The Cryosphere Discussions

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Comment on tc-2021-121

Anonymous Referee #2

Referee comment on "Eighteen-year record of circum-Antarctic landfast-sea-ice distribution allows detailed baseline characterisation and reveals trends and variability" by Alexander D. Fraser et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-121-RC2, 2021

This submission explores many aspects of fast ice around the periphery of Antarctica, including trends, links with bathymetric depth, monthly timings of minimum and maximum coverage, age, and persistence etc. It is based on the analysis of 18 years of record obtained via hires remote sensing.

The submission has the potential to make a significant contribution to the literature, but it is not quite there yet. Before I would be able to recommend acceptance, there are a number of issues which need to be addressed.

Lines 51-54: The authors should comment on how their dataset might different from one that used the improved scheme of Paul and Huntemann applied to MODIS to detect cloud cover over Antarctic sea ice as well as its discrimination from sea-ice cover and open-water areas. See

Stephan Paul and Marcus Huntemann, 2021: Improved machine-learning-based open-water-sea-ice-cloud discrimination over wintertime Antarctic sea ice using MODIS thermal-

infrared imagery. The Cryosphere, 15, 1551-1565, doi: 10.5194/tc-15-1551-2021.

Lines 56-58, and various other places in paper: It makes sense that the five sectors that have been traditionally used for sea ice analyses might not be appropriate for fast ice (because of the very different dynamics and thermodynamics). The authors later go on to explain how they choose eight coherent sectors for the fast ice investigation. Then throughout the paper they refer to the 'newly-defined regions'. This becomes a little tedious and is really unnecessary – I suggest they just refer to the 'regions', as the meaning will be quite clear.

In the Appendices they describe the autocorrelation approach to identifying the eight regions, and their approach is reasonable. They also point out some of the caveats of how they have done this. An extra caveat that should be mentioned is that they have obtained these semi-coherent sectors in a 'a posteriori' fashion rather from, e.g., physical arguments. Hence, by its very nature coherent collections are identified, which in turn will mean than any trends will have an enhanced level of statistical significance. I don't have a great problem with the approach, but the caveat should be made clear.

Appendix A and B: As a point related to that raised immediately above, it seems that the 'traditional' five sectors are only used in these Appendices (and in Fig. A1). Given that, I strongly suggest that these five sectors (the red ones) be removed from Figure 2, as it makes that Fig. more complicated than it needs to be. (The longitude limits of these sectors can be presented in the text in the Appendices). As a separate idea I would suggest that an extra column be added to Table 1 to present the trends (and p values) for the eight regions; this would mean that the results of the trend analyses (which are perhaps the most interesting aspect of the paper) are presented 'front and center' to catch the reader's eye.

Also on Figure 2 (and also Figures 3 and 4) the sectors are labelled 1 thru 8. These numbers are not referred to, so they should be deleted.

Line 76-77: Author names have been repeated.

Lines 83-86: Why not simply say here ‘the first four Fourier components’? Also, perhaps make clear why the standard method of calculating Fourier amplitudes and phases was not used. What was the advantage of the L-M approach here?

Line 95 (and elsewhere where relevant): Jodie Smith’s paper now has a doi, so should now be referenced as ‘Smith et al. (2021)’

Line 113: To avoid any possible confusion perhaps best to be explicit and write ‘circumpolar extent time’ as ‘circumpolar fast ice extent time’.

Line 117: Also cite here the update of Simmonds et al., 2021: Trends and variability in polar sea ice, global atmospheric circulations and baroclinicity. Annals of NY Acad. Sciences, doi: 10.1111/nyas.14673.

Lines 128-132: Authors should comment on the physics that may be responsible for these phase difference between the fast ice and the sea ice.

Line160: Change ‘Fogwill et al. (2016),’ to ‘(Fogwill et al., 2016),’ Lines before lines 162 (caption of Figure 5): The caption text says '… trend p-value are indicated in the title of each sub-plot' but the p values are not shown (only the standard error). Please add the p values.

Lines 162-164: Authors should present some ideas or speculation on what this environmental forcing over a large spatial scale' might be.

Line 183: Delete one of the 'Fraser et al.'.

Lines 180-191: Some interesting points are raised here, and certainly warrant future work. For the moment however, some extra discussion is required here. The tentative link/association made here with sea ice extent should be reinforced with comparison with sea ice concentration. The four regions of fast ice decrease and four of increase for the most part closely follow the trends in sea ice concentration shown by Li et al. (2021) 'Trends and variability in polar sea ice, global atmospheric circulations and baroclinicity. *Ann. NY Acad. Sci.*, doi: 10.1111/nyas.14673'. Reference to that paper and some extra comments on this will make this part of the interpretation much stronger.

Lines 199-207: Also helpful to reference at this point in the text the more recent paper by

Aoki, S., 2017: Breakup of land-fast sea ice in Lützow-Holm Bay, East Antarctica, and its teleconnection to tropical Pacific sea surface temperatures. *Geophysical Research Letters*, **44**, 3219-3227, doi: 10.1002/2017GL072835.

Lines 283-285: Relevant remote atmospheric teleconnections into the Peninsula from warming down in the Tasman Sea have recently been identified by Sato, K and coauthors 2021 - Antarctic Peninsula warm winters influenced by Tasman Sea temperatures. Nature Comms, 12, 1497, doi: 10.1038/s41467-021-21773-5. Valuable to also reference this here

Line 317: Reinforce this statement by also referencing Sato et al., 2021 ('Antarctic skin temperature warming related to enhanced downward longwave radiation associated with increased atmospheric advection of moisture and temperature. *Env. Res. Lett.*, **16**, 064059, doi: 10.1088/1748-9326/ac0211') (his Fig. 4).

Lines 395-396: Please to note missing details plus wrong order of authors -

Kim, M., H.-C. Kim, J. Im, S. Lee and H. Han, 2020: Object-based landfast sea ice detection over West Antarctica using time series ALOS PALSAR data. Remote Sensing of Environment, 242, 111782, doi: 10.1016/j.rse.2020.111782.

Lines 450-451: Please note full details of this paper are …

Claire L. Parkinson, 2019: A 40-y record reveals gradual Antarctic sea ice increases followed by decreases at rates far exceeding the rates seen in the Arctic. *Proceedings of the National Academy of Sciences of the United States of America*, **116**, 14414-14423, doi: 10.1073/pnas.1906556116.

Lines 461-462: Updated details are:

Smith J., Nogi Y., Spinoccia M., Dorschel B. and Leventer A. (2021) A bathymetric compilation of the Cape Darnley region, East Antarctica. Antarc. Sci., doi: 10.1017/S0954102021000298.

Lines 466-467:

Turner, John et al., 2016: Absence of 21st century warming on Antarctic Peninsula consistent with natural variability. Nature, 535, 411-415, doi: 10.1038/nature18645.