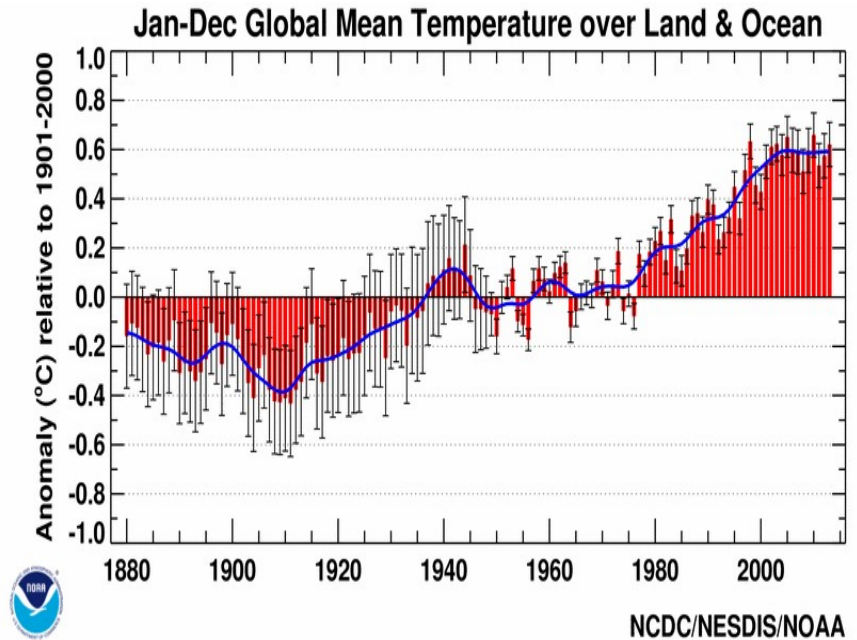


## Climate Science and Policy for Nonscientists

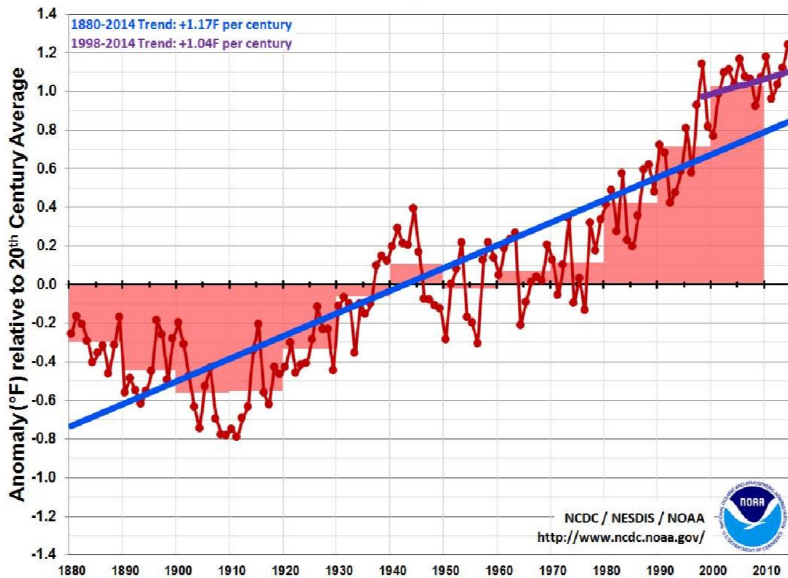
Good policy must be based on good science.

### How Much has the World Warmed?

Scientists started systematically recording world temperatures in the late 1800s, resulting in the Modern Temperature Record. So, when a scientist says that 2016 was the warmest year “on record,” she means the warmest year since the late 1800s. The world has been much, much warmer than 2016 for most of its history prior to the 1880s, but that is a subject for another newsletter. There is some clear cyclical movement to the temperature line, but there is also a clear upward trend. Scientists agree that the world is getting warmer.

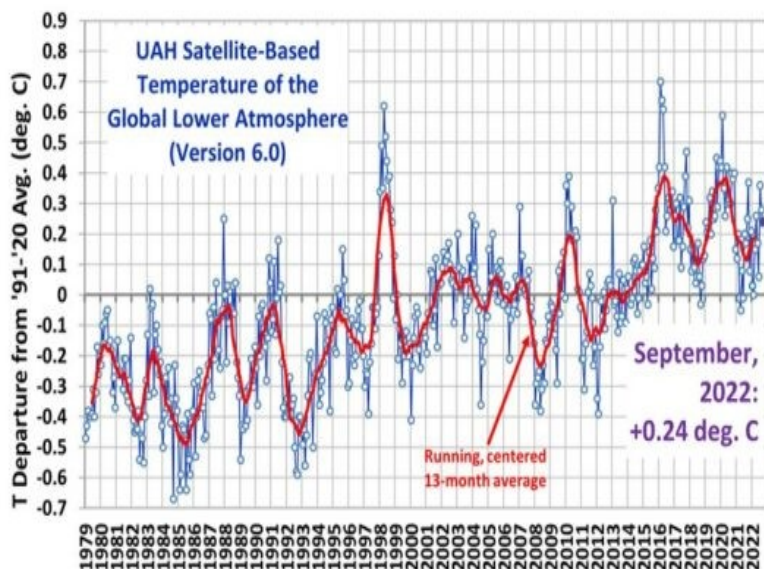
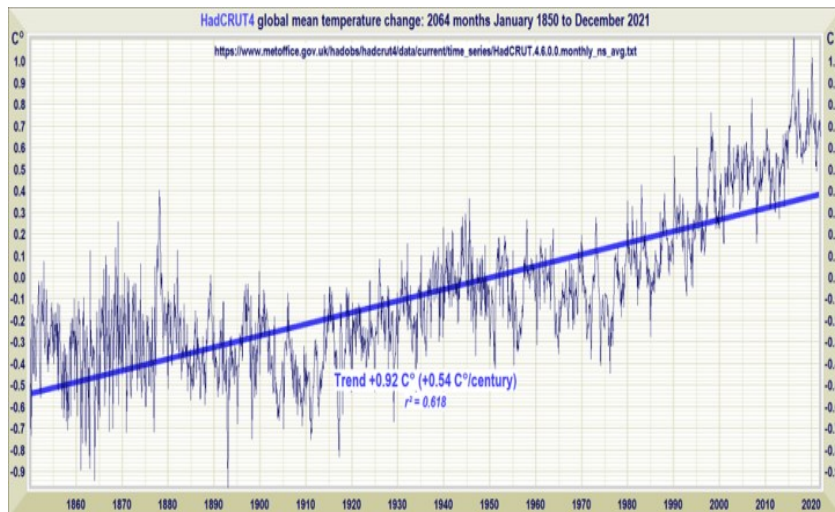


Annual Global Temperature (Combined Land & Ocean)



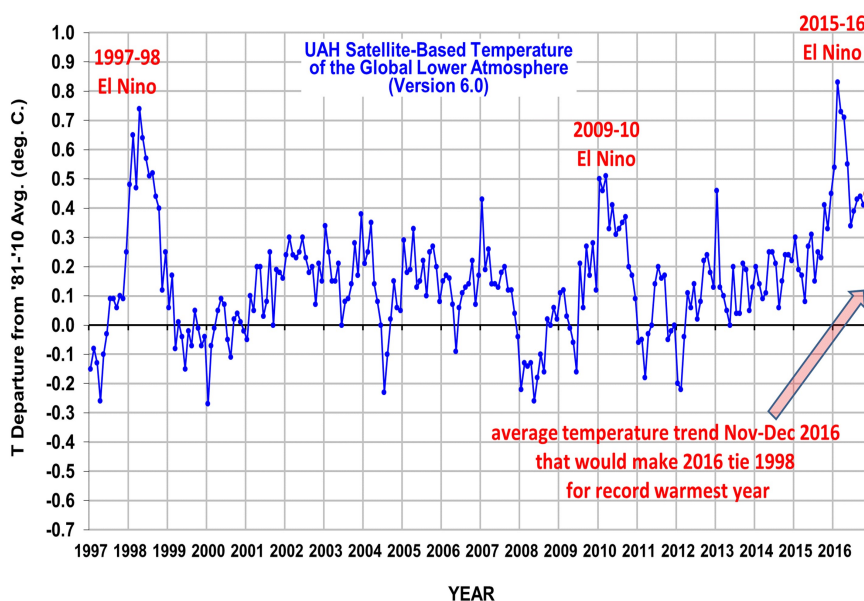
Scientists use statistical methods to reduce data to a trend line to show a rate of change. The graph shows an upward trend of 1.17 F per century (0.65 C) decreasing to 1.04 (0.58 C) since 1998. The trend line is a reasonable fit for the data since about 1890, suggesting a reasonably linear upward trend with a possible slight deceleration in the rate of rise since 1998.

Different temperature datasets (there are about a dozen) show somewhat different rates of change. For instance, the Had-CRUT4 dataset shows 0.92 C per century. The IPCC in its Sixth Assessment Report (AR6 2021) concludes that the world has warmed by 1.09 C since the “preindustrial period,” which is defined as from 1850 to 1900. (Fn.1) So according to the IPCC the temperature rate of rise is 0.9 C per century, assuming all the warming occurred since 1900, or less if the warming started before 1900.



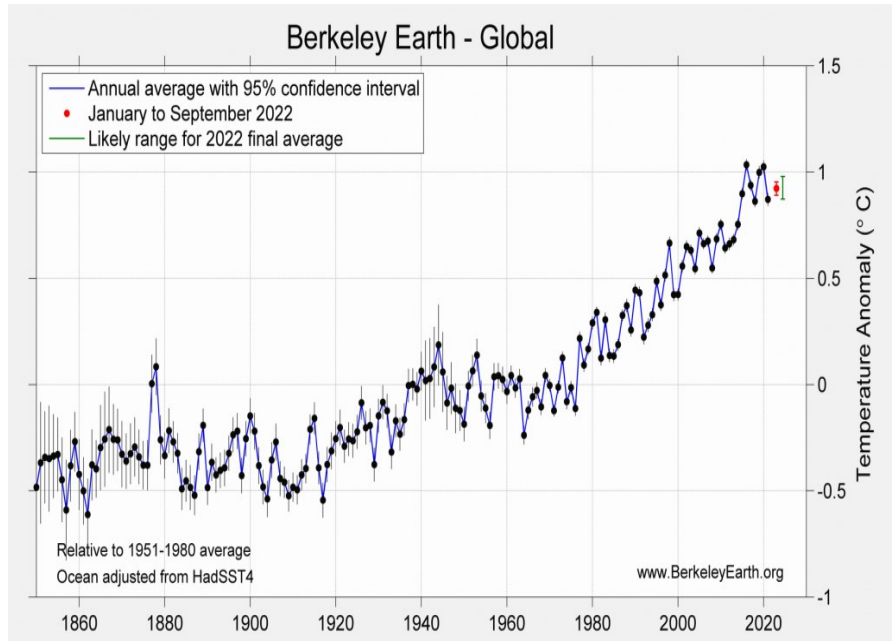
The media commonly states that the rate of warming is accelerating, but the IPCC makes no such claim. It claims only that the temperature rise is “unprecedented.” (Fn.2) Significant data, such as the second graph above, shows that the rate of warming is declining, as does this satellite dataset from the University of Alabama, which shows that the temperature rise paused from 2002-2015 and has also paused since 2016. The IPCC denies that these pauses exist, so the existence of any pause is disputed.

There is also a dispute as to how much of the warming since 1997 is real global warming and how much is just heat energy being passed back and forth between the oceans and the atmosphere by the strong El Ninos and La Ninas that have occurred since 1997

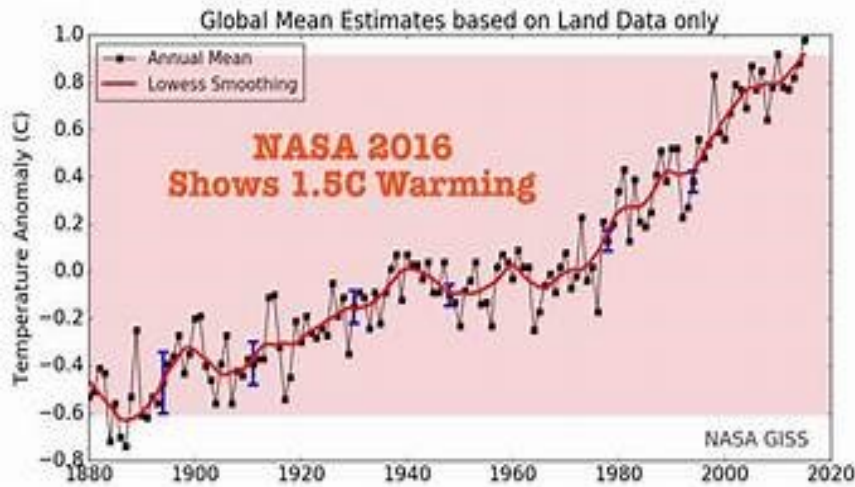


The Berkeley Earth dataset shows temperatures rising at a rate higher than the IPCC number, and it shows no pauses over the last 20 years.

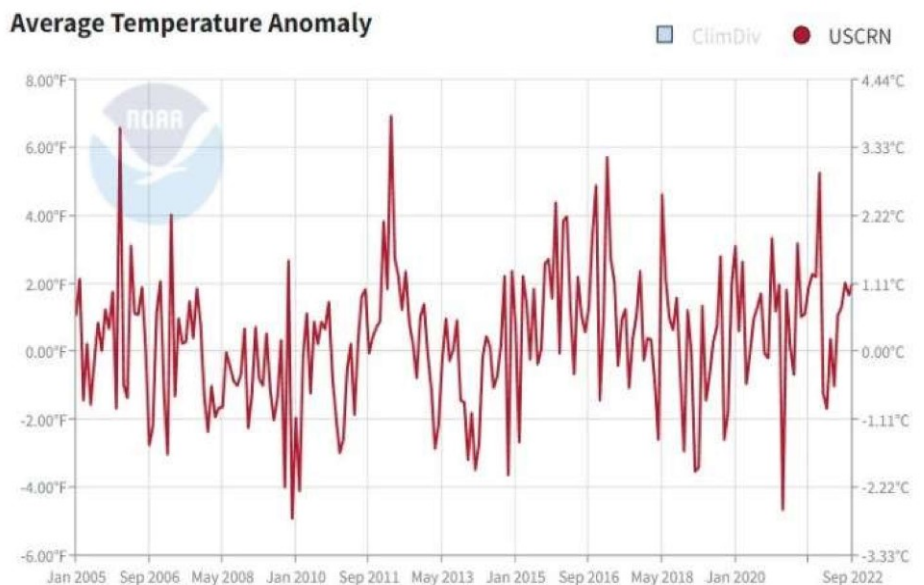
It shows the rate of temperature rise to be very linear over the last 60 years with no increase or decrease in the rate..

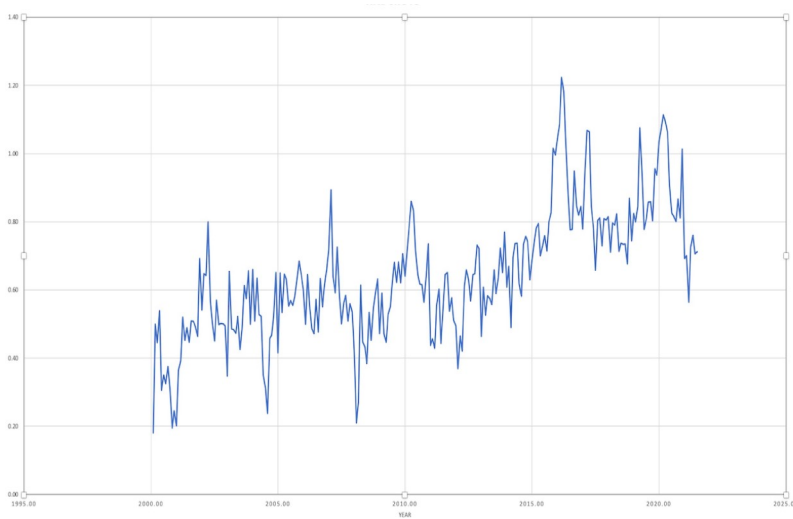


The NASA dataset shows warming of 1.5 C since about 1890 with no acceleration and no pauses since about 1960. The NASA rise is greater than the rise that the IPCC recognizes, because the NASA dataset uses land-only data. The oceans cover about 70% of the globe, and ocean temperatures are rising at a significantly slower rate than land temperatures. The IPCC states that the temperature increase over land since the preindustrial period has been 1.59 C but over the ocean only 0.88 C. (Fn.3)



The US National Oceanographic and Atmospheric Administration's (NOAA) most accurate dataset for the continental US shows temperatures virtually unchanged since 2005. The collection of data for this dataset only began in 2005.

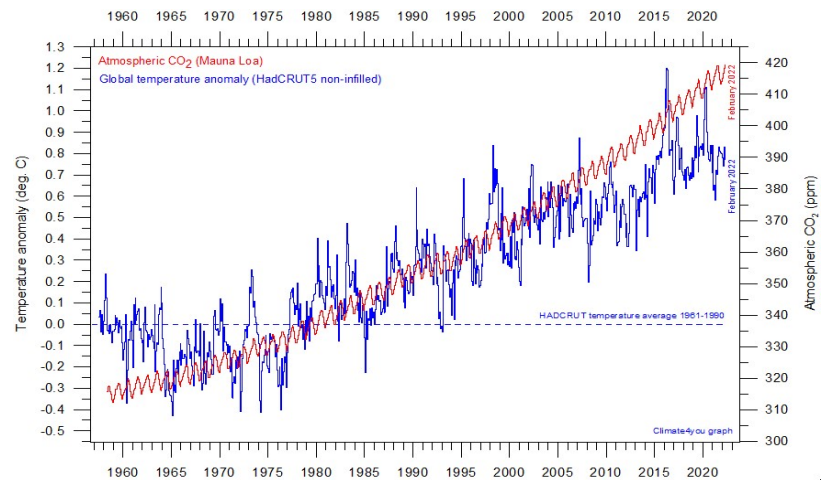




The HadCRUT5 dataset (land and ocean data) shows both the 2002-2015 pause and the pause since 2016. Historically this has been the dataset preferred by the IPCC.

*Global temperature 2000-2021; Source HadCRUT5, Met Office*

The rate of rise of atmospheric CO2 levels (the red line) has been generally linear since around 1960 with a slight acceleration. If the temperature rise over the last 20 years or so (the blue line) has declined, as shown by the HadCRUT5 and other datasets, then the rate of temperature rise has fallen below the rate of CO2 rise, as shown in the graph.



## Conclusions

1. There is general agreement that world temperatures have been rising at a roughly linear rate of around 1 C (1.8 F) per century since about the year 1900.
2. The actual data shows no acceleration in the rate of temperature rise, and the IPCC does not claim that it is accelerating.
3. There is significant evidence that the rate of temperature rise has decreased over the last 20 years or so, but some datasets show no decrease, so whether or not there has been a deacceleration is disputed.

Important questions that will be addressed in future newsletters -

1. Is a 1 C temperature rise per century net good or net bad?
2. Everyone agrees that CO2 is a greenhouse gas, and that it causes some warming, but how strong is the CO2 warming effect? How much warmer will the world get by the year 2100?



All footnote citations are to the Intergovernmental Panel on Climate Change's publication, [Climate Change 2021 The Physical Science Basis](#), the first part of the Sixth Assessment Report .

1. Id at 5.

2. Id at 6

3. Id at 5



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