Testimony to be presented before the House Committee on Energy and Commerce on "Hockey Stick Temperature Studies" (July 19, 2006)

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I thank the committee for the opportunity to submit my response to the findings of the NRC and Wegman Reports. As background to my testimony, I will briefly state my credentials. I received a Ph.D. in marine geology from Brown University and have a long interest in the history of the Earth's past climates, both from a modeling and observational viewpoint. I have published about 100 peer-reviewed papers and have co-authored a book on the subject. I have worked in academia, the private sector, and at two government agencies – at NSF as a program director in climate and at NASA/Goddard Space Flight Center as a National Research Council senior fellow. I am presently the Nicholas Professor of Earth Systems Science in the Nicholas School of the Environment at Duke University.

Because this hearing has been called to better understand the influence of the much-discussed 1998 and 1999 papers by Michael Mann, Raymond Bradley, and Malcolm Hughes, I think it would be useful to provide a brief scientific background to the subject. Prior to 1998 there had been only one attempt to summarize the various types of data from past climate to get a broader picture as to how it has changed over the last few centuries. In 1998 Mann et al. introduced a new technique to develop more quantitative estimates of the nature of climate change since AD 1400 for the northern hemisphere, and in 1999 the group extended that record back to AD 1000 and concluded that the late 20th

century warming was the largest in the last 1000 years. This report was among a number of scientific studies highlighted in the IPCC Third Assessment Report (TAR) to conclude that "there is new and stronger evidence that most of the observed warming over the last fifty years is attributable to human activities".

With respect to the committee's interests in whether the objectivity of the IPCC with respect to the Mann et al. studies I elaborate on several points below. At the time of IPCC TAR it represented the best estimate of past millennial temperatures and their uncertainties, and that the most important conclusion from IPCC (stated above) does not depend on the Mann et al. papers for its credibility, and are even more robust today than they were in 2001.

The final part of my presentation involves a number of objections, both major and minor, to the Wegman Report.

I have five main points to make concerning the following subjects:

(1) <u>The relation between the Mann et al paper and the IPCC Third Report in 2001</u>. The Mann et al paper was certainly influential in the IPCC Third Assessment Report (TAR), but so were many other papers. But the papers that made the biggest difference were the ones focusing on the instrumental record in which it was shown that models and data could not be reconciled unless an anthropogenic greenhouse influence was invoked. The most compelling driver of all was the fact that global temperatures kept going up

and up since the 1996 report, and meltback of glaciers increased in many parts of the world. I might add that this trend has only accelerated since 2001, with melting in the Arctic and on Greenland reaching alarming levels.

(2) The Mann et al paper in and of itself. At the time of IPCC TAR there were two other reconstructions going back to the Middle Ages, with decadally smoothed data showing, at best, past millennial temperatures comparable to the mid-20th century warm interval. One reconstruction (Crowley and Lowery, attached) using a completely different methodology agreed with Mann et al. quite well (Fig. 2). However, Mann et al. was the only paper of the three that estimated uncertainties, and it is no surprise that this paper was the one chosen to highlight the millennial perspective for IPCC. *The significant criticisms of the Mann et al. paper that have been published since 2001 are by definition after the fact with respect to IPCC TAR*.

(3) The present state of our knowledge on millennial changes Science always progresses and sometimes past conclusons have to be modified. A notable example with respect to IPCC involves the significant reassessment of satellite upper air data that previously had not agreed with model predictions of increasing air temperatures in that region; new assessments indicated that the models and data were now in approximate agreement. Similarly, some papers have been published in the last five years suggesting greater variability than Mann et al. Contrary to the claims of the Wegman Report, one of these reconstructions (Hegerl et al., attachment 2) uses a completely independent

data set from borehole measurements (fig. 3) of the effects of air temperature change on heat flow in the upper part of the Earth's crust.

Because Mann et al. have more recently obtained results similar to their earlier work, but now using a different methodology, it continues to be necessary to understand the causes of differences among the different reconstructions before the estimates of higher temperature variability can be accepted. Even if the latter estimates ultimately prove to be more accurate, there is no room for gloating (as sometimes seems evident in discussion of the newer results), *for the higher variability inevitably implies a higher climate sensitivity, which is a cause of much more serious concern for either the committee, or society at large*. By this I mean that for any given level of climate forcing from carbon dioxide, the expected temperature response would be larger than it would if the Mann et al. reconstruction was ultimately deemed to be the "final word" on the magnitude of past climate change (see Hegerl et al., third attachment).

(4) <u>The claim of unusual level of warmth for the late 20th century is still valid for all but one of the new reconstructions</u>. Contrary to the conclusions of the the Wegman report, there *is* reason to believe in the unique nature of late 20th century warmth (this is the only major point in which I differ from the NRC report). Although the early millennium records are small in number, the composite reconstruction agrees in the overlap interval (A.D. 1500-1960) with reconstructions using more extensive data sets. Furthermore, examination of the raw data indicates that even in the high latitude northern

hemisphere they show regional variations in the timing of warmth that is much greater than in the late 20th century. In other words, some regions are warm and some cold – a very different pattern from the late 20th century, where almost every region has warmed over the last 100 years. It is therefore no surprise that, when these records are composited, the sum value is smaller than for the late 20th century.

(5) The conclusions and recommendations of the Wegman Report have some serious flaws. In addition to a number of technical errors, large and small, the following comments can be made in the bullets on page two of the committee's summary of findings (fact sheet):

(a) bullet one (concerning specifics of Mann et al.) – responses discussed above

(b) bullet two – "many of the proxies are reused in most of the papers….it is not surprising that would obtain similar results…" This almost sounds as if it is wrong for everyone to use the best existing data! The more important point, and one not stated, is that different methodologies are employed by each of the investigators. Furthermore, there is nothing wrong with talking to or even collaborating with someone else in a field that you respect, and has expertise that you don't have. The Wegman Report almost seems to imply that collaboration is equivalent to collusion, a result that would apply to the Wegman Report itself if that were always true.

The inference in the same bullet concerning the failure of the peer review statement is an oversimplification. The anonymity of peer review still allows papers to be rejected, as almost any scientist can testify. As a former NSF program director, I have had significant opportunity to evaluate the peer-review system. It is not perfect but in general the best work gets funded. For publications, editors usually select a variety of reviewers who cover the different expertises in the study. But it is just not practical to expand the number of peer reviews for many publications – the work load is just too onerous for the reviewing pool, and most people will simply decline the request to review the papers. Finally, I would like to comment that the Wegman Report now before the committee has not undergone any extensive peer review from anyone in the climate community prior to its submission to the committee for inclusion into the record and, most problematically, possible use as a guide to further recommendations by the committee.

(c) Bullet three – <u>the researchers do not seem to be interacting with the statistical community</u>. This statement is based on a small subsample of paleoclimate papers. Overall, there is increasingly strong incorporation of statistical methodologies in the climate sciences, including increased interactions with statisticians. For example, the National Center for Atmospheric Research has had a postdoctoral program for statisticians for thirteen years. A key project jointly

funded by DOE and NOAA for detection and attribution of climate change involves not only several statistical climatologists but also explicitly seeks out input from statisticians. The present (and key) IPCC Fourth assessment chapter on detection and attribution of climate change has a statistician and statistical climatologist (with a training in applied mathematics) as co-lead authors. Statisticians are welcome to respond to any of the chapters in the review process. From these statements it is clear that the Wegman Report is somewhat uninformed with respect to the effort to include statisticians in the IPCC review process.

I might add that interactions between geoscientists and statisticians have long been hampered by what can only be described by some as a condescending attitude from some statisticians that geoscientists were not employing the most recent, state of the art statistical methods. Such attitudes almost guarantee subsequent poor communication and fail to recognize the unusual nature of "field laboratory" geoscience data, which are very different than "closed laboratories" where the conditions of an experiment are well controlled. The latter types of data require an intimate understanding of the raw data and simpler, more robust statistical methodologies that recognize the limitations of such data.

(d) Bullet four – <u>authors of policy assessment should not assess their own work</u>. This statement may sound fine but in practice but seems almost

totally workable. Who else but experts should produce an expert report? The third and fourth IPCC reports involved hundreds of scientists around the world, a review of thousands of papers, and received on the order of 10,000 comments in the early stages of drafts. The final summary for policymakers requires a vote – by government representatives of the signatory nations -- on every single sentence before it is accepted! I can attest from personal experience that the resultant high quality of the IPCC documents make them ideal choices for teaching graduate and professional courses because they are by definition our best statement on the present state of knowledge of the climate system. It is inconceivable to me that a report of this quality could be produced by a group of nonspecialists.

(e) Bullet five – <u>paleoclimate data does not provide insight into physical processes</u> The statement on physical processes is completely wrong. In fact, paleoclimate modeling results indicate that about half of the decadally scaled variance between 1270 and 1850 can be explained by natural variations in solar and (primarily) volcanic forcing. When these forcings are carried over into the 20th century, they cannot explain the 20th temperature rise. Only greenhouse gases can explain the rise, not only for the late 20th century, but also in part for the mid-20th century.

In this same bullet the Wegman Report recommends that federal research should emphasize fundamental understanding of the

mechanisms of climate change and should focus on interdisciplinary teams to avoid narrowly focused discipline research. I find this to be an extremely naïve statement. Climate studies are among the most interdisciplinary field that one can imagine – as just one example I submit a copy of a paper (attachment four) on causes of climate change over the last millennium that discusses changes in solar output, volcanism, trace gas variations in climate, tree rings, ice cores, climate models, impact of vegetation, etc etc. There are many other examples of interdisciplinary activities.

As a former program director at the National Science Foundation, I think I can also speak for many present program managers in federal agencies concerning the lack of interdisciplinary activities on different projects. This interdisciplinary is the core concept of terms such as "Global Change" and "Earth Systems Science" and as such the agencies have made a great effort at supporting interdisciplinary research. Furthermore, every major modeling group in IPCC addresses a host of interdisciplinary science.

But it would be a big mistake to forget the lone investigator. Sometimes the most fundamental findings in a field come from these lone investigators (who may nevertheless have much contact with many others). There must be room for individual creative science in climate science.

Summary and Concluding Remarks In my view the debate over the Mann et al paper is a tempest in a teapot. It is legitimate material for scientific discussion but the implications with respect to the operations of the IPCC are unproven and seemingly based, in my opinion, much more on repetition of innuendo than on any real facts. Although there is always a need for enhanced interaction with the statistics community, the lack of communication is seriously misrepresented in the Wegman Reprot. I believe that this report should not be used as either a legitimate assessment of the science or as a guide to policy modification. Finally, I believe it is time to stop using Michael Mann as a whipping post and to start directing attention to the more important matters of whether anything should be done about global warming, and if so, what?

Attachments:

1. Crowley, T.J., and Lowery, T.S., 2000. How warm was the Medieval Warm Period? *Ambio* (publication of the Royal Swedish Academy of Sciences), v. 29, no. 1, pp 51-54.
2. Hegerl, G.C., Crowley, T.J., Allen, M., Hyde, W.T., Pollack, H.N., Smerdon, J., and Zorita, E., 2006. Detection of human influence on a new, validated, 1500 year temperature reconstruction, *Journal of Climate* (accepted).
3. Hegerl, G.C., Crowley, T.J., Hyde, W.T., and Frame, D.J., 2006. Climate sensitivity constrained by temperature reconstructions of the past seven centuries. *Nature*, v. 440, 1029-1032.
4. Crowley, T.J., Causes of climate change over the last 1000 years. *Science*, v. 289, 270-277.


On the Need for Perspective
Regarding the Mann et al Reconstruction
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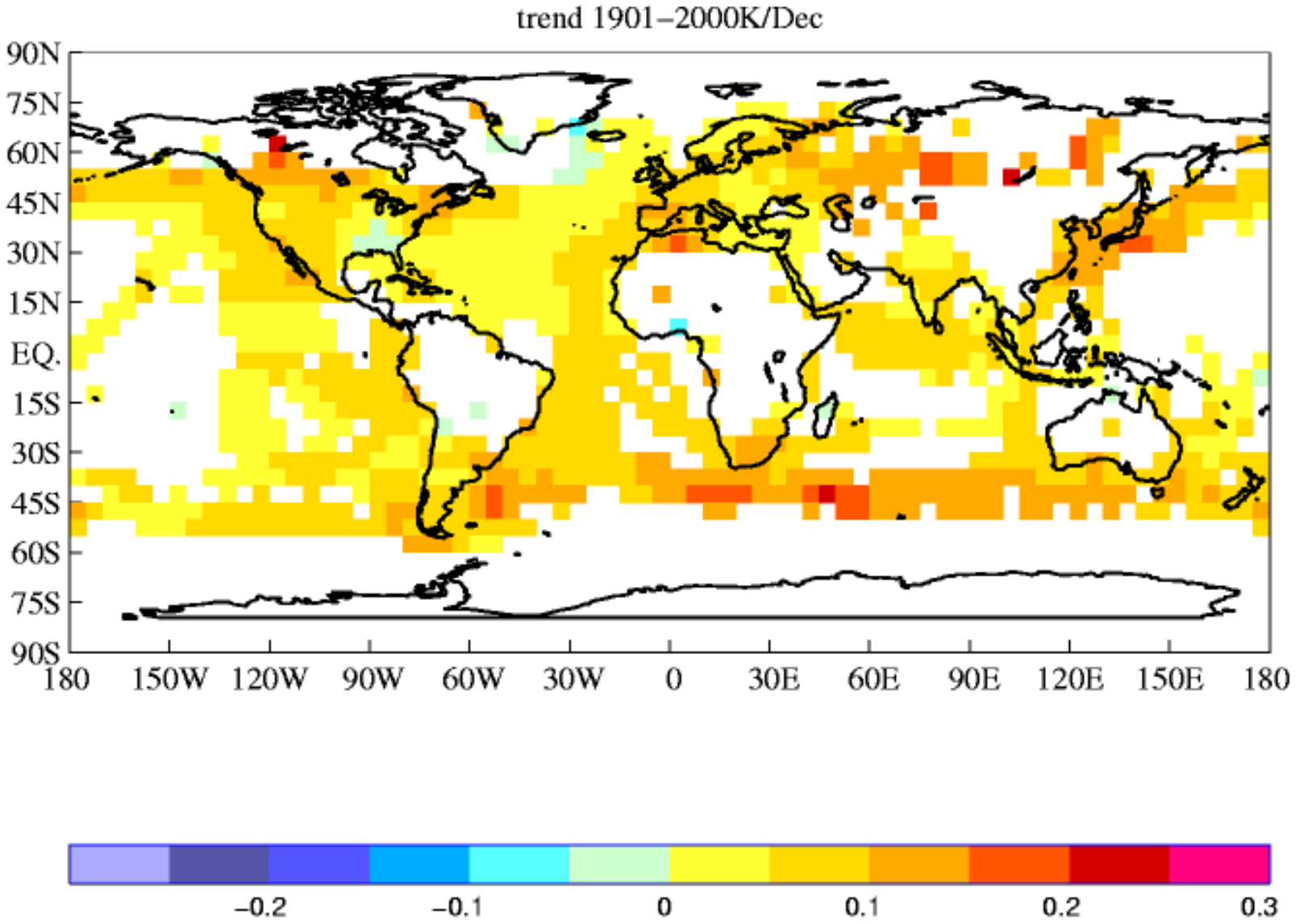
Photo: Glacier Meltback in the High Andes since the Little Ice Age
Photo Courtesy of John Garver and Donald Rodbell

(1) Mann et al and IPCC

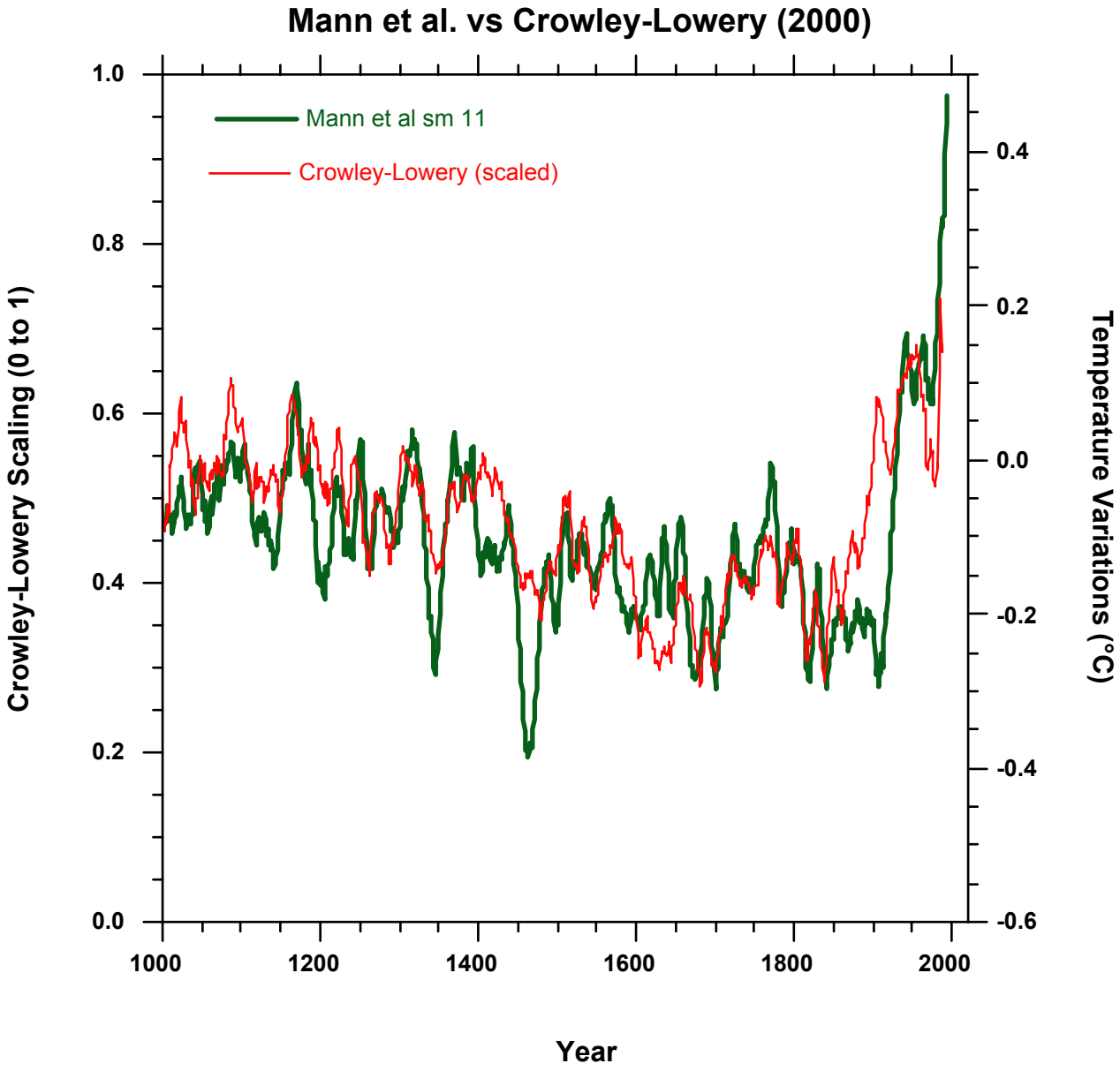
Magnitude of influence over-rated



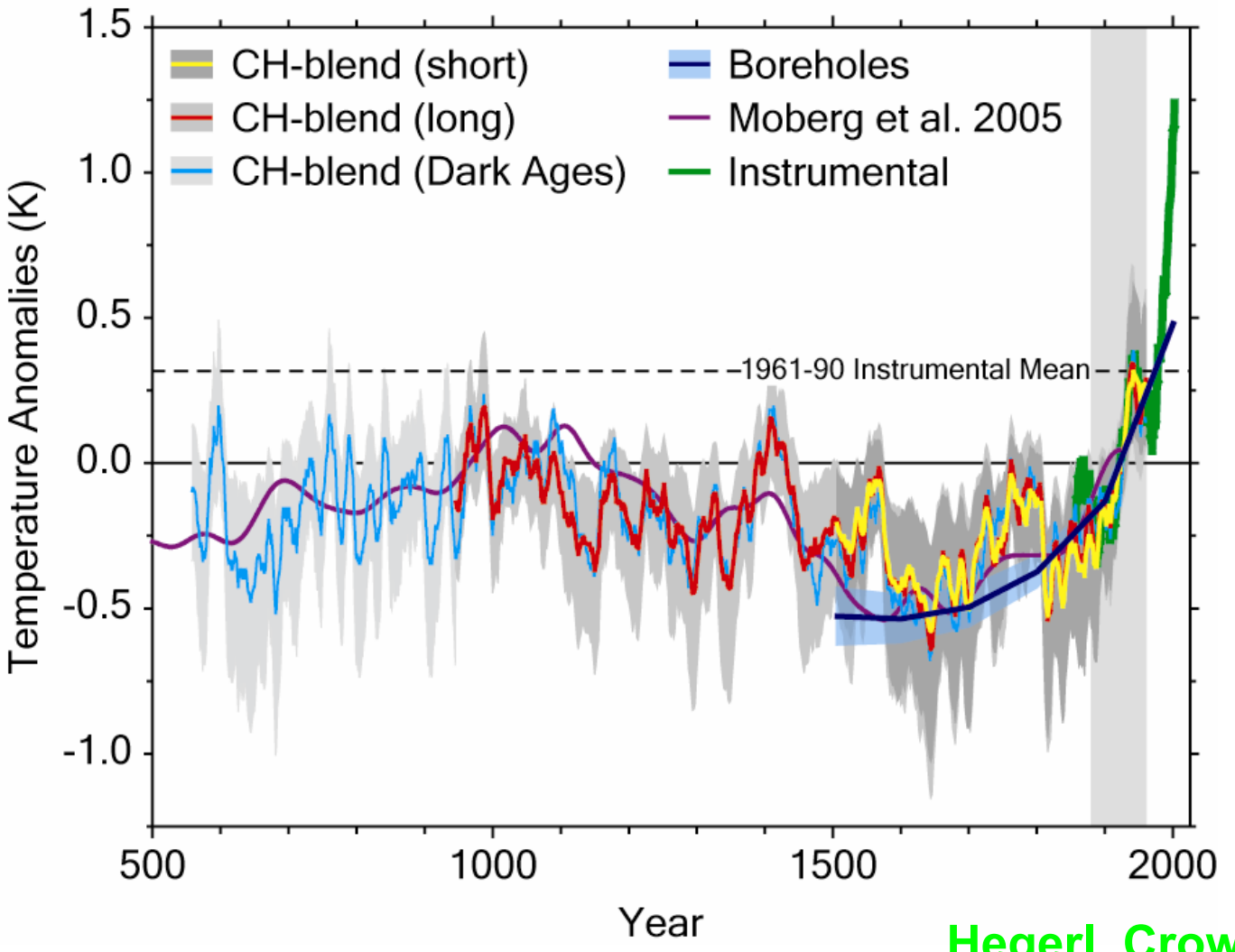
Courtesy G.H egerl

(2) Mann et al. in and of itself

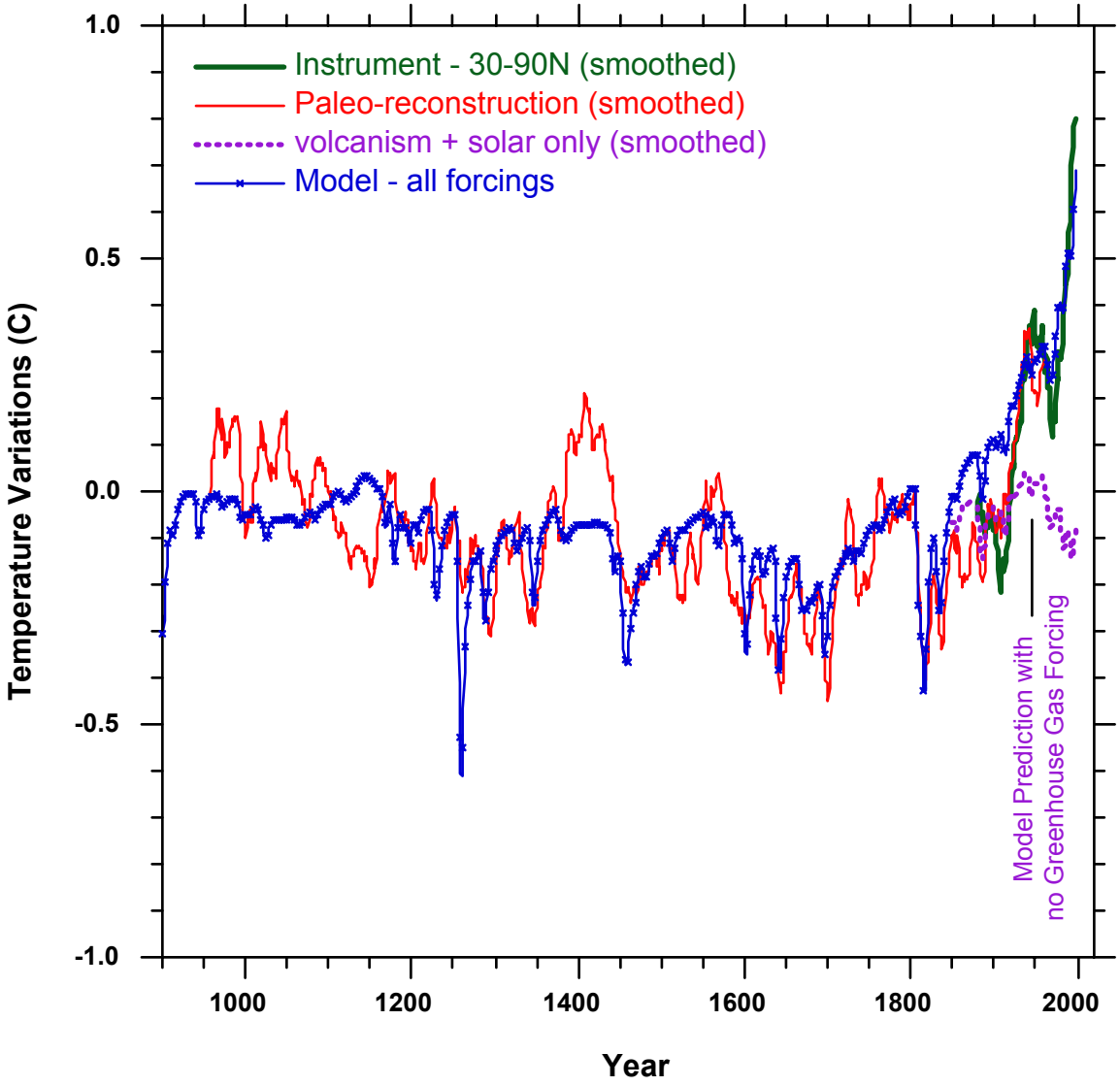
The best estimate we had at the time


Mann et al. vs Crowley-Lowery (2000)
Mann et al sm 11
Crowley-Lowery (scaled)
Crowley-Lowery Scaling (0 to 1)
Temperature Variations (°C)
Year
1.0
0.8
0.6
0.4
0.2
0.0
0.4
0.2
0.0
-0.2
-0.4
-0.6
1000
1200
1400
1600
1800
2000

N. Hemisphere land temperatures (30-90N)

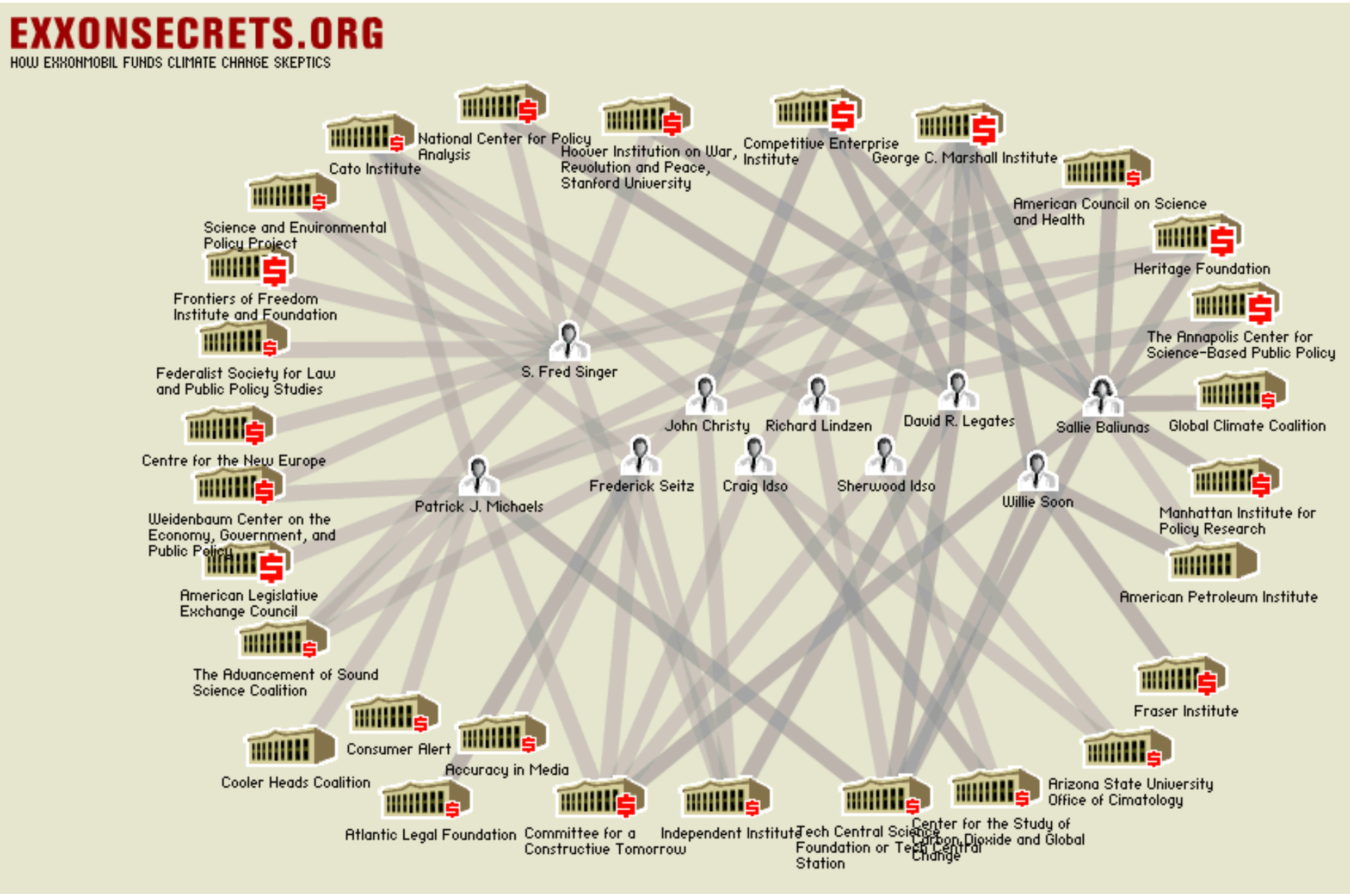


Hegerl, Crowley et al. submitted


Evidence for Overwhelming
Anthropogenic Greenhouse Gas
Influence on 20th Century Temperatures
Instrument - 30-90N (smoothed)
Paleo-reconstruction (smoothed)
volcanism + solar only (smoothed)
Model - all forcings
Model Prediction with
no Greenhouse Gas Forcing
Temperature Variations (C)
1.0
0.5
0.0
-0.5
-1.0
1000
1200
1400
1600
1800
2000
Year

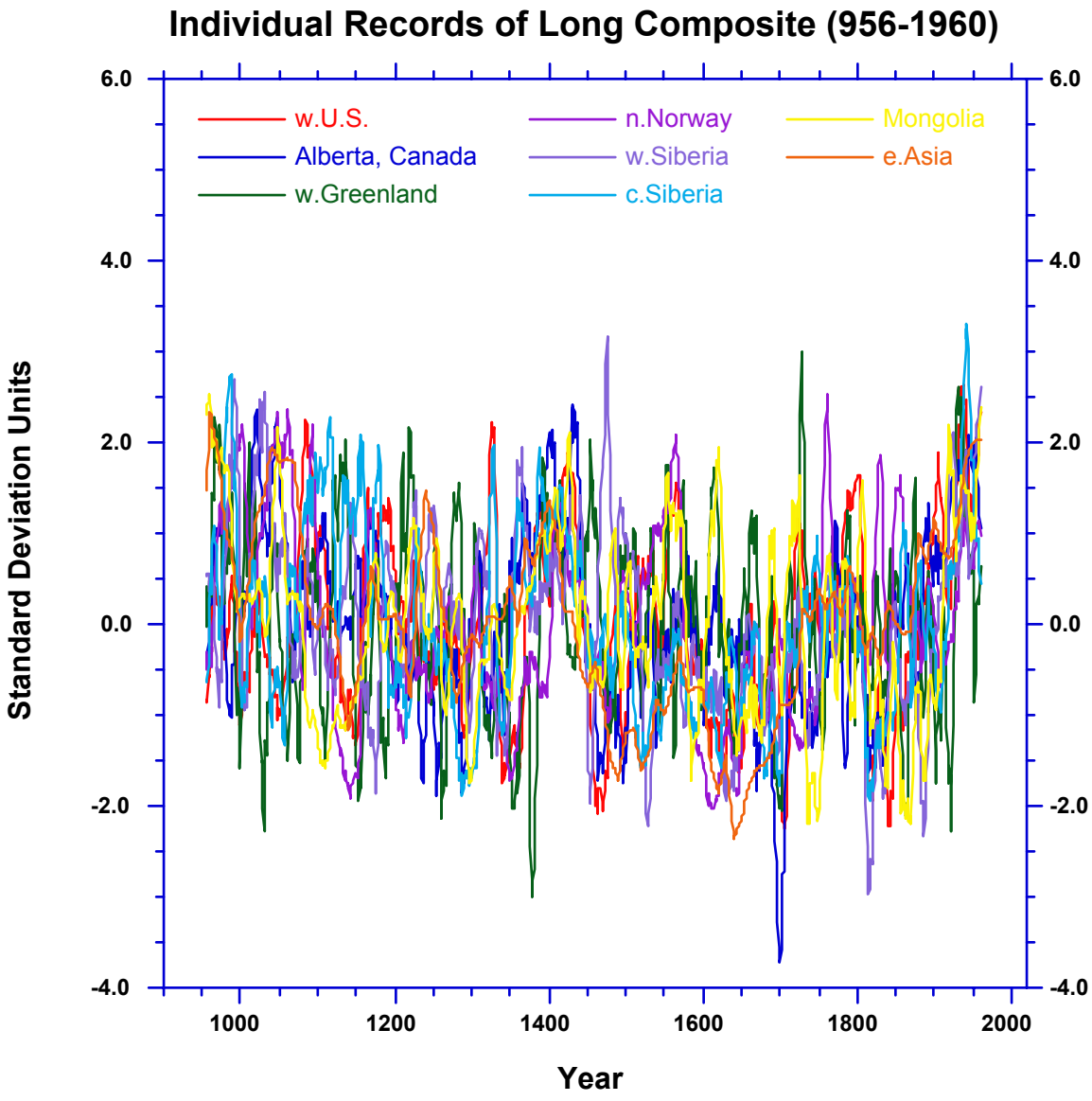
EXXONSECRETS.ORG

HOW EXXONMOBIL FUNDS CLIMATE CHANGE SKEPTICS



QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

East Antarctic Ice Sheet Cuts a Path Through the Transantarctic Mountains
(Photo: Michael J. Hambrey)


Individual Records of Long Composite (956-1960)
w.U.S.
Alberta, Canada
w.Greenland
n.Norway
w.Siberia
c.Siberia
Mongolia
e.Asia
Standard Deviation Units
Year
6.0
4.0
2.0
0.0
-2.0
-4.0
1000
1200
1400
1600
1800
2000