Central Coast Climate Science Education

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Commentary on the video "Extreme Weather: What Role Does Global Warming Play?

(Last edit: October 30, 2016)

This 33 minute video, "Extreme Weather: What Role Does Global Warming Play", https://www.youtube.com/watch?v=QnzSHsi4pus is by climate scientist Stefan Rahmstorf. Prof. Rahmstorf is a frequent contributor to http://www.realclimate.org/ . RealClimate.org is one of my favorite resources, and the most authoritative site for up-to-the-minute posts by leading climate scientists.

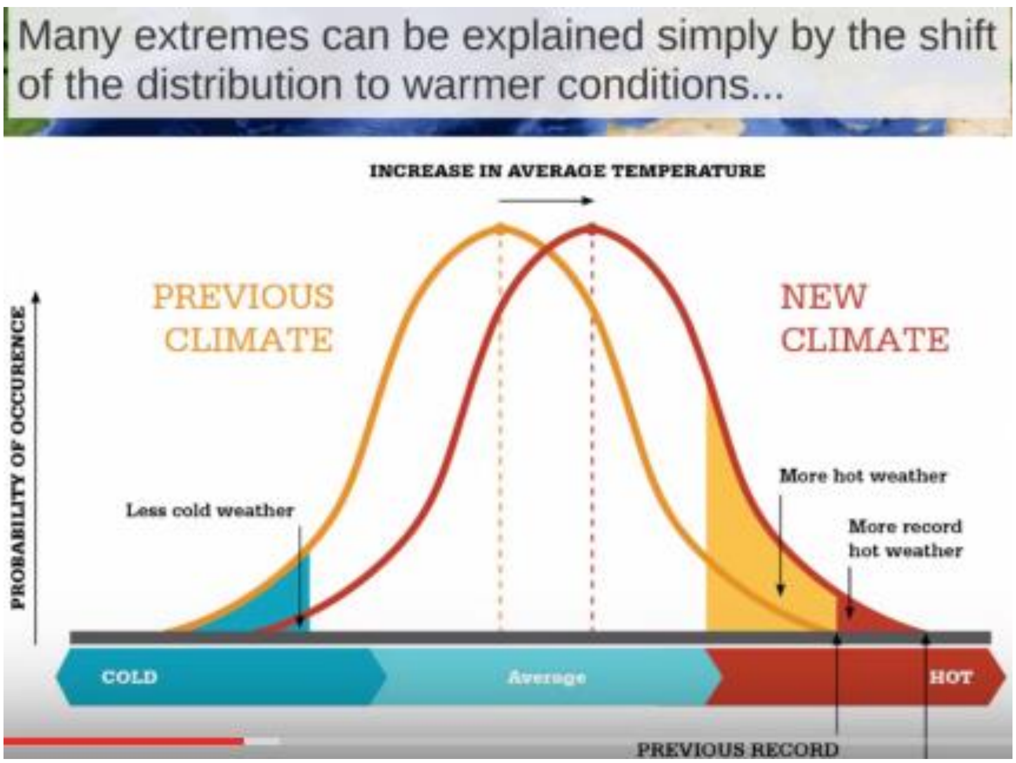
The video features quite a bit of graphical material that goes by fairly quickly, so here is a simple brief summary and commentary of the main points:

Extreme events, such as more frequent and more intense heat waves, are fairly straightforward to understand---up to a point. It is beyond reasonable doubt that the globally-averaged surface temperature has increased rapidly since the beginning of the industrial revolution, and especially during the last few decades. This is true at nearly every point on the planet. At any point, superimposed on this systematic rise in temperature, there will be the ebb and flow of high and low pressure systems ("weather") over the course of the year, and longer-term variations resulting from the ocean-atmosphere swings of El Nino/La Nina events. These fluctuations will cause fluctuations in the temperature.

During a relatively short interval of time, say a decade, the distribution of temperatures will follow the familiar "bell curve". There will be some average, most frequent temperature, but with excursions to both the warmer and cooler sides of this distribution. This "bell curve" (or, more scientifically, the "Gaussian distribution") occurs in a wide variety of situations whenever a large number of more-or-less random effects combine to give the overall situation.

For example, suppose in 1960 we measured the weight of a large number of men from the U.S. at age 40, and from a homogeneous socio-economic group. We would get such a bell curve. Repeating the same procure on a similar group in 2016 we would also get a bell curve but (regrettably) the average weight will have shifted several pounds heavier. This means that a given weight that was quite a bit heavier than the 1960 average, and thus relatively rare, would be encountered more frequently in the 2016 sample.

The same thing is happening with the temperature record at most locations. Here is one image from the video that illustrates this point:



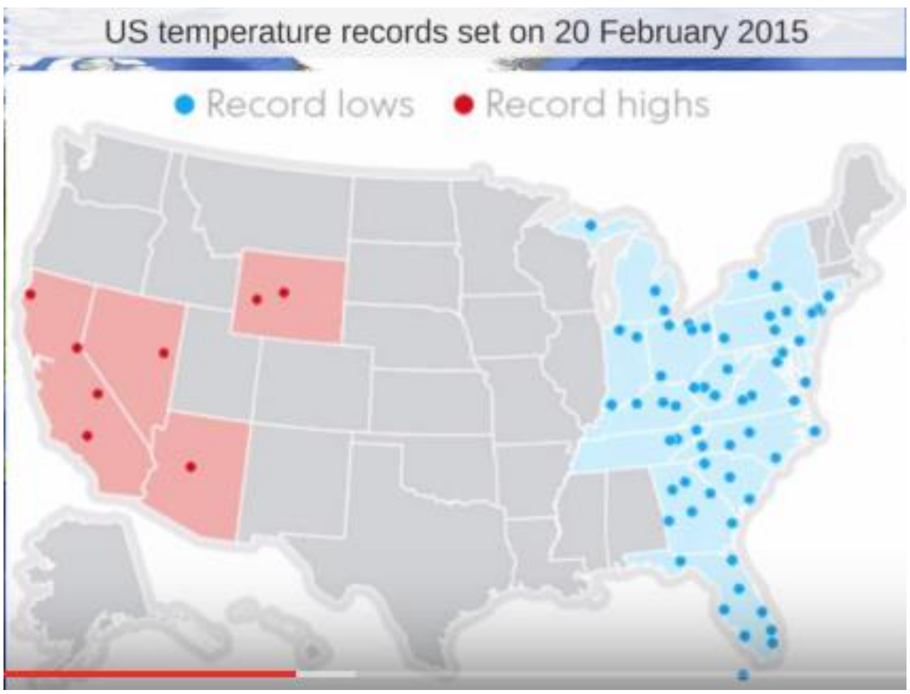
So, as Rahmstorf explains, compared to the distribution in the decade from, say 1960 to 1970, the decade from 2005 to 2015 saw more extreme high temperatures and fewer extreme lower temperatures than in 1960-1970.

The same general trend occurs in measures of intense rainfall events simply because a warmer atmosphere contains more water vapor, though the statistical evidence is not as robust for precipitation as it is for temperature.

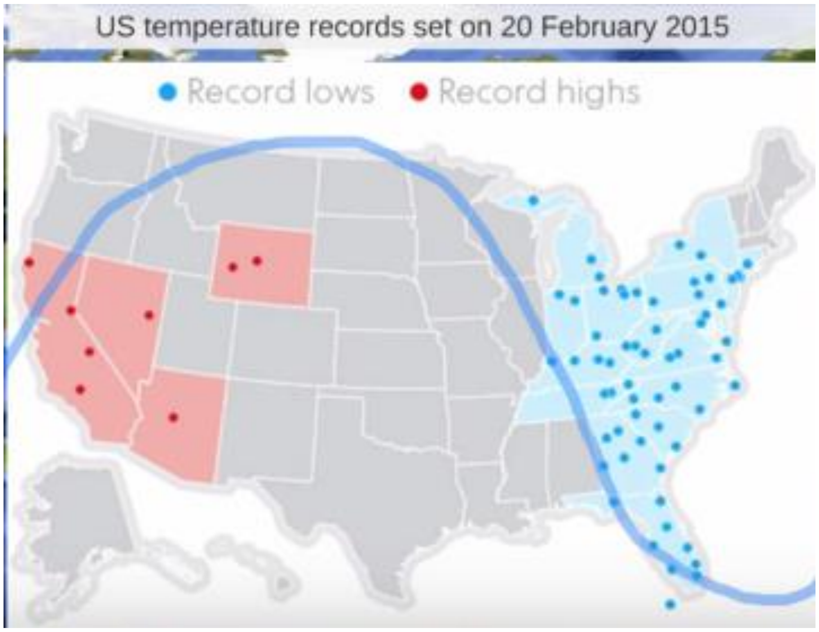
But there is more to the story than this, and it is this somewhat unforeseen twist that Rahmstorf describes in the video.

An indication that something else is going on other than the shift of the bell curve is provided by some recent events. An example is the severe and extended heat wave of 2010 in Russia. This was so severe that, as best as climate scientists are able to tell, that event was unique in at least 500 years. This heat wave seems such an "outlier" that something other than the simple shift in mean temperatures illustrated by the graph above is likely to be involved.

A clue as to what this other phenomenon involves is suggested by another image from the video:



This *record* cold, not just cold, temperature in the Eastern U.S. was, not surprisingly, seized upon by climate change contrarians as "proof" that global warming is nonsense. But it is remarkable that on the same date several record *high* temperatures were set in several places in the Western U.S. What was occurring becomes clearer when Rahmstorf superimposed the jet stream location on this same image:

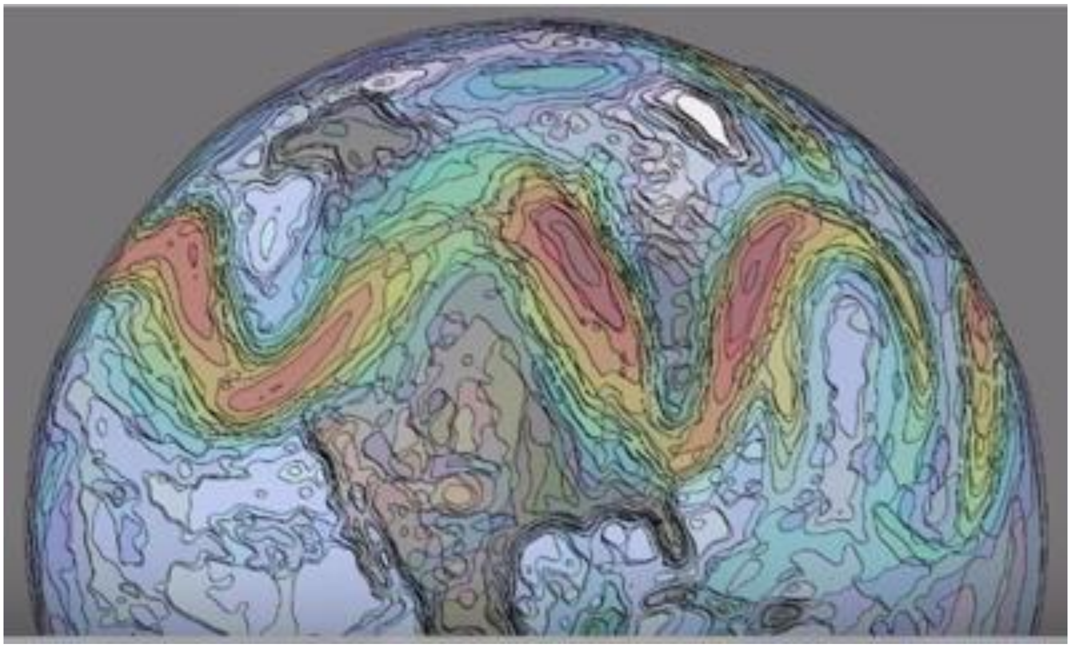


The blue line represents the path of the jet stream at that time.
The jet stream (there are actually two--the one discussed here is the "polar" jet stream) is formed in mid to high latitudes when two large-scale circulation loops carrying energy northward meet each other, one from about latitude 30 degrees to 60 degrees and the other from 60 degrees to the polar region. This meeting, together with the Earth's rotation, drives a high speed river of air, the jet stream, flowing from west to east at speeds of typically 100 mph.

The jet stream tends to "steer" air masses and storms in its direction.
While the average direction of the jet stream is from west to east along constant latitude, it may "meander" and have a strong north-south component. This is the case in the image above.

The consequence was that in the western U.S., the jet stream pulled in warm air from warmer low latitudes, while in the eastern U.S. very cold air was steered down into the U.S. from very cold arctic regions.

The "meat" of the video is a discussion of the circumstances that trigger such N/S meandering patterns like the following:



The details are complex, but involve “forced resonance”. Rahmstorf uses the analogy of a child being pushed on a swing. There is a natural rate of back-and forth to the swing, and if the person pushing the swing times her pushes to this natural frequency the swing really gets going.

Musical instruments provide another analogy: If you ask a beginner to play a flute, she will blow a stream of air across the “embouchure” hole and probably will not produce a very nice sound. But a skilled flute player will direct and focus the stream of air in such a way that a full, pure, beautiful note will result.

But which note will be produced? That depends of course on which keys are pressed and thus on which of the tone holes are open and which are closed. A particular combination will result in a natural frequency of the sound waves in the flute. The intensity of the vibrations of air of that frequency will be far greater than other frequencies and the result will be a beautiful pure musical note.

Something similar seems to occur with the jet stream. The question is what is it that "tunes" the jet stream to produce the meandering pattern shown above with perhaps six or seven "meanders" circling the globe.

The detailed mathematical analysis suggests that it is an abnormal "bump" in the run of temperature from the equatorial regions to the polar regions occurring at latitudes of between 60 to 70 degrees.

The interesting suggestion is that this bump is associated with open arctic ocean replacing arctic sea ice. The ocean absorbs far more heat from the sun than highly reflective sea ice. Since there has been a dramatic overall decline in summer sea ice over the last few decades, these meandering jet stream events might be expected to become more frequent.

This is not the first time that it has been suggested that changes in the character of the jet stream might be associated with decreasing arctic sea ice.
(See for example Sewall and Sloan, Geophysical Research Letters, 24 March, 2004 and work by Jennifer Francis and colleagues, as summarized in this short 2013 video by Dr. Francis: https://www.google.com/ - q=Jennifer+Francis+Jet+stream) but the present analysis is the most detailed.

There is a "double whammy" associated with this behavior of the jet stream. Not only does it involve a strong North/South flow, but the speed at which the pattern of wiggles moves from west to east may slow and "stall" for prolonged periods.

In the case of temperature extremes, this means that the duration of such temperature extremes will be prolonged. Additionally, if warm moist air is drawn to a certain area with resultant heavy rain, the lingering pattern can result in severe flooding.

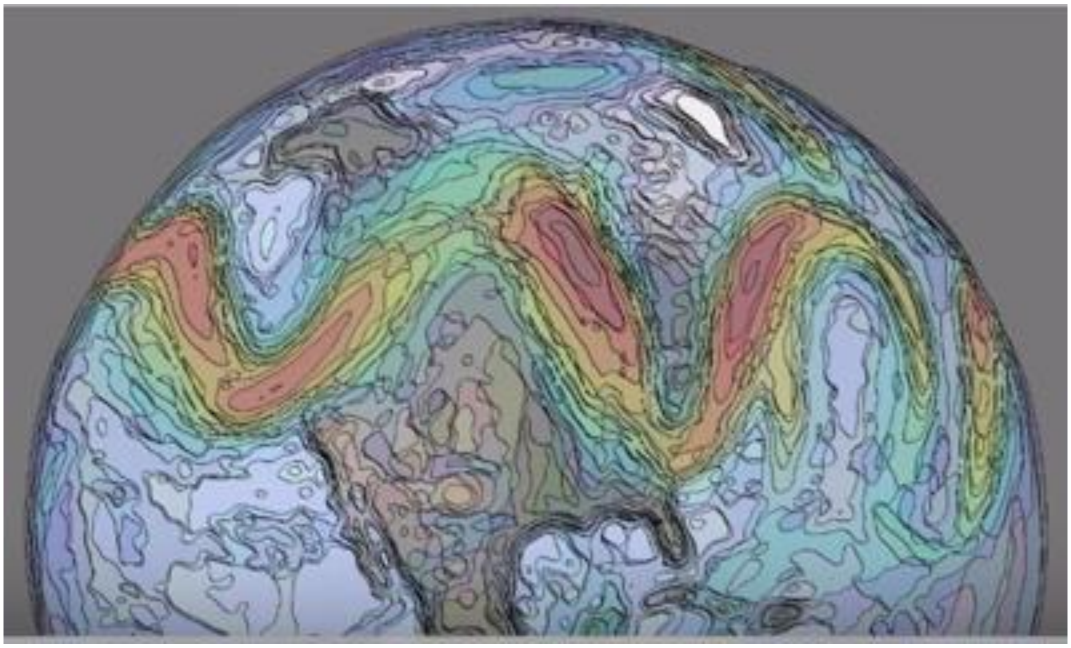
As the video points out, such severe flooding occurred in Pakistan during the same period as the Russian heat wave.

Aside from the specifics of the description of the behavior of the jet stream discussed in the video, I think there are two rather general lessons to be learned about global warming and how it influences extreme weather events.

First, we should not be surprised at the unexpected. There are several variations on the following famous quote:
"Humanity is conducting an unintended, uncontrolled, globally pervasive experiment..." in the course of changing crucial components of the Earth's atmosphere. Or to put it more succinctly "Don't mess with Mother Nature." The influence of this uncontrolled experiment on the jet stream and associated extreme weather events is probably just one example of unanticipated results.

Second, the tendency to completely misinterpret and misrepresent extreme weather events by those guided by ideological views instead of science must be relentlessly combated. I hope that the teaching of critical thinking and the scientific method to children and young adults will help in this regard. Instead of interpreting extreme events like this:

future generations will instead rely more on real scientific insights like this:



Thanks to Mr. Walt Reil for calling my attention to the Rahmstorf video.