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Climate of the Past Discussions

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Interactive Comment

Interactive comment on "Millennial temperature reconstruction intercomparison and evaluation" *by* M. N. Juckes et al.

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D) PROBLEMS WITH METHODS. (Cont'd from Multidisciplinary Review 2)

Assumption of Stable Global Temperature Field: One of the underlying, and untested, assumptions of the CVM method is that the global temperature field is stable over time. That is to say, will a CVM average that works in one century necessarily work in another? As noted in Review 2, the assumption of stationarity in the variance is not supported by the data, so there is no a priori reason for assuming that a CVM average will work over a multi-century period. This assumption needs justification.

Lack of Correlation with Gridcell Temperature: Overall, the average of the absolute correlation of the individual UR proxies with the NH data is passable (0.31 ś 0.09 [95%CI]).

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But the average of the absolute correlation of the UR proxies with local gridcell temperature is much lower, 0.20 ś 0.08 (95%CI). In addition, there is a negative correlation between how well the proxies compare with the local gridcell, and how well they correlate with the Northern Hemisphere. In other words, on average, the worse a proxy does at correlating with the local temperature, the better the correlation it has with the NH data. This is particularly evident in the four proxies that are in one gridcell, Upper Wright, Methuselah Walk, Boreal, and Indian Garden (USA). They have a statistically very strong ($p = 0.003$) inverse relationship between local and NH correlation. This leaves us with an interesting problem. If the proxies are not well correlated with local temperatures, by what mechanism can they be better correlated with the NH data? Certainly, there are “teleconnections” between climate patterns in widely separated parts of the globe. But what is the possible mechanism whereby the NH data can affect a proxy without affecting the local temperature?

Lack of a Validation Period, Calibration Period Only: The problem of poor performance “out of sample” in any type of reconstruction method (e.g. OLR, CVM) is widely recognized, and is taught in undergraduate statistics. The way to test for this is to divide the NH data into a “calibration” period and a “validation” period. The proxy data is first calibrated against one period, and then validated against the other. Then the two periods are reversed, the calibration period becoming the validation period and vice versa. Tree ring data are particularly well suited for this purpose. (Rutherford and Mann 2004) This allows us to determine how well the reconstruction performs “out of sample”. Since the historical period is entirely “out of sample”, this is the only way we have to determine how well the proposed reconstruction will perform during the historical “out of sample” period. This is such elementary and standard practice that any deviation from the practice requires a very strong theoretical reason for its omission. No such reason is provided in the paper.

No Subsampling: Subsampling is the routine practice of dividing the proxies into different groups, either by type or randomly, to see how well they perform. (e.g. Xiong 2001,

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St. George 2000). With the exception of rudimentary subsampling done by removing one proxy at a time, this has not been done with the UR. Figure 3 in the SOM shows the results of one such test, showing the proxies divided into ice core data, tree ring data, and "other". Note that during the calibration period, there is good agreement between the three different groups of proxies, and all of them agree in general with the NH data. However, when we look at the full period 1000-1850 shown in Figure 4, the situation is quite different. All three of the proxy groups, which correlated well with the NH data during calibration, do not agree with each other at all during the 1000-1850 period. This points to a fundamental flaw in the argument that we can just average them and get a useful or accurate reconstruction.

Problems with Autocorrelation: According to the MITRIE paper, the CVM method depends on normalization of the individual proxies. To do this requires an accurate estimator of the variance of the proxies over the calibration and verification periods. The usual method for estimating variance in the presence of autocorrelation is to calculate an "effective N", a reduced number of degrees of freedom due to autocorrelation. This effective N is then used to estimate the variance. The MITRIE paper has two problems in this regard: 1) No adjustment is made for autocorrelation, and 2) Some of the proxies are so highly autocorrelated that it is not possible to calculate the variance. The paper contains no acknowledgement of these problems regarding CVM, nor any proposals of how to deal with the problems.

E) PROBLEMS WITH THE GROWTH MODEL: The paper assumes that the growth response model for tree rings is linear in average annual T, of the form G = T + e where G is the growth (tree ring width), T is the annual temperature and e is the error. In fact, the growth function is a complex non-linear function, where G is the integral of some function the daytime conditions f (T,M,C) + e over the growing season, where T is daytime temperature, M is moisture, and C is CO_2. Dr. Juckes has stated that this is not a problem because "The data used in our study are selected from sites where temperature is expected to be a growth limiting factor." However, the paper does not

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provide any verification of this claim.

Underlying Form of the Tree Ring Response: Plants do not have a linear or even a quasi-linear growth response to temperatures. Instead, they have an upside-down “U’ shaped response to temperature. They grow fastest at an optimum temperature, and grow more poorly if the temperature is either higher or lower than that temperature. (Pisek 1973) Tree ring proxy analyses assume a linear response to temperature, with wider rings correlating to higher temperatures and narrower rings correlating to lower temperatures. The effect of this is to reduce the high-temperature peaks in the proxy response that correspond to high temperatures. When the temperature is too hot and the rings are correspondingly narrow, this is incorrectly interpreted as a cooler temperature.

This is one of the major unsolved problems with tree ring proxies, which is that they identify higher than optimum temperatures as lower than optimum temperatures. While the problem is unsolved, it should not be ignored, as at a minimum it should be reflected in increased error estimations on the warm peaks.

The location of the optimum temperature for any plant depends on the available moisture. Without adequate water, a plant will wilt and stop growing at a temperature at which it will grow strongly with adequate water. Thus, the problem of the “U” shaped response curve cannot be separated from the previous problem of the number of variables in the growth response curve. In particular, in order to use tree ring proxies for temperature reconstruction, it is necessary to show that the growth function for the selected tree proxies is invertible, or that the limitation of the non-linear response curve can be addressed in some other manner. Although this question of non-linear response has received some interest in the specialty literature (e.g. Fritts 2003), it has not been addressed in long-term paleoclimatology reconstructions.

F) PRIOR RELEVANT INVESTIGATIONS: It is normal in scientific investigations to refer to previous studies of the same subject. Regarding historical reconstructions of

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climate, two of the most important reviews of the subject are the reviews done by the NAS Panel (NAS 2006), and the Wegman Report (Wegman 2006). The MITRIE paper has managed to totally avoid any comment on these two very important documents. In addition, the paper has not addressed the issues unresolved by the Nature Corrigendum (Nature Corrigendum 2004, McIntyre 2004).

Overall, the MITRIE paper needs extensive work on both the “Intercomparison and Evaluation” and the “Union Reconstruction” aspects before it is ready for publication.

Interactive comment on Clim. Past Discuss., 2, 1001, 2006.