → ISOMIP+ Ocean1: ... and only refer to this experiment by Ocean1 (not experiment 1 of ISOMIP+). Same for 4.1 and 4.2 for the IceOcean experiments. In part 3.2, both Ocean1 and Ocean2 are in fact described.

page 9893: for ISMIP+, a pdf file is asked. Should be the same? Also, I suggest to have also the required inputs in this file to be in a numbered list, as for ISMIP+.

page 9894, line 18: from Parallel Ocean Program version 2 extended (POP2x) ... → from POP2x ...

page 9897, lines 18-20: I would suggest to remove these two sentences, which are a bit contradictory?

page 9898, line 12: website address already given.

Table 1:  $\rho_{fw}$  not given (but may be too obvious to be ambiguous?)

Table 2, caption: A list ... → List ...

Figure 1: change notations if bedrock equations are modified

Figure 2: axes label are a bit small

Figure 3: the color bar should be the same height than the plot itself.

Figure 8: replace "expt i" by "Oceani" in the legend.

Figure 13a: the colorbar legend is too small and I would suggest to avoid a colored background.

## References

- Gagliardini, O., D. Cohen, P. Råback and T. Zwinger. 2007, Finite-element modeling of subglacial cavities and related friction law. *J. Geophys. Res.*, **112**(F2), F02027.
- Schoof, C. 2005, The effect of cavitation on glacier sliding. *Proc. R. Soc. A*, **461**, 609–627.
- Tsai, V. C., A. L. Stewart and A. F. Thompson. 2015, Marine ice-sheet profiles and stability under Coulomb basal conditions. *Journal of Glaciology*, **61**(226), 205–215.