Climate Impact Lab

Frequently Asked Questions: "How Much Hotter Is Your Hometown Than When You Were Born?"

This document responds to inquiries about the Friday, Aug. 31, publication of the New York Times, "How Much Hotter is Your Hometown Than When You Were Born?" The interactive is based on an analysis from the Climate Impact Lab, a consortium of climate scientists, economists and data engineers at Rhodium Group, University of California Berkeley, University of Chicago and Rutgers University. Our methodology is available here: http://www.impactlab.org/wp-content/uploads/2018/08/CIL_Days-over-90_Method.pdf

1. Q: Why does my location say it is "not prone to 90-degree days"?
Short answer: Locations with fewer than 3 days of 90+ temperatures on average in our data throughout the historical and future periods (1960 through 2089) are not shown.

Long answer: Each year in the interactive is an average of the number of 90+ days in that year and in the 10 years before and 10 years after the date. Places with low or zero counts of 90+ days are very sensitive to the underlying temperature data – small shifts in the maximum temperature value can drastically change the count of 90+ days if the maximum temperature hovers around the 90F threshold. The number of 90+ degree days is therefore deemed less reliable in these locations.

2. Q: Why does my location say that data is "not available"?
Short answer: We excluded locations where we have less confidence in the projections of days above 90F in the future period.

Long answer: To produce estimates of the number of days over 90F for both the future and historical period, we combined historical and modeled future temperatures from two different sources. While the data sets both represent daily maximum temperature, counts of extreme values (like days over 90F) are particularly sensitive to small differences in data sources and assumptions. For example, the historical data directly incorporates observational data from weather stations, while the future data is based on climate model outputs. To align these datasets, we adjust the projections so the temperature in each location and on each calendar day (e.g. July 1) matches station observations on average over the period 1990-2010. This guarantees that the average temperatures will be consistent from the historical period to the future, and that changes in the climate will come from changes projected by the models, rather than just discrepancies between the two datasets. Despite this, the day-to-day fluctuations around that long run average may still not be the same in the historical period compared to the modelled future. In some locations where some part of the year hovers around a maximum temperature of 90F, we found that a discrepancy in the day-to-day temperature variability between the historical data and the model simulations of this period suppresses the count of 90+ degree days. This happens even though the average maximum temperature stays the same. We therefore exclude locations where the count of 90+ degree days in modelled simulations deviated by 50% or

more from historical observations of the same period and marked these locations as "not available."

3. Q: Why does the historical data start in 1960?
Short answer: Our historical data starts in 1950, which means the 21-year rolling averages shown in the interactive start in 1960. Weather station coverage worldwide is poor before about 1950, resulting in inaccurate estimates of the number of 90+ degree days.

Long answer: Our historical data starts in 1950, which means the 21-year rolling averages start in 1960. While there is daily data available before 1950 for some parts of the world, there are many missing values in space and time due to poor station coverage. After about 1950 there is generally better coverage and so measurements worldwide are more reliable. Relatedly, the data product we use to downscale the 1-degree Berkeley Earth historical data to 0.25 degree (Princeton's Global Meteorological Forcing Dataset) starts in 1948. Therefore, 1950 was a logical start year for this analysis.

4. Q: Can the change in days over 90F in the historical data be attributed solely to the effect of increasing greenhouse gas emissions on temperature?
Short answer: No.

Long answer: There are a lot of things that affect changes in the climate. On month-to-decade timescales, there are naturally occurring variations in global and local temperature due for example, to the movement of heat into and out of the ocean (e.g. El Niño-La Niña cycles). The 21-year rolling average helps to average out these natural fluctuations, but there are other climate drivers we don't control for, such as changes in the emissions of pollution particles, ozone and CFC emissions, volcanic eruptions, or changes in land-use, to name a few. These effects are controlled for by the teams building the climate models driving our projections, and don't bias the results. But we wished to portray an accurate historical record of days over 90F, so did not remove the effect of these other drivers of changes in climate from our historical projections.

5. Q: The data presented in the interactive doesn't match my experience or my local weather station records. Why is there a discrepancy?
Answer: There are three primary reasons for a discrepancy – 1. Station records have been averaged over an area approximately 625 kilometers squared. Urban heat islands and other microclimates may not be captured. 2. Our historical observations end in 2010 after which modelled temperatures are used, which will not match specific historical observations as they are meant to represent the average expectation of climate. In some locations, the small day-to-day variation in maximum temperature in the model projections (see Question 2) acts to suppress the number of 90+ degree days after the year 2000, though if this effect is very large, we will have excluded this location. Additionally, recent years have been abnormally hot on average, and the effect of these hot years is missing from our estimates of recent year days over 90F. 3. Each year shown in the interactive is an average of that year with the previous and subsequent 10 years of numbers of 90+ degree days.

6. Q: Why doesn't the data have a spike in years I know were really hot or cold?
Answer: Each year shown in the interactive is an average of that year with the previous and subsequent 10 years of numbers of 90+ degree days, and not a representation of that

specific year. This has the effect of washing out any spikes or dips in the number of 90+ degree days.

7. Q: My location doesn't have much of a rise in 90+ degree days in the future. Why is that?
Short answer: A change in daily maximum temperatures does not always result in a similarly sized change in the count of days over 90F. If your location is too cold, too hot, or even if the change in seasons happens very quickly, your location may not experience a dramatic change in days over 90F, even if temperatures are changing.

Long answer: It is expected that daily maximum temperatures will rise, on average, across the globe over the century if greenhouse gas emissions continue as projected. Whether this translates into an increase in 90+ degree days in a given location depends on its current climate – an increase will only occur in places where at least some of the year has daily high temperatures near 90F. If daily maximum temperature is much below or much above 90F for the entire year, little or no change in the count of days will occur. Additionally, some regions experience much of the summer above 90F and much of the winter far below 90F, with very few days in spring and fall near the threshold. In such locations, an increase in temperatures throughout the year may not change the number of days above 90F by a significant margin, even if the summers are getting hotter. Finally, in some locations, the issue of smaller day-to-day fluctuations in maximum temperature in the modelled future projections (see also Question 2) also plays a role in suppressing the number of 90+ degree days.

8. Q: There is a large increase in the near future, but then it levels out. Why is that?
Short answer: While days over 90F may be commonplace in some locations, in most places they can only happen in the summer. This limits the amount that days over 90F can increase in many locations.

Long answer: While climate change may mean an increase in the number of unexpected, out-of-season 90-degree days in some locations, most places are limited by the seasons in the number of 90-degree days that can occur. This can have the effect of flattening out the number of days over 90F in the future. This does not, however, mean that temperatures are no longer rising. A second reason could be related to the emissions scenario we used. For this assessment, we use a scenario from the Intergovernmental Panel on Climate Change (IPCC), Representative Concentration Pathway (RCP) 4.5. In this scenario, greenhouse gas emissions peak around 2050 at around 50 percent higher than 2000 levels and then decline rapidly over the next 30 years, stabilizing at half of 2000 levels. In response to this dramatic cutback in emissions, the increase in temperatures begins to slow by the end of the century, likely between 3.1 and 5.8 degrees F above pre-industrial levels. This slowdown in temperature increases could also be a driver of a slowdown in the increase of days over 90F in some locations. To some, RCP 4.5 might be described as "unrealistically optimistic." This scenario is more or less consistent with an assumption that all nations (including the US) meet their 2030 emission commitments under the Paris Agreement. As Rhodium Group's recent Taking Stock report explains, the US is a far cry from meeting its Paris targets under current policy. Thus, RCP 4.5 is a moderately aggressive climate policy scenario – especially after 2050. Outcomes could be far worse than these projections. This is not a forecast for what happens under current policy.

9. Q: How can the "likely range" decrease over time?

Short answer: In some locations, even if we're unsure how much temperatures might increase, we can be very sure that they'll be above 90F for certain parts of the year.

Long answer: We assimilate the projections of a large number of climate models from many research teams around the world to produce our estimates of future temperatures. Each of these models produces estimates of the daily maximum temperature for each day up to 2099, and we combine these projections in a way that accounts for uncertainty in the climate's response to emissions to form both the central (median) estimate and the likely range shown in the interactive. A lot of factors go into the responses of these models to emissions, and each model has a different estimate of future temperatures. In general, these projections diverge over time as uncertainty in the climate response becomes greater far in the future. However, the models do agree on many things, and in some cases, even if the models have a high degree of uncertainty about the actual temperatures in a location, they might agree that they are above 90F on any given day. For example, some locations which currently have a large number of days just under 90F and a large number of days just over 90F in the far future. Models may disagree about when this transition happens but agree that it will happen before 2100. This results in a widening of the likely range in the medium term, but a narrowing in later years.