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Interactive comment on "The Ross Sea Dipole – Temperature, Snow Accumulation and Sea Ice Variability in the Ross Sea Region, Antarctica, over the Past 2,700 Years" *by* Nancy A. N. Bertler et al.

Anonymous Referee #1

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Overall: This paper provides an analysis of a new dataset stemming from the Roosevelt Island Climate Evolution ice core. The authors identify how well this ice core compares with ERA-Int data, approximate the regional temperature and precipitation variability, and how well it compares with other proxy data in West Antarctica and portions of the western Ross Ice Shelf. The authors note an finding of a 'Ross Sea dipole' where there are periods of opposite relationships between the eastern and the western Ross Ice Shelf.

I think the paper holds promise, and certainly this new dataset needs to be presented and discussed widely. However, I find concern in interpreting the Ross Sea dipole to

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the SAM.

The authors base the SAM connection with the Ross Sea dipole from one paper, Marshall and Thompson (2016), presumably Fig. 2b in this paper. This figure from Marshall and Thompson (2016) indeed shows opposite patterns of heat flux across the eastern and western Ross Ice shelf associated with the SAM. However, I'm not sure that this can easily be implied as consistent with the results from the anti-phase relationships observed in the proxy data presented in the paper, for a few reasons:

a) The relationships in the Marshall and Thompson (2016) paper were based on daily data, and the authors note that the heat flux relationships with the SAM are much weaker when integrated over time periods more than a week. It is therefore really hard to know if they still exist on annual mean data (let alone data that are smoothed with 200-year moving averages!). This dipole pattern with the SAM and the heat flux is also found in reanalysis data since 1979, which certainly can't tell us much about its persistence on timescales back more than 100 years.

b) Even if there were a dipole pattern associated with the SAM that persisted, there clearly isn't a dipole pattern with temperature and the SAM (Fig. 3b of Marshall and Thompson (2016) and many other works, including Marshall (2007), Thompson and Solomon (2002) etc.). In terms of temperature, the SAM exerts the same-sign relationship across the entire Ross Ice shelf, and West Antarctica and East Antarctica. For precipitation / accumulation, there may be more of a dipole like structure (this is nearly impossible to verify with observations or reanalyses), but so many local factors influence precipitation / accumulation that it is hard to say how robust any Ross Sea dipole pattern is.

c) Climate connections with the ASL, whether from ENSO or the SAM, show dipole patterns on much larger scales, with differences (in temperature, precipitation, winds, etc) occurring between the Antarctic Peninsula / eastern West Antarctica and the Ross Sea (Ice Shelf) / western West Antarctica. I don't know fully how a dipole pattern across

just the Ross Ice Shelf, from annual mean data or longer, could be related to these much larger-scale climate patterns, at least based on observations and contemporary reanalyses.

I therefore found the climate connections and their interpretation with the RICE data to be far too simplistic and an incorrect interpretation of one figure from Marshall and Thompson (2016). The authors need to revise this portion of the paper and better justify / support the pattern in relationship to the SAM, or simply not make claims that it is consistent with the SAM.

Minor comments:

Abstract, line 31: change 'Annual' to 'Annular'

Line pg 3: 26: gradient of what, exactly? Just pressure / height, or other fields?

Lines pg 3. 30-33: you should specify this is increase in total Antarctic SIE, as there are regional differences.

Figure 2: the color scale for the correlations is odd. It makes it challenging to see what the magnitude of the correlations are in the top panel. Even if they are significantly different from zero, a small correlation explains very little of the interannual variability and therefore may not be an ideal representation of temperature variability at other regions in West Antarctica or off the Ross Ice Shelf.

Fig 2e, discussion of temp. trends on pg. 6 lines 37-40 and pg. 7 lines 1-7: It is fair to say ERA-Int may not capture the correct trend at the RICE site, but why not compare with observations directly at McMurdo / Scott Base or any of the longer Wisconsin AWS records (Gill , Ferrell, etc.) on the Ross Ice Shelf? These are strongly correlated with the RICE site based on Fig. 2a. I think comparing with NB2014 is helpful, but I think it is a huge oversight to not do any comparisons with direct observations (you could even use the Byrd temperature record here).

Fig 3, discussion page 7 lines 30-31: ERA-Int could also be different in that it uses a

different snow density and/or conversion from precipitation to water equivalent. (something with the microphysics in ERA-Int model).

Figure 4: Also not particularly happy about the color scale here for the correlations.

Page 7, lines 37-38: It would be more instructive to say that the negative correlation includes regions of the South Pacific, Antarctic Peninsula, and eastern West Antarctica, rather than the 'ASL region' since the ASL varies its location from month to month, and the correlation is not significant across the entire region that the ASL may reside.

Page 9, lines 3-5: The Nino 3.4 and Nino 4 are close (and overlap partially), and are therefore strongly temporally correlated. However PSA1 and PSA2, by design through EOF, are uncorrelated in time and space. I don't think using Nino 4 for PSA2 is a good idea because of this.

Page 9, Table 2 ENSO correlations lines 10-15: In addition to differences in the phasing of ENSO and SAM, using annual means for ENSO is also compromising the correlations, since ENSO events wrap around a calendar year (peaking in December often). They are likely stronger on seasonal means; this should be mentioned.

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