EPA UPDATED CLAIM:

"Arctic sea ice extent continues to decline in all months of the year; the reductions in September sea ice extent are unprecedented in at least the past 1,000 years (very likely an almost 13 percent reduction per decade between 1979 and 2018)."

Rebuttal:

THE ARCTIC

Satellite and surface temperature records and sea surface temperatures show that both the East Antarctic Ice Sheet and the West Antarctic Ice Sheet are cooling, not warming and glacial ice is increasing, not melting. Satellite and surface temperature measurements of the southern polar area show no warming over the past 37 years. Growth of the Antarctic ice sheets means sea level rise is not being caused by melting of polar ice and, in fact, is slightly lowering the rate of rise. Satellite Antarctic temperature records show 0.02C/decade cooling since 1979. The Southern Ocean around Antarctica has been getting sharply colder since 2006. Antarctic sea ice is increasing, reaching alltime highs. Surface temperatures at 13 stations show the Antarctic Peninsula has been sharply cooling since 2000.

The Arctic includes the Arctic Ocean, Greenland, Iceland, and part of Siberia and northern Alaska. Because of the absence of any land mass in the Arctic Ocean, most of area lacks glaciers, which require a land mass. Thus, most of the Arctic contains only floating sea ice. Greenland, Iceland, northern Alaska, and northern Siberia contain the only glaciers in the general Arctic region. Arctic temperature records show that the 1920s and 1930s were warmer than 2000. Records of historic fluctuations of Arctic sea ice go back only to the first satellite images in 1979. That happens to coincide with the end of the 1945–1977 global cold period and the maximum extent of Arctic sea ice. During the warm period from 1978 until recently, the extent of sea ice has diminished, but has increased in the past several years. The Greenland ice sheet has also grown recently.

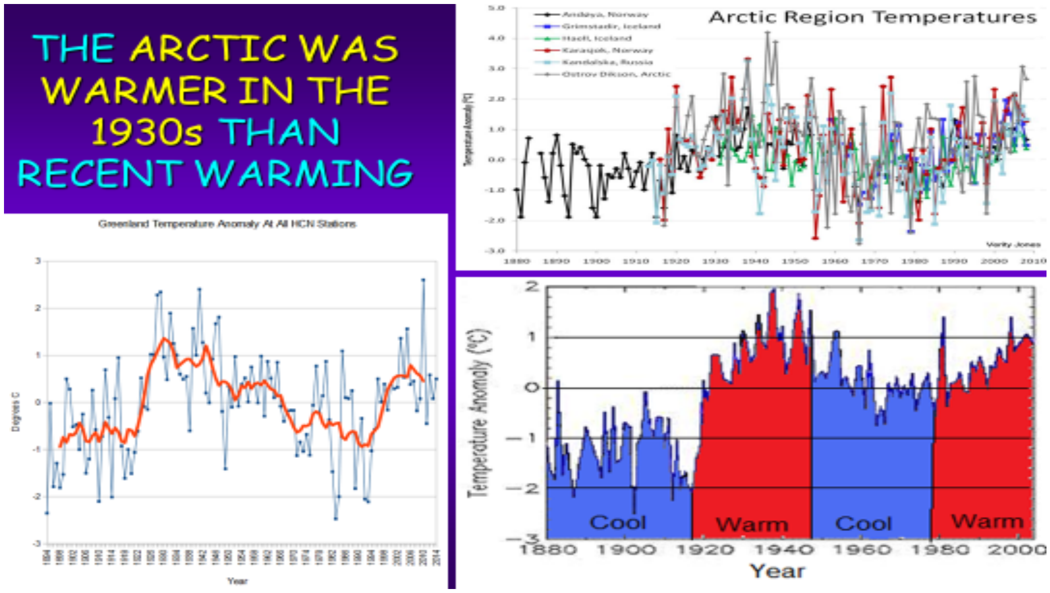

Figure 1. Arctic temperatures were warmer in the 1930s than today. The graph on the left shows temperatures in Greenland from 1894 to 2014 (high temperatures in left center during the 1930s) were warmer than today (right side). Upper right graph is Arctic temperature from Iceland, Russia, and Norway 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).

Greenland's GISP2 ice core (Figure 2) shows the millennium scale warm and cold cycle. Note that the peak of the Minoan, Roman and Medieval and current warming have been successfully lower.

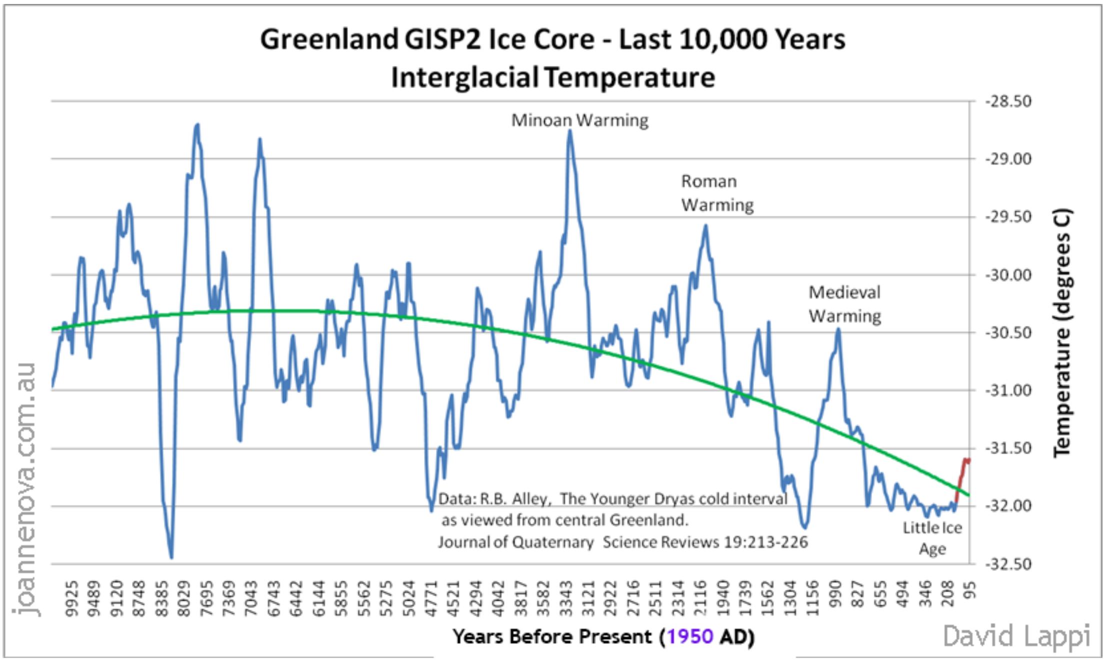

Figure 2: Greenland GISP2 Ice Core Temperatures

A 2019 study by [*Bevis etal*]() claimed "*Greenland is melting faster than scientists previously thought, with the pace of ice loss increasing four-fold since 2003."* Their claim that ice loss in 2012 was greater than in 2003 is based on one year's weather, and not the long-term trend. Note that by 2016/17, the Greenland Surface Ice Mass Balance had rebounded to near the top of the 1981-2010 annual range (Figure 3). [NASA JPL]() has found the melting has slowed related to cooling North Atlantic Ocean temperatures.

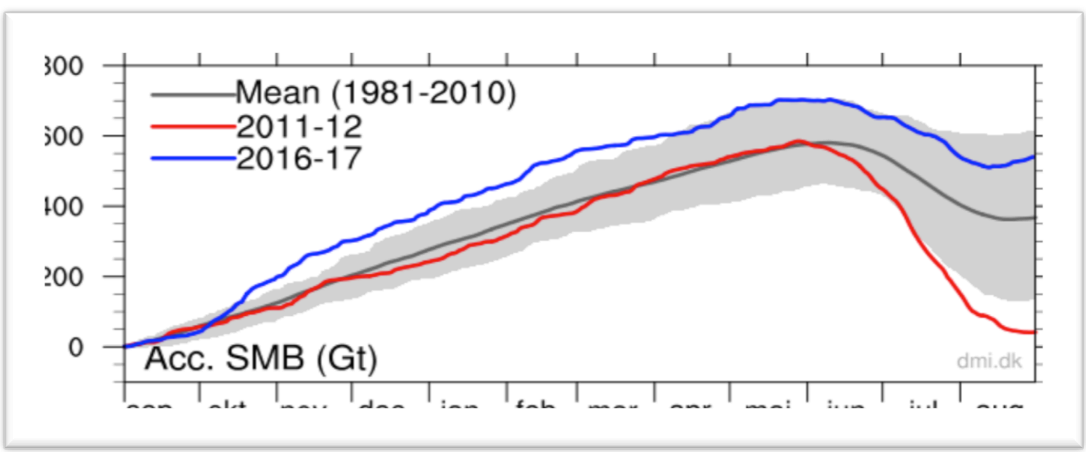

Figure 3. Recent growth of the Greenland ice sheet. (Danish Meteorological Institute)

See that Atlantic Ocean temperatures as reflected by the Atlantic Multidecadal Oscillation links closely with Greenland temperatures (Figure 4).

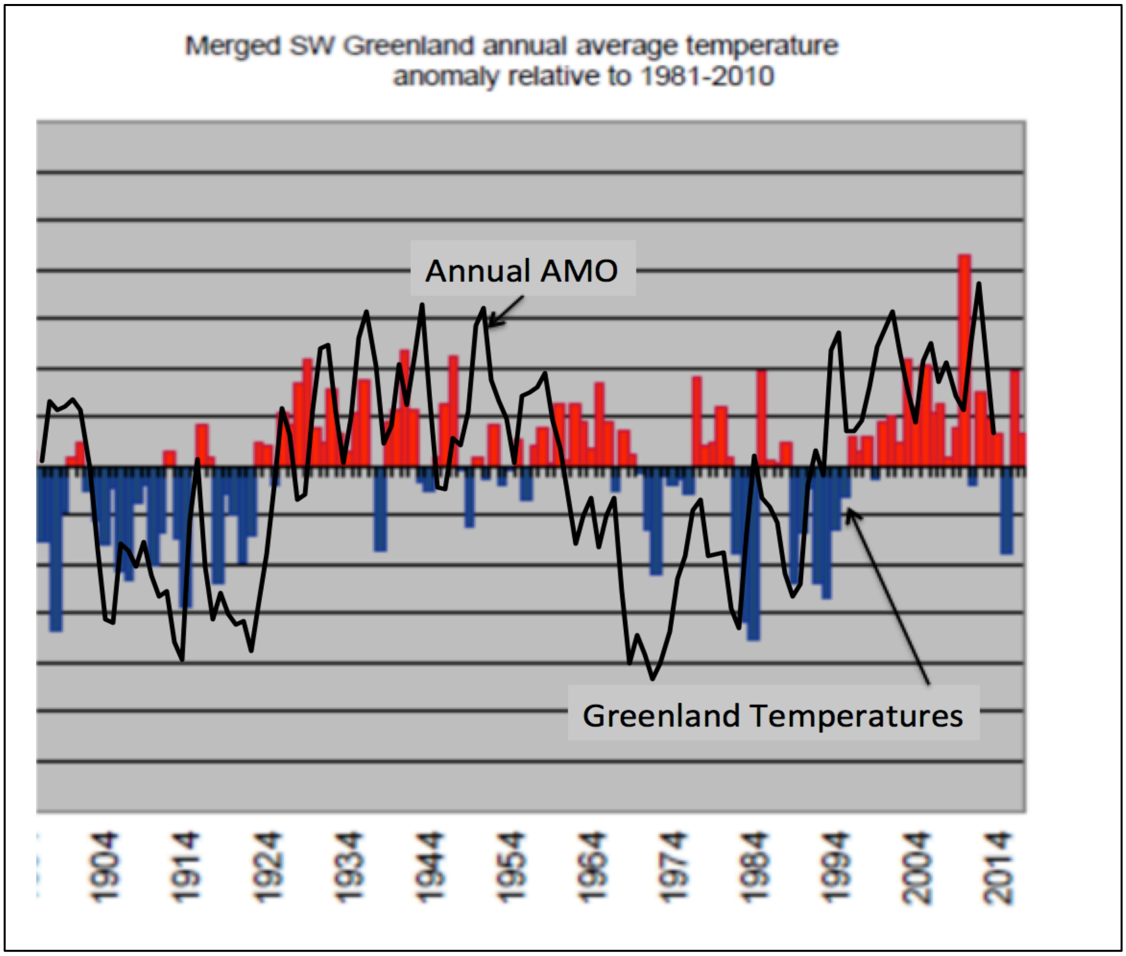

Figure 4. Greenland Annual Temperatures versus the AMO

ARCTIC ICE AND MULTIDECADAL OCEAN TEMPERATURE CYCLES

Changes in the arctic ice and temperatures strongly correlate with the ocean multi-decadal cycles and solar activity and poorly with CO2. Both oceans exhibit multi-decadal changes in ocean temperatures on the order of every 25-35 years.
Since the ice is floating, the North Atlantic and North Pacific are in their warm phases, warm water is carried by currents under the ice, thinning it and shortening the ice cover season. There are many stories and anecdotal evidence that arctic ice was in a major decline from the 1920s to 1940s.

The following from Chylek (GRL 2009) shows the tight correlation of the AMO and arctic temperatures. The authors conclude "Our analysis suggests that the ratio of the Arctic to global temperature change varies on multi-decadal time scale. The commonly held assumption of a factor of 2–3 for the Arctic amplification has been valid only for the current warming period 1970 – 2008. The Arctic region did warm considerably faster during the 1910–1940 warming compared to the current 1970–

2008 warming rate. During the cooling from 1940-1970 the Arctic amplification was extremely high, between 9 and 13.

The Atlantic Ocean thermohaline circulation multi-decadal variability is suggested as a major cause of Arctic temperature variation."

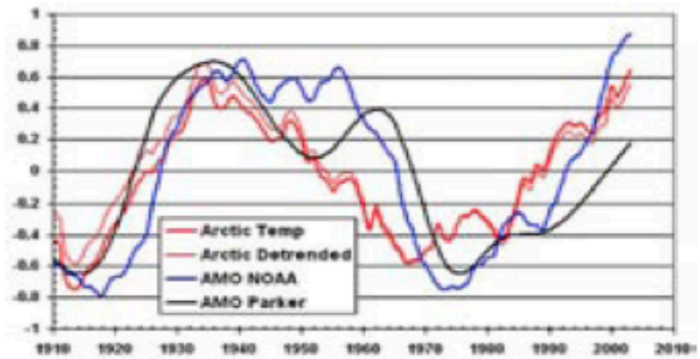

Figure 3. 11 year running average of the Arctic temperature (combined low and high Arctic stations with long term temperature records) anomaly (thin red line) with respect to 1910–2008 average, detrended anomaly (thick red line), and the AMO index anomaly. The NOAA (blue) and the [*Parker et al* [2007] (black) AMO index anomaly have been normalized to a peak value of 0.7 within 1930–1940s.

Figure 5: 11 year running averages of the arctic temperatures versus the AMO

Both the Pacific multidecadal cycle (PDO) and the Atlantic Multidecadal Oscillation (AMO) reflect a tripole of ocean temperatures. Both have warmer than normal water in the north and in the subtropics and cool relative to normal in the central Basin in the positive phase and cold north and tropics and warm in between in the negative phase.

By normalizing and adding the two data sets, you get a measure of net warmth or cooling potential for both global and arctic temperatures. See how well the sum tracks with the arctic temperatures (figure 6).

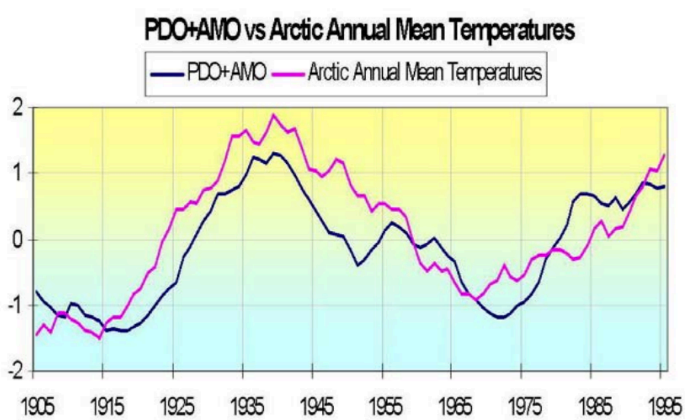

Figure 6: PDO+AMO versus Arctic Annual Mean Temperatures (Polyakov)

There are many stories and anecdotal evidence that arctic ice was in a major decline from the 1920s to 1940s. Francis et al. (GRL 2007) showed how the warming in the arctic and the melting ice was related to warm water (+3C) in the Barents Sea moving slowly into the Siberian arctic and melting the ice. She also noted the positive feedback of changed "albedo" due to open water then further enhances the warming. The International Arctic Research Center at the University of Alaska, Fairbanks showed how arctic temperatures have cycled with intrusions of Atlantic water - cold and warm (figures 7 and 8).

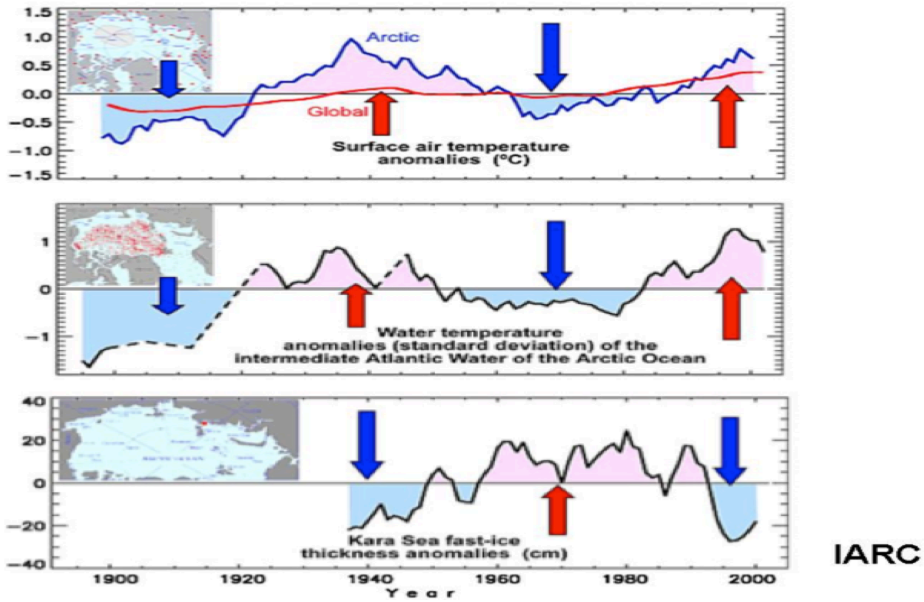

Figure 7: IAF IARC plot of arctic surface temperatures versus water temperatures in the intermediate Atlantic water of the Arctic ocean and Kara Sea fast-ice

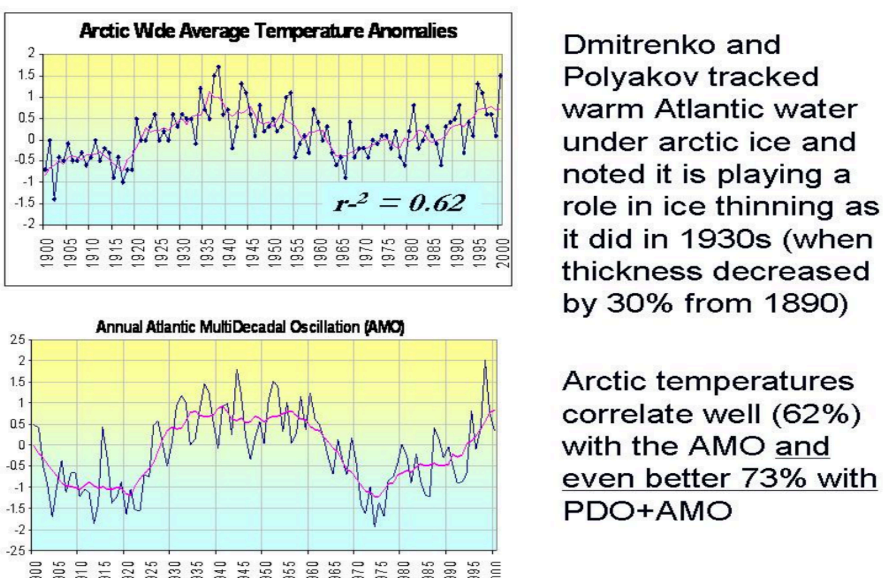

Figure 8: Arctic wide average temperature anomalies versus the annual AMO

Importantly before the NSIDC was silenced in their objectivity, they wrote after 2007,

"One prominent researcher, Igor Polyakov at the University of Fairbanks, Alaska, points out that pulses of unusually warm water have been entering the Arctic Ocean from the Atlantic, which several years later are seen in the ocean north of Siberia. These pulses of water are helping to heat the upper Arctic Ocean, contributing to summer ice melt and helping to reduce winter ice growth.

Another scientist, Koji Shimada of the Japan Agency for Marine-Earth Science and Technology, reports evidence of changes in ocean circulation in the Pacific side of the Arctic Ocean. Through a complex interaction with declining sea ice, warm water entering the Arctic Ocean through Bering Strait in summer is being shunted from the Alaskan coast into the Arctic Ocean, where it fosters further ice loss.

Many questions still remain to be answered, but these changes in ocean circulation may be important keys for understanding the observed loss of Arctic sea ice."

NSIDC report after 2020, *"the 2020 maximum sea ice extent is the eleventh lowest in the 42-year satellite record, but the highest since 2013." NSIDC reported after 2021/22 winter that the maximum ice level was highest in 10 years (Figure 9)*

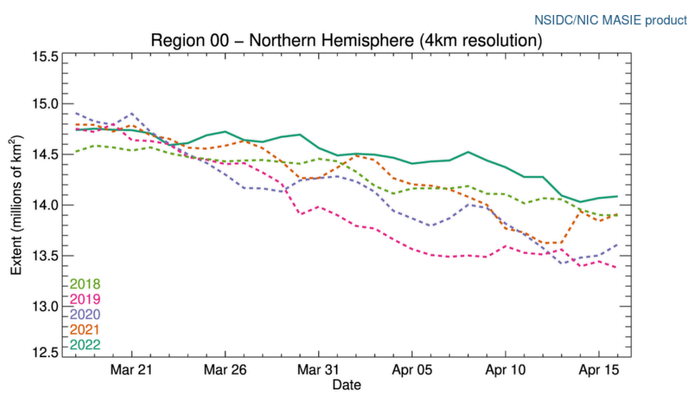

Figure 9: Rebounding arctic ice

[3 More New Studies Show Modern Arctic Sea Ice Extent Is Greater Than Nearly Any Time In The Last 10,000 Years]

For years scientists have been using biomarker evidence (IP_{25}, PIP_{25}) to reconstruct the Arctic's sea ice history. The evidence shows modern (20th-21st century) Arctic sea ice is at its greatest extent since the Holocene began.

Scientists (Wu et al., 2020) have determined that from about 14,000 to 8,000 years ago, when CO2 lingered near 250 ppm, the Beaufort Sea (Arctic) was "nearly ice free throughout the year" (<0.2 PIP_{25}) and ~4°C warmer than today in winter. With CO2 at ~400 ppm, this region is 70-100% ice-covered (>0.8 PIP_{25}) for all but 1-2 summer months in the modern (1988-2007) era.

HADLEY ARCTIC TEMPERATURES

Hadley Arctic temperatures show that the recent warming is comparable to or less than the warming that occurred a century ago (Figure 10).

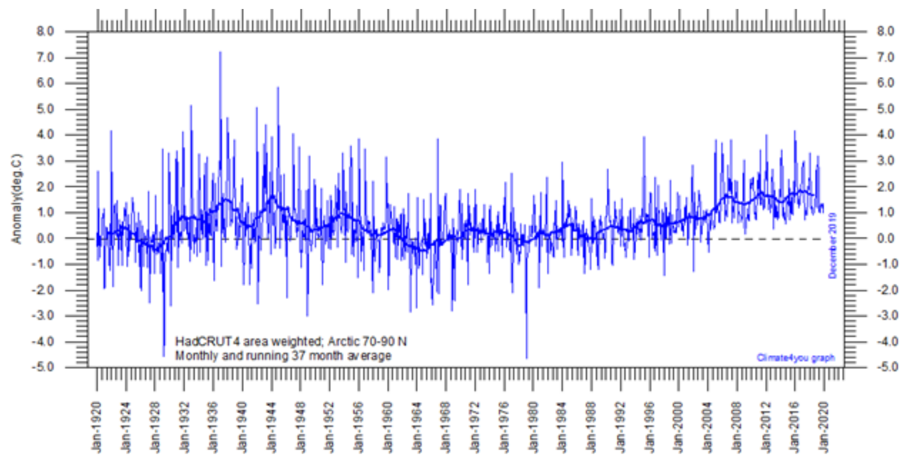

Figure 10: Hadcut4 Arctic temperature