Science Topics 09-23-23

Updated through 06-17-24 at end

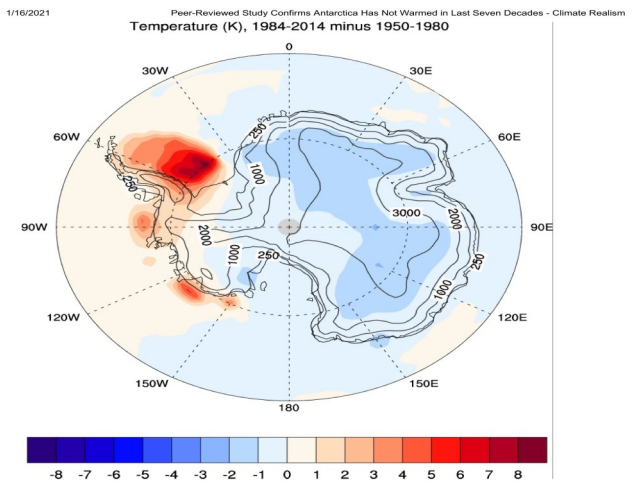
CliSciPol

Climate Science and Policy for Nonscientists

One picture is worth a thousand words.

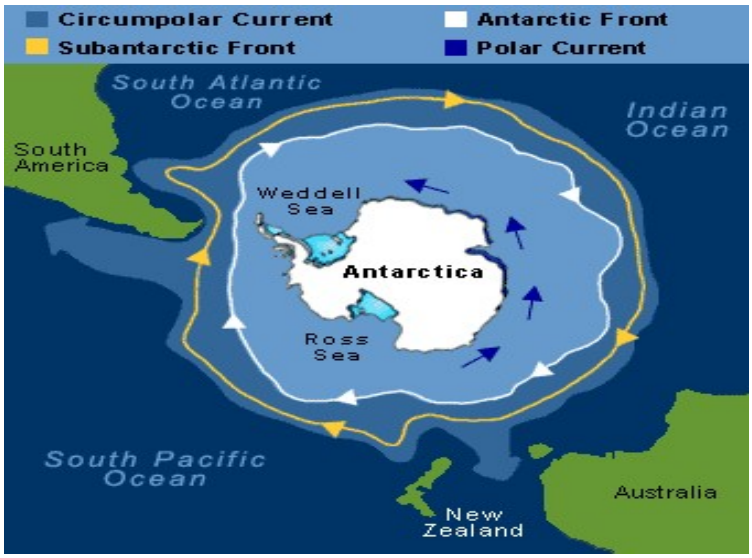
What is happening in the Antarctic and the Arctic?

Antarctica is a massive continent, 3/4 times larger than the continental US, located with the South Pole close to its center. It is the highest continent with an average elevation of about 7,500 feet, which contributes to how cold it is. Along the South-Western coast from the Antarctic Peninsula is a mountain chain that is a continuation of the Andes chain, and that is one of the world's most active volcanic areas.

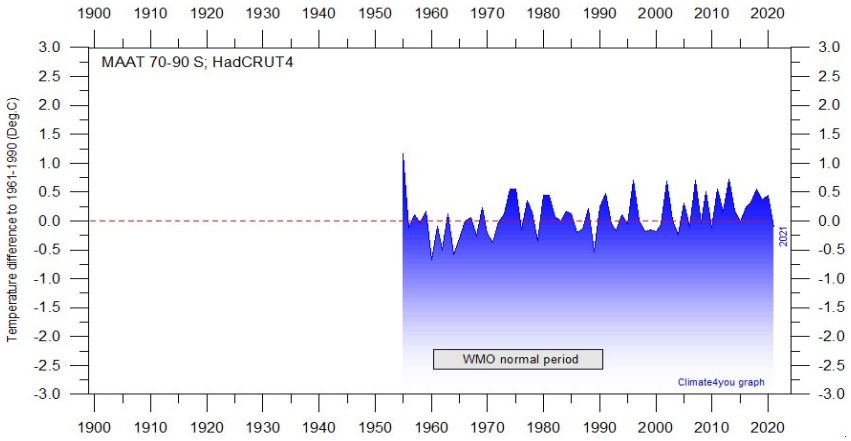


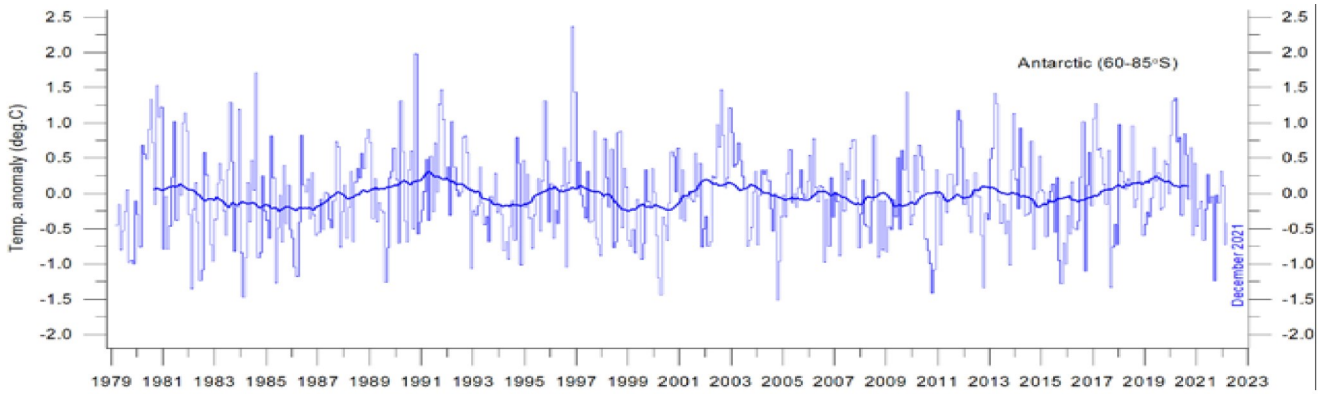
The continent is surrounded by the Antarctic Circumpolar Current, which is the strongest, largest, and fastest current in the world, and which keeps warm water from the surrounding oceans from reaching Antarctica, thus keeping Antarctica cold.

Over the last 70 years the Western edge of Antarctica has been warming while the rest of Antarctica has been cooling.



Antarctica, as a whole, has not warmed at least since 1955 according to the HadCRUT4 dataset covering South latitudes from 70-90 (90 being the South Pole). The average temperature of the interior is about -70 F. The average temperature around the coast is about 14 F. Ice melts at 32 F.





The UAH satellite dataset agrees that Antarctica has not warmed at least since 1979 when the dataset begins. The Antarctic Ice Sheet has lost 2.7 thousand gigatons of ice from 1992-2020 (Ar6 WGI p..77), but the total ice sheet is 26.5 million gigatons, so the loss over 28 years is less than 0.01%. With Antarctic temperatures as low as they are it is impossible for much ice to melt. Rather it breaks off around the edges. IPCC AR5 (2013) projected that in the future the Antarctic Ice Sheet would increase in size, not diminish, and AR6 expresses "medium confidence" in that projection. (AR6 WGI p.1267-1268). But then AR6 also says that it is "likely" that the ice sheet will continue to lose mass throughout this century. (WGI p.1272). But then AR6 adds that "deep uncertainty" persists with respect to the possible evolution of the Antarctic Ice Sheet." (WGI p.77).

The Keeling Curve is the standard expression used to describe the rise of atmospheric CO2 concentrations since the 1950's. This behaviour can be seen by comparing the measured values to a straight line fit. This is shown in Figure 1 with a least squares fit to the South Pole measurements.

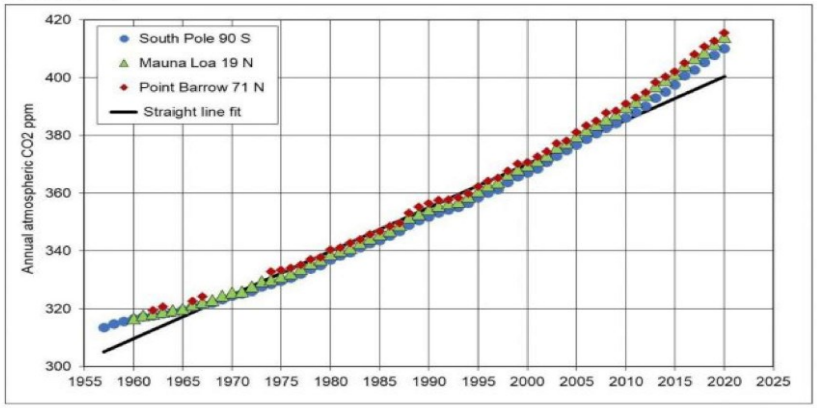
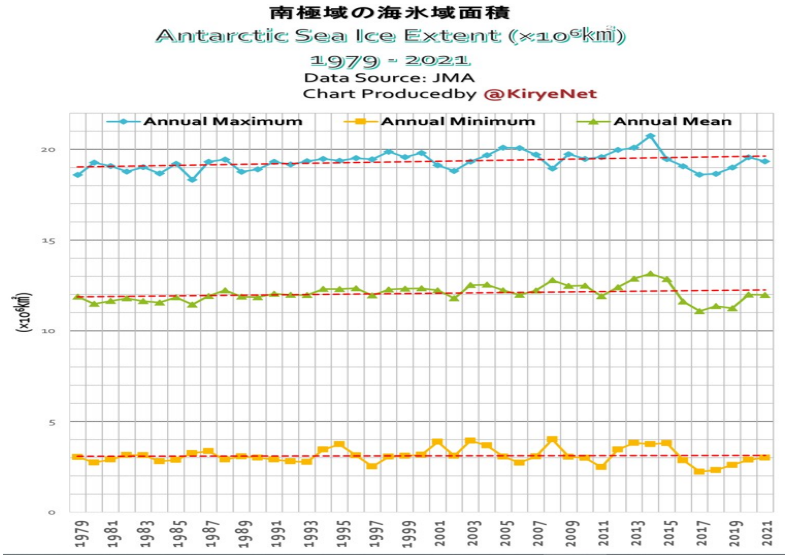
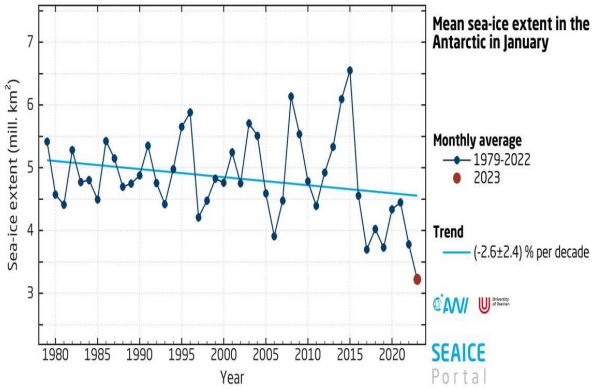


Figure 1: *Measured annual atmospheric CO2 concentrations. The straight line is a fit to the CO2 concentrations at the South Pole.*

The non-warming contradicts the CO2 Greenhouse Theory, because CO2 levels over Antarctica are rising just as rapidly as over the rest of the world, but there is no warming. CO2 and the other two commonly mentioned Greenhouse gases, methane (CH4) and nitrous oxide (N2O), are commonly called the "well distributed" Greenhouse gases, as shown with respect to CO2 from measurements taken in Antarctica, Mauna Loa Hawaii, and Point Barrow Alaska. The climate models do not predict the stable Antarctic temperatures. At present the climate models are not capable of reliably simulating the Antarctic climate.

According to the Japanese Meteorological Agency, Antarctic sea ice has remained essentially unchanged since 1979 at the annual maximum (September), the annual minimum (February), and the annual mean. Recently (2022-2023) sea ice has significantly decreased for reasons not yet fully understood.





Another dataset shows a 3% per decade decline of January (summer) sea ice since 1979 with substantial annual variability. AR6 concludes that there has been no significant trend in Antarctic sea ice area from 1979 to 2020, and that there is "low confidence" in model projections of changes in sea ice in the future. (WGI p.76).

In summary, neither the ice sheet nor the sea ice in the Antarctic is showing much change, which is inconsistent with the projections of most climate models, and which rebuts the CO2 Greenhouse Theory. The models actually project that global warming will be the greatest in the polar regions.

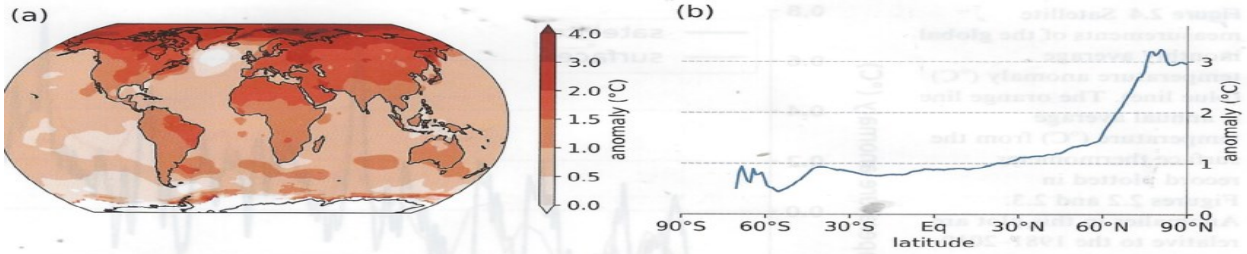
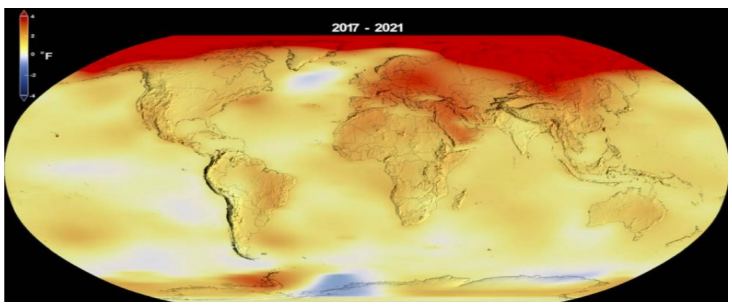


Figure 2.3 The distribution of modern warming (in °C). (a) Spatial distribution of the warming; (b) the warming as a function of latitude. Warming is calculated as the difference between the 1850–1900 average and 2009–2018 average. Data are from Berkeley Earth (http://berkeleyearth.org/data/, retrieved October 14, 2020).

Moving to the Arctic—World warming has not been uniform by latitude. Warming has been concentrated in the Arctic with relatively little warming in the Antarctic, the mid-latitudes, and the Tropics.

This image shows the distribution of warming by latitude over the 4 year time period, 2017-2021.



The climate models project warming in the tropical Troposphere, a "Tropical hot spot," but this is not happening. The red line in the graph is the average of the IPCC AR6 models. The open circles are the actual measured temperatures. This is another failure of the climate models

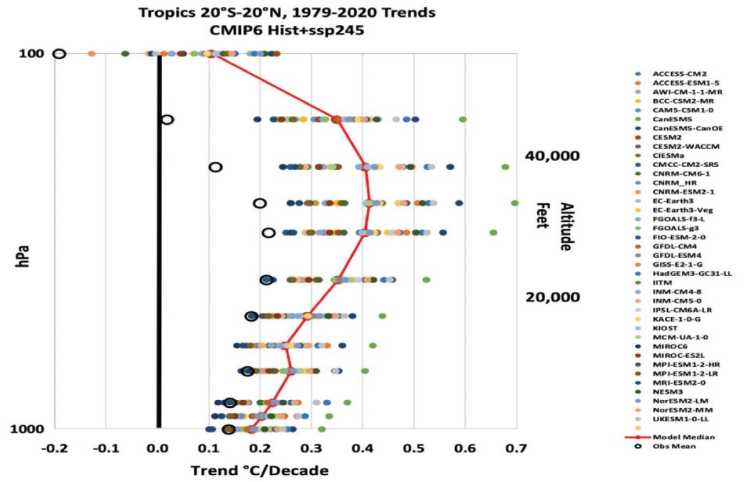
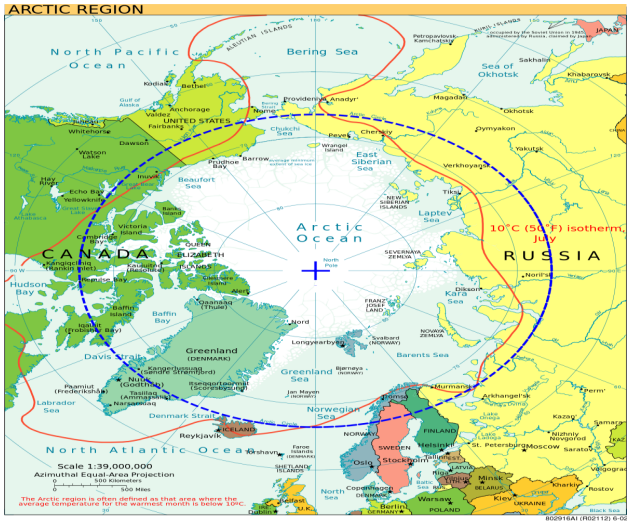
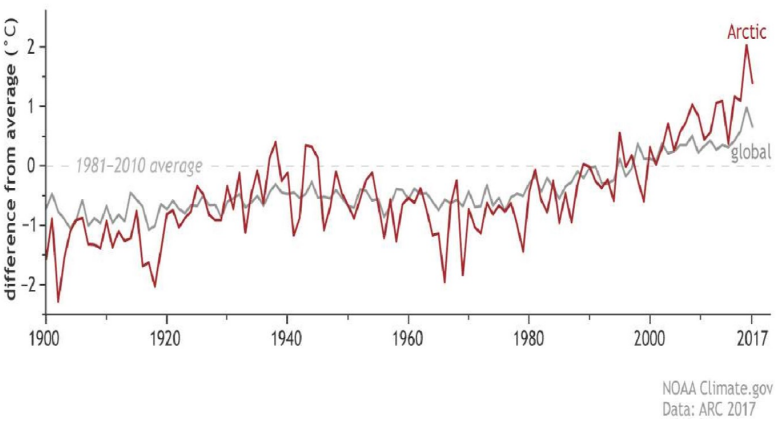


Figure 18. Tropical temperature trends from the surface to about 50,000 ft in the atmosphere for 1979-2020. Open circles are the observations and solid circles the model output for the same region and time period. The red line represents the median result from the models. The model names are in the list on the right.



Unlike the Antarctic region most of the Arctic region is ocean. Greenland is about 1/4th the size of the continental US and about 1/7th the size of the Antarctic continent. The Greenland ice sheet is not as thick as the Antarctic ice sheet, and has only about 1/10th the amount of ice as the Antarctic ice sheet.

Arctic temperatures are rising at least twice as fast as the global average. Some contend that the rate differential is three times as fast, or even four times. AR6 states that Arctic temperatures warm about twice as fast as the world average. (WGI p.1771). While, in general, the climate models over-predict world temperature rise, they under-predict Arctic temperature rise.



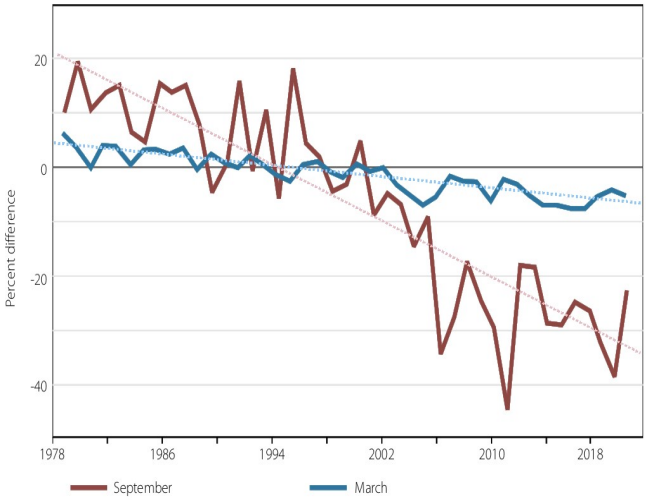
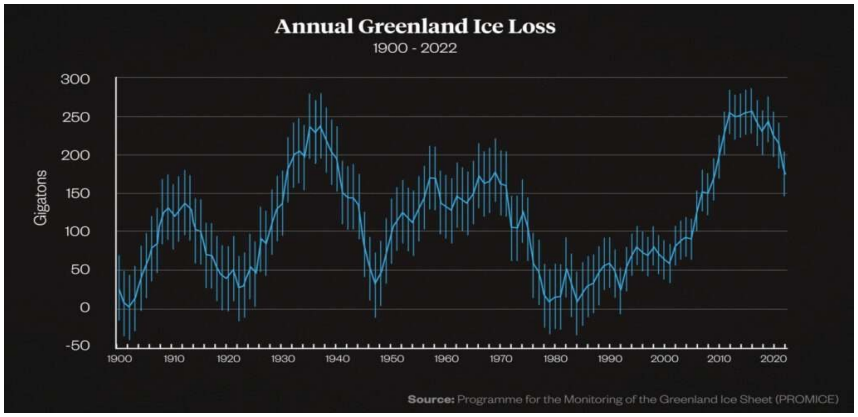


Figure 3: Sea ice extents, 1979–2021.

Arctic sea ice follows an annual cycle with its maximum in March and its minimum in September. The March maximum (blue line) has changed relatively little. Most all of the change has been the decline in the September minimum (red line), which had an exception low in 2012. Beginning in 1979 scientists have very good quality data from satellites on sea ice extent, which is shown in this graph. AR6 states that summer sea ice has decreased about 40% and winter sea ice about 10% since 1979. (WGI p.5)



A substantial number of scientists believe that the mass of the Greenland ice sheet has been cycling up and down since 1900, as shown in this image, but the accuracy of the ice mass data prior to the satellite era (1979) is disputed.

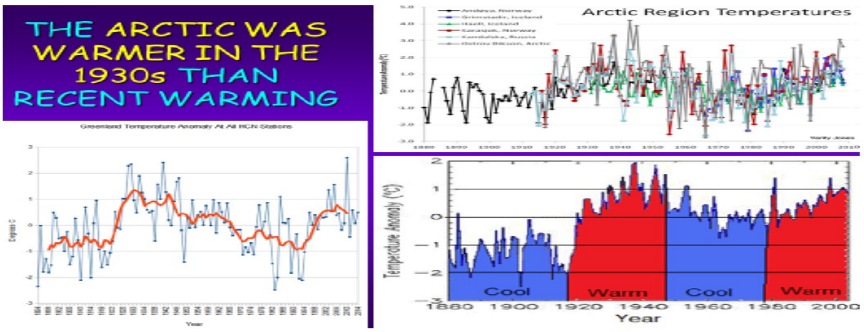
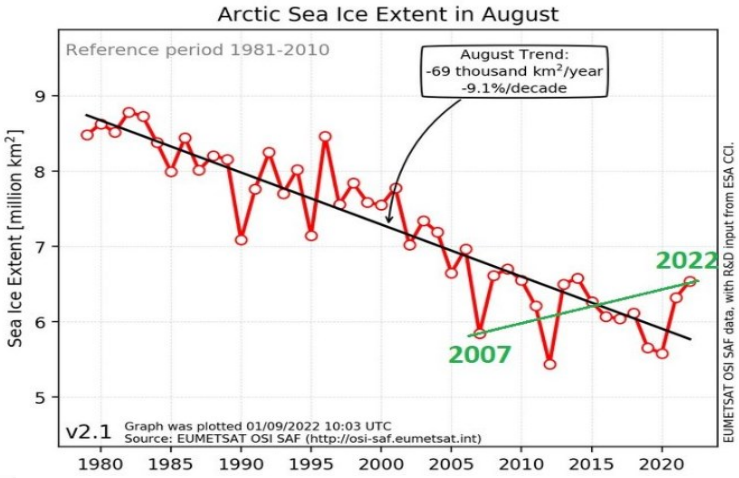


Figure 9. Arctic temperatures were warmer in the 1930s than today. The graph on the left shows temperatures in Greenland from 1894 to 2014 (high temperatures in left center during the 1930s) were warmer than today (right side). Upper right graph is Arctic temperature from Iceland, Russia, and Norway showing that the 1930s were warmer than recent decades. Lower right shows Arctic temperatures from 1880 to 2000 for 70 –90° latitude. Note that the 1920s and 1930s were warmer than 2000. (Easterbrook, 2016).

The scientists who believe that Greenland ice sheet mass is cycling up and down attribute this to cycling Arctic temperatures, as shown in this image, but the accuracy of the Arctic temperature data prior to 1979 is also disputed.

Some scientists attribute the exceptionally low summer sea ice extent in September 2012 to the massive El Hierro submarine volcanic eruption from October 2011 to March 2012, which caused an ocean heat wave, which was carried all the way to the Arctic by ocean currents. In any event Arctic sea ice is arguably rebounding since 2007. AR6 predicts only that sea ice will fall below 15% of ocean coverage at least once before 2050. (WGI p.76).



Back in 2009 Al Gore predicted that Arctic summer sea ice would be nearly all gone by 2014. But melting summer sea ice due to warming in the Arctic is arguably a good thing for humans, flora, and fauna, as discussed more fully below.

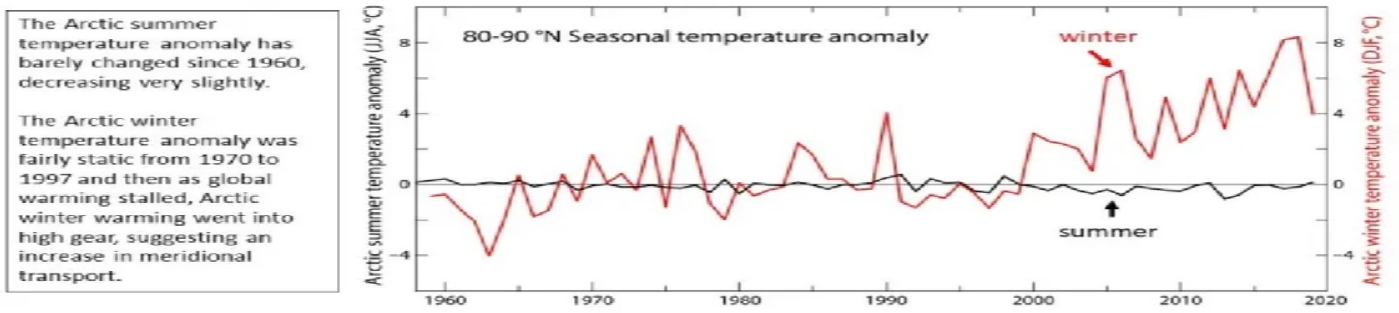


Figure 7. Arctic summer (black) and winter (red) temperatures.

Curiously the Arctic warming started roughly in the year 2000 (which contradicts the CO2 Greenhouse Theory—there was no change in the rate of human CO2 emissions around that time) and is occurring mostly in the winter. But most of the sea ice melt has been occurring in the summer. AR6 agrees that surface warming in Arctic has shown the greatest increase during the cold season. (WGI p.1379). "Meridional transport" refers to the movement of heat energy by air or ocean currents within the earth's climate system, as opposed to heat energy being added to the climate system.

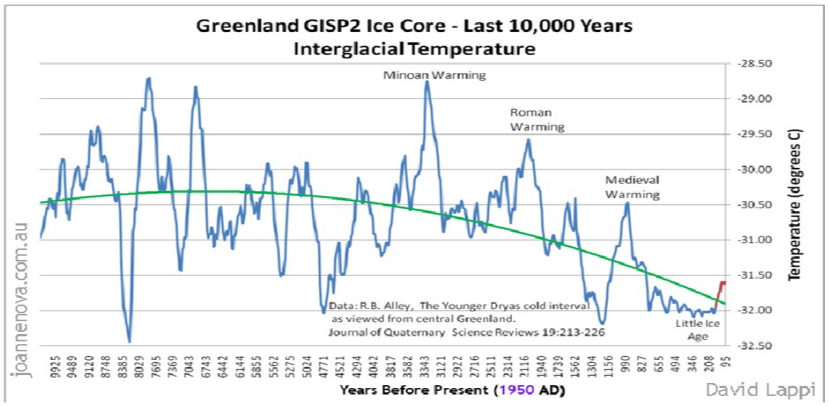


Figure 11: Greenland GISP2 Ice Core Temperatures

Greenland ice core data shows that Greenland has been much warmer than at present for most of the last 10,000 years. Thus there is nothing unusual or unprecedented about present Greenland temperatures. AR6 agrees that the Greenland ice sheet was small during this period and then reached a "recent maximum" during the Little Ice Age, 1450-1850. (WGI p.77)

From 2007-2016 the Greenland ice sheet was losing about 300 gigatons of ice per year. Since the total ice sheet is about 2,400 million gigatons, the loss per year was about 0.01% of the total (1 part in 10,000). Since 2016 the rate of loss has significantly declined. The loss in 2021 was only about 100 gigatons and the 2022 loss was 84 gigatons. Due to the complexities involved, scientists have had difficult modeling the Greenland ice sheet, and all that AR6 can say is that it is "virtually certain" that the sheet will continue to lose mass through 2100. (WGI p.1259-1260).

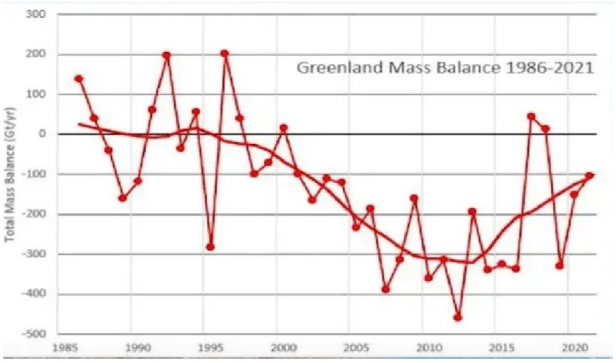
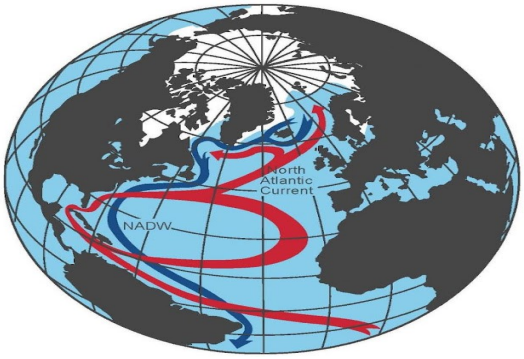
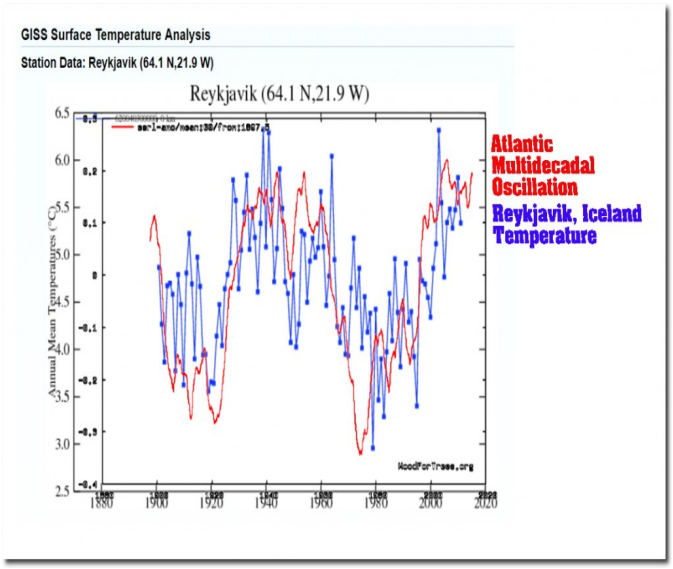


Figure 3. The TMB (red line) did indeed decrease between 1996 to 2012; however, the trend has very clearly shifted since then, to one of overall growth.



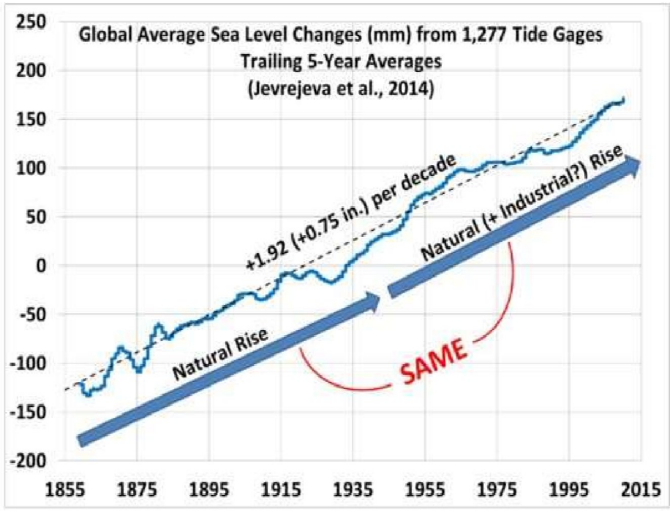
Some scientists believe that the Arctic warming and the melting of Arctic sea ice has been driven by oscillating ocean currents (an example of meridional transport) rather than by rising world temperatures. This is disputed.

But the cycles of the Atlantic Multidecadal Oscillation drive the climate of Iceland. This current is due to flip from its hot phase to its cold phase during the period 2025-2030. When this flip occurs, we will see if Arctic ice starts growing again.



The ocean current theory of causation explains why the Arctic sea ice melt is decidedly regional, located in the path of the relatively warm Atlantic current. The melt is not distributed generally as one would expect if the melt was caused by global warming.

The melting of the Antarctic and Greenland ice sheets is of concern, because ice sheet melt raises sea levels around the world. But the tide gauge data show sea level rise to be gradual and steady with no increase since the 1950s when world CO2 emissions increased dramatically. The melting of sea ice does not raise sea levels. Aside from ice sheet melt, the warming of the Arctic is probably net beneficial for humans, flora, and fauna. It is certainly beneficial for all the land areas within or near the Arctic Circle, e.g. Alaska, Canada, Greenland/ Denmark, Iceland, Scandinavia, and Russia.



Conclusion

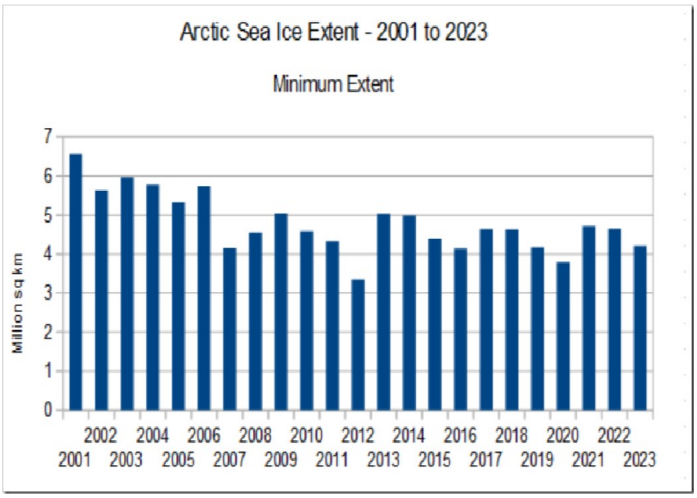
Temperatures in the Antarctic have not warmed since the 1950s, contradicting the IPCC AR6 computer models based on the CO2 Greenhouse Theory, which proposes that CO2 is a strong greenhouse gas and is causing dangerous global warming. But temperatures in the Arctic have warmed significantly more than the computer climate models predict. The distribution of the world temperature rise by latitude contradicts the CO2 Greenhouse Theory. Thus what is happening both in the Antarctic and in the Arctic undermines the credibility of the CO2 Greenhouse Theory. The slow and steady rise of world sea levels confirms that the Antarctic and Greenland ice sheet melt is slow and steady.

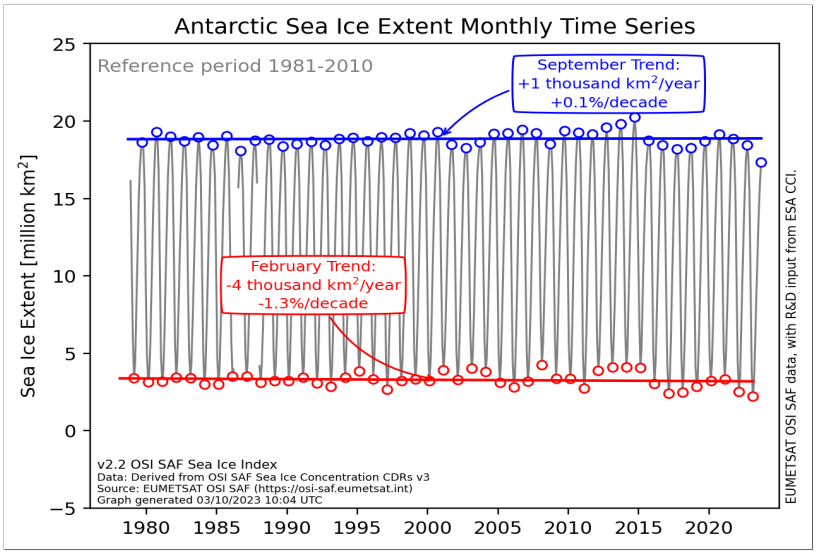
Works Cited

All citations are to the Intergovernmental Panel on Climate Change Assessment Report 6 Working Group I Report, The Physical Science Basis (2021) , which is cited as WGI.

UPDATE 11-25-23

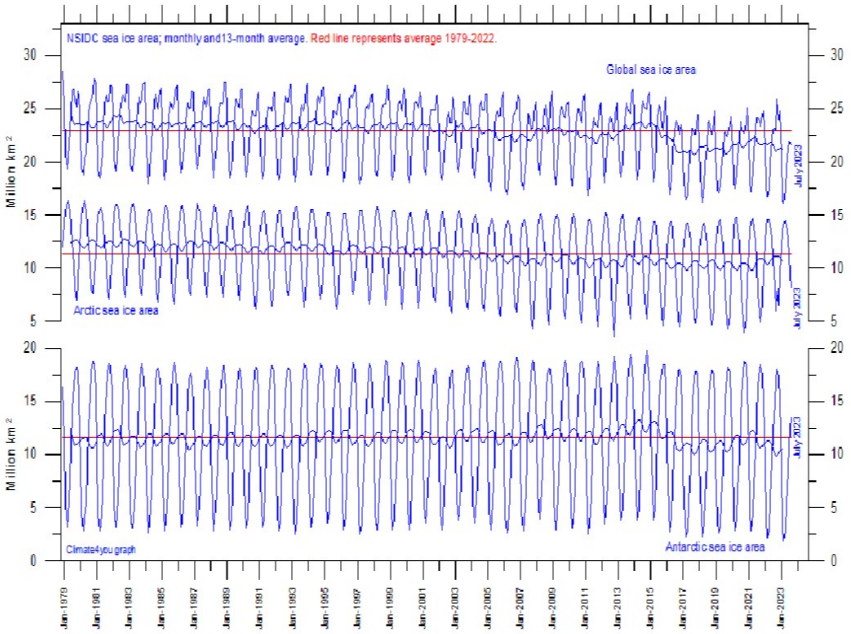
In its annual cycle Arctic sea ice reaches its minimum in September. The figures for the September 2023 minimum appear to the right. The extent is virtually identical to the 2007 number, confirming a level trend for 16 years. Arctic sea ice is not dis-appearing.

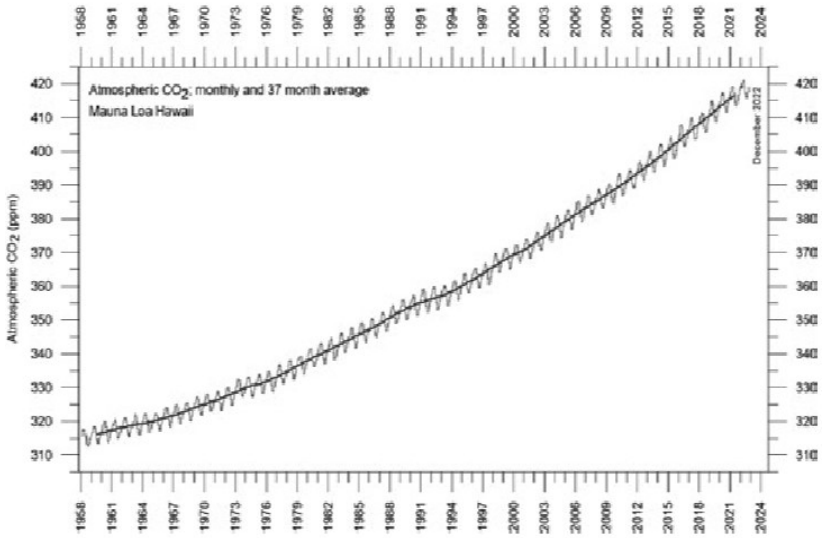




In the Antarctic both winter maximum sea ice and summer minimum sea ice have shown virtually no change from 1979 (when scientists first started getting accurate data on sea ice extent via satellites) to early 2023.

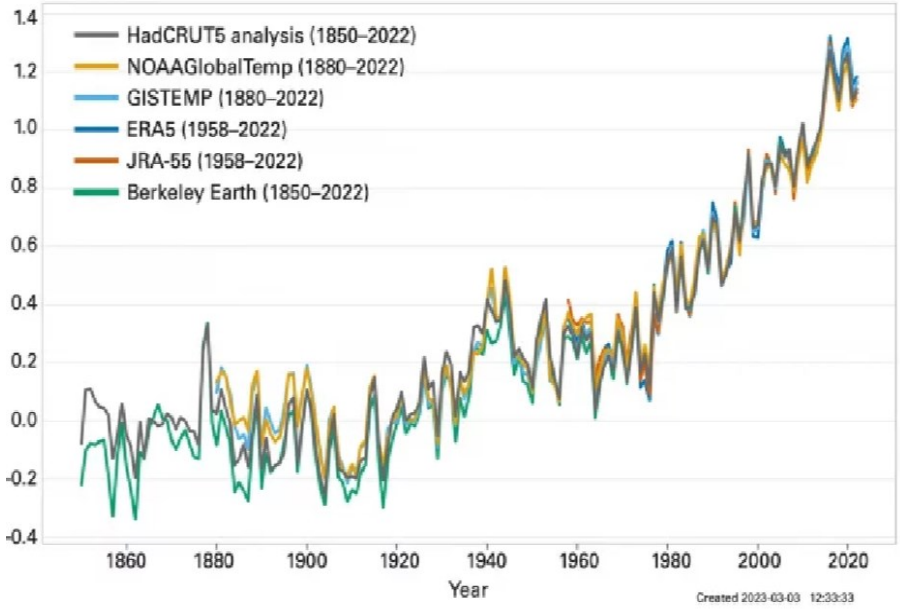
This graph shows Arctic, Antarctic, and global sea ice from 1979 through July 2023. There is a slight one-time decline around 2016 but nothing significant.





The sea ice data shows no correlation with CO2 levels, which continue to rise at a significant and steady rate.

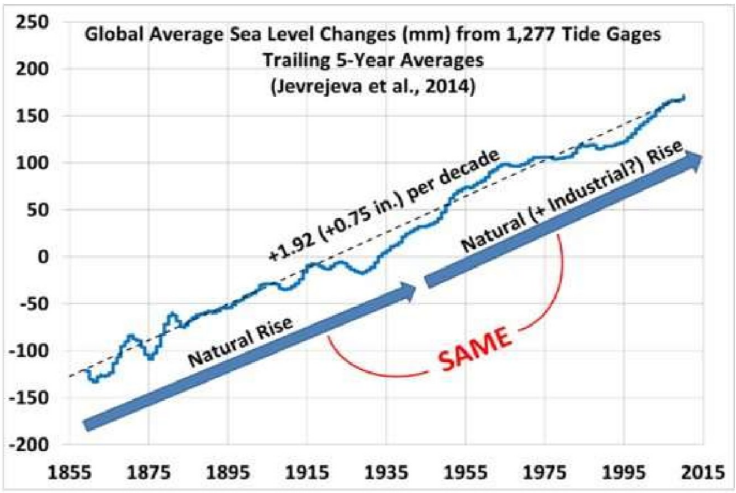
Nor does the sea ice data correlate with world temperature, which continues to rise at a steady rate. The evidence is mounting (disputed - not generally accepted) that variations in sea ice are caused more by variations in ocean currents, wind patterns, and storms than by variations in world temperatures.



SOURCES OF SEA LEVEL RISE ACCORDING TO THE IPCC AR6 P.11 (2021)	
Thermal expansion of sea water	50%
Ice loss from glaciers	22%
Greenland and the Antarctic ice sheets	20%
Changes in land-water storage	08%

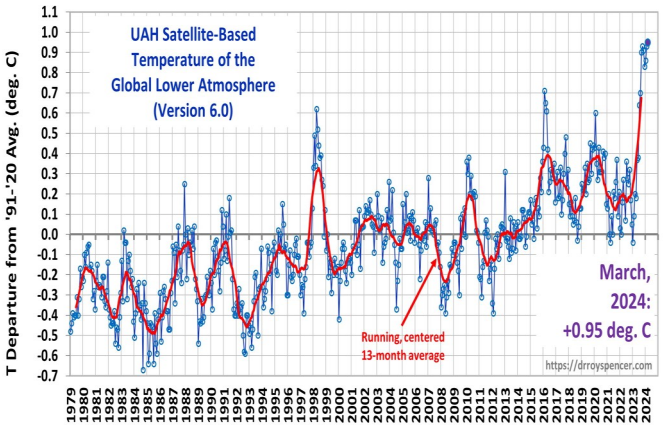
The IPCC has determined that the primary cause of sea level rise (50%) is thermal expansion of existing sea water. The melting of glaciers contributes 22% and the melting of the Greenland and Antarctic ice sheets contributes 20%.

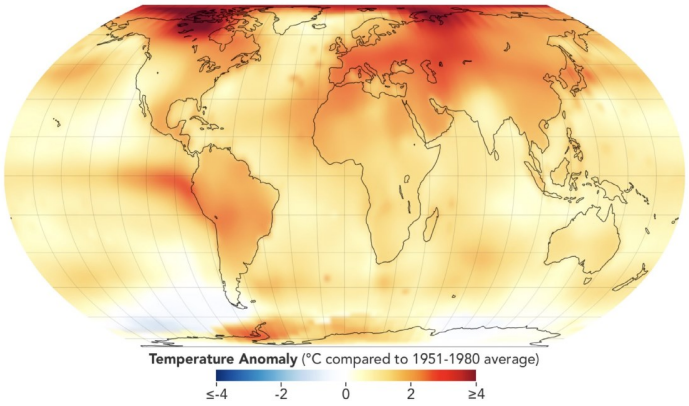
Thus one would expect sea level rise to correlate with world temperature rise. Compare this graph with the prior graph of world temperatures. The tide gauge data from over a thousand locations around the world shows sea levels rising at the slow and steady rate of about 7-8" per century. Thus, if world temperatures continue to rise at a steady rate for the next century, one would expect sea levels to continue to rise at a rate of about 7-8" per century.



UPDATE 04-13-24

In May 2023 world temperatures started to rise dramatically, reaching a high in November. Since then, temperatures have remained relatively steady at the high November level.

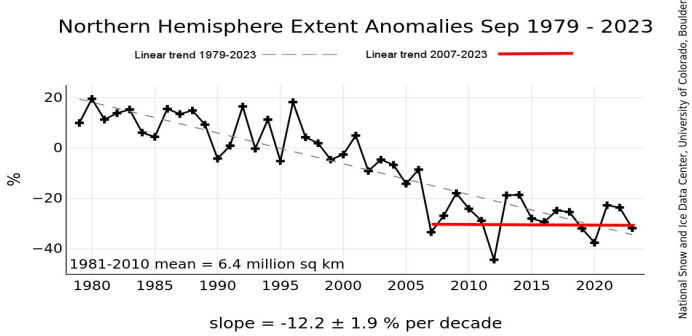


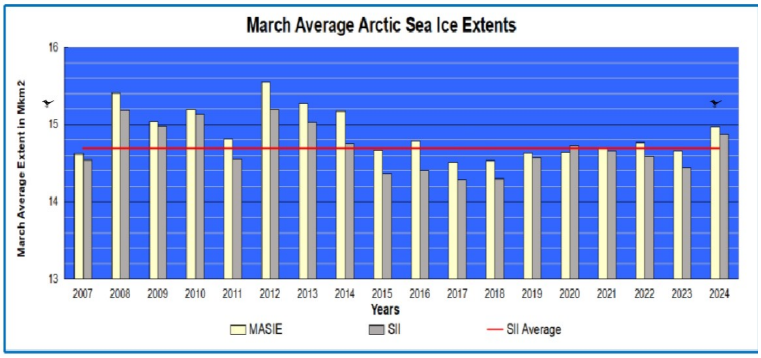


The Global Heat Anomaly 2023

Warming has not been distributed evenly around the world. Rather it has been mostly in the Arctic region.

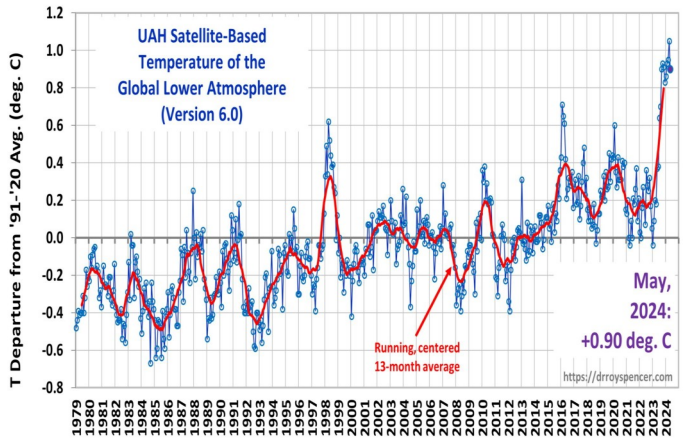
Arctic summer sea ice reaches its minimum in September. The September 2023 minimum continued the level trend that began in 2007.





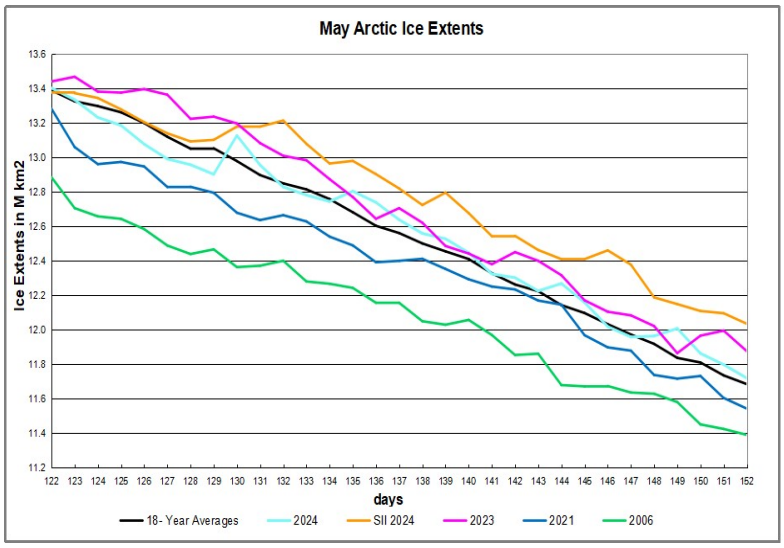
Arctic sea ice reaches its maximum in March. The March 2024 data shows more sea ice than any year since 2014. The trend is level since 2007 despite the high temperature of 2023.

UPDATE 06-17-24



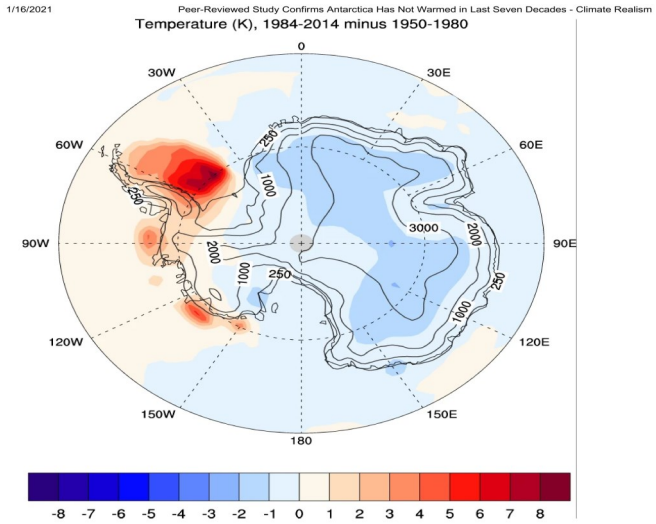
The temperature spike that began in the spring of 2023 continues unabated through the end of May 2024.

But Arctic sea ice for May (the light blue line) is above the 18-year average (the black line), far above the extreme low of 2006 (the green line), and slightly above the 2021 level (the dark blue line)



Calculating the Antarctic land ice mass is extremely difficult. Antarctica is 76% larger than the continental US (5.5 million square miles versus 3.1).

Significant temperature differentials exist across the continent. In particular the Antarctic Peninsula has been warming and losing ice, but that amounts to only about 4% of Antarctica's total land area. Any determination of total land ice mass must consider not only changes in glacier fronts, but also changes in ice thickness over the whole continent.



A major new study has concluded that for most of Antarctica -

1. Since the 1950s there have been no significant trends in annual or seasonal mean air temperatures.
2. Antarctic snow accumulation appears to have increased over the last 200 years.
3. Overall there has been no declining trend in fixed ice on land, and perhaps even a net growth.

Due to the difficulties in measurement, disagreement exists on all these issues. The IPCC believes that it is "likely" that the Antarctic ice sheet has been losing ice mass and will continue to lose ice mass. {AR6 WGI p.1272 (2021)].