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Trends in Extreme Weather Events since 1900 – An Enduring Conundrum for Wise Policy Advice

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Abstract

It is widely promulgated and believed that human-caused global warming comes with increases in both the intensity and frequency of extreme weather events. A survey of official weather sites and the scientific literature provides strong evidence that the first half of the 20th century had more extreme weather than the second half, when anthropogenic global warming is claimed to have been mainly responsible for observed climate change. The disconnect between real-world historical data on the 100 years' time scale and the current predictions provides a real conundrum when any engineer tries to make a professional assessment of the real future value of any infrastructure project which aims to mitigate or adapt to climate change. What is the appropriate basis on which to make judgements when theory and data are in such disagreement?

Keywords: Global warming; Weather; Climate change

Introduction

There have been many reports on the future impacts of human-related greenhouse gas emissions on a changing climate during the 21st century. Just two will suffice here: 'Resilience to Extreme Weather' [1] and 'Climate Change: Evidence and Causes' [2] were both published in 2014 by the Royal Society of London, the second report jointly with the US National Academy of Science. Both reports dwell on the expectation that in future, because of man-made global warming, we can expect extremes of weather to be both more intense and more frequent. By implication, one must allocate vast sums of money in mitigating and adapting to this future of more extreme weather.

The members of the Intergovernmental Panel on Climate Change in Working Group I are clear that man-made global warming started in earnest in about 1960, so it is reasonable to see to what extent the weather has been getting more extreme more frequently over the last 55 years. That same report suggests that IPCC scientists have low confidence in recent extreme weather events being specifically attributed to global warming [3]. Further, an additional IPCC report on 'Managing extreme events and disasters to advance climate change mitigation', (known as SREX [4]), relies heavily on papers that only start with data in 1950 [5] and 1960 [6]. The graphical data is not shown in SREX, as it is here, but a one-phrase summary is incorporated. Furthermore, they chose definitions of extremes that represent the upper or lower deciles of occurrence, rather than treating extremes as extremes.

It is therefore surprising to discover that by all the various real world data considered here, the weather in the first half of the 20th century was, if anything, more extreme than in the second half. I have not found any data, including in SREX, that contradicts these trends. Furthermore there are no signs of this trend changing (i.e. lessening and reversing) in recent years. The lack of public, political and policymaker appreciation of the disconnect between empirical data and theoretical constructs is profoundly worrying, especially in terms of policy advice being given. For example the first report cited above is without empirical foundation, the second is misleading, and the already modest claims in SREX are further weakened when compared with the longer term data.

A comment on etymology is in order: I am using the word extreme in the same way that the authors of references [1,2] to mean events that are several standard deviations away from the average of the distribution by which they are measured and described. I am not referring to the ultimate extreme in recorded history, although these would also support my case.

The approach taken in this paper is wherever possible to list the original source research yielding the data, but where that is not available to use the earliest accessible details. Not all the relevant data is located in the regular scientific literature. Much of this data is on official government-backed meteorological websites, while other data is only available secondarily or appears in appropriately derived form in various web-sites devoted to critiques in the global warming debate. To my knowledge, this material has not before been gathered systematically in the manner it has here. By referring to a much broader base than temperature data only, I hope to avoid the continuing debate on the myriad of adjustments made to original data that has almost without exception exacerbated the trends being sought, particularly in rising temperature over the 20th century. These adjustments are such that in some places (e.g. New Zealand) the inferred temperature rise is entirely a result of these post-hoc adjustments.

The Conundrum Introduced: Where the Weather is shown to have been Less Extreme Recently

Figure 1 is a collage of data that make the case that weather was more extreme between 1900 and 1960 than since. It has been collected from the literature and from websites since the beginning of 2014. For

each of these diagrams there are many more that make the same story with complementary detail, or with data from other parts of the world. This section is devoted to explaining the origin and content of each graph.

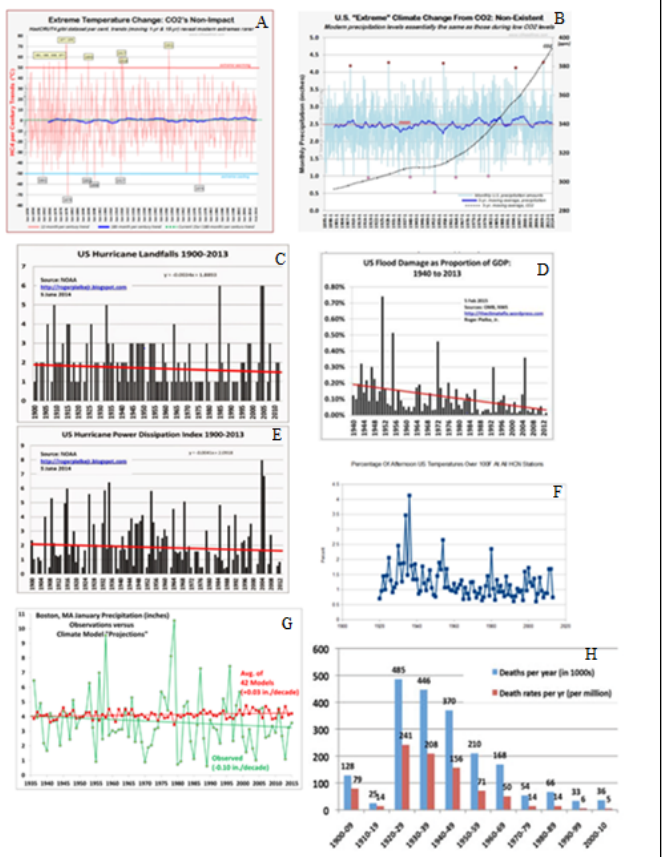


Figure 1: weather was more extreme between 1900 and 1960.

The first graph takes the HADCRUT4 data set and plots the time derivative of the globally averaged mean surface temperature from 1850 to the present day [7]. It shows that the periods of maximum warming or cooling rates are all in the 19th century or at the start of the 20th century. Since the recent period of global warming started in 1975 there has been a quiescent temperature profile. As the author states: (i) All the huge extreme changes took place over 40 years ago, with the great majority occurring prior to 1950. (ii) The huge CO2 emissions have not been associated with a single global warming acceleration extreme since 1951, over 60 years ago. (iii) Since the 1970's, the climate extremes' range appears to be narrowing, with each accelerated warming and cooling trend rate getting smaller. (iv) When major (minor too) extremes occur, the climate system does not hit a "tipping point" of positive feedbacks. Instead, the natural climate responds with negative feedbacks to bring the climate back to some level of short-term equilibrium. By contrast the SREX report on extreme temperatures is largely down to two key papers [5,6]. Warm maximum and minimum temperatures are expected to track with the overall average temperature [5] in the Americas, but the broadening is weak, and the extremes are eclipsed by data from the 1930s. Furthermore both positive and negative trends are present in the temperature extremes in different regions in the global data [6], so that the total extremes have some internal cancellation. The findings also were that the total precipitation was not changing but there was a weak tendency towards more extreme single incidents of precipitation. A separate study on precipitation comes to a similar conclusion, a 7% rise in daily precipitation maxima per degree C rise in temperature, but a result that masks different and opposing trends in different parts of the world [8]. Nonetheless, where extreme precipitation has actually been measured, nearly all the extremes predate this period for all periods less than one year [9]. Most recently, a report confirms that fluctuations in extreme weather events (especially temperatures) become less severe with rising average temperatures [10].

The second chart is a plot of NOAA monthly measurements of precipitation since 1895, through June 2014 [11]. The black dots represent the moving 5-year (60-month) average of atmospheric CO2 levels. The dark blue curve is the simple 60-month moving average of precipitation; the red line denotes the average monthly rainfall over the 1,434 months. The moving average and the average since 1985 are almost identical, and show that any recent suggestions of climate extremes from one-off events in the USA are not borne out by the accumulated data.

The third and fifth charts show the steady decline on average of both the frequency and power of hurricanes making landfall in the USA over the 20th century [12]. Other data, not shown here, shows a 30% step down in the frequency of tornados of strength 3 and above in the USA in 1975, the year that global cooling turned to global warming [13].

The fourth panel shows the fall in the annual cost of flooding in the USA as a function of the Gross domestic product of the USA [14]. The sixth panel shows that extremes of temperature in the USA were greatest in the 1930s, and much greater than anything different [15].

The seventh panel shows the actual decline in precipitation in Boston since 1935 compared with the predicted increase from the average of many models, showing a discrepancy in the sign of the change [16], which must be a contributory factor in the wider search for an answer to the question about whether or not extreme weather is on the increase.

The final panel summarises a key issue that is not often considered in the debate: the deaths from climate related severe weather events has been in steady decline since 1900, and if there is to be a change to an increase in future, a specific reason must be given for this to distinguish any such prediction from speculation [17]. There are multiple causes of this decrease – better warnings, more robust defences being just two.

Several points arise: (1) While some of the data is global, much of the detailed data is from the USA where the trends are all at odds with what is assumed to be happening globally. In the next section we describe data from many other places in the world showing that there has been no change in the frequency or severity of extreme weather events. Much of this is from the UK where, as for the US, has extensive networks exist for gathering relevant data over the whole period. A separate table is introduced below to summarise the scattered reports from other parts of the world. (2) It is noted that most of the data comes from official sources, but the way it has been presented and interpreted represents the added value as per the source from which the graphs were actually derived. (3) In some places we can get contradictory data as exemplified below in section 4.

The Conundrum Widens: There is much Evidence of No Change over 100 Years

Figure 2 is a similar collage to that in Figure 1, but showing aspects of extreme weather events that seem to be constant over the last 100 years.

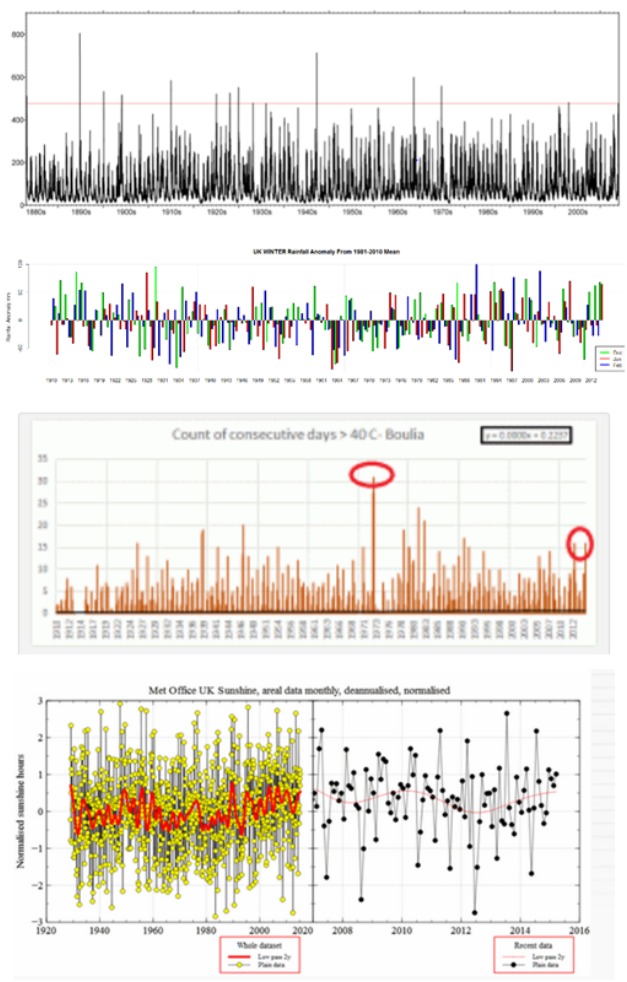


Figure 2: no change in the frequency or severity of extreme weather events.

In the winter of 2013-4, there was severe flooding in the UK's West Country and in the Thames River Basin [18]. This was claimed to be the worst ever and just the sort of thing that climate change should bring. In fact the first chart shows the peak water flow past Kingston on Thames for the last 100 years, and the red line marks the peak flow in 2014, which was exceeded several times over that period. Indeed all these other more extreme events occurred before 1970.

The second graph shows the overall deviation from the long term average of the accumulated UK rainfall from 1910-2010, and there is no discernible trend in the deviations from the average over that period [19].

The third graph shows the temperature at a site in the centre of Australia [20]. It accompanied a piece that challenged the statement: "There is no point in denying it: Australia is getting hotter, and it's not going to stop. And we have the figures to prove it". In the next section below we see the difficulty of preparing comprehensive data of extreme heat in Australia.

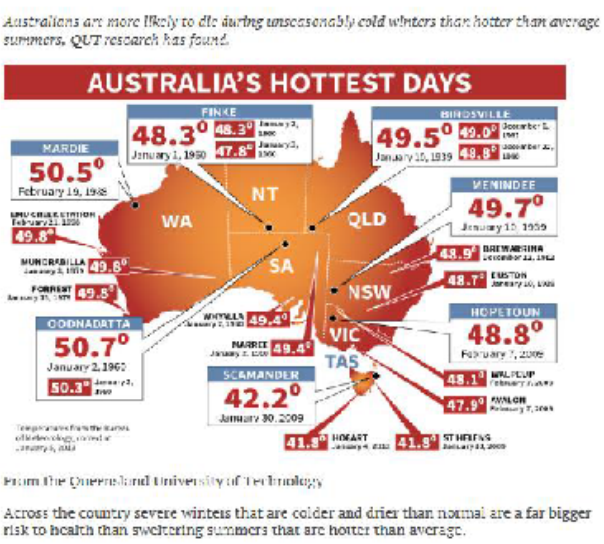
The fourth panel shows the data on sunshine in the UK over the last 100 years, indicating that there are no trends in the extreme deviations from the average hours of sunshine [21]. This is important as it challenges a statement of the UK Met Office that extreme sunshine has been on the increase. This is an example of the power of data on the web to provide direct contradiction of official agency interpretations.

Difficulties with the Data Itself

The purpose of the two previous sections is to highlight the data, much of it official in origin, that provides support to the hypothesis that extreme weather events have not been on the increase in the 50 years, in spite of that being the common belief. However, in many cases there are also problems with the accuracy or representativeness of the data itself. In Figure 3 we show two pictures of extreme heat events in Australia, both taken from the same official sources [22,23]. They tell different stories. One from the University of Queensland shows that extreme temperatures have been getting worse, whereas the one from the independent site has data that does not show such a trends. Indeed if one had to judge between them, the latter data shows higher temperatures that seem to have been missed in the former.

The compilation of temperature records are a source of problematic methodology of a kind not seen elsewhere in science. Under the umbrella term of "homogenisation", there now seem to be a growing myriad of post-hoc adjustments to the original raw data that all seem to go in one direction, namely to increase the overall rate of global warming. This happens even on official websites. The total change is often somewhat greater than the 0.8-1°C rise over the 20th century that is agreed by most people, critics or not. This is exemplified by data in Figure 4 [24]. This makes the problem of dispassionate engineering assessment almost impossible to achieve. Hansen (1981) wrote : "A remarkable conclusion from Figure 3 is that the global temperature is almost as high today as it was in 1940." It is not clear now why this should be remarkable, although at the time, the rise in temperature from about 1975 had cancelled out some of the cooling since 1940 in the then available data. At the time, he showed 1980 temperatures were about 0.15°C cooler than 1940. Now, NASA shows 1980 temperatures about 0.2°C warmer than 1940. They have made a relative shift of +0.35°C, and the adjustment represents ~40% of the century variation. The lesson from this is that the data integrity for claiming extreme events needs to shown to be of the highest order, and that the results claimed do not depend on the data manipulation itself.

To avert any challenge of cherry-picking of data on my part, Table 1 includes further sets of references that show that storms, droughts, and other trends in extreme events from other places in the world complement the material that which I have already provided in more detail above.



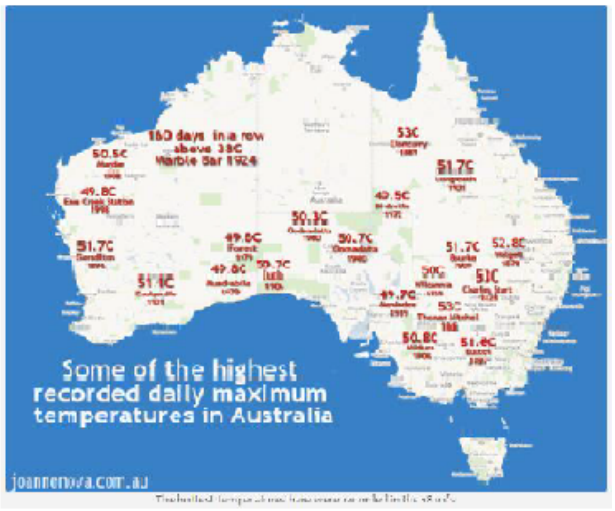
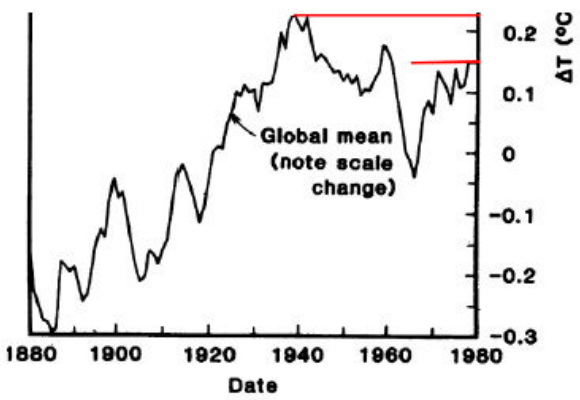


Figure 3: Two evaluations of extreme heat in Australia.



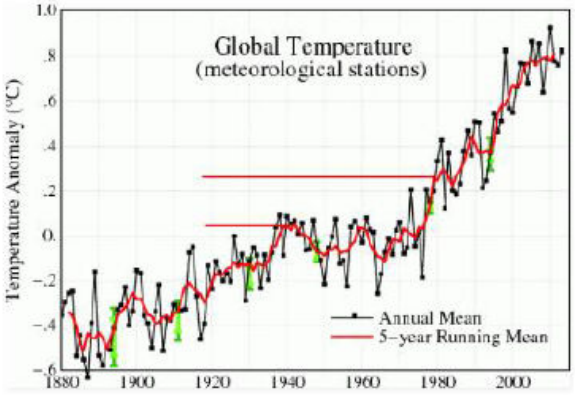


Figure 4: The evolution of data sets with time: note the relative change of the temperatures in 1840 and 1980 have moved by 0.35°C, between 1981 and now.

The accumulated data presented in this paper requires a systematic rebuttal based on real world data if claims of increases in extreme weather caused by anthropogenic global warming are to be taken seriously.

The Consequences

Question 17 of the joint Royal Society/National Academy of Sciences report [2] asks whether a few degrees rise in temperature matters. The 220-word reply focusses entirely on the possible downsides of rising temperature, with a wriggle room phrase in the concluding sentence. "Even though certain regions may realise some local benefit from the warming, the long-term consequences overall will be disruptive." In fact the vast majority of research has been on the downsides, but the list of upsides is accumulating.

The food per person has increased by 25% while the population has increased by 140% since 1960. Indeed since 1998, more food is being produced on less land each year (Figure 5) [25].

Satellite images show that the world is overall greener than it was even 20 years ago, with most of the greening in areas where it matters most, eg the Sahel [26].

More people die of cold than heat, and the rapid decline of climate-related deaths (last panel of Figure 1) is evidence that business-as-usual has produced much greater resilience to extreme weather over the last century [17].

T1	Temperature profile of Reykjavik adjusted by NASA and NOAA decreasing the temperature around 1940 by 1.5˚C.
T2	According to UK Met Office data, there have been eight other 2-month periods in England, which have been wetter since 1910, than the January/February 2014 total of 274mm. (The different England and Wales dataset, which dates to 1766, also shows that there were five years, prior to 1910, that also had higher 2-month totals : 1771, 1811, 1822, 1852 and 1877). Note also that in 1914/15, 1929/30 and 2000/01, the high levels of rainfall extended over three months, not just two.
T3	Both 1934 and 1954 had more extreme weather across the globe than any years since 1960.
T4	A comparison of the UK rainfall in the months of December 1934, November 1940, January 1848 and November 1951 show that January 2014 is not an unprecedented level of extreme precipitation.
T5	Chinese droughts were worse in the past. According to the authors, the longest drought occurred from 1867-1932, the longest wet period occurred from 1934-1957, and the 19th century was the driest century. The authors find, "recent drought in 1993–2008 was still within the frame of natural climate variability based on the 306 yr PDSI reconstruction."
T6	Climate modelling of the US corn-belt fitting the models to the data over the period 1920-1990 shows a striking divergence since then.
T7	A catalogue of climate scares since 1895 that have proven unfounded by subsequent data.
T8	In a massive review of the subject conducted by a team of seventeen researchers hailing from eleven different countries, i.e., Kundzewicz et al., we learn the following: (1) "no gauge-based evidence has been found for a climate-driven, globally widespread change in the magnitude/frequency of floods during the last decades," (2) "there is low confidence in projections of changes in fluvial floods, due to limited evidence and because the causes of regional changes are complex," (3) "considerable uncertainty remains in the projections of changes in flood magnitude and frequency," (4) increases in global flood disaster losses reported over the last few decades "may be attributed to improvements in reporting, population increase and urbanization in flood-prone areas, increase of property value and degraded awareness about natural risks (due to less natural lifestyle)," (5) "the linkages between enhanced greenhouse forcing and flood phenomena are highly complex and, up to the present, it has not been possible to describe the connections well, either by empirical analysis or by the use of models," and (6) "the problem of flood losses is mostly about what we do on or to the landscape," which they say "will be the case for decades to come."
T9	An analysis of flash flooding in Dartmoor over the last century shows that the worse was before the recent instrumental record. Analysis of longer term flood frequency is often limited by the use of short instrumental flow records (last 30–40 years) that do not adequately cover alternating flood-rich and flood-poor periods over the last 2 to 3 centuries. In contrast, this research extends the upland flood series of South West England (Dartmoor) back to ca AD 1800 using lichenometry. Results show that the period 1820 to mid-1940s was characterized by widespread flooding, with particularly large and frequent events in the mid-to-late 19th and early 20th centuries. Since ca 1850 to 1900, there has been a general decline in flood magnitude that was particularly marked after the 1930s/mid-1940s. Local meteorological records show that: (1) historical flood-rich periods on Dartmoor were associated with high annual, seasonal and daily rainfall totals in the last quarter of the 19th century and between 1910 and 1946, related to sub-decadal variability of the North Atlantic Oscillation and receipt of cyclonic and southerly weather types over the southwest peninsula; and (2) the incidence of heavy daily rainfall declined notably after 1946, similar to sedimentary archives of flooding. The peak period of flooding on Dartmoor predates the beginning of gauged flow records, which has practical implications for understanding and managing flood risk on rivers that drain Dartmoor.
T10	The apparent increase in flooding witnessed over the last decade appears in consideration of the long term flood record to be unexceptional, whilst the period since 2000 is considered as flood-rich, the period 1970–2000 is relatively “flood poor”, which may partly explain why recent floods are often perceived as extreme events. The much publicised (popular media) apparent change in flood frequency since 2000 may reflect natural variability, as there appears to be no shift in long term flood frequency.
T11	Severe storms in the Pacific region, including Vanuatu, and near Japan, have been on the wane since 1970. Furthermore the sea-level with respect to Vanuatu has been stable since 2000.
T12	The number of typhoons hitting Japan have reduced by about 15% during 1991-2010 compared with 1951-1970
T13	There has been a 7.3% increase in the area of Pacific atolls over the past century.

Table 1: Supplementary Evidence

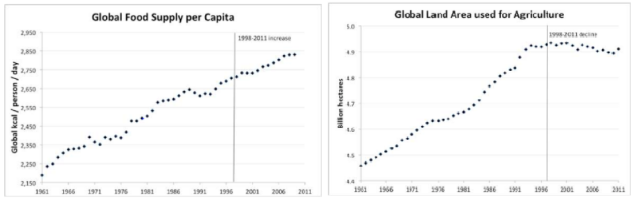


Figure 5: Food production during the period of global warming since 1960.

The Core Conundrum Revisited

Items of physical infrastructure, for example, for housing, transportation, and energy supplies, must last 50-100 years, and are therefore generally designed to last over that period. Engineers involved in such projects have to assess the value-for-money for clients. They will be assisted by economic and environmental assessments, both of which will have uncertainties associated with predictions of the future. Extreme events play an important role in deciding the safety margins and the point where extra protection is not worth it. The lack of clarity about future extreme weather, after 20 years of intensive analysis of future climates is deeply worrying. There is nothing that emerges from references [1,2] that would require a significant refinement of the margins that have applied over the last half-century,

and hyperbole is no substitute for hard facts in the engineering of the physical infrastructure. Over-adaptation that is not needed leaves clients free to sue advisors if the problems have been oversold and the costs of protection prove to have been excessive, even on a 20-year basis.

Acknowledgements

I wish to thank the many colleagues who have helped sharpen the arguments made in this paper.

T1	See the NASA and NOAA data in animated form at http://stevengoddard.wordpress.com/2014/01/04/nasa-and-noaa-data-tampering-makes-legitimate-climate-science-impossible/
T2	A systematic study of the 2014 floods in the UK in comparison with earlier Met Office data: https://notalotofpeopleknowthat.wordpress.com/2014/02/09/so-what-about-1929-julia/
T3	A long list of severe weather events that count as extreme events when compared with the weather of the last 50 years can be found at http://www.c3headlines.com/bad-stuff-happens.html. Two years in particular were were worse than anything else in the last 100 years: 1934 http://www.c3headlines.com/2014/05/obamas-claim-that-modern-severe-weather-is-unprecedented-due-to-co2-is-empirically-false.html and 1954http://www.c3headlines.com/2014/02/1954-a-bad-year-of-climate-change-natural-disasters-pummel-large-swaths-of-globe-again-1.html
T4	https://notalotofpeopleknowthat.wordpress.com/2014/02/22/no-julia-rainfall/
T5	Cai Q (2014) Reconstruction of the March–August PDSI since 1703 AD based on tree rings of Chinese pine (Pinus tabulaeformis Carr.) in the Lingkong Mountain, southeast Chinese loess. Plateau Clim Past 10: 509-521.
T6	Original NOAA and USHCN data replotted and annotated at http://www.c3headlines.com/2014/03/climate-models-documentation-from-noaa-confirms-quackery-of-computer-simulations.html
T7	An extended list has been compiled at http://wattsupwiththat.com/2014/07/29/a-brief-history-of-climate-panic-and-crisis-both-warming-and-cooling/
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Supplementary file: References for Table I

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