

## **REPORT OF JUDITH CURRY, PH. D.**

I submit this report under D.C. Superior Court Civil Rule 26(a)(2)(B) & (C) as both fact and expert witness to address the subject matter on which I expect to present evidence and to summarize the facts and opinions on which I expect to testify. This report includes my observations and opinions as a lay and expert witness concerning three principal topics: (I) the nature of the scientific and public controversy concerning the Hockey Stick graph; (II) whether the Hockey Stick graph can be regarded as 'fraudulent'; and (III) Michael Mann's role in the downward spiral of climate science discourse. I present sections (I) and (III) mostly in my capacity as a fact/lay opinion witness and section (II) in my capacity as an expert witness.

The facts and data that I considered in forming my opinions are available from public sources and cited in this report. I am being compensated at a rate of \$400 per hour for time that I spend on the case. During the previous four years, I have not testified as an expert at trial or by deposition.

### **SUMMARY**

This report addresses the issue of whether it is reasonable to refer to the Hockey Stick graph as 'fraudulent' in the course of the public debate on climate change.

#### **I. What is the nature of the scientific and public controversy concerning the Hockey Stick?**

It is my opinion that the Hockey Stick has generated a dynamic and heated debate about its significance and its flaws. Since its publication, Mann's Hockey Stick has been the subject of intense and often polemical comment and argument in: (a) peer-reviewed, scientific publications critical of the Hockey Stick; (b) analyses of the science behind the Hockey Stick on technical climate blogs; (c) published books on the Hockey Stick controversy; (d) articles by leading science journalists in the mainstream media; (e) online encyclopedia entries on the 'Hockey Stick Controversy'; (f) Congressional hearings and investigations related to the Hockey Stick; and (g) the personal controversy surrounding Michael Mann in his efforts to defend the Hockey Stick and to thwart his critics.

#### **II. Is it reasonable to regard the Hockey Stick as 'fraudulent'?**

It is my opinion that it is reasonable to have referred to the Hockey Stick in 2012 as 'fraudulent,' in the sense that aspects of it are deceptive and misleading:

- (i) Image falsification: Mann's efforts to conceal the so-called "divergence problem" by deleting downward-trending post-1960 data and also by splicing earlier proxy data with later instrumental data is consistent with most standards of image fraud.
- (ii) Cherry picking: Evidence shows that Mann engaged in selective data cherry picking to create the Hockey Stick, and that this cherry picking contributes to the

perception of a "fraudulent" Hockey Stick by journalists, the public and scientists from other fields.

- (iii) Data falsification (the 'upside-down' Tiljander proxy): Substantial evidence shows that Mann inverted data from the Tiljander proxies in a version of the Hockey Stick published in 2008. Mann did not acknowledge his mistaken interpretation of data. Even after published identification of the mistake, this mistake has propagated through subsequent literature including the IPCC 4th Assessment Report.

### **III. What is Mann's role in the downward spiral of climate science discourse?**

It is my opinion that the scientific discourse surrounding climate change in general, and the Hockey Stick in particular, has deteriorated in civility and professionalism, and that Mann has played a significant and active role in this corrosion and unprofessional degradation of tone. Mann's approach to public discourse about his work and broader topics in climate change has contributed much to the hostility and animosity that characterize and mark these exchanges. My opinion is based on: (a) the norms of science and scientific discourse; (b) Mann's withholding of data from his peers; (c) Mann's efforts to stifle skepticism; and (d) Mann's attacks on scientists who disagree with him.

### **QUALIFICATIONS**

I am Professor Emerita and former Chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology ("Georgia Tech"). I am currently President of Climate Forecast Applications Network (CFAN). I received a Ph.D. in atmospheric science from the University of Chicago in 1982. Prior to joining the faculty at Georgia Tech, I held faculty positions at the University of Colorado, Penn State University and Purdue University. My published research spans a variety of topics in climate, including climate dynamics of the Arctic, climate dynamics of extreme weather events, cloud microphysics and climate feedbacks, climate sensitivity and scenarios of future climate variability, and reasoning about climate uncertainty. I have been elected to the rank of Fellow of the American Meteorological Society, the American Association for the Advancement of Science, and the American Geophysical Union. I have previously served on the NASA Advisory Council Earth Science Subcommittee, the Department of Energy's Biological and Environmental Research Advisory Committee (BERAC), the National Academies Climate Research Committee and the Space Studies Board, and the National Oceanic and Atmospheric Administration (NOAA) Climate Working Group. I am a prominent public spokesperson on issues associated with the integrity of climate science, and am proprietor the weblog Climate Etc. at [judithcurry.com](http://judithcurry.com).

Additional information can be found at:

<http://curry.eas.gatech.edu/>

<http://www.cfanclimate.net/>

<http://judithcurry.com/about/>

My particular qualifications that are relevant to this report include:

- Extensive published research on the topics of climate dynamics and change
- My appointments to many national and international committees and boards that evaluate climate research
- My essays on challenges to the integrity of climate science and scientists have been published in *Physics Today* and the *New York Times*. I was invited to make a presentation on this topic by the United Nations InterAcademy Council
- My engagement with the public on the debate about climate change through my weblog Climate Etc. [judithcurry.com](http://judithcurry.com)
- My expertise and contributions on these topics is supported by my invitations to provide Congressional testimony twelve times since 2006.

My complete curriculum vitae is included in Appendix A.

## I. THE SCIENTIFIC AND PUBLIC CONTROVERSY SURROUNDING THE HOCKEY STICK

The Hockey Stick is a graph of global temperatures for the last 600 to 1000 years, reconstructed from tree rings and other so-called proxy data. Its name comes from its shape – a long flat ‘handle’ representing comparatively stable temperatures in earlier centuries, followed by a dramatic uptick – the ‘blade’. The Hockey Stick graph was originally published in two papers co-authored by Michael Mann, Raymond Bradley, and Malcolm Hughes (MBH98, MBH99)<sup>1</sup>. MBH98 included a 600-year reconstruction and MBH99 included a 1000-year reconstruction.

Although Mann had only recently received his Ph.D., he was named as a lead author for a chapter in the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR), published in 2001. The Hockey Stick graph appeared seven times in the IPCC TAR, and appeared as the backdrop in the IPCC press conference announcing the findings of the report. Rather than displaying all of the long-term temperature reconstructions considered by the IPCC TAR, the opening figure of the Working Group 1 Summary for Policymakers highlighted a graph of temperature reconstructions based only on the MBH99 paper.

Following the public release of the IPCC TAR, the Hockey Stick was regarded as central to the IPCC's case for global warming. The Hockey Stick was, for a time, arguably the most important graph in the world. Its message of unprecedented warmth at the end of the twentieth century was a vital part of the campaign to persuade the public that mankind had changed the world's climate.

Since publication of the Hockey Stick in Mann's paleoclimate reconstructions of temperatures (MBH98/99) and its prominence in the IPCC Third Assessment Report (TAR; 2001)<sup>2</sup>, there has been substantial scientific controversy over the methods that Mann and his

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<sup>1</sup> <https://www.nature.com/articles/33859>

<https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/1999g1900070>

<sup>2</sup> <https://www.ipcc.ch/reports/>

co-authors used in this research. The controversy extends to the results of their analysis, which contradicted existing geological and historical knowledge of the Medieval Warm Period and the Little Ice Age.

Of particular note are two papers published by McIntyre and McKittrick in 2005 that challenged the MBH98/99 analyses (section IIA). These papers motivated two Congressional investigations and hearings in 2006 (section IIE).

In November 2009, the unauthorized release of emails from the Climatic Research Unit at the University of East Anglia (UK) ("Climategate") revealed that several scientists (including Mann) had evaded Freedom of Information Act requests for data, manipulated the peer review process, downplayed uncertainty about their research and attempted to squash disagreement and dissent from 'skeptics.' The publicity surrounding Climategate (Sections IIB, IIC) brought the Hockey Stick controversy back into the public debate on climate change, largely vindicating a range of concerns that had been raised by McIntyre and McKittrick.

The analysis presented in this section documents the controversy surrounding the Hockey Stick, without passing judgment on the merits (or not) of the original research or the criticisms.

As an active participant in the debate over climate change and the Hockey Stick, I recall the development of this debate.

I summarize this controversy by considering the following sources:

- Scientific journal publications critical of the Hockey Stick
- Critical analyses in technical climate blogs
- Published books on the Hockey Stick controversy
- Articles by leading science journalists in the mainstream media
- Online encyclopedia entries on the 'Hockey Stick Controversy'
- Congressional Hearings and investigations related to the Hockey Stick
- Controversy surrounding Michael Mann

### ***A. Scientific publications***

Papers published in peer-reviewed scientific journals are the basis for criticisms of the methodology and outcome results of the MHBH98/99 papers. Papers featured prominently in the public debate surrounding the Hockey Stick include:

Soon and Baliunas (2003), *Proxy climatic and environmental changes of the past 1000 years*<sup>3</sup>

Soon and Baliunas prepared a literature review which used data from previous papers to argue that the Medieval Warm Period had been warmer than the 20th century, and that recent warming was not unusual, and argued for a greater role for solar variations. The

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<sup>3</sup> <https://www.int-res.com/articles/cr2003/23/c023p089.pdf>

authors concluded: "Our results suggest a different interpretation of the multiproxy climates compared to recent conclusions of Mann et al. (1998, 1999, 2000)."

von Storch, Zorita, et al. (2004), *Reconstructing Past Climate from Noisy Data* <sup>4</sup>

"The statistical methods used in the MBH reconstruction were questioned in a 2004 paper by Hans von Storch with a team including Eduardo Zorita, which said that the methodology used to average the data and the wide uncertainties might have hidden abrupt climate changes, possibly as large as the 20th century spike in measured temperatures."

McIntyre and McKittrick (2003), *Corrections to the Mann et al. (1998) Proxy Data Base and Northern Hemispheric Average Temperature Series* <sup>5</sup>

"The data set of proxies of past climate used in Mann, Bradley and Hughes (1998, 'MBH98' hereafter) for the estimation of temperatures from 1400 to 1980 contains collation errors, unjustifiable truncation or extrapolation of source data, obsolete data, geographical location errors, incorrect calculation of principal components and other quality control defects."

McIntyre, S and R. McKittrick (2005), *Hockey sticks, principal components, and spurious significance* <sup>6</sup>

"Their method, when tested on persistent red noise, nearly always produces a hockey stick shaped first principal component (PC1) and overstates the first eigenvalue. In the controversial 15th century period, the MBH98 method effectively selects only one species (bristlecone pine) into the critical North American PC1, making it implausible to describe it as the 'dominant pattern of variance'."

McKittrick, R. and S. McIntyre (2005), *The M&M Critique of the MBH98 Northern Hemisphere Climate Index: Update and Implications* <sup>7</sup>

"The recent Corrigendum by Mann et al. denied that these differences between the stated methods and actual methods have any effect, a claim we show is false. We also refute the various arguments by Mann et al. purporting to salvage their reconstruction, including their claims of robustness and statistical skill."

Bürger and Cubasch, (2005), *Are multiproxy climate reconstructions robust?* <sup>8</sup>

"The described error growth is particularly critical for parameter-intensive, multi-proxy climate field reconstructions of the MBH98 type."

Von Storch and Zorita (2007), *Climate Feedback: The decay of the hockey stick* <sup>9</sup>

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<sup>4</sup> <https://science.sciencemag.org/content/306/5696/679>

<sup>5</sup> <https://journals.sagepub.com/doi/abs/10.1260/095830503322793632>

<sup>6</sup> <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2004GL021750>

<sup>7</sup> <https://journals.sagepub.com/doi/abs/10.1260/0958305053516226>

<sup>8</sup> <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2005GL024155>

"Bürger's papers in 2005; Moberg's paper in *Nature* in 2005; various papers on borehole temperature; The *National Academy of Science Report* from 2006 – all of which have helped to clarify that the hockey-stick methodologies lead indeed to questionable historical reconstructions."

Holland (2007), *Bias and concealment in the IPCC process: The hockey-stick' affair and its implications* <sup>10</sup>

"The climatic 'hockey stick' hypothesis has systemic problems."

While some of the authors of the aforementioned articles have been labeled by Mann and others as climate 'skeptics' or 'contrarians,' Mann's more recent (2012) article in *Nature* <sup>11</sup> triggered a letter to the editor of *Nature* sharply criticizing the paper.<sup>12</sup> The authors of the letter included many of the world's leading paleoclimatologists and tree ring experts, including many of Mann's previous collaborators:

Kevin J Anchukaitis, Petra Breitenmoser, Keith R Briffa, Agata Buchwal, Ulf Büntgen, Edward R Cook, Rosanne D D'Arrigo, Jan Esper, Michael N Evans, David Frank, Håkan Grudd, Björn E Gunnarson, Malcolm K Hughes, Alexander V Kirilyanov, Christian Körner, Paul J Krusic, Brian Luckman, Thomas M Melvin, Matthew W Salzer, Alexander V Shashkin, Claudia Timmermann, Eugene A Vaganov and Rob J S Wilson

Excerpts from the letter:

"Several aspects of their tree-ring growth simulations are erroneous. First, they use an algorithm that has not been tested for its ability to reflect actual observations, even though established growth models, such as the Vaganov–Shashkin model are available. They rely on a minimum growth temperature threshold of 10°C that is incompatible with real-world observations. Mann and colleagues arbitrarily and without justification require 26 days with temperatures above their unrealistic threshold for ring formation. Their resulting growing season becomes unusually short, at 50–60 days rather than the more commonly observed 70–137 days. Furthermore, they . . . ignore any day length and moisture constraints on growth . . ."<sup>121</sup>

### ***B. The blogosphere and the Hockey Stick controversy***

The 'climate auditor' movement was started by Steve McIntyre, a semi-retired Canadian mining and minerals executive. In 2002, McIntyre became suspicious of the paleoclimate Hockey Stick that was featured prominently in the IPCC TAR. McIntyre stated: "In financial circles, we talk about a hockey stick curve when some investor presents you with a nice, steep curve in the hope of palming something off on you." From 2003 to 2005, McIntyre and

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<sup>9</sup> [http://blogs.nature.com/climatefeedback/2007/05/the\\_decay\\_of\\_the\\_hockey\\_stick.html](http://blogs.nature.com/climatefeedback/2007/05/the_decay_of_the_hockey_stick.html)

<sup>10</sup> <https://journals.sagepub.com/doi/abs/10.1260/095830507782616788>

<sup>11</sup> <https://www.nature.com/articles/ngeo1394>

<sup>12</sup> <https://www.st-andrews.ac.uk/~rjsw/all%20pdfs/Anchukaitisetal2012.pdf>

environmental economist Ross McKittrick published three high-profile papers that were critical of the MBH98/99 papers (described in Section A above).

McIntyre started the blog *Climate Audit* [climateaudit.org](http://climateaudit.org) in 2005 so that he could defend himself against claims being made at the blog *RealClimate* [realclimate.org](http://realclimate.org) by Mann and others with regards to his critique of the Hockey Stick. McIntyre's auditing became very popular not only with climate skeptics, but also with the progressive open source community. Internet voting by the public awarded Climate Audit the 2007 Weblog "Best Science Blog" award.<sup>13</sup>

Climate Audit stimulated a number of skeptical (technical) climate blogs that were particularly active during the period 2006-2012. A partial list of those that made significant contributions to analyses related to the Hockey Stick include: The Air Vent,<sup>14</sup> The Blackboard,<sup>15</sup> The Reference Frame,<sup>16</sup> RomanM,<sup>17</sup> BishopHill.<sup>18</sup>

So who are the climate auditors? They are technically educated people, mostly outside of academia. Several individuals have developed substantial expertise in aspects of climate science, although they mainly audit rather than produce original scientific research. They tend to be watchdogs that are demanding greater accountability and transparency of climate research and assessment reports. They have found a collective voice in the blogosphere and their posts are often picked up by the mainstream media and also by politicians.

With their focus on data quality and statistical analysis methods, it is very difficult to categorize the climate auditors as 'anti-science.' A 2013 article published in The Guardian<sup>19</sup> asked the question: "Are climate sceptics the true champions of the scientific method?" The climate audit movement initiated a new era of extended and unforgiving online post-publication review of scientific publications on climate change.

The blog Climate Audit has a high profile not only in the public climate debate, but this blog is also read by both U.S. elected government officials (and their staffers) and civil servants. While I was Chair of Earth and Atmospheric Sciences at Georgia Tech, I was contacted several times by phone call from a paleoclimate Program Manager at the National Science Foundation to discuss blog posts at Climate Audit and concerns about the paleoclimate community.

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<sup>13</sup> <http://2007.weblogawards.org/polls/best-science-blog-1.php>

<sup>14</sup> <https://noconsensus.wordpress.com>

<sup>15</sup> <http://rankexploits.com/musings/>

<sup>16</sup> <https://motls.blogspot.com/search/label/climate>

<sup>17</sup> <https://statpad.wordpress.com>

<sup>18</sup> <http://bishophill.squarespace.com>

<sup>19</sup> <https://www.theguardian.com/science/political-science/2013/jul/30/climate-sceptics-scientific-method>

### ***C. Published books on the Hockey Stick controversy***

Following the Climategate affair, a number of books were published on the Hockey Stick controversy.

Michael Mann discusses the controversy surrounding the Hockey Stick in a book he published in 2012:

- *The Hockey Stick and Climate Wars – Dispatches from the Front Line* – by Michael Mann.<sup>20</sup> Amazon's description of the book explains that "The Hockey Stick became a central icon in the 'climate wars' " <sup>13</sup>

A balanced analysis of the debate is provided by UK journalist Fred Pearce, following Climategate:

- *The Climate Files: The Battle for the Truth About Global Warming* – by Fred Pearce.<sup>21</sup> One review explains: "Debates revolve around which data is used to build up that picture, tree rings data being a bone of particular contention. Sceptics and critics point to Mike Mann's famous 'hockey stick' graph and argue that he cherry picked the data in order to show flat temperatures followed by the more recent spike, an accusation which Mann himself has argued against for years. Pearce explains patiently and clearly what all this means, and the different sides of the debates."<sup>22</sup>

Drawing heavily from the Climategate emails and technical analyses from climate blogs such as Climate Audit and Bishop Hill, several other books delved deeply into criticisms of the Hockey Stick, including the Climategate emails:

- *The Hockey Stick Illusion* –by Andrew Montford.<sup>23</sup> A review from the Property and Environment Research Center states that Montford's book "exposes in delicious detail, datum by datum, how a great scientific mistake of immense political weight was perpetrated, defended and camouflaged by a scientific establishment that should now be red with shame." <sup>24</sup>
- *Hiding the Decline* – by Andrew Montford.<sup>25</sup> From Amazon's description of the book: "*Hiding the Decline* is the definitive history of the Climategate affair, tracing the story back to its roots in the struggle over the notorious Hockey Stick graph, reviewing the explosive revelation of the emails themselves and then examining in forensic detail the cover-ups that followed."<sup>18</sup>
- *Climategate: The Crutape Letters* – by Steven Mosher and Thomas Fuller.<sup>26</sup> From Amazon's description: "The Climategate scandal covered from beginning to end--from

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<sup>20</sup> <https://www.amazon.com/Hockey-Stick-Climate-Wars/>

<sup>21</sup> <https://www.amazon.com/Climate-Files-battle-global-warming-ebook/>

<sup>22</sup> <https://www.transitionculture.org/2010/07/29/book-review-the-climate-files-by-fred-pearce/>

<sup>23</sup> <https://www.amazon.com/Hockey-Stick-Illusion-Andrew-Montford-ebook/>

<sup>24</sup> <https://www.perc.org/2010/06/09/the-case-against-the-hockey-stick/>

<sup>25</sup> <https://www.amazon.com/Hiding-Decline-W-Montford/>

<sup>26</sup> <https://www.amazon.com/Climategate-Crutape-Letters-Steven-Mosher/>

'Hide the Decline' to the current day. Written by two authors who were on the scene—Steven Mosher and Tom Fuller—Climategate takes you behind that scene and shows what happened and why."<sup>19</sup>

#### ***D. Mainstream media articles on the Hockey Stick controversy***

The Hockey Stick controversy has been featured prominently in the mainstream media. The scientific and public debate surrounding the Hockey Stick became particularly heated in 2005, following publication of two peer-reviewed papers by Stephen McIntyre and Ross McKittrick that challenged the Hockey Stick analysis (section IIA). Some example articles in the mainstream media are described below. Their content, describing the heated debate surrounding the Hockey Stick, is reflected by their titles:

- *In Climate Debate, the 'Hockey Stick' Leads to a Face-off*, Wall Street Journal (2/14/05)<sup>27</sup>
- *Row over climate 'hockey stick'*, BBC News (03/16/05)<sup>28</sup>
- *Tree Ring Circus*, Fox News (7/31/05)<sup>29</sup>
- *Hockey Stick Hokum*, Wall Street Journal (7/14/06)<sup>30</sup>
- *Climate Science on Trial: How a single scientific graph became the focus of the debate over global warming* Chronicle of Higher Education (9/8/06)<sup>31</sup>
- *Breaking the hockey stick*, Canadian National Post (1/27/04)<sup>32</sup>

Following the unauthorized release of the Climategate emails, UK science journalist Fred Pearce published a series of articles in *The Guardian* (February 2010) that described the internal debates among climate scientists surrounding the Hockey Stick graph:

- *Controversy behind the 'hockey stick' graph*. Subtitle: *Pioneering graph used by IPCC to illustrate a compelling story of man-made climate change raises questions about transparency*.<sup>33</sup>
- *Hockey stick graph took pride of place in IPCC report, despite doubts*. Subtitle: *Emails expose tension between desire for scrupulous honesty, and desire to tell simple story to tell the policymakers*.<sup>34</sup>
- *Climate change debate overheated after sceptics grasped hockey stick*.<sup>35</sup>

The enduring controversy surrounding the 'Hockey Stick' is best described by the title of a 2013 article published in *The Atlantic*, written by science journalist Chris Mooney:

- *Hockey Stick: The Most Controversial Graph in Science* <sup>36</sup>

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<sup>27</sup> <https://www.wsj.com/articles/SB110834031507653590>

<sup>28</sup> <http://news.bbc.co.uk/2/hi/science/nature/4349133.stm>

<sup>29</sup> <https://web.archive.org/web/20110208112922/http://www.foxnews.com/story/0,2933,163999,00.html>

<sup>30</sup> <https://www.wsj.com/articles/SB115283824428306460>

<sup>31</sup> <https://www.chronicle.com/article/Climate-Science-on-Trial/34665>

<sup>32</sup> <https://web.archive.org/web/20110820234754/http://www.canada.com/national/nationalpost/financialpost/story.html?id=ba5c8f1e-60a1-42f3-8e72-e95e19a8163e>

<sup>33</sup> <https://www.theguardian.com/environment/2010/feb/02/hockey-stick-graph-climate-change>

<sup>34</sup> <https://www.theguardian.com/environment/2010/feb/09/hockey-stick-graph-ipcc-report>

<sup>35</sup> <https://www.theguardian.com/environment/2010/feb/09/hockey-stick-michael-mann-steve-mcintyre>

### ***E. Online encyclopedia articles on the 'Hockey Stick controversy'***

The Hockey Stick controversy is sufficiently well known with a sufficiently high profile that the two leading online encyclopedias have articles about the Hockey Stick controversy:

- The Wikipedia has an extensive article *Hockey Stick Controversy*<sup>37</sup> with 214 references.
- Encyclopedia.com has an entry *Hockey Stick Controversy*<sup>38</sup> that includes 9 references.

### ***F. Congressional Hearings and investigations related to the Hockey Stick***

Because of the magnitude and significance of the controversy, the Hockey Stick has been the subject of several Congressional Hearings and formal investigations instigated by Congressional Committees.

Following publication of the two papers by McIntyre and McKittrick in 2005 that were critical of the MBH98/99 papers, two Congressional investigations were initiated. These investigations led to the publication of two reports in July 2006:

- The National Research Council Report ("NRC Report"): North, Gerald R.; Biondi, Franco; Bloomfield, Peter; Christy, John R.; Cuffey, Kurt M.; Dickinson, Robert E.; Druffel, Ellen R. M.; Nychka, Douglas; Otto-Bliesner, B.; Roberts, N.; Turekian, K.; Wallace, J. (22 June 2006), *Surface temperature reconstructions for the last 2,000 years*, Washington, D.C.: National Academies Press, ISBN 0-309-10225-1.
- The "Wegman Report": Wegman, Edward J.; Said, Yasmin H.; Scott, David W. (2006), Ad Hoc Committee Report On The 'Hockey Stick' Global Climate Reconstruction Congressional Report, United States House Committee on Energy and Commerce (published 14 July 2006).<sup>39</sup>

The Wegman Report was the product of an independent investigation of the Hockey Stick initiated by Representative Joe Barton of the U.S. House Energy Subcommittee on Oversight and Investigations. Representative Boehlert regarded such an investigation to be the purview of the House Science Committee. Barton dismissed the offer of a joint investigation with an independent panel appointed by the U.S. National Academy of Sciences (NAS). In September 2005, Congressman Barton's staff contacted statistician Edward Wegman about possible Congressional testimony related to the Hockey Stick. Wegman formed a team to review materials provided by Barton's staff.

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<sup>36</sup> <https://www.theatlantic.com/technology/archive/2013/05/the-hockey-stick-the-most-controversial-chart-in-science-explained/275753/>

<sup>37</sup> [https://en.wikipedia.org/wiki/Hockey\\_stick\\_controversy](https://en.wikipedia.org/wiki/Hockey_stick_controversy)

<sup>38</sup> <https://www.encyclopedia.com/environment/energy-government-and-defense-magazines/hockey-stick-controversy>

<sup>39</sup> [https://web.archive.org/web/20060716210311/http://energycommerce.house.gov/108/home/07142006\\_Wegman\\_Report.pdf](https://web.archive.org/web/20060716210311/http://energycommerce.house.gov/108/home/07142006_Wegman_Report.pdf)

The NRC Report was the product of a November 2005 request from the House Science Committee to the National Academies of Science ("NAS") to commission a Report to evaluate the controversy surrounding the Hockey Stick. A special 'Committee on Surface Temperature Reconstructions for the Past 2,000 Years' was assembled by the National Research Council (NRC) to prepare a report. The NRC Committee, chaired by Gerald North, consisted of 12 scientists and statisticians from different disciplines. Its task was "to summarize current scientific information on the temperature record for the past two millennia, describe the main areas of uncertainty and how significant they are, describe the principal methodologies used and any problems with these approaches, and explain how central is the debate over the paleoclimate temperature record to the state of scientific knowledge on global climate change."

Both the Wegman Report and NRC Report were published in July 2006. Shortly after the publication of these two documents, the Subcommittee on Oversight and Investigations of the House Committee on Energy and Commerce held two Hearings on *Questions surrounding the 'Hockey Stick' temperature studies; implications for climate change assessments*.<sup>40</sup> Witnesses included: Edward Wegman, Gerald North, Hans von Storch, Stephen McIntyre, Michael Mann, and John Christy.

The Press Release from the House Committee on Energy and Commerce<sup>41</sup> emphasized the Wegman Report, with the title *Report Raises New Questions About Climate Change Assessments*.

The Statement by Science Committee Chairman Sherwood Boehlert emphasized the NRC Report, stating:

"The report clearly lays out a scientific consensus position on the historic temperature record. One element of that consensus is that the past few decades have been the hottest in at least 400 years. The report does show, unsurprisingly, that scientists need to continue to work to develop a more precise sense of what global temperatures were between the beginning of the last millennium and about 1600. Congress ought to let them go about that work without political interference."<sup>42</sup>

Examples of the range of news coverage of the investigations and the Hearings are provided below. That the investigations and Hearings failed to settle the Hockey Stick debate is clearly indicated by the titles:

- *Science Panel Backs Study on Warming Climate*, New York Times (22 June 2006).<sup>43</sup>
- *Panel Study Fails to Settle Debate on Past Climates*, Wall Street Journal (23 June 2006).<sup>44</sup>

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<sup>40</sup> <https://www.govinfo.gov/content/pkg/CHRG-109hhr31362/html/CHRG-109hhr31362.htm>

<sup>41</sup> [https://web.archive.org/web/20060719023232/http://energycommerce.house.gov/108/home/07142006\\_Wegman\\_fact\\_sheet.pdf](https://web.archive.org/web/20060719023232/http://energycommerce.house.gov/108/home/07142006_Wegman_fact_sheet.pdf)

<sup>42</sup> <https://web.archive.org/web/20060629112529/http://www.house.gov/science/hot/climate%20dispute/6%2022%2006%20SB%20quote%20re%20NAS%20hockey%20stick%20report.pdf>

<sup>43</sup> <https://www.nytimes.com/2006/06/22/science/22cnd-climate.html>

<sup>44</sup> <https://www.wsj.com/articles/SB115098487133887497>

### ***G. The controversy surrounding Michael Mann***

The Hockey Stick controversy is not limited to the scientific research. Many aspects of Mann's behavior in defending the Hockey Stick are also controversial. Described here are criticisms of Mann's behavior from Mann's colleagues and collaborators, specifically as related to his defense of the Hockey Stick. These statements were found in the Climategate and other emails, blog posts and interviews with journalists.

***Wallace Broecker***, geochemist, Newberry Professor in the Department of Earth and Environmental Sciences at Columbia University (deceased 2019):

In a 2010 interview with *The Guardian*: "The goddam guy is a slick talker and super-confident. He won't listen to anyone else," one of climate science's most senior figures, Wally Broecker of the Lamont-Doherty Earth Observatory at Columbia University in New York, told me. "I don't trust people like that. A lot of the data sets he uses are shitty, you know. They are just not up to what he is trying to do.... If anyone deserves to get hit it is goddam Mann."<sup>45</sup>

***Raymond Bradley***, University Distinguished Professor Geosciences and Director of the Climate System Research Center, University of Massachusetts. Bradley is the 'B' in MBH:

"I would like to disassociate myself from Mike Mann's view. As for thinking that it is "Better that nothing appear, than something unacceptable to us ... as though we are the gatekeepers of all that is acceptable in the world of paleoclimatology seems amazingly arrogant. Science moves forward whether we agree with individual articles or not."<sup>46</sup>

***Phil Jones***, former Director of the Climate Research Unit at U. of East Anglia:

"Keith [Briffa] didn't mention in his *Science* piece but both of us think that you're on very dodgy ground with this long-term decline in temperatures on the thousand-year timescale. It is better we put the caveats in ourselves than let others put them in for us."<sup>47</sup>

***Keith Briffa***, paleoclimatologist, former Deputy Director of the Climate Research Unit at the University of East Anglia (deceased 2017):

"I have just read this letter – and I think it is crap. I am sick to death of Mann stating his reconstruction represents the tropical area just because it contains a few tropical series. He is just as capable of regressing these data against any other target series, such as the increasing trend of self-opinionated verbiage he has produced over the last few years"<sup>48</sup>

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<sup>45</sup> <https://www.theguardian.com/environment/2010/feb/09/hockey-stick-michael-mann-steve-mcintyre>

<sup>46</sup> [http://www.climateaudit.info/pdf/mcintyre-heartland\\_2010.pdf](http://www.climateaudit.info/pdf/mcintyre-heartland_2010.pdf)

<sup>47</sup> <https://junkscience.com/2011/11/climategate-2-0-jones-briffa-say-mann-hockey-stick-on-dodgy-ground/>

<sup>48</sup> <http://www.di2.nu/foia/1024334440.txt>

**Edward Cook**, Director of Tree Ring Lab, Lamont-Doherty Earth Observatory:

"I will be sure not to bring this up to Mike. As you know, he thinks that CRU is out to get him in some sense. I am afraid that Mike is defending something that increasingly cannot be defended. He is investing too much personal stuff in this and not letting the science move ahead." <sup>49</sup>

**Eduardo Zorita**, paleoclimatologist, Senior Scientist at the Institute for Coastal Research, GKSS Research Centre in Geesthacht, Germany:

"Why I Think That Michael Mann, Phil Jones and Stefan Rahmstorf Should be Barred from the IPCC Process. Short answer: because the scientific assessments in which they may take part are not credible anymore. These words do not mean that I think anthropogenic climate change is a hoax. On the contrary, it is a question which we have to be very well aware of. But I am also aware that editors, reviewers and authors of alternative studies, analysis, interpretations, even based on the same data we have at our disposal, have been bullied and subtly blackmailed." <sup>50</sup>

**Hans von Storch**, climate scientist and Director of the Institute for Coastal Research in Geesthacht, Germany:

"A conclusion could be that the principle, according to which data must be made public, so that also adversaries may check the analysis, must be really enforced. Another conclusion could be that scientists like Mike Mann, Phil Jones and others should no longer participate in the peer-review process or in assessment activities like IPCC." <sup>51</sup>

**David Rind**, climate scientist, NASA Goddard Institute for Space Studies:

"Concerning the hockey stick: what Mike Mann continually fails to understand, and no amount of references will solve, is that there is practically no reliable tropical data for most of the time period, and without knowing the tropical sensitivity, we have no way of knowing how cold (or warm) the globe actually got. I've made the comment to Mike several times, but it doesn't seem to get across." <sup>52</sup>

**Tom Wigley**, climate scientist, University of Adelaide, former director of the Climatic Research Unit at the University of East Anglia

"I have just read the M&M stuff criticizing MBH. A lot of it seems valid to me. At the very least MBH is a very sloppy piece of work – an opinion I have held for some time. Can you give me a brief heads up? Mike is too deep into this to be helpful." <sup>53</sup>

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<sup>49</sup> <http://di2.nu/foia/foia2011/mail/4369.txt>

<sup>50</sup> <https://www.climatedepot.com/2009/11/27/un-scientists-turn-on-each-other-un-scientist-declares-climategate-colleagues-mann-jones-and-rahmstorf-should-be-barred-from-the-ipcc-process-they-are-not-credible-any-more/>

<sup>51</sup> <http://www.spiegel.de/spiegel/print/d-32362275.html> <sup>[1]</sup>

<sup>52</sup> <http://di2.nu/foia/foia2011/mail/4133.txt>

<sup>53</sup> <http://assassinationscience.com/climategate/1/FOIA/mail/1098472400.txt>

**Robert Way**, physical geographer, Assistant Professor in Department of Geography and Planning, Queens University:

"I don't mean to be the pessimist of the group here but Mc2 brought up some very good points about the original hockey stick. I've personally seen work that is unpublished that challenges every single one of his reconstructions because they all either understate or overstate low-frequency variations. Mann et al stood by after their original HS and let others treat it with the confidence that they themselves couldn't assign to it. The original hockey stick still used the wrong methods and these methods were defended over and over despite being wrong. He fought like a dog to discredit and argue with those on the other side that his method was not flawed. And in the end he never admitted that the entire method was a mistake. They then let this HS be used in every way possible despite knowing the stats behind it weren't rock solid."<sup>54</sup>

## ***H. Conclusion***

The controversy surrounding the Hockey Stick is not merely an arcane academic debate about the quality of data and statistical analysis methods. For the past 20 years there has been a very public debate about the Hockey Stick, owing to its prominence in the IPCC Third Assessment Report and the movie *An Inconvenient Truth*. This debate entered high gear following the 2009 release of the Climategate emails.

Much of the analysis into the research behind the Hockey Stick has come from outside the small community of paleoclimatologists – from academics in other fields and from experts in data and statistical analysis that are active in the technical blogosphere. This external probity has identified problems that were missed by co-authors, the peer review process, and more generally by most of the community of academic paleoclimatologists.

The Hockey Stick controversy has been covered extensively in the mainstream media as well as the blogosphere. The public significance of the controversy is further reflected by Congressional Hearings on the topic and lengthy entries in online encyclopedias. The public controversy has been amplified by the behavior of lead author Michael Mann, in defending what even his colleagues find to be indefensible.

The scientific and public controversy surrounding the Hockey Stick provides ample rationale for public statements that criticize the Hockey Stick.

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<sup>54</sup> <http://climateaudit.org/2013/11/20/behind-the-sks-curtain/>

## II. IS THE HOCKEY STICK 'FRAUDULENT'?

Accusations that the Hockey Stick is a “fraud” have permeated the public debate about the graph for more than twenty years. In one of the most famous of the Climategate emails, Phil Jones of the University of East Anglia referred to Michael Mann’s “trick” in the Hockey Stick graph when he wrote: “I’ve just completed Mike’s *Nature* trick of adding in the real temps to each series for the last 20 years (i.e., from 1981 onwards) and from 1961 for Keith’s to hide the decline.”<sup>55</sup> This phrase — “Mikes Nature trick . . . to hide the decline” — went viral. And it stoked an already politically and scientifically charged debate.

Fraud accusations concerning Mann and the Hockey Stick graph are legion. The following provides a sample of published statements. No attempt is made here to assess the reliability of these sources or the credibility of these statements. Rather, the existence of these statements in the public domain provides a basis for referring to the Hockey Stick as 'fraudulent' in an internet post:

- "Michael Mann hockey stick update: now definitely established to be **fraud**" <sup>56</sup>
- "Since 2001, there have been repeated claims that the reconstruction is at best seriously flawed and at worst a **fraud**"<sup>57</sup>
- "Others have described it [the Hockey Stick] as rubbish or even as a downright **fraud**"<sup>58</sup>
- "The Hockey Stick Hoax was perpetrated by Michael Mann in the form of a **fraudulent** reconstruction of the Earth's atmosphere temperature created by Michael Mann"<sup>59</sup>
- "The messages . . . reveal correspondence between British and American researchers engaged in **fraudulent** reporting of data to favor their own climate change agenda."<sup>60</sup>
- "Climate sceptics accused Mann of science **fraud**."<sup>61</sup>
- "Inventor of **fraudulent** temperature 'hockey stick' is humiliated in Canadian court"<sup>62</sup>
- "Climate's long arc and **fraud**"<sup>63</sup>
- "But the hockey stick graph is a **fraud**"<sup>64</sup>
- "The 100% **fraudulent** hockey stick"<sup>65</sup>

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<sup>55</sup> <https://www.theguardian.com/environment/2010/jul/07/hacked-climate-emails-analysis>

<sup>56</sup> <https://www.manhattancontrarian.com/blog/2019-8-26-michael-mann-hockey-stick-update-now-definitively-proven-to-be-fraud>

<sup>57</sup> <https://www.newscientist.com/article/dn11646-climate-myths-the-hockey-stick-graph-has-been-proven-wrong/>

<sup>58</sup> <https://www.newscientist.com/article/mg18925431-400-climate-the-great-hockey-stick-debate/>

<sup>59</sup> [https://www.conservapedia.com/Hockey\\_Stick\\_Hoax](https://www.conservapedia.com/Hockey_Stick_Hoax)

<sup>60</sup> <https://www.thenewamerican.com/tech/environment/item/6748-ipcc-researchers-admit-global-warming-fraud>

<sup>61</sup> <https://www.theguardian.com/environment/2010/jul/02/michael-mann-cleared>

<sup>62</sup> <https://www.technocracy.news/fatal-courtroom-act-ruins-michael-hockey-stick-mann/>

<sup>63</sup> <https://www.redbluffdailynews.com/2019/08/26/climates-long-arc-and-fraud/>

<sup>64</sup> <https://climate.news/2019-08-26-climate-change-hoax-collapses-as-michael-mann-bogus-hockey-stick-graph.html>

<sup>65</sup> <https://realclimatescience.com/2016/06/the-100-fraudulent-hockey-stick/>

- "Mann's hockey stick established to be a **fraud**."<sup>66</sup>
- "The hockey stick graph was a **fraud** the day it was generated."<sup>67</sup>
- "Should Michael 'hockey stick' Mann be prosecuted for climate **fraud**?"<sup>68</sup>
- "Hockey stick graph and other notable **frauds**."<sup>69</sup>
- "Michael Mann is a **fraud** and a liar, as well as a bully."<sup>70</sup>

The prevalent public accusation that the Hockey Stick is a “fraud” is largely based on image manipulation that deleted adverse data and splicing together different data sets (to "hide the decline") in a highly publicized version of the Hockey Stick that appeared in the IPCC TAR. Also contributing to a view of the Hockey Stick as 'fraudulent' are charges of 'cherry picking' the tree ring data and misrepresentation of a proxy dataset (the so-called upside-down Tiljander proxy).

These manipulations of data – most particularly the elimination of adverse data and splicing together of different data sets in the IPCC TAR – combine to create a deceptive impact. On February 23, 2011, I posted an article on my blog Climate Etc. entitled *Hiding the Decline*,<sup>71</sup> in which I said:

There is no question that the diagrams and accompanying text in the IPCC TAR, AR4 and WMO 1999 are misleading. I was misled. Upon considering the material presented in these reports, it did not occur to me that recent paleo data was not consistent with the historical record. The one statement in AR4 (put in after McIntyre’s insistence as a reviewer) that mentions the divergence problem is weak tea.

It is obvious that there has been deletion of adverse data in figures shown IPCC AR3 and AR4, and the 1999 WMO document. Not only is this misleading, but it is dishonest.

I would like to know what the heck Mann, Briffa, Jones et al. were thinking when they did this and why they did this, and how they can defend this, although the emails provide pretty strong clues. Does the IPCC regard this as acceptable? I sure don’t.

Referring to the Hockey Stick as fraudulent is justified by the following public perceptions and understandings of fraud and misconduct:

- Dictionary definitions of fraud include "an act of deceiving or misrepresenting; trick".<sup>73</sup> "Mike’s Nature trick" clearly links "trick" to the idea of "fraud."

<sup>66</sup>[https://www.realclearpolitics.com/2019/08/30/manns\\_hockey\\_stick\\_established\\_to\\_be\\_a\\_fraud\\_484829.html](https://www.realclearpolitics.com/2019/08/30/manns_hockey_stick_established_to_be_a_fraud_484829.html)

<sup>67</sup> <http://www.ccfsh.org/climate/climate-change-hoax-collapses-as-michael-manns-bogus-hockey-stick-graph-defamation-lawsuit-dismissed-by-the-supreme-court-of-british-columbia/>

<sup>68</sup> <https://principia-scientific.org/should-michael-hockey-stick-mann-be-prosecuted-for-climate-fraud/>

<sup>69</sup> <https://www.libertynation.com/the-hockey-stick-graph-and-other-notable-frauds/>

<sup>70</sup> <https://www.powerlineblog.com/archives/2014/05/michael-mann-is-a-liar-and-a-cheat-heres-why.php>

<sup>73</sup> <https://www.merriam-webster.com/dictionary/fraud>

- Generally, the term 'scientific fraud' is used to describe intentional misrepresentation of the methods, procedures, or results of scientific research.<sup>74</sup> Misrepresenting and cherry picking of data and image fraud are associated with intentional misrepresentation of results of scientific research.
- The definition of 'research misconduct', which is often identified with 'scientific fraud',<sup>75</sup> includes "falsification," or the "manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record."

Evidence is provided here that this public understanding of 'fraud' is consistent with how the issues of 'Mike's Nature trick' and 'hiding the decline' were portrayed in the Climategate emails and by the media. For individuals and journalists paying greater attention to the issues surrounding climate data, cherry picking and misrepresentation of the tree ring data (the Tiljander proxies) would also contribute to a view of the Hockey Stick as 'fraudulent.'

#### *A. Mistakes or errors in science versus 'fraud' and scientific misconduct*

Mistakes and errors in scientific research do not constitute misconduct; rather they are an inevitable part of scientific progress. Mistakes and errors are common in the course of scientific research. These may be identified in the peer review process, by the investigators themselves, or in subsequent investigations by other researchers or technical analysts. In climate science, a recent development has been vigorous auditing of climate science papers on social media, most notably on the technical climate blogs (Section IB).

Federal policies on research misconduct from The Office of Research Integrity state:

To be considered as research misconduct, actions must represent a significant departure from accepted practices, must have been committed intentionally or knowingly or recklessly and must be proven by a preponderance of evidence. Research misconduct does not include differences of opinion, or inadvertent mistakes or errors. A crucial distinction between research misconduct and error or negligence is the intent to deceive. When researchers intentionally deceive their colleagues, they are violating fundamental research standards and basic societal values.<sup>91</sup>

The U.S. Office of Science and Technology Policy has developed a statement<sup>92</sup> that defines research misconduct as "fabrication, falsification or plagiarism in proposing, performing or reviewing research or in reporting research results."

<sup>74</sup> <https://www.encyclopedia.com/history/dictionaries-thesauruses-pictures-and-press-releases/scientific-fraud>.

<sup>75</sup> <https://www.ncbi.nlm.nih.gov/books/NBK214564/>

<sup>91</sup> <https://ori.hhs.gov/content/chapter-2-research-misconduct-federal-policies>

<sup>92</sup> <https://ori.hhs.gov/content/chapter-2-research-misconduct-office-science-and-technology-policy>

Falsification is of specific relevance to concerns about the Hockey Stick. Falsification is defined as “changing or omitting data or results such that the research is not accurately represented in the research record.”

In cherry-picking, scientists use legitimate evidence, but not all of the evidence. They select segments of evidence that seem to confirm a particular position while ignoring a significant portion of related cases or data that may contradict that position. As described in an Editorial published in *Nature Cell Biology* (2011):

Cherry-picking data so as to selectively report only results that support a desired outcome may be more common than deliberate fabrication of data at the time of experimental set-up and data acquisition. Admittedly, an effort must be made to construct a narrative and present only the findings that are directly relevant to the central claims of a study. But massaging the data so that they support a favoured hypothesis straddles the fine line between sloppy science and scientific misconduct.<sup>94</sup>

Photo manipulation and image fraud is a growing concern, particularly in data-driven fields such as medicine, biology, psychology and nutrition. The same Editorial published in *Nature Cell Biology* (2011) states:

*Nature* journals also have clear guidelines on data presentation that should allow authors to avoid some of the common pitfalls associated with overzealous data beautification (see Guide to Authors<sup>95</sup>). In cases of extreme and rampant beautification, for example if a study has multiple instances of data from distinct experiments having been patched together to create more convincing . . . images, the journal reserves the right to not consider the study further if our confidence in the core conclusions has been eroded.

In general the following image manipulations are not allowed: splicing together different images to represent a single experiment; and any change that conceals information.<sup>97</sup> “Some changes are obvious fraud (deleting one portion of an image or copying an image and passing it off as multiple figures), but other manipulations are more subtle.”<sup>98</sup>

The complexity of making a judgment regarding whether a particular data manipulation technique constitutes fraud is summarized below:

By today's standards, omission of data that inexplicably conflicts with other data or with a scientist's proposed interpretation is considered scientific fraud. [There is] an inherent difficulty of drawing a line between scientific fraud on the one hand, and the exercise of creative judgment and the force of conviction that remain integral to scientific achievement on the other hand.<sup>99</sup>

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<sup>94</sup> <https://www.nature.com/articles/ncb0111-1>

<sup>95</sup> <https://www.nature.com/nature/for-authors>

<sup>97</sup> <https://www.aje.com/en/arc/avoiding-image-fraud-7-rules-editing-images/>

<sup>98</sup> <https://www.aje.com/en/arc/avoiding-image-fraud-7-rules-editing-images/>

<sup>99</sup> <https://www.encyclopedia.com/history/dictionaries-thesauruses-pictures-and-press-releases/scientific-fraud:>

## B. The Hockey Stick's Deceptions

Three specific aspects of the data analysis and image presentation of the Hockey Stick have been characterized as deceptive:

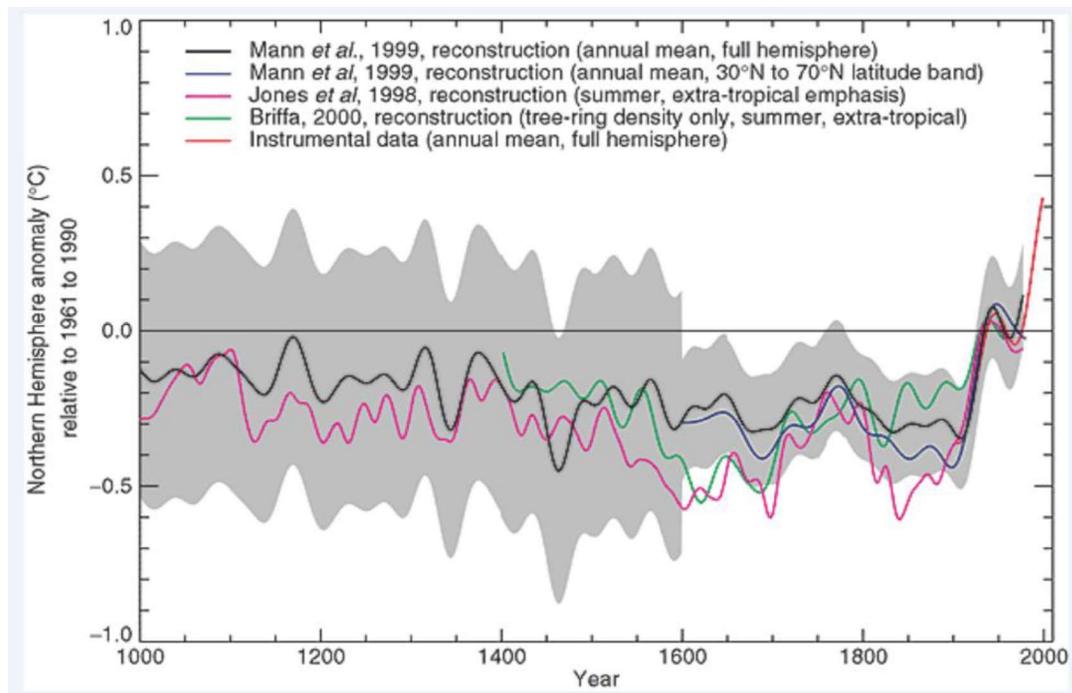
- changing and omitting data in the versions of the Hockey Stick graph used in the IPCC TAR and WMO Report;
- 'cherry picking' the tree ring data to select proxies that support a particular result; and
- falsification by using a proxy data set 'upside down.'

### (i) Data and image falsification -- 'Mike's Nature trick . . . to hide the decline'

Popular accusations that Mann's graph is 'fraudulent' primarily refer to versions of the Hockey Stick graph portrayed in Chapter 2 of the IPCC TAR (for which Mann was lead author), which was based on MBH98/99.<sup>100</sup>

Almost coincident with the publication of MBH98, Briffa et al. published a temperature reconstruction based on a large network of tree ring data in northern Canada and Siberia.<sup>101</sup> Briffa's results were diametrically opposite to MBH98 that showed sharply higher temperatures in the late 20<sup>th</sup> century – Briffa's reconstruction had a noticeable *decline* in the late 20<sup>th</sup> century.

The key issue of relevance here is Figure 2.21 in the IPCC TAR.



<sup>100</sup> An overview of the history of figure 2.21 in the IPCC TAR is provided in a report by Steve McIntyre [http://www.climateaudit.info/pdf/mcintyre-heartland\\_2010.pdf](http://www.climateaudit.info/pdf/mcintyre-heartland_2010.pdf).

<sup>101</sup> <https://www.nature.com/articles/30943>

Mann (lead author of Chapter 2) deleted the late 20<sup>th</sup> century portion of Briffa's data set (the green curve above) to conceal the sharp temperature decline that would have upset the Hockey Stick curve that made the graph famous.

McIntyre summarizes how and why this deletion transpired, by considering successive drafts of the IPCC TAR and emails among the relevant scientists. The graph in the zeroth order draft of IPCC TAR included both Mann's and Briffa's reconstructions. Briffa's reconstruction is barely visible in yellow in the left-hand version of the diagram; McIntyre created the diagram on the right that highlights Briffa's reconstruction in a more visible red color.

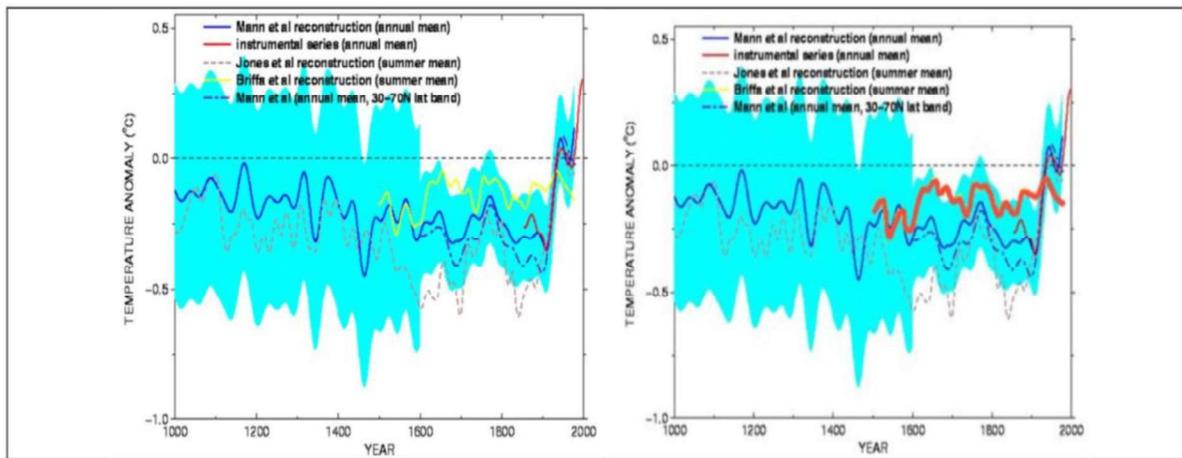


Figure 5. IPCC Zero Draft Figure 2.2.3a. Comparison of millennial Northern Hemisphere (NH) temperature reconstructions from different investigators (Briffa et al, 1998; Jones et al, 1998; Mann et al, 1998;1999a)... All the series were filtered with a 40 year Gaussian filter. **Briffa reconstruction is in yellow (left – original); re-colored for emphasis on right.**

A 1999 email exchange (from the 2009 unauthorized released of emails from the Climate Research Unit at the University of East Anglia) between Chapter 2 coordinating Lead Author Folland, Mann and Briffa illustrates this deception:<sup>102</sup>

**Folland:** A proxy diagram of temperature change is a clear favourite for the Policy Makers summary. But the current diagram with the tree ring only data [i.e. the Briffa reconstruction] somewhat contradicts the multiproxy curve and dilutes the message rather significantly. We want the truth. Mike thinks it lies nearer his result (which seems in accord with what we know about worldwide mountain glaciers and, less clearly, suspect about solar variations). The tree ring results may still suffer from lack of multicentury time scale variance. This is probably the most important issue to resolve in Chapter 2 at present.

**Mann:** Keith's series... differs in large part in exactly the opposite direction that Phil's does from ours. This is the problem we all picked up on (everyone in the room at IPCC was in agreement that this was a problem and a potential distraction/detraction from the

<sup>102</sup> <http://scienceandpublicpolicy.org/wp-content/uploads/2009/12/trick.pdf>

reasonably consensus viewpoint we'd like to show w/ the Jones et al and Mann et al series.)

**Briffa:** I know there is pressure to present a nice tidy story as regards 'apparent unprecedented warming in a thousand years or more in the proxy data' but in reality the situation is not quite so simple... [There are] some unexpected changes in response that do not match the recent warming. I do not think it wise that this issue be ignored in the chapter.

**Mann:** So, if we show Keith's series in this plot, we have to comment that "something else" is responsible for the discrepancies in this case. . . . Otherwise, the skeptics have a field day casting doubt on our ability to understand the factors that influence these estimates and, thus, can undermine faith in the paleo estimates. I don't think that doubt is scientifically justified, and I'd hate to be the one to have to give it fodder!

In the First Reviewer Draft of IPCC TAR Chapter 2, Mann's new diagram included no 20<sup>th</sup> century decline by deleting the adverse data from Briffa's reconstruction after 1960. Apart from simple deletion of the adverse data, McIntyre identified a second element of concern in this the hockey stick graph: the addition of instrumental data.

"A second element of the trick was a little more subtle. Any smoothed series requires forward values to calculate the smooth. It appears that Mann substituted instrumental data for actual data after 1960 to calculate the smooth before truncating the smooth in 1960. This pulled up the end values of the smoothed series, further disguising the decline. The truncation was not reported and is not readily noticed in the tangle of spaghetti strands."<sup>103</sup>

The IPCC TAR did not disclose the deletion of post-1960 data from Briffa's reconstruction in the graphic. The text describing the figure stated:

"There is evidence, for example, that high latitude tree-ring density variations have changed in their response to temperature in recent decades, associated with possible nonclimatic factors (Briffa *et al.*, 1998a). By contrast, Vaganov *et al.* (1999) have presented evidence that such changes may actually be climatic and result from the effects of increasing winter precipitation on the starting date of the growing season."<sup>104</sup>

Mann's deletion of the adverse post-1960 Briffa data without disclosure and splicing of proxy and instrumental data concealed recent tree ring data that has in many cases failed to reflect contemporary observed increases in global temperature. This phenomenon, obscured by Mann's data manipulation, is known as the "divergence" problem. It calls into question the Hockey Stick's reliance on tree ring proxy data to accurately measure temperatures centuries in the past. The (2006) NRC Report highlighted this concern with the Hockey Stick:

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<sup>103</sup> [http://www.climateaudit.info/pdf/mcintyre-heartland\\_2010.pdf](http://www.climateaudit.info/pdf/mcintyre-heartland_2010.pdf)

<sup>104</sup> <https://www.ipcc.ch/reports/>

The observed discrepancy between some tree ring variables that are thought to be sensitive to temperature and the temperature changes observed in the late 20th century (Jacoby and D'Arrigo 1995, Briffa et al. 1998) reduces confidence that the correlation between these proxies and temperature has been consistent over time. Future work is needed to understand the cause of this “divergence,” which for now is considered unique to the 20th century and to areas north of 55°N (Cook et al. 2004).<sup>105</sup>

In 2011, Richard Muller, Professor of Physics at University of Berkeley, criticized the data deletions:

What they did is they took the data from 1961 on, from this peak, and erased it. What was their justification for erasing it? The fact that it went down . . . This justification would not have survived peer review in any journal that I am willing to publish in . . . And what is the result in my mind? Quite frankly as a scientist, I now have a list of people whose papers I won't read anymore. You're not allowed to do this in science. This is not up to our standards.<sup>106</sup>

In short, the 'divergence problem' related to tree ring proxies is a critical issue for paleoclimatologists. If the modern warming is unprecedented, then tree-rings should be reaching unprecedented sizes and densities. But some tree rings are not responding to recent temperature rises in the expected way. This contradictory evidence raises serious doubts about the reliability of paleoclimate temperature reconstructions using tree rings.

Mann concealed the “divergence problem” in the Hockey Stick by deleting Briffa's post-1960 tree ring data that diverged from actual observed temperatures. While observed temperatures were rapidly increasing from 1950-2000, the tree ring data suggested that temperatures were decreasing. Mann's splicing of proxy and instrumental data enhanced his concealment of the divergence problem by “patch[ing] together . . . multiple instances of data from distinct experiments . . . to create more convincing . . . images.”<sup>107</sup> Together, these manipulations are consistent with most definitions of image fraud.

#### (ii) *Data 'cherry picking' - tree ring data*

The Hockey Stick has been challenged for cherry picking data relating to Bristlecone Pines. The graph relies heavily on Bristlecone Pines to produce its Hockey Stick shape. Mann weighted these proxies more heavily than other datasets to produce this outcome. However, the reliability of Bristlecone Pines to reflect changes in temperature, as opposed to other factors like CO<sub>2</sub> fertilization or moisture content, has been called into question, leading even Mann's own collaborators to criticize the Hockey Stick's overreliance on this single dataset.

The Wegman Report provides this summary:

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<sup>105</sup> <https://www.nap.edu/read/11676/chapter/1>

<sup>106</sup> <https://www.youtube.com/watch?v=VbR0EPWgkEI>

<sup>107</sup> <https://www.nature.com/articles/ncb0111-1>

Bondi et al. (1999) suggest [bristlecones] “are not a reliable temperature proxy for the last 150 years as it shows an increasing trend in about 1850 that has been attributed to atmospheric CO<sub>2</sub> fertilization.”<sup>108</sup>

Dr. Gordon Jacoby, a pioneer in dendrochronology and founder and Senior Research Scientist of the Tree-Ring Laboratory of the Lamont-Doherty Earth Observatory, noted Mann’s cherry-picking:

When I investigated the continuing row surrounding the graph in 2006, Gordon Jacoby of Columbia University in New York, said: ‘Mann has a series from central China that we believe is more a moisture signal than a temperature signal . . . He included it because he had a gap. That was a mistake and it made tree-ring people angry.’ A large data set he used from bristlecone pines in the American west has attracted similar concern.<sup>109</sup>

Further evidence of inappropriate 'cherry picking' of the tree ring proxies is provided by the Climategate emails and the published analyses by McIntyre and McKittrick.

From the Climategate emails: Mann's coauthor Malcom Hughes (the 'H' in MBH) writes about his own concerns about cherry-picking the Bristlecone data:

=====  
From: Malcolm Hughes  
To: Michael E. Mann  
Subject: Re: close call  
Date: Monday, July 31, 2000 3:00:26 PM

Dear Mike – I have read and re-read the draft, and have come to the conclusion that it would be a mistake to publish it. I would also urge you not to publish it. I think my enthusiasm aroused by the first version of the figure allowed me to ignore the most important problem. In the 1999 GRL paper the dangers of using too few proxies for a hemispheric reconstruction were rehearsed – that was our intention. **That this new version of your post-1980 calculations should be so sensitive to the omission of a single record is very worrying indeed.** It should also be noted that nothing much happens in the ‘new’ reconstruction until the last three years. I fear this would give a wonderful opportunity to those who would discredit the approach we used in MBH 1998 and 1999. They would almost certainly seize it to attack the use of the MBH99 reconstruction in the IPCC. . . .<sup>110</sup>

Two publications by McIntyre and McKittrick showed that tree ring data from one single tree dominated the MBH temperature reconstructions (Section IA). Ross McKittrick summarized

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<sup>108</sup> [http://scienceandpublicpolicy.org/wp-content/uploads/2010/07/ad\\_hoc\\_report.pdf](http://scienceandpublicpolicy.org/wp-content/uploads/2010/07/ad_hoc_report.pdf)

<sup>109</sup> <http://www.theguardian.com/environment/2010/feb/09/hockey-stick-graph-ipcc-report>

<sup>110</sup> Page 978 of 1050 in the 2019/02/00249611.pdf file.

these papers and their explanation of the impact of cherry-picking on the Hockey Stick, as follows:

If the flawed bristlecone pine series are removed, the hockey stick disappears regardless of how the PCs [principal components] are calculated and regardless of how many are included. The hockey stick shape is not global, it is a local phenomenon associated with eccentric proxies. Mann discovered this long ago and never reported it.<sup>111</sup>

Mann himself has admitted his cherry-picking affected the shape of the Hockey Stick. Mann wrote that after MBH98 was published he performed tests that

. . . revealed that not all of the records were playing an equal role in our reconstructions. Certain proxy data appeared to be of critical importance in establishing the reliability of the reconstruction—in particular, one set of tree ring records spanning the boreal tree line of North America published by dendroclimatologists Gordon Jacoby and Rosanne D'Arrigo.<sup>112</sup>

Mann knew that his results were entirely dependent upon a small amount of tree ring data, as shown in this additional email exchange with Mann's collaborators:

date: Tue, 24 Jun 2003 14:06:25 -0400  
from: "Michael E. Mann"  
subject: Re: ice cores/China series (FYI)  
to: Keith Briffa and others

Thanks Keith,

I just read your email after reading the others. **We actually eliminate records with negative correlations** (this is mentioned briefly in the GRL article), and we investigated a variety of weighting schemes to assure the basic robustness of the composite--but I certainly endorse your broader point here. Many of these records have some significant uncertainties or possible sources of bias, and this isn't the place to get into that. . . .

Mann readily admits in his publications, emails and other public statements that he eliminated data records with an undesirable correlation and employed weighting schemes to produce the desired result. While some data quality assessment is required in any research, Mann appears, in my professional opinion, to have gone beyond acceptable bounds as evidenced by email comments from his collaborators and colleagues.

Although data cherry picking is not inherently/necessarily regarded as scientific misconduct, in the way that data falsification is, Mann's data cherry picking "straddles the fine line between sloppy science and scientific misconduct."<sup>113</sup> At a minimum, the publicly available

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<sup>111</sup> <http://www.geo.utexas.edu/courses/387H/PAPERS/conf05McKittrick.pdf>

<sup>112</sup> Mann, Michael, *Hockey Stick and the Climate Wars*, p. 51. [FULL CITE]

<sup>113</sup> <https://www.nature.com/articles/ncb0111-1>

documents and emails reviewed above contribute to the perception of a 'fraudulent Hockey Sick' among journalists, the public and scientists from other fields.<sup>114</sup>

**(iii) Data falsification - the 'upside-down' Tiljander proxy**

In a subsequent reconstruction of paleo-temperatures, Mann used the Tiljander proxies (data taken from sediments from Lake Korttajarvi in Iceland) in Mann et al. (2008), which was published in the Proceedings of the National Academies of Sciences (PNAS).<sup>122</sup> The data from the Tiljander proxies was not the problem: the problem is that Mann used this data upside down.

McIntyre and McKittrick (2009) published a letter in PNAS<sup>123</sup> that claimed Mann et al. (2008) used the Korttajarvi sediments with the axes upside down, which was confirmed by Mia Tiljander (who created the data set). The effect of this upside down flip is to switch the Medieval Warm Period and Little Ice Age. Not only was this 'flip' not admitted by Mann, but it was dismissed as 'bizarre' in a published reply to McKittrick and McIntyre's PNAS letter.<sup>124</sup>

Mann's manipulation of the Tiljander series was strongly criticized by Matti Saarnisto, Tiljander's coauthor on the 2003 paper presenting this data set. Saarnisto made the following statements in a Finnish talk show:

HUOVINEN: Matti, your own research result has been distorted in public. Tell us what was done.

SAARNISTO: One of the people who have been in the public eye, Professor Mann from Pennsylvania State University, he has published several articles about the climate history of the past thousand years. The last time it was the history of the last two thousand years... In that article, my group's research material from Korttajärvi, near Jyväskylä, was used in such a way that the Medieval Warm Period was shown as a mirror image.

HUOVINEN: That is, the graph was flipped?<sup>[SEP]</sup>

SAARNISTO: The graph was flipped upside-down... It was in *Science*...

HUOVINEN: Why was that done, how do you interpret that?

SAARNISTO: That is something I've tried to sort out... In this email I received yesterday from one of the authors of the article, my good friend Professor Ray Bradley ...says there was a large group of researchers who had been handling an extremely large amount of research material, and at some point it happened that this graph was turned upside-down.

HUOVINEN: So it was not done on purpose? It was a mistake?

SAARNISTO: It has been turned upside-down twice in *Science*, and now I doubt if it can be a mistake anymore... This group, which has been seen in a negative light by the public, I know them... They have been somehow skeptical about this Medieval Warm Period and have tried to hide it to some extent. I have always thought that this was purely a case of scientific critique, but now in the last few days I have come somewhat to a conclusion

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<sup>114</sup> <http://di2.nu/foia/foia2011/mail/3555.txt>

<sup>122</sup> [http://www.meteo.psu.edu/holocene/public\\_html/Mann/articles/articles/MannetalPNAS08.pdf](http://www.meteo.psu.edu/holocene/public_html/Mann/articles/articles/MannetalPNAS08.pdf)

<sup>123</sup> [https://climateaudit.files.wordpress.com/2009/09/mcintyre\\_McKittrick.2009.pnas.pdf](https://climateaudit.files.wordpress.com/2009/09/mcintyre_McKittrick.2009.pnas.pdf)

<sup>124</sup> [http://www.meteo.psu.edu/holocene/public\\_html/shared/articles/MMReplyPNAS09.pdf](http://www.meteo.psu.edu/holocene/public_html/shared/articles/MMReplyPNAS09.pdf)

that there is some purposefulness in this... But how it is possible that this type of material is repeatedly published in these top science journals? It is because of the peer review process central to science. There is a small circle going round and around, relatively few people are reviewing each other's papers, and that is in my opinion the worrying aspect.<sup>126</sup>

Another coauthor of Tiljander, Atte Korhola, made the following statement referring to Mann's manipulation of his data in the Hockey Stick:

Proxies have been included selectively, they have been digested, manipulated, filtered, and combined - for example, data collected from Finland in the past by my own colleagues has even been turned upside down such that the warm periods become cold and vice versa. Normally, this would be considered as a scientific forgery, which has serious consequences.<sup>127</sup>

In summary, it appears that Mann's original use of the upside-down Tiljander proxy was based on a mistaken interpretation of the Tiljander et al. publication. This mistake propagated through several subsequent publications: Tingley and Huybers (2010)<sup>128</sup>, Kaufmann et al. (2009)<sup>129</sup> and Mann et al. (2009)<sup>130</sup>. Further, the contaminated reconstruction from Mann et al. (2008) was used in the IPCC AR4. Kaufmann et al. issued a corrigendum (formal correction) associated with his misuse of Mann's upside down version of the Tiljander proxy;<sup>131</sup> Mann never issued a corrigendum. Continuing to misuse the incorrect version of the data after being notified of the issue is a clear example of data falsification.

### *C. Mann's criteria for scientific 'fraud'*

In assessing whether it reasonable to characterize the Hockey Stick as “fraudulent,” it is useful to look at what Michael Mann considers “scientific fraud” regarding the Hockey Stick. In an email to New York Times journalist Andy Revkin, Mann wrote:

Date: Fri, 04 Feb 2005 15:52:53 -0500  
Subject: Re: FW: "hockey stock" methodology misleading

Hi Andy,  
The McIntyre and McKittrick paper is **pure scientific fraud**. I think you'll find this reinforced by just about any legitimate scientist in our field you discuss this with. Please see the RealClimate response:  
[1]<http://www.realclimate.org/index.php?p=111> and also:

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<sup>126</sup> <https://climateaudit.org/2010/02/06/say-my-name—february-rerun/>

<sup>127</sup> <http://climateaudit.org/2009/10/02/atte-korhola-scientific-and-social-playground/>

<sup>128</sup> <https://journals.ametsoc.org/jcli/article/23/10/2759/31995>

<sup>129</sup> <https://www.geo.umass.edu/climate/papers2/Kaufman2009a.pdf>

<sup>130</sup> [http://www.meteo.psu.edu/holocene/public\\_html/Mann/articles/articles/MannetalScience09.pdf](http://www.meteo.psu.edu/holocene/public_html/Mann/articles/articles/MannetalScience09.pdf)

<sup>131</sup> <https://science.sciencemag.org/content/325/5945/1236.full>

[2]<http://www.realclimate.org/index.php?p=114>.<sup>133</sup>

The realclimate.org posts Mann referenced do not use the word 'fraud'. From the first link (a blog post written by Michael Mann), here are the most critical statements of McIntyre and McKittrick:

"Following the all-too-familiar pattern, this deeply flawed paper was heavily promoted by special interests as somehow challenging the scientific consensus that humans are altering the climate"

MM however, continue to promote false and specious claims. McIntyre and McKittrick (2005), in a paper they have managed to slip through the imperfect peer review filter of GRL, now simply recycle the very same false claims made by them previously in their comment on MBH98 that was rejected by *Nature*.

Sifting through a large number of false and misleading statements in this latest paper, there are two primary criticisms of MBH98 that they raise, both of which are demonstrably specious."

From a 2005 interview published by Mother Jones, Mann states in apparent reference to the McIntyre and McKittrick papers:

There are quite a few papers undergoing peer review now and studies in press which detail the critical flaws in the arguments that these contrarians have been putting forward about the hockey stick in the past few months. As it plays out in the peer-reviewed literature, it will soon be evident that many of claims made by the contrarians were **fraudulent**.<sup>134</sup>

From one of the Climategate emails:<sup>135</sup>

Date: Thu, 30 Dec 2004 09:22:02 -0500  
To: Phil Jones  
From: "Michael E. Mann  
Subject: Re: Fw: Rutherford et al. [2004]

Phil,

I would immediately delete anything you receive from this **fraud**. You've probably seen now the paper by Wahl and Ammann which independently exposes McIntyre and McKittrick for what it is – pure crap. Of course, we've already done this on "RealClimate", but Wahl and Ammann is peer-reviewed and independent of us. I've attached it in case you haven't seen (please don't pass it along to others yet). It should be

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<sup>133</sup> From the Climategate emails, referring to the publication McIntyre and McKittrick (2005), <http://di2.nu/foia/foia2011/mail/3045.txt>

<sup>134</sup> <https://archive.is/TGmPF>

<sup>135</sup> <http://www.di2.nu/foia/1104855751.txt>

in press shortly. Meanwhile, I would NOT RESPOND to this guy. As you know, only bad things can come of that. The last thing this guy cares about is honest debate--he is funded by the same people as Singer, Michaels, etc. . . talk to you soon, mike

Based on Mann's own statements, Mann's criteria for 'scientific fraud' can be summarized by:

- 'Speciousness.' The definition of specious is 'apparently good or right though lacking real merit; superficially plausible, but actually wrong' <sup>136</sup>
- A paper that challenges the scientific consensus on climate change;
- Scientists who are seeking data in order to audit Mann's research;
- A paper that is promoted by special interests that are not aligned with Mann's interests; and
- Being rejected by the journal *Nature*, which only accepts for publication 7.7% of the manuscripts submitted. <sup>137</sup>

#### ***D. Conclusions***

The focus of the arguments presented here is based on the public understanding of “fraud,” particularly in connection with internet commentary. Referring to the Hockey Stick as 'fraudulent' is supported by the public understanding of fraud and how the issues surrounding the Hockey Stick have been portrayed in the media. These include:

- Image fraud with regards to the versions of Hockey Stick images portrayed in the IPCC TAR report that deleted adverse paleoclimate proxy data post-1960, and spliced in the post 1960 historical temperature record
- Data cherry picking, by selecting only the tree ring proxies that produced the results desired by Mann
- Data falsification, by persistent use of the Tiljander proxies upside down, even after a letter pointing this out was published in PNAS and three of the authors on the Tiljander paper calling this out.

Mann's own loose use of the word 'fraud' to dismiss anyone who criticizes his research arguably lowers the bar in terms of how the word 'fraud' is used to characterize scientific research in the context of this lawsuit.

### **III. THE DOWNWARD SPIRAL OF CLIMATE SCIENCE DISCOURSE**

In my opinion, Michael Mann has been instrumental in the downward spiral of climate science discourse, the very thing that he decries in this lawsuit. He has (a) withheld data from scientists who are critical of his work; (b) stifled criticism of his work within the IPCC and by distorting the peer review process; and (c) employed what he calls the “Serengeti Strategy” to attack scientists who disagree with him.

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<sup>136</sup> <https://www.dictionary.com/browse/specious>

<sup>137</sup> <https://medium.com/@journalsfriend/nature-communications-should-you-publish-here-c4e384f8608d>

Each of these acts, in different ways, violates the 'Mertonian Norms of Science,' a set of principles that guide the development of modern science. I provide a brief overview of the Mertonian norms before explaining the various ways that Mann's violations of these norms have contributed to the heated and vitriolic nature of the climate change debate, especially surrounding the Hockey Stick.

### *A. Norms of science and scientific discourse*

The Mertonian Norms of Science,<sup>138</sup> introduced in 1942, describe four sets of institutional imperatives [comprising] the ethos of modern science:

- **Communalism:** all scientists should have equal access to scientific goods (intellectual property) and there should be a sense of common ownership in order to promote collective collaboration; secrecy is the opposite of this norm.
- **Universalism:** all scientists can contribute to science regardless of race, nationality, culture, or gender.
- **Disinterestedness:** according to which scientists are supposed to act for the benefit of a common scientific enterprise, rather than for personal gain.
- **Organized Skepticism:** skepticism means that scientific claims must be exposed to critical scrutiny before being accepted.

A recent article in the *Journal of Higher Ed*<sup>139</sup> summarizes critiques of the Mertonian norms. The paper concludes with this paragraph:

The Mertonian norms, as principles representative of the normative system of science, have been challenged, attacked, dismissed, contested, inconsistently referenced, and, in short, battered and bruised by controversy and careless application. They nonetheless have endured for over 65 years as part of the communal property of science.

There is considerable debate about the appropriate roles and responsibilities of scientists regarding advocacy, and whether this violates the norm of 'disinterestedness.' However, if an individual chooses to be an advocate/activist, and then engages in violations of the other norms, then their activism will amplify the public concern over these other violations.

Mann finds himself singled out for attacks because he is perceived to have violated the norms of science and the norms of behavior for a scientist. These violations are amplified in the public mind by his activism and advocacy for climate policies.

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<sup>138</sup> Merton, Robert K. [1942], "The Normative Structure of Science", in Merton, Robert K. (ed.), *The Sociology of Science: Theoretical and Empirical Investigations*, Chicago: University of Chicago Press, ISBN 978-0-226-52091-9, OCLC 755754

<sup>139</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2995462/>

## B. Withholding data

The emails leaked during the Climategate disclosures reveal that Mann withheld the data and other information underlying the Hockey Stick from multiple scientists seeking to assess his work. Mann's unwillingness to share the data underlying his work violates the Mertonian Norm of 'communalism' because it prevents equal access to the scientific data and other information at the heart of the Hockey Stick. In particular, Mann has withheld data and other information from McIntyre and McKittrick because they have challenged his findings.

In one of the emails leaked in the Climategate disclosures, Mann wrote to fellow scientist Phil Jones and referred to McIntyre and McKittrick as follows:

At 10:19 09/02/2004 -0500, Michael Mann wrote:

Hi Phil,

Personally, I wouldn't send him anything. I have no idea what he's up to, but you can be sure it falls into the "no good" category. There are a few series from our '03 paper that he won't have--these include the latest Jacoby and D'Arrigo, which I digitized from their publication (they haven't made it publicly available) and the extended western North American series, which they wouldn't be able to reproduce without following exactly the procedure described in our '99 GRL paper to remove the estimated non-climatic component. I would not give them \*anything\*. I would not respond or even acknowledge receipt of their emails. There is no reason to give them any data, in my opinion, and I think we do so at our own peril! talk to you later, mike <sup>141</sup>

McIntyre has summarized another example of Mann's derivation from the norms of scientific discourse in a series of emails, where Mann attempts to hide the 'dirty laundry' associated with MBH98 and MBH99:<sup>142</sup>

### **Michael Mann to Tim Osborn, CRU, [July 2003](#)**

*Attached are the calibration residual series for experiments based on available networks back to: AD 1000, AD 1400, AD 1600... You only want to look at the first column (year) and second column (residual) of the files. I can't even remember what the other columns are! mike*

*p.s. I know I probably don't need to mention this, but just to insure absolutely clarify on this, I'm providing these for your own personal use, since you're a trusted colleague. So please don't pass this along to others without checking w/ me first. **This is the sort of "dirty laundry" one doesn't want to fall into the hands of those who might potentially try to distort things...***

### **McIntyre to Mann, [December 2003](#) cc NSF**

*In MBH98 and MBH99, you refer to analyses of residuals carried out in these studies. Could you please provide me with (a) preferably, a FTP location for the residual series,*

<sup>141</sup> <http://www.climateaudit.info/data/CG1/1076359809.txt>

<sup>142</sup> <https://climateaudit.org/2009/12/01/dirty-laundry/>

together an FTP reference for the program generating the residuals; or, (b) in the absence of such FTP location, an email enclosing this information. Your analysis of these residuals was used to estimate confidence intervals in an influential scientific paper.

**McIntyre to Ziemelis of Nature, [August 2004](#)**

*we are writing to reiterate long-standing requests for data and results from MBH98, which we have already communicated on several occasions. You had stated that these requests would be resolved in the new SI, but unfortunately this is not the case. While you are undoubtedly weary of this correspondence, our original request for disclosure was reasonable and remains reasonable. It is only the unresponsiveness of the original authors that is placing a burden on you and your associates. Some of these items have been outstanding for 7 months. They were not attended to in the new SI and need to be dealt with promptly. ... Since their claims of skill in reconstructing past climates depend on these “experiments” and their estimation of confidence intervals is based on the residual series, it is unnecessary to explain why these data are of interest. Again, we have repeatedly requested this data.*

Mann's unwillingness to share requested data and other information underlying the Hockey Stick with other scientists reinforces skepticism about the veracity of his analyses and has contributed to a lack of transparency and openness in climate science discourse.

***C. Stifling skepticism***

In addition to shielding data from scientists, Mann has worked to stifle skepticism directed at his own research and broader climate change research by (i) influencing assessment reports to stifle skeptical perspectives; and (ii) working to influence the peer review process in a manner favorable to his own research. This conduct violates the Mertonian norm of “organized skepticism” because it prevents his work from being exposed to critical scrutiny.

***(i) Stifling skeptical perspectives in assessment reports***

John Christy—a Lead Author of Chapter 2 of the IPCC Third Assessment Report (TAR; 2001), along with Michael Mann—has described Mann’s efforts to stifle skepticism. The following are excerpts from Christy's 2011 Testimony to the House Science, Space and Technology Committee: <sup>143</sup>

"My experience as Lead Author in the IPCC TAR, Chapter 2 “Observed Climate Variability and Change”, allowed me to observe how a key section of this chapter, which produced the famous Hockey Stick icon, was developed.

We were appointed L.A.s in 1998. The Hockey Stick was prominently featured during IPCC meetings from 1999 onward. I can assure that those [committee members] not familiar with issues regarding reconstructions of this type (and even many who should

<sup>143</sup> [https://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/ChristyJR\\_written\\_110331\\_all.pdf](https://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/ChristyJR_written_110331_all.pdf)

have been) were truly enamored by its depiction of temperature and sincerely wanted to believe it was truth. Skepticism was virtually non-existent. Indeed it was described as a “clear favourite” for the overall Policy Makers Summary (Folland, 0938031546.txt).

In our Sept. 1999 meeting (Arusha, Tanzania) we were shown a plot containing more temperature curves than just the Hockey Stick including one from K. Briffa that diverged significantly from the others, showing a sharp cooling trend after 1960. It raised the obvious problem that if tree rings were not detecting the modern warming trend, they might also have missed comparable warming episodes in the past. In other words, absence of the Medieval warming in the Hockey Stick graph might simply mean tree ring proxies are unreliable, not that the climate really was relatively cooler.

When we met in February 2000 in Auckland NZ, the one disagreeable curve was not the same anymore because it had been modified and truncated around 1960. Not being aware of the goings-on behind the scenes, I had apparently assumed a new published time series had appeared and the offensive one had been superceded (I can't be certain of my actual thoughts in Feb. 2000). Now we know, however, that the offensive part of Briffa's curve had simply been amputated after a new realization was created three months before. So, at this point, data which contradicted the Hockey Stick, whose creator was the L.A. [Mann], had been eliminated. No one seemed to be alarmed (or in my case aware) that this had been done.

To compound this sad and deceptive situation, I had been quite impressed with some recent results by Dahl-Jensen et al., (Science 1998), in which Greenland ice-borehole temperatures had been deconvolved into a time series covering the past 20,000 years. Their result indicated a clear 500-year period of temperatures, warmer than the present, centered about 900 A.D. – commonly referred to as the Medieval Warm Period, a feature noticeably absent in the Hockey Stick.

I discussed this with the paleo-L.A. [Mann] at each meeting, asking that he include this exceptional result in the document as evidence for temperature fluctuations different from his own. To me Dahl-Jensen et al.'s reconstruction was a more robust estimate of past temperatures than one produced from a certain set of western U.S. tree-ring proxies. But as the process stood, the L.A. was not required to acknowledge my suggestions, and I was not able to convince him otherwise. It is perhaps a failure of mine that I did not press the issue even harder or sought agreement from others who might have been likewise aware of the evidence against the Hockey Stick realization.

As it turned out, this exceptional paper by Dahl-Jensen et al. was not even mentioned in the appropriate section (TAR 2.3.2). There was a brief mention of similar evidence indicating warmer temperatures 1000 years ago from the Sargasso Sea sediments (TAR 2.3.3), but the text then quickly asserts, without citation, that this type of anomaly is not important to the hemisphere as a whole.

So, to summarize, an L.A. [Mann] was given final say over a section which included as its (and the IPCC's) featured product, his very own chart, and which allowed him to leave out not only entire studies that presented contrary evidence, but even to use another

strategically edited data set that had originally displayed contrary evidence."

*(ii) Interfering with the peer review process*

After publication of the IPCC TAR, scientists began challenging the Hockey Stick. Rather than engaging with the scientists who were challenging his research, the Climategate emails reveal that Mann attempted to thwart publication of their papers through control of the peer review process. Some examples are provided here:

Email: <sup>144</sup>

From: Michael E. Mann  
To: Phil Jones and others  
Subject: Re: Fwd: Soon & Baliunas  
Date: Tue, 11 Mar 2003 08:14:49 -0500

Thanks Phil, (Tom: Congrats again!)

The Soon & Baliunas paper couldn't have cleared a 'legitimate' peer review process anywhere. That leaves only one possibility--that the peer-review process at Climate Research has been hijacked by a few skeptics on the editorial board. And it isn't just De Frietas, unfortunately I think this group also includes a member of my own department...

The skeptics appear to have staged a 'coup' at "Climate Research" (it was a mediocre journal to begin with, but now its a mediocre journal with a definite 'purpose'). Folks might want to check out the editors and review editors: [1]<http://www.int-res.com/journals/cr/crEditors.html>

. . . It is pretty clear that the skeptics here have staged a bit of a coup, even in the presence of a number of reasonable folks on the editorial board (Whetton, Goodess, ...). My guess is that Von Storch is actually with them (frankly, he's an odd individual, and I'm not sure he isn't himself somewhat of a skeptic himself), and without Von Storch on their side, they would have a very forceful personality promoting their new vision.

There have been several papers by Pat Michaels, as well as the Soon & Baliunas paper, that couldn't get published in a reputable journal. This was the danger of always criticising the skeptics for not publishing in the "peer-reviewed literature". Obviously, they found a solution to that – take over a journal!

So what do we do about this? I think we have to stop considering "Climate Research" as a legitimate peer-reviewed journal. Perhaps we should encourage our colleagues in the climate research community to no longer submit to, or cite papers in, this journal. We would also need to consider what we tell or request of our more reasonable colleagues who currently sit on the editorial board ... What do others think? mike

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<sup>144</sup> <http://www.assassinationscience.com/climategate/1/FOIA/mail/1047388489.txt>

Email: <sup>145</sup>

At 20:12 21/05/2008, Michael Mann wrote:

Hi Phil, Gavin and I have been discussing, we think it will be important for us to do something on the Thompson et al paper as soon as it appears, since its likely that naysayers are going to do their best to put a contrarian slant on this in the blogosphere. Would you mind giving us an advance copy. We promise to fully respect *Nature's* embargo.

From Climategate email #1566 <sup>146</sup>

FYI--thought you guys should have this (below). This guy "McIntyre" appears to be yet another shill for industry – he appears to be the one who forwarded the scurrilous 'climateskeptiiic" criticisms of the recent Bradley et al. Science paper. Here is an email I sent him a few weeks ago in response to an inquiry. . . .

The best that can be done is to ignore their desperate emails, and if they manage to slip something into the peer-reviewed literature, as in the case of Soon & Baliunas, deal wi/ it as we did in that case – i.e. the Eos response to Soon et al. – they were stung badly by that and the bad press that followed. . . .

Cheers,

Mike

After McIntyre and McKitrick (M&M) published papers in peer reviewed journals that challenged the integrity of the Hockey Stick, Mann was not pleased. As summarized by UK journalist Fred Pearce:<sup>147</sup>

"Mann replied in kind. The emails reveal that he heard about the "M&M" paper for the first time the day before it was published. He was angry that the journal had not asked him to review the paper, or at least comment on it, before publication. He put his friends on attack alert. "My suggested response is to dismiss this as a stunt appearing in a 'journal' already known to have defied standard practices of peer-review. It is clear, for example, that nobody we know has been asked to 'review' this so-called paper... the claim is nonsense."

He went on: "Who knows what sleight of hand the authors have pulled. Of course the usual suspects are going to try to peddle this crap. The important thing is to deny that this has any intellectual credibility whatsoever." "

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<sup>145</sup> <http://www.assassinationscience.com/climategate/1/FOIA/mail/1211462932.txt>

<sup>146</sup> <http://bishophill.squarespace.com/blog/2011/12/30/poisoning-the-well.html?currentPage=2>

<sup>147</sup> <https://www.theguardian.com/environment/2010/feb/09/hockey-stick-michael-mann-steve-mcintyre>

Such interference with the peer review process reinforces the need for outside evaluation of paleoclimate research, such as is provided by the 'climate auditors' and the technical climate blogs (Section IB).

#### ***D. Mann's 'Serengeti strategy'***

Mann explicitly and implicitly claims to be the 'victim' of attacks, particularly in his book *The Hockey Stick and Climate Wars*. Mann often alludes to these attacks as what he calls the 'Serengeti strategy,' which he described to the U.S. Congress in 2017:<sup>148</sup>

“I coined the term “Serengeti strategy” back in 2012 in *The Hockey Stick and the Climate Wars* to describe how industry special interests who feel threatened by scientific findings—be it tobacco and lung cancer, or fossil fuel burning and climate change—single out individual scientists to attack in much the same way lions of the Serengeti single out an individual zebra from the herd. In numbers there is strength, but individuals are far more vulnerable. Science critics will therefore often select a single scientist to ridicule, hector, and intimidate. The presumed purpose is to set an example for other scientists who might consider sticking their neck out by participating in the public discourse over certain matters of policy-relevant science.”

Mann applies these same strategies against scientists and journalists who have criticized his research or his public behavior, and also against journalists and other public figures that do not support Mann's preferred climate policies.

Several illustrative examples of Mann applying the "Serengeti strategy" to other scientists are provided here.

##### ***(i) Attacks against Steve McIntyre***

While many disparaging comments against Steve McIntyre can be found in Mann's emails (some of which are cited earlier in this document); he has also tweeted such comments:

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<sup>148</sup> <https://docs.house.gov/Committee/Calendar/ByEvent.aspx?EventID=105796>

 **Michael E. Mann** ✓ @MichaelEMann

McIntyre is a professional liar/denier-for-hire. Laid out in great detail in "The Hockey Stick and the Climate Wars" [amazon.com/Hockey-Stick-C...](https://www.amazon.com/Hockey-Stick-C...)  
#HSCW

 **Juan José Gómez-Navarro** @onturenio · Aug 8, 2019  
Replying to @ClimateAudit  
This is misinformation with the only purpose to mislead people. You either didn't read the paper, or more likely you are lying on purpose. I'll try to make my point below ↴

---

 **Michael E. Mann** ✓ @MichaelEMann · Sep 19, 2012  
Stephen **McIntyre** uses same dishonest "recipe for manufacturing doubt" behind his original attacks on Hockey Stick [on.fb.me/OcLgLQ](https://on.fb.me/OcLgLQ)  
#HSCW

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 **Michael E. Mann** ✓ @MichaelEMann · Dec 22, 2017  
Replying to @past\_is\_future  
Just when you thought Steve **McIntyre** couldn't go any lower. Just a horrible, horrible person.

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 **Michael E. Mann** ✓ @MichaelEMann · Oct 22, 2019  
Replying to @pjackson\_nl @ClimateAudit and 4 others  
**McIntyre** had his 15 minutes and can't get over the fact that he's become an irrelevant joke as the science has moved on and his charade long exposed...

*(ii) Attack against Rob Wilson*

Rob Wilson is a paleoclimatologist at the University of Edinburgh. In 2013, he delivered a lecture at Scotland's University of St. Andrews. A report on this lecture is provided at Bishop Hill's blog.<sup>149</sup>

<sup>149</sup> <http://www.bishop-hill.net/blog/2013/10/21/wilson-on-millennial-temperature-reconstructions.html>

While discussing historical climate, Wilson documented several major procedural and substantive flaws in Mann's Hockey Stick. Taking care to reassure people he is not part of the "skeptic" camp, Wilson nevertheless emphasized the importance of sound, unbiased science. Wilson concluded Mann's Hockey Stick was "ultimately a flawed study." As described in the blog post:

"The real fireworks came when Mann's latest papers, which hypothesize that tree ring proxies have large numbers of missing rings after major volcanic eruptions, were described as "a crock of xxxx". "

Mann tweeted:<sup>150</sup>

“  
*Michael E. Mann @MichaelEMann*  
  
*Closet #climatechange #denier Rob Wilson, comes out of the closet big time: <http://www.bishop-hill.net/blog/2013/10/21/wilson-on-millennial-temperature-reconstructions.html> ... #BadScience #DisingenuousBehavior*

Mann's tweet prompted a long discussion with climatologist Tamsin Edwards over labeling Rob Wilson as a denier:

The screenshot shows a Twitter thread. At the top is a tweet from Tamsin Edwards (@flimsin) posted 6 hours ago. She is replying to Michael E. Mann (@MichaelEMann) and says, "You are seriously calling Rob a denier for criticising your work, M? That's pretty strong to call a prof climate colleague." Below her tweet is an "Expand" link. Below that is a tweet from Michael E. Mann (@MichaelEMann) posted 5 hours ago. He is replying to Tamsin Edwards and says, "Not for criticizing my work, but for apparently regurgitating #denialist drivel by the likes of McIntyre etc." Below his tweet are links for "Hide conversation", "Reply", "Retweet", "Favorite", and "More". At the bottom of the thread, it says "6:18 AM - 21 Oct 13 · Details".

### *(iii) Attacks against Bjorn Lomborg*

Dr. Bjorn Lomborg has a Ph.D. in political science from the University of Copenhagen. He is president of the Copenhagen Consensus Center and visiting Professor at Copenhagen Business School. He is former director of the Danish government's [Environmental Assessment Institute](#) (EAI) in [Copenhagen](#). In 2004 he was named in TIME's list of top 100

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<sup>150</sup> This tweet was subsequently deleted by Mann, only a text version survives:  
<https://wattsupwiththat.com/2013/10/21/paleoscientist-manns-recent-work-was-a-crock-of-xxxx/>

Scientists and Thinkers. He has ranked in the top 100 Public Intellectuals in the Foreign Policy Poll and in the Foreign Policy Top 100 Global Thinkers.

Lomborg's position on climate change is summarized by this statement from his book, *The Skeptical Environmentalist*:

"This chapter accepts the reality of man-made global warming but questions the way in which future scenarios have been arrived at and finds that forecasts of climate change of 6 degrees by the end of the century are not plausible". In a 2010 interview with the *New Statesman*, Lomborg summarized his position on climate change: "Global warming is real – it is man-made and it is an important problem. But it is not the end of the world."<sup>151</sup>

Although Lomborg does not appear to have directly provoked Mann by criticizing Mann's research or behavior, nevertheless Mann has relentlessly attacked Lomborg as a 'denier', 'fossil fuel industry apologist', 'propagandist.' From a 2009 Article written by Mann:

"Among the rogues gallery of leading climate change deniers are: Congressman Joe Barton (R-TX), fossil fuel shill Steve Milloy, media mogul Rupert Murdoch, self-styled "Skeptical Environmentalist" Bjorn Lomborg, scientist-turned-denier-for-hire Fred Singer, the inimitable Sarah Palin, conservative funders Charles and David Koch (aka the Koch Brothers), and "swift-boat" architect Marc Morano."<sup>152</sup>

From a 2016 Facebook post by Mann:

"That is a straw-man argument promoted by propagandists like Bjorn Lomborg."<sup>153</sup>

## ***E. Conclusions***

Michael Mann claims to be the victim of a Serengeti strategy by political opponents of climate change policies. Mann has arguably been singled out for attacks because he has violated the norms of science: (a) withheld data from scientists who are critical of his work; (b) stifled criticism of his work within the IPCC and by distorting the peer review process; and (c) employed what he calls the "Serengeti strategy" to attack scientists who disagree with him.

Of specific relevance to this lawsuit, Mann has been instrumental in the downward spiral of discourse surrounding climate change, the very thing that he decries in this lawsuit. His loose use of the word 'fraudulent' with regards to research that is critical of his own plus characterizing people that he disagrees with as 'professional liar for hire', 'denier,' 'anti-science,' among other things, contributes to an 'anything goes' environment for discourse surrounding this controversial and contentious topic.

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<sup>151</sup> <https://www.newstatesman.com/environment/2010/09/interview-gay-climate>

<sup>152</sup> <https://www.ecowatch.com/michael-mann-climate-deniers-2009591213.html>

<sup>153</sup> <https://www.facebook.com/MichaelMannScientist/posts/1106368706085997>

## **CONCLUSION**

I hereby certify that this report is a complete and accurate statement of all of my opinions, and the basis and reasons for them, to which I will testify under oath.

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JUDITH CURRY

## APPENDIX A

### JUDITH A. CURRY

#### GENERAL INFORMATION

##### Education

- 1982 Ph.D. The University of Chicago, Geophysical Sciences  
1974 B.S. cum laude Northern Illinois University, Geography

##### Professional Experience

- 2016-present Professor Emerita, School of Earth and Atmospheric Sciences  
Georgia Institute of Technology
- 2006-present President, Climate Forecast Applications Network, LLC
- 2002-2016 Professor, School of Earth and Atmospheric Sciences  
Georgia Institute of Technology
- 2002-2014 Chair, School of Earth and Atmospheric Sciences  
Georgia Institute of Technology
- 1992-2002 Professor, University of Colorado-Boulder  
Department of Aerospace Engineering Sciences  
Program in Atmospheric and Oceanic Sciences  
Environmental Studies Program
- 1989-1992 Associate Professor, Department of Meteorology, Penn State
- 1986-1989 Assistant Professor, Dept of Earth and Atmospheric Sciences, Purdue University
- 1982-1986 Assistant Scientist, Dept of Meteorology, University of Wisconsin-Madison

##### Awards/Honors

- 2017 Top 50 Women in STEM – Best Schools
- 2011 Graetzinger Moving School Forward Award, Georgia Tech
- 2007 Fellow, American Association for the Advancement of Science
- 2006 Best Faculty Paper Award, Georgia Tech Sigma Xi
- 2004 Fellow, American Geophysical Union
- 2002 NASA Group Achievement Award for CAMEX-4
- 2002 Green Faculty Award, University of Colorado
- 1997 Elected Councilor, American Meteorological Society
- 1995 Fellow, American Meteorological Society
- 1992 Henry G. Houghton Award, the American Meteorological Society
- 1988 Presidential Young Investigator Award, the National Science Foundation

## Professional Activities (since 2000)

### World Meteorological Organization / International Council of Scientific Unions / International Ocean Commission / World Climate Research Programme

- Global Energy and Water Experiment (GEWEX) Radiation Panel (1994-2004)
- GEWEX Cloud System Studies (GCSS) Science Steering Group (1998-2004)
- Chair, GCSS Working Group on Polar Clouds (1998-2004)
- Chair, GEWEX Radiation Panel SEAFLUX Project (1999-2004)
- Steering Committee, IGAC/SOLAS Air-Ice Chemical Interactions (2003-2006)
- Science Steering Group, Arctic Climate System (ACSYS) Programme (1994-2000)

### National Research Council – National Academies

- Space Studies Board (2004-2007)
- Climate Research Committee (2003-2006)
- Panel: A Strategy to Mitigate the Impact of Sensor Descopes and De-manifests on the NPOESS and GOES-R Spacecraft (2007-2008)
- Committee to review CCSP SAP 1.1 Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences (2007)

### U.S. Federal Agencies

- DOE Biological & Environmental Research Advisory Committee (BERAC) (2012-2015)
- Earth Science Subcommittee, NASA Advisory Council (2009-2013)
- Search Committee, NSF Director for Geoscience (2007)
- External Advisory Board, NCAR Atmospheric Technology Division (2004-2006)
- Science Board, DOE ARM Climate Reference Facility, (2008-2011)
- External Review Committee, COSIM Program, Los Alamos National Laboratory (2007)
- NOAA Climate Working Group (2004-2009)

### Professional Societies

- Executive Committee, American Physical Society Topical Group on Physics of Climate (2013-2016)
- Member, Fellows Committee, American Geophysical Union (2013-2014)
- Executive Committee of the Council, American Meteorological Society (1998-2000)
- Councilor, American Meteorological Society (1997-2000)

## RESEARCH

### Books

- Khvorostyanov, V.I. and J.A. Curry, 2014: *Kinetics and Thermodynamics of Clouds and Precipitation*. Cambridge University Press, Cambridge University, 762 pp
- Curry, J.A. and P.J. Webster, 1999: *Thermodynamics of Atmospheres and Oceans*. Academic Press, London, 467 pp (second edition under contract).
- Holton, J.P., J.A. Curry, and J. Doyle, eds., 2003: *Encyclopedia of Atmospheric Sciences*. Academic Press, London, 6244 pp.

## Refereed Publications

1. Curry, J.A., 1983: On the formation of continental Polar air. *J. Atmos. Sci.*, 40, 2278-2292.
2. Herman, G.F. and J.A. Curry, 1984: Observational and theoretical studies of solar radiation in Arctic stratus clouds. *J. Clim. Appl. Met.*, 23, 5-24.
3. Curry, J.A. and G. F. Herman, 1985: Infrared radiative properties of Arctic stratus clouds. *J. Clim. Appl. Met.*, 24, 525-538.
4. Curry, J.A. and G.F. Herman, 1985: Relationships between large-scale heat and moisture budgets and the occurrence of Arctic stratus clouds. *Mon. Wea. Rev.*, 113, 1441-1457.
5. Curry, J.A., 1986: Interactions among turbulence, radiation and microphysics in Arctic stratus clouds. *J. Atmos. Sci.*, 43, 90-106.
6. Curry, J.A., 1986: Reply to comments on "Interactions between turbulence, radiation and microphysics in Arctic stratus clouds." *J. Atmos. Sci.*, 43, 2753-2755.
7. Curry, J.A., 1987: The contribution of radiative cooling to the formation of cold-core anticyclones. *J. Atmos. Sci.*, 44, 2575-2592.
8. Curry, J.A., E.E. Ebert, and G.F. Herman, 1988: Mean and turbulence structure of the summertime Arctic cloudy boundary layer. *Quart. J. Roy. Met. Soc.*, 114, 715-746.
9. Curry, J.A., 1988: Arctic cloudiness in spring from satellite imagery: some comments. *J. Climatol.*, 8, 543-549.
10. Curry, J.A. and C.-H. Moeng, 1989: Role of cloud-top radiative cooling in the production of turbulence kinetic energy. *IRS'88: Current Problems in Atmospheric Radiation*, 60-63.
11. Curry, J.A., F.G. Meyer and E.E. Ebert, 1989: Cloudless ice-crystal precipitation in the polar regions. *IRS '88: Current Problems in Atmospheric Radiation*, 80-83.
12. Tian, L. and J.A. Curry, 1989: Cloud overlap statistics. *J. Geophys. Res.*, 94, 9925-9935.
13. Curry, J.A. and E.E. Ebert, 1990: Sensitivity of the thickness of Arctic sea ice to the optical properties of clouds. *Ann. Glaciol.*, 14, 43-46.
14. Curry, J.A., F.G. Meyer, L.F. Radke, C.A. Brock, E.E. Ebert, 1990: The occurrence and characteristics of lower tropospheric ice crystals in the Arctic. *Int. J. Climatol.*, 10, 749-764.
15. Curry, J.A., C.D. Ardeel, and L. Tian, 1990: Liquid water content and precipitation characteristics of stratiform clouds as inferred from satellite microwave measurements. *J. Geophys. Res.*, 95, 16659-16671.
16. Meyer, F.G., J.A. Curry, C.A. Brock and L.F. Radke, 1991: Springtime visibility in the Arctic. *J. Appl. Meteor.*, 30, 342-357.
17. Ebert, E.E. and J.A. Curry, 1992: A parameterization of cirrus cloud optical properties for climate models. *J. Geophys. Res.*, 97, 3831-3836.
18. Sheu, R.-S. and J.A. Curry, 1992: Interactions between North Atlantic clouds and the large-scale environment. *Mon. Wea. Rev.*, 120, 261-278.
19. Curry, J.A. and G. Liu, 1992: Assessment of aircraft icing potential using satellite data. *J. Appl. Meteor.*, 31, 605-621.
20. Curry, J.A. and E.E. Ebert, 1992: Annual cycle of radiative fluxes over the Arctic Ocean: Sensitivity to cloud optical properties. *J. Climate*, 5, 1267-1280.

21. Liu, G. and J.A. Curry, 1992: Retrieval of precipitation from satellite microwave measurements using both emission and scattering. *J. Geophys. Res.*, 97, 9959-9974.
22. Ebert, E. and J.A. Curry, 1993: An intermediate one-dimensional thermodynamic sea ice model for investigating ice-atmosphere interactions. *J. Geophys. Res.*, 98, 10085-10109.
23. Tan, Y.C. and J.A. Curry, 1993: A diagnostic study of the evolution of an intense North American anticyclone during winter 1989. *Mon. Wea. Rev.*, 121, 961-975.
24. Liu, G. and J.A. Curry, 1993: Determination of characteristics of cloud liquid water from satellite microwave measurements. *J. Geophys. Res.*, 98, 5069-5092.
25. Wilson, L.D., J.A. Curry, and T.P. Ackerman, 1993: On the satellite retrieval of lower tropospheric ice crystal clouds in the polar regions. *J. Climate*, 6, 1467-1472.
26. Curry, J.A., J. Schramm and E.E. Ebert, 1993: Impact of clouds on the surface radiation budget of the Arctic Ocean. *Meteor. and Atmos. Phys.*, 57, 197-217.
27. Curry, J.A. and L.F. Radke, 1993: Possible role of ice crystals in ozone destruction of the lower Arctic atmosphere. *Atmos. Environ.*, 27, 2873-2879.
28. Curry, J.A. et al., 1994: New Program to Research Issues of Global Climate in the Arctic. *EOS*, 75, 249-252.
29. Liu, G., J.A. Curry and M. Weadon, 1994: Atmospheric water balance in Typhoon Nina as determined from SSM/I satellite data. *Meteor. Atmos. Phys.* 54, 141-156.
30. Curry, J.A., J. Schramm and E. E. Ebert, 1995: On the sea ice albedo climate feedback mechanism. *J. Climate*, 8, 240-247.
31. Curry, J.A., 1995: Interactions Among Aerosols, Clouds and Climate of the Arctic Ocean. *The Science of the Total Environment*, 160/161, 777-791.
32. Liu, G., J.A. Curry, and C.A. Clayson, 1995: Study of tropical cyclogenesis using satellite data. *Meteor. Atmos. Phys.*, 56, 111-123.
33. Pinto, J.O., J.A. Curry and K.L. McInnes, 1995: Atmospheric convective plumes emanating from leads. Part I: Thermodynamic structure. *J. Geophys. Res.*, 100, 4621-4632.
34. Pinto, J.O. and J.A. Curry, 1995: Atmospheric convective plumes emanating from leads. Part II: Cloud microphysical and radiative properties. *J. Geophys. Res.*, 100, 4633- 642.
35. Alam, A. and J.A. Curry, 1995: Lead-induced atmospheric circulations. *J. Geophys. Res.*, 100, 4643-4652.
36. McInnes, K.L. and J.A. Curry, 1995: Modelling the mean and turbulent structure of the summertime Arctic cloudy boundary layer. *Bound. Lay. Meteor.*, 73, 125-143.
37. Liu, G., J.A. Curry, and R.S. Sheu, 1995: Classification of clouds over the western equatorial Pacific Ocean using combined infrared and microwave satellite data. *J. Geophys. Res.*, 100, 13,811-13,826.
38. Curry, J.A., J.L. Schramm, M.C. Serreze, and E.E. Ebert, 1995: Water vapor feedback over the Arctic Ocean. *J. Geophys. Res.*, 100, 14,223-14,229.
39. Ebert, E.E., J.L. Schramm, and J.A. Curry, 1995: Disposition of shortwave radiation in sea ice. *J. Geophys. Res.*, 100, 15965-15976.
40. Curry, J.A., D. Randall, and W.B. Rossow, and J.L. Schramm, 1996: Overview of arctic cloud and radiation characteristics. *J. Clim.*, 9, 1731-1764.
41. Webster, P.J., C.A. Clayson, and J.A. Curry, 1996: Clouds, radiation, and the diurnal cycle of sea surface temperature in the tropical western Pacific. *J. Clim.*, 9, 1712-1730.

42. Considine, G. and J.A. Curry, 1996: A statistical model of drop size spectra for stratocumulus clouds. *Quart. J. Roy. Meteor. Soc.*, 122, 611-634.
43. Sheu, R.-S., J. A. Curry, and G. Liu, 1996: Satellite retrieval of tropical rainfall using ISCCP analyses and microwave measurements. *J. Geophys. Res.*, 101, 21291-21301.
44. Liu, G., J.A. Curry, 1996: Large-scale cloud features during winter in the north Atlantic Ocean determined from SSM/I and SSM/T2 observations. *J. Geophys. Res.*, 101, 7019-7032.
45. Clayson, C.A. and J.A. Curry, 1996: Determination of surface turbulent fluxes for TOGA COARE: Comparison of satellite retrievals and in situ measurements. *J. Geophys. Res.*, 101, 28,503-28,513.
46. Clayson, C.A., C.W. Fairall, and J.A. Curry, 1996: Evaluation of turbulent fluxes at the ocean surface using surface renewal theory. *J. Geophys. Res.*, 101, 28,515-28,528.
47. Sheu, R.-S., J.A. Curry, and G. Liu, 1997: Vertical Stratification of Tropical Cloud Properties as Determined from Satellite. *J. Geophys. Res.*, 102, 4231-4246.
48. Duane, G. and J.A. Curry, 1997: Entropy of a convecting water-air system and the interpretation of cloud morphogenesis. *Quart. J. Roy. Meteorol. Soc.*, 123, 605-629
49. Schramm, J.L., M. Holland, J.A. Curry, and E.E. Ebert, 1997: Modeling the thermodynamics of a distribution of sea ice thicknesses. Part I: Sensitivity to ice thickness resolution. *J. Geophys. Res.*, 102, 23079-23092.
50. Holland, M., J.A. Curry, J.L. Schramm, 1997: Modeling the thermodynamics of distribution of sea ice thicknesses. Part II: Ice/ocean interactions. *J. Geophys. Res.*, 102, 23093-23108.
51. Pinto, J.O., J.A. Curry, and C.W. Fairall, 1997: Radiative characteristics of the Arctic atmosphere during spring as inferred from ground-based measurements. *J. Geophys. Res.*, 102, 6941-6952.
52. Liu, G. and J.A. Curry, 1997: Precipitation characteristics in the GIN Seas determined using satellite microwave data. *J. Geophys. Res.*, 102, 13987-13998.
53. Curry, J.A., J.O. Pinto, T. Benner, and M. Tschudi, 1997: Evolution of the cloudy boundary layer during the autumnal freezing of the Beaufort Sea. *J. Geophys. Res.*, 102, 13851-13860.
54. Pinto, J.O. and J.A. Curry, 1997: Role of radiative transfer in the modeled mesoscale development of summertime arctic stratus. *J. Geophys. Res.*, 102, 13861-13872.
55. Alam, A. and J.A. Curry, 1997: Determination of surface turbulent fluxes over leads in arctic sea ice. *J. Geophys. Res.*, 102, 3331-3344.
56. Considine, G., J.A. Curry, and B.A. Wielicki, 1997: Modeling cloud fraction and horizontal variability in boundary layer clouds. *J. Geophys. Res.*, 102, 13
57. Schramm, J.L., M.M. Holland, and J.A. Curry, 1997: Applications of a single-column ice/ocean model understanding the mass balance of sea ice and snow in the Central Arctic. *Ann. Glaciol.*, 25, 287-291.
58. Holland, M.M., J.L. Schramm, and J.A. Curry, 1997: *Thermodynamic feedback processes in a single-column sea ice/ocean model.* *Ann. Glaciol.*, 25, 327-332.
59. Arbetter, T., J.A. Curry, M.M. Holland, and J. M. Maslanik, 1997: Response of sea ice models to perturbations in surface heat flux. *Ann. Glaciol.*, 25, 193-197.
60. Tschudi, M., J.A. Curry, and J.M. Maslanik, 1997: Determination of areal surface feature coverage in the Beaufort Sea using aircraft video data. *Ann. Glaciol.*, 25, 434-438.

61. Considine, G. and J.A. Curry, 1998: Role of entrainment and droplet sedimentation on the microphysical structure in stratus and stratocumulus clouds. *Quart. J. Roy. Meteorol. Soc.*, 24, 123-150.
62. Randall, D., J. A. Curry, et al., 1998: Outlook for Large-Scale Modelling of Atmosphere Ice-Ocean Interactions in the Arctic. *Bull. Amer. Meteor. Soc.*, 70, 197-219.
63. Liu, G. and J.A. Curry, 1998: Remote sensing of ice water characteristics in tropical clouds using aircraft microwave measurements. *J. Appl. Meteor.*, 37, 337-355.
64. Liu, G. and J. A. Curry, 1998: An investigation of the relationship between emission and scattering signals in SSM/I data. *J. Atmos. Sci.*, 55, 1628-1643.
65. Alam, A. and J.A. Curry, 1998: Evolution of new ice and turbulent fluxes from freezing Arctic leads. *J. Geophys. Res.*, 103, 15,783-15,802.
66. Benner, T.C. and J.A. Curry, 1998: Characteristics of small tropical cumulus clouds and their impact on the environment. *J. Geophys. Res.*, 103, 28753-28768.
67. Webster, P.J. and J.A. Curry, 1998: The Oceans and Weather. *Scien. Amer.*, 9, 38-43.
68. Stamnes, K., Ellingson, R.G., J.A. Curry, J.E. Walsh, and B. D. Zak, 1999: Review of science issues and deployment strategies for the North Slope of Alaska/Adjacent Arctic Ocean (NSA/AAO) ARM site. *J. Climate*, 12, 46-63.
69. Pinto, J.O., J.A. Curry, and A.H. Lynch, 1999: Modeling clouds and radiation for the November 1997 period of SHEBA using a column climate model. *J. Geophys. Res.*, 104, 6661-6678.
70. Liu, G. and J.A. Curry, 1999: Tropical ice water amount and its relations to other atmospheric hydrological parameters as inferred from satellite data *J. Appl. Meteor.*, 38, 1182-1194.
71. Khvorostyanov, V.I., and J.A. Curry, 1999: A simple analytical model of aerosol properties with account for hygroscopic growth. Part I: Equilibrium size spectra and CCN activity spectra. *J. Geophys. Res.*, 104, 2163-2174.
72. Khvorostyanov, V.I., and J.A. Curry, 1999: A simple analytical model of aerosol properties with account for hygroscopic growth. Part II: Scattering and absorption coefficients. *J. Geophys. Res.*, 104, 2175-2184.
73. Perovich, D. K., E.L. Andreas, J.A. Curry, et al., 1999: Year on ice gives climate insights. *EOS*, 80, 481.
74. Khvorostyanov, V.I. and J.A. Curry, 1999: Theory of Stochastic Condensation in Clouds. Part I: A General Kinetic Equation. *J. Atmos. Sci*, 56, 3985-3996.
75. Khvorostyanov, V.I. and J.A. Curry, 1999: Theory of Stochastic Condensation in Clouds. Part II: Analytical Solutions of the Gamma-Distribution Type. *J. Atmos. Sci*, 56, 3997-4013.
76. Arbetter, T.E., J.A. Curry, and J.A. Maslanik, 1999: On the effects of rheology and ice thickness distribution in a dynamic-thermodynamic sea ice model. *J. Phys. Oceanog.*, 29, 2656-2670
77. Holland, M.M. and J.A. Curry, 1999: The role of different physical process in determining the interdecadal variability of Arctic sea ice. *J. Climate*, 12, 3319-3330.
78. Curry, J.A. et al., 1999: High-resolution satellite-derived dataset of the ocean surface fluxes of heat, freshwater and momentum for the TOGA COARE IOP. *Bull. Amer. Meteorol. Soc.*, 80, 2059-2080.

79. Kosovic, B., and J.A. Curry, 2000: A quasi steady state of a stable stratified atmospheric boundary layer: a large-eddy simulation study. *J. Atmos. Sci.*, 57, 1052-1068.
80. Jiang, H. W.R. Cotton, J.O. Pinto, J.A. Curry, and M.J. Weissbluth, 2000: Sensitivity of mixed-phase Arctic stratocumulus to ice forming nuclei and large-scale heat and moisture advection. *J. Atmos. Sci.*, 57, 2105-2117..
81. Liu, G. and J.A. Curry, 2000: Determination of ice water path and mass median particle size using multichannel microwave measurements. *J. Appl. Meteor.*, 39, 1318-1329.
82. Schramm, J.L., G. M. Flato, and J.A. Curry, 2000: Towards the modeling of enhanced basal melting in ridge keels. *J. Geophys. Res.*, 105, 14081-14092.
83. Khvorostyanov, V.I. and J.A. Curry, 2000: A New Theory of Heterogeneous Ice Nucleation for Application in Cloud and Climate Models. *Geophys. Res. Lett.*, 27 , 4081-4084.
84. Curry, J.A., J.L. Schramm, D. Perovich, and J.O. Pinto, 2001: Application of SHEBA/FIRE data to evaluation of sea ice surface albedo parameterizations. *J. Geophys. Res.*, 106, 15345-15356.
85. Pinto, J.O., J.A. Curry, and J. Intrieri, 2001: Cloud-aerosol interactions during autumn over the Beaufort Sea. *J. Geophys. Res.*, 106, 15077-15098.
86. Haggerty, J.A., and J.A. Curry, 2001: Microwave emissivity of sea ice estimated from aircraft measurements during FIRE-SHEBA. *J. Geophys. Res.*, 106, 15265-15278.
87. Tschudi, M., J.A. Curry, and J.M. Maslanik, 2001: Airborne observations of summertime surface features and their effect on surface albedo during SHEBA. *J. Geophys. Res.*, 106, 15335-15344.
88. Benner, T., J.A. Curry, and J.O. Pinto, 2001: Radiative transfer in the summertime Arctic. *J. Geophys. Res.*, 106, 15173-15184.
89. Girard, E. and J.A. Curry, 2001: Simulation of arctic low-level clouds observed during the FIRE Arctic Clouds Experiment using a new bulk microphysics scheme. *J. Geophys. Res.*, 106, 15139-15154.
90. Khvorostyanov, V.I., J.A. Curry et al., 2001: Evaluation of an explicit microphysics scheme using observations of an upper-level cloud system observed during FIRE.ACE. *J. Geophys. Res.*, 106, 15099-15112.
91. Curry, J.A., 2001: Introduction to special section: FIRE Arctic Clouds Experiment. *J. Geophys. Res.*, 106, 14985-14989
92. Holland, G.H., P.J. Webster, J.A. Curry, et al., 2001: The Aerosonde robotic aircraft: A new paradigm for environmental observations. *Bull. Amer. Meteorol. Soc.*, 82, 889-901.
93. Lin, B., P. Minnis, A. Fan, J.A. Curry, et al., 2001: Comparison of cloud liquid water paths derived from in situ and microwave radiometer data taken during the SHEBA/FIREACE. *Geophys. Res. Lett.*, 28, 975-978
94. Liu, G., J.A. Curry, J.A. Haggerty, and Y. Fu, 2001: Retrieval and Characterization of Cloud Liquid Water Path Using Airborne Passive Microwave Data during INDOEX. *J. Geophys. Res.*, 106, 28,719-28,730.
95. Tschudi, M., J.A. Curry, and J. Maslanik, 2002: Characterization of springtime leads in the Arctic Ocean from airborne observations during FIRE/SHEBA. *J. Geophys. Res.*, 107, art no. 8034

96. Uttal, T., Curry, J.A., and 26 others, 2002: Surface Heat Budget of the Arctic Ocean. *Bull. Amer. Meteor. Soc.*, 83, 255-275.
97. Curry, J.A. and A.H. Lynch, 2002: Comparing Arctic Regional Climate Models. *EOS*, Trans. Amer. Geophys. Union, 83, p 87.
98. Pinto, J.O., A. Alam., J.A. Maslanik, and J.A. Curry, 2003: Characteristics and atmospheric footprint of springtime leads at SHEBA. *J. Geophys. Res.*, 108, art no 8051..
99. Haggerty, J.A., J.A. Maslanik, and J.A. Curry, 2003: Heterogeneity of sea ice surface temperature at SHEBA from aircraft measurements. *J. Geophys. Res.*, 108, art no. 8052.
100. Curry, J.A., J.L. Schramm, A. Alam, R. Reeder, T.E. Arbetter, P. Guest, 2002: Evaluation of data sets used to force sea ice models in the Arctic Ocean. *J. Geophys Res.*, 107, art. no 3102.
101. Haggerty, J.A., J.A. Curry, and G. Liu, 2002: The potential for estimating cloud liquid water path over sea ice from airborne passive microwave measurements. *J. Geophys. Res.*, 107, art. No. 4007.
102. Randall, D., S. Krueger, C. Bretherton, J.A. Curry, et al., 2003: Confronting Models with Data: The GEWEX Cloud System Study. *Bull. Amer. Meteor. Soc.*, 84, 455-469
103. Khvorostyanov, V.I. and J.A. Curry, 2002: Terminal Velocities of Droplets and Crystals: Power Laws with Continuous Parameters Over the Size Spectrum. *J. Atmos. Sci.*, 59. 1872-1884.
104. Khvorostyanov, V.I., J.A. Curry, I. Gultepe, 2003: Simulations and observations of springtime cloud over the Cape Bathurst polynya. *J. Geophys. Res.*, 108 Art. No. 4296
105. Liu, G. and J.A. Curry, 2003: Observation and Interpretation of Microwave "Hot Spots" Over the Arctic Ocean During Winter. *J. Appl. Met.*, 42, 51-64.
106. Liu, G., H. Shao, J.A. Coakley, J.A. Curry, et al., 2003: Retrieval of Cloud Droplet Size from Visible and Microwave Radiometric Measurements during INDOEX: Implication to Aerosols Indirect Radiative Effect. *J. Geophys. Res.*, 108 (D1): art. no. 4006.
107. Morison, H., M. Shupe, J.A. Curry, 2003: Evaluation of a bulk microphysical scheme using SHEBA data. *J. Geophys. Res.*, 108, art no. 4225.
108. Brunke, M.A., C.W. Fairall, X. Zeng, L. Eymard, J.A. Curry, 2003: Which bulk aerodynamic algorithms are least problematic in computing ocean surface turbulent fluxes? *J. Clim.*, 15, 619-635.
109. Liu, J.P., J.A. Curry, and D.G. Martinson, 2004: Interpretation of recent Antarctic sea ice variability. *Geophys. Res. Lett.*, 31, Art. No. L02205.
110. Khvorostyanov, V.I., J.A. Curry, 2004: Toward the theory of heterogeneous ice nucleation. Part I: Critical radius, energy and nucleation rate. *J. Atmos. Sci.*, 61, 2676-2691.
111. Curry, J.A., J.M. Maslanik, G.J. Holland, and J.O. Pinto, 2004: Applications of Aerosondes in the Arctic. *Bull. Amer. Meteorol. Soc.*, 85,1855-1861.
112. Agudelo, P.A. and J.A. Curry, 2004: Analysis of spatial distribution in tropospheric temperature trends. *Geophys. Res. Lett.*, 31, Art. No. L222207.
113. Inoue, J. and J.A. Curry, 2004: Application of Aerosondes to high-resolution observations of sea surface temperature over Barrow Canyon. *Geophys. Res. Lett.*, 31, Art. No. L14312.
114. Liu, J.P., J.A. Curry and Y.Y. Hu, 2004: Recent Arctic sea ice variability: connections to the Arctic Oscillation and the ENSO. *Geophys. Res. Lett.*, 31, L09211.

115. Curry, J.A. and 22 others, 2004: SEAFLEX. *Bull. Amer. Meteor. Soc.*, 85, 409-419.
116. Khvorostyanov, V.I. and J.A. Curry, 2004: On the Thermodynamic Theory of Freezing and Melting of Water and its Solutions: *J. Phys. Chem. A*, 108, 11073-11085.
117. Lynch, A.H., J. A. Curry, et al., 2004: Towards an integrated assessment of the impacts of extreme wind events on Barrow, Alaska. *Bull. Amer. Meteorol. Soc.*, 85, 209+
118. Khvorostyanov, V.I. and J.A. Curry, 2005: Toward the theory of heterogeneous ice nucleation. Part II: Parcel model simulations. *J. Atmos. Sci.*, 62, 261-284.
119. Mirocha, J.D., B. Kosovic, J.A. Curry, 2005: Vertical heat transfer in the lower atmosphere over the Arctic Ocean during clear sky periods. *Bound. Layer Meteorol.*, 117, 37-71.
120. Inoue, J., B. Kosovic and J.A. Curry, 2005: Evolution of a storm-driven boundary layer in the Arctic. *Bound. Layer Meteorol.*, 117, 213-230.
121. Morrison, H., J.A. Curry, V.I. Khvorostyanov, 2005: A new double-moment microphysics parameterization. Part 1: Description. *J. Atmos. Sci.*, 62, 1665-1677.
122. Morrison, H. J.A. Curry, et al., 2005: A new double-moment microphysics parameter-ization. Part 2: Application to Arctic stratiform clouds. *J. Atmos. Sci.*, 62, 1678-1693.
123. Liu, J., J.A. Curry, W. B. Rossow, J.R. Key, X. Wang, 2005: Comparison of surface radiative flux data sets over the Arctic Ocean. *J. Geophys. Res.*, 110, Art. No. C02015.
124. Khvorostyanov, V.I., J.A. Curry, 2005: Fall Velocities of Hydrometeors in the Atmosphere: Refinements to a Continuous Quasi - Power Law. *J. Atmos. Sci.*, 62, 4343-4357.
125. Morrison, H., M. Shupe, J.O. Pinto, J.A. Curry, 2005: Possible role roles of ice nucleation mode and ice nuclei depletion in the extended lifetime of arctic mixed phase clouds. *Geophys. Res. Lett.*, 32 (18): Art. No. L18801.
126. Webster, P.J., G.J. Holland, J.A. Curry, H.-R. Chang, 2005: Changes in tropical cyclone number, duration and intensity in a warming environment. *Science*. 309 (5742): 1844-1846
127. Inoue, J., J. Liu and J.A. Curry, 2005: Intercomparison of arctic regional climate models: Modeling clouds and radiation for SHEBA in May 1998. *J. Climate*, 19, 4167-4178.
128. Agudelo, P.A., J.A. Curry, C.D. Hoyos, P.J. Webster, 2006: Transition between suppressed and active phases of ISOs in the Indo-Pacific warm pool. *J. Climate*, 19, 5515-5530.
129. Rinke, A., K. Dethloff, J. Cassano, J.A. Curry, et al., 2006: Evaluation of an Ensemble of Arctic Regional Climate Models: Spatiotemporal Fields during the SHEBA Year. *Climate Dyn.*, 26, 459-472.
130. Khvorostyanov, V.I., H. Morrison, J.A. Curry, P. Lawson, D. Baumgardner, 2006: High supersaturation and modes of ice nucleation in thin tropopause cirrus: Simulation of the 13 July 2002 CRYSTAL case. *J. Geophys. Res.*, 111., Art. No. D02201.
131. Curry, J.A., P.J. Webster, and G.J. Holland, 2006: Mixing Politics and Science in Testing the Hypothesis that Greenhouse Warming is Causing an Increase in Hurricane Intensity. *Bull. Amer. Meteorol. Soc.*, 87, 1025-1037.
132. Khvorostyanov, V.I. and J.A. Curry, 2006: Aerosol Size Spectra and CCN Activity Spectra: Reconciling the Lognormal and Power Laws. *J. Geophys. Res.*, 111, Art. D12202.
133. Hoyos, C.D., P.A. Agudelo, P.J. Webster, J.A. Curry, 2006: Deconvolution of the factors contributing to the increase in global hurricane activity. *Science* 312, (5770).

134. Webster, P.J., J.A. Curry, J. Liu, G.J. Holland, 2006: Response to comment on “Changes in tropical cyclone frequency and intensity in a warming environment”. *Science*, 311 (5768).
135. Liu, J.P. and J.A. Curry, 2006: Variability of the tropical and subtropical ocean surface latent heat flux during 1989-2000. *Geophys. Res. Lett.*, 33, Art. No L05706.
136. Inoue J, Liu JP, Pinto JO, et al., 2006: Intercomparison of Arctic Regional Climate Models: Modeling clouds and radiation for SHEBA in May 1998 *J. Climate*, 19, 4167-4178
137. Agudelo PA, Curry JA, Hoyos CD, PJ Webster, 2006: Transition between suppressed and active phases of intraseasonal oscillations in the Indo-Pacific warm pool. *J. Clim.*, 19, 5519-5530
138. Khvorostyanov VI, Curry JA, 2007: Refinements to the Köhler's theory of aerosol equilibrium radii, size spectra, and droplet activation: Effects of humidity and insoluble fraction *J. Geophys. Res.*, 112 (D5): Art. No. D05206
139. Liu JP, Curry JA, Dai YJ, et al., 2007: Causes of the northern high-latitude land surface winter climate change. *Geophys. Res. Lett.*, 34 (14): Art. No. L14702
140. Wyser, K., Jones, CG, . . ., Curry JA et al., 2008: An evaluation of Arctic cloud and radiation processes during the SHEBA year: simulation results from eight Arctic regional climate models. *Climate Dynamics*, 30, 203-223.
141. Inoue, J., Curry JA, Maslanik JA, 2008: Application of Aerosondes to melt pond observations over Arctic sea ice. *J. Atmos. Ocean Tech.*, 25, 237-334.
142. Khvorostyanov, V. I., J. A. Curry, 2008. Analytical solutions to the stochastic kinetic eqn for liquid and ice particle size spectra. Part I: small-size fraction. *J. Atmos. Sci.*, 65, 2025-2043
143. Khvorostyanov, V. I. and J. A. Curry, 2008. Analytical Solutions to the Stochastic Kinetic Equation for Liquid and Ice Particle Size Spectra. Part II: Large-Size Fraction in Precipitating Clouds. *J. Atmos. Sci.*, 65, 2044-2063.
144. Khvorostyanov, V. I. and J. A. Curry, 2008. Kinetics of cloud drop formation and its parameterization for cloud and climate models. *J. Atmos. Sci.*, 65, 2784-2802
145. Morrison, H., J.O. Pinto, J.A. Curry, G.M. McFarquhar, 2008: Sensitivity of M-PACE mixed-phase stratocumulus to cloud condensation and ice nuclei in a mesoscale model with two-moment bulk cloud microphysics. *J. Geophys. Res.*, 113, D05203
146. Agudelo, P.A., C. D. Hoyos, P. J. Webster, J. A. Curry, 2008: Prediction skill of intraseasonal variability of an operational model in a serial extended forecast experiment. *Climate Dynamics*, 32, 855-872.
147. Khvorostyanov, VI and JA Curry, 2009: Critical humidities of homogeneous and heterogeneous ice nucleation: inferences from extended classical nucleation theory. *J. Geophys. Res.*, 114, D04207.
148. Kim, HM, PJ Webster, JA Curry, 2009: Impact of shifting patterns of Pacific Ocean Warming on North Atlantic tropical cyclones. *Science*, 325, 77-80.
149. Khvorostyanov, VI, JA Curry, 2009: Parameterization of cloud drop activation based on analytical asymptotic solutions to the supersaturation equation. *J. Atmos. Sci.*, 66, 1905-1925.
150. Khvorostyanov, VI, JA Curry, 2009: Comment on “Comparisons with analytical solutions from Khvorostyanov and Curry (2007) on the critical droplet radii and

- supersaturations of CCN with insoluble fractions” by Kokkola et al. (2008). *Atmos. Chem. Phys.*, 9, 6033-6039.
151. Belanger, JI, JA Curry, CD Hoyos, 2009: Variability in tornado frequency associated with U.S. landfalling tropical cyclones. *Geophys. Res. Lett.*, 36, L17805.
  152. Liu, J. and JA Curry, 2010: Accelerated warming of the Southern Ocean and its impacts on the hydrological cycle and sea ice. *PNAS*, 107, 14987-14992.
  153. Sokolik, I.N., J. A. Curry, and V. Radionov, 2010: Interactions of Arctic aerosols with land-cover and land-use changes in Northern Eurasia and their role in the Arctic climate system. In *Arctic land-cover and land-use in a changing climate: Focus on Eurasia*, G.Gutman and A. Reissell (Eds.), Springer.
  154. Romanou A, Tselioudis G, Zerefos CS, Curry JA et al. 2010: Evaporation-precipitation variability over the Mediterranean and the Black Seas from satellite and reanalysis estimates. *J. Climate*, 23, 5268-5287.
  155. Webster PJ, Jian J, Hopson TM, Hoyos CD, Agudelo PA, Chang HR, Curry JA, Grossman RL, Palmer TN, Subbiah AR, 2010: Extended-range probabilistic forecasts of Ganges and Brahmaputra floods in Bangladesh. *Bull. Amer. Meteorol. Soc.*, 91, 1493-U121.
  156. Belanger JI, Curry JA, Webster PJ, 2010: Predictability of North Atlantic Tropical Cyclone Activity on Intraseasonal Time Scales. *Mon. Weather Rev.*, 138, 4362-4374.
  157. Liu JP, Curry JA, Zhang ZH, et al. 2011: Evaluation of satellite sea surface temperatures in the southern hemisphere using Chinese Antarctic research cruise observations. *Int. J. Rem. Sens.*, 32, 171-184.
  158. Agudelo PA, Hoyos CD, Curry JA, Webster, PJ, 2011: Probabilistic discrimination between large-scale environments of intensifying and decaying African Easterly Waves. *Clim. Dyn*, 36, 1379-1401.
  159. Kim HM, Webster PJ, Curry JA, 2011: Modulation of North Pacific Tropical Cyclone Activity by Three Phases of ENSO. *J. Climate*, 24, 1839-1849.
  160. Liu, J., Curry JA, Clayson CA, Bourassa, MA 2011: High resolution satellite surface latent heat fluxes in North Atlantic hurricanes. *Mon Weather Rev.*, 139, 2735-2747.
  161. Curry, JA 2011: Reasoning about climate uncertainty. *Climatic Change*, 108, 723-732 (invited).
  162. Curry, JA and Webster PJ 2011: Climate science and the uncertainty monster. *Bull Amer Meteorol. Soc.*, 92, 1667-1682.
  163. Curry, JA 2011: Nullifying the climate null hypothesis. *WIREs Climate Change*, 2, DOI: 10.1002/wcc.141
  164. Zhang, H., I. N. Sokolik, and J. A. Curry, 2011: Impact of Saharan dust as nucleating aerosols on Hurricane Helene’s early development, *Atmos. Chem. Phys. Disc.*, acp-2011-246, 2011.
  164. Liu, J. J.A. Curry et al. 2012: Impact of declining sea ice on Arctic snowfall. *PNAS*, 109, 4074-4079.
  166. Choi, S., Wang, Y., . . . Curry, J., et al., 2012: Analysis of satellite-derived Arctic tropospheric BrO columns in conjunction with aircraft measurements during ARCTAS and ARCPAC, *Atmos. Chem. Phys.*, 12, 1255-1285.
  167. Curry, JA and VI Khvorostyanov, 2012: Assessments of parameterizations of ice heterogeneous nucleation in cloud and climate models. *Atmos. Phys. Chem.*, 10, 2669–2710

168. Belanger, J. I., P. J. Webster, J. A. Curry, and M. T. Jelinek, 2012: Extended Prediction of North Indian Ocean Tropical Cyclones, *Weather & Forecasting*, 27, 757-769.
169. Kim, H. M., P. J. Webster and J. A. Curry, 2012: Seasonal prediction skill of ECMWF System 4 and NCEP CFSv2 retrospective forecast for the Northern Hemisphere Winter, *Climate Dynamics*, DOI: 10.1007/s00382-012-1364-6.
170. Kim, HM, PJ Webster, JA Curry 2012: Evaluation of short-term climate change predictions in multi-model CMIP5 decadal hindcasts. *Geophys. Res. Lett.*, 39, L10701.
171. Liu, J and JA Curry, 2012: Reply to Li and Wu: Arctic sea ice and winter snowfall. *PNAS*, 109, E1899-E1900.
172. Young, AH, JJ Bates, JA Curry, 2012: Complementary use of passive and active remote sensing for detecting penetrating convection from CloudSat, CALIPSO, and Aqua MODIS. *J. Geophys Res. – Atmos.*, 117, D13205.
173. Khvorostyanov, VI and JA Curry, 2012: Parameterization of homogeneous ice nucleation for cloud and climate models based on classical nucleation theory. *Atmos. Chem. Phys.*, in press.
174. Hellmuth, O., JA Curry, et al. 2013: Review on the phenomenology of and mechanism of atmospheric ice formation: selected questions of interest. In JWP Schmelzer, G Ropke, VB Priezzhev, eds.: *Nucleation Theory and Its Applications*, JINR Dubna, p 424-543.
175. Liu, J., JA Curry, HJ Wang, JM Horton, MR Song, 2012: Reply to Li and Wu: Arctic sea ice and winter snowfall. *PNAS*, 109, E1899-E1900.
176. Muller, R., J.A. Curry, et al. 2013: Decadal variations in the global land temperature. *J. Geophys. Res.*, 118, 5280–5286.
177. Wickham, C., R. Rohde, R. Muller, J. Wurtele, J.A. Curry, et al. 2013: Influence of urban heating on the global temperature land average using rural sites identified from MODIS classifications. *Geoinformatics & Geostatistics*, doi:10.4172/gigs.1000104.
178. Rohde, R., R. Muller, R. Jacobsen, S. Perlmutter, A. Rosenfeld, J. Wurtele, D. Groom, J.A. Curry, C. Wickham, 2013: Berkeley Earth Temperature Averaging Process. *Geoinformatics and Geostatistics*, doi:10.4172/gigs.1000103.
179. Muller, R., J. Wurtele, R. Rohde, R. Jacobsen, S. Perlmutter, A. Rosenfeld, JA Curry, et al, 2013: Earth atmosphere land surface temperature and station quality in the United States. *Geoinformatics and Geostatistics*, doi:10.4172/2327-4581.1000107.
180. Curry JA, 2013: Climate change: No consensus on consensus. *CAB Reviews*, 8, 001.
181. Holley, AH, JJ Bates and JA Curry, 2013: Application of cloud vertical structure from CloudSat to investigate MODIS-derived properties of cirriform, anvil, and deep convective clouds. *J. Geophys. Res.*, DOI: 10.1002/jgrd.50306.
182. Wyatt, MG and JA Curry, 2013: Dynamics of the propagation of a secularly varying hemispheric climate signal during the 20<sup>th</sup> century. *Climate Dynamics*, DOI 10.1007/s003821-013-1950-2.
183. Liu, J., JA Curry, H. Wang, R. Horton, MR Song, 2014: Reply to Li and Wu: Arctic sea ice and winter snowfall. *PNAS*, 111, E530.
184. Curry JA, 2014: Climate science: Uncertain temperature trends. *Nature Geoscience*, 7, 83-84.
185. Kravtsov, S., MG Wyatt, JA Curry, A Tsonis, 2014: Two contrasting views of multidecadal climate variability in the 20<sup>th</sup> century. *Geophys. Res. Lett.*, 41, 6881-6888.

186. Lewis, N. and JA Curry, 2015: The implications for climate sensitivity of AR5 forcing and heat uptake estimates. *Climate Dynamics*, DOI 10.1007/s00382-2342-y.
187. Kravtsov, S., M.G. Wyatt, J.A. Curry, A.A. Tsonis, 2015: Comment on 'Atlantic and Pacific multidecadal oscillations and Northern Hemisphere Temperatures.' *Science*, 350 DOI: 10.1126/science.aab3570
188. Belanger, J.I., J.A. Curry, M.T. Jelinek, 2016: A climatology of easterly waves in the tropical Western Hemisphere. *Geoscience Data Journal*
189. Lewis, N. and JA Curry, 2018: The impact of recent forcing and ocean heat uptake data on estimates of climate sensitivity. *Journal of Climate*, 31, 6051-6071
190. Lewis, N. and JA Curry, 2020: Reply to Comment on: The impact of recent forcing and ocean heat uptake data on estimates of climate sensitivity. *Journal of Climate*, 33, 397-404.

### Recent Invited Lectures

- *Probabilistic subseasonal weather forecasts for the energy sector*. NOAA Webinar Series, June 2, 2020
- *Beyond ENSO: new signals of seasonal to interannual predictability*. Annual meeting of the Weather Risk Management Assoc., June 5, 2018, Miami, FL
- *Climate sensitivity: lopping off the fat tail*. 2nd International Workshop on Econometrics Applications in Climatology. Guelph, Ontario, Apr 23, 2015
- *Panel Discussion on Climate Change*, Winter Meeting of the National Association of Regulatory Utility Commissioners (NARUC), Washington DC, Feb 10, 2015
- *State of the Climate Debate*, Tampa Chapter of the Georgia Tech Alumni Association, Nov 13, 2014
- *State of the Climate Debate*, Ohio University, Nov 10, 2014
- *Sea ice physical processes*, Nanjing University, Oct 10, 2014
- *Climate dynamics of sea ice*, Nanjing University, Oct 11, 2014
- *State of the Climate Debate*, Oberlin University, Oct 1, 2014
- *Panel Discussion- Science of Climate Change*, At the Crossroads: Energy and Climate Policy Summit, Houston, Sept 25, 2014
- *State of the Climate Debate*, George Marshall RoundTable, National Press Club, Washington DC, Sept 16, 2014
- *Global climate change: The science & the debate & the solutions*. Columbus GA Chapter of the Georgia Tech Alumni Association, Apr 24, 2014
- *The scientific debate on climate change*. World Affairs Conference, Boulder, CO, Apr 9, 2014.
- *Causes and implications of the growing discrepancy between climate models and observations*, American Physical Society Meeting, March 2014, Denver,
- *Statement on the IPCC AR5 WGI Report*, American Physical Society Climate Change Statement Workshop, New York City, January 2014,
- *Generating possibility distributions of scenarios for regional climate change*. UK-US Workshop on Climate Science Needed to Support Robust Adaptation Decisions. Feb 2014, Atlanta

- *A 21<sup>st</sup> century perspective on climate models from a climate scientist.* Workshop on the Roles of Climate Models: Epistemic, Ethical and Socio-political Perspectives Oct 2013, Eindhoven, The Netherlands
- *Application of ECMWF forecast products for the energy sector.* European Centre for Medium Range Weather Forecasting Annual Users Meeting, June 7, 2013
- *The impact of declining Arctic sea ice on northern hemisphere winter weather.* American Geophysical Union Fall meeting: December 7, 2012, San Francisco.
- *Climate models: fit for what purpose?* Royal Society Workshop on Handling Uncertainty in Weather and Climate Prediction Applications: October 5, 2012, London.
- *Berkeley Earth Temperature Project.* American Physical Society meeting, April 3, 2012, Atlanta.
- *What can we learn from climate models?* Department of Energy BERAC, February 27, 2012, Washington DC.
- *Research integrity and scientific responsibility.* U.N. InterAcademy Council (IAC) Norway meeting: January 26, 2012
- *Engaging the public on climate change.* American Geophysical Union Fall meeting: December 11, 2011, San Francisco.
- *Climate Science and the Uncertainty Monster.* Santa Fe Conference on Climate Change: November 2, 2011
- *A critical look at the IPCC AR4 attribution argument.* Santa Fe Conference on Climate Change: November 3, 2011
- *Climate Science and the Uncertainty Monster.* Victor Starr Memorial Lecture at the Massachusetts Institute for Technology: September 30, 2011, Boston
- *Climate Science and the Uncertainty Monster.* American Chemical Society Annual Meeting (Denver): August 28, 2011, Denver

## ENGAGEMENT in SCIENCE and TECHNOLOGY POLICY

### Congressional Testimony

- Testimony, House Committee on Science, Space and Technology, “Using Technology to Address Climate Change,” 5/16/18
- Testimony, House Committee on Science Space and Technology, “Climate Science: Assumptions, Policy Implications and the Scientific Method,” 3/29/17  
<https://curryja.files.wordpress.com/2017/03/curry-house-science-testimony-mar-17.pdf>
- Testimony, Senate Subcommittee on Space, Science and Competitiveness, “Data or Dogma? Promoting Open Inquiry in the Debate Over the Magnitude of Human Impact on Climate Change,” 12/8/15 <https://curryja.files.wordpress.com/2015/12/curry-senate-testimony-2015.pdf>
- Testimony, House Committee on Science, Space and Technology, “The President’s U.N. Climate Pledge,” 4/15/15, <https://curryja.files.wordpress.com/2015/04/house-science-testimony-apr-15-final.pdf>

- Testimony, Senate Environment and Public Works, “President’s Climate Action Plan,” 1/16/14  
[http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore\\_id=07472bb4-3eeb-42da-a49d-964165860275](http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=07472bb4-3eeb-42da-a49d-964165860275)
- Testimony, Senate Committee on Environment and Public Works, "Natural Resource Adaptation: Protecting Ecosystems and Economies," 10/2/13  
<https://curryja.files.wordpress.com/2020/05/curry-senatetestimony-2013.pdf>
- Testimony, House Subcommittee on Energy & Environment, “Policy Relevant Climate Issues in Context”, 4/26/13 <http://curryja.files.wordpress.com/2013/04/curry-testimony-2013-il.pdf>
- Testimony, House Subcommittee on Energy & Environment, “Rational Discussion of Climate Change: the Science, the Evidence, the Response,” 11/17/10  
<http://curryja.files.wordpress.com/2013/02/curry-epw-testimony.pdf>
- Testimony, House Select Committee on Energy Independence and Global Warming, “Dangerous Climate Change,” 4/26/07  
<http://curryja.files.wordpress.com/2013/02/energy-curry-testimony.pdf>
- Testimony, House Reform Committee, “Hurricanes and Global Warming,” 7/20/06  
<http://curry.eas.gatech.edu/climate/pdf/testimony-curry.pdf>

### Essays on the Integrity of Science

- Opinion: Can scientists rebuild trust in Climate Science? *Physics Today*, 2/10/10  
[http://www.physicstoday.org/daily\\_edition/politics\\_and\\_policy/1.2531584](http://www.physicstoday.org/daily_edition/politics_and_policy/1.2531584)
- An open letter to graduate students and young scientists in fields related to climate research. NYTimes <http://dotearth.blogs.nytimes.com/2009/11/27/a-climate-scientist-on-climate-skeptics/>
- Research Integrity and Scientific Responsibility. U.N. InterAcademy Council (IAC) Norway 1/26/12 <http://judithcurry.com/2012/01/26/questions-on-research-integrity-and-scientific-responsibility-part-ii/>

### Weblog

- Proprietor of the weblog Climate Etc. <http://www.judithcurry.com>  
Climate Etc. provides a forum for climate researchers, academics and technical experts from other fields, citizen scientists, and the interested public to engage in a discussion on topics related to climate science and the science-policy interface.