Clim. Past Discuss.,
https://doi.org/10.5194/cp-2017-18-RC2, 2017


Climate of the Past Discussions
Open Access
EGU



# *Interactive comment on* "Review of regional Antarctic snow accumulation over the past 1000 years" *by* Elizabeth R. Thomas et al.

**Anonymous Referee #2**

Received and published: 14 July 2017

Thomas et al. have compiled available high-resolution ice core accumulation records from Antarctica, and review those within the PAGES 2k framework. They divide the cores into 7 regions to provide a regional perspective on ice accumulation and surface mass balance in Antarctica. The surface mass balance of Antarctica is an important topic of study, with implications for the Antarctic contribution to sea-level rise. Overall the study is relevant, interesting, well-written and clear. I propose some minor corrections and additions for readability, procedural clarity and a more thorough analysis.

General comments:

1) My first concern is procedural clarity and treatment of uncertainties.

1a) Combining individual records must be done carefully to avoid jumps in the com-



Printer-friendly version

Discussion paper

posite at the locations where the number of cores changes. There is some discussion in section 2.6, but it could be expanded. How did you normalize the records? Did you scale the variance, or just the mean? Did all records include the full 1960-1990 reference period?

1b) How are age uncertainties incorporated? Are all chronologies based on annual layer counts? Section 2.3 merely states they need to have annual resolution, so I assume this is the case. The age uncertainties are of course critical when comparing to RACMO and ERA-interim. What is the typical uncertainty in the age scales, and can this influence the conclusions?

Also, dating uncertainties will introduce accumulation uncertainties, because accumulation is essentially the derivative of the depth-age relationship. So a 5% age uncertainty results in a 5% accumulation uncertainty.

1c) I assume that all RACMO and ERA data are annual means? Were these taken as calendar years? The annual proxies used in the layer count could of course represent another time period (e.g. spring to spring).

1d) How was the layer thinning correction done? Was the treatment identical for all records? Section 2.2 reviews several methods (Nye, Dansgaard-Johnsen and Roberts), but it's not stated which one is used. Was this done on a case-by-case basis?

This does not matter for the inter-annual variability, but this is critical for investigating the long-term trends. Details are needed for the reader to evaluate how reliable the trends are. Please elaborate on this.

1e) What is the typical uncertainty in the thinning correction, and how does it influence the reconstructed centennial-scale trends?

2) My second suggestions focus on the analysis of the records

2a) The authors test how representative the records are by comparing them to RACMO

and ERA-interim using spatial correlation plots, which is very qualitative and includes some hand-waving. Since RACMO and ERA-interim are gridded products, it should be trivial to extract the SMB time series directly at the core locations – these model time series could then be composited for the exact same time periods and in the same way as the ice core records were composited. This will allow for easy quantitative analysis. For example, how well are the model and data composites correlated? How well does the model capture variability within each region? Etc. This could complement the figures provided.

2b) How well do individual cores in a region represent the regional composite? It would be very easy to figure out in a principal component analysis. The variance explained by the first component will tell you how much of the signal variance is shared between the records.

2c) In Figs 4 and 5 the authors attempt to link the accumulation records to atmospheric drivers. However, in some regions the simulated accumulation does not match the observed accumulation. Would it be worth repeating these analyses using the modeled accumulation rates for each of the regions? That way you're evaluating something that has consistent internal physics, which would presumably make the correlations stronger and the conceptual picture more clear.

2d) There is much interest in the relationship between temperature and accumulation in Antarctica. Is there a paper planned on this topic within the Antarctic 2k consortium? If not, it would be interesting to include it here. I understand this would go beyond the scope of the present work, and it is of course not a prerequisite for publication.

Minor comments:

P2L11: "composites capture the regional precipitation and SMB variability": I don't understand what this sentence means. Do the composites capture the SMB variability in the models? Or do you see coherence between the records, suggesting a regional signal?

P2L15-16: Do you mean there are only 4 records that cover the last 1000 years, and all 4 show a decrease? Or are there more 1000 year records, but they don't show a decrease? Please clarify

P4L2: I couldn't find Frieler et al in the reference list. I didn't check all references, but there may be more like this. Please check all references.

P5L26-27: I don't get what "equally spaced" means here. The distance between all layers will decrease, whether or not they were equally spaced at the surface. Please rephrase.

P8L9: to clarify: the regional, annual mean from the data are correlated with the annual-mean RACMO values at each grid point?

Fig 2 and 3: is there a way to outline the area of interest? I found myself going back and forth between Figs 1 and 2 to figure out what the acronyms meant again. Alternatively, you could just write out the acronyms in full, in which case we'd know what part of the map is relevant. The figure is not incorrect, it would just be a kind thing to do for the readers.

P8L27: WS appears reasonably well correlated to RACMO over Berkner Island – which is where the only core is from? This could be quantified by extracting the RACMO SMB at the core location, rather than looking at the entire WS area.

P10L6: "high interannual variability": in the data, the model, or both? I suppose sastrugi etc. matter more at low-accumulation sites, as a wind feature of a given size influences more annual layers there?

P12L1: "positive phase of the SAM and the ASL". What is a positive phase of the ASL? Does this mean the ASL has a negative pressure anomaly? Please just write it out in pressure terms.

P12L7: is it possible that the AP snow accumulation anomaly and Bellingshausen sea ice are both just driven by the same SAM trend? Or do you suggest that the

Bellingshausen sea-ice anomaly drives the AP accumulation?

P15L13 What does this “conversion” entail? Is it basically just a linear scaling, or is there more going on? Why not just compare accumulation, rather than SMB? I guess I don’t see the added value of this step.

15L14 unitless (no space)

P15L21: Out of the 650 mm/year, the trend of 0.15 mm is just a 0.02% increase. Given the variability and uncertainties (such as in the thinning correction), I would just call this trend zero – i.e. I cannot believe it is statistically robust

P15L31: Is the AP increase the only one that is statistically robust? That would be an important conclusion.

P16L34: Can you express how unusual the current AP trend is in terms of nr. of standard deviations? Is the current trend 2sigma above mean, or 4sigma, for example.

P17L14 Is the SMB increase 44 GT w.e. *per year*? Please check units.

P17L20: I guess for all four regions with a single 1000-year record it is questionable how well a single core represents the entire region – not just WS.

P18L10: Your analysis says nothing about how exceptional the current SMB trend is on the long term perspective. Perhaps you could add an Antarctic-wide histogram to Fig. 8?

---

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2017-18, 2017.