CLIMATE CHANGE & HEAT WAVES

The Earth is getting hotter due to human activities that release heat-trapping gases into the atmosphere. This human-caused global warming is undisputed in the scientific literature, and numerous studies have identified the human fingerprint on recent extreme heat events.

Recent heat waves affecting the US were greatly exacerbated by climate change:

- It is virtually certain that the Northern Hemisphere heat waves in Summer 2018 could not have occurred without climate change. Moreover, observed climate change has exposed an extra 16 percent of the populated and agricultural areas in the Northern Hemisphere to extreme heat waves (Vogel et al. 2019).
- Human-induced climate change contributed to the record breaking global hot temperatures in 2014, 2015, and 2016. The 2016 temperatures had a 27 percent chance of being record-breaking, but without climate change, that chance would have been one-in-a-million (Mann et al. 2017a).
- For the 2000-2009 decade, climate change quadrupled the likelihood of a record-breaking hot year for all of the US (Christidis et al. 2012).
- Climate change has at least doubled the likelihood of record-breaking hot summer days in the US (Diffenbaugh et al. 2017).
- Climate change is increasing heat stress, a dangerous threat to human health. Nighttime temperatures are increasing faster than daytime (Zwiers et al. 2011), making it harder for the human body to cool down at night (Knutson et al. 2016).
- Even with these figures, there is evidence that we may be underestimating the effect of climate change on heat waves (Li et al. 2018; Mann et al. 2018).

HOW DOES CLIMATE CHANGE AFFECT HEAT WAVES?

The clearest and most direct effect of human-driven climate change is the increase in global temperatures. We have already observed a rise of 1 degree Celsius (1.8 degrees Fahrenheit) in global average temperatures. Heat waves have always affected societies, long before human-driven climate change. However, when a 'wave' of hot temperatures occur in an already 1-degree-warmer world, they are more likely to be pronounced heat waves. Thus, climate change has increased the probability that a heat wave will be severe and has increased the frequency of heat waves and record-breaking seasons and years.

Climate change is also altering atmospheric circulation (e.g. the jet stream), and some of these changes are dramatically amplifying local heat extremes (Mann et al. 2017). For instance, the jet stream is increasingly going off its traditional course and sometimes stalls altogether. When it stalls, high pressure ridges get 'stuck', leading to longer and more intense heat waves.

"FOR ME, THESE TEMPERATURES FOR THE PAST DECADE ARE NOT JUST STATISTICS: THEY HAVE NAMES AND STORIES. HEAT WAVES KILL MORE PEOPLE THAN ANY OTHER EXTREME WEATHER EVENT."

- Dr. Renee Salas,
MD, Emergency Medicine

REGIONAL SPOTLIGHT

The earth is not warming evenly - certain places, seasons, and even times of day are warming faster than others. In fact, the east-west pattern of freezing east coast weather happening at the same time as hot California winters is likely due to climate change - climate change has led to more frequent warm winters in the Western US while the Eastern US experiences cold winters (Singh et al. 2016).

WESTERN US:

- In the Western US, half of all record breaking heat waves would not have been record-breaking without climate change (Coumou et al. 2013).
- In summer, heat waves are now five times more likely to occur due to climate change (Christidis et al. 2014). We can see these effects in recent heat waves - the combination of human-induced climate change and natural variability made the 2013 US Southwest heat wave significantly more likely (Shiogama et al. 2014).

CENTRAL US:

- Climate change has been detected in record-breaking hot seasons and years as early as the mid-1990's (King et al. 2016).
- These effects have been muted, however, by the presence of the 'warming hole' (Dittus et al. 2016). The 'warming hole' is an area extending across the south-central US which has warmed more slowly than the rest of the US, and in some cases even cooled; however, it is mostly due to natural variability and local pollutants, and is not evidence of a 'hiatus' in global climate change.
- The 2011 Texas heat wave occurred in a region partially overlapping with the 'warming hole.' While 80 percent of the direct contribution to the heat wave was natural variability, 20 percent was due to climate change (Hoerling et al. 2013). Moreover, the extreme temperatures were made ten times more likely by climate change (Paciorek et al. 2018; Rupp et al. 2015).

EASTERN US:

- Climate change has made extreme heat events at least three times more likely in winter and at least five times more likely in summer (Christidis et al. 2014).
- Climate change has quadrupled the frequency of events like the 2012 hot summer over the North-Central and Northeastern US (Diffenbaugh et al. 2013) and increased the likelihood of the 2012 Eastern US March-May heat event by a factor of 12 (Knutson et al. 2013).
- In the Eastern US, one-out-of-every-ten record breaking heat waves would not have been record-breaking without climate change (Coumou et al. 2013).

ALASKA:

- Alaska has warmed more than any other state.
- Hot winters and summers in Alaska are now five times more likely to occur due to climate change (Christidis et al. 2014).
- Record breaking heat in the Arctic during winter 2016 would not have been possible without climate change (Kam et al. 2018).
- Record Arctic heat in 2016 led to an unprecedented marine heat wave off the coast of Alaska that decimated marine ecosystems. The marine heat wave likely could not have occurred without climate change (Walsh et al. 2018). According to one study, climate change made it up to 50 times more likely to occur (Oliver et al. 2018).

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