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Discussions

Interactive comment on "A two-layer flow model to represent ice-ocean interactions beneath Antarctic ice shelves" *by* V. Lee et al.

Anonymous Referee #2

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General comments:

The authors of this paper develop a two-layer (the plume and ambient layers) model to describe melt rates of an idealized ice shelf. The notable difference from the previous studies is the introduction of the ambient ocean layer to better describe the ocean circulation beneath the ice-shelves. The plume and ambient layers are connected by assuming that the pressure is continuous across the interface. The model results were compared to the one-layer models.

I do not understand the mix use of linear and quadratic drag terms in this manuscript. Authors justify the use of linear drag law for the whole cavity(P72 Line 15), whereas the quadratic drag law is employed to describe the plume. It is not clear whether the physics of the plume and whole cavity motions are consistent with each other. The

plume velocity is defined as the vertically integrated cavity velocity, equation (26). Does this mean that the vertically integrated equation (1), linear drag law, become equivalent to the equation (25), quadratic drag law? It is not obvious to me.

I am not entirely convinced that this model is a good candidate for coupling to ice sheet models, mentioned in P115, line 4. There are general circulation models (GCMs) that can solve Boussinesq equations in N layers. I think the validation against GCMs will be interesting before coupling to ice sheet models. Rather than adding complex physics to a simple model, it may be beneficial to utilize GCMs to predict the future change of ice shelves.

Specific comments:

P76 6: Commas needed "the plume at the top, consisting of relatively fresh water with density ρ_p and depth D_p, and the other, the ambient with density ρ_a and depth D_a.

p78 5: This model does not solve the full momentum equations to calculate the plume velocity. Instead, the equation (28) is used. The derivation of plume velocity in equation (28) needs more explanation. Authors mentioned the use of Picard iteration to solve equation (27) and obtained equation (28). I think either citations or complete explanation of this method is needed, because the authors note that the use of equation 28 is one of the main differences between this model and the earlier one (P83 Line10).

P82 section 2.4.2: The melt rate is calculated, using the fields from the plume layer. Equation (44), (45), and (46) are the balance of heat and salt fluxes. I am wondering whether it makes sense to use the velocity, temperature and salinity from far fields. Are there any differences in melt rate if the velocity, temperature and salinity from the ambient layer are used?

P108 10-15: The authors mentioned about the possibility of artificial internal gravity waves. I am not clear what physics in this model can create internal gravity waves.

P108 20-25: I do not understand the point of showing the figures (7c and 10), which are not discussed in the paper. The authors mentioned that the ambient temperature became unphysical, but what makes the authors to believe the result is unphysical?

Interactive comment on Geosci. Model Dev. Discuss., 4, 65, 2011.