Social science trio
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LETTERS

edited by Etta Kavanagh

Testing Climate Reconstructions

A 2005 U.S. CONGRESSIONAL ENQUIRY (*1*) FOCUSED ON THE VALIDITY of the climate reconstruction of the past millennium by Mann *et al.* (*2*) and referred to a *Science* Report that challenged the reconstruction method ("Reconstructing past climate from noisy data," H. von Storch *et al.*, 22 Oct. 2004, p. 679; published online 30 Sept. 2004). This Report was also discussed in the U.S. Senate in 2005 (*3*). In this discussion, it has been overlooked that von Storch *et al.*'s Supporting Online Material (SOM) in fact supports the Mann *et al.* reconstruction.

von Storch *et al.* presented tests of the climate proxy method with two climate models: the HadCM3 model (shown only in the SOM) and the ECHO-G model. Both are compared in the figure. The HadCM3 simulation (solid blue) is consistent with the climate proxy data reconstruction (grey band). The ECHO-G model has since been found to be afflicted by a major artificial climate drift due to an undocumented, inappropriate initialization procedure (*4*).

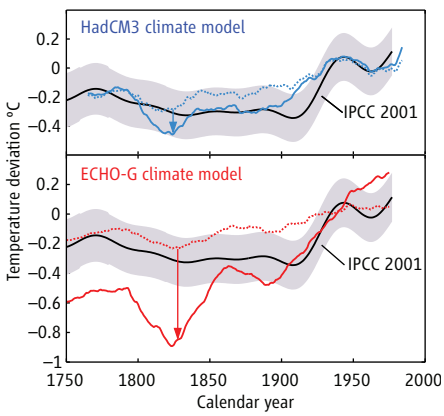
The error of simulated proxies (dotted blue) found in the HadCM3 model is smaller than the error margin given by Mann *et al.* for their method and shown in the IPCC report (*5*). For the time period common to both models, the RMS error of the simulated proxies is 0.24ºC in ECHO-G, but only 0.07ºC in HadCM3—less than one-third.

The two models thus give rather different, conflicting results about the potential errors of proxy reconstructions. This is not mentioned in the Report, which merely states, "Similar results are obtained with a simulation with the third Hadley Centre coupled model (HadCM3), demonstrating that the results obtained here are not dependent on the particular climate characteristics of the ECHO-G simulation" (p. 680).

In addition, it has since been found (*6*) that the proxy method was implemented incorrectly by von Storch *et al.*; with correct implementation, the error is even smaller in HadCM3 than the 0.07ºC shown here. A similar, more recent test with the NCAR climate system model (*7*) also suggests only small errors for the proxy method, supporting the climate reconstruction of the past millennium by Mann *et al*.

STEFAN RAHMSTORF

Potsdam Institute for Climate Impact Research, Box 601203, 14412 Potsdam, Germany.



Test of proxy climate reconstruction method with two climate models, HadCM3 and ECHO-G. Solid lines show Northern Hemisphere temperature in the models (31-year running means); the dotted lines show simulated proxy reconstructions where the proxies are degraded with 75% noise. The error of the proxy method is the difference between the solid and dotted lines (arrows). For comparison, we show the Mann *et al.* 40-year-smoothed reconstruction for the Northern Hemisphere temperature (black) with its 95% confidence interval (grey), as shown in the IPCC Third Assessment Report (*5*).

Response

RAHMSTORF CRITICIZES OUR PREVIOUS CONclusions about the climate reconstruction method of Mann *et al.* (*1*) (MBH98). In our previous analyses (*2*, *3*), we found that MBH98 underestimates past temperature variations when tested in climate simulations of the past few centuries. Rahmstorf argues that the simulated Northern Hemisphere temperature lies outside the uncertainty bounds of the pseudoreconstructions in the simulation with the model ECHO-G, but inside the uncertainty bounds in the HadCM3 simulation. He concludes that our analysis supports the Mann *et al.* (*1*) reconstructions. This conclusion is wrong. The problem is the determination of the error bounds.

To successfully compute uncertainty bounds requires an error model. Updated uncertainty bounds for the MBH98 series, on 40-year time scales, can be found in fig. 1B of Gerber *et al.* (*4*). Mann was a co-author on this study, and these uncertainties are consistent with the ones derived in our analysis (*3*). Further, they are about a factor of 3 smaller than those published two years earlier in the IPCC Third Assessment Report (*5*) and used in Rahmstorf's Letter (2σ of roughly 0.07 K rather than 0.25 K for circa 1800). The result of the pseudoreconstruction and the target temperature in the HadCM3 model are therefore statistically well separated when using the proper uncertainties (*3*).

We think that the Letter [as does (*5*)] illustrates a common confusion in our field. There are two sources of uncertainty in reconstructing past climate from proxy records: (i) calibration uncertainty—which part of the signal is not captured by the statistical method; and (ii) residual uncertainty—how much additional, unrelated variability is engraved in the proxy records. Our most recent comment (*3*) did not make this point explicitly, but its uncer-

References and Notes

1. See www.realclimate.org/index.php?p=172 for links to the request and the scientists' responses.
2. M. E. Mann, R. S. Bradley, M. K. Hughes, *Geophys. Res. Lett.* **26**, 759 (1999).
3. See http://inhofe.senate.gov/pressreleases/climateupdate.htm.
4. T. J. Osborn, S. T. C. Raper, K. R. Briffa, *Clim. Dyn.* **27**, 185 (2006), DOI: 10.1007/s00382-006-0129-5.
5. IPCC (Intergovernmental Panel on Climate Change), *Climate Change 2001: The Scientific Basis* (Cambridge Univ. Press, Cambridge, 2001), fig. 2.21, p. 134. The error bars for time scales >40 years shown there were computed by Mann *et al.* from calibration residuals, accounting for their spectral "redness." The data were obtained from the National Climate Data Center at http://www.ncdc.noaa.gov/paleo/pubs/mann_99.html.
6. E. R. Wahl, D. M. Ritson, C. M. Amman, *Science* **312**, 529 (2006).
7. M. E. Mann, S. Rutherford, E. Wahl, C. Amman, *J. Clim.* **18**, 4097 (2005).
8. We thank von Storch *et al.* for providing the data of their simulations.

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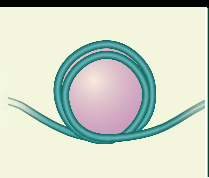
Mimicking enzymes

1885



Precision splicing

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tainty estimates are based on calibration error. We showed that the MBH98 method implemented in the simulations leads to pseudoreconstructed temperatures being too warm and with differences from the target temperature larger than our calibration uncertainty ranges.

Rahmstorf also alludes to a climate drift in the ECHO-G simulation (*2*). However, this drift mostly affects the earlier centuries of the millennium, when the pseudoreconstruction performs better, and is probably minor after 1400 A.D., when the pseudoreconstruction performs worse. For instance, ECHO-G simulates a difference in the Northern Hemisphere temperature between 1900 and 1980 (the calibration period) and the Late Maunder Minimum (around 1700) of 0.97 K, whereas a simulation with the CSM climate model from NCAR yields 0.87 K (*6*). Therefore, this issue cannot explain the bias of the reconstruction method.

In conclusion, we feel that the paleoreconstruction community would be well served if it used error models describing uncertainties from both calibration and "noise," which leads to uncertainties that have complex, possibly intermittent nonstationary behavior on different time scales. We also urge the community to test methods using realistic "pseudo-proxies" as they offer a good laboratory.

HAUS VON STORCH,[1] EDUARDO ZORITA,[1] JULIE JONES,[1] FIDEL GONZALEZ-ROUCO,[2] SIMON TETT[3]

[1]Institute for Coastal Research, GKSS Research Centre, Geesthacht 21502, Germany. [2]Department of Astrophysics and Atmospheric Physics, Universidad Complutense de Madrid, Madrid 28040, Spain. [3]UK Meteorological Office, Hadley Centre, Reading RG6 6BB, UK.

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1. M. E. Mann, R. S. Bradley, M. K. Hughes, *Nature* **392**, 779 (1998).
2. H. von Storch *et al.*, *Science* **306**, 679 (2004).
3. H. von Storch *et al.*, *Science* **312**, 529 (2006).
4. S. Gerber *et al.*, *Clim. Dyn.* **20**, 281 (2003).
5. IPCC (Intergovernmental Panel on Climate Change), *Climate Change 2001: The Scientific Basis* (Cambridge Univ. Press, Cambridge, 2001), fig. 2.21, p. 134.
6. M. E. Mann, S. Rutherford, E. Wahl, C. Ammann, *J. Clim.* **18**, 4097 (2005).

Team Science and the NIBIB

I WOULD LIKE TO EXPLORE ISSUES RELATING TO the funding of biomedical engineering and imaging at the National Institute of Biomedical Imaging and Bioengineering (NIBIB) that are raised in an article on the Whitaker Foundation ("Spending itself out of existence, Whitaker brings a field to life," D. Grimm, News Focus, 3 Feb., p. 600).

Fiscal year 2005 was the NIBIB's third full year with an operating budget and its third year with a double-digit percentage annual growth in grant applications received. Even in the face of this large growth, the NIBIB's budget projections and management plan resulted in paying to the 20th percentile, well within the range of paylines for the more established institutes. In addition, nearly all of the funded applications contained bioengineering, even those internally labeled as "imaging." Because this type of science is fundamentally interdisciplinary, it is difficult to accurately describe the relative support of biomedical imaging and bioengineering, reflecting progress toward achieving the goal of team science.

In addition to the pervasive bioengineering content in our research portfolio, the institute has multiple training programs that target bioengineering, interdisciplinary science, and young investigators. Indeed, the majority of the NIBIB's current training budget supports such programs. Of note, the NIBIB seeks to significantly enhance the success of new investigators through its policy that increases the payline by 5 percentile points for first-time investigators. During the last fiscal year, this policy resulted in 33% more funded first-time NIBIB investigators.

It is the team science approach, inclusive of young investigators, that is critical for realizing our vision of profoundly improving health care through technological innovation.

RODERIC I. PETTIGREW

Director, National Institute of Biomedical Imaging and Bioengineering, National Institutes of Health/U.S. Department of Health and Human Services, Bethesda, MD 20892, USA.

Funding for Young Investigators at Whitaker

WE WISH TO ADD SOME ADDITIONAL INFORMATION to the points made in the News Focus article "Spending itself out of existence, Whitaker brings a field to life" (D. Grimm, 3 Feb., p. 600). First, it should be noted that nonimaging-related biomedical engineering research was relatively underfunded, not that most of the funding was supporting clinical imaging research. For example, the 2004 numbers indicated that nonimaging research projects constituted less than 40% of the funded individual investigator-initiated grants. Second, the total