A warming world interspersed with cooling periods

By Zack Guido

When the globe's average temperature hit an all-time warm record in 2005, perceptions grew that global warming would cause a successively hotter future. But in the years since, the average temperature has been lower, culminating in 2008 with a drop of roughly 0.2 degrees Fahrenheit—a decline of around 0.4 degrees F from the record high. These observations have now prompted some newspapers and Web sites to pose the question: has global warming stopped?

The resounding answer, presented in recent peer-reviewed journal articles, is no. Natural climate variability causes year-to-year fluctuations in temperature that can give the appearance of stable or cooling global temperatures during short intervals but do not constitute strong trends—a more trusted measure of climate change.

Indeed, climate variability is as natural to the climate system as thunder and lightning are to the Southwest monsoon and is experienced over many intervals. During the past 100 years, while the global temperature has generally increased, volcanic eruptions, El Niño Southern Oscillation (ENSO) events, and other natural occurrences have amplified global temperature at times but also have cooled the planet. Future climates will likely have similar short cool spells, some a few decades in duration, while the longer-term temperature trend continues to climb.

Recent temperature observations

The longer the trend, the more statistically powerful it is. A rising stock market for 12 consecutive weeks is more assuring than when the market has risen for only two successive weeks. It's the same with temperature patterns. Each year, NASA's Goddard Institute for Space Studies (GISS) and several other institutions such as the National Oceanic and Atmospheric Administration (NOAA) and Britain's Hadley Center compare the average global surface air temperature to all the years since 1880.

According to GISS, the global temperature in 2008 was about 0.75 degrees Fahrenheit warmer than the 1951–1980 average, continuing a trend of warmer-than-average years (Figure 1). The 30-year average, often referred to as the climatological period, is chosen as a baseline to compare years. This gives an indication of how warm or cold a given year is compared to what is considered normal. While the global temperatures were higher than normal in 2008, temperatures in the Southwest ranged between average and a few tenths of a degree F warmer than average.

The wide angle view, which focuses on the entire temperature record, puts in perspective the global warming trend that began around 1900. From this vantage point, 2008 was the ninth warmest year in the period of instrumental measurements, which extends back to 1880, around the time when widespread monitoring began. The 10 warmest years have occurred since 1997.

Focusing on this decade alone, however, captures a different picture. The average global temperature dipped in 2008 and was the coolest year since 2000. In comparison to 2007, 2008 was cooler by about a tenth of a degree Celsius, or two-tenths of a degree F; most yearly differences in average global temperature are less. Many climate scientists attribute the drop in mercury in part to the effect of La Niña, which is characterized by cooler tropical Pacific Ocean temperatures and often causes cooler global temperatures. This slight temperature dip is a seemingly small change. However, it is large enough to erase the warming trend of the last eight years. The natural climate variability plays a role in changing yearly temperatures, at times accentuating warming and at times dampening it.

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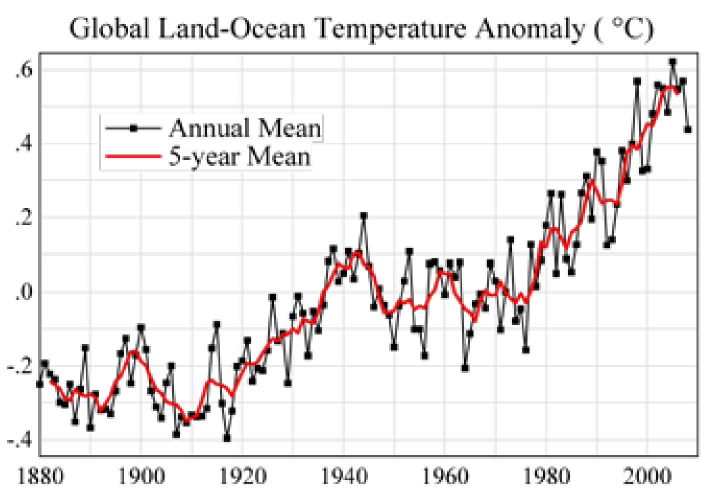

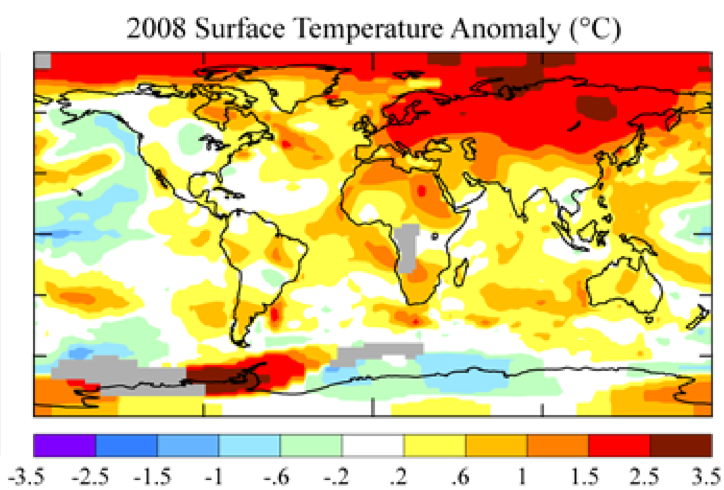

Figure 1. Global average temperature difference from the 1951–1980 average. Differences between 2008 and the 30-year average are expressed in degrees Celsius, which can be multiplied by 1.8 to obtain degrees F. This figure was created by GISS and has been slightly modified.

A Warming World, continued

Climate variability

In April the tropical Pacific Ocean's sea surface temperatures (SSTs) slightly warmed, shifting the existing La Niña event into a neutral state. The warmer ocean temperatures likely will release more heat to the atmosphere in 2009 than they did in 2008. If ENSO was the only contributor to natural variability, then 2009 would likely be warmer than 2008. But air temperatures are influenced by numerous other natural fluctuations in the climate system that occur over time intervals that impact climate on annual and decadal scales, as well as over thousands of years.

Scientists often separate natural climate variability into two categories: external and internal. External variability arises from changes in the amount of solar radiation striking the Earth (affected by 11–year sunspot cycles and longer-term changes in the Earth's orbit around the Sun), volcanic bursts that eject ash and other debris into the atmosphere, and greenhouse gases (GHGs). While the Sun provides energy to the system, volcanoes and GHGs adjust the amount of energy that is trapped within it. When Mount Pinatubo erupted in 1992, for example, a blanket of ash wafted in the upper atmosphere for about two years and slightly cooled global temperatures (Figure 2).

Against this backdrop of external variability, yet separate from it, internal variability arises when natural forces intrinsic to the climate system change temperatures on Earth, much like a thermostat. As long as solar radiation pumps energy into the atmosphere, the physical processes that move energy around the globe—such as ocean and wind currents—will create year-to-year changes in temperature. The Intergovernmental Panel on Climate Change (IPCC), an international consortium of scientists who synthesized the state of the climate in the latest assessment report in 2007, noted eight ocean temperature and air pressure fluctuations that influence internal variability. ENSO is one of these. Global temperature often has shot up during El Niño phases; indeed, one of the largest ENSO-related spikes occurred during the record-breaking year of 1998 (Figure 2). The average global temperature that year was about 1 degree F above the 30-year average; GISS stated that 0.2 degree F of the warming is attributed to the warming effect of El Niño.

While the temperature of any given year is influenced by natural variability, the longer term warming trend is likely the handiwork of GHGs emitted by burning fossil fuels. Instrumental and paleoclimate records of the past 1,000 years and results from climate models strongly suggest that the recent increase in global average temperature is beyond what is possible from natural variability. As a result, the IPCC stated it is extremely unlikely natural climate variability explains warming during the past half century.

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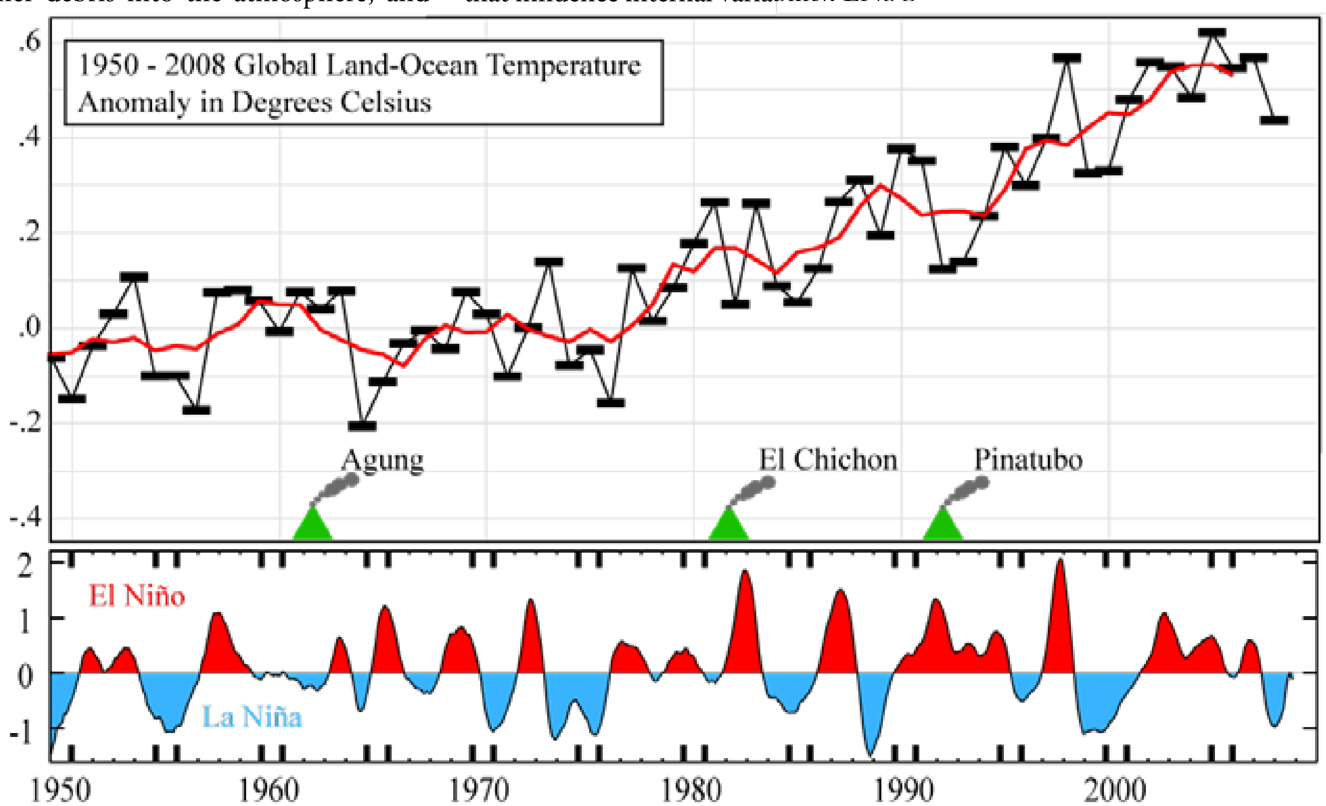

Figure 2. The global average temperature change between 1950 and 2008. El Niño Southern Oscillation and volcanic eruptions contribute to the year-to-year natural climate variability. This figures was created by GISS and slightly modified for this publication.

Future climate likely to have cooling periods

The phrase, "Lies, damn lies and statistics," popularized by Mark Twain, can be applied to temperature trends in terms of the ability of numbers to support different interpretations. Temperatures since 1900 have increased even with the inclusion of 2008, providing strong support for human-caused global warming. But no warming trend has been detected since 1998, which has been cited as evidence against global warming.

To clarify this discrepancy, researchers David Easterling and Michael Wehner dissected the global temperature record and combed simulations of future climates to assess the historical and future occurrences of stable or cooling periods. Their work, published in the peer-reviewed scientific journal *Geophysical Research Letters* in April, suggests that periods similar to the 10 years since 1998 will occur in the future, and the progression of global warming will be interspersed with cooler periods.

Climate scientists often extract trends in the data to smooth out yearly jumps and dips. Easterling and Wehner derived a five-year moving average—the average of two years prior to and after a given year—to minimize the effect of any one year. In the five-year average, warming since 1970 is nearly constant, with the two drops in temperature occurring after large volcanic eruptions (Figure 2).

Globally, average temperatures have been climbing since 1975, indicating the world is progressively warming. Nevertheless, temperatures remained steady or cooled slightly during several periods within the past 34 years. For example, Easterling and Wehner noted that no warming or cooling temperature trends stood out during 1977–1985 or 1981–1989 or since 1998. A factor in this lack of fluctuation is the temperature on the start and end date of a trend. For short periods, which are less scientifically meaningful than long ones, beginning the analysis in a warm year and ending it in a cool year can generate cooling trends. Over longer time periods, such as 100 years, the skewing effect of the first and last temperatures is diminished.

Easterling and Wehner also looked forward, using a climate model to assess the likelihood of future decadal cooling periods. Analyzing temperatures of the 21st century from simulations used in the IPCC's latest assessment report, the authors found a 5 percent chance for cooling trends during any 10-year interval, even in the absence of any simulated volcanic eruptions. From this, the authors stated that the natural variability of the real (as opposed to modeled) climate system will likely produce multi-year periods of sustained cooling or at least periods with no real trend, even in the presence of long-term human-caused warming.

What does this mean?

A disconnection often exists between the time periods discussed by climatologists and those useful in planning. Scientists typically present temperature scenarios for mid-century or 2100, all of which show some degree of warming globally and in the Southwest. But, for the public and private sectors, including agencies in charge of managing water resources and energy development, understanding climate change in decade-long periods is useful. During a cooler period, for example, the knowledge that temperature trends will fluctuate amid warming can prevent decision makers from second-guessing adaptation plans that prepare for a warmer world.

Although 2008 was the coolest year since 2005, warming is likely to return: according to GISS, it seems likely that, with the return of El Niño later this year or in 2010, a new global surface air temperature record will be set within the next one to two years.

For questions or comments, please contact Zack Guido, CLIMAS Associate Staff Scientist, at zguido@email.arizona.edu or (520) 882-0879.

Related Publications

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