100 VIEWS OF CLIMATE CHANGE

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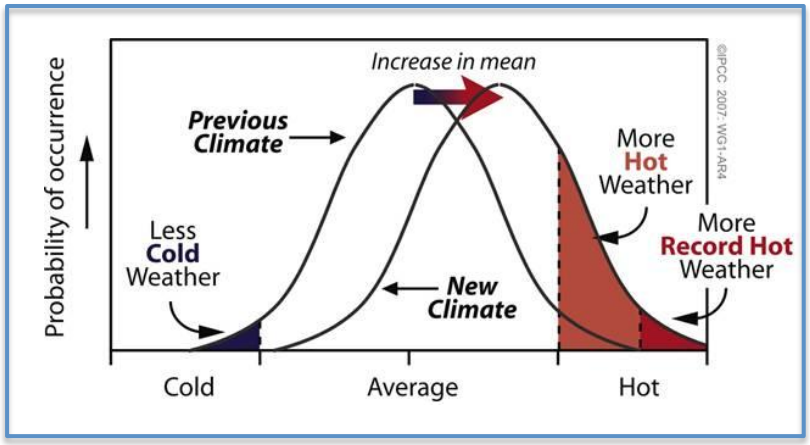
Why a Little Global Warming Means Big Increases in Heat Waves, Droughts, and Floods

Small changes in *averages* can mean big increases in *extremes*. Summer temperatures just a few degrees hotter will mean many more heat waves and droughts; sea levels just a few inches higher will mean many more coastal floods. The 2003 European heat wave that killed tens of thousands of people, the 2012 drought in the US that ruined crops and burned forests, the flooding caused by Hurricane Sandy: as the CO_2 we add to the air raises the planet's average temperatures, such extreme events will happen much more often.

WHAT BELL CURVES HAVE TO DO WITH THIS

Many aspects of climate graph into bell curves—thick (or high) in the center, where most numbers will fall, and increasingly thin (or low) on both sides, where higher and lower numbers will fall. For instance, if for many years we measure a region's high summer temperatures and then graph those numbers, we'll find that most years will fall somewhere in the bell's thick center, where they are close to the average (or mean), the highest point on the bell. Summers that are warmer and cooler than average will appear along the sloping sides. The very hottest and coldest summers will fall along the bell's skinny tails.

The shape of a bell curve shows the strongly decreasing likelihood of events that are far above or below average. It also shows us how even a small shift of the bell to the left or right can produce huge changes in the likelihood of these "extreme" events.



This sketch illustrates what happens when a bell curve of temperatures shifts to the right. Note how the coldest temperatures nearly vanish and the hottest become much more likely. And note how a whole new zone of extremely hot temperatures grows on the bell curve's right-hand tail.

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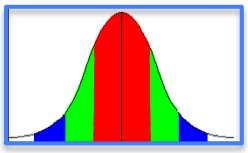
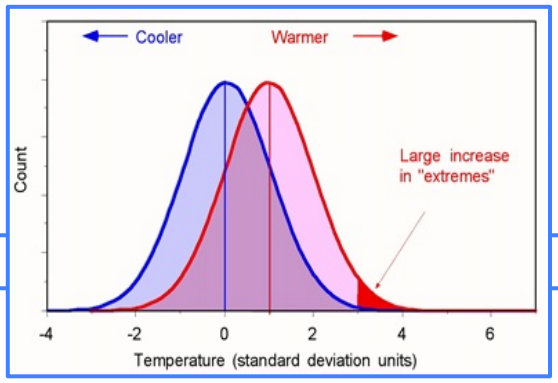
STANDARD DEVIATIONS



The width of the bell (which indicates variability) is measured in units called standard deviations, as illustrated by this red, green, and blue bell. By definition:

- Things that happen about 2/3 of the time (68%) fall in the red space, within one standard deviation from the center (the norm or average): we could call this red zone ***ordinary.***
- Things that happen from 5% to about a third (32%) of the time fall in the green space, between 1 and 2 standard deviations from the norm: we could call the green zone ***unusual.*** Just 1 in every 20 events will fall outside these two zones.
- Things that happen from 0.3% to 5% of the time fall in the blue space, between 2 and 3 standard deviations from the norm: we could call them ***rare*** or ***very rare.***
- Only 3 events of every 1000 fall outside these 3 standard deviations: these events are ***practically unheard-of.***



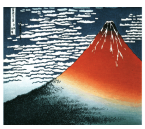
So with a shift of just 2 standard deviations, what was once ordinary becomes very rare, what was once very rare becomes ordinary, and what was once practically unheard-of becomes merely unusual.

In June and August 2003, much of western Europe experienced a **HEAT WAVE** so severe that it killed at least 35,000 people. Average temperatures were 6-7°C (roughly 11°F) hotter than usual—or, in terms of the bell curve, 4 to 5 standard deviations above average. A temperature just 3 standard deviations higher than normal would likely occur only 1½ times every thousand years; this summer was so far out on the skinny tails of the curve that scientists had to scramble to grasp the data. If we keep burning fossil fuels at our current rates, western Europe is expected to warm enough to shift the bell curve of its average temperatures far enough to the right that summers like 2003 will become ordinary.

The story is similar for **DROUGHT**. Even if nothing else changes, a shift to the right of the temperature bell curve means a dramatic increase in the occurrence of drought, simply because more heat evaporates more water. But rainfall is expected to change, too—to increase in some regions and decrease in others. In some places, more rain may compensate for more evaporation, but in semi-arid places like the Mediterranean, the southwestern US, and the Middle East, rain will most likely decrease, making droughts even more likely. How much? That depends on what we do about carbon dioxide and fossil fuels.

COASTAL FLOODING will also increase: rising sea levels shift the high-water bell curve to the right. The floods that once came only with gigantic storms will happen much more often.

The flooding in New York and New Jersey during Hurricane Sandy followed 11 inches of sea level rise in the past century, and it was that last 11 inches that washed away buildings and submerged subways. During the lifetime of a child born today, similar floods may occur every 2 or 3 years along America's central Atlantic coast—a bigger risk from sea-level rise than the slow swamping of low-lying areas.



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