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Climate of the Past Discussions

Interactive comment on "Recent warming inconsistent with natural association between temperature and atmospheric circulation over the last 2000 years" *by* P. A. Mayewski and K. A. Maasch

P. A. Mayewski and K. A. Maasch

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We thank Eric Wolff for his comments and in particular his mention of the overall value of our approach. Following we address more specific comments.

(1) Concern is raised over our development of atmospheric circulation proxies using chemical tracers. This work is supported by a reasonably large number of peer-reviewed papers. As with any calibration there are expected issues. It is true that the available instrumented records and reanalysis products do not overlap the ice core records for as long a period as one would ideally hope. We use in our published reconstructions instrumented records of, for example, the Trans Polar Index (TPI) re-

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lationship to Siple Dome Na to produce a proxy for the Amundsen Sea Low. The TPI extends back close to 100 years. For any comparisons utilizing reanalysis products the overlap period is, of course, shorter. The most trusted portions of the reanalysis record extend back only to the late 1970s but we also investigate calibrations extending back to the earliest part of the reanalysis records (1950s) if the calibration back to the late 1970s is sufficiently strong. Our calibrations require, as noted in our publications, not just significant associations on a year to year basis, but also they must be consistent with the seasonal input timing of the glaciochemical indicator (known from on site core and snowpit studies), and also an appropriate source region must be significantly correlated (eg., marine source for seasalt). In the case of K+ we did in fact find strong correlations between GISP2 K+ and surface pressure changes for the Siberian High as published. Why K+, because there is abundant K+ in Asia, K+ travels as a very fine grained fraction (known from ours and others comparison of microparticle size range associations with chemistry), and because transport from the Siberian High source region to Greenland is known to occur. Details and reference for the GISP2 K+ calibration appear in Meeker and Mayewski (2002).

In answer to the comment that we should refer to the atmospheric proxies by their chemical label (eg., GISP2 Ca) - we do so in all of our figures.

We would, of course, greatly prefer that our calibrations be extended over significantly longer periods of overlap. The reality, however, is that the instrumental record is short and we have little recourse. In some cases we can partly get around this issue using multiple cores, as noted in some of our published papers. In other cases we can find major, yet discontinuous events such as droughts, storms, forest fires, etc that extend calibrations. It is essential not to assume that any calibrations of temperature, atmospheric circulation, precipitation, etc. are extended beyond their appropriate boundary conditions. As a consequence we present in this paper only the past 2000 years - a period of relatively similar climate to the calibration era.

(2) We agree with the reviewer that our sentence referring to “the most notable..” with

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reference to AD1400 and the last 9000 years is hard to follow so we have revised the sentence.

(3) We also agree that the term calm is more appropriate for atmospheric circulation than mild and have made the appropriate changes to the text.

(3) We have inserted an explanation for B2K in the figure caption as suggested. (4) Issue is raised concerning our choice of the sequence of event timing. This is indeed a critical question and we agree that too many previous studies have depended primarily on wiggle matching or the author's best visual guess. Quantification is clearly required. We offer two statistically developed techniques. The first is the one presented in our reviewed paper and a second is now included because we agree with the reviewer that more can be done statistically. In the first technique we differentiate on the basis of the mean ś one standard deviation. In the newly added technique climate jumps are detected using the signal-to-noise (S/N) ratio defined by Yamamoto et al. (1986). This method of analysis is similar to a procedure called non-overlapping consecutive epoch ananlysis (Karl and Riebsame, 1984). Each time series is broken into 250 year long segments. The mean for each of these segments, along with its 95% confidence limit, is calculated for the 250 years before and after a reference year. The S/N ratio is defined as the absolute value of the difference between the mean before and after the reference year divided by the sum of the confidence limits before and after the reference year. The reference year is moved over the data to obtain a S/N time series. Detection of a jump is defined as a S/N ratio greater than 1.0. Discussion is included in the text.

We agree with the reviewer that we only offer one example of a major warming and of course it would be preferable to offer more examples. Unfortunately the hemispheric reconstruction of past temperature is only available for the last 2000 years and this time period includes only one major warm event, notably the MWP. There is certainly much more work to be done examining smaller warming event sequencing of the last 2000 years but these will be more likely regional scale events outside the scope of this

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paper.

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