STATEMENT OF
DR. ROGER PIELKE, JR.
to the COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
of the UNITED STATES HOUSE OF REPRESENTATIVES

HEARING on
Climate Science: Assumptions, Policy Implications, and the Scientific Method
2318 Rayburn House Office Building
29 March 2017

My testimony focuses on how members of Congress can better support scientific integrity in climate research and the steps that members can take to avoid contributing to the pathological politicization of science.

Take-Home Points

- Science offers a powerful set of methods, evidence and an orientation to knowledge that can be essential to effective decision making.
- The science and policy communities have together over many decades developed highly credible, legitimate and relevant mechanisms for the assessment of the state of knowledge in any area of relevance to decision making.
- The legislative process is essential to a well-functioning democracy, but it is not well suited to the reliable characterization of the overall state of knowledge on a particular topic.
- How elected officials chose to utilize assessment and legislative processes for characterizing knowledge has great influence over the degree to which science becomes pathologically politicized.
- Ultimately, on complex, political issues like climate policy, reaching agreement on matters of science is neither necessary nor sufficient for policy action to occur.

My Recent Experiences Where Science Meets Politics

Despite publishing many peer reviewed papers on a wide range of climate-related topics with colleagues around the world and having my research included in the reports of the Intergovernmental Panel for Climate Change (IPCC),[1] I experienced an organized effort of delegitimization by members of Congress and the White House, supported by their political allies in the media and in well-funded advocacy groups. These efforts were successful in that they resulted in me re-orienting my academic career away from climate-related research.

Here are some specifics of my experiences over the past few years:

- Several months after I testified before this committee in December, 2013, the White House posted on its website a 6-page essay by the President's Science Advisor,

[1] See: https://scholar.google.com/citations?user=WtqpmdIAAAAJ&hl=en&oi=ao

John Holdren, which claimed falsely that my testimony before this committee was "not representative of mainstream views on this topic in the climate-science community" and was "seriously misleading."[2]

- Science advisor Holdren's false claims were put forward even though my testimony was drawn from and consistent with the most recent reports of the IPCC. I have for decades supported the scientific assessment process of the IPCC and did so explicitly in my 2013 Congressional testimony.
- One year later, Congressman Raul Grijalva (D-AZ) opened a formal investigation of me and six other professors (three of us are testifying here today). In his letter to my university's president, Mr. Grijalva justified the investigation of me by relying on the science advisor's false claims: "John Holdren, director of the White House Office of Science and Technology Policy, has highlighted what he believes were serious misstatements by Prof. Pielke of the scientific consensus on climate change," and cited Dr. Holdren's essay on the White House website.[3]
- In his letter, Mr. Grijalva introduced another false implication -- that I, and the other academics, had "potential conflicts of interest and failure to disclose corporate funding sources."[4] Mr. Grijalva's letter cited Exxon Mobil and the Koch Foundation as possible sources of undisclosed funding that I may have received.
- The communications director for the House Natural Resources Committee explained how we seven academics were chosen to be investigated by Mr. Grijalva: "The way we chose the list of recipients [of Mr. Grijalva's letter] is who has published widely, who has testified in Congress before, who seems to have the most impact on policy in the scientific community."[5]
- Publishing widely, testifying before Congress when asked and doing work with policy impact are usually held up as virtues among academics who are supported with public funds, but not in this circumstance.
- My university conducted the investigation as requested by Mr. Grijalva, and (no surprise to me) found that I have never received any fossil fuel or Koch Foundation funding. In 2016, the University of Colorado's elected Board of Regents issued a statement of support for me and academic freedom more generally.[6]
- Despite being ultimately vindicated about the integrity my research and my funding sources, as well as receiving the strong support of my University's leadership, the investigation proved extremely harmful to my ability to work in the field of climate.
- I have academic tenure (thankfully) and have chosen to shift the focus of my research to other interesting subjects at the intersection of science, policy and politics.

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[2] J. P Holdren, Drought and Global Climate Change: An Analysis of Statements by Roger Pielke Jr., 28 February 2014. (Available at: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/critique_of_pielke_jr_statements_on_drought.pdf)

[3] Letter from Congressman Raul Grijalva (D-AZ) to Bruce Benson, President, University of Colorado, 24 February 2015.

[4] Ibid.

[5] Quoted in: http://www.al.com/news/huntsville/index.ssf/2015/02/arizona_congressman_asking_que.html

[6] I am very proud to be associated with the University of Colorado, whose leadership offered unwavering support throughout my experiences, see: http://www.dailycamera.com/cu-news/ci_30558681/cu-board-shows-support-faculty-students-academic-freedom

- Further details of my experiences can be found in an op-ed included as Appendix A to this testimony.

Lessons of My Experience

- Scientific evidence in support of the conclusions I presented to this committee in 2013 is even stronger today. There is little scientific basis in support of claims that extreme weather events – specifically, hurricanes, floods, drought, tornadoes – and their economic damage have increased in recent decades due to the emission of greenhouse gases. In fact, since 2013 the world and the United States have had a remarkable stretch of good fortune with respect to extreme weather, as compared to the past.
- The lack of evidence to support claims of increasing frequency or intensity of hurricanes, floods, drought or tornadoes on climate timescales is also supported by the most recent assessments of the IPCC and the broader peer reviewed literature on which the IPCC is based.
- I have included an update of relevant data and summary conclusions of the IPCC related to trends in extreme weather as an Appendix B to this testimony.
- My experience as an inconvenient academic is not unique. Politicians, including elected officials in Congress, and enthusiastic advocates from both sides of the aisle have targeted climate researchers whose peer-reviewed research they do not like – including all four witnesses testifying here today. Such dynamics of delegitimization are not unique to the climate issue.
- Academics -- no matter how solid their research may be -- are no match for well-funded advocacy groups, activists in the media, the White House or Congress.
- Members of Congress have great power to delegitimize inconvenient experts, even derail their careers, and in the process, contribute to the pathological politicization of science.
- Members of Congress also have the power to defuse the pathological politicization of science, to uphold scientific integrity and put both science and politics in their proper places.
- This is a bipartisan challenge which can only be addressed with a bipartisan commitment to scientific integrity.

Recommendations to improve the state of scientific integrity in climate science

I have studied and written about science in policy and politics for several decades. I am a part of an international community of scholars and practitioners who focus on the challenges of science advice to governments.[7] There is consequently a deep body of knowledge and evidence on scientific advice – what works, and what does not.

[7] See http://www.ingsa.org/
My most well-known contribution to this area of scholarship and practice is **The Honest Broker: Making Sense of Science in Policy and Politics** (Cambridge University Press, 2007).

Drawing on my experiences, my research and that of the broader community focused on scientific advice I offer the following recommendations focused on how members of Congress can help to improve the state of scientific integrity in climate science.

- Policy makers and scientists have developed well-established established processes for assessing the state of scientific knowledge on subjects of relevance to policy makers.
- Such processes include federal advisory committees, those of the National Academies, the assessments of the IPCC and many others nationally and internationally.
- There is also an enormous academic literature on the role of scientific assessments in policy and politics. Google Scholar lists almost a million articles under the key words "scientific assessments policy politics."[8]
- Assessments of scientific knowledge are most effective when they address questions that policy makers have judged to be relevant to decision making and do so in a way that is viewed to be authoritative, unbiased and inclusive.[9]
- Such processes work best when they accurately characterize areas of uncertainty and ignorance, in addition to what is known with greater certainty. Such accurate characterization is facilitated when assessment processes are populated by a diversity of experts, including those who may hold minority or unpopular perspectives.
- Members of Congress have the standing and authority to call for such assessments, to ensure through oversight that they are conducted with integrity and are responsive to their information requests.
- In contrast, while the legislative process can be extremely effective in highlighting partisan differences on policy, it is not well suited to provide an accurate characterization of the state of scientific understandings.
- Sometimes debates over science serves as a proxy for debates about policy preferences or political orientation. When members of Congress participate in such proxy debates, it contributes to the pathological politicization of science.
- Assessments are best conducted outside the spotlight of high stakes political conflict.
- There is of course a risk that such assessments might be captured by interests, fall prey to groupthink or gatekeeping, or fail to accurately represent scientific understandings. In such instances the assessment process may become viewed as partisan, illegitimate or simply not useful. In my area of expertise this occurred in the Fourth Assessment Report of the IPCC.[10]
- Climate science is a particularly politicized research area, meaning that careful attention should be paid to how assessments are organized and who leads and participates in them.
- Consequently, oversight of the integrity of these assessments is an important and appropriate role for Congressional committees, among others.

[8] https://scholar.google.com/scholar?q=scientific+assessments+policy+politics&btnG=&hl=en&as_sdt=0%2C6

[9] Sarewitz, D., & Pielke, R. A. (2007). The neglected heart of science policy: reconciling supply of and demand for science. *Environmental Science & Policy*, **10**:5-16.

[10] See Chapter 6 of *The Climate Fix* for details.

- However, the investigation of individual researchers (whether governmental on non-governmental) is not an appropriate role for Congress and is unlikely to contribute positively to the upholding of scientific integrity.
- A bipartisan truce ending such investigations of individual researchers should start immediately.
- Congress should support the role of scientific assessments in providing an accurate perspective on questions asked by policy makers. In climate, the IPCC, if it did not exist, would have to be invented. If members of Congress wish to to secure robust answers to questions of climate science, impacts or economics, they might look to the IPCC.
- However, if the IPCC is not viewed to be legitimate, then Congress could easily request the US National Academy of Sciences (or other authoritative body) to empanel a high level, unimpeachable assessment process. Such assessments related to climate have of course been done for decades and the overarching scientific conclusions have remained consistent.
- We have plenty of knowledge and experience about how to arrive at accurate assessments of the state of scientific understandings on any topic. It is a choice whether or not to utilize that knowledge and experience.
- Irrespective of the state of scientific understandings, policy action related to energy policies and improving adaptation to climate variability and change does not require that everyone believe the same things about climate science or that all uncertainties be eliminated.[11]

To avoid any confusion – My views on climate science and policy

Because the climate issue is so deeply politicized, it is necessary to include several statements to clearly present my views. The following conclusions are taken from my book *The Climate Fix* in a section titled "Guidelines for a Common Sense Approach to Climate Policy" (Chapter 1, pp. 32-34). In that book I call for a low but rising carbon tax to fund energy innovation, focused on cleaner, cheaper and more broadly accessible energy technologies. If the world's economy is to decarbonize, it will be because of advances in energy technology, and not because everyone comes to hold the same views of climate science.[12]

Increasing Carbon Dioxide Influences the Climate System, Perhaps Dramatically and Irreversibly

That human activities have led to changes in the earth system is broadly accepted. So too is the possibility that such changes could lead to undesirable outcomes in the future. For those wanting to know more—much more—about aspects of climate science, the report of Working Group I of the IPCC is an excellent place to start further investigations, even as aspects of that report continue to be contested.

[11] See: **The Climate Fix: What Scientists and Politicians Won't Tell you About Global Warming** (2011, Basic Books)

[12] More broadly see: Rayner, S., & Caine, M., **The Hartwell Approach to Climate Policy**. (Routledge, 2014).

The Climate System Is Subject to Multiple Human Influences

Carbon dioxide … is not the only important human influence. The climate system is complex and is still not fully characterized. Even so, many scientists and policy makers have concluded that dealing with carbon dioxide should be a top policy priority.

Our Ability to See the Future Is Limited

There are debates about how the future will play out that simply cannot be resolved on the timescales of decision making. Efforts to gain clarity about the future may in fact have the paradoxical consequence of making that future even cloudier. Decisions about climate change will occur in the context of contestation, uncertainties and ignorance.

Certainty Is Not Forthcoming

As decisions are made about decarbonizing economies and improving adaptation to climate in the coming years, certainties about the long-term climate future are not forthcoming. UK science adviser John Beddington explains, "There is a fundamental uncertainty about climate change prediction that can't be changed." As Andy Revkin summarizes his years of covering the climate debate: "What the debate comes down to is not whether changes are coming but when they'll occur—and how severe they'll be. There is serious scientific disagreement about such vital questions as how fast and far temperatures, seas, and storm strength could rise." Such disagreements will persist for the foreseeable future. Uncertainties are a reality to be lived with and managed. They are not going away.

Stabilizing Atmospheric Concentrations of Carbon Dioxide Does Not Stop Climate Change

Carbon policy is not a comprehensive climate policy. It is possible that the world could successfully address accumulating concentrations of carbon dioxide in the atmosphere and still have to deal with a significant issue of human influences on the climate system. For this reason, among others, Mike Hulme has written that climate change is a problem to be managed, not solved.[13] Our debates about climate change would benefit by distinguishing carbon policies from greenhouse gas policies and broader conceptions of climate policy.

[13] Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge University Press.

Biography of Roger Pielke Jr.

Roger Pielke, Jr. has been on the faculty of the University of Colorado since 2001. Currently, he serves as the director of the Sports Governance Center, a new initiative on campus, and faculty affiliate of the Center for Science and Technology Policy Research. He is a Professor in the Environmental Studies Program and from 2001-2016 was a Fellow of the Cooperative Institute for Research in Environmental Sciences (CIRES). Roger served several terms as the founding director of the university's Center for Science and Technology Policy Research. Roger's research focuses on science, innovation and politics, which he has explored in many topical areas over recent decades, including: space policy, natural disasters, energy policy, climate policy and more recently, in sports governance.

Roger holds degrees in mathematics, public policy and political science, all from the University of Colorado. In 2012 Roger was awarded an honorary doctorate from Linköping University in Sweden and he was also awarded the Public Service Award of the Geological Society of America. Roger also received the Eduard Brückner Prize in Munich, Germany in 2006 for outstanding achievement in interdisciplinary climate research. Before joining the faculty of the University of Colorado, from 1993-2001 Roger was a Scientist at the National Center for Atmospheric Research. Roger is a Senior Fellow of the Breakthrough Institute, and has held academic appointments at Macquarie University in Sydney, Australia, Oxford University and the London School of Economics.

Roger has hundreds of peer-reviewed publications and, for those who consider such things, he has an H-Index of 51 (Google). He is also author, co-author or co-editor of eight books, including **The Honest Broker: Making Sense of Science in Policy and Politics** published by Cambridge University Press (2007), **The Climate Fix: What Scientists and Politicians Won't Tell you About Global Warming** (2011, Basic Books), and **The Rightful Place of Science: Disasters and Climate Change** (CSPO: ASU, 2014)**.** His most recent book is **The Edge: The War Against Cheating and Corruption in the Cutthroat World of Elite Sports** (Roaring Forties Press, 2016).

Appendix 1
December 2016 op-ed on my experiences in climate research

My Unhappy Life as a Climate Heretic[14]

My research was attacked by thought police in journalism, activist groups funded by billionaires and even the White House.

Much to my surprise, I showed up in the WikiLeaks releases before the election. In a 2014 email, a staffer at the Center for American Progress, founded by John Podesta in 2003, took credit for a campaign to have me eliminated as a writer for Nate Silver's FiveThirtyEight website. In the email, the editor of the think tank's climate blog bragged to one of its billionaire donors, Tom Steyer: "I think it's fair [to] say that, without Climate Progress, Pielke would still be writing on climate change for 538."

WikiLeaks provides a window into a world I've seen up close for decades: the debate over what to do about climate change, and the role of science in that argument. Although it is too soon to tell how the Trump administration will engage the scientific community, my long experience shows what can happen when politicians and media turn against inconvenient research—which we've seen under Republican and Democratic presidents.

I understand why Mr. Podesta—most recently Hillary Clinton's campaign chairman—wanted to drive me out of the climate-change discussion. When substantively countering an academic's research proves difficult, other techniques are needed to banish it. That is how politics sometimes works, and professors need to understand this if we want to participate in that arena.

More troubling is the degree to which journalists and other academics joined the campaign against me. What sort of responsibility do scientists and the media have to defend the ability to share research, on any subject, that might be inconvenient to political interests—even our own?

I believe climate change is real and that human emissions of greenhouse gases risk justifying action, including a carbon tax. But my research led me to a conclusion that many climate campaigners find unacceptable: There is scant evidence to indicate that hurricanes, floods, tornadoes or drought have become more frequent or intense in the U.S. or globally. In fact we are in an era of good fortune when it comes to extreme weather. This is a topic I've studied and published on as much as anyone over two decades. My conclusion might be wrong, but I think I've earned the right to share this research without risk to my career.

Instead, my research was under constant attack for years by activists, journalists and politicians. In 2011 writers in the journal Foreign Policy signaled that some accused me of being a "climate-change denier." I earned the title, the authors explained, by "questioning certain graphs presented in IPCC reports." That an academic who raised questions about

[14] https://www.wsj.com/articles/my-unhappy-life-as-a-climate-heretic-1480723518

the Intergovernmental Panel on Climate Change in an area of his expertise was tarred as a denier reveals the groupthink at work.

Yet I was right to question the IPCC's 2007 report, which included a graph purporting to show that disaster costs were rising due to global temperature increases. The graph was later revealed to have been based on invented and inaccurate information, as I documented in my book "The Climate Fix." The insurance industry scientist Robert-Muir Wood of Risk Management Solutions had smuggled the graph into the IPCC report. He explained in a public debate with me in London in 2010 that he had included the graph and misreferenced it because he expected future research to show a relationship between increasing disaster costs and rising temperatures.

When his research was eventually published in 2008, well after the IPCC report, it concluded the opposite: "We find insufficient evidence to claim a statistical relationship between global temperature increase and normalized catastrophe losses." Whoops.

The IPCC never acknowledged the snafu, but subsequent reports got the science right: There is not a strong basis for connecting weather disasters with human-caused climate change.

Yes, storms and other extremes still occur, with devastating human consequences, but history shows they could be far worse. No Category 3, 4 or 5 hurricane has made landfall in the U.S. since Hurricane Wilma in 2005, by far the longest such period on record. This means that cumulative economic damage from hurricanes over the past decade is some $70 billion less than the long-term average would lead us to expect, based on my research with colleagues. This is good news, and it should be OK to say so. Yet in today's hyper-partisan climate debate, every instance of extreme weather becomes a political talking point.

For a time I called out politicians and reporters who went beyond what science can support, but some journalists won't hear of this. In 2011 and 2012, I pointed out on my blog and social media that the lead climate reporter at the New York Times,Justin Gillis, had mischaracterized the relationship of climate change and food shortages, and the relationship of climate change and disasters. His reporting wasn't consistent with most expert views, or the evidence. In response he promptly blocked me from his Twitter feed. Other reporters did the same.

In August this year on Twitter, I criticized poor reporting on the website Mashable about a supposed coming hurricane apocalypse—including a bad misquote of me in the cartoon role of climate skeptic. (The misquote was later removed.) The publication's lead science editor, Andrew Freedman, helpfully explained via Twitter that this sort of behavior "is why you're on many reporters' 'do not call' lists despite your expertise."

I didn't know reporters had such lists. But I get it. No one likes being told that he misreported scientific research, especially on climate change. Some believe that connecting extreme weather with greenhouse gases helps to advance the cause of climate policy. Plus, bad news gets clicks.

Yet more is going on here than thin-skinned reporters responding petulantly to a vocal professor. In 2015 I was quoted in the Los Angeles Times, by Pulitzer Prize-winning reporter Paige St. John, making the rather obvious point that politicians use the weather-of-the-moment to make the case for action on climate change, even if the scientific basis is thin or contested.

Ms. St. John was pilloried by her peers in the media. Shortly thereafter, she emailed me what she had learned: "You should come with a warning label: Quoting Roger Pielke will bring a hailstorm down on your work from the London Guardian, Mother Jones, and Media Matters."

Or look at the journalists who helped push me out of FiveThirtyEight. My first article there, in 2014, was based on the consensus of the IPCC and peer-reviewed research. I pointed out that the global cost of disasters was increasing at a rate slower than GDP growth, which is very good news. Disasters still occur, but their economic and human effect is smaller than in the past. It's not terribly complicated.

That article prompted an intense media campaign to have me fired. Writers at Slate, Salon, the New Republic, the New York Times, the Guardian and others piled on.

In March of 2014, FiveThirtyEight editor Mike Wilson demoted me from staff writer to freelancer. A few months later I chose to leave the site after it became clear it wouldn't publish me. The mob celebrated. ClimateTruth.org, founded by former Center for American Progress staffer Brad Johnson, and advised by Penn State's Michael Mann, called my departure a "victory for climate truth." The Center for American Progress promised its donor Mr. Steyer more of the same.

Yet the climate thought police still weren't done. In 2013 committees in the House and Senate invited me to a several hearings to summarize the science on disasters and climate change. As a professor at a public university, I was happy to do so. My testimony was strong, and it was well aligned with the conclusions of the IPCC and the U.S. government's climate-science program. Those conclusions indicate no overall increasing trend in hurricanes, floods, tornadoes or droughts—in the U.S. or globally.

In early 2014, not long after I appeared before Congress, President Obama's science adviser John Holdren testified before the same Senate Environment and Public Works Committee. He was asked about his public statements that appeared to contradict the scientific consensus on extreme weather events that I had earlier presented. Mr. Holdren responded with the all-too-common approach of attacking the messenger, telling the senators incorrectly that my views were "not representative of the mainstream scientific opinion." Mr. Holdren followed up by posting a strange essay, of nearly 3,000 words, on the White House website under the heading, "An Analysis of Statements by Roger Pielke Jr.," where it remains today.

I suppose it is a distinction of a sort to be singled out in this manner by the president's science adviser. Yet Mr. Holdren's screed reads more like a dashed-off blog post from the nutty wings of the online climate debate, chock-full of errors and misstatements.

But when the White House puts a target on your back on its website, people notice. Almost a year later Mr. Holdren's missive was the basis for an investigation of me by Arizona Rep. Raul Grijalva, the ranking Democrat on the House Natural Resources Committee. Rep. Grijalva explained in a letter to my university's president that I was being investigated because Mr. Holdren had "highlighted what he believes were serious misstatements by Prof. Pielke of the scientific consensus on climate change." He made the letter public.

The "investigation" turned out to be a farce. In the letter, Rep. Grijalva suggested that I—and six other academics with apparently heretical views—might be on the payroll of Exxon Mobil (or perhaps the Illuminati, I forget). He asked for records detailing my research funding, emails and so on. After some well-deserved criticism from the American Meteorological Society and the American Geophysical Union, Rep. Grijalva deleted the letter from his website. The University of Colorado complied with Rep. Grijalva's request and responded that I have never received funding from fossil-fuel companies. My heretical views can be traced to research support from the U.S. government.

But the damage to my reputation had been done, and perhaps that was the point. Studying and engaging on climate change had become decidedly less fun. So I started researching and teaching other topics and have found the change in direction refreshing. Don't worry about me: I have tenure and supportive campus leaders and regents. No one is trying to get me fired for my new scholarly pursuits.

But the lesson is that a lone academic is no match for billionaires, well-funded advocacy groups, the media, Congress and the White House. If academics—in any subject—are to play a meaningful role in public debate, the country will have to do a better job supporting good-faith researchers, even when their results are unwelcome. This goes for Republicans and Democrats alike, and to the administration of President-elect Trump.

Academics and the media in particular should support viewpoint diversity instead of serving as the handmaidens of political expediency by trying to exclude voices or damage reputations and careers. If academics and the media won't support open debate, who will?

Mr. Pielke is a professor and director of the Sports Governance Center at the University of Colorado, Boulder. His most recent book is "The Edge: The Wars Against Cheating and Corruption in the Cutthroat World of Elite Sports" (Roaring Forties Press, 2016).
Appeared in the Dec. 03, 2016, print edition, Wall Street Journal.

Appendix B
An Update on Trends in Extreme Events in the US and Globally

An update to my 2013 House & Senate Testimony

- The latest science on trends in extreme events
  - Hurricanes (tropical cyclones)
  - Tornadoes
  - Floods
  - Drought
  - Other (temps, extreme precip)
- These data are updated from the summary of data and the IPCC found in my short 2014 book →

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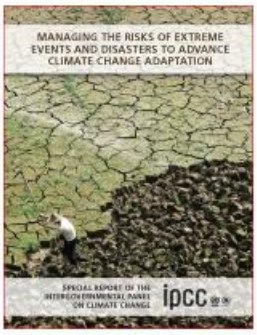
A note on references

- IPCC = Intergovernmental Panel on Climate Change
- IPCC AR5 = 5th assessment report in 2013/14
- IPCC SREX = Special Report on Extreme Events in 2012

IPCC AR5



IPCC SREX

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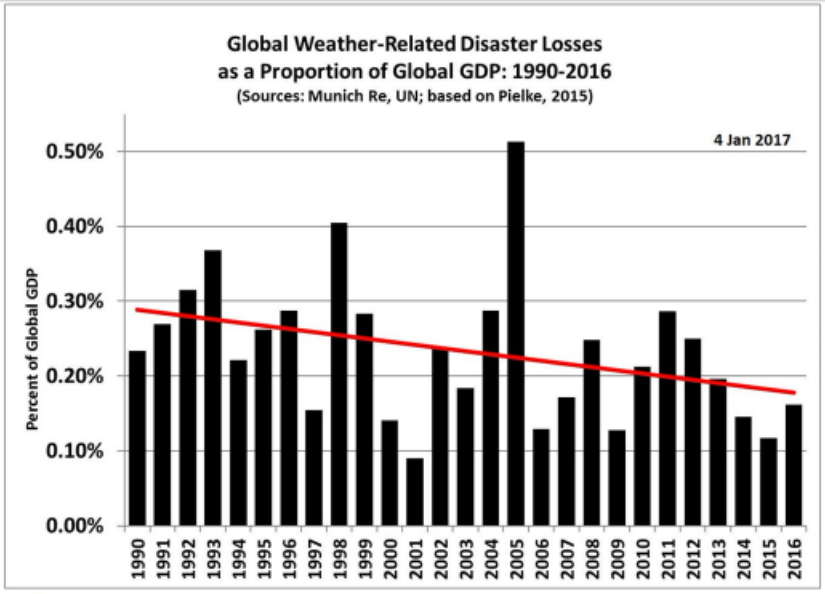
Disaster costs in the global economy: 1990-2016



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IPCC AR5 – Extreme temperatures

"[T]here is medium confidence that globally the length and frequency of warm spells, including heat waves, has increased since the middle of the 20th century although it is likely that heatwave frequency has increased during this period in large parts of Europe, Asia and Australia."

"Medium confidence: increases in more regions than decreases but 1930s dominates longer term trends in the USA."

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IPCC AR5 – Extreme precipitation

"[I]t is likely that since 1951 there have been statistically significant increases in the number of heavy precipitation events (e.g., above the 95th percentile) in more regions than there have been statistically significant decreases, but there are strong regional and subregional variations in the trends."

"[T]here is medium confidence that anthropogenic forcing has contributed to a global scale intensification of heavy precipitation over the second half of the 20th century in land regions where observational coverage is sufficient for assessment."

Note: "Likely" = >66%

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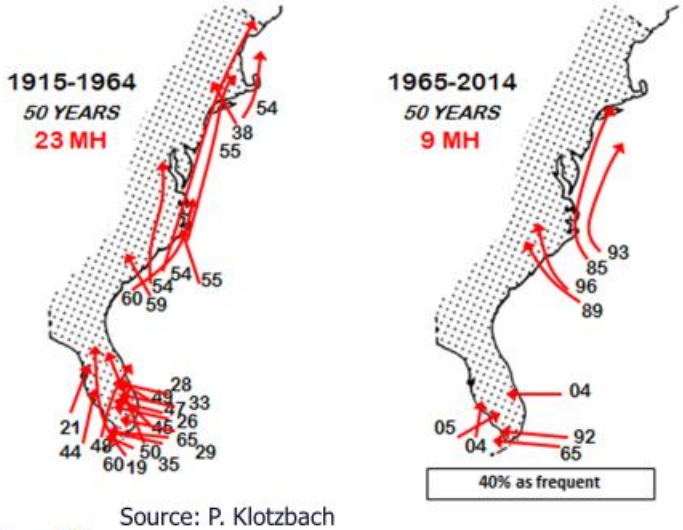
Where did they go?

U.S. MAJOR HURRICANE IMPACTS



Source: P. Klotzbach

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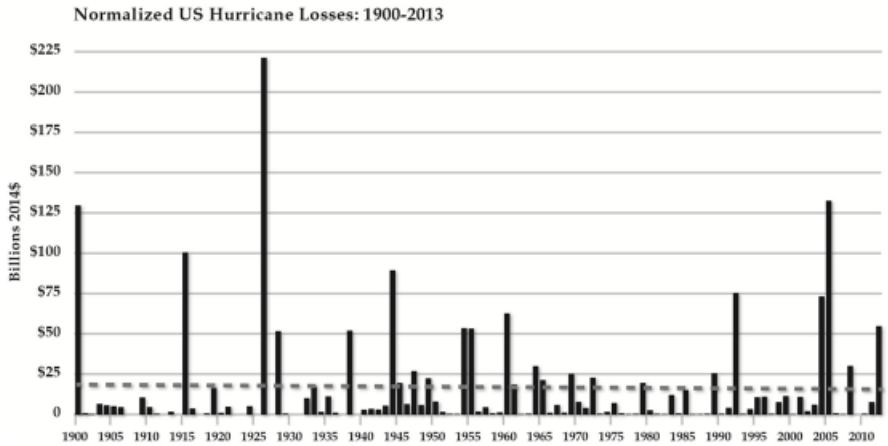
Normalized hurricane losses 1900-2013



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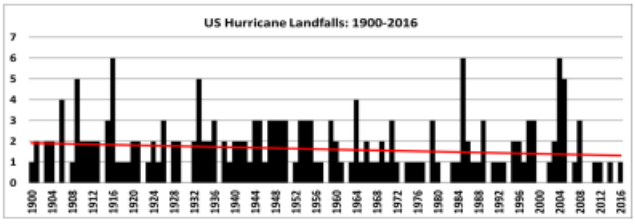
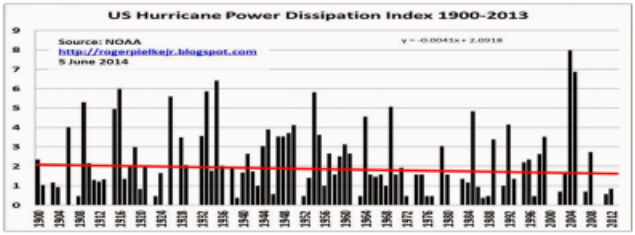
Use climate data as a check on normalization results



With no upwards trends in hurricane landfall frequency or intensity, there is simply no reason to expect to see an upwards trend in normalized losses.



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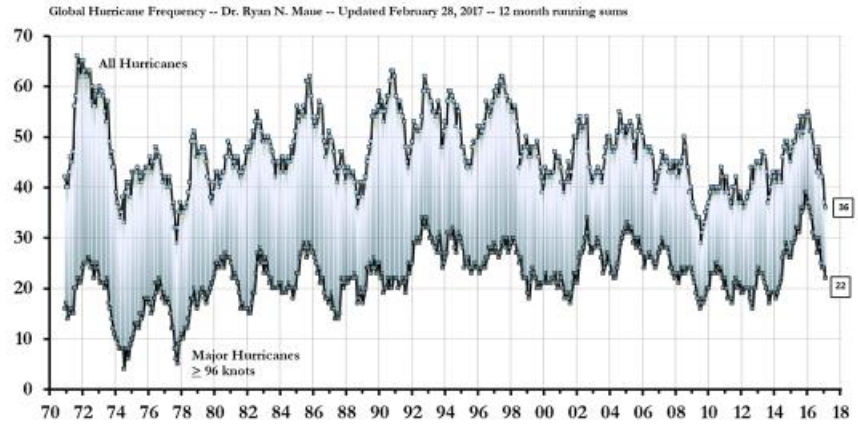
A global view of tropical cyclone trends



Source: Ryan Maue, after Maue (2011)
http://models.weatherbell.com/global_major_freq.png

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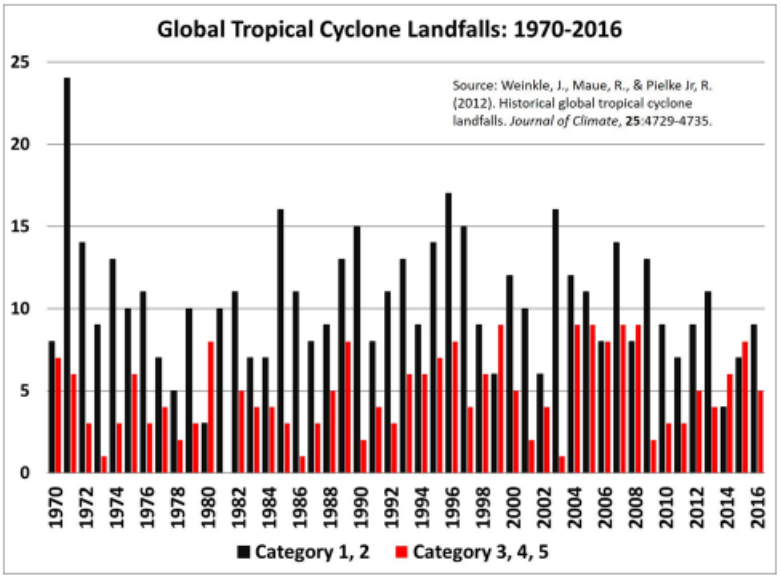
Updated: Global TC Landfalls



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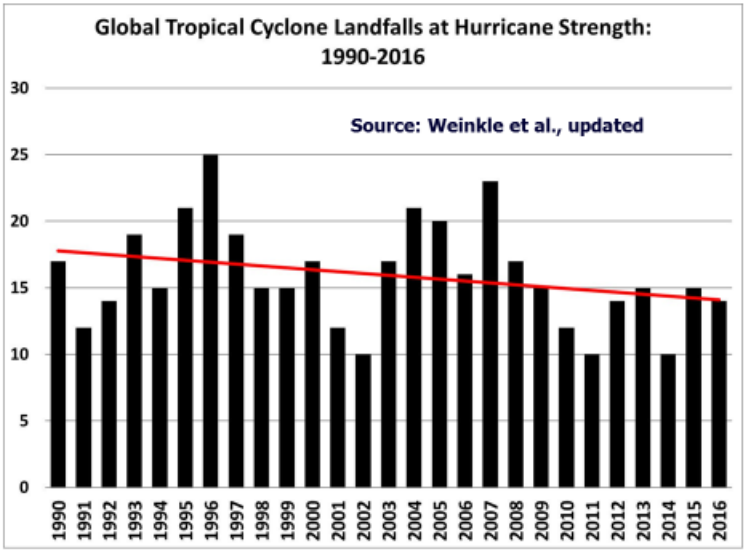
Global landfalls updated through 2016 . . .



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IPCC AR5 – Tropical cyclones

"Current datasets indicate no significant observed trends in global tropical cyclone frequency over the past century."

"No robust trends in annual numbers of tropical storms, hurricanes and major hurricanes counts have been identified over the past 100 years in the North Atlantic basin."

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IPCC AR5 – Floods

"In summary, there continues to be a lack of evidence and thus low confidence regarding the sign of trend in the magnitude and/or frequency of floods on a global scale."

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IPCC SREX co-authors – Floods

"a direct statistical link between anthropogenic climate change and trends in the magnitude/frequency of floods has not been established...

There is such a furore of concern about the linkage between greenhouse forcing and floods that it causes society to lose focus on the things we already know for certain about floods and how to mitigate and adapt to them."

Zbigniew et al. 2014
Hydrological Sciences Jopurnal

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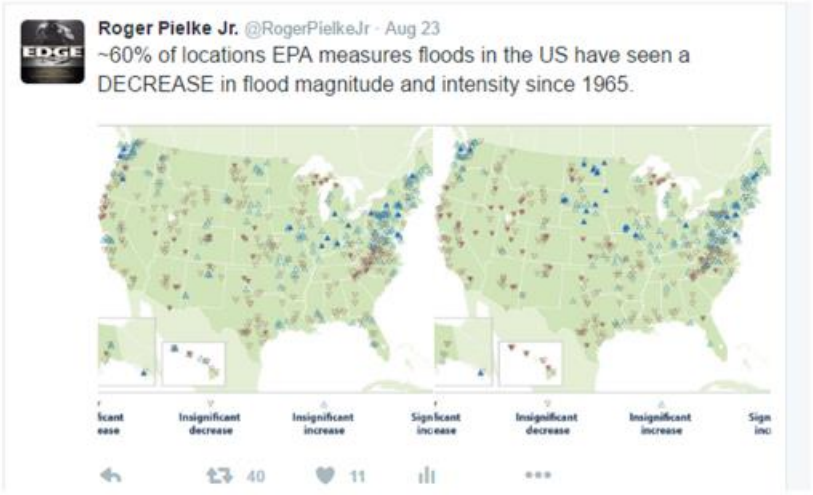
In the US more decreases than increases



Source: https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding

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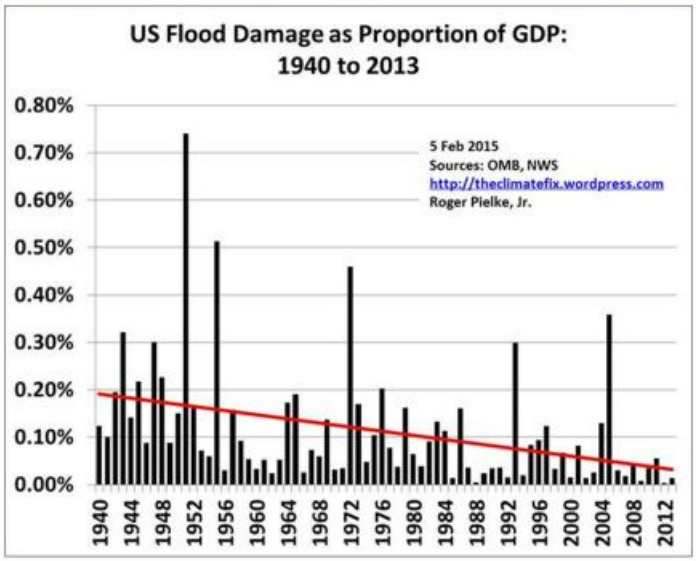
Getting better



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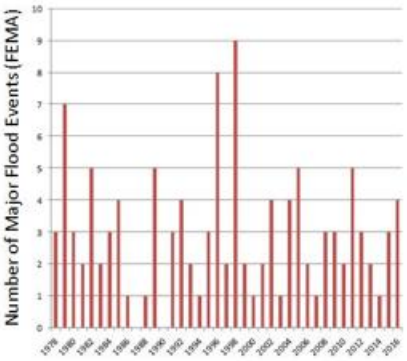
FEMA agrees ...

- Major U.S flood events continue be a major loss focus.
- 2016 had 4 major flooding event.
  - Late Winter Severe Storms – March
  - Torrential Rains – Texas - April
  - Louisiana Flooding - Aug
  - Hurricane Matthew – Oct (Pending Official Data)
- However, no real trend in flood event since 1978

*Major Flood Event = Flooding events with 1,500 FEMA claims.



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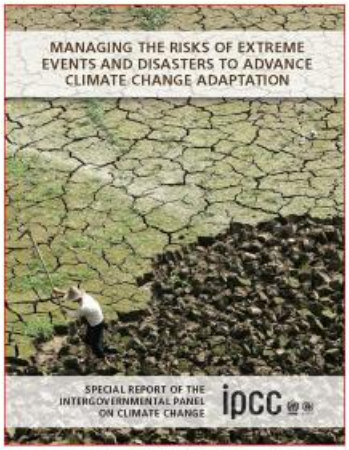
IPCC SREX – Tornadoes



"There is low confidence in observed trends in small spatial-scale phenomena such as tornadoes and hail."

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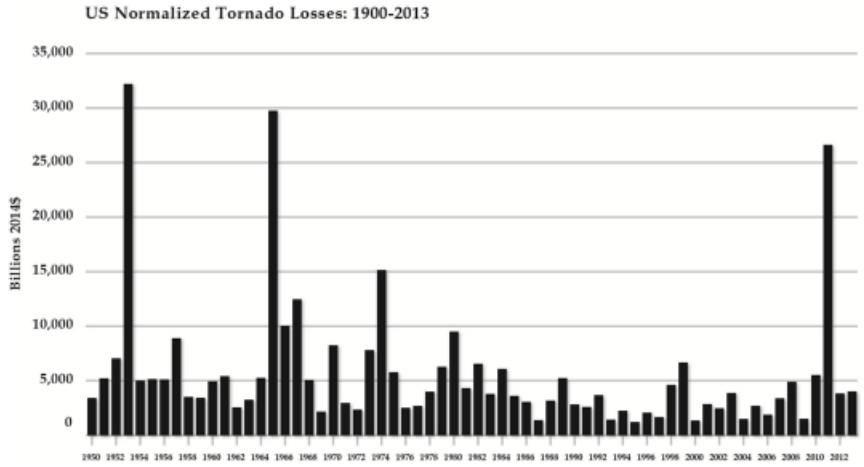
Normalized Tornado Losses in the US



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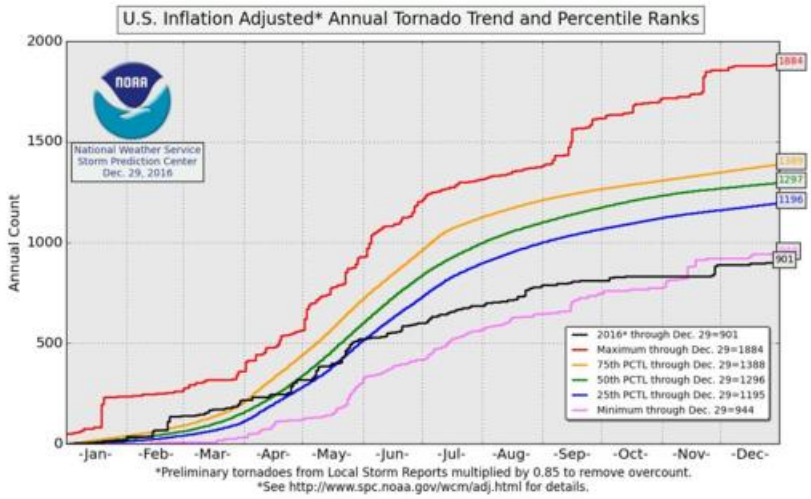
2016 Tornadoes –record low



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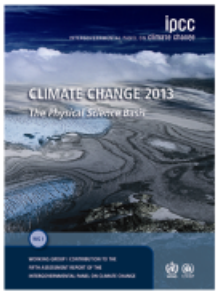
IPCC AR5 – Drought

"There is not enough evidence to support medium or high confidence of attribution of increasing trends to anthropogenic forcings as a result of observational uncertainties and variable results from region to region. . . we conclude consistent with SREX that there is low confidence in detection and attribution of changes in drought over global land areas since the mid-20th century."

"Recent long-term droughts in western North America cannot definitively be shown to lie outside the very large envelope of natural precipitation variability in this region"



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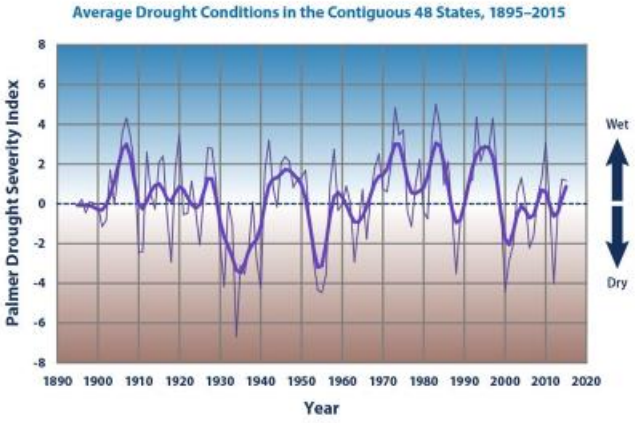
Via EPA 2016 (US drought trends) ...



Data source: NOAA (National Oceanic and Atmospheric Administration). 2016. National Centers for Environmental Information. Accessed January 2016. www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.js.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

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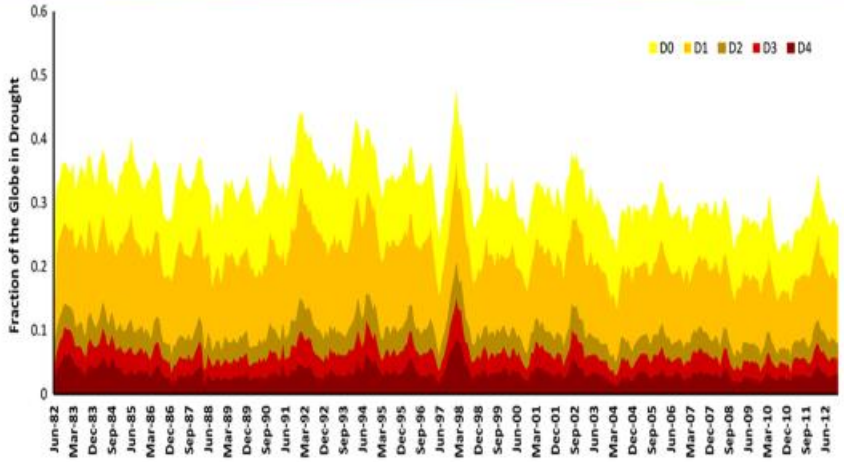
Fraction of the earth in drought: 1982-2012



Hao et al. 2014
Scientific Data
http://www.nature.com/articles/sdata20141

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Summary

Have disasters in the US or globally become more costly because of human-caused climate change?

Only one answer to this question is strongly supported by the available data, the broad scientific literature and the assessments of the IPCC:

No.

There is exceedingly little evidence to support claims that disasters have become more costly because of human caused climate change.

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