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Interactive comment on “A record of Antarctic sea ice extent in the Southern Indian Ocean for the past 300 yr and its relationship with global mean temperature” by C. Xiao et al.

Anonymous Referee #3

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This paper presents an MS- ice core record from Princess Elizabeth Land in East Antarctica, correlates the record to sea ice extent, and relates changes in sea ice extent and MS- to global temperature.

Certainly the MS- record from the ice core should be published as it adds to the archive of data from which the understanding of MS- and its relationship to sea ice is based. This is still a relationship for which the scientific understanding is incomplete. Empirically, the relationship varies both in magnitude and spatial extent depending on the location of the ice core on the Antarctic continent, and MS- has been found to be more strongly related to atmospheric transport in some locations and other signals. See Abram et al., (2013) for the recent review on this subject.

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The paper assumes that the relationship is straightforward between MS- and sea ice at this location. Given that the correlation coefficient is only 0.4, i.e., the variance in sea ice explains only 16% of the variance in MS-, a stronger argument can be made for the relationship if the authors examined and presented in detail the relationship between MS- and the wind field, SAM index, precipitation at the site, etc. If the dominant relationship remains with sea ice, it bolsters the case that long term variations in MS- reflect changes in sea ice in these sectors. Abram et al., (2010) methodically step through the various possibilities in their paper regarding ice extent in the Bellingshausen Sea, and I'd suggest a similar methodology here.

Before publication, more detail in describing and establishing the link for MS- and sea ice at this particular ice core location is necessary.

I have strong reservations about sections 3 and 4.

Section 3: Sea ice extent and global temperature.

It is not clear why the authors seek a relationship with global surface temperature or with NH surface temperature.

Let us assume that Antarctic sea ice extent should covary with global mean temperature, by the argument that global surface mean temperature is an indicator for surface radiative forcing. (We'll ignore the most recent decades where SIE does not covary with temperature.)

One might expect that in general this relationship works for total circumpolar Antarctic sea ice extent. It is already mentioned in the manuscript that the regional sea ice extent variations is not coherent, primarily due to the variability in surface wind forcing around the continent. If in fact the sea ice extent reflects the global mean temperatures, it would be at least necessary to show first that the variability of sea ice extent in 70-100E is indicative of the circumpolar sea ice extent variability. Otherwise, there is no reason to expect that SIE in this region would have any particular relationship with

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temperature. Or that an observed relationship between SIE in this sector and global temperatures carries any meaning to understanding circumpolar ice conditions.

It is not clear that the correlation with SAM at this point is helpful. Perhaps it should be investigated at the presentation of the record as one of the potential influences on the MS- record. See also comment below regarding correlation to SAM.

Section 4: Sea ice changes over the wider Indian Ocean.

Though comparison of these two ice cores may be slightly useful, it is not clear that any relationship should exist between the sea ice extent in the two sectors. In Fig 2b, a comparison of the 70E sector to the sectors between 80E and 140E shows little correlation. Why then would one expect the long term reconstructions to resemble each other in any way?

Specific comments:

P3613 L27 Please give the snow/SWE accumulation rate in the text.

P3615 L20 'The LGB69 MS...' In order to present the relationship between MS- and temperature as credible, one needs to quantify it. It's not clear just from comparing the two curves by eye.

P3615 L26 'We suggest that this paradox ...' Steig et al., (2009) have shown that Antarctic temperatures have been warming across the continent in recent decades, though the changes in E. Antarctica are smaller than on the Peninsula and W. Antarctica.

P3616 L8 'Both the summer SAM ...' The relationship with SAM could be tested with the SIE and MS- records for the calibration period to check to see whether the possible relationships between SAM and MS- or SAM and SIE exist. That would help remove some of the speculation about the reasons for the correlation in this paragraph. Also, it's not clear why a positive SAM favors transport of MS- to the continent.

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P3617 L10 'The proxy record...' This seems to be a bit of circular logic: The proxy is calibrated to satellite sea ice extent including the period since 1985, but then it is stated here that the proxy confirms that the sea ice extent increases during the same period.

Fig 3a. Is the SIE curve smoothed? The SIE values in the yellow curve do not seem to match the values in the the inset scatter plot.

References:

Nerilie J. Abram, Eric W. Wolff, Mark A.J. Curran, A review of sea ice proxy information from polar ice cores, *Quaternary Science Reviews*, Available online 11 February 2013, ISSN 0277-3791, <http://dx.doi.org/10.1016/j.quascirev.2013.01.011>.

Steig EJ, Schneider DP, Rutherford SD, Mann ME, Comiso JC, Shindell DT. Warming of the Antarctic ice sheet surface since the 1957 International Geophysical Year. *Nature* 457 459-462 (2009).

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