

## ***Interactive comment on “Mid-Holocene Antarctic sea-ice increase driven by marine ice sheet retreat” by Kate E. Ashley et al.***

**Anonymous Referee #2**

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Review of Ashley et al. This study presents a new Holocene record (12 ka to present) from the Adelie basin to infer past changes in meltwater from Antarctica as well as sea-ice changes. Hydrogen isotopes of fatty acids, relative abundance of phytoplankton, and organic compound composition are measured in the marine sediment core. Other measurements were made (e.g. grain size analysis), but are not shown in the main text. In addition, meltwater experiments are performed with an eddy-permitting ocean model. The study is interesting, presenting a lot of information, which can help in the understanding of the deglaciation of Antarctica. I think in between the main text and Supp. all the information is there. However, the manuscript needs to be significantly restructured as it is currently very hard to follow. The reasoning and result from each analysis/modelling needs to be more clearly laid out. This is developed in the

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comments below:

1) Numerical modelling: I was quite excited at first to see a series of simulations performed with 1/6deg model. However, the results are only very briefly described in the paragraph L. 261. The motivation behind the modelling experiments should be more clearly explained as well as the limitations/assumptions taken. The volume of ice equivalent to each meltwater input should be given. They have the advantage of being performed with a high-resolution ocean model, however for the problem at hand (understanding the percentage of meltwater coming from the Ross Sea, without the use of water isotopes), they are a bit limited. The paragraph L. 261 surprised me, as the setting of the study is described, and suddenly some results of the numerical simulations are described. Until looking at the figures, it was very unclear to me that you were referring to your own simulations. Please be more specific, or consider restructuring, also because Figures 3 and 4 are (very briefly) described, whereas Figure 2 has not been called yet.

2) Based on the Methods, a lot of analyses have been made on the sediment core, but i) only d2H of fatty acids, phytoplankton %, and organic compound composition are shown in the main text, ii) only hydrogen isotopes of fatty acids are presented in the “results”(there is in fact no “result” section), iii) most of the other analyses are in fact presented in the “Discussion” section and the supplementary. As reading L. 536 in the Discussion, I realized you were in fact talking about your results (Ba/Ti). Searching through the document I realized this was briefly mentioned elsewhere, but this should be made much more obvious. Methods could be shorter but by going to the point of each measurement that you need for your interpretation. It would be good to have all the necessary/needed sediment analyses and modelling results presented in the “Results” section as well as in the Figures of the main text. The discussion section should then focus on the bigger picture and putting the results within the context of previous studies.

Suddenly in the Discussion section (e.g. L. 544, L. 550), conclusions are presented

about changes in sea-ice, without knowing where this is coming from. Please clearly state in the results section how you infer the changes in sea-ice and what the main changes across the Holocene are.

It is not clear to me that all the other proxies (from other marine sediment/ice cores) presented in Figure 2 are consistently discussed in the text. Please make sure to clearly mention what each proxy suggest/represent (i.e. how to interpret changes in MSA, Lithics... might not be straight forward for all readers), and refer to it as Fig. 2f, 2g, with the appropriate reference.

3) The manuscript is quite well referenced, particularly with respect to the setting of the study, but I am surprised (particularly given the co-author list) not to see any comparison or discussion with previous modelling work on Antarctic deglaciation. Even though these simulations (e.g. Golledge et al., 2014) are associated with significant uncertainties, they might help in discussing the origin and magnitude of Antarctic meltwater.

4) Minor points and typos: L.101: “sealed”

L. 191: Please use present tense.

L. 257: Please correct the typo “10^6” and add Sv, so it should read (1 Sv=10^6 m3/s).

L. 257: Maybe add a caveat to the “76 Sv”, which seems a bit high. In Thompson et al., 2018 (Review of Geophysics on the ASC), they state that Pena-Molino et al., (2016) find a highly variable ASC at 113E from 0 to 100 Sv, but with a mean of 21 Sv.

L. 259: “the gyre transport is around”

L. 268: “of the meltwater input.”

L. 347: there is something wrong with that sentence.

L. 597-598: “most models”, There are not many transient simulations of the Holocene currently published, and the one you refer to could be the only one. So instead of “most models”, simply state the “TRACE21 simulation”

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