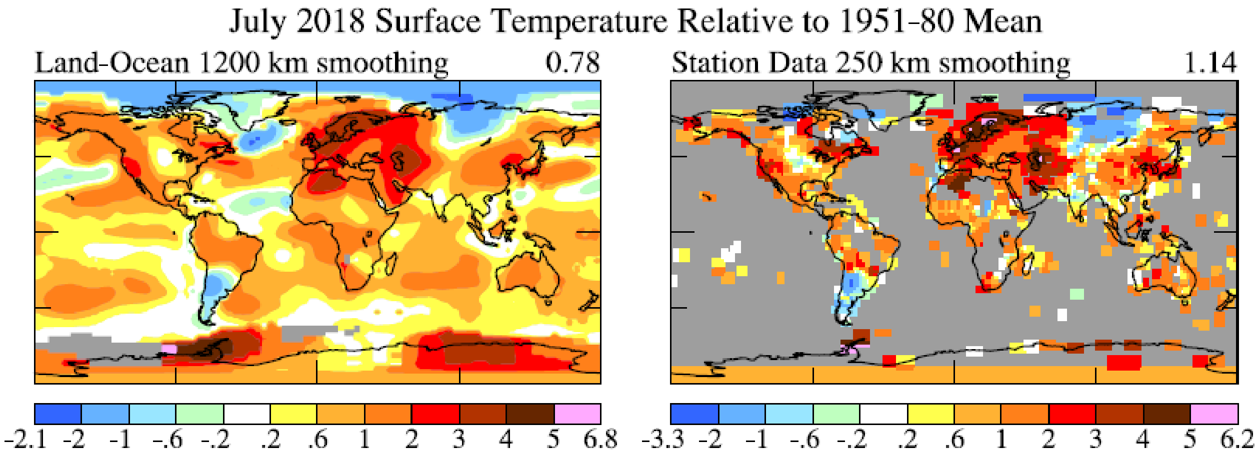
July 2018 Global Temperature Update



Heat waves seemed unusually widespread in July, as the media reported extreme heat in Europe, the Middle East, northern Africa, Japan and western United States. Extreme heat contributed to extensive wildfires in the western United States, Greece and Sweden, with fire extending into the Arctic Circle.

The left map is the global distribution of temperature anomalies with our usual 1200 km smoothing; the right map has 250 km smoothing and uses only meteorological stations (no sea surface temperatures). Area-weighted warming over land (1.14°C) is 1.5 times larger than global warming (0.78°C), consistent with data for the past century (see graphs at http://www.columbia.edu/~mhs119/Temperature/T_moreFigs/).

Globally July 2018 was the third warmest July since reliable measurements began in 1880, 0.78°C warmer than the 1951-1980 mean. The warmest Julys, in 2016 and 2017, were 0.82°C and 0.81°C, respectively. July 2018 temperature was +1.06°C relative to the 1880-1920 base period, where the latter provides our best estimate of pre-industrial global temperature.

It is incorrect to describe the July 2018 climate conditions in the global hotspots as a "new normal" climate for those regions. Hotspots move from one summer to another. Sweden, for example, may have a much cooler summer next year. However, the chance of having such extreme conditions is increasing dramatically. Realistic description of the changing climate is perhaps shown best by our shifting "bell curves" for seasonal temperature anomalies (Regional Climate Change and National Responsibilities).

Figure 2, from our paper, shows that global warming has greatly increased the frequency or chance of an extreme hot summer, e.g., two standard deviations or more warmer than average 1951-1980 climate. The bell curve is shifted by 1-1.5 standard deviations by 2005-2015 in the regions shown in Figure 2.

An important point is that the bell curves are continuing to shift, which is another reason not to suggest a fixed "new normal." How much has the bell curve continued to shift in just the past few years?

The 2015-2018 global temperature relative to 1951-1980 is +0.90, which compares with +0.66 for the period 2005-2015. To a good approximation an increase of global warming from +0.66 to +0.90°C increases the rightward shift of the bell curve shown for 2005-2015 by the factor 0.90/0.66 ~ 1.36.

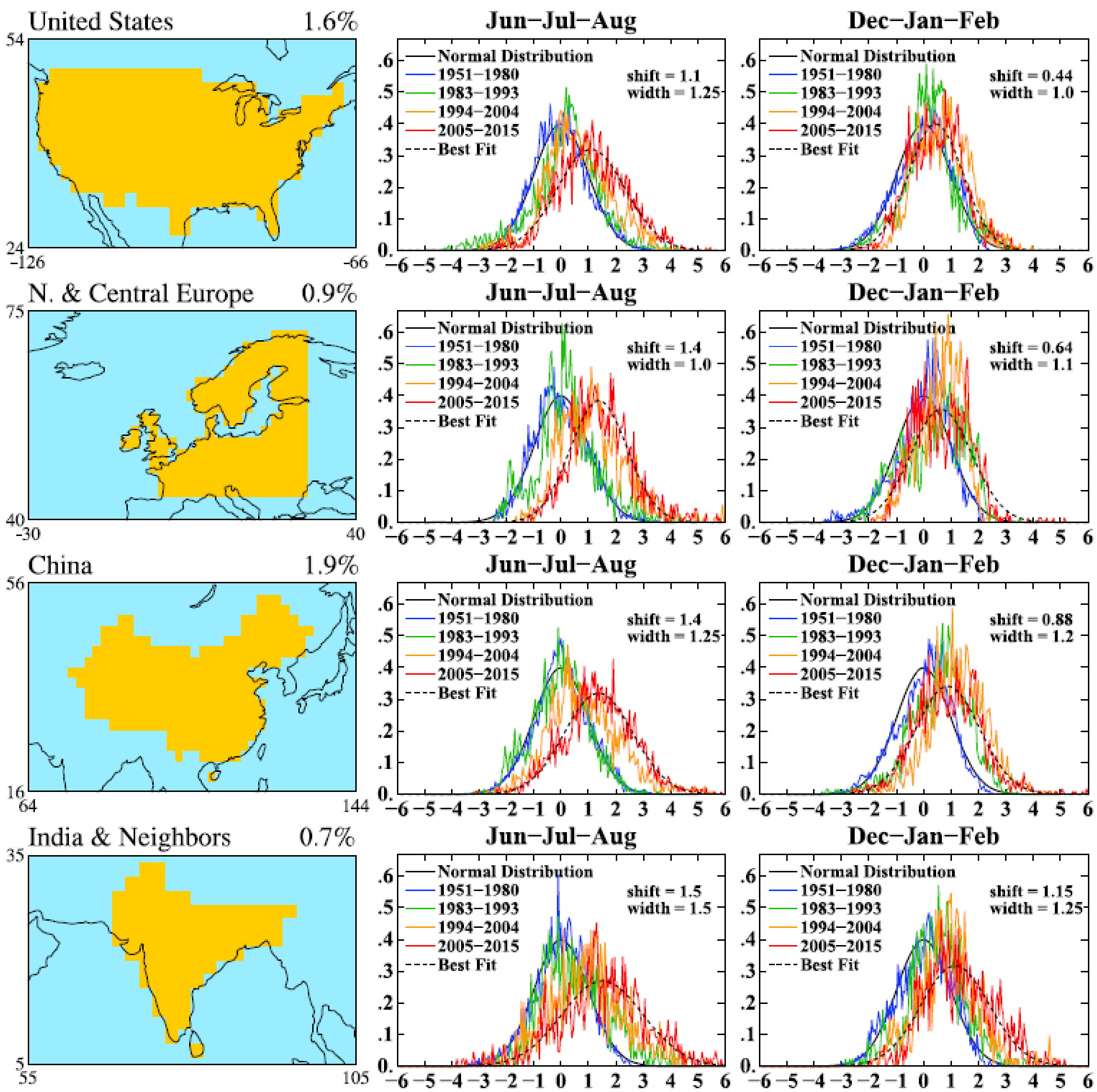


Figure 2. Bell curves that define the frequency of local temperature anomalies relative to 1951-1980 base period. Numbers above maps are % of globe covered by the selected region. 'Shift' and 'width' refer to 2005-2015 data.

This large warming and movement of the bell curve, if it is representative of the coming decade, is an acceleration of the warming trend. Of course, a strong El Nino (Figure 3) contributed to 2015-2018 warmth. However, we will argue that the present 12-month running mean (Fig. 3) has already reached the inter-El Nino minimum global temperature, at a value that is above the trend line for the average.

If the latter assertion is correct, we may have entered a period of accelerated global warming. Jeremy Grantham, in The Race of Our Lives Revisited, draws that conclusion from comparison of global temperatures at the peaks of the last two El Ninos. An acceleration of warming is consistent with recent acceleration of climate forcings described in Young people's burden: requirement of negative CO2 emissions. We will take a closer look at acceleration of global warming in our next Communication

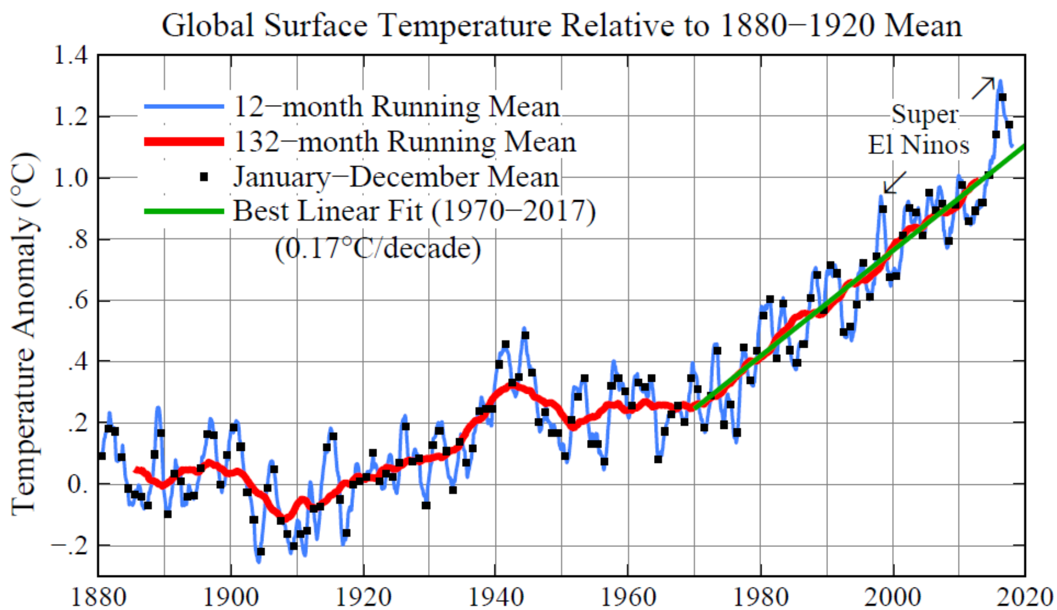


Figure 3. Global surface temperature relative to 1880-1920 based on GISTEMP analysis (Hansen, J., Ruedy, R., Sato, M., and Lo, K.: Global surface temperature change, *Rev. Geophys.*, 48, RG4004, 2010.).

Climate shifts in the subtropics in the summer and in the tropics all year, as shown if Figure 4, are larger than at higher latitudes, with the unit of measurement being the standard deviation of local temperature. Warming in these regions is particularly important, because the regions were already hot without added warming. There is a danger that these regions will become less livable, increasing the pressures for migration, as discussed in Regional Climate Change and National Responsibilities.

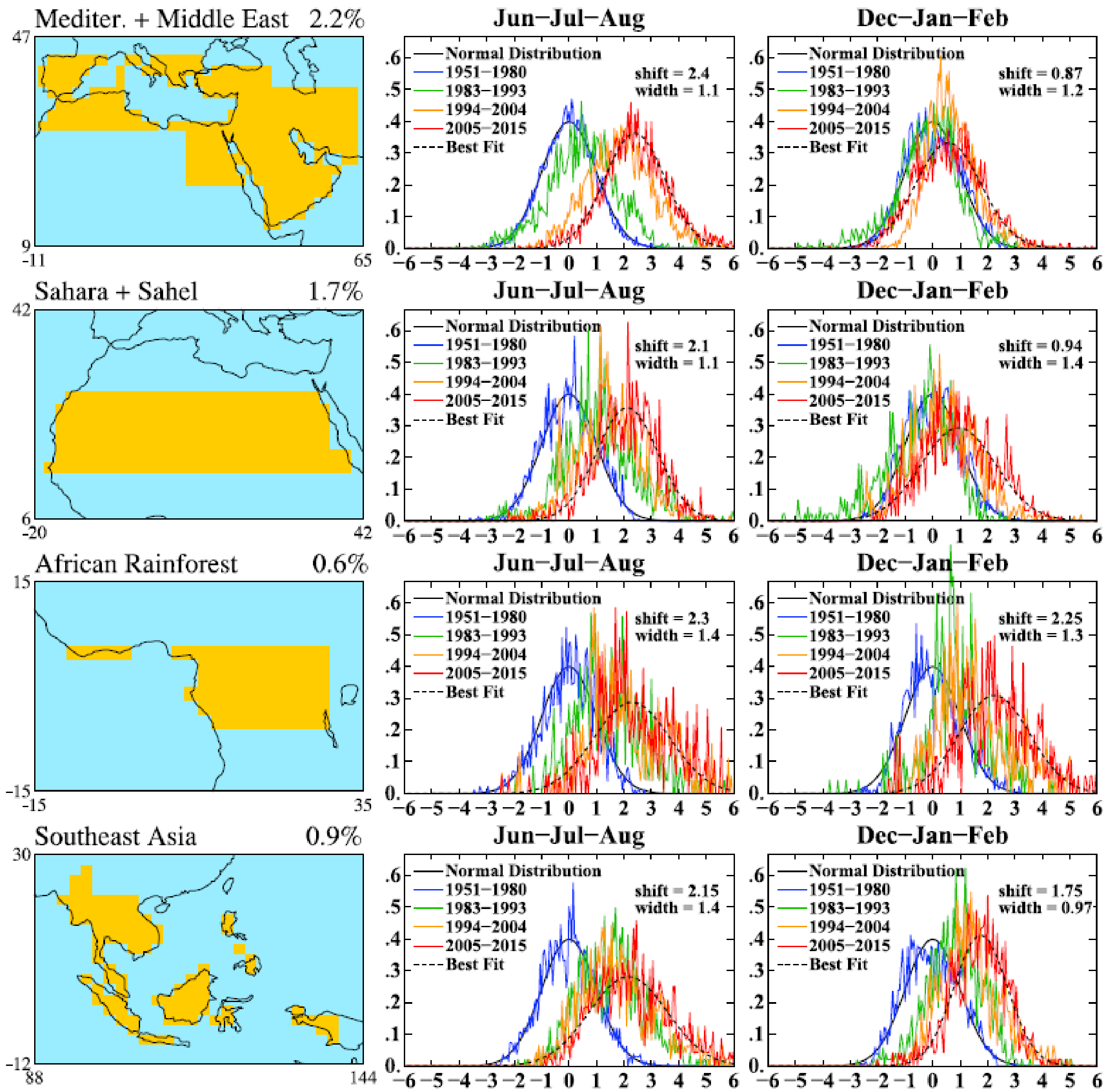


Figure 4. Bell curves that define the frequency of local temperature anomalies relative to 1951-1980 base period. Numbers above maps are % of globe covered by the selected region. 'Shift' and 'width' refer to 2005-2015 data.

You can sign up for our monthly temperature update at http://eepurl.com/bnhnMT.