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The Cryosphere Discussions

Interactive comment on "Tidal influences on a future evolution of the Filchner-Ronne Ice Shelf cavity in the Weddell Sea, Antarctica" *by* Rachael D. Mueller

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General comments:

The authors present a very comprehensive study of the influence of tides (K1, O1, M2, S2) on the circulation beneath, melting at the base, and spreading of glacial melt within the cavity of the largest - by volume - Antarctic ice shelf. This has been done, switching the tidal forcing on/off, for two different initial ocean temperatures, today and moderate warming of the cavity, and a modified cavity geometry, which considers the reduction of ice shelf thickness due to increased melting. Despite the large number of simulations the reader does not get lost, since the presentation of the results is well

organized, allowing for an easy 'digestion' of the findings. The study is very timely not only in view of an increasing awareness that the ocean is the prime driver of the Antarctic Ice Sheet mass loss but also in view of the long-existing assumption, based on a few model exercises (e.g., MacAyeal 1985), that tides might play a significant role in the basal processes, though not being considered in present state-of-the-art coupled ocean-ice shelf-models. This paper demonstrates that the incorporation of tides is necessary to correctly simulate the melt/freez pattern in a large 'cold cavity' because of the consequences it has for the dynamics of the ice shelf and thus the whole ice sheet, not only for today but also in view of the changes ice shelf cavities might face in a warming climate.

The results, however, should be viewed more in a qualitative manner, due to several model shortcomings with regard to the set up and the forcing, but here the model is in good company with other 'more sophisticated' models. I especially like the study of the interplay between different ice stream inlets and their dependency on location and strength of upstream melting.

In summary, I strongly recommend publication in TC after the comments have been considered and corrections made.

Specific comments:

L032 – How can a paper published in 2006 cover the period 2002-2016? Actually, according to Monaghan et al. (2006), which covers the period 1955-2004, small changes in SA only occurred on the EAIS.

L055 – With regard to the direct flow of CDW into the ice shelf cavities of ABS Jenkins et al. (2010) is a more appropriate reference.

L081 – More precise: Hellmer et al. (2017) not just reversed the atmospheric conditions to a colder state but to 20th -century conditions.

L164 - Equation (4) must read wb = QT0/L x rho . And, somewhere it should be

mentioned that heat flux through the ice shelf is ignored.

L216 – It comes as a surprise that open ocean wct = h has a maximum value of 1914 m, though the model domain (Fig. 1) only covers the southern Weddell Sea continental shelf.

L283 – It is not clear whether the 'bulk dye' was added to the whole water column or just to the suface-sigma layer. The confusion starts when looking at Fig. 8a, which looks more like a 'bottom dye' distribution.

L305 – It is not clear what is meant with 'outer/interior grounding line' – please explain.

L335 – Here, a serious deficit of the model becomes obvious, since the refreezing along the eastern coast of Berkner Island (e.g., Rignot et al. (2013)) is missing, certainly because the model exaggerates the flow into the Filchner cavity.

L396 – A reduction of area-averaged melt rates due to adding tides also happens for Support Force.

L426 – The comparison with Hellmer et al. (2012) is risky because this kind of circulation only happens for the 'warm phase', while here the same circulation pattern exists for the 'standard cold case'. Such comparison might provoke a critical reader to question ROMS' performance in general.

L714 – By summarizing important results I miss (5): The increase of refreezing in central RIS in the 'standard cold case', representing today's conditions. This is an important finding because refreezing in this area certainly changes the dynamics of the ice shelf by increasing the buttressing around Henry and Korff.

L1044 – Please explain the difference between 'region' and 'inlet', used in Fig. 8.

L1061 – Please explain why Foundation shows a high dye concentration at the bottom. The signal cannot be advected from Support Force because there it does not exist, and highest melting beneath Foundation should stabilize the water column such that most,

if not all, of the dye should concentrate at the base.

Technical corrections:

L031 – The dominant terms in the Antarctic ICE SHEET (AIS) mass budget....

L060 – We focus here ON . . .

L267 - . . . over the LAST 30 days?

L298 - . . . ice shelf frontal zone (ISFZ) of the RIS (here, front is redundant)

L337 - ...northWESTERN RIS.

L466 - . . . from all upstream sourceS.

L510 – Fig. 10e

L 833 – HelLmer, H. H.

L1000 - .. the extent of thE ice shelf...

L1017 – Locations of the six meltwater dye RELEASES..

References: Jenkins, A. et al. (2010), Nature Geoscience, doi:10.1038/ngeo890

MacAyeal, D. R. (1985) The evolution of tidally triggered meltwater plumes below ice shelves. Oceanology of the Antarctic Continental Shelf, ed. S. S. Jacobs, Antarctic Research Series, 43, 133 – 143, American Geophysical Union, Washington D.C.

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