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

HEARING on
A FACTUAL LOOK AT THE RELATIONSHIP OF CLIMATE AND WEATHER
11 December 2013

Short Biographical Note

My academic degrees are in mathematics, public policy and political science. I began studying extreme weather and climate in 1993 at the National Center for Atmospheric Research in Boulder, CO. Over the past 20 years I have collaborated with researchers around the world to publish dozens of peer-reviewed papers on hurricanes, floods, tornadoes, Australian bushfires, earthquakes and other subjects related to extreme events. Since 2001, I have been a professor of environmental studies at the University of Colorado. A longer bio can be found as an appendix to this testimony. My views on climate policy and politics, not discussed in this testimony, can be found in my recent book, *The Climate Fix* (Basic Books, 2011).

Take-Home Points

- There exists exceedingly little scientific support for claims found in the media and political debate that hurricanes, tornadoes, floods and drought have increased in frequency or intensity on climate timescales either in the United States or globally.[1]
- Similarly, on climate timescales it is incorrect to link the increasing costs of disasters with the emission of greenhouse gases.
- These conclusions are supported by a broad scientific consensus, including that recently reported by the Intergovernmental Panel on Climate Change (IPCC) in its fifth assessment report (2013) as well as in its recent special report on extreme events (2012).

Here are some specific conclusions, with further details provided below:

- Globally, weather-related losses ($) have not increased since 1990 as a proportion of GDP (they have actually decreased by about 25%) and insured catastrophe losses have not increased as a proportion of GDP since 1960.
- Hurricane landfalls have not increased in the US in frequency, intensity or normalized damage since at least 1900. The same holds for tropical cyclones globally since at least 1970 (when data allows for a global perspective).
- Floods have not increased in the US in frequency or intensity since at least 1950. Flood losses as a percentage of US GDP have dropped by about 75% since 1940.
- Tornadoes in the US have not increased in frequency, intensity or normalized damage since 1950, and there is some evidence to suggest that they have actually declined.
- Drought has "for the most part, become shorter, less frequent, and cover a smaller portion of the U. S. over the last century."[2] Globally, "there has been little change in drought over the past 60 years."[3]

[1] The IPCC defines climate timescales to be 30-50 years and longer.
[2] This quote comes from the US Climate Change Science Program's 2008 report on extremes in North America.
[3] Sheffield et al. in Nature, http://www.nature.com/nature/journal/v491/n7424/full/nature11575.html

- The absolute costs of disasters will increase significantly in coming years due to greater wealth and populations in locations exposed to extremes. Consequent, disasters will continue to be an important focus of policy, irrespective of the exact future course of climate change.

To avoid any confusion

Because the climate issue is so deeply politicized, it is necessary to include several statements beyond those reported above.

- Humans influence the climate system in profound ways, including through the emission of carbon dioxide via the combustion of fossil fuels.[4]
- Researchers have detected and (in some cases) attributed a human influence in other measures of climate extremes beyond those discussed in this testimony, including surface temperatures (heat waves) and in some measures of precipitation.[5]
- The inability to detect and attribute increasing trends in the incidence of hurricanes, floods, tornadoes and drought does not mean that human-caused climate change is not real or of concern.
- It does mean however that some activists, politicians, journalists, corporate and government agency representatives and even scientists who should know better have made claims that are unsupportable based on evidence and research.
- Such claims could undermine the credibility of arguments for action on climate change, and to the extent that such false claims confuse those who make decisions related to extreme events, they could lead to poor decision making.
- A considerable body of research projects that various extremes may become more frequent and/or intense in the future as a direct consequence of the human emission of carbon dioxide.[6]
- Our research, and that of others, suggests that assuming that these projections are accurate, it will be many decades, perhaps longer, before the signal of human-caused climate change can be detected in the statistics of hurricanes (and to the extent that statistical properties are similar, in floods, tornadoes, drought).[7]

The remainder of this written testimony provides data and references to support the claims made in the "take-home points" above. The "take-home points" are broadly supported by peer-reviewed research, US governmental assessments of climate science and the recent reports of the Intergovernmental Panel on Climate Change, specifically its Special Report on Extreme Events (IPCC SREX 2012) and its recently-released Working Group I report of its fifth assessment.[8]

[4] See, e.g., Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2013, http://www.ipcc.ch

[5] The IPCC AR5 (2013) summarizes at the global scale, "Overall, the most robust global changes in climate extremes are seen in measures of daily temperature, including to some extent, heat waves. Precipitation extremes also appear to be increasing, but there is large spatial variability…There is limited evidence of changes in extremes associated with other climate variables since the mid-20th century."

[6] There are exceptions, for instance, the IPCC SREX (2012) concludes of winter storms, "There is medium confidence that there will be a reduction in the number of extratropical cyclones averaged over each hemisphere." However, the IPCC AR5 (2013) concludes of observations to date, "In summary, confidence in large scale changes in the intensity of extreme extratropical cyclones since 1900 is low."

[7] Crompton, RP, RA Pielke and KJ McAneney (2011), Emergence timescales for detection of anthropogenic climate change in US tropical cyclone loss data. *Environ. Res. Lett.* **6** (1) doi: 10.1088/1748-9326/6/1/014003

[8] IPCC SREX (2012) refers to IPCC, 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi,

Global Weather-Related Disaster Loss ($) Trends

What the IPCC SREX (2012) says:

- "There is high confidence, based on high agreement and medium evidence, that economic losses from weather- and climate-related disasters have increased"
- "There is medium evidence and high agreement that long-term trends in normalized losses have not been attributed to natural or anthropogenic climate change"
- "The statement about the absence of trends in impacts attributable to natural or anthropogenic climate change holds for tropical and extratropical [winter] storms and tornadoes"
- "The absence of an attributable climate change signal in losses also holds for flood losses."

What the data says:

1. **Globally, weather-related losses have not increased since 1990 as a proportion of GDP (they have actually decreased by about 25%).**

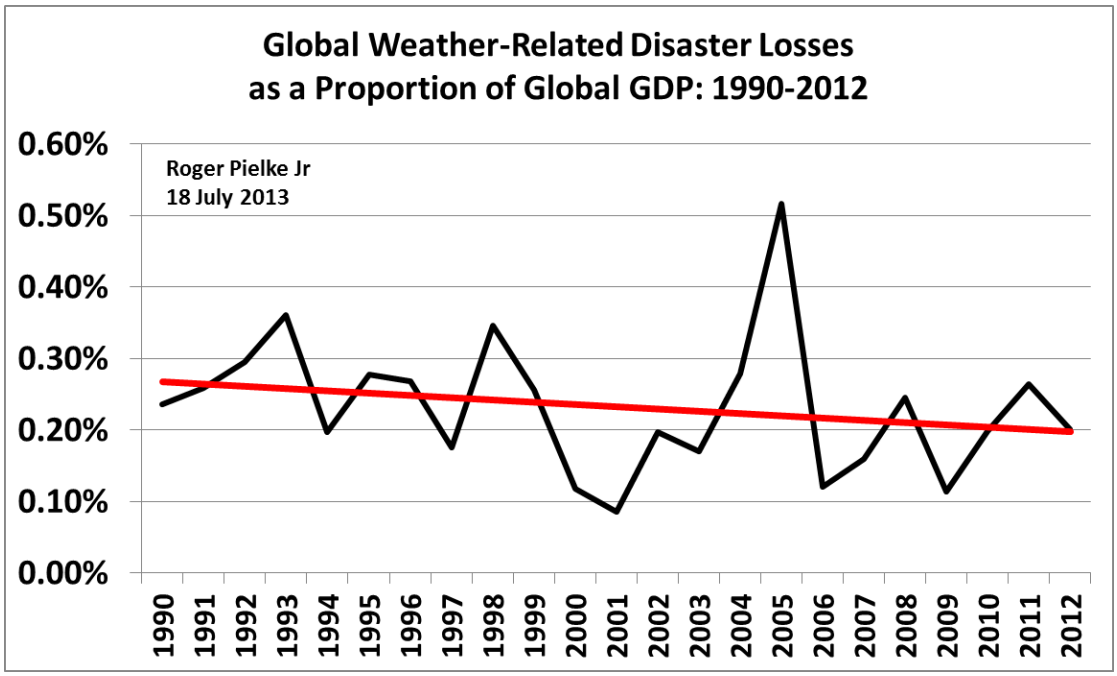

Figure 1. Global weather-related disasters as a proportion of global GDP, 1990-2012. Source of loss data: Munich Re.[9] Source of GDP data: United Nations.[10]

M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (Eds.) Cambridge University Press.

[9] http://www.munichre.com/en/reinsurance/business/non-life/georisks/natcatservice/great_natural_catastrophes.aspx

[10] http://unstats.un.org/unsd/snaama/dnllist.asp

2. Insured catastrophe losses have not increased as a proportion of GDP since 1960.

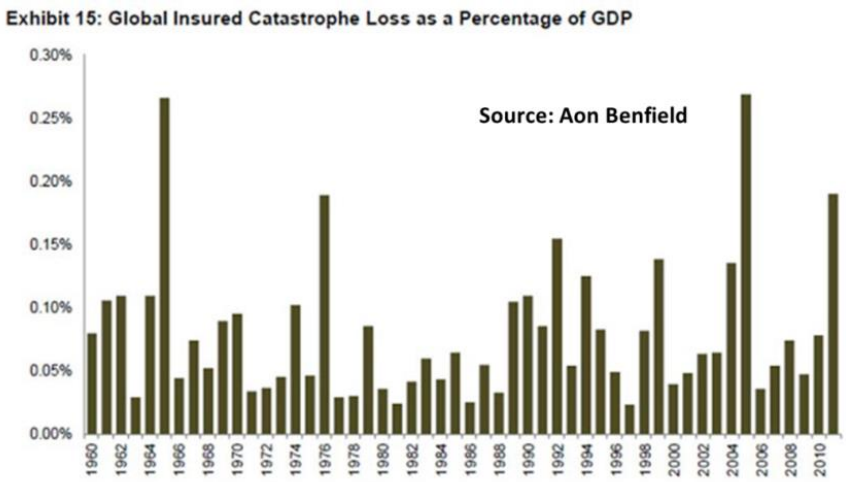

Figure 2. Global insured catastrophe loss as a percentage of global GDP. Source: Aon Benfield.[11]

Note: The peer-reviewed literature on this subject is extensive and robust. Neumayer and Barthel (2011), in a study conducted at the London School of Economics and supported financially by Munich Reinsurance conclude:

> "[B]ased on historical data, there is no evidence so far that climate change has increased the normalized economic loss from natural disasters."[12]

Hurricanes

What the IPCC AR5 (2013) says:

- "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"

What the IPCC SREX (2102) says:

- "Low confidence in attribution of any detectable changes in tropical cyclone activity to anthropogenic influences."

What the data says:

3. Hurricanes have not increased in the US in frequency, intensity or normalized damage since at least 1900.

[11] http://thoughtleadership.aonbenfield.com/Documents/20130103_reinsurance_market_outlook_external.pdf

[12] Neumayer, E. and F. Barthel. 2011. Normalizing Economic Loss from Natural Disasters: A Global Analysis, *Global Environmental Change*, **21**:13-24

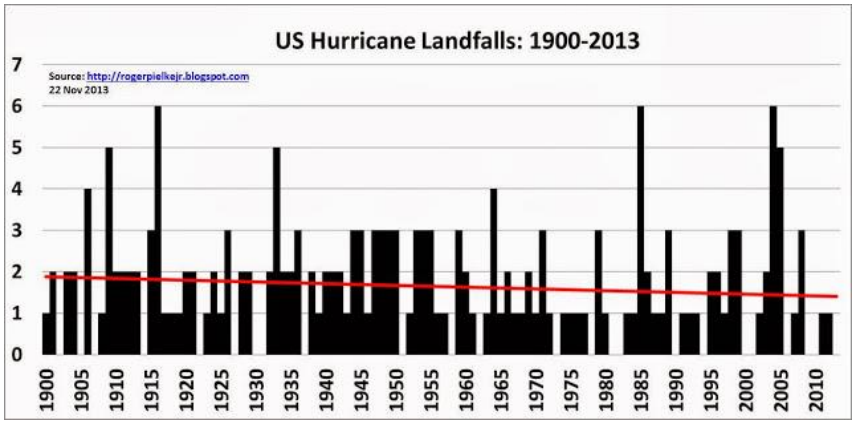

Figure 3a. Number of landfalling US hurricanes from 1900-2013. The red line shows the linear trend, exhibiting a decrease from about 2 to 1.5 landfalls per year since 1900. Source: NOAA.[13]

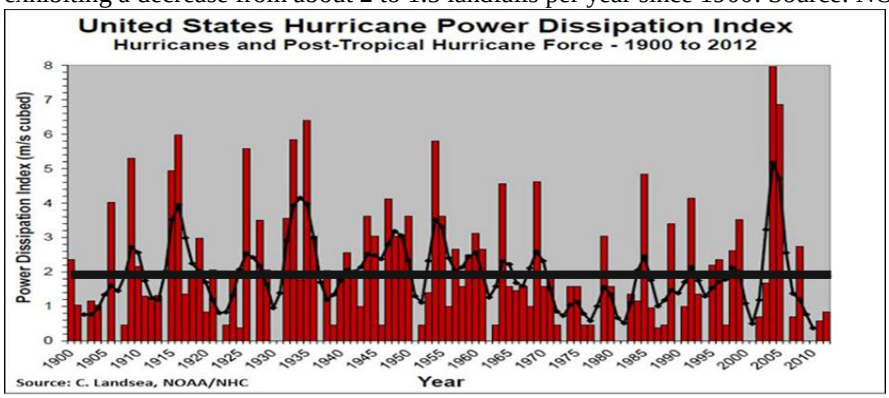

Figure 3b. Intensity of US hurricanes at landfall, 1900-2012 (measured as the summed power dissipation for each year). The heavy black line shows the linear trend. Source NOAA, figure courtesy Chris Landsea, NOAA/NHC.

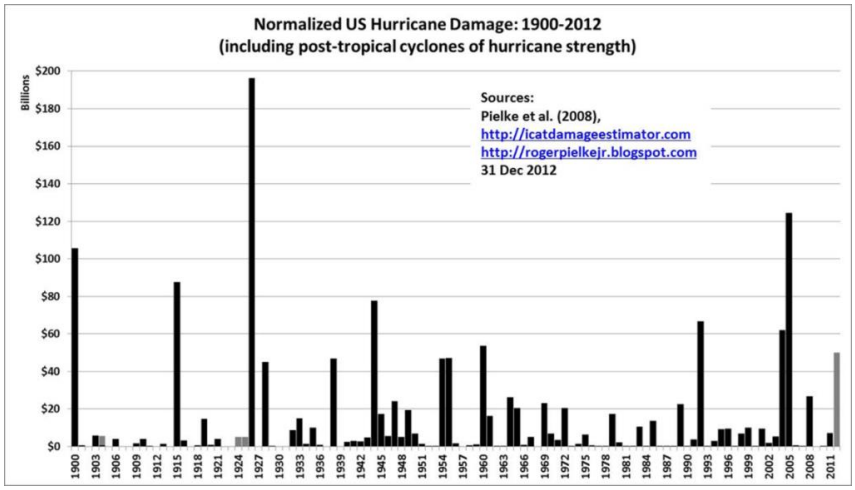

Figure 3c. Normalized US hurricane damage 1900-2012, estimated total damage if each past hurricane season occurred with 2012 levels of development. After Pielke et al. 2008.[14] Note that the figure includes Superstorm Sandy (2012) in gray and placeholders for the three other "post-tropical cyclones of hurricane strength" which made landfall in 1904, 1924 and 1925.

[13] http://www.aoml.noaa.gov/hrd/hurdat/All_U.S._Hurricanes.html

[14] Pielke, Jr., R.A., J. Gratz, C.W. Landsea, D. Collins, M. Saunders, and R. Musulin (2008), Normalized Hurricane Damages in the United States: 1900-2005. *Natural Hazards Review* **9**:29-42. Data updated to 2012 values using the ICAT Damage Estimator: http://www.icatdamageestimator.com

4. **There are no significant trends (up or down) in global tropical cyclone landfalls since 1970 (when data allows for a comprehensive perspective), or in the overall number of tropical cyclones.**

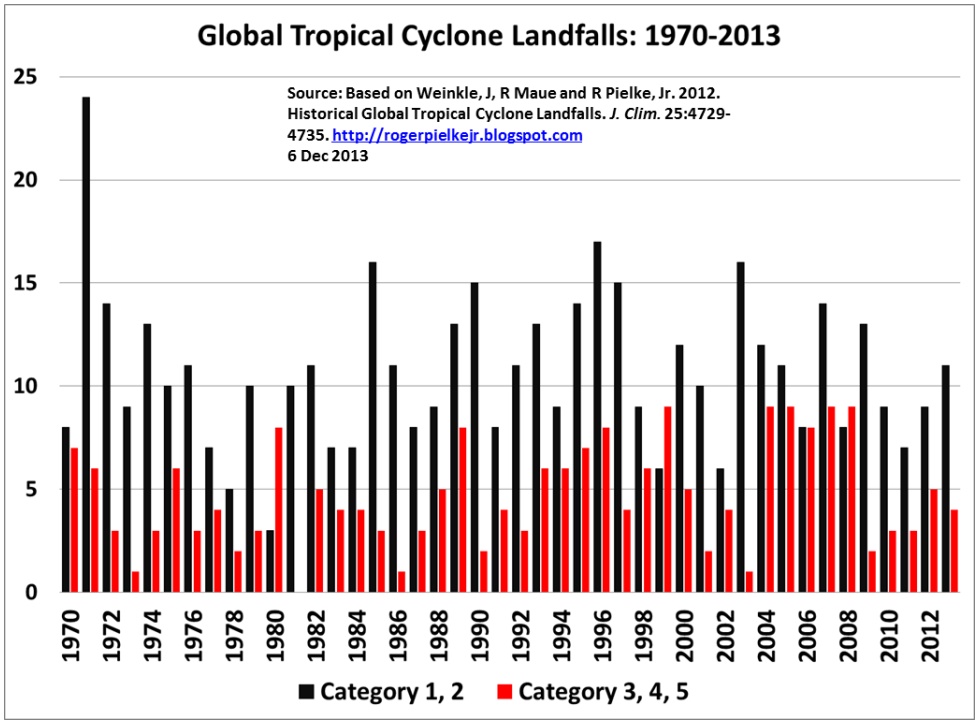

Figure 4a. Global tropical cyclone (called hurricanes in the North Atlantic) landfalls, 1970-2013, after Weinkle et al. 2012.[15] Note: 2013 is preliminary, thanks to R. Maue.

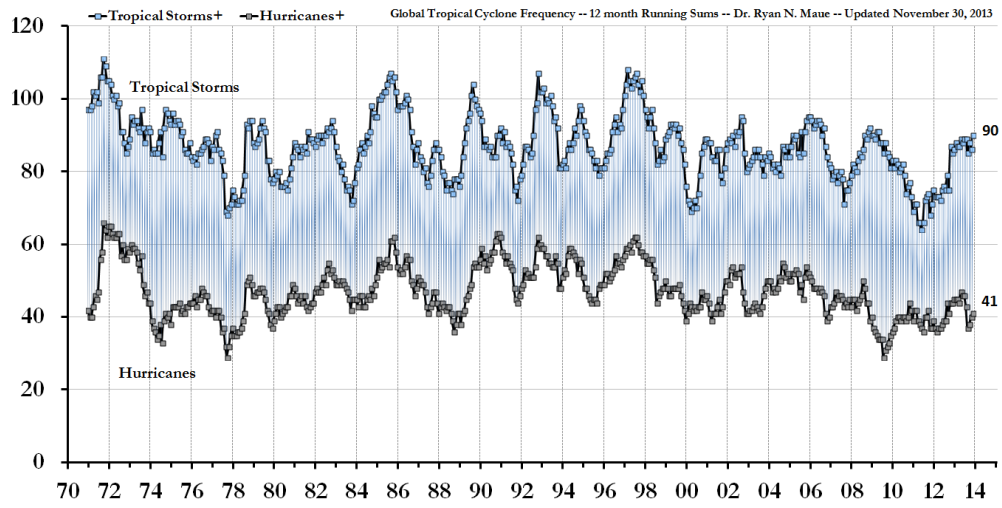

Figure 4b. Total count of tropical cyclones of tropical storm (top curve) and hurricane strength, 12-month running sums 1970 through November 30, 2013. Figure courtesy Ryan Maue.[16]

[15] Weinkle, J, R Maue and R Pielke (2012), Historical Global Tropical Cyclone Landfalls. Journal of Climate, **25**:4729-4735

A Note on US Hurricanes

The United States is currently in a remarkable stretch with no major hurricane (Category 3+) landfalls, as shown in the figure below. The five-year period ending 2013 has seen 2 total hurricane (Cat 1+) landfalls. That is a record low for any five-year period since 1900. Two other five-year periods have seen 3 landfalls (years ending in 1984 and 1994). Prior to 1970 the fewest landfalls over a five-year period was 6. From 1940 to 1957, every 5-year period had more than 10 hurricane landfalls (1904-1920 was almost as active).

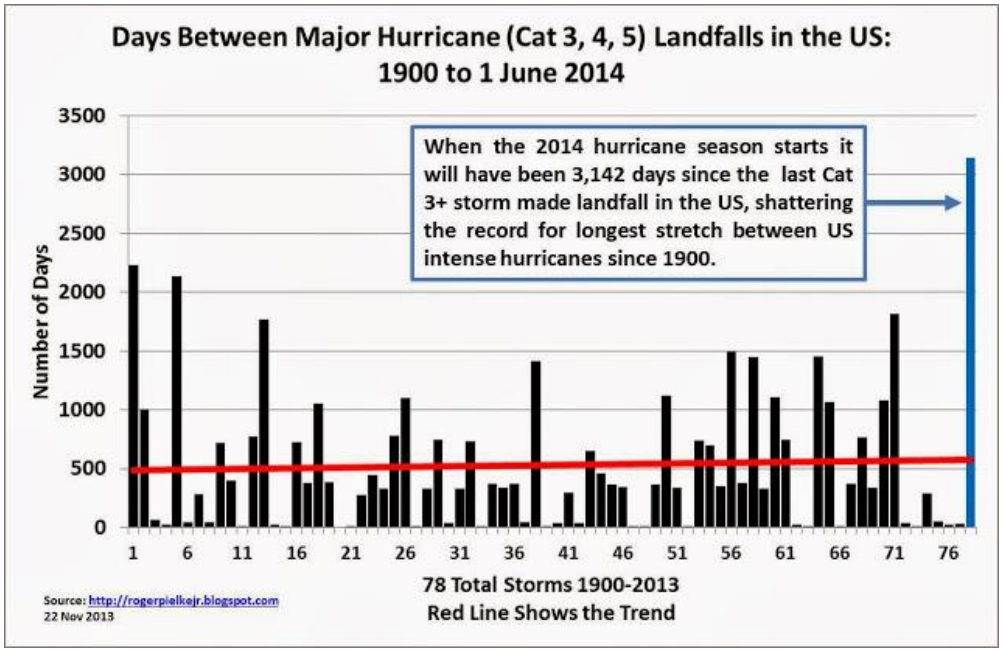

Figure 5. Days between major hurricane landfalls in the United States since 1900. There have been 78 major hurricane landfalls in the US from 1900 to 2013. Source: NOAA.

Floods

What the IPCC AR5 (2103) says:

- "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."

What the IPCC SREX (2012) says:

- "There is limited to medium evidence available to assess climate-driven observed changes in the magnitude and frequency of floods at regional scales"
- "there is low agreement in this evidence, and thus overall low confidence at the global scale regarding even the sign of these changes.."

[16] After Maue, R. N. (2011), Recent historically low global tropical cyclone activity. , *Geophys. Res. Letts.* **38**:L14803, doi:10.1029/2011GL047711.

What the data says[17]:

5. **Floods have not increased in the US in frequency or intensity since at least 1950.**

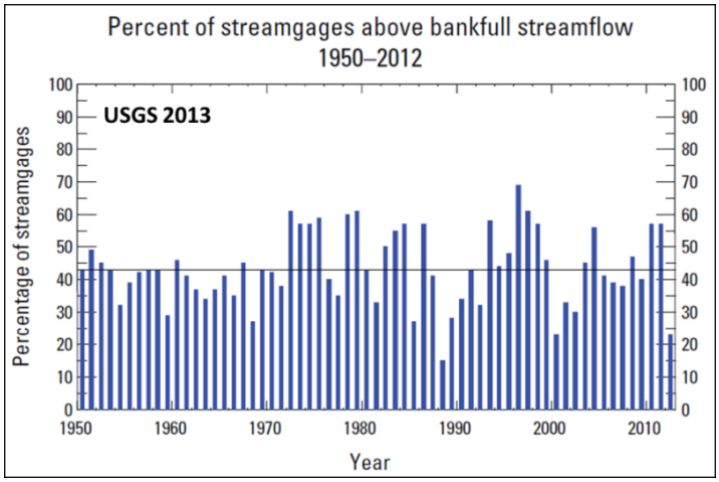

Figure 5. One measure of flood frequency from the USGS, percent of US stream gauges above "bankfull streamflow." The USGS explains: "The bankfull streamflow is defined as the highest daily mean streamflow value expected to occur, on average, once in every 2.3 years."[18]

6. **Flood losses as a percentage of US GDP have dropped by about 75% since 1940.**

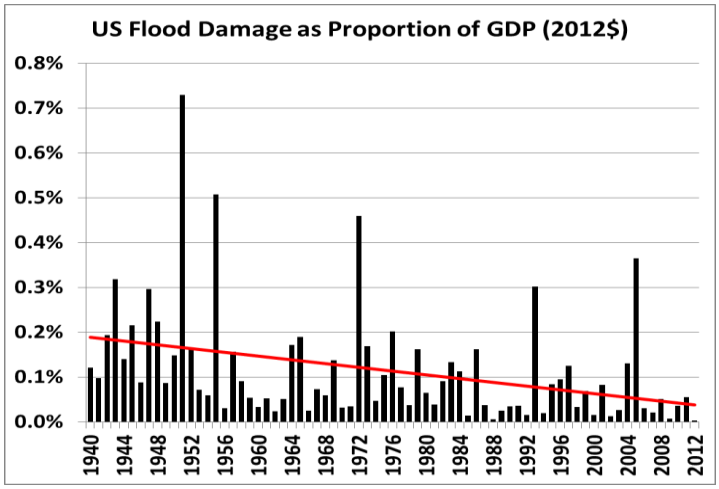

Figure 6. US flood losses as a percentage of US GDP. [19] Annual flood losses have decreased from about 0.20% of US GDP to <0.05% since 1940. Flood loss data from NOAA HIC[20], GDP data from OMB.[21]

[17] Note: A 2005 peer-reviewed paper examined flood trends around the world and concluded: "observations to date provide no conclusive and general proof as to how climate change affects flood behaviour." Source: Kundzewicz, Z.W., D. Graczyk, T. Maurer, I. Przymusińska, M. Radziejewski, C. Svensson and M. Szwed, 2005. Trend detection in river flow time-series: 1. annual maximum flow. *Hydrol. Sci. Journal*, **50**:797-810.

[18] Xiaodong Jian, David M. Wolock, Harry F. Lins, and Steve Brady, Streamflow of 2012—Water Year Summary, U.S. Geological Survey, Reston, Virginia, May 2013.

[19] After Downton, M., J.Z.B. Miller, and R. A. Pielke, Jr. (2005), Reanalysis of the U.S. National Flood Loss Database. *Natural Hazards Review* **6**:13-22

[20] http://www.nws.noaa.gov/hic/

[21] http://www.whitehouse.gov/sites/default/files/omb/budget/fy2014/assets/hist10z1.xls

Tornadoes (and small scale weather extremes, such as hail)

What the IPCC AR5 (2013) says:

- "In summary, there is low confidence in observed trends in small-scale severe weather phenomena such as hail and thunderstorms because of historical data inhomogeneities and inadequacies in monitoring systems."

What the IPCC SREX (2012) says:

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

What the data says:

7. **Tornadoes have not increased in frequency, intensity or normalized damage since 1950, and there is some evidence to suggest that they have actually declined.**[22]

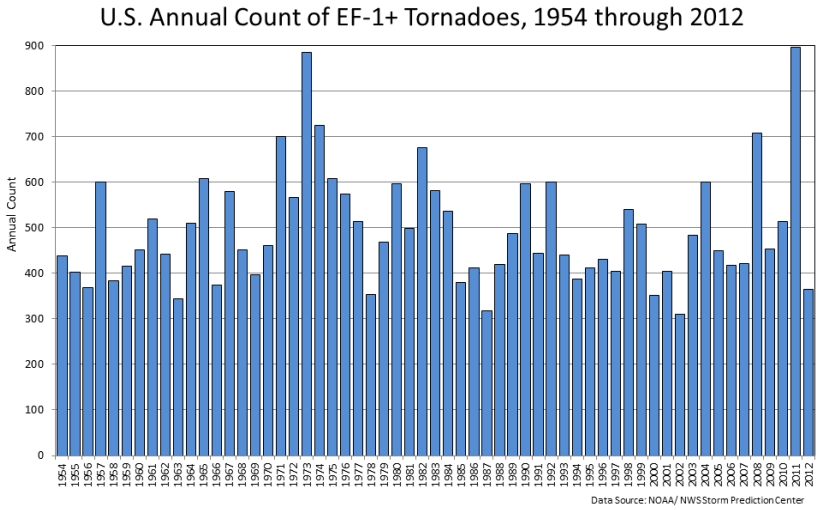

Figure 7a. Count of US tornadoes of at least EF1 strength, 1954-2012. For a discussion of challenges in interpreting trends in tornado data, see Simmons et al. 2013 and references therein.

Source: NOAA, http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html

[22] Simmons, KM, D Sutter and R Pielke (2013), Normalized tornado damage in the United States: 1950-2011. *Environ. Hazards* **12**:132-14.

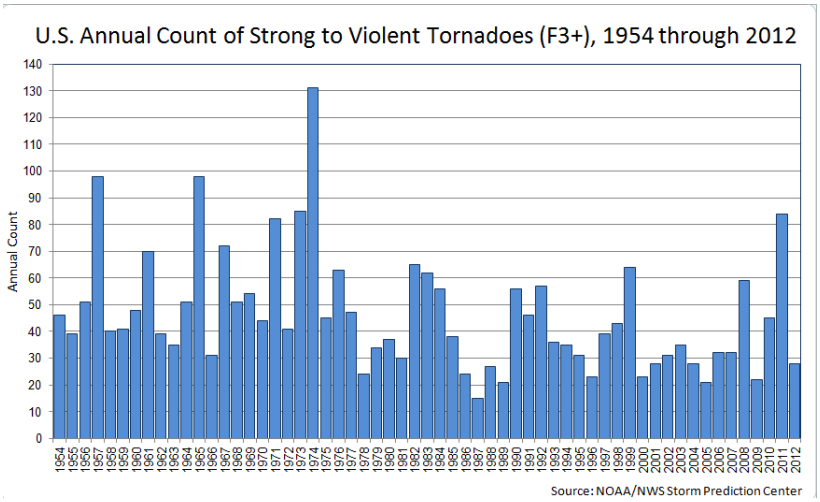

Figure 7b. Count of US tornadoes of at least EF3 strength, 1954-2012. For a discussion of challenges in interpreting trends in tornado data, see Simmons et al. 2013 and references therein.

Source: NOAA, http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html

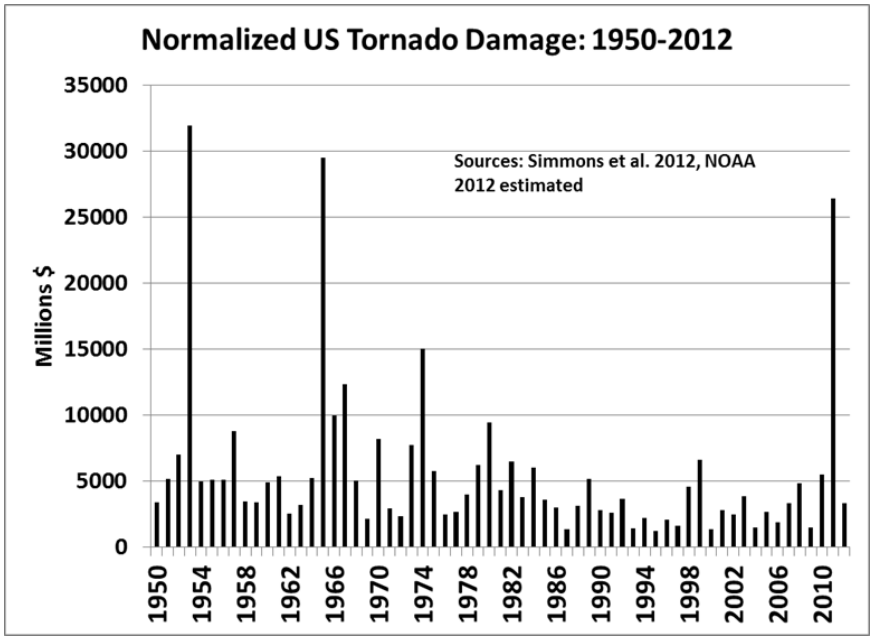

Figure 7c. Normalized US tornado damage, estimated total damage if tornadoes of past years occurred with 2012 levels of development. After Simmons et al. 2013. Note 2012 is estimated.[23]

Here is what Simmons et al. (2013) concluded with respect to long-term trends in tornado incidence and normalized losses:

[23] Simmons, KM, D Sutter and R Pielke (2013), Normalized tornado damage in the United States: 1950-2011. *Environ. Hazards* **12**:132-14. Preliminary estimates show that 2013 damage will be comparable to 2012.

> "The analysis presented in this paper indicates that normalized tornado damage in the US from 1950 to 2011 declined in all three normalization methods applied (two are statistically significant one is not). The degree to which this decrease is the result of an actual decrease in the incidence of strong tornadoes is difficult to assess due to inconsistencies in reporting practices over time. However, an examination of trends within sub-periods of the dataset is suggestive that some part of the long-term decrease in losses may have a component related to actual changes in tornado behaviour. Further research is clearly needed to assess this suggestion. However, we can definitively state that there is no evidence of increasing normalized tornado damage or incidence on climatic time scales."

In addition, earlier this month six leading US tornado experts wrote that claims for the existence of trends in tornado incidence (up or down) was not supported by evidence: "no one knows what effect global warming is having on tornado intensity. Tornado records are not accurate enough to tell whether tornado intensity has changed over time."[24] Our recent work finds no evidence for increasing incidence of the strongest tornadoes, and is suggestive that some part of an observed decline may be due to actual changes in incidence, rather than fully explained by changes in reporting (Simmons et al. 2013).

Drought

What the IPCC AR5 (2013) says:

- "In summary, the current assessment concludes that there is not enough evidence at present to suggest more than low confidence in a global-scale observed trend in drought or dryness (lack of rainfall) since the middle of the 20th century"[25]

What the IPCC SREX (2012) says:

- "There is medium confidence that since the 1950s some regions of the world have experienced a trend to more intense and longer droughts, in particular in southern Europe and West Africa, but in some regions droughts have become less frequent, less intense, or shorter, for example, in central North America and northwestern Australia."
- For the US the CCSP (2008)[26] says: "droughts have, for the most part, become shorter, less frequent, and cover a smaller portion of the U. S. over the last century."[27]

What the data says:

[24] http://news.yahoo.com/real-truth-tornadoes-op-ed-180014832.html

[25] The AR5 explains that its low confidence on drought trends is, "due to lack of direct observations, geographical inconsistencies in the trends, and dependencies of inferred trends on the index choice. Based on updated studies, AR4 conclusions regarding global increasing trends in drought since the 1970s were probably overstated. However, it is likely that the frequency and intensity of drought has increased in the Mediterranean and West Africa and decreased in central North America and north-west Australia since 1950."

[26] CCSP, 2008: Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Thomas R. Karl, Gerald A. Meehl, Christopher D. Miller, Susan J. Hassol, Anne M. Waple, and William L. Murray (eds.)]. Department of Commerce, NOAA's National Climatic Data Center, Washington, D.C., USA, 164 pp.

[27] CCSP (2008) notes that "the main exception is the Southwest and parts of the interior of the West, where increased temperature has led to rising drought trends."

8. **Drought has "for the most part, become shorter, less frequent, and cover a smaller portion of the U. S. over the last century."[28]**

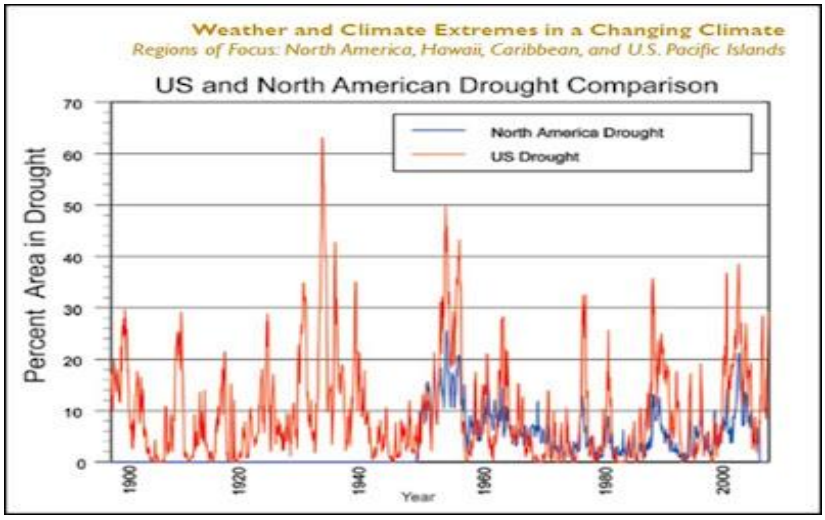

Figure 8. Figure 2.6 from CCSP (2008) has this caption: "The area (in percent) of area in severe to extreme drought as measured by the Palmer Drought Severity Index for the United States (red) from 1900 to present and for North America (blue) from 1950 to present."[29]

[28] This quote comes from the US Climate Change Science Program's 2008 report on extremes in North America.

[29] Note: Writing in Nature Senevirnate (2012) argues with respect to global trends that, "there is no necessary correlation between temperature changes and long-term drought variations, which should warn us against using any simplifications regarding their relationship."
http://www.nature.com/nature/journal/v491/n7424/full/491338a.html

Biography of Roger Pielke Jr.

Roger Pielke, Jr. has been on the faculty of the University of Colorado since 2001. He is a Professor in the Environmental Studies Program and a Fellow of the Cooperative Institute for Research in Environmental Sciences (CIRES), where he serves as Director of the Center for Science and Technology Policy Research. Roger's research focuses on science, innovation and politics and in 2011 began also to write and research on the governance of sports organizations. 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 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 holds academic appointments at Macquarie University in Sydney, Australia and the London School of Economics. He is also author, co-author or co-editor of seven books, including **The Honest Broker: Making Sense of Science in Policy and Politics** published by Cambridge University Press (2007). His most recent book is **The Climate Fix: What Scientists and Politicians Won't Tell you About Global Warming** (2011, Basic Books). He is currently working on a book on technology, innovation and economic growth.