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Climate of the Past
Discussions

Interactive comment on "Sea Ice dynamics at the Western Antarctic Peninsula during the industrial era: a multi-proxy intercomparison study" *by* Maria-Elena Vorrath et al.

Anonymous Referee #1

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Given the dramatic climatic and environmental impact of the ongoing global warming on the Antarctic Peninsula, numerous studies have scrutinised and examined the modern variability of sea ice over the past few years. However, we still know a little about its pre-industrial evolution, i.e. under natural climatic forcing, and its evolution throughout the transition toward an increasingly "industrialised world". To this aim, Vorrath et al. present here a very interesting study about sea ice dynamic in the Northern Antarctic Peninsula during the past 200 years. They combine molecular and micropaleontological proxy records from three strategically located and well dated marine sediment core sites located within the Bransfield Strait, NW of the Peninsula. After comparing their records with satellite, ice core and model data, the authors document changes in sea

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ice in the NW of the Peninsula since the 1800's and the potential processes (ENSO and SAM) controlling its recent past variability.

This manuscript is well written, concise, clear, includes adequate references and addresses most of the critical questions concerning the proxy used and their interpretation. The authors also introduce all the potential biases and limits of their records.

This study is of major and broad interest for both the paleoclimate and paleoceanography communities but also for oceanographers, biologists, ecologists, physicist and modelers. I therefore recommend this article for publication. Nevertheless, I have some comments that may help to improve the manuscript before publication.

1. Given the lack of ENSO records, I can understand that the authors have chosen to cite Li et al. 2013, even though the latter reconstruction might have some limits - like any existing ENSO records - and therefore might not strictly reflect the past ENSO variability. Have the co-authors ever considered to compare their records with those for El Nino or La Nina generated by the NOAA since 1870 (https://psl.noaa.gov/enso/dashboard.html)? When looking at these latter records, it seems to me that there might be a better correspondence with their IPSO25 record than discussed in the manuscript. Could it change their interpretation regarding the impact of ENSO on the regional sea ice evolution if they would consider such records?

2. If I am not wrong, there is no clear statement on why the authors use both the TEX86-OH and TEX86-L. They should include few sentences explaining the differences between the two SST-derived proxies so that the non-experts would better understand what these two proxies mean and why they might show different patterns.

3. Simulations still hardly reproduce sea ice dynamic around Antarctica. This might be even more true in the Antarctic Peninsula given the strong seasonal contrast. I would therefore clearly highlight here the limitations of the model used on its representation of sea ice.

4. It is a bit disturbing to read section 4.1. before 4.2., 4.3. and 4.4 in a way that the authors use their proxies to reconstruct the last 200 years evolution of the oceanographic and sea ice conditions and then make the comparison with the model simulations, observations and ice core data. I am still wondering if it would not be more coherent and logical to first discuss the comparisons between their proxy records and available data and afterward propose hypotheses on sea ice variability for the last 200 years.

5. I am not surprised that their proxy records do not show a strong coherency with ice core and model data because (1) the ice core is located in James Ross Island, i.e. in the Northeastern Antarctica Peninsula, influenced by the Weddell gyre, where sea ice presence is almost year-round and therefore show a different climatic pattern than the one on the western side; and (2), models are still quite limited in reproducing properly sea ice cover. After carefully reading their conclusions, it sounds like the authors might not be so confident when interpretating their own data while they fit quite well with the satellite ones. I would suggest the authors to believe more in their data, bring forward the main issues with both the ice core and model estimations and posit that more data are needed in their studied area, especially on reconstructing air temperatures.

6. The authors have unique records spanning both the preindustrial and industrial periods, a transition during which there is a major increase in GHG. Nevertheless, the authors never link changes in sea ice with increasing CO2 emissions for instance. Could they more clearly state or better explain if changes in sea ice could be related to any anthropogenic forcing? That would really interesting.

7. I do not see the need to show the campesterol, desmosterol or the B-sitosterol concentrations in the supplementary if they are not discussed in the main manuscript. I would suggest the authors to focus only on marine proxies helping to track sea ice dynamic and remove these records.

8. Although the manuscript already includes a lot of references, I would add a couple more. For instance, I would add two references on the modern local hydrography:

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Dotto et al. (Multidecadal freshening and lightening in the deep waters of the Brasnfield Strait, Antarctica, JGR, 2016) and Ruiz Barlett et al. (On the temporal variability of intermediate and deep waters in the Western Basin of the Bransfield Strait, Deep-Sea Res., 2017). I would also add some on the modern sedimentation, Palanques et al. (Annual evolution of downward particle fluxes in the Western Bransfield Strait (Antarctica) during the FRUELA project, Deep-Sea Res. 2002), and the nutrient distribution and their influence on local marine productivity, Frants et al. (optimal multiparameter analysis of source water distributions in the Southern Drake Passage, Deep-Sea Res. 2013).

8. In the figure 1 captions, Abram et al. 2010 is mentioned 7 times which is a bit too much.

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