August 2023

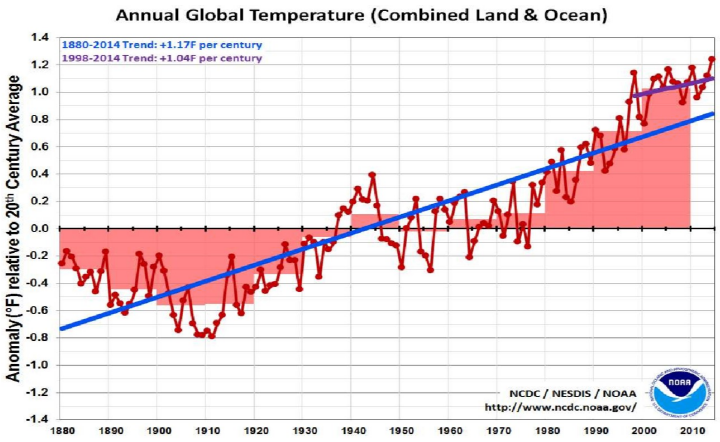
CliSciPol

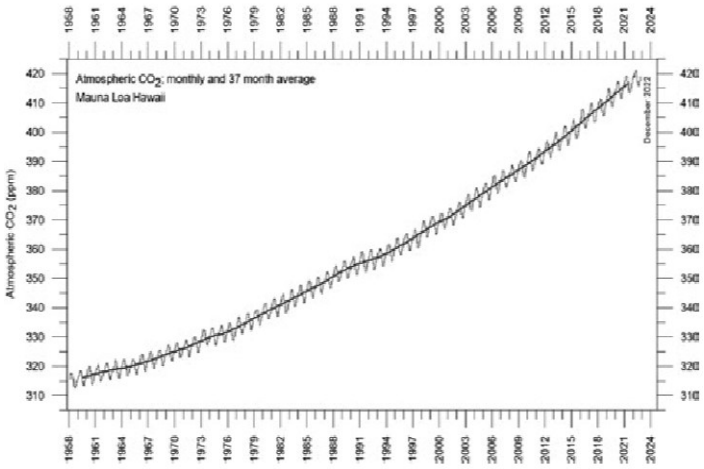
Climate Science and Policy for Nonscientists

One picture is worth a thousand words.

HEATWAVES - How Much Hotter? How Much More Frequent?

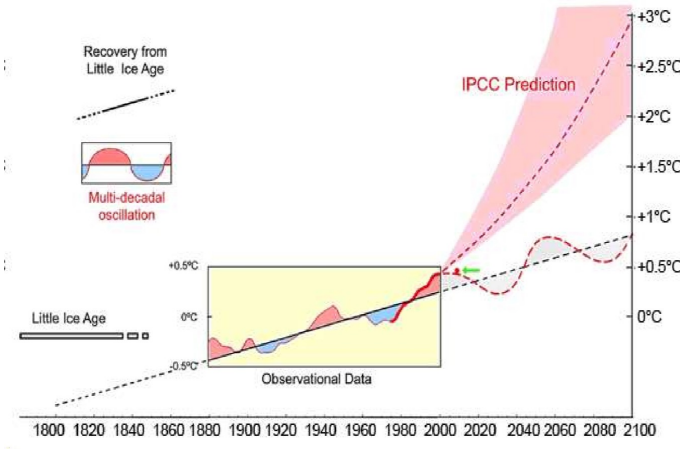
The climate is changing. The IPCC concludes that the world has warmed 1.09 C since the preindustrial period. [AR6 WGI p.5 (2021)]. The graph shows a relatively linear rate of warming of 1.17 F per century or 0.7 C per century. The IPCC puts the current rate of warming at about 0.8 C per century, or, rounding up, about 1 C per century.





Atmospheric CO2 levels have been rising significantly and steadily since about 1960. The rate of rise has been about 5% per decade with a slight increase over the last 20 years. So there has been over 60 years of reasonably linear CO2 rise matched by a reasonably linear rate of temperature rise of about 1 C per century.

For nearly 30 years the IPCC computer models have been calculating that temperatures will rise immediately and rapidly at rates much higher than 1 C per century. But the actual measured temperatures show no such acceleration. Temperatures continue to rise at roughly the trend-line rate of about 1 C per century.



IPCC AR6 WGI p. 8 (2021)

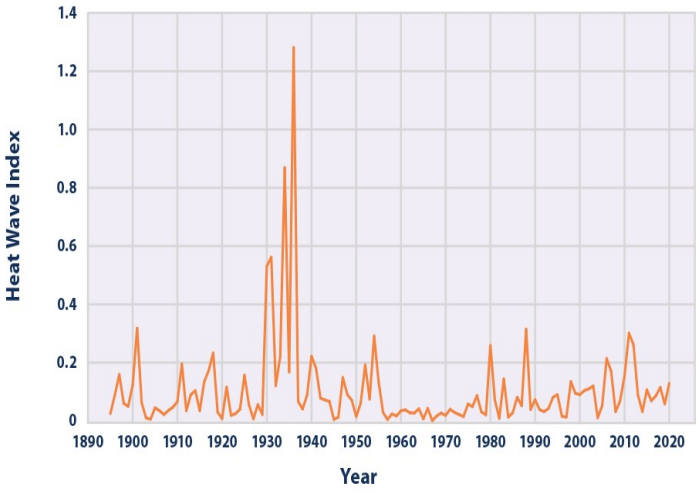
"It is virtually certain that hot extremes (including heatwaves) have become more frequent and more intense across most land regions since the 1950s, while cold extremes (including cold waves) have become less frequent and less severe."

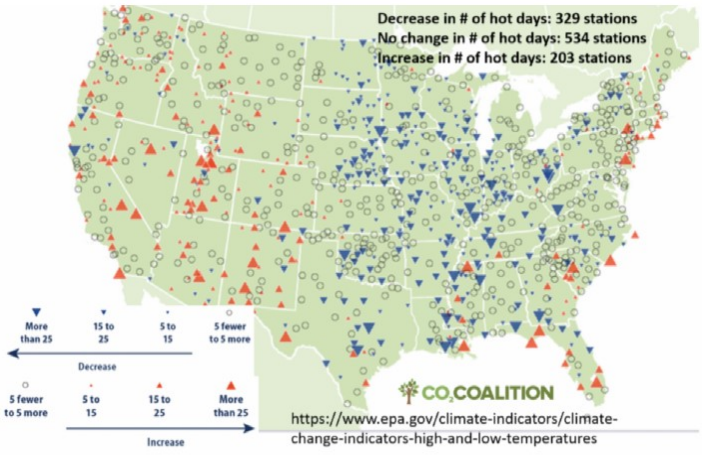
As global temperatures rise, the number of hot days and of heat waves can also be expected to rise, and the IPCC so predicts. At the same time the number of cold extremes is declining. The image shows the most recent IPCC finding. So -

1. How much hotter will hot days and heat waves get?
2. How much more frequent will they become?
3. Will the overall effect be net good or net bad?

The IPCC concludes that the warming of temperature extremes tends to "scale linearly with global warming." (AR6 WGI p. 1554). Since 1880 the world average temperature has risen from about 57 F to 59 F (1 C = 1.8 F). Therefore, if the world temperatures continue to rise at about 1 C per century, hot days and heatwaves, on average, can be expected to warm by about 1 C. Boston experiences annual temperature swings from about 10 F in the winter to 95 F in the summer. So 100 years from now the swing will be from about 11.8 F to 96.8 F, hardly noticeable over a 100 year period.

The US heatwave index has shown a modest increase since the 1960s, but the levels since 2000 have been comparable to the levels from 1900-1960 and much, much cooler than the unusual 1930s.

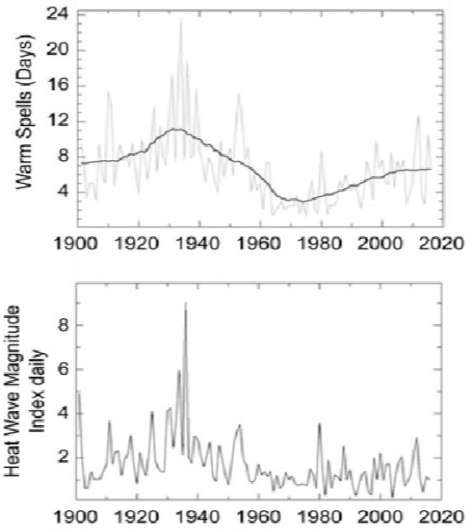




As reported by EPA, only 19% of all weather stations report an increase in the number of hot days since 1948!

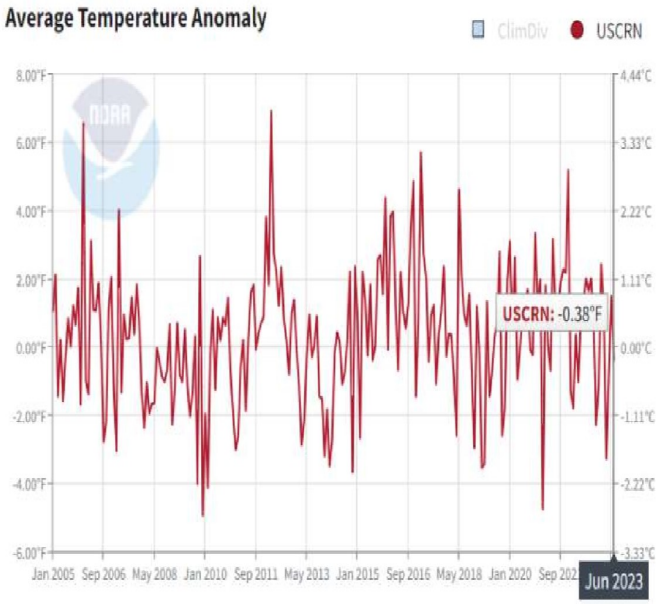
As to frequency of hot days and heatwaves, the IPCC provides no quantification or even discussion. (AR6 WGI p. 1548-1557). In the US only 19% of weather stations have reported an increase in the number of hot days since 1949, but about 31% (329 stations) have reported a decrease.

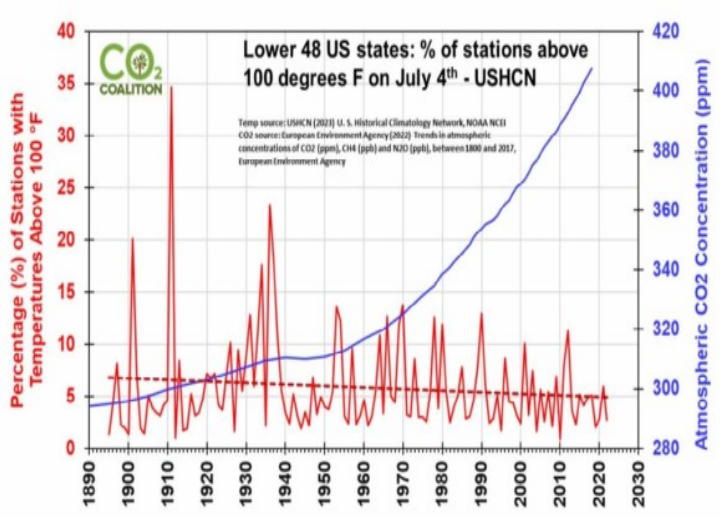
This past July the media presented extensive coverage of so-called “unprecedented” heat on July 4, but the percentage of US weather stations reporting over 100 F on July 4 has been slightly declining since 1895 despite rising global temperatures and CO2 levels.



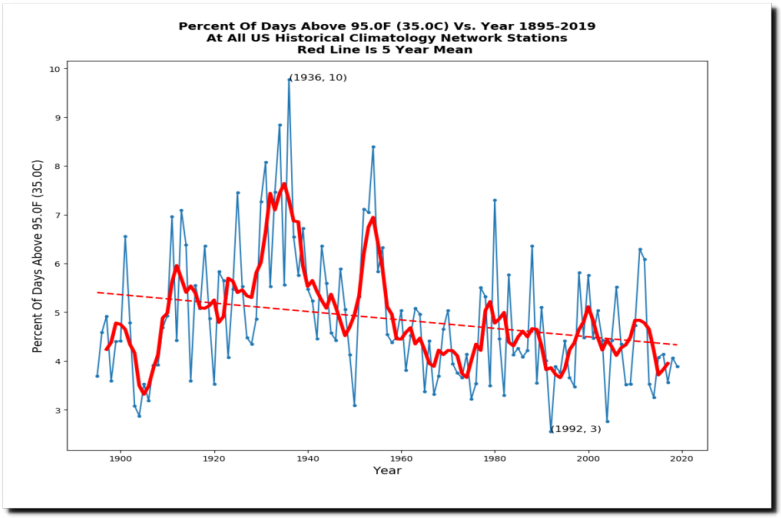
US heat wave frequency (top) and intensity (bottom) since 1900, from the Fourth U.S. National Climate Assessment. Source; USNCA 2017

The % of US days per year above 95 F has been declining over the period 1895-2019.



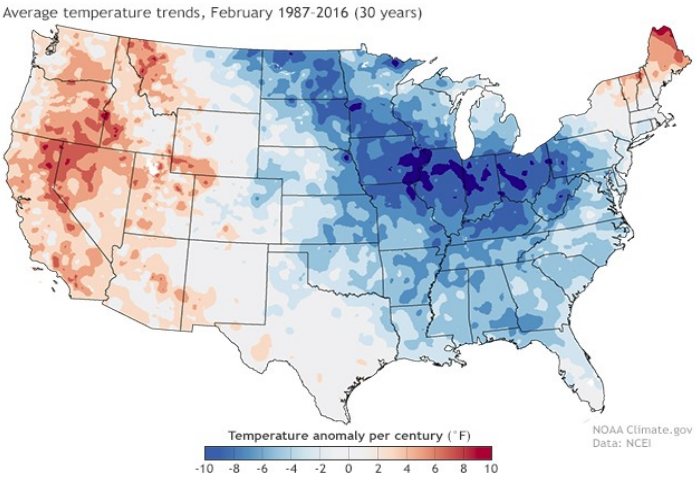


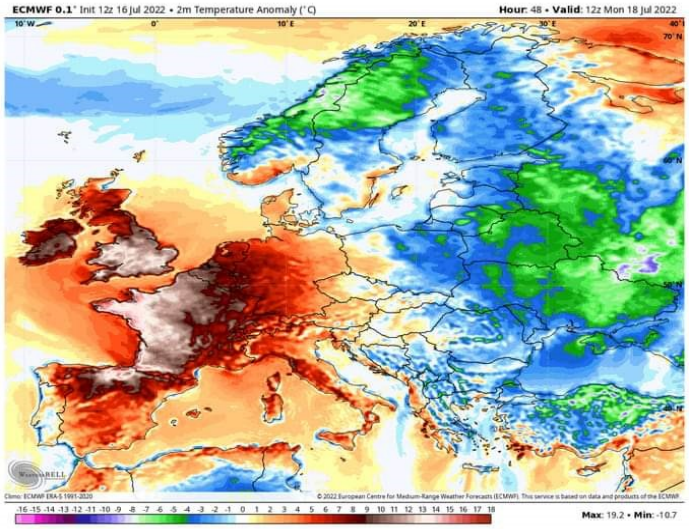
The 4th US National Climate Assessment (2017) showed no significant increase in US heatwave frequency or intensity since 1900.



The US government’s most accurate data collection network, the Climate Reference Network (CRN), maintained by NOAA, shows that the continental US has not warmed at all since January 2005, when the CRN first started collecting data.

There are decadal regional temperature trends that are concealed by use of an average number for the continental US or for the world. Thus data for the US West coast shows rising temperatures 1987-2016 while the greater part of the country has had constant or declining temperatures.

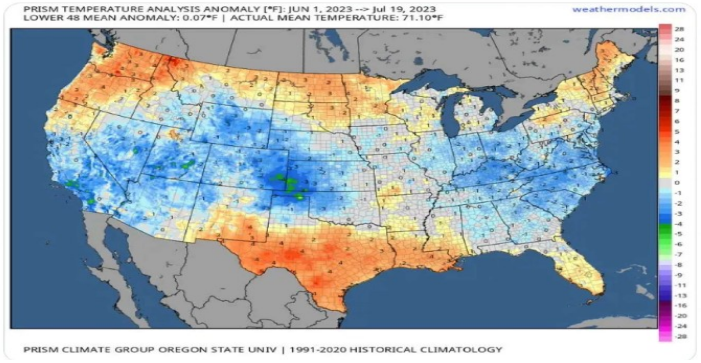




When one region of the world is unusually warm, it is common that an adjoining region is simultaneously unusually cold. The image shows the unusual heatwave that Western Europe experienced in July 2022, and shows that Eastern Europe was simultaneously experiencing unusual cold. This is caused by short-term variations in the Jet Stream that have nothing to do with climate change.

This past June-July Texas experienced an extreme Heat Dome, but most of the US was colder than normal. The average temperature for the entire continental US for June 1-July 18 was only 0.07 C (0.13 F) higher than normal.

Summer June 1 - July 19, 2023 so far across the Lower 48 states has seen near normal temperatures: +0.07°C

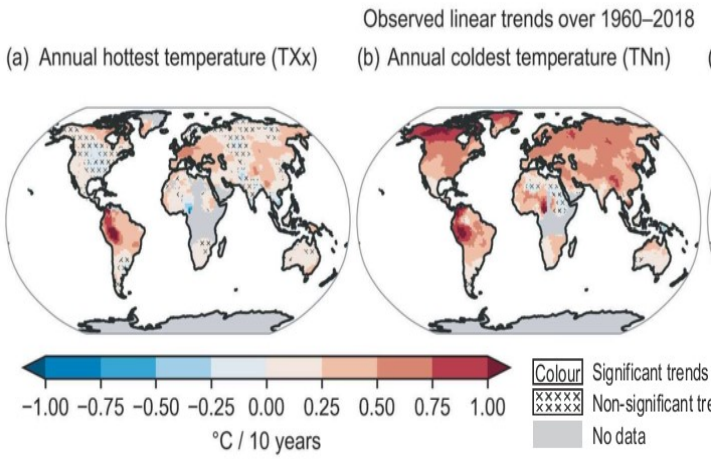


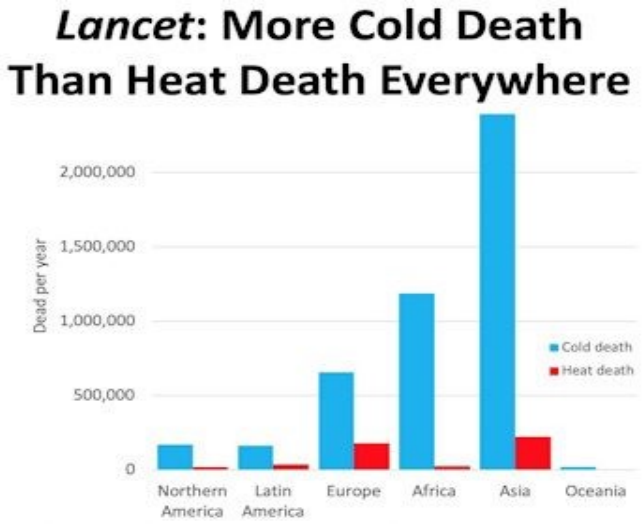
IPCC AR6 WGI p. 2233 (2021)

Heatwave: A period of abnormally hot weather, often defined with reference to a relative temperature threshold, lasting from two days to months. Heatwaves and warm spells have various and, in some cases, overlapping definitions.

What is the overall significance of increasing heatwave intensity and frequency? Is this a net beneficial change or a net detrimental change? Much depends on when and where the warming is occurring. Most nonscientists think of hot days and heatwaves in absolute terms, e.g. a day with temperature greater than a particular temperature, such as 95 F (35 C). But scientists and the IPCC tend to define hot days in relative terms, e.g. a day where the temperature is 10 F or 5 C hotter than the average temperature for that day over the prior, say, 30 years. Using this relative definition, scientists can talk about hot days and heatwaves in Alaska in the winter. Such hot days and heatwaves are beneficial to, and welcomed by, Alaska residents.

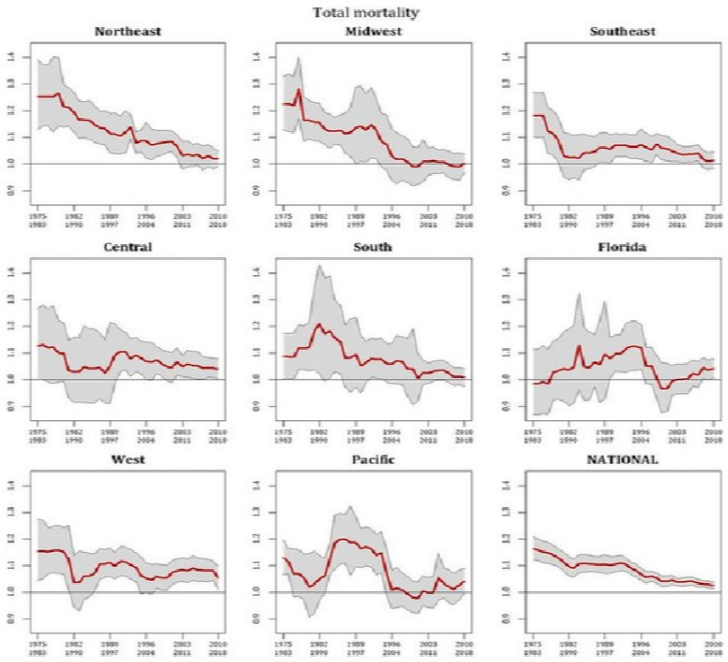
Warming, more hot days, and more frequent heat-waves are generally net beneficial for places like Canada, Scandinavia, Northern Europe, and Russia. They are generally beneficial for countries, or at least the areas of countries, that have winters, such as the US. Much of global warming occurs (1) in winter, (2) at higher latitudes (places closer to the poles and hence colder to start with than the tropics), and (3) in the middle of the night rather during the heat of the day. This IPCC image (AR6 WGI p. 1549) shows that for significant parts of the world (including significant parts of North America) there has been no discernable trend in the annual hottest temperature, but a significant and broad rise in the annual coldest temperature. In North America minimum winter temperatures are projected to rise faster than mean winter temperatures, and cold spells are projected to decrease with the largest decrease most common in the winter season. (AR6 WGI p. 1556, 1830). Climate change is not a single, global problem. It is a problem of different types in different places, and best addressed at the regional or local level.





Heatwaves do kill people, but the studies are virtually unanimous that cold waves kill a lot more people than heat waves. The relative numbers differ significantly from study to study with the range being roughly 5-15 or more times more people killed by cold than by heat. So rising global temperatures save lives.

In the US the risk of death due to heat waves has been declining significantly in 7 of the 8 regions and in the country as a whole.



Relative risk by region for total mortality on "extreme heat event" days versus non-extreme heat event days. National total is shown in the bottom right figure. Source: Sheridan et al. 2021

The Bulletin - Jul 25, 1936

Heat Wave Toll Over 12,000 in 86 Cities in Week

Washington, July 25 (LP)—The first official figures on the death toll of last week's heat wave indicated today that literally thousands of lives were lost in the temperatures of 100 degrees and higher throughout a large part of the nation.

The census bureau released mortality statistics today for the week ending July 18 showing 3332 more deaths in 86 cities than in the worst heat week of 1934.

For the week ended July 18, the bureau reported 12,183 deaths this year compared with 8,851 deaths in the same 86 cities for the week ended July 28 in 1934. The present drought was blamed for a 65 per cent rise in deaths as compared with the corresponding 1935 week, when 7439 deaths were reported during that week of normal temperatures.

A week long heatwave in July 1936 killed over 12,000 people. With modern air conditioning most Americans can now maintain most of their regular daily activities during a heatwave without risk to their health.

The IPCC and most environmentalists regularly suggest (although rarely actually state) that the preindustrial climate was "good," and that, therefore, climate change from the preindustrial is "bad." But the truth is the exact opposite.

During the period 1450-1850, the world was in the Little Ice Age. The climate was inhospitable for humans. It was a miserable time to be alive in Europe with repeated crop failures, famines, and epidemics. Glaciers advanced in the Alps and crushed whole villages. We are fortunate that the world has warmed since the preindustrial period.

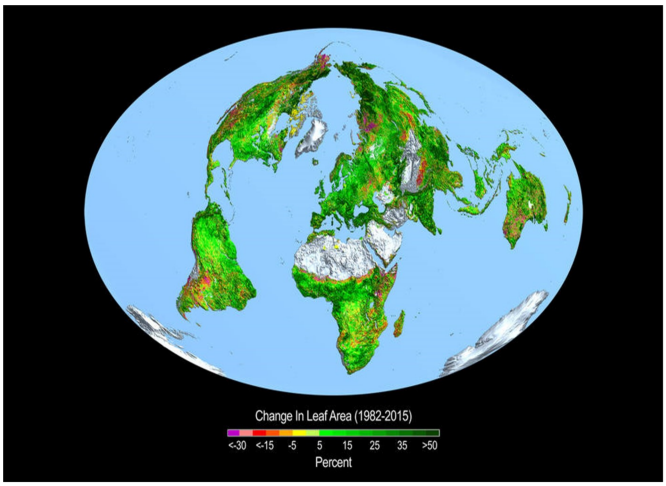
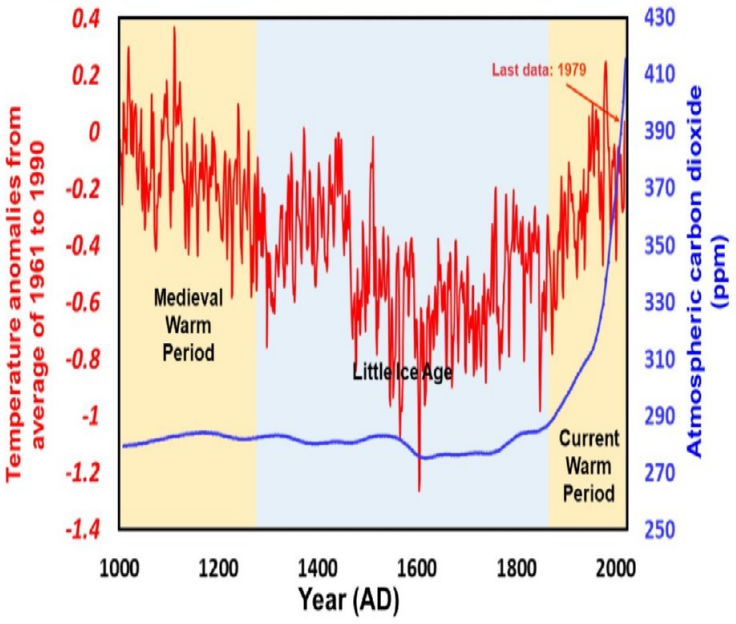


Figure 6: 1,000 Years of Temperature and CO_2 Show No Linkage Between the Two

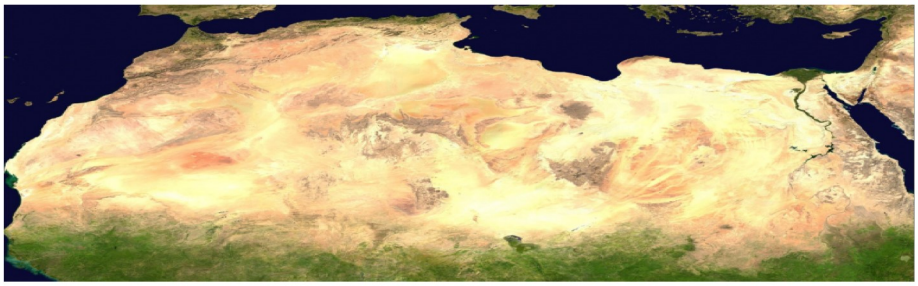


(Source data: Temperature: Moberg 2005; CO_2: EEA 2022, Law Dome C)

As a result of rising CO2 and rising temperatures satellite data shows that the world has significantly greened from 1982 to 2015. Scientists have attributed this greening 70% to the rising CO2 (CO2 is plant food) and 30% to the rising temperature.

The entire Southern rim of the Sahara is greening. The size of the Sahara Desert shrank 8% from 1989-2018.

Using satellite images, Venter et al. 2018 found an eight percent increase in woody vegetation in sub-Saharan Africa over the last three decades, underscoring the global "greening trend".



Recent study by Venter et al finds that the Sahara has shrunk by 8% over the past three decades. NASA image, public domain.

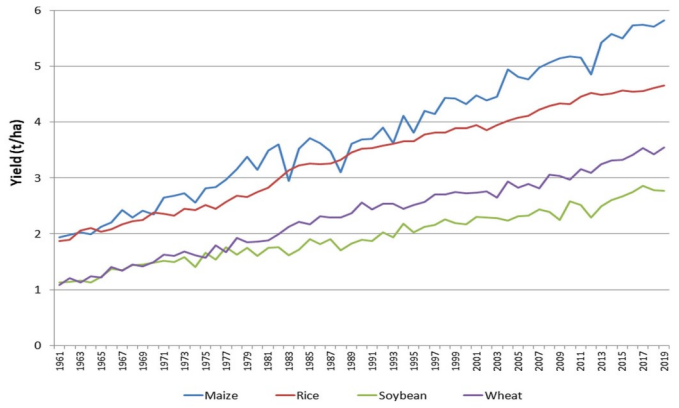


Fig. 7 1961–2019 time series of global average yields (t/ha) for maize, rice, soybean and wheat (source of

Global crop yields have risen dramatically over the period 1961- 2019. The IPCC agrees: (1) that the growing season has lengthened, (2) that there has been increasing productivity of the land biosphere with the increasing atmospheric CO2 concentration as the main driver, (3) that global-scale vegetation greenness has increased since the 1980s, and (4) that there was a 7% rise in global tree cover from 1982 to 2016. (AR6 WGI p. 5, 82, 364-5)

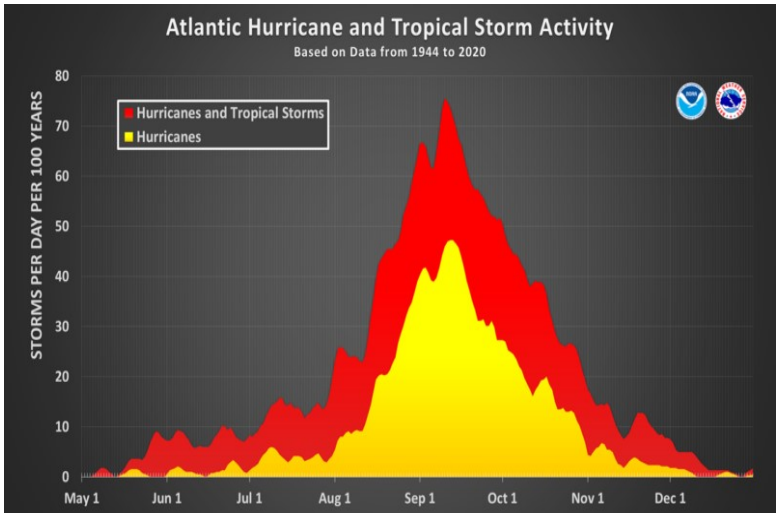
CONCLUSION AS TO HEATWAVES

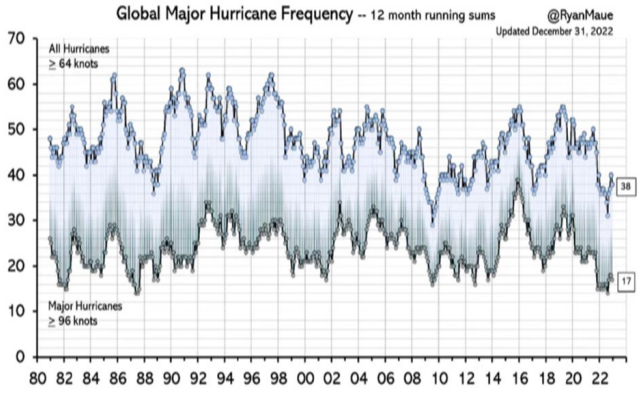
Obviously there is disagreement as to these issues, and the foregoing constitutes just a very brief introduction, but, overall, a very strong case can be made that hot days and heatwaves, while increasing, are not increasing at a significant rate, and that the overall effect of temperatures and CO2 rising at current rates is net beneficial. The world today is much better off than if we were living in the climate of the Little Ice Age, 1450-1850.

The IPCC in AR6 presents numerous computer model runs calculating a wide range of future temperature rises based on various assumptions, but the models have a long history of failed predictions. The IPCC in AR6 makes no actual prediction of a faster rate of temperature rise than the current 1 C per century, and the rate of CO2 rise is generally expected to diminish in the future.

HURRICANE SEASON PREVIEW

Hurricane season runs from June to November with activity picking up significantly in August and peaking in September. In July in the Atlantic there was a single hurricane, Don, which barely made hurricane status (winds >= 74 mph) and which weakened after only 12 hours before coming anywhere near land. Arlene, Bret, and Cindy were named storms (>= 39 mph) but never achieved hurricane status.

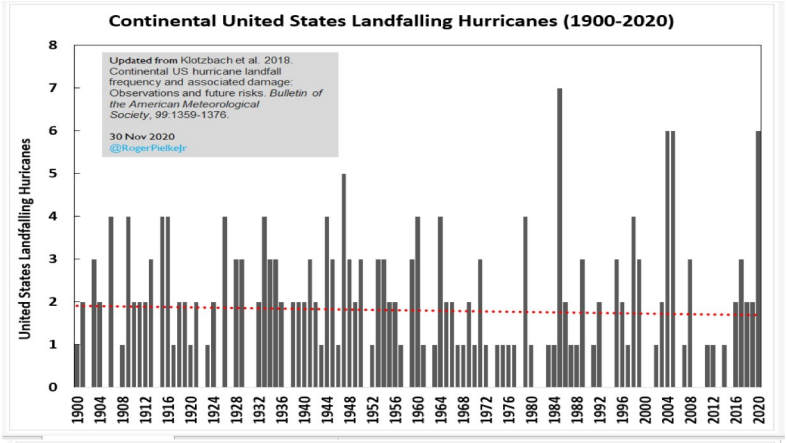


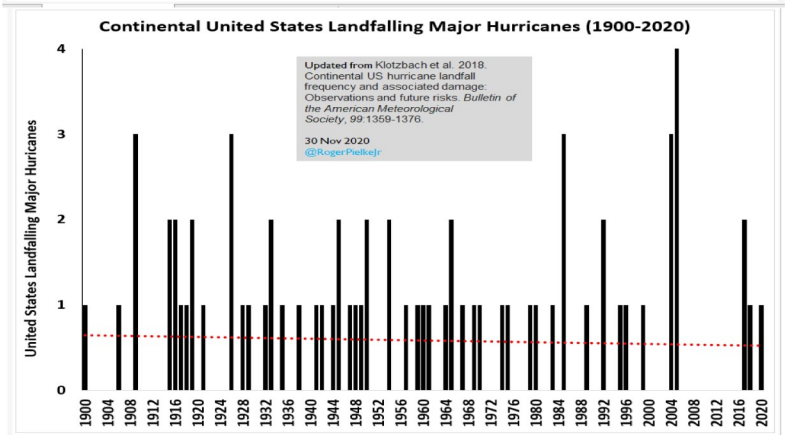


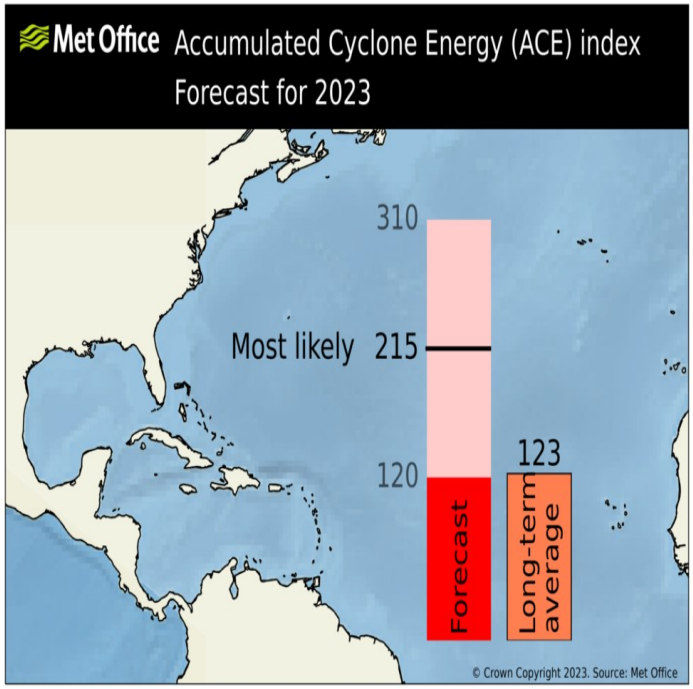
Running 12 month sums of global hurricane and major hurricane counts.

On average since 1980 there have been roughly 40 hurricanes worldwide per year about half of which have been major hurricanes (Cat 3+). The trend has been slightly down, and recent years have been slightly below average. The IPCC could not find any increase in the frequency of any category hurricane. (AR6 WGI p.9)

On average about 2 hurricanes hit the US each year, and about one major hurricane every 2 years, so in many years no major hurricane hits the US. The trend in both is slightly down. Florida is the most vulnerable state. About 41% of all US landfalling hurricanes hit Florida, which is exposed on both the Atlantic coast and the Gulf coast.



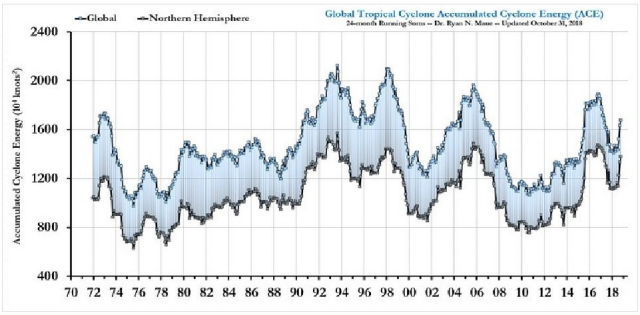




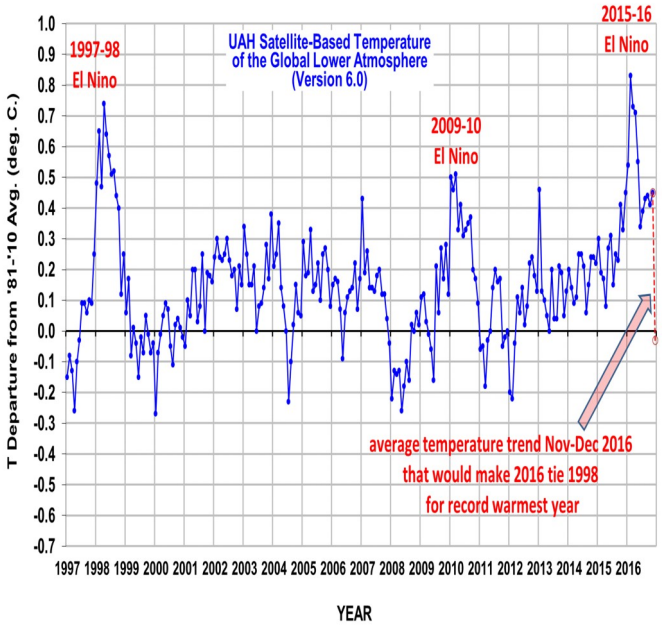
The US government (NOAA) in May predicted a "near normal" hurricane season (40% chance) with 30% chance of "above-normal" activity and 30% of "below-normal" activity. It now (August) predicts a 60% chance of "above-normal." Colorado State University predicts an "unusually busy" hurricane season. The current forecast by the British Met Office (see image) is for Accumulated Cyclone Energy (ACE) to "far exceed" the long-term average. ACE takes into account both the frequency of hurricanes and the strength of the individual hurricanes. There are numerous computer models that attempt to predict hurricane frequency, but none of them have yet demonstrated any significant accuracy.

Over the last 50 years global and Northern Hemisphere ACE has cycled up and down without any clear trend. There is no correlation between hurricane frequency or intensity or ACE and the steady rise of atmospheric CO2 and of temperature., shown in prior graphs.

Cyclonic energy, globally and Northern Hemisphere, from 1970 through October 2018

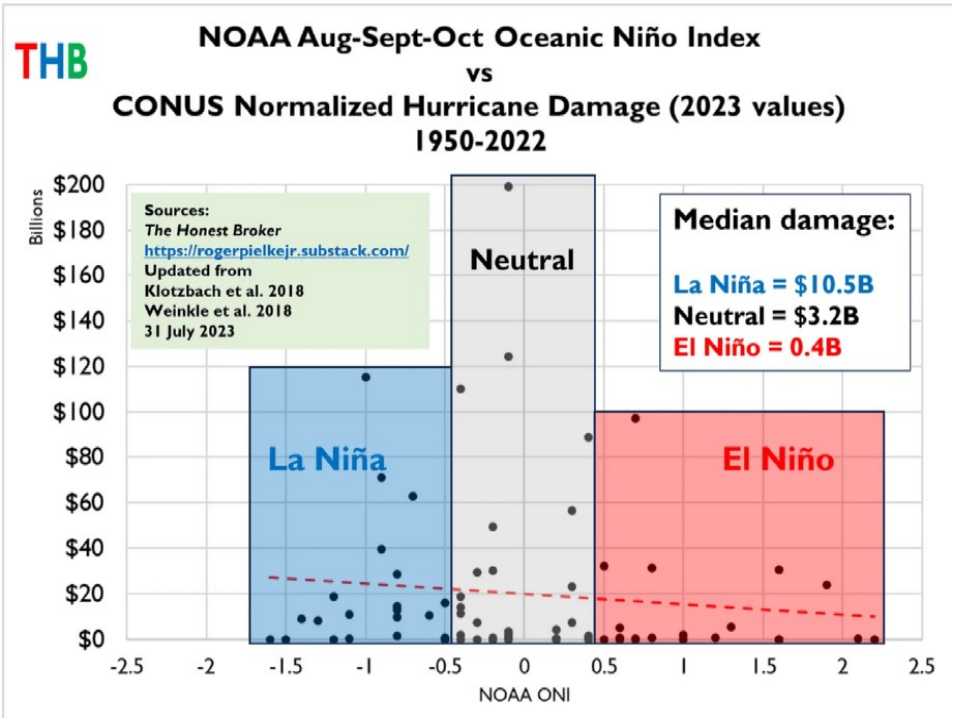


Last four decades of global and Northern Hemisphere Accumulated Cyclone Energy (ACE): 24-month running sums. Note that the year indicated represents the value of ACE through the previous 24 months for the Northern Hemisphere (bottom line/gray boxes) and the entire globe (top line/blue boxes). The area in between represents the Southern Hemisphere total ACE. *Source:* Maue, 2018.

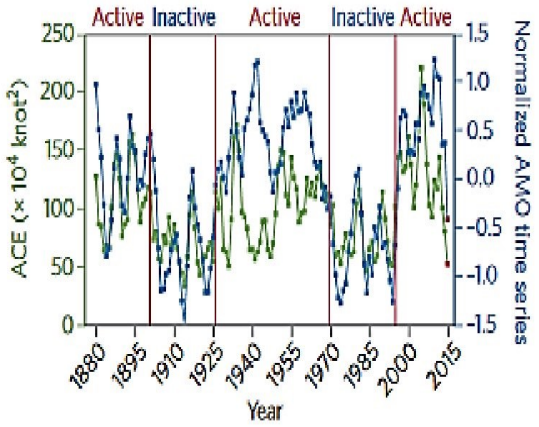


2023 is expected to be an El Nino year, and so world temperatures for 2023-2024 will show a temporary spike, as they did in 1998-99, 2009-10, and 2015-16, and then will decline in 2024 as the El Nino fades away.

Hurricane cycles appear to be driven more by ocean current cycles, such as El Nino, than by atmospheric temperatures or CO2 levels. Hurricane damage in the US is much greater in La Nina (cold) years than in El Nino (hot) years. It is generally agreed that an El Nino will "suppress" Atlantic hurricane activity.



Tropical cyclone Atlantic multidecadal variability



Three-year-averaged accumulated cyclone energy (ACE) in the Atlantic basin (green line) and three-year-averaged standardized normalized Atlantic multidecadal oscillation (AMO) (blue line) from 1880–2014 with predicted value for 2015 (red squares). The 2015 AMO value is the January–June-averaged value. The year listed is the third year being averaged (for example, 1880 is the 1878–1880 average). Correlation between the two time series is 0.61. *Source:* Klotzbach *et al.*, 2015.

There also appears to be a correlation between Accumulated Cyclone Energy and the cycles of the Atlantic Multidecadal Oscillation. The current status of both the El Nino and the AMO suggest that this year's hurricane season will be less active than average. But to date scientists have not be able to predict accurately hurricane frequency, because they do not understand hurricane formation well enough. So, we will all watch and see how the hurricane season develops.

Work Cited

Intergovernmental Panel on Climate Change, Assessment Report 6, Working Group I Report , The Physical Science Basis (2021) (AR6 WGI)