

## Review of “A synthesis of the antarctic surface mass balance during the last eight centuries”

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### Synopsis

This paper examines a combination of ice core and stake proxy records, with some cores extending up to 800 yrs, in order to get an understanding of how SMB of the AIS has changed over time, and in particular, how SMB change since the 1960's compares to the longer historical record. The authors present a couple of fairly interesting results (1) an ~10% increase of accumulation in elevated coastal regions and over the highest part of the IDEA since the 1960's; (2) when averaged over the continent, however, SMB increases are not significant compared to the historical record. The authors point out that this seems to contradict expectations based on Global Climate Model predictions that precipitation over the AIS will increase under the influence of global warming and offset SL rise. At the end of the paper, the authors present a hypothesis (involving blocking anti-cyclones) for what could be offsetting the expected net accumulation.

### General Comments

- (1) While the paper contains a lot of interesting information, the organization and writing of the paper could be significantly improved. In the results section, I sometimes found it difficult to tell what the authors themselves did, as nearly every sentence references prior papers, except for in the 2 last paragraphs of the section. Do these references simply refer to who published the original core data, or are these all previously published assertions? If the latter, then much of this information goes in the intro/background section.
- (2) There minor grammar, punctuation and word usage errors throughout the paper. More importantly, there are several instances of minor inconsistencies (e.g., is the assessed dataset from 21 or 51 records?), or, instances of basic information being treated as assumed knowledge, despite the fact that it may not be for all readers (e.g., casual references to proxy record sites; isotope record-derived parameters are referred to almost off-handedly in the discussion, but never mentioned or defined/explained in the data description section, etc.). Not all readers will have worked with proxy records. These types of issues should really be worked out before a paper is submitted the first time.
- (3) The blocking-anticyclone hypothesis sounds potentially plausible, but I have some notable concerns regarding their argument, and without further work it is fairly speculative. More detail and some schematic diagrams might be needed, especially if they intend this to be a main point of the paper, as implied from the abstract. For example, *it is not clear to me that there is any evidence for increased blocking cyclone frequency*, since “intensity” is not the same thing, and as they state themselves, frequency and intensity tend to be anti-correlated on decadal timescales. Additionally, since the authors are basing their argument largely on the apparent correlation between AIS SMB and proxy-derived irradiance, they should try to explain (a) why the *variability of the irradiance record does not correlate with the AIS accumulation between 1700 and the early 1900's* (something they gloss over in the paper), and (b) why, when it does correlate, the *irradiance sometimes appears to lag slightly behind the accumulation rate*; based on my understanding of their argument, it should be the other way around. I'm wondering if the correlation, when it exists, is not causal, but more indirect. (These things are also mentioned in the specific comments.)

### Specific Comments

- (1) Title: “Antarctic” is a proper adjective and should probably be capitalized.

- (2) Pg.824, Line 6: change “atmospheric teleconnections and circulations shift” to “atmospheric teleconnection and circulation shifts”
- (3) Pg. 825, Line 1: One likely assumes this to be austral winter warming, but the first time you refer to winter it would be nice to include the months in parentheses, for those who usually work in the northern hemisphere or tropics.
- (4) Pg. 825, Line 18: should be ‘at *the* centennial scale’
- (5) Pg. 825, Line 18-19: change to, ‘For this reason, we used 7 new firn/ice records of Northern Victoria Land and Wilkes Land, together with 59 existing firn/ice records, to...’
- (6) Pg. 825, Line 25 and throughout paper, try to be consistent with the format of numbers used in a similar context, e.g., “...the last 40 years, the last 150 years, and the last 8 centuries...”
- (7) Lots of small grammar issues in this section, including using past tense when present tense should be used, e.g., “In Section X, we present/discuss” instead of “In Sect. X we presented/discussed” and “...reasons *for* the observed SMB temporal variability” instead of “reasons *of*”, etc.
- (8) Pg. 829, line 1: I don’t work much with proxy data; are these averages spatially weighted? If so, how did you determine spatial extents?
- (9) Pg. 829, line 16-17:
  - a. Please indicate what/where the Gomez site is (explain briefly and provide coordinates, or, reference a figure that clearly shows its location)
  - b. Briefly define the SAM for those who work in different geographical regions.
- (10) Pg. 829, line 17-18: Its not apparent that Figure 2 gives any information about this indicated causal link between SMB and SAM, but the way the sentence is written implies that it should. Please support this statement, e.g., either add a plot showing the relationship to SAM or provide an appropriate reference.
- (11) Pg. 829, line 25 and others: “XX century” is odd notation. I’d just say “20<sup>th</sup> century” (or analogous for other centuries, such as XIX on pg. 831)
- (12) Middle of page 829 -> end of 830:
  - a. A heading for the ‘results’ section appears on pg. 829, but the text seems to be more appropriate for a background/lit review section, given that it is a summary of several related but previous published papers. It appears that new results are not *really* discussed until page 831. If this is not accurate, then I recommend couching the presentation differently.
  - b. There are some awkward sentences in this section. Many lack commas, adding to the awkwardness. Please tighten and simplify sentence structure where possible and add commas and correct prepositions where appropriate (e.g., read the sentences aloud and insert commas at natural pauses).
- (13) **Figure 2:**
  - a. There are references in the text to the Btot data set and fig 2, yet Btot data is not indicated anywhere in Figure 2;
  - b. The caption contradicts the plot key in panel B. The key says triangles show SMB>300 and the caption says SMB<300.
- (14) Page 831, lines 1-3: Put reference to the Fig 2 earlier in the sentence and say “(not shown)” for the comparison of B40 and Btot, since Btot does not appear to be shown.
- (15) Page 831, last paragraph + **Fig 3**: The time series are so long, it is difficult to plot them in a way that also allows all of the details you describe to be easily identified. It would be useful to put some labeled markers on the plots to indicate specific periods with interesting trends, or when phasing/anti-phasing occurs. Otherwise, I am not always certain that what you are referring in the text is the same feature(s) I am looking at. Also, why is there regional phasing/anti-phasing? Why is this interesting?

(16) **Figure 3:** 21 or 51 cores? Pg.828 says 51.

(17) Page 832, line 5-7: Should be punctuated/reworded as follows: “However, snow precipitation reflects not only air temperature variations, but also other climatologic/environmental effects. Moreover, SMB represents the snow precipitation minus ablation, driven mainly by wind.”

(18) Page 832...

- Line 8-10: Briefly define  **$\delta^{10}\text{Be}$**  (perhaps this should even be done in the data description section?). Why not show the line plots from the core with the correlation in the results section?
- You refer to cyclic variability at “continental and regional scale” but refer to Fig 4, which only appears to show a continental time series...
- Line 14, fix spelling of ‘reconstruction’
- Line 13-14, sentence structure implies you have already discussed the solar irradiance correlation, when you have not. Perhaps this correlation/plot should be mentioned/shown in the results section, then diagnosed in the discussion.
- Line 14:
  - The word “mirrored” to me implies anti-correlated (180 out of phase), not correlated (in phase);
  - Fix 10Be so 10 is superscript; also, define its meaning for this context, just as a matter of good form—readers will know the symbol, but not all readers will already know that this is a proxy for solar activity.

(19) **Figure 4:**

- It’s not clear why this figure is discussed in the “discussion” section and not in the “results” section
- Please label events/time periods, such as the Wolf and Maunder Minima, volcanic eruptions, etc., directly on the figure.
- Caption: 21 or 51 cores?
- Gray filled lines: very hard to see “fill”

(20) Page 833, line 12-14: This sentence needs a reference. You should also (very briefly) define blocking anti-cyclone for non-meteorologists

(21) Page 834: First paragraph is good. Second paragraph: Earlier you noted the correlation between increased cyclone intensity and decreased frequency in positive PDO phases; then, you cite Simmond et al, which shows evidence for increased intensity, not increased frequency (I looked up the paper to confirm this). But in this paragraph you seem to make a leap to “the higher frequency of blocking anti-cyclones”. Is there any evidence for increased **frequency of blocking cyclones**? If so, please cite reference, show plot demonstrating this, or, explain your reasoning more clearly. Additionally, it is my understanding that an increase in cyclone activity would not necessarily mean a corresponding increase in blocking anti-cyclone activity, but there may be regional considerations with which I am not familiar. Please clarify.

(22) Why does the variability of the irradiance record *not* correlate with the AIS accumulation between 1700 and the early 1900's, and, why, when it does correlate, does the irradiance sometimes appear to lag slightly behind the accumulation rate variability?

(23) Page 834, line 20: Please write out ‘percent’ instead of using % if there is no number in front of it