Author replies (AC) to editor comments in blue, revised text in "red italics".

Deleted: Dear Dr. van Wessem, dear co-authors,

EC: I value the work done on the revised manuscript, which has appropriately addressed the reviewers' comments. However, the simulated aquifer spatial extents over the Wilkins ice shelf seem largely underestimated when compared to observations recently published by Montgomery et al. (2020). Montgomery et al. (2020) have mapped the aquifer extent on the Wilkins ice shelf using airborne radar observations, and they have confirmed the aquifer presence with ground-based radar data and drillings. While this study is referenced in your manuscript, there is no mention of this underestimation. As a result, I am returning this manuscript to you for adding clarification text that would benefit all readers.

AC: Dear editor. Thank you for your positive comments about our revision. We are aware of this new study having been released during (and after) the review and revision of this manuscript. We have tried to address your suggestions appropriately by adding the following paragraph to section 5.1.1.

"The presence of an extensive PFA on Wilkins ice shelf (WIS) as reported by Montgomery et al. (2020) is confirmed by our results. Although they do not provide a quantitative estimate of total surface area of the WIS aquifer, their results from the MCoRDS radar system onboard NASA's Operation IceBridge fight on 16 November 2014 suggest a greater westward aquifer extent than in either IMAU-FDM or SNOWPACK (Fig. 5). In addition, their study provides field observations of e.g. liquid water content and firn density. A comparison of these observations with our results remains difficult, as these in-situ observations were performed in 2018, i.e. after the model period used here. Moreover, neither firn model treats meltwater ponding on top of ice lenses or lateral water flow, further hampering such a direct comparison. It is well possible that the underestimated PFA extent is a result of these model limitations."

More specifically:

EC: 1) it appears that the simulated aquifer spatial extents (based on two snow models) presented in the current TCD manuscript do not match the large extent identified with observations based on an established airborne radar system. This is currently not stated in the manuscript in spite of a dedicated subsection to Wilkins (section 5.1.1). Also, the abstract may offer up front a misleading statement with the following sentence: "Most persistent and extensive are PFAs modelled on and around Wilkins ice shelf. Here, both meltwater production and accumulation rates are sufficiently high to cause PFA formation on 49% of the ice shelf area […]". Based on airborne observations (and acknowledging that data only exists along track), it seems that a much larger area of the Wilkins ice shelf has an aquifer. The latter sentence should restate that the information provided results from simulations. Moreover, it seems appropriate to address this discrepancy thoroughly in section 5.1.1, because the simulated extent seems largely underestimated.

AC: As stated above, we have added a paragraph addressing this study in more detail in section 5.1.1. To accommodate the above comment, we have edited the sentence in the abstract: "Here, both meltwater production and accumulation rates are sufficiently high to sustain a PFA on 49% of the ice shelf area, in (up to) 100% (depending on the model) of the years in the 1979--2016 period. Although this PFA presence is confirmed by recent observations, its extent in the models appears underestimated." and in the conclusion section: "The most extensive PFA system is modelled on Wilkins ice shelf, covering 49% of its total area in both models. Observations confirm the presence of an extensive aquifer on the WIS, but suggest that the modelled extent may be underestimated (Montgomery et al., 2020)."

EC: 2) of note, Montgomery et al. (2020) have published density profiles on the Wilkins ice shelf, where there is an aquifer. The in situ, ground-based, and airborne measurements presented in that study are available at https://www.usap-dc.org/view/dataset/601390. I encourage the authors to add these new density profiles in their density model evaluation, which at the moment exclusively includes density profiles over non-aquifer areas on the Larsen C ice shelf.

AC: A direct comparison with these observations of liquid water content and density would require a hydrological model that explicitly treats meltwater ponding on top of ice lenses as well as lateral water flow. As neither firn model includes parametrizations of these processes, a direct comparison is deemed less useful, as we have now explained in the added text (see above).

Reference

Montgomery, L., Miège, C., Miller, J., Scambos, T. A., Wallin, B., Miller, O., et al. (2020). Hydrologic properties of a highly permeable firn aquifer in the Wilkins Ice Shelf, Antarctica. Geophysical Research Letters, 47, e2020GL089552. https://doi.org/10.1029/2020GL089552