Research links extreme summer heat events to global warming

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(Phys.org) -- A new statistical analysis by NASA scientists has found that Earth's land areas have become much more likely to experience an extreme summer heat wave than they were in the middle of the 20th century. The research was published today in the journal *Proceedings of the National Academy of Sciences*.

The statistics show that the recent bouts of extremely warm summers, including the intense heat wave afflicting the U.S. Midwest this year, very likely are the consequence of global warming, according to lead author James Hansen of NASA's Goddard Institute for Space Studies (GISS) in New York.

"This summer people are seeing extreme heat and agricultural impacts," Hansen says. "We're asserting that this is causally connected to global warming, and in this paper we present the scientific evidence for that."

Video: Earth's Northern Hemisphere over the past 30 years has seen more "hot" (orange), "very hot" (red) and "extremely hot" (brown) summers, compared to a base period defined in this study from 1951 to 1980. This visualization shows how the area experiencing "extremely hot" summers grows from nearly nonexistent during the base period to cover 12 percent of land in the Northern Hemisphere by 2011. Watch for the 2010 heat waves in Texas, Oklahoma and Mexico, or the 2011 heat waves the Middle East, Western Asia and Eastern Europe. Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio

Hansen and colleagues analyzed mean summer temperatures since 1951 and showed that the odds have increased in recent decades for what they define as "hot," "very hot" and "extremely hot" summers.

The researchers detailed how "extremely hot" summers are becoming far more routine. "Extremely hot" is defined as a mean summer temperature experienced by less than one percent of Earth's land area between 1951 and 1980, the base period for this study. But since 2006, about 10 percent of land area across the Northern Hemisphere has experienced these temperatures each summer.

In 1988, Hansen first asserted that global warming would reach a point in the coming decades when the connection to extreme events would become more apparent. While some warming should coincide with a noticeable boost in extreme events, the natural variability in climate and weather can be so large as to disguise the trend.

Video: James Hansen and colleagues use the bell curve to show the growing frequency of extreme summer temperatures in the Northern Hemisphere, compared to the 1951 to 1980 base period. The mean temperature for the base period is centered at the top of the green curve, while hotter than normal temperatures (red) are plotted to theright and colder than normal (blue) to the left. By 1981, the curve begins to shift noticeably to the right, showing how hotter summers are the new normal. The curve also widens, due to more frequent hot events. Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio

To distinguish the trend from natural variability, Hansen and colleagues turned to statistics. In this study, the GISS team including Makiko Sato and Reto Ruedy did not focus on the causes of temperature change. Instead the researchers analyzed surface temperature data to establish the growing frequency of extreme heat events in the past 30 years, a period in which the temperature data show an overall warming trend.

NASA climatologists have long collected data on global temperature anomalies, which describe how much warming or cooling regions of the world have experienced when compared with the 1951 to 1980 base period. In this study, the researchers employ a bell curve to illustrate how those anomalies are changing.

A bell curve is a tool frequently used by statisticians and society. School teachers who grade "on the curve" use a bell curve to designate the mean score as a C, the top of the bell. The curve falls off equally to both sides, showing that fewer students receive B and D grades and even fewer receive A and F grades.

Hansen and colleagues found that a bell curve was a good fit to summertime temperature anomalies for the base period of relatively stable climate from 1951 to 1980. Mean temperature is centered at the top of the bell curve. Decreasing in frequency to the left of center are "cold," "very cold" and "extremely cold" events. Decreasing in frequency to the right of center are "hot," "very hot" and "extremely hot" events.

Plotting bell curves for the 1980s, 1990s, and 2000s, the team noticed the entire curve shifted to the right, meaning that more hot events are the new normal. The curve also flattened and widened, indicating a wider range of variability. Specifically, an average of 75 percent of land area across Earth experienced summers in the "hot" category during the past decade, compared to only 33 percent during the 1951 to 1980 base period. Widening of the curve also led to the designation of the new category of outlier events labeled "extremely hot," which were almost nonexistent in the base period.

Hansen says this summer is shaping up to fall into the new extreme category. "Such anomalies were infrequent in the climate prior to the warming of the past 30 years, so statistics let us say with a high degree of confidence that we would not have had such an extreme anomaly this

summer in the absence of global warming," he says.

Other regions around the world also have felt the heat of global warming, according to the study. Global maps of temperature anomalies show that heat waves in Texas, Oklahoma and Mexico in 2011, and in the Middle East, Western Asia and Eastern Europe in 2010 fall into the new "extremely hot" category.

Provided by NASA's Goddard Space Flight Center