

Communications exercise 2: attribution of extreme events to climate change

A major heat wave occurs in your country and has persisted for some time. The extended heat is starting to raise concerns about drought and risks to agriculture and food security as well as freshwater supplies for households, industry and energy generation. Heat waves are a naturally occurring event and have many causes, but climate change is, and will increasingly, lead to more and stronger heat waves in many regions.

Produce a report on the outlook for the ongoing heat wave and expected drought, include an explanation of to what extent climate change may be a contributing factor.

Probabilities

While it may not be possible to attribute a specific event to climate change, it can be possible to speak about a change in probabilities. For example, 100 years ago a major storm may have occurred once every 10 years, while today it happens once every five years. To take one specific example among many, according to the World Resources Institute, a recent study by NOAA scientists "found that the conditions leading to the 2011 Texas drought are 20 times more likely to occur now, in a world warmed by greenhouse gas emissions, than in the 1960s."

Metaphors

Culturally-appropriate metaphors can also be used to help viewers understand the link between climate change and extreme events. For example, everyone has suffered a fever at one time or another. Even though a 1°C rise in body temperature doesn't sound like much, it make you feel very sick. Sports metaphors are popular: if the football goal posts are placed 1 meter further apart than the official distance, even though one meter isn't very much, we could expect to more goals (extreme events). Or consider Mr Kim, who smoked cigarettes his whole life and then died of lung cancer. Did smoking cause his lung cancer? It's impossible to know for sure -- maybe he would have developed lung cancer even if he had never smoked. Nevertheless, it is clear that his *risk* of lung cancer increased because he smoked. Just as with lung cancer and smoking, the *risk* of certain types of extreme weather events is increasing because of human-influenced climate change. It may not be possible to prove that a specific weather event resulted from human-influenced climate change. However, it may be possible to say that the *risk* of this type of weather extremes increased.

Other metaphors that have been used to explain the climate-extremes link (in the United States, and so may not be well-understood in other countries) include rolling loaded dice, so that double sixes (representing an extreme event) appear more often than they would if climate change has not loaded the dice, and "baseball on steroids", where because of the use of performance-enhancing drugs (climate change) a batter hits more home runs than before (before climate change).

New report from NOAA finds human-caused climate change increased the severity of many extreme events in 2014

November 5, 2015

Human activities, such as greenhouse gas emissions and land use, influenced specific extreme weather and climate events in 2014, including tropical cyclones in the central Pacific, heavy rainfall in Europe, drought in East Africa, and stifling heat waves in Australia, Asia, and South America, according to a new report released today. The report, "[Explaining Extreme Events of 2014 from a Climate Perspective](#)" published by the Bulletin of the American Meteorological Society, addresses the natural and human causes of individual extreme events from around the world in 2014, including Antarctica. NOAA scientists served as three of the five lead editors on the report.

"For each of the past four years, this report has demonstrated that individual events, like temperature extremes, have often been shown to be linked to additional atmospheric greenhouse gases caused by human activities, while other extremes, such as those that are precipitation related, are less likely to be convincingly linked to human activities," said Thomas R. Karl, L.H.D., director of NOAA's National Centers for Environmental Information. "As the science of event attribution continues to advance, so too will our ability to detect and distinguish the effects of long-term climate change and natural variability on individual extreme events. Until this is fully realized, communities would be well-served to look beyond the range of past extreme events to guide future resiliency efforts."

The report "Explaining Extreme Events of 2014 From a Climate Perspective" can be viewed [online](#). Credit: Bulletin of the American Meteorological Society

In this year's report, 32 groups of scientists from around the world investigate 28 individual extreme events in 2014 and break out various factors that led to the extreme events, including the degree to which natural variability and human-induced climate change played a role. When human influence for an event cannot be conclusively identified with the scientific tools available today, this means that if there is a human contribution, it cannot be distinguished from natural climate variability.

The report this year added analysis on new types of events including wildfires and Antarctic sea ice extent, and in one case looked at how land use patterns may influence the impacts and severity from precipitation.

New report identifies human-caused climate change and/or natural drivers behind 29 major weather events of 2014. (Credit: NOAA)

Key findings for each of the assessed events include:

North America

- Overall probability of California wildfires has increased due to human-induced climate change, however, no specific link could be made for the 2014 fire event.
- Though cold winters still occur in the upper Midwest, they are less likely due to climate change.
- Cold temperatures along the eastern U.S. were not influenced by climate change, and

eastern U.S. winter temperatures are becoming less variable.

- Tropical cyclones that hit Hawaii were substantially more likely because of human-induced climate change.
- Extreme 2013-14 winter storm season over much of North America was driven mainly by natural variability and not human caused climate change.
- Human-induced climate change and land-use both played a role in the flooding that occurred in the southeastern Canadian Prairies.

Around the World

South America

- The Argentinean heat wave of December 2013 was made five times more likely because of human-induced climate change.
- Water shortages in Southeast Brazil were not found to be largely influenced by climate change, but increasing population and water consumption raised vulnerability.

Europe

- All-time record number of storms over the British Isles in winter 2013-14 cannot be linked directly to human-induced warming of the tropical west Pacific.
- Extreme rainfall in the United Kingdom during the winter of 2013-2014 was not linked to human-caused climate change.
- Hurricane Gonzolo was within historical range of strength for hurricanes transitioning to extratropical storms over Europe.
- Extreme rainfall in the Cévennes Mountains in southern France was three times more likely than in 1950 due to climate change.
- Human influence increased the probability of record annual mean warmth over Europe, NE Pacific, and NW Atlantic.

Middle East and Africa

- Two studies showed that the drought in East Africa was made more severe because of climate change.
- The role of climate change in the Middle East drought of 2014 remains unclear. One study showed a role in the southern Levant region of Syria, while another study, which looked more broadly at the Middle East, did not find a climate change influence.

Asia

- Extreme heat events in Korea and China were linked to human-caused climate change.
- Drought in northeastern Asia, China and Singapore could not conclusively be linked to climate change.
- The high west Pacific tropical cyclone activity in 2014 was largely driven by natural variability.
- Devastating 2014 floods in Jakarta are becoming more likely due to climate change and other human influences.
- Meteorological drivers that led to the extreme Himalayan snowstorm of 2014 have increased in likelihood due to climate change.

- Human influence increased the probability of regional high sea surface temperature extremes over the western tropical and northeast Pacific Ocean during 2014.

Australia

- Four independent studies all pointed toward human influence causing a substantial increase in the likelihood and severity of heat waves across Australia in 2014.
- It is likely that human influences on climate increased the odds of the extreme high pressure anomalies south of Australia in August 2014 that were associated with frosts, lowland snowfalls and reduced rainfall.
- The risk of an extreme five-day July rainfall event over Northland, New Zealand, such as was observed in early July 2014, has likely increased due to human influences on climate.

Antarctica

- All-time maximum of Antarctic sea ice in 2014 resulted chiefly from anomalous winds that transported cold air masses away from the Antarctic continent, enhancing thermodynamic sea ice production far offshore. This type of event is becoming less likely because of climate change.

"Understanding our influence on specific extreme weather events is groundbreaking science that will help us adapt to climate change," said Stephanie C. Herring, Ph.D., lead editor for the report at NOAA's National Centers for Environmental Information. "As the field of climate attribution science grows, resource managers, the insurance industry, and many others can use the information more effectively for improved decision making and to help communities better prepare for future extreme events."

The report was edited by Herring, along with Martin P. Hoerling, NOAA's Earth System Research Laboratory; James Kossin, NOAA's National Centers for Environmental Information; Thomas Peterson, World Meteorological Organization's Commission for Climatology and formerly with NOAA's National Centers for Environmental Information; and Peter A. Stott, UK Met Office Hadley Centre. The report includes a global authorship from 21 countries. View the full report [online](#).

"AMS is pleased to collaborate with NOAA on providing the public with an accessible, peer-reviewed basis for understanding our changing world," said American Meteorological Society Executive Director Keith Seitter. "Between the State of the Climate report earlier this year and now this annual Explaining Extremes collection, an ever clearer picture emerges of our advancing scientific capabilities to identify how climate change is affecting us."

NOAA's mission is to understand and predict changes in the Earth's environment, from the depths of the ocean to the surface of the sun, and to conserve and manage our coastal and marine resources. Join us on **Twitter**, **Facebook**, **Instagram** and our other **social media channels**. Visit our **news release archive**.

Event attribution: An application to the global and UK record temperatures of 2014

Source: WMO Statement on the Status of the Global Climate in 2014

Reference: Christidis, N., P. A. Stott, and F. W. Zwiers, Fast-track attribution assessments based on pre-computed estimates of changes in the odds of warm extremes. Clim. Dynamics, 2015 (online early-view)

Authors: Nikos Christidis, Peter Stott

Detection and attribution studies have demonstrated that human influence on the climate has been a main driver of the unequivocal warming of the global climate system observed since the 1950s, according to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Human influence has also led to significant regional temperature increases at the continental and sub-continental levels. Shifts of the temperature distribution to warmer regimes are also expected to bring about increases in the frequency and intensity of extremely warm events. It is interesting to note that, unlike the observed slowdown in the global mean temperature increase over the last 15 years, the occurrence of high temperature extremes has continued to increase across a range of spatial scales. The fast-growing research area of event attribution has been developing new scientific tools to determine the influence of anthropogenic climate change on extreme events by estimating the change in the likelihood of extremes relative to a counterfactual climate that is not influenced by human activity. Here, a new event attribution technique is applied to the global and UK mean record temperature of 2014.

Event attribution assessments aim to disentangle the contributions of several different possible influences on the event, such as the atmospheric circulation, prevalent modes of climate variability and the state of the ocean at the time of the event, as well as the effect of external climatic forcings such as greenhouse gas emissions from human activity. Such assessments have typically appeared a year or more after the event occurs and can therefore be classed as “slow track”. However, scientists are often questioned about the role of climate change in the immediate aftermath of a high-impact extreme event and asked to provide a robust scientific analysis at media timescales. Hence, “fast-track” attribution techniques are being developed to provide timely assessments of how human influence may have changed the chances of events in a general case, i.e. irrespective of the specific conditions at the time of the event under consideration, until more thorough “slow-track” investigations become available. A “fast-track” attribution methodology was published last year by Met Office Hadley Centre scientists based on pre-computed tables of the change in the likelihood of temperature extremes. Tables can be constructed for any region of the world and are available for the study of both annual and seasonal temperature extremes.

The methodology comprises three steps. First, an optimal fingerprinting analysis is carried out. This analysis combines information from state-of-the-art climate models and observational datasets to provide the temperature response of the global climate to different climatic forcings. In the second step, regional information is extracted from the global response for the region of interest. Finally, the simulated overall effect of internal climatic variability is introduced into the analysis. Regional temperature distributions with and without the effect of human influence are constructed. Figure 1 shows the resulting temperature distributions for a) the global mean and b) the UK mean. The observed temperatures in 2014 are also marked on the figure.

Once the regional temperature distributions are produced, the likelihood of exceeding an extreme temperature threshold with and without human influence on the climate can be estimated. Tables of the change in the risk can then be produced by obtaining likelihood estimates over a range of thresholds. Once a record is equalled or broken, as in the two cases considered here, the tables provide an instant assessment of the effect of anthropogenic forcings on the event. This enabled the Met Office to issue a press release on the record temperatures as soon as the event was established. Regarding the global mean surface temperature, the observed record (vertical black line in Fig. 1a) lies within the red distribution, but in the extreme warm tail of the green distribution. This suggests that the record would not have been equalled or broken in a natural climate without the effect of anthropogenic forcings.

The UK record of 2014 lies within both distributions, albeit more to the extreme warm tail of the green distribution (Fig. 1b). The UK distributions are broader and overlap to a greater extent because natural variability is higher relative to the attributed anthropogenic changes at this smaller scale. At a global scale, the relative contribution of the anthropogenic component is much larger, and thus the distributions overlap hardly at all. It is estimated that human influence has increased the likelihood of the observed record-breaking temperatures in the UK by a factor of ten.

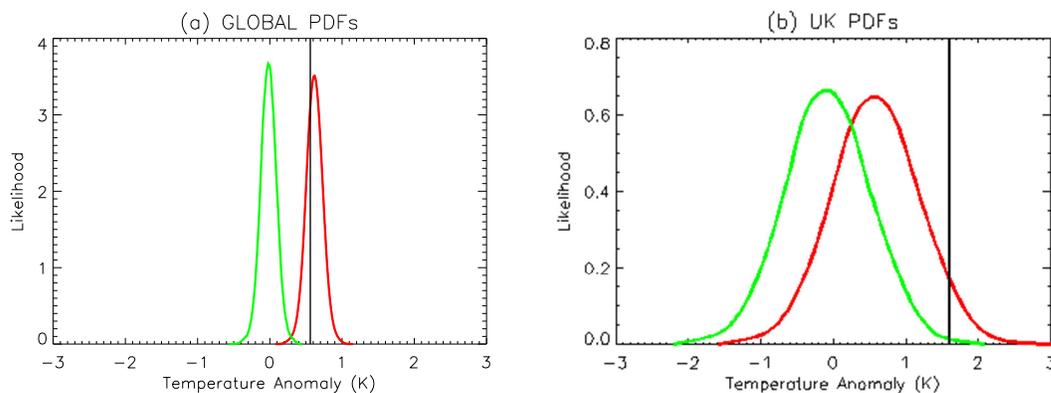


Fig. 1 Distributions of a) annual mean and b) UK mean temperature anomalies relative to 1961-1990 from the fast-track attribution methodology with (red line) and without (green line) the effect of human influence on the climate. The temperature records of 2014 are represented by the black vertical lines.

For more information:

<http://www.nytimes.com/2015/11/06/science/climate-change-extreme-weather-global-warming.html?smprod=nytcore-iphone&smid=nytcore-iphone-share>

<http://www.economist.com/news/international/21650552-scientists-are-getting-more-confident-about-attributing-heatwaves-and-droughts-human?fsrc=rss%7Cint>

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<http://www.theguardian.com/environment/2014/dec/17/europes-record-hot-year-made-35-times-more-likely-climate-change>

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<http://www2.ucar.edu/atmosnews/attribution/steroids-baseball-climate-change>