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Climate of the Past Discussions

Interactive comment on "Antarctic climate variability at regional and continental scales over the last 2,000 years" *by* Barbara Stenni et al.

Anonymous Referee #2

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General Comments:

This is an important piece of work on temperature variability and change over the Antarctic from large regional areas to continental scales for up to 2000 years. It is based on assembling 112 water stable isotope time series from ice cores and converting these concentrations into temperature using three approaches. And it is a very important data set for testing the performance of coupled climate models, as stated. I have two main issues that should be addressed in the revised manuscript.

First, there is the conversion of isotope variations into temperature. The introduction lays out the many complicating factors contributing to controls on the proxy temperature derived from isotopes. I expected to see in Section 5 an evaluation of the impact of these factors on the results. Two aspects come particularly to mind. Isn't it true

that low altitude ice cores are particularly susceptible to local influences like sea ice variations? (Masson-Delmotte et al. (2008) mention different moisture sources and transportation paths below and above 2000 m elevation). You have many near coastal ice cores shown in Figure 1. How do such effects contaminate/modulate your results? The other issue is that the stable isotope concentration is a precipitation signal (you use precipitation weighting with the ECHAM5-wiso simulated isotope results – good) and a better temperature is the condensation temperature where the precipitation forms, not the surface temperature. I didn't see any mention of this, so what do your derived temperatures actually represent? Changes to advection conditions (and thus the moisture source) can and do happen and influence the condensation temperature, and the advection conditions may not stay fixed across decades to millennia. Consider the following paper: Gorodetskaya, I. V., M. Tsukernik, K.Claes, M.F.Ralph, W.D.Neff,and N. P. M. Van Lipzig (2014), The role of atmospheric rivers in anomalous snow accumulation in East Antarctica, Geophys. Res. Lett.,41, 6199-6206 ,doi:10.1002/2014GL060881. Such atmospheric river events contribute up to 80% of the annual accumulation at Princess Elizabeth Station in East Antarctica, with significant interannual variability; in some cases the precipitation origin resides in the subtropics. This perspective surely adds to the envelope of uncertainty for the temperature reconstructions and it seems unlikely that ECHAM5 even at 100 km resolution would adequately capture such narrow moisture transport events.

The second major issue is that section 4.3 on "Response to volcanic forcing" comes across as so premature that it should be dropped from the manuscript. There is no consistent signal in Figure 9. Why should one believe the results for some regions and not others without some compelling reason other than this is the expected result. Page 18, line 18 calls this "only a preliminary attempt to assess the possible climatic response of Antarctic climate to short-term volcanic eruptions". Page 19, line 4 says "showed possible negative temperature effects in some regions". The big story here is the temperature reconstructions that need substantially more consideration as outlined above. The inconclusive volcanic aspect is an unnecessary distraction. Better to leave

this topic for detailed exploration elsewhere.

Lesser aspects:

1. Page 2, lines 17 and 19: please discriminate between the two Jones et al. (2016) references.

2. “Weddel” is incorrectly used in Tables 3-4 and Figures 1 and 4-6.

3. Consider redoing the time series in Figures 4 and 5 that are too faint.

4. What is the source of the NB2014 data used extensively in this analysis?

5. Page 9, line 31 onward to Page 10, line 10 discusses the very variable delta 18O-temperature slopes. To me this says that the conversion from isotope concentrations to temperature is not robust except perhaps in the Antarctic interior. This is another reason for having an extended evaluation of isotope-temperature conversion at the end of your manuscript and how the associated uncertainties impact your results. This information (basically the error bars) is needed to ensure that a robust evaluation of climate model results can be conducted.

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