

REPLY TO "Global-scale temperature patterns and climate forcings over the past six centuries: A comment." By S. McIntyre and R. McKittrick

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McIntyre and McKittrick ('MM04') claim that the mean features of the MBH98 (1) reconstruction are artifacts of (a) the standardization procedure used by MBH98 in calculating principal components (PCs) of the North American ITRDB data and (b) the use of infilled values in one tree-ring series from AD 1400-1403. We demonstrate these claims to be specious.

The choice of centering of the data in PCA simply changes the relative ordering of the leading patterns of variance. Application of Preisendorfer's selection rule "Rule N " (MBH98) selects 2 PCs for the MBH98 centering (1902-1980), but 5 PCs for the MM04 centering (1400-1971). Although not disclosed by MM04, precisely *the same 'hockey stick' PC pattern appears using their convention*, albeit lower down in the eigenvalue spectrum (PC#4) (Figure 1a). If the correct 5 PC indicators are used, rather than incorrectly truncating at 2 PCs (as MM04 have done), a reconstruction similar to MBH98 is obtained. Moreover, similar results are obtained whether or not proxy networks are represented in terms of PCs. To demonstrate this, we used the MBH98 procedure employing all 95 individual proxy indicators of MBH98 available back to AD 1404 with equal weight, standardized to have unit variance and zero mean over a 1902-1971

calibration period (this interval avoids a modest number of missing proxy values after 1971). We performed an additional analysis back to AD 1400 eliminating the "Gaspé" series challenged by MM04. The results of these analyses (Figure 1b), which demonstrate skill against independent 19th century instrumental (2) data ($RE=0.39, 0.33$, respectively--only moderately lower than the MBH98 result $RE=0.51$), are virtually indistinguishable and similar to the MBH98 reconstruction.

We reconstruct the anomalous early 15th century warmth of MM04 only when *both* the 'Gaspé' series and the entire ITRDB North American data set are eliminated from the proxy network (Figure 1c). These data (in fact, 70% of all of the proxy data used by MBH98 prior to AD 1600) were explicitly censored by McIntyre and McKittrick in their original analysis (3), yielding a result that fails cross-validation (4). MM04 here have instead filtered out the leading pattern of low-frequency variability in the data through the inappropriate PCA truncation described above. Unlike the MBH98 reconstruction, the resulting reconstruction (Figure 1d) clearly fails the standard measure of skill verification (5-7), the 'reduction of error' metric (RE), with $RE = -0.76$ ($RE < 0$ exhibits no skill, with $RE = -1$ is the average value for a random estimate). While MM04 *accept that their reconstruction fails verification*, they also made an error in their calculation of verification scores that underestimates the resolved variance of the MBH98 reconstruction by almost a factor of two. They also fail to recognize that the R^2 scores they prefer to cite (which are also incorrect), are inappropriate measures of forecasting or reconstructive skill since they do not account for possible changes in mean or variance in the prediction outside the calibration interval (8).

As for the hypothesized impact of 'CO₂ fertilization' on certain high-elevation Western tree-ring chronologies, this is hardly new to us. This issue was both discussed and dealt with by

us in a follow-up to MBH98 (9). MM04 demonstrate their failure to understand our methods by claiming that we required that “proxies follow a linear temperature response”. In fact we specified (MBH98) that indicators should be “linearly related to one or more of the instrumental training patterns”, not local temperatures. Finally, MM04 demonstrate an apparent lack of familiarity with the well known mathematical identity between the left and right eigenvectors of the SVD of a data matrix and the 'PCs' and 'EOFs' derived from the corresponding data covariance matrix.

A comparison of various published Northern Hemisphere temperature reconstructions (9-14), demonstrates the robustness of the main features of MBH98 when entirely different statistical reconstruction methodologies and proxy datasets are used. In particular, all reconstructions show anomalous late 20th century warmth and no evidence of MM04's anomalous early 15th century warmth.

We conclude that MM04's criticisms are without merit and in no way invalidate our method or conclusions.

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Figure 1.

- (A) Comparison of leading pattern of low-frequency variability based MBH98 PCA procedure (PC#1--red) and MM04 PCA procedure when the correct PC selection rule is used (PC#5--blue; mean and standard deviation set to that of red curve for comparison).
- (B) Comparison of MBH98 reconstruction from AD 1400-1980 (blue) with alternative reconstructions from AD 1400-1971 based on the direct use of the individual 95 proxy series available back to AD 1403 (yellow), and the 94 proxy series (all 95 series except the 'Gaspé' series discussed in text) available back to AD 1400 (green). Shown for comparison is the instrumental NH annual mean record 1856-1980 (red). The MBH98 reconstruction was based on a 'stepwise' approach employing increasingly more proxy data over time, while the other two reconstructions, for simplicity, are performed with the same ('frozen') proxy network over the entire interval.
- (C) Comparison of MBH98 reconstruction (blue) from AD 1400-1980 (thick black curve is 40 year smoothed version) with a reconstruction over AD 1400-1600 (yellow) based on the 'censored' network described in the text, arising from the elimination of the 'Gaspé' and North American ITRDB data from the predictor network prior to AD 1600. A suitable approximation to the 'stepwise' MM04 reconstruction is provided by a splice of the yellow curve from AD 1400-1600 with the MBH98 reconstruction (blue) from AD 1600-1971. The resulting series is shown smoothed on a 40 year timescale (thick orange).

(D) Comparison as in (B), but showing the continued 'frozen' reconstruction based on use of the 'censored' network after AD 1600 (green curve), and the full instrumental Northern Hemisphere temperature record (1856-2003). The failure of the MM04 reconstruction to verify against independent instrumental temperature is evident from the extremely large discrepancy in variance between the yellow and red series during the 1854-1901 verification interval.