

MAR07-2006-020041

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

The uncertain hockey stick: a statistical perspective on the reconstruction of past temperatures

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A reconstruction of past temperatures based on proxies is inherently a statistical process and a deliberate statistical model for the reconstruction can also provide companion measures of uncertainty. This view is often missed in the heat of debating the merits of different analyses and interpretations of paleoclimate data. Although statistical error is acknowledged to be just one component of the total uncertainty in a reconstruction, it can provide a valuable yardstick for comparing different reconstructions or drawing inferences about features. In this talk we suggest a framework where the reconstruction is expressed as a conditional distribution of the temperatures given the proxies. Random draws from this distribution provide an ensemble of reconstructions where the spread among ensemble members is a valid statistical measure of uncertainty. This approach is illustrated for Northern Hemisphere temperatures and the multi-proxy data used by Mann, Bradley and Hughes (1999). Here we explore the scope of the statistical assumptions needed to carry through a rigorous analysis and use Monte Carlo sampling to determine the uncertainty in maxima or other complicated statistics in the reconstructed series. The principles behind this simple example for the Northern Hemisphere can be extended to regional reconstructions, incorporation of additional types proxies and the use of statistics from numerical models.