

TESTIMONY OF DR. MICHAEL E. MANN

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BEFORE THE

**COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY.**

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Mr. Chairman, and members of the Committee. My name is Michael Mann. I am Distinguished Professor of Atmospheric Science at Penn State University, and Director of the Penn State Earth System Science Center. My research involves the use of climate models, the analysis of empirical climate data, and developing methods for comparing observations and model predictions. The primary focus of my research is understanding the long-term behavior of the climate system, and determining the roles of various potential agents of climate change, both natural and human.

I have served as organizing committee chair for the National Academy of Sciences *Frontiers of Science*, and as the co-author or advisor for several National Academy of Sciences reports related to climate change. I have served as editor for the *Journal of Climate* of the American Meteorological Society and have served as a member of numerous other international and U.S. scientific working groups, panels and steering committees. I was awarded the Hans Oeschger Medal of the European Geophysical Union in 2012 and received the Friend of the Planet Award from the National Center for Science Education in 2014. I am a Fellow of the American Geophysical Union, the American Meteorological Society, and the American Association for the Advancement of Science. I have authored more than 200 publications, and several books including *Dire Predictions: Understanding Climate Change*, *The Hockey Stick and the Climate Wars* and *The Madhouse Effect: How Climate Change Denial Is Threatening Our Planet*, *Destroying Our Politics*, and *Driving Us Crazy* with Tom Toles, the Pulitzer Prize-winning editorial cartoonist for the *Washington Post*.

Let me first comment about *why* I went into science. I was fascinated by the natural world as a child and wanted to devote my life to understanding it. This led me on a lifelong journey of scientific discovery that is every bit as thrilling to me today as it was

as a child. When the science has broader societal importance, that's icing on the cake. Earlier this week, for example, my colleagues and I published a study in the journal *Scientific Reports* using a combination of observations and climate model simulations to demonstrate a linkage between climate change and jet stream behavior linked to extreme, persistent weather events like the 2011 Texas & Oklahoma Drought and the 2015 California wildfires. Continuing to pose questions and to seek to answer them using scientific tools and observations—that's what I truly love doing.

But I'm here today because I'm also passionate about communicating what we know to the public and to policymakers. I have [become convinced](#) that no pursuit could be more noble. So about this hearing: It is important to make clear at the outset that there is extremely broad agreement among the world's scientists on the basic facts of human-caused climate change. The U.S. National Academy of Sciences, the Royal Society of the U.K., and [all of the scientific societies](#)¹ of all of the industrial nations—the [more than 30 scientific societies](#)² in the U.S. that have weighed in on the matter, and [at least 97%](#)³ of scientist publishing in the field have all concluded, based on the evidence, that climate change is real, is human-caused, and is already having adverse impacts on us, our economy, and our planet.

Yet we find ourselves at this hearing today, with three individuals who represent that tiny minority that reject this consensus or downplay its significance, and only one—myself—who is in the mainstream. That's 25%, a far cry from the 97-99% figure that actually characterizes where the world's scientists stand on this issue. This creates the

¹ [Joint science academies' statement: Global response to climate change](#), 2005

² "Scientific Consensus on Global Warming", Union of Concerned Scientists: http://www.ucsusa.org/global_warming/science_and_impacts/science/scientific-consensus-on.html#.WNfu6I61v_Q

³ John Cook *et al* 2016 *Environ. Res. Lett.* **11** 048002

illusion of a debate that does not exist. This is not an auspicious start for a hearing that purports to be examining science rather than antiscience, fact rather than fiction.

I coined the term “Serengeti Strategy” back in 2012 in “[The Hockey Stick and the Climate Wars](#)”⁴ 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.

I should know. I’ve [found myself](#)⁵ at the center of such episodes more than once, as a result of the iconic “hockey stick” that my co-authors and I published in the late 1990s that demonstrates the unprecedented nature of recent warming. While the hockey stick is [hardly the basis](#)⁶ of the case for human-caused climate change, the visually compelling character of the graphic has made it—and indeed, me—a target of climate change deniers for years.

In October 2003 just days before a critical U.S. Senate resolution to acknowledge the threat of human-caused climate change, an “article” was published by climate change-denial friendly “journal” that engaged in dubious attacks on the hockey stick. A fossil fuel industry front group published an op-ed trumpeting the specious criticisms in *USA Today* on the morning of the Senate vote. Senator James Inhofe of “climate change

⁴ Mann, M.E., *The Hockey Stick and the Climate Wars*, Columbia University Press (2012)

⁵ Ibid 4

⁶ What If ... the “Hockey Stick” Were Wrong? By Stefan Rahmstorf, RealClimate.org, Jan 27, 2005.

is the [greatest hoax](#)⁷ ever perpetrated on the American people” infamy happily trumpeted the article during the senate floor debate. While the critique on the hockey stick would soon be [summarily dismissed](#)⁸, it served the short-term purpose of hijacking the discussion. The bill did not pass.

In 2005, as the House of Representatives was considering energy and climate legislation, Joe Barton (R-TX), Chair of the House Energy and Commerce Committee and a leading recipient of fossil fuel money engaged in what was widely condemned as a “[witch-hunt](#)”⁹ against me and my hockey stick co-authors. Barton demanded all of my personal emails and correspondence with other scientists, and numerous other materials, in an apparent effort to find something, anything, he could use to try to discredit the iconic Hockey Stick. In the cynical minds of our critics, discrediting our work would somehow undermine the entire case for concern over human-caused climate change.

On the eve of the Copenhagen U.N. climate summit of December 2009—seen as the greatest opportunity yet for an international agreement to limit greenhouse gas emissions, a trove of emails, including many of my own—had been stolen, and combed through for words and phrases (like “trick”—a completely appropriate term in science for a clever approach) that might seem embarrassing or even damning. The out-of-context snippets were posted on climate change deniers’ websites and then spread through right-wing blogs and news sites. Soon even mainstream news organizations were credulously parroting the denialist narrative that a few stolen emails somehow called into question the fundamental evidence behind human-caused climate change, a result of [nearly two](#)

⁷ Inhofe: Calling Climate Change “The Greatest Hoax Ever” Is “Doing The Lord’s Work” by Joe Romm, Climate Progress, Dec 5, 2011.

⁸ “Global warming debate heats up Capitol Hill” by Dan Vergano, USA Today, Nov 18, 2003.

⁹ “Republicans accused of witch-hunt against climate change scientists” by Paul Brown, The Guardian, Aug 30, 2005.

[centuries](#)¹⁰ of scientific research. I and a small number of other leading climate scientists found ourselves at the very center of the smear campaign.

At least 10 investigations and reviews [have established](#)¹¹ that there was no wrongdoing on the part of the scientists (indeed, the only wrongdoing was the criminal theft of the emails in the first place). The vindications, however, occurred long after fossil fuel interests and those doing their bidding had the opportunity to sabotage efforts to reach an international agreement limiting carbon emissions (Oil-rich Saudi Arabia, for example, [insisted](#)¹² in Copenhagen that the stolen emails justified opposition to any agreement to limit carbon emissions; Russia also appears to have played some role in the hacking and/or dissemination of the emails).

We now have the latest in this perpetual series of bad-faith assaults on climate science, and the story is eerily familiar. The attacks, as always, have focused on a particular individual—in this case, [Tom Karl](#)¹³, the recently retired Director of NOAA’s National Climatic Data Center and a scientist for whom I have the deepest respect.

For proper context, we must consider the climate denial myth *du jour* that global warming has “stopped”. Like most climate denial talking points, the reality is pretty much the opposite of what is being claimed by the contrarians. All surface temperature products, including the controversial UAB satellite temperature record, show a clear long-term warming trend over the past several decades (Exhibit A). We have now broken

¹⁰ “Two Centuries of Climate Science: part one – Fourier to Arrhenius, 1820- 1930 by John Mason, *Skeptical Science*, Apr 26, 2012.

¹¹ “Debunking Misinformation About Stolen Climate Emails in the “Climategate” Manufactured Controversy”, Union of Concerned Scientists: http://www.ucsusa.org/global_warming/solutions/fight-misinformation/debunking-misinformation-stolen-emails-climategate.html

¹² ‘Climategate’: Hacked e-mails show climate scientists in a bad light but don't change scientific consensus on global warming. By [Jess Henig](#), FactCheck.org, Dec 10, 2009.

¹³ “Tom Karl Retires After Nearly 41 Years of Service”, NOAA Press Release, Aug 4, 2016.

the all-time global temperature record for [three consecutive years](#)¹⁴ and a number of published articles have convincingly demonstrated that global warming has continued unabated despite when one properly accounts for the vagaries of natural short-term climate fluctuations. A prominent [such study](#)¹⁵ was published by Tom Karl and colleagues in 2015 in the leading journal *Science*. The article was widely viewed as the final nail in the “globe has stopped warming” talking point’s coffin.

Last month, opinion writer David Rose of the British tabloid the *Daily Mail*—[known for](#)¹⁶ his serial misrepresentations of climate change and his serial attacks on climate scientists, published a [commentary](#)¹⁷ online attacking Tom Karl, accusing him of having “manipulated global warming data” in the 2015 Karl et al article. This fake news story was built entirely on an interview with a single disgruntled former NOAA employee, John Bates, who had been demoted from a supervisory position at NOAA for his inability to work well with others.

Bates’ allegations were also published on the blog of climate science denier Judith Curry (I use the term carefully—reserving it for those who deny the most basic findings of the scientific community, which includes the fact that human activity is substantially or entirely responsible for the large-scale warming we have seen over the past century—something [Judith Curry](#)¹⁸ [disputes](#)¹⁹). That blog post and the *Daily Mail* story have now

¹⁴ “How 2016 Became Earth’s Hottest Year on Record” by Jugal K. Patel, *New York Times*, Jan 18, 2017.

¹⁵ Karl et al, “Possible artifacts of data biases in the recent global surface warming hiatus”, *Science*, 348, pp. 1469-1472 (2015).

¹⁶ See the DeSmogBlog entry for David Rose: <https://www.desmogblog.com/david-rose>

¹⁷ “Exposed: How world leaders were duped into investing billions over manipulated global warming data” by David Rose, *The Daily Mail* (UK), Feb 4, 2017.

¹⁸ “Scott Pruitt’s office deluged with angry callers after he questions the science of global warming” by Juliet Eilperin and Brady Dennis, *Washington Post*, March 11, 2017.

¹⁹ “IPCC attribution statements redux: A response to Judith Curry” by Gavin Schmidt, *RealClimate.org*, Aug 27, 2014.

been thoroughly debunked by the actual [scientific community](#)²⁰. The *Daily Mail* claim that data in the Karl et al. *Science* article had been manipulated was not supported by Bates. When the scientific community pushed back on the untenable “data manipulation” claim, noting that other groups of scientists had [independently confirmed](#)²¹ Karl et al’s findings, Bates [clarified](#) that the real problem was that data had not been properly archived and that the paper was rushed to publication. These claims too quickly fell apart.

Though Bates claimed that the data from the Karl et al study was “not in machine-readable form”, independent scientist Zeke Hausfather, lead author of [a study](#)²² that accessed the data and confirmed its validity, [wrote in a commentary](#)²³ "...for the life of me I can't figure out what that means. My computer can read it fine, and it's the same format that other groups use to present their data." As for the claim that the paper was rushed to publication, Editor-in-chief of *Science* Jeremy Berg says, “With regard to the ‘rush’ to publish, as of 2013, the median time from submission to online publication by *Science* was 109 days, or less than four months. The article by Karl *et al.* underwent handling and review for almost six months. Any suggestion that the review of this paper was ‘rushed’ is baseless and without merit. *Science* stands behind its handling of this paper, which underwent particularly rigorous peer review.”

Shortly after the *Daily Mail* article went live, a video attacking Karl (and NOAA and even NASA for good measure) was posted by the *Wall Street Journal*. Within hours,

²⁰ “Climate Change, Science, NOAA Falsely Maligned by Tabloid Spin” , *Climate Nexus*, <http://climatenexus.org/messaging-communication/current-events/climate-change-science-noaa-falsely-maligned-tabloid-spin>

²¹ Hausfather et al, “Assessing recent warming using instrumentally homogeneous sea surface temperature records”, *Science Advances*, 3, e1601207 (2017).

²² Ibid 21

²³ “Factcheck: Mail on Sunday’s ‘astonishing evidence’ about global temperature rise” by Zeke Hausfather, *Carbon Brief*, Feb 5, 2017: <https://www.carbonbrief.org/factcheck-mail-sundays-astonishing-evidence-global-temperature-rise>

the *Daily Mail* story spread like a virus through the right-wing blogosphere, appearing on numerous right-wing websites and conservative news sites. It didn't take long for the entire Murdoch media empire in the U.S, U.K. and elsewhere to join in, with the execrable *Fox New* for example [alleging](#)²⁴ Tom Karl had “cooked” climate data and, with no sense of irony, for *political reasons*.

Rep. Lamar Smith (R-TX), chair of this committee has [a history](#)²⁵ of launching attacks on climate science and climate scientists. He quickly posted a press release praising the *Daily Mail* article, placing it on the science committee website, and falsely alleging that government scientists had “falsified data”. Smith, it turns out, had been planning a congressional hearing timed to happen just days after this latest dustup, intended to [call into question](#)²⁶ the basis for the EPA regulating carbon emissions. His accusations against Karl and NOAA of tampering with climate data was used in that hearing to claim that the entire case for concern over climate change was now undermined.

Of course, even if the Karl study was completely wrong, it wouldn't in any way alter what we know about climate change. Just as our critics have intentionally ignored the many independent [studies reaffirming](#)²⁷ the “Hockey Stick’ curve in the peer-reviewed scientific literature (see Exhibit B), so too have Karl's critics ignored that his findings have been replicated and confirmed by other research groups publishing in the

²⁴ “Federal scientist cooked climate change books ahead of Obama presentation, whistle blower charges”, *Fox News* (Feb 17, 2017).

²⁵ “The Assault on Climate Science” by Michael E. Mann, *New York Times*, Dec 8, 2015.

²⁶ “Global warming skeptic Lamar Smith sets “Make EPA Great Again” hearing” by [Kiah Collier](#), *Texas Tribune*, Feb. 2, 2017

²⁷ “Most Comprehensive Paleoclimate Reconstruction Confirms Hockey Stick” by Stefan Rahmstorf, *Climate Progress*, Jul 8, 2013: <https://thinkprogress.org/most-comprehensive-paleoclimate-reconstruction-confirms-hockey-stick-e7ce8c3a2384#.p1bm8mmfd>

peer-reviewed literature. That includes [the study](#)²⁸ led by Zeke Hausfather of the “Berkeley Earth” project—a project funded in part by the Koch Brothers and [including](#)²⁹ as one of its original team members, climate change contrarian Judith Curry. The authors showed that the Karl et al estimates agree with the best available independent estimates of ocean warming (see Exhibit C). Lead author Hausfather has [stated](#)³⁰ that “The fact that the new NOAA record is effectively identical with records constructed only from higher quality instruments (buoys, satellite radiometers, and Argo floats) strongly suggests that NOAA got it right and that we have been underestimating ocean warming in recent years.”

Let me make some additional observations with regard to this latest episode. Climate contrarians like to accuse scientists of understating uncertainty. Anyone who knows scientists and is familiar with scientific research understands how absurd that accusation is. Scientists embrace the concept of uncertainty, because it guides us—it informs our choices of what additional measurements to make and hypotheses to pursue. I would note that our 1999 “hockey stick” article that is so much maligned by climate change deniers, contained the words “uncertainties” and “limitations” in the title. Let me also remind you that the implications of scientific “uncertainty” are rather different from what your contrarian witnesses would like you to believe. Leading economists like Harvard’s Marty Weitzman [have shown that](#)³¹ uncertainty is most likely a reason for even more concerted action to mitigate climate change because of what is known as the “heavy tail” of the distribution of risk, namely the huge potential costs if the impacts turn out to

²⁸ Ibid 21

²⁹ Sourcwatch page on Judith Curry: http://www.sourcwatch.org/index.php/Judith_Curry

³⁰ Ibid 23

³¹ “Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change” by Martin L. Weitzman, Symposium on Fat Tails and the Economics of Climate Change, Oxford University Press, 2011.

be even greater than predicted, something that appears to be the case now with the [potential rapid collapse](#)³² of the West Antarctic Ice Sheet and the increased sea level rise that will come with it.

Contrarians also falsely accuse scientists of conspiring to enforce “dogma”. But the way scientists get articles in leading journals like *Science* or *Nature* is by demonstrating something novel—something we didn’t already know, not by simply re-iterating what is known. And herein lies a conundrum for those attacking the Karl et al study. One of the articles seized upon in a previous hearing by Chairman Smith as a supposed indictment of Karl et al is a *Nature Climate Change* [article](#)³³ (Fyfe *et al* 2016) on which I was a co-author. As a co-author of this article, I can assure you that it in no way calls into question the integrity of NOAA’s data, or the honesty of Tom Karl and his colleagues, whom I hold in the highest esteem. We simply differed with them on the best interpretation of the temperature record, demonstrating that the interpretation of whether or not there was a temporary slowdown in warming during the first decade of the 21st century depends on precisely how the baseline warming trend is defined.

Chairman Smith can’t have it both ways. This study can’t both be an indictment of Tom Karl and colleagues and at the same time support the Chairman’s conspiracy theories about climate scientists colluding with each other and being compromised by “groupthink”. What our *Nature Climate Change* piece actually demonstrates is that there is indeed a robust, healthy, and respectful debate among scientists when it comes to interpreting data and testing hypotheses. True scientists are skeptics—real skeptics,

³² “Climate Model Predicts West Antarctic Ice Sheet Could Melt Rapidly” by Justin Gillis, *New York Times*, Mar 30, 2016.

³³ Fyfe J. et al, “Making sense of the early-2000s warming slowdown” *Nature Climate Change*, 6, 224–228 (2016)

contesting prevailing paradigms and challenging each other, in the peer-reviewed literature, at scientific meetings, and in seminars—the proper channels for good faith scientific debate. That, of course, is inconvenient to the caricature that Congressman Smith and his contrarians witnesses have sought to paint when it comes to climate science and climate scientists.

While we're at it, let me address another favorite talking point of the critics, the claim that climate models we use to project future climate change are unreliable and untested. The reality is that the models have been tested vigorously and rigorously in numerous ways, and have passed a number of impressive tests in the past, such as James Hansen's [famous successful predictions](#)³⁴ from the 1980s and 1990s. Let me take the opportunity to bring your attention to [one particular analysis](#)³⁵ that appears in the latest issue of *Nature Climate Change*. Back in 1989, legendary climate scientists Ron Stouffer (a graduate of our program at Penn State I'm proud to say) and Suki Manabe made a prediction not just of the average warming of the globe, but of the precise global pattern of that warming. That pattern matches the observed pattern of warming that has ensued remarkably well (see Exhibit D).

When I was [attacked by Joe Barton](#)³⁶ a little more than decade ago over the “hockey stick”, at a time when both houses of congress and the presidency were in the hands of Republicans, I found support in the hands of both the Bush Administration's Office of Science and Technology Policy, and moderate, pro-science, pro-environment Republicans in the Senate and House such as John McCain (R-AZ) and Sherwood Boehlert (R-NY). Mr. Boehlert was the Republican Chairman of this Committee, the

³⁴ “Hansen's 1988 projections” by Gavin Schmidt, *RealClimate.org*, May 15, 2007: <http://www.realclimate.org/index.php/archives/2007/05/hansens-1988-projections/>

³⁵ Stouffer, R.J. and Manabe, S., Assessing temperature pattern projections made in 1989, *Nature Climate Change*, 7, 163-166 (2017).

Science Committee, at the time. Where are these good faith conservatives today? Why are they not speaking out against this latest abuse against science and reason? If they fail to force their concerns, we must worry just how far down the antiscience rabbit hole we'll be going this time.

There is a worthy debate to be had about climate policy. And I am deeply appreciative of the efforts of conservatives like [Bob Inglis](#)³⁷ of South Carolina, former Reagan administration officials [Jakes Baker and George Schultz](#)³⁸, and Republican-led groups like [RepublicEN](#)³⁹ and the [Niskanen Center](#)⁴⁰, to promote conservative solutions to solving the climate problem. It is time for other Republicans to put aside the antiscience and engage instead in the worthy debate to be had about how we solve this great challenge to all of humanity.

³⁶ Ibid 4

³⁷ JFK "Profile In Courage" Award Announcement (2015): <https://www.jfklibrary.org/Events-and-Awards/Profile-in-Courage-Award/Award-Recipients/Congressman-Bob-Inglis-2015.aspx>

³⁸ "Senior Republican statesmen propose replacing Obama's climate policies with a carbon tax" by Chris Mooney and Juliet Eilperin, *Washington Post*, Feb 8, 2017.

³⁹ RepublicEN.org: <http://www.republicen.org/>

⁴⁰ Niskanen Center: <https://niskanencenter.org/>

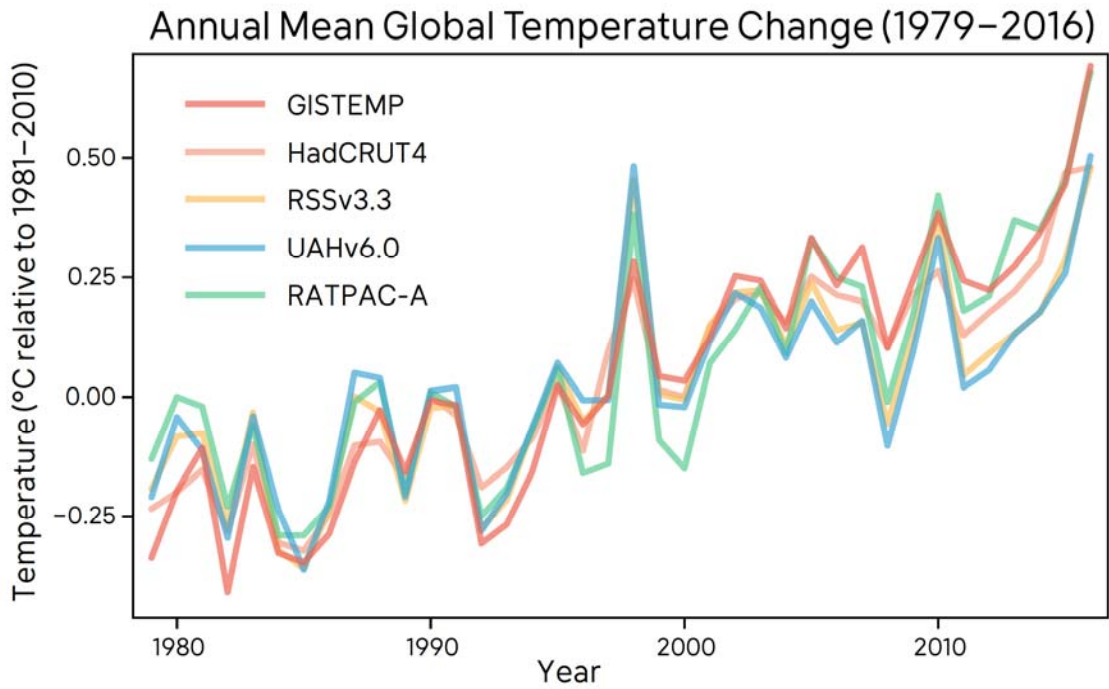


Exhibit A. Comparison of the various surface or lower atmospheric temperature records (during past few decades (Graph by Peter Jacobs of George Mason University)).

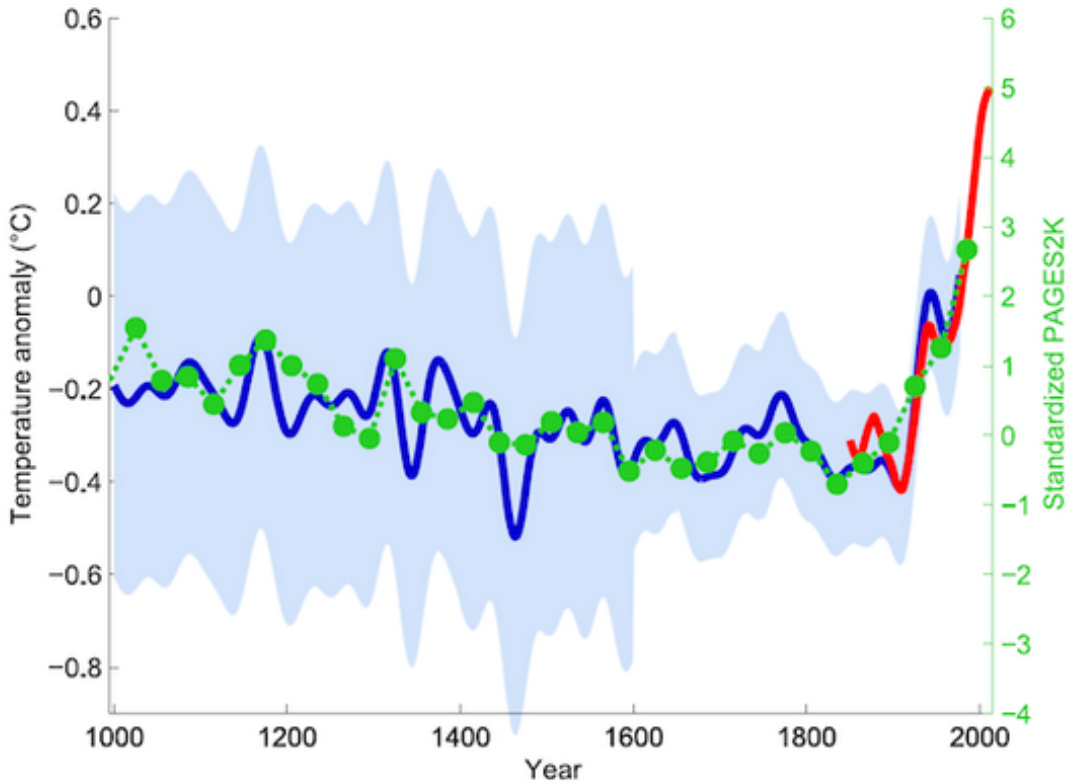


Exhibit B. PAGES 2k temperature reconstruction published by team of 78 scientists around the world using the most widespread paleoclimate database to date (Ahmed *et al*, *Nature Geoscience*, 2014) shown (green) along with the original Mann et al 1999 “Hockey Stick” reconstruction (blue), and instrumental (HadCRUT4) temperature record (red). Blue shading indicates uncertainty in the Mann et al temperature reconstruction (Graph by Klaus Bitterman of Potsdam Institute for Climate Studies).

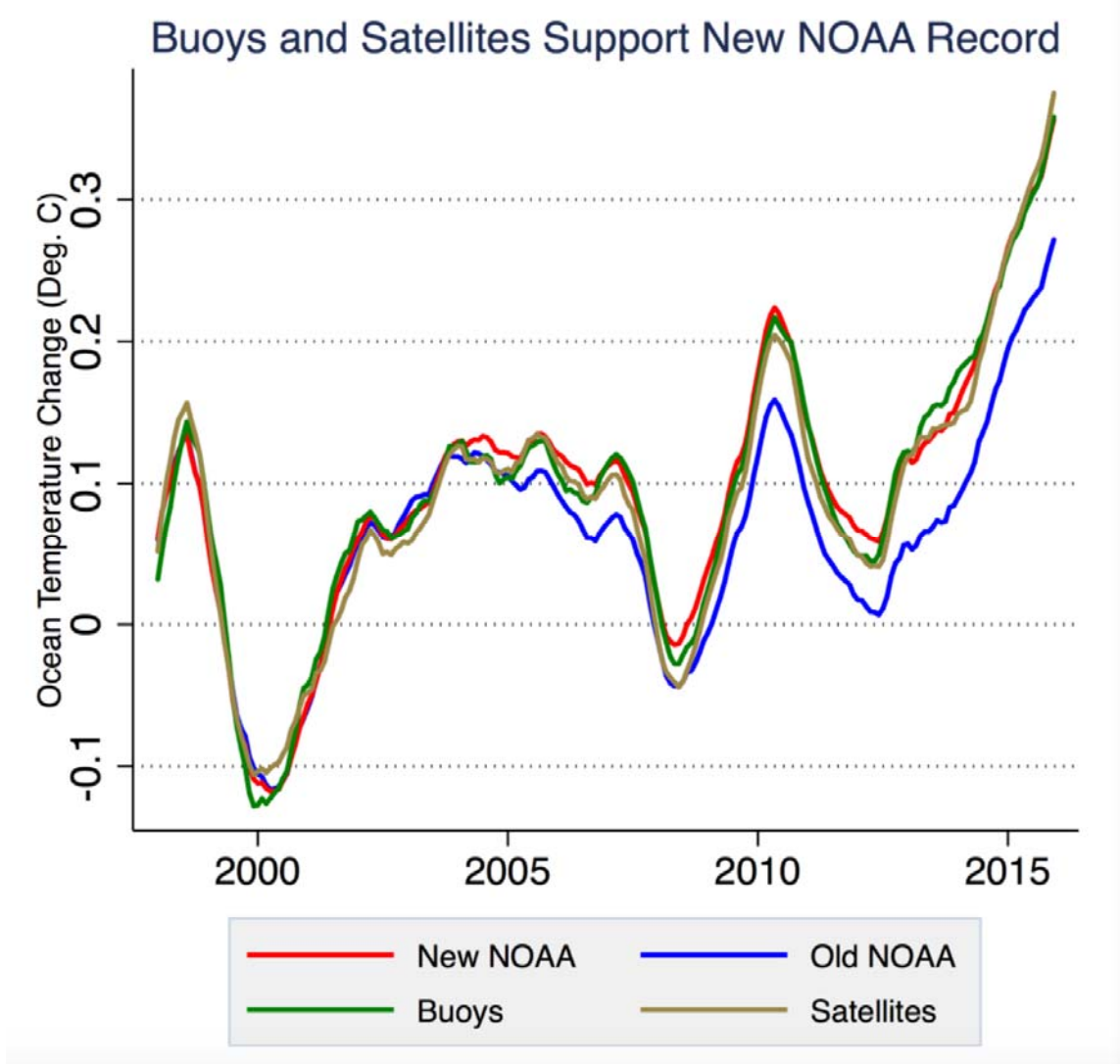


Exhibit C. Global sea surface temperatures from the old NOAA record (ERSSTv3b), the new NOAA record (ERSSTv4), and instrumentally homogenous records from buoys and satellites. See Hausfather et al (2017) for details, as well as comparisons with shorter Argo-based records.



Michael E. Mann

Biographical Sketch

Dr. Michael E. Mann is Distinguished Professor of Atmospheric Science at Penn State University, with joint appointments in the Department of Geosciences and the Earth and Environmental Systems Institute (EESI). He is also director of the Penn State Earth System Science Center (ESSC). Dr. Mann received his undergraduate degrees in Physics and Applied Math from the University of California at Berkeley, an M.S. degree in Physics from Yale University, and a Ph.D. in Geology & Geophysics from Yale University. His research involves the use of theoretical models and observational data to better understand Earth's climate system.

Dr. Mann was a Lead Author on the *Observed Climate Variability and Change* chapter of the Intergovernmental Panel on Climate Change (IPCC) Third Scientific Assessment Report in 2001 and was organizing committee chair for the National Academy of Sciences *Frontiers of Science* in 2003. He has received a number of honors and awards including NOAA's outstanding publication award in 2002 and selection by *Scientific American* as one of the fifty leading visionaries in science and technology in 2002. He contributed, with other IPCC authors, to the award of the 2007 Nobel Peace Prize. He was awarded the Hans Oeschger Medal of the European Geosciences Union in 2012 and was awarded the National Conservation Achievement Award for science by the National Wildlife Federation in 2013. He made Bloomberg News' list of fifty most influential people in 2013. In 2014, he was named Highly Cited Researcher by the Institute for Scientific Information (ISI) and received the Friend of the Planet Award from the National Center for Science Education. He is a Fellow of the American Geophysical Union, the American Meteorological Society, and the American Association for the Advancement of Science. He is also a co-founder of the award-winning science website RealClimate.org.

Dr. Mann is author of more than 200 peer-reviewed and edited publications, and has published three books including *Dire Predictions: Understanding Climate Change*, *The Hockey Stick and the Climate Wars* and most recently, *The Madhouse Effect* with Washington Post editorial cartoonist Tom Toles.