LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Biases and variance losses in RegEM pseudo-proxy reconstructions for different coupled-model integrations: The impact of standardization procedures

Jason E. Smerdon

Lamont-Doherty Earth Observatory of Columbia University

Alexey Kaplan

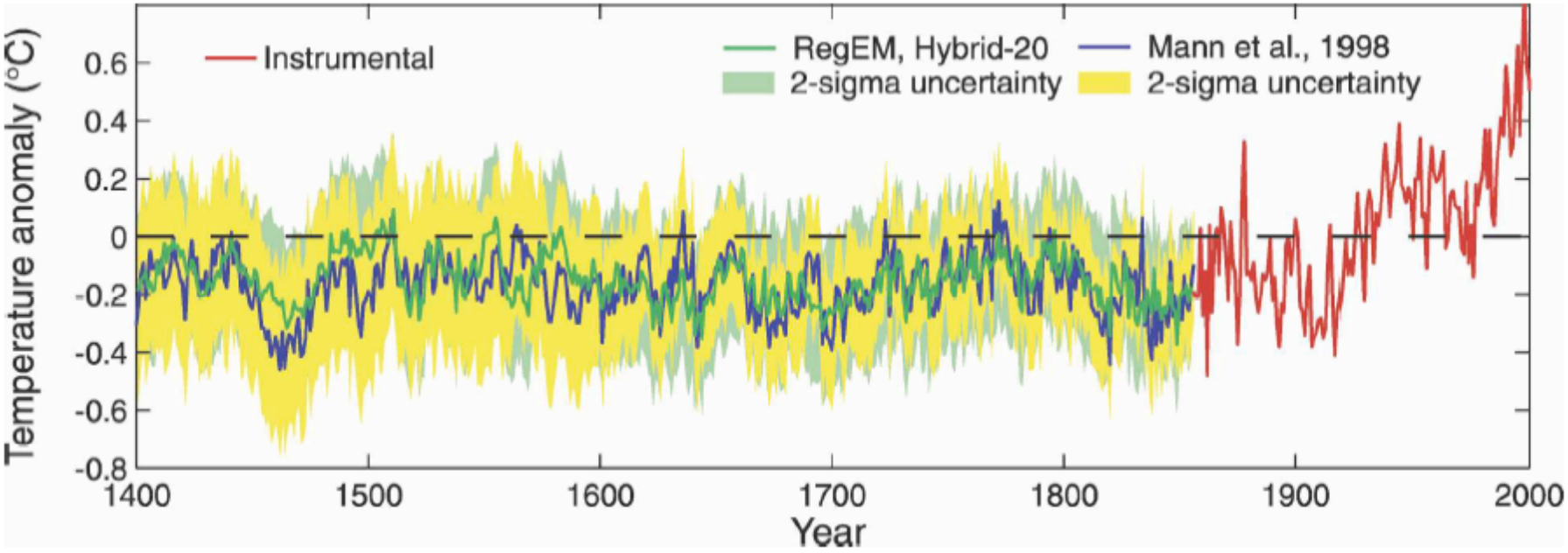
Lamont-Doherty Earth Observatory of Columbia University

Alexander J. Carver

University of Wisconsin-Madison

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

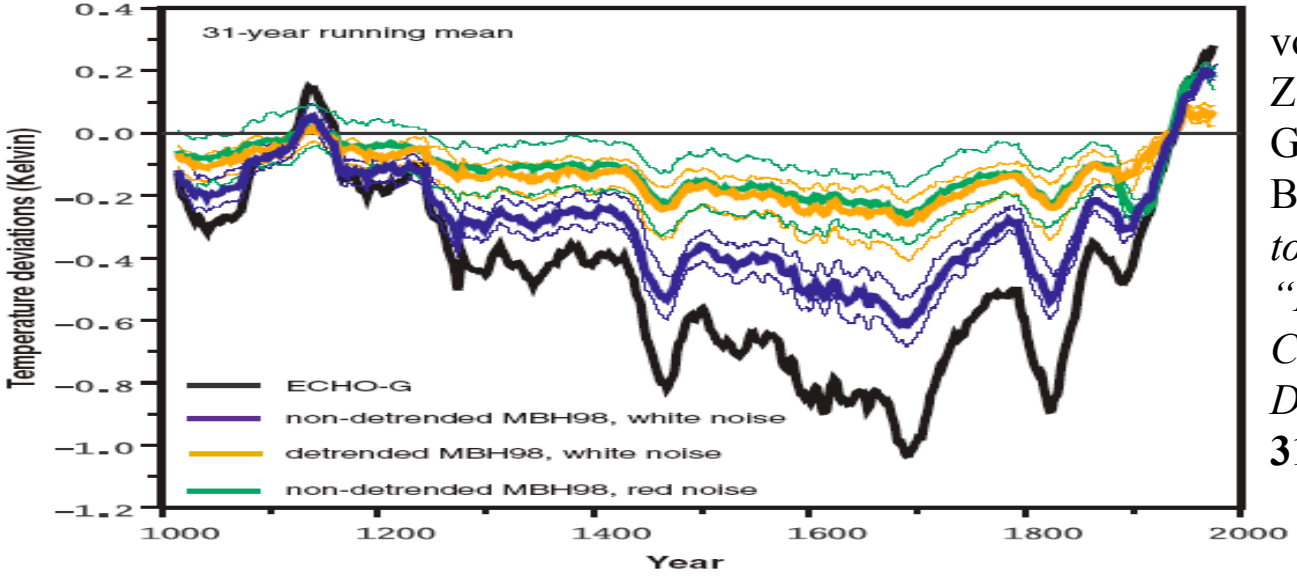
Comparison of the Mann et al. (1998) and Rutherford et al. (2005) Reconstructions



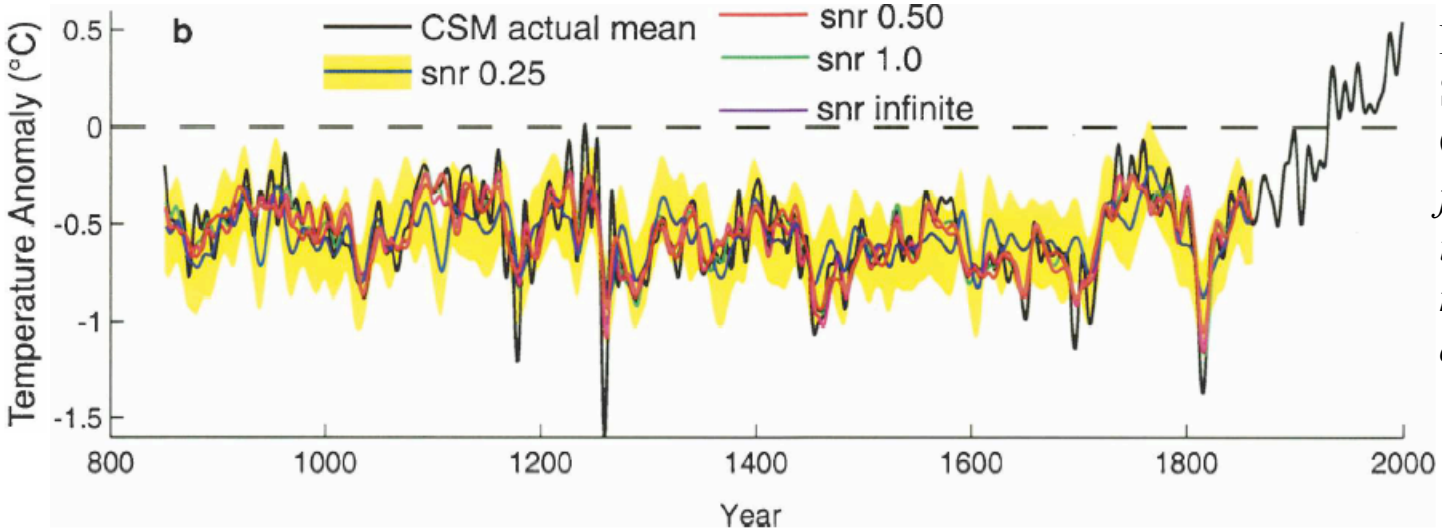
Rutherford, S., M.E. Mann, T.J. Osborn, R.S. Bradley, K.R. Briffa, M.K. Hughes, P.D. Jones, 2005: *Proxy-based Northern Hemisphere Surface Temperature Reconstructions: Sensitivity to Methodology, Predictor Network, Target Season and Target Domain*, *J. Clim.*, **18**, 2308-2329.

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Contradictory Pseudo-Proxy Results?



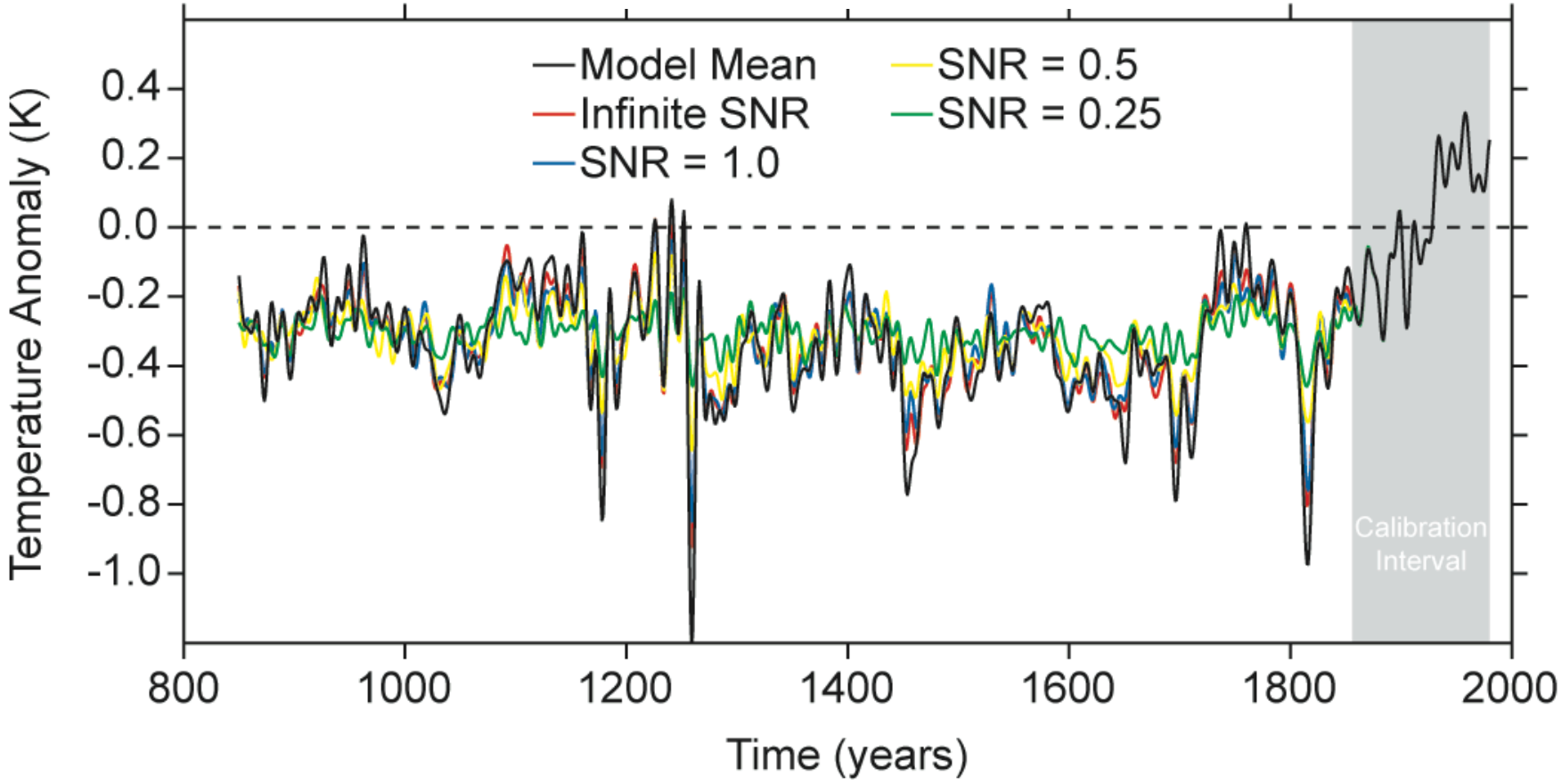
von Storch, H., E. Zorita, J. M. Jones, J. F. Gonzalez-Rouco, S. F. B. Tett, 2006: *Response to Comment on "Reconstructing Past Climate from Noisy Data", Science*, **312**, 5773, 529.



Mann, M.E., Rutherford, S., Wahl, E., Ammann, C., 2005: *Testing the fidelity of methods used in proxy-based reconstructions of past climate*, *J. Clim.*, **18**, 4097-4107.

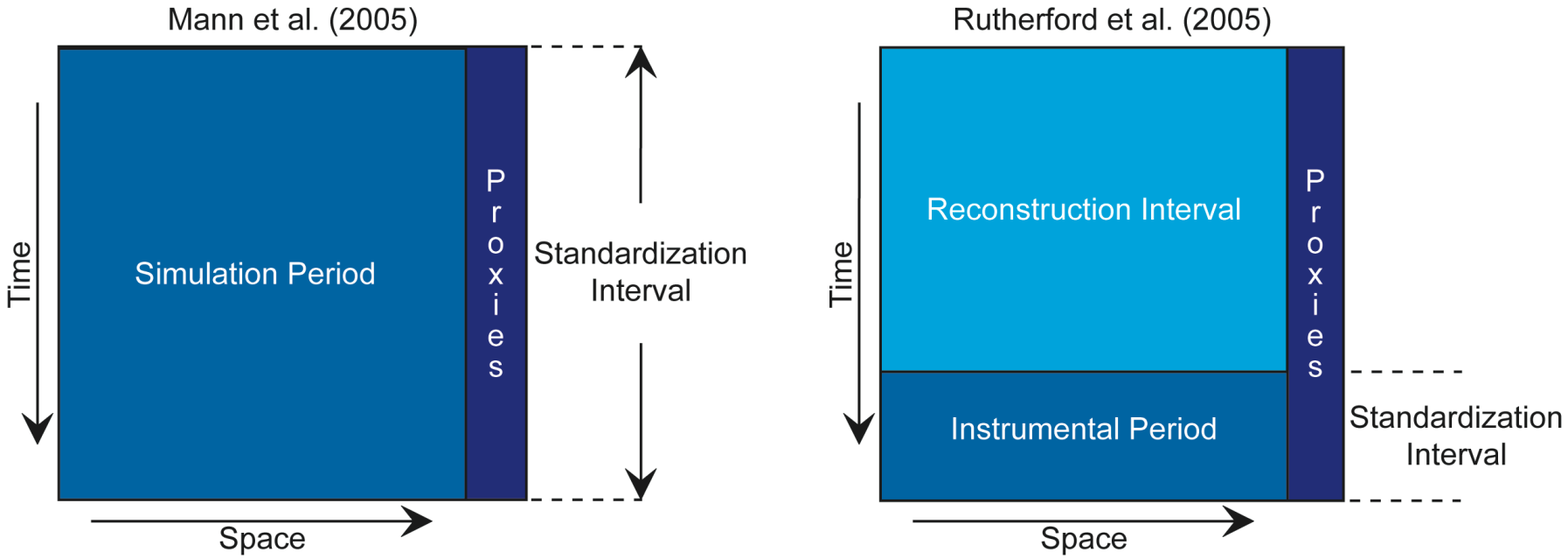
LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Reproduction of the Mann et al. (2005) RegEM Pseudo-Proxy Reconstructions



Smerdon, J.E., and A. Kaplan, Comment on "Testing the fidelity of methods used in proxy-based reconstructions of past climate": The role of the standardization interval, *Journal of Climate*, in review.

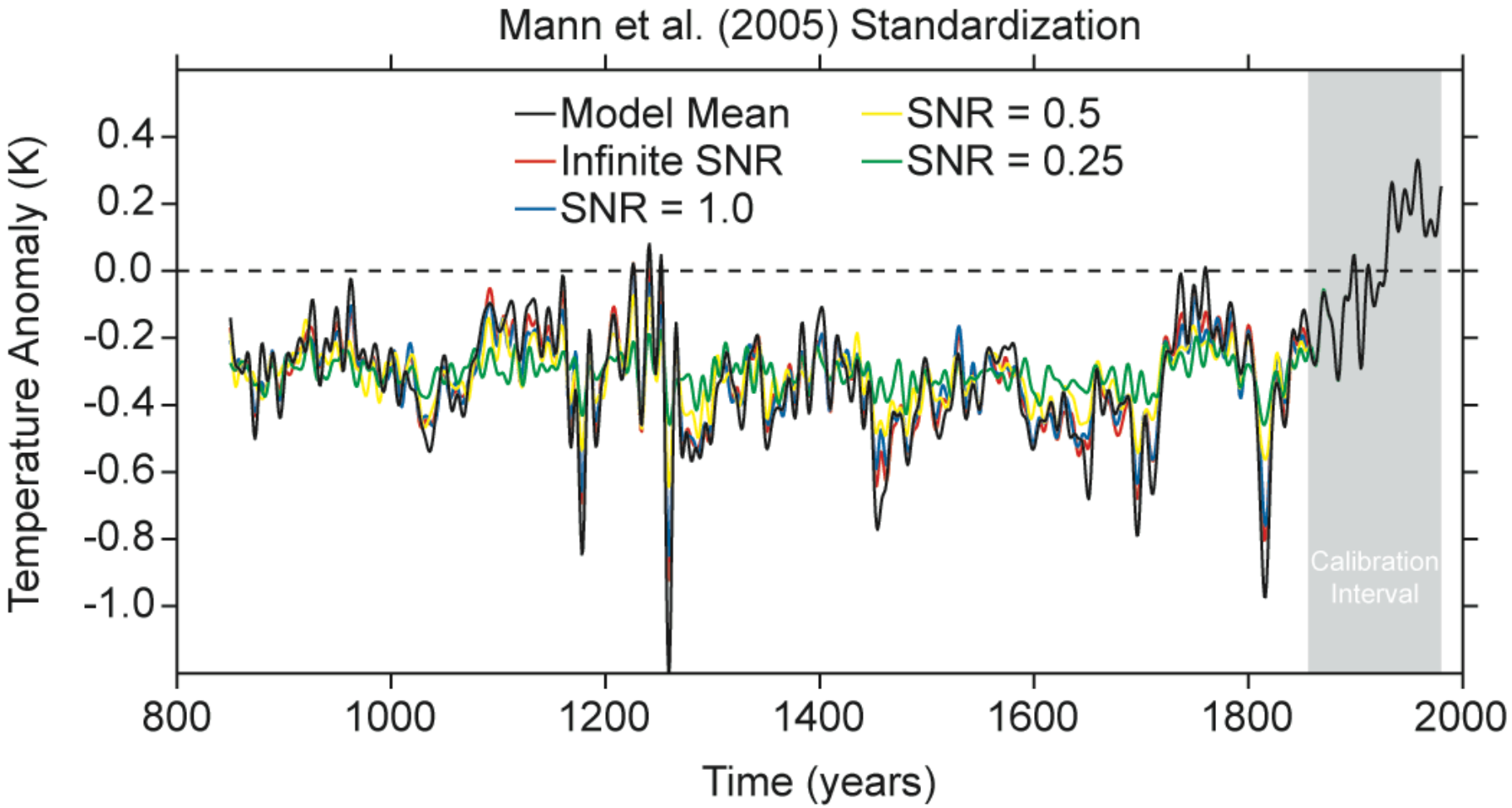
Two Standardization Choices



Standardization: The normalization of a time series by it's standard deviation and the centering of a time series by the subtraction of it's mean, both over a given interval.

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

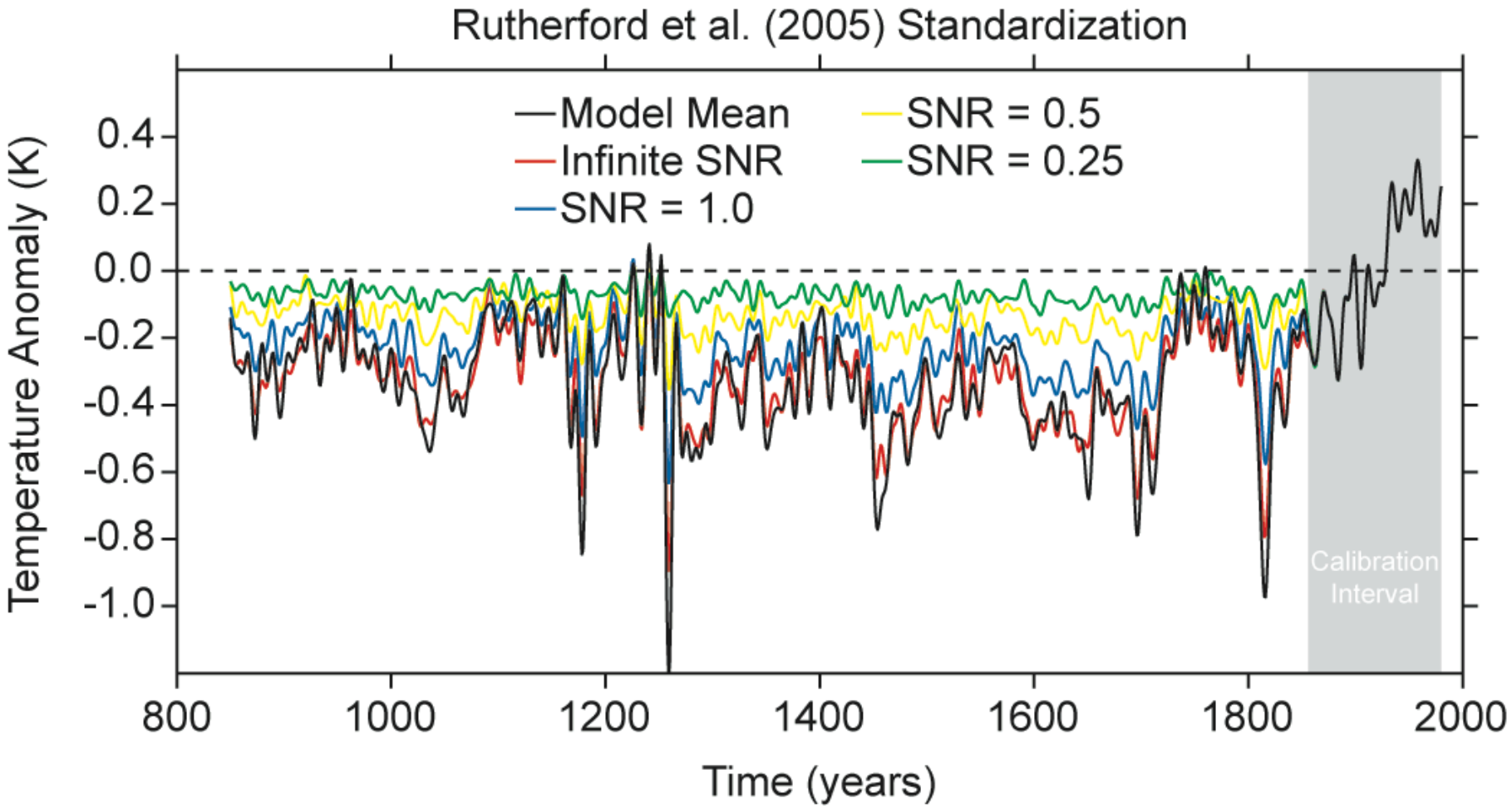
NCAR CCSM Results



Smerdon, J.E., and A. Kaplan, Comment on "Testing the fidelity of methods used in proxy-based reconstructions of past climate": The role of the standardization interval, *Journal of Climate*, in review.

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

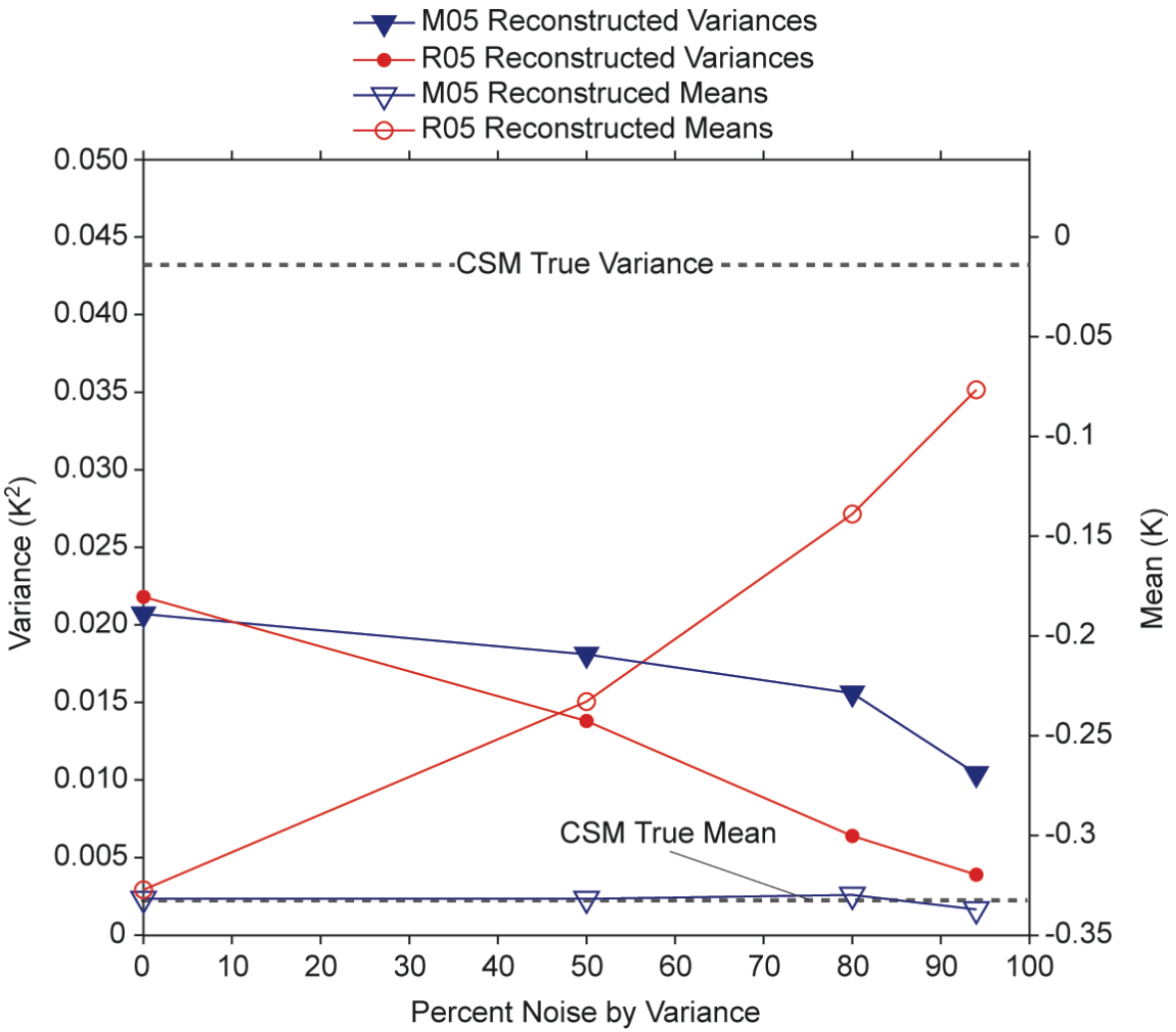
NCAR CCSM Results



Smerdon, J.E., and A. Kaplan, Comment on "Testing the fidelity of methods used in proxy-based reconstructions of past climate": The role of the standardization interval, *Journal of Climate*, in review.

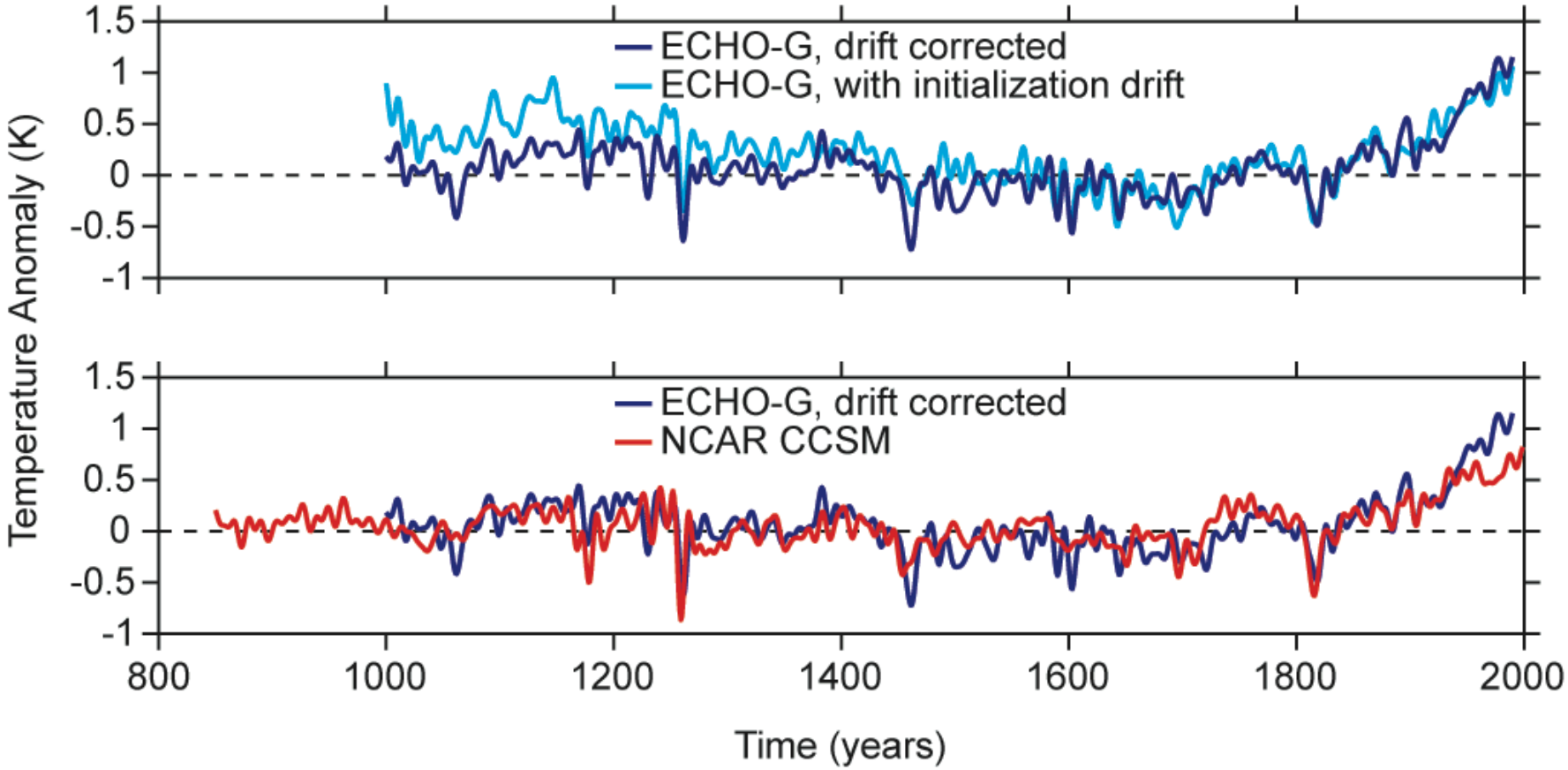
LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Mean and Variance of the CCSM Experiments using the R05 and M05 Methods



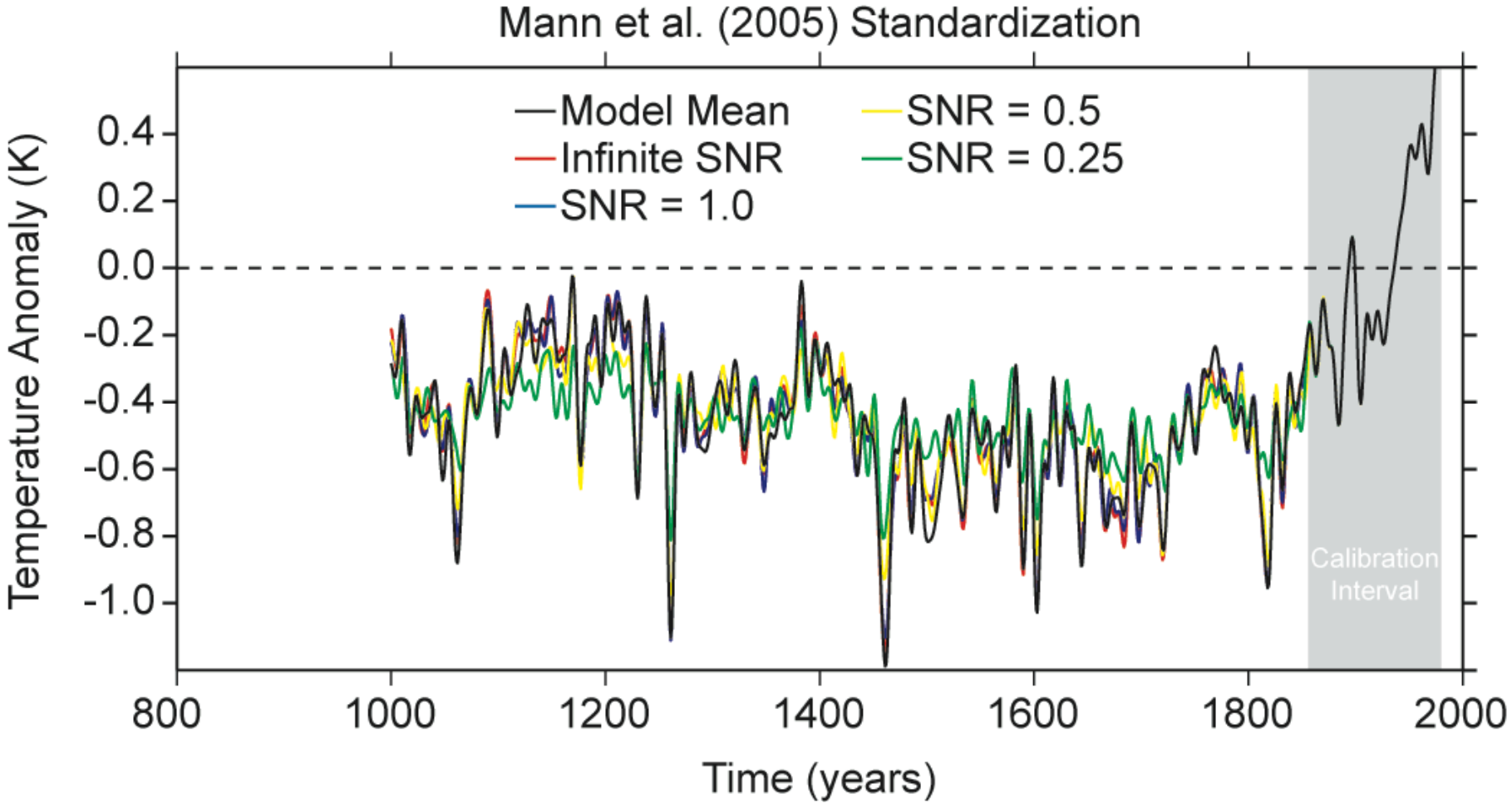
LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Comparison of Mean NH Surface Temperature in the NCAR CCSM and GKSS ECHO-G Simulations



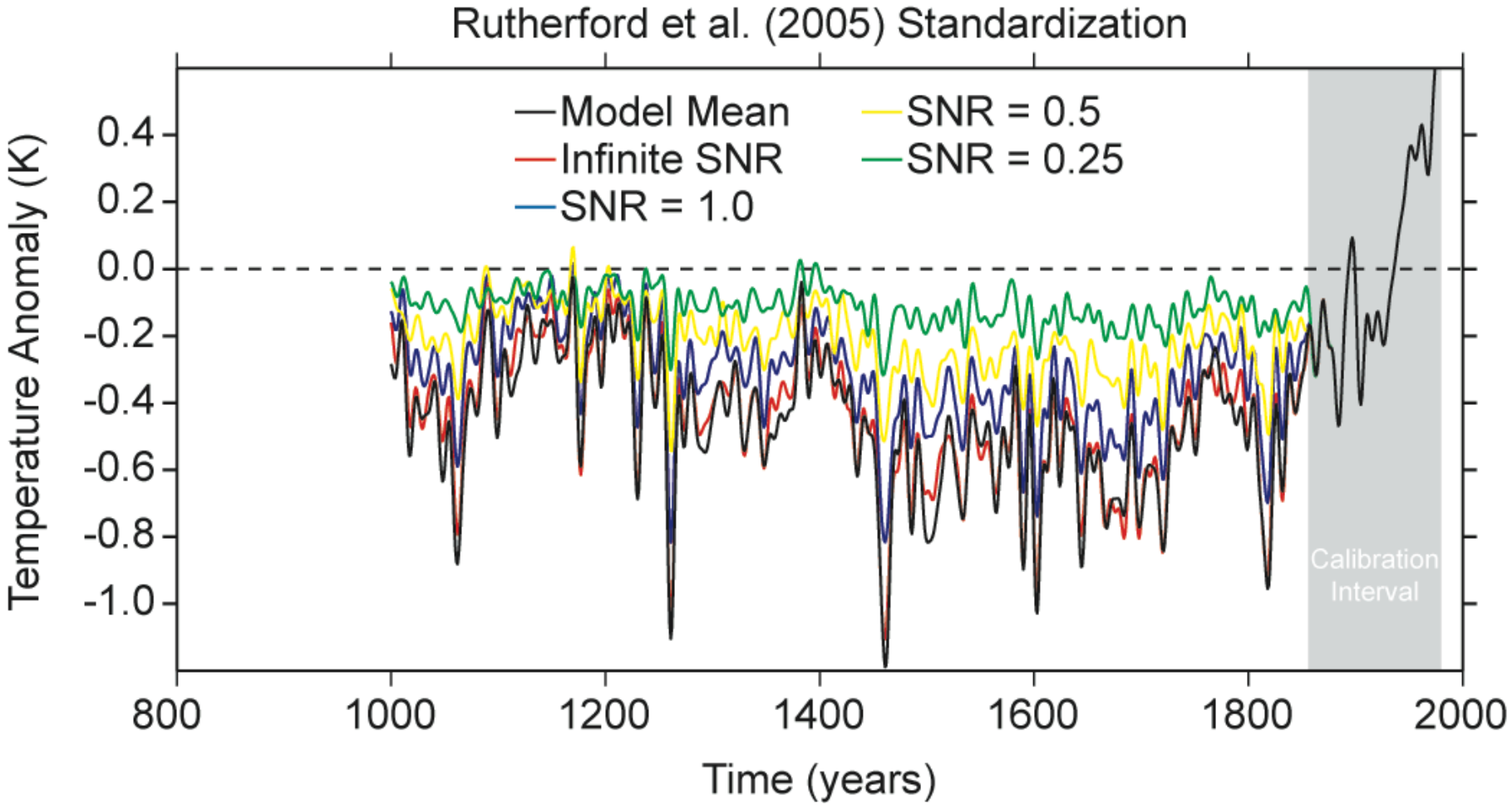
LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

GKSS ECHO-G Results using the Drift-Corrected Integration



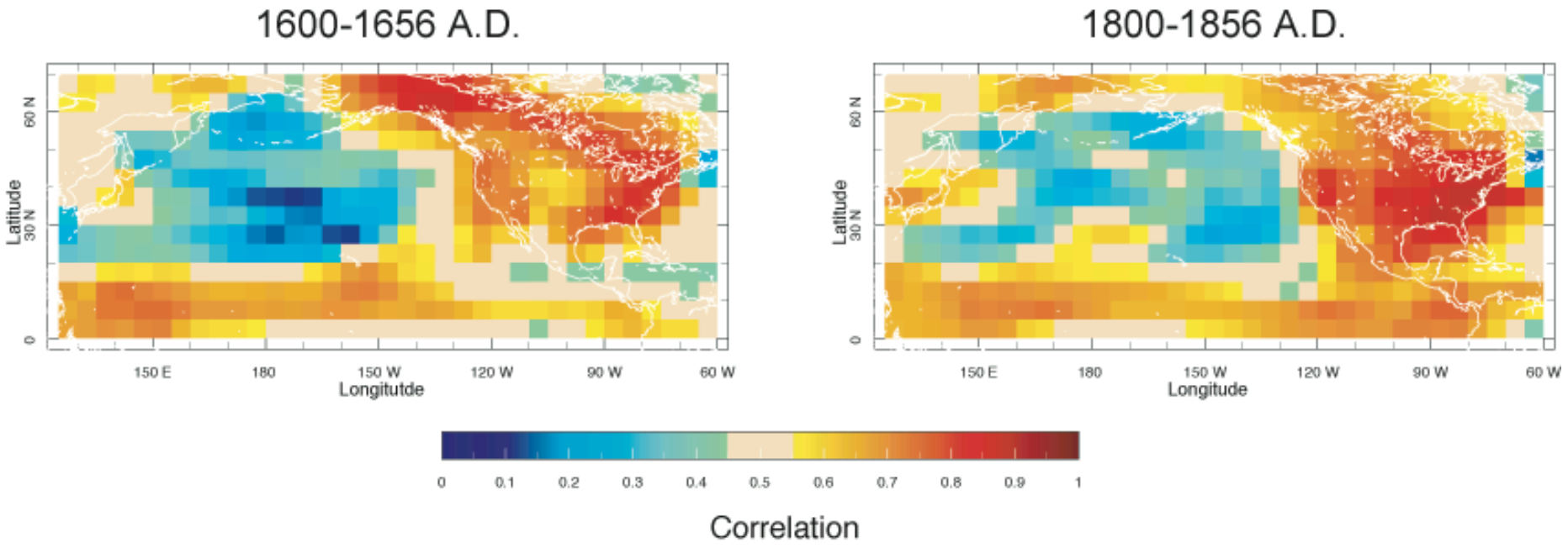
LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

GKSS ECHO-G Results using the Drift-Corrected Integration

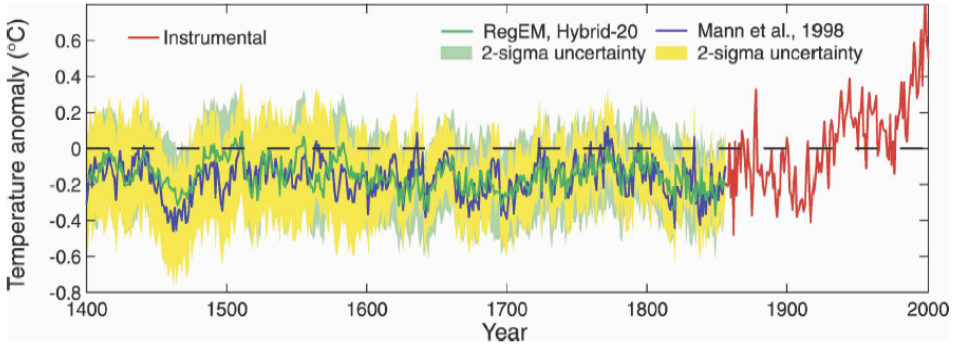


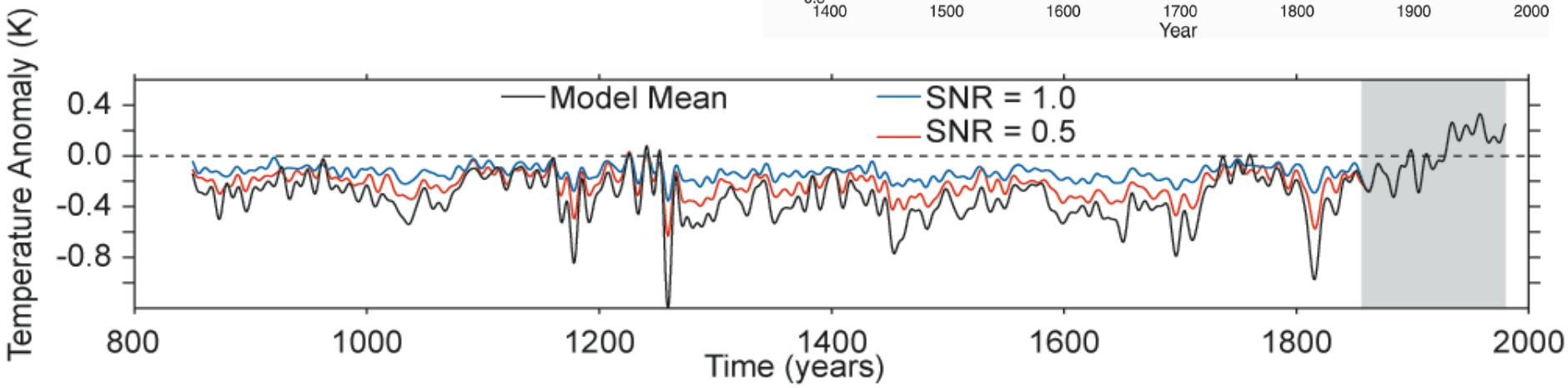
LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Spatial Correlation between the ECHO-G Simulated and Reconstructed Fields



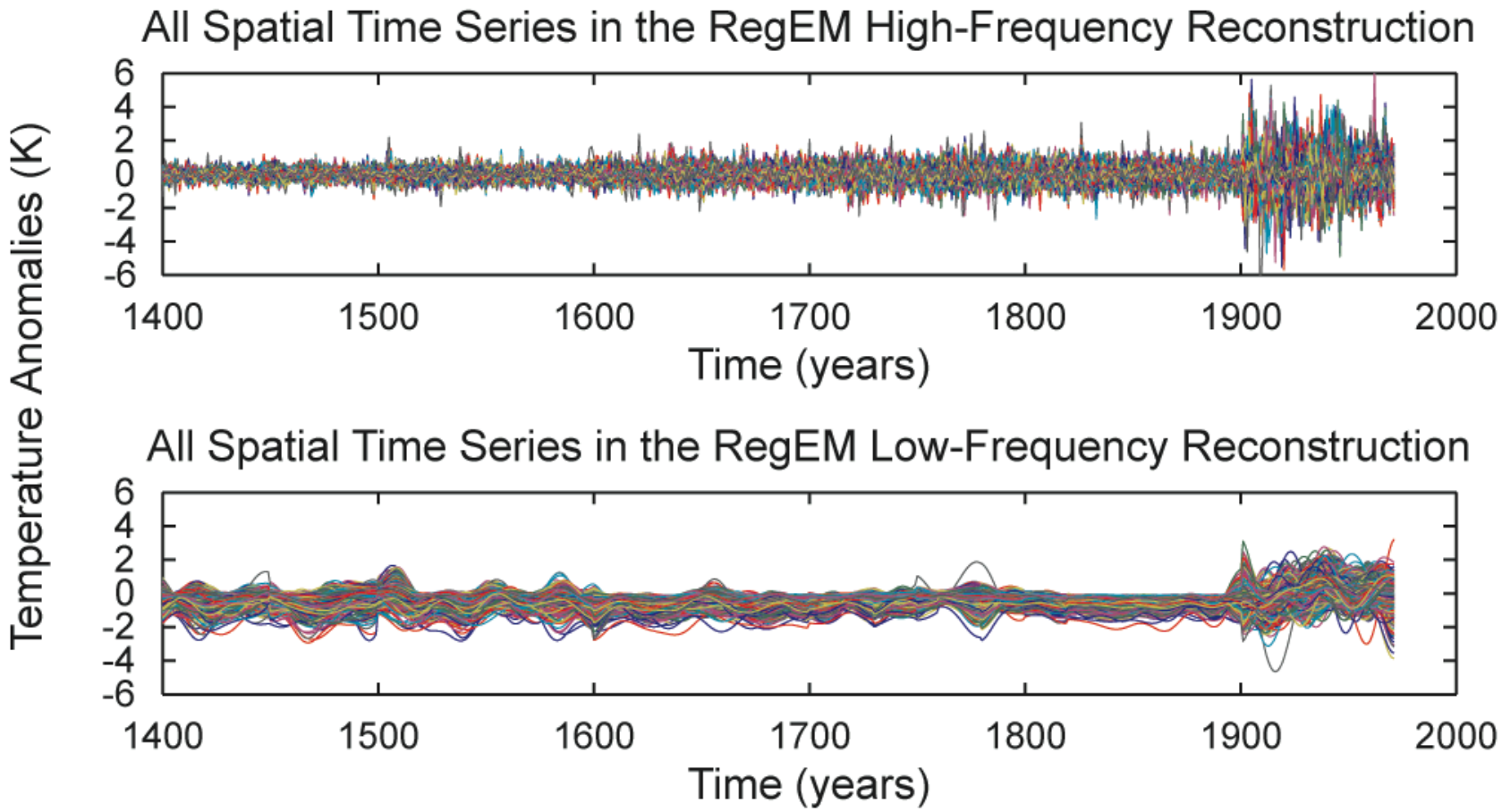
Implications…





LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

All Spatial Time Series From the Rutherford et al. (2005) Historical Reconstruction



Conclusions

- The Rutherford et al. (2005) formulation of RegEM causes warm biases and variance losses in derived pseudo-proxy reconstructions.
- Differences between the GKSS and NCAR GCMs are not likely sources of large differences between the results of current pseudo-proxy experiments.
- Given real-world constraints, the Mann et al. (2005) pseudo-proxy test used a RegEM formulation that makes it inapplicable.
- The Rutherford et al. (2005) RegEM reconstruction of historical climate is likely an underestimate of past variability from annual to centennial scales, and by comparison, so too is the Mann et al. (1998) result.
- Our results do not invalidate RegEM as a suitable reconstruction technique, but suggest that currently documented results suffer from the shortcomings that we describe.

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Acknowledgements

Scott Rutherford

Roger Williams University

J. Fidel Gonzalez-Rouco

Universidad Complutense de Madrid

Eduardo Zorita

Institute for Coastal Research of the GKSS Research Centre

Michael Evans

University of Arizona

Edward Cook

Lamont-Doherty Earth Observatory of Columbia University