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Climate of the Past Discussions

Interactive comment on "Can we reconstruct the formation of large open ocean polynyas in the Southern Ocean using ice core records?" *by* Hugues Goosse et al.

Anonymous Referee #2

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General Comments

This article is an interesting and valuable contribution to our ability to determine the frequency of large, multi-year open-ocean polynyas in the Weddell Sea. The authors use a combination of continental observations and atmospheric model simulations to identify the potential signature from these open-ocean polynyas in continental ice cores located between 50 oW and 0 oE. The authors then use a series of high-resolution ice core records to estimate when large Weddell Sea open-ocean polynyas have occurred during the 800 yrs prior to the satellite era. There are substantial uncertainties associated with the reconstruction methods utilised here, which are clearly stated and

discussed throughout the paper.

The paper presents novel techniques for identifying past open-ocean polynyas which are worth publishing. However, the uncertainties result in the majority of the conclusions being largely speculative. Therefore, this paper would benefit from a refocused discussion on the possible wider implications of the predicted polynya occurrence frequency, as these implications would help guide future work into corroborating or disproving the polynya frequency predicted by the authors.

Specific Comments

=> The introduction is very long, with substantial detail on polynya formation that seems superfluous to the focus and aims of the paper. If more discussion were to be added on the link between the formation mechanisms and the predicted occurrences in Figure 6 then this detail would become more relevant to the scope of the paper.

=> In both Figures 3a and 4 there are anomalies across large parts of the West Antarctic Peninsula and Amundsen-Bellingshausen Seas regions. The authors indicate in line 274 that these anomalies are not related to the Weddell Sea polynya. However, there is no further discussion of what is causing these anomalies. It is important to at least speculate as to what is causing these anomalies and, crucially, whether it is also responsible for the anomalies closer to the polynya that are currently being interpreted as a signal from the polynya itself.

=> Concerning the Hadley Centre data set used to drive the ECHAM5-wiso atmospheric model, it is not clear which years have been used in this study. Lines 189-190 suggest that data from 1871-2011 has been used whereas Figure 4 only seems to have the years 1958-2000. For either option there needs to be an appreciation of the limitations in using the Antarctic sea ice data from Rayner et al. (2003) to run the model. For example, the Antarctic sea-ice extents for the years 1871-1927 are all duplications of the 1927 climatology.

=> There should be some discussion of how changes in wind direction could influence the variability seen in Figures 6 and 7 as well as possible explanations for the hypothesised centennial-scale variability in line 432.

Technical Corrections

Lines 55-57: statements on the ocean preconditioning should be referenced.

Line 229: replace “averages is” with “averages are”.

Line 357: presumably should be 50 oW not 50 oE, as in line 368.

Line 399: should be Figure 5 not Figure 4.

Lines 425-428: it is unclear whether this is referring to years when any single index is greater than 0.8/1 or when the average of all the indices is greater than 0.8/1.

Figure 6: the use of “complete” and “all” to identify different time ranges is confusing for the reader.

Figure 6: all the overlapping coloured records make it difficult to identify years with high values in all the indices, especially in Figure 6a. The addition of arrows to indicate which years had an average index value greater than 0.8 or 1 would be beneficial for analysing the changes in polynya frequency during the last millennium.

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