

Interactive comment on “Countervailing regional snowfall patterns dampen Antarctic surface mass variability” by Jeremy Fyke et al.

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To Dr. Genthon,

First, many thanks for your valuable thoughts on our manuscript. Particularly, we appreciate your identification of previous papers that are directly relevant to our study, and so should have been referenced and discussed. We will do this in a revised version of this manuscript. Below, we attempted to extract your main points (quoted) for further discussion. After reading our replies, please do not hesitate to continue the discussion as you see fit.

“[Correlated/anti-correlated regional precipitation patterns] at continental scales is not a new information... this occurs because the regional interannual variability of pre-

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precipitation is generally associated to shifting or variable strength of major influencing synoptic systems. This is not new . . . in Antarctica.”

We agree that the general concept of (anti)-correlated regional precipitation patterns at continental scales is not new, even for Antarctica. We will certainly emphasize this further and reference your indicated studies, which are important for our study and which we apologize for missing. Regardless, we believe our contribution (i.e., basin-scale disaggregation of precipitation variability from the 1800-year record of unforced Antarctic climate in the coupled climate model) is still significant, largely because it provides a clean evaluation of continent-wide basin-specific natural Antarctic spatial variability that is by definition uncontaminated by anthropogenically forced signals (unlike reanalyses and/or ice cores, which are nonetheless valuable in their own right).

“Spatially coherent (correlated and anticorrelated) patterns of variability of precipitation have previously been exhibited by principal component analysis and interpreted in terms of the variability of the atmospheric circulation, major driving Antarctic synoptic systems and thus patterns of moisture advection towards of from Antarctica. Corroboration by ice cores has also been highlighted.”

Thanks - we should definitely note these analyses in our manuscript to identify prior findings linking snowfall variability to atmospheric circulation. Building on these results, we suggest that our basin-scale compositing approach to identify important patterns of atmospheric circulation is still an important and novel advance, because it uniquely extracts from a millennial-scale climate model simulation the characteristic patterns of atmospheric circulation/moisture advection that are specific to individual ice sheet drainage basins. With this approach, regional differentiations in important atmospheric circulation modes emerge, in a manner not possible with continental-scale PCA analysis that is dominated by a few major modes (e.g. the ABSL). Additionally, our model-based, basin-scale approach is able to explicitly identify a lack of sea ice control on regional Antarctic snowfall variability, which has been posited as important in other recent studies.

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“I don’t think that a ‘clear analysis of spatial heterogeneity in Antarctic snowfall variability’ is really fully lacking.”

Particularly after being pointed to your earlier work, we agree, and will temper our statements accordingly in the revised manuscript.

“I find it hard to buy this idea of “dampening” of continental scale precipitation variability by (anti)correlated regional variability.”

We are not sure the analogy of ENSO temporal variability dampening a long-term global temperature trend (i.e. a forced response) applies to the argument we make regarding dampening of AIS spatial variability by regionally opposing variability signals. Or perhaps we just misunderstand your comment, in which case, please feel free to let us know how we’re getting it wrong! Specifically, in the ENSO case, it is true that La Nina and El Nino are in a sense anticorrelated. However, this anticorrelation occurs with a multi-year time lag so that, for example, in terms of overall variability, an El Nino doesn’t ‘cancel’ a La Nina. Conversely, the presence of opposing Antarctic snowfall variability at different locations with zero time lag, indicates that these regional patterns are cancelling, in their impact on AIS-integrated snowfall variability (and thus sea level variability). Furthermore, statistical significance of these opposing variability signals indicates that the dampening is not simply an effect of averaging random signals, but rather (at least in part) due to active cancellation of correlated signals associated with variability in large-scale atmospheric moisture transport.

“To confuse snow fall, precipitation and accumulation is misleading.”

We agree, and will rephrase our manuscript to be more accurate.

“Links to broader patterns of atmospheric variability falls a bit short.”

We welcome this comment, and pending reviewer comments we will consider how to improve this aspect of our study in the revised version.

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