

I. Background Information

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This comment focuses on comments

- (1) Arctic sea ice and the large ice sheets on Greenland and parts of Antarctica are melting faster than expected. Page 6
- (2) The Greenland Ice Sheet has also been experiencing record amounts of surface melting in recent years. Studies suggest that the surface melt water is flowing down to the base of the ice sheet, providing lubrication that causes the ice to flow more easily to the sea, speeding the loss of ice. Page 24
- (3) Global sea level rise has been projected to rise 1 to 2 feet during this century, but these estimates purposefully do not include the accelerated melting of the Greenland and West Antarctic ice sheets that many scientists think is likely to occur. Several recent projections suggest that sea level rise by the end of this century could be 3 to 5 feet, especially in subsiding coastal areas. Page 153

CORRECTION IS REQUIRED

These described changes in Greenland and the arctic are not at all unprecedented nor are they are described. This happens predictably every 60 years or so and is in fact entirely natural, related to multidecadal ocean cycles and possibly recently accentuated by major undersea volcanism and the invasion of tundra shrubs and deposition of soot from Asia.

Records of arctic ice cover extent start in 1979. Multidecadal cyclical warming was observed before in the 1800s and middle 1900s long before the industrial revolution. Also there is more recent evidence showing the idea of lubrication by melt water accelerating loss of glacial or icecap ice is not valid.

THE OCEAN MULTIDECADAL CYCLES

The natural multidecadal cycles in the [Pacific](#) (called the Pacific Decadal Oscillation or PDO) and [Atlantic](#) (called the Atlantic Multidecadal Oscillation or AMO) correlate strongly with temperatures over Greenland and the arctic.

In early May 2008, a paper appeared in Nature (Keenlyside) showing how by including long term ocean cycles in models the recent global cooling or at least lack of warming [may continue to 2020](#). The same week, a story by [NASA's Earth Observatory](#) reported

on the flip of the Pacific Decadal Oscillation to its cool mode. “This multi-year Pacific Decadal Oscillation ‘cool’ trend can intensify La Niña or diminish El Niño impacts around the Pacific basin,” said Bill Patzert, an oceanographer and climatologist at NASA's Jet Propulsion Laboratory, Pasadena, Calif. “The persistence of this large-scale pattern tells us there is much more than an isolated La Niña occurring in the Pacific Ocean.”

GREENLAND

Many recent studies have addressed Greenland ice mass balance. They yield a broad picture of slight inland thickening and strong near-coastal thinning, primarily in the south along fast-moving outlet glaciers. AR4 assessment of the data and techniques suggests overall mass balance of the Greenland Ice Sheet ranging between growth by 25 Gigatonnes per year (Gt/year) and shrinkage by 60 Gt/year for 1961-2003. This range changes to shrinkage by 50 to 100 Gt/year for 1993-2003 and by even higher rates between 2003 and 2005.

Most recently a study by van de Waal in *Science* showed as the [New Scientist](#) reported that “Much noise has been made about how water lubricates the base of Greenland's ice sheet, accelerating its slide into the oceans. In a rare "good news" announcement, climatologists now say the ice may not be in such a hurry to throw itself into the water after all. Mother Nature, it seems, has given it brakes.

Since 1991, the western edge of Greenland's ice sheet has actually slowed its ocean-bound progress by 10%, say the team, who have studied the longest available record of ice and water flow in the region.” They looked at how meltwater has correlated with the speed of ice flow at the western edge of the sheet, just north of the Arctic Circle, since 1991. They found that [meltwater pouring down holes in the ice – called "moulins"](#) – did indeed cause ice velocities to skyrocket, from their typical 100m per year to up to 400m per year, within days or weeks.

But the acceleration was short-lived, and ice velocities usually returned to normal within a week after the waters began draining. Over the course of the 17 years, the flow of the ice sheet actually decreased slightly, in some parts by as much as 10%.

"For some time, glaciologists believed that more meltwater equaled higher ice speeds," van de Waal says. "This would be kind of disastrous, but apparently it is not happening."

Van de Waal believes that the channels that carry the meltwater out to sea freeze up during the winter months. In summer, pulses of water rushing down the moulins to the bedrock overwhelm the narrowed channels, and the increased pressure lifts the ice sheet off the rock, enabling it to move faster.

However, after a few days the channels are forced open by the water, and it drains away from the glacier. As a result, the ice grinds back down against the bedrock and the

lubricant effect is lost. NO LUBRICATION: Van De Waal says this indicates that, overall, meltwater has a negligible effect on the rate at which the ice sheet moves.”

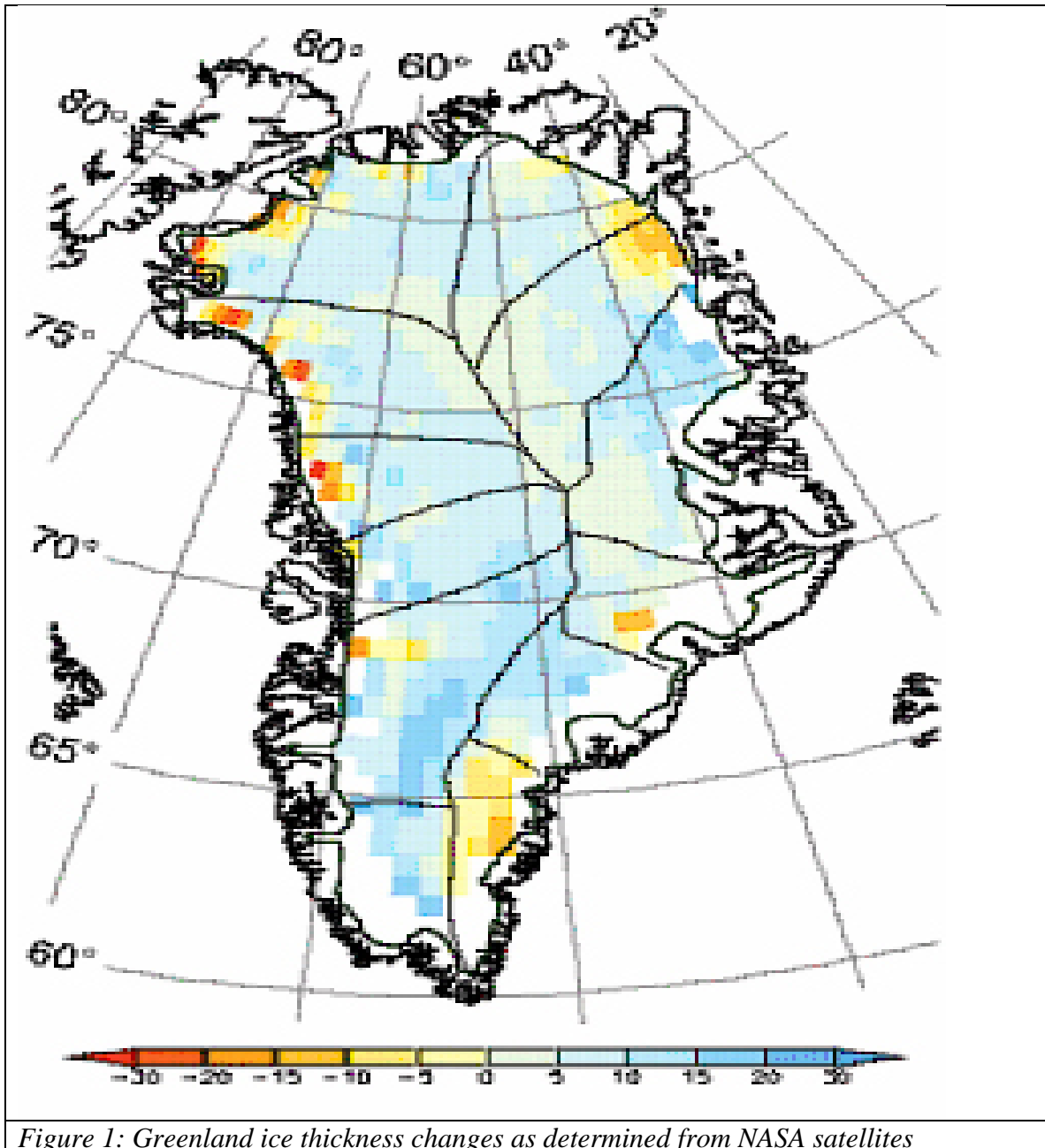


Figure 1: Greenland ice thickness changes as determined from NASA satellites

Other scientists have confirmed that interannual variability is very large, driven mainly by variability in summer melting and sudden glacier accelerations. Consequently, the short time interval covered by instrumental data is of concern in separating fluctuations from trends. But in a paper published in *Science* in February 2007, Dr. Ian Howat of the

University of Washington reports that two of the largest glaciers have suddenly slowed, bringing the rate of melting last year down to near the previous rate. At one glacier, Kangerdlugssuaq, "average thinning over the glacier during the summer of 2006 declined to near zero, with some apparent thickening in areas on the main trunk."

Dr. Howat in a follow-up interview with the New York Times went on to add

"Greenland was about as warm or warmer in the 1930's and 40's, and many of the glaciers were smaller than they are now. This was a period of rapid glacier shrinkage world-wide, followed by at least partial re-expansion during a colder period from the 1950's to the 1980's. Of course, we don't know very much about how the glacier dynamics changed then because we didn't have satellites to observe it. However, it does suggest that large variations in ice sheet dynamics can occur from natural climate variability."

Thomas, et al. (2000) showed great variance in mass balance of the Greenland ice sheet with highly variable thickening and thinning depending on location. This February (2008) during a bitter cold winter, [Denmark's Meteorological Institute](#) stated that the ice between Canada and southwest Greenland reached its greatest extent in 15 years.

Temperatures were warmer in the 1930s and 1940s in Greenland. They cooled back to the levels of the 1880s by the 1980s and 1990s. In a GRL paper in 2003, Hanna and Cappelen showed a significant cooling trend for eight stations in coastal southern Greenland from 1958 to 2001 (-1.29°C for the 44 years). The temperature trend represented a strong negative correlation with increasing CO2 levels.

Shown below in figure 2, see the temperature plot for Godthab Nuuk in southwest Greenland. Note how closely the temperatures track with the AMO (which is a measure of the Atlantic temperatures 0 to 70N). It shows that cooling from the late 1950s to the late 1990s even as greenhouse gases rose steadily, a negative correlation over almost 5 decades. The rise after the middle 1990s was due to the flip of the AMO into its warm phase. They have not yet reached the level of the 1930s and 1940s.

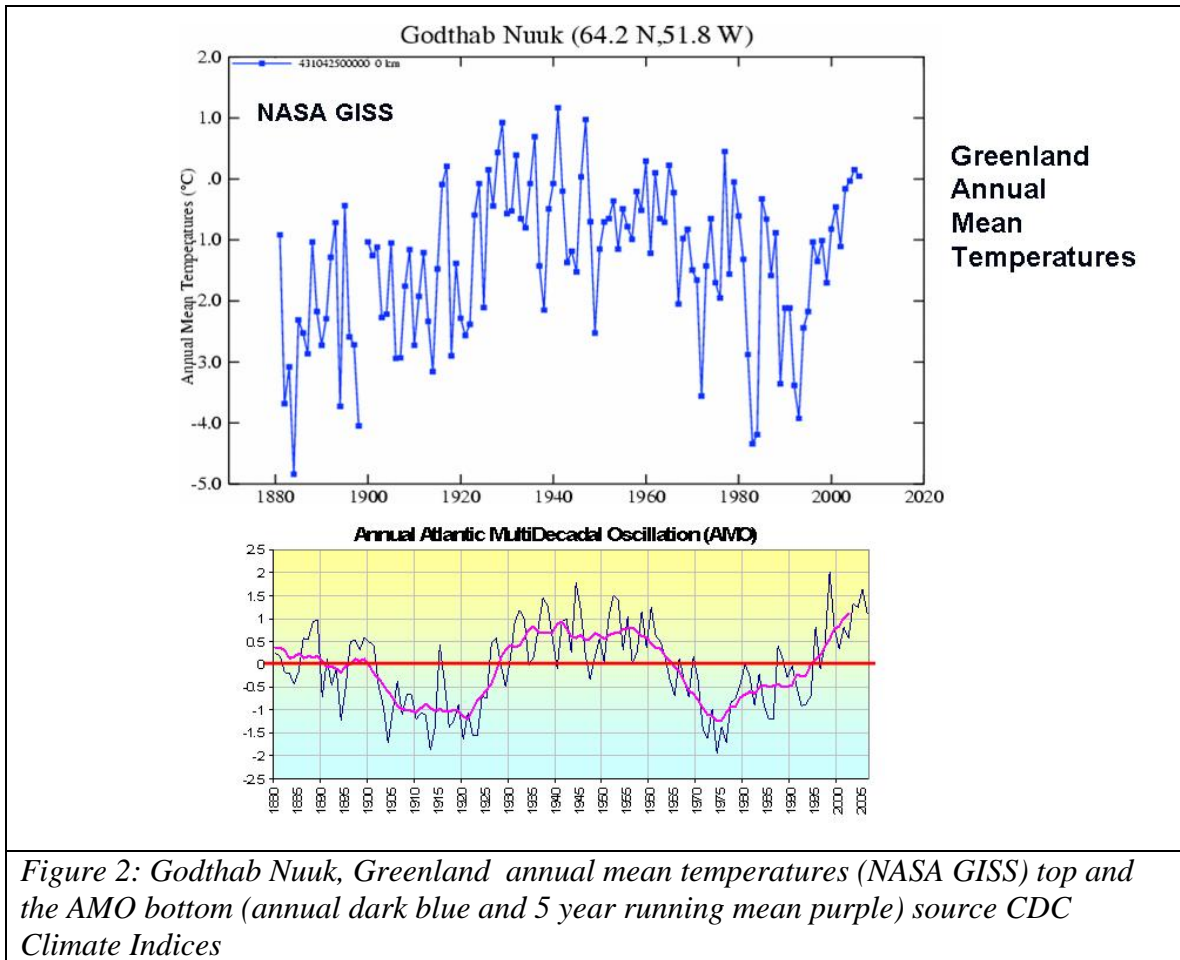


Figure 2: Godthab Nuuk, Greenland annual mean temperatures (NASA GISS) top and the AMO bottom (annual dark blue and 5 year running mean purple) source CDC Climate Indices

A SIMILAR STORY IN THE ARCTIC

Warming in the arctic is likewise shown to be cyclical in nature. This was acknowledged in the AR4 which mentioned the prior warming and ice reduction in the 1930s and 1940s. Warming results in part from the reduction of arctic ice extent because of flows of the warm water associated with the warm phases of the PDO and AMO into the arctic from the Pacific through the Bering Straits and the far North Atlantic and the Norwegian Current.

Hartmann et al., 2005 showed how the rapid Great Pacific Climate Shift that was the change of the PDO from cold to warm in 1977 produced stepladder discontinuities in Alaskan temperatures.

Polyakov et al (2002) created a temperature record using stations north of 62 degrees N. The late 1930s-early 1940s were clearly the warmest of the last century. In addition, the numbers of available observations in the late 1930s-early 1940s (slightly more than 50) is comparable to recent decades. The annual temperatures are plotted in figure 3.

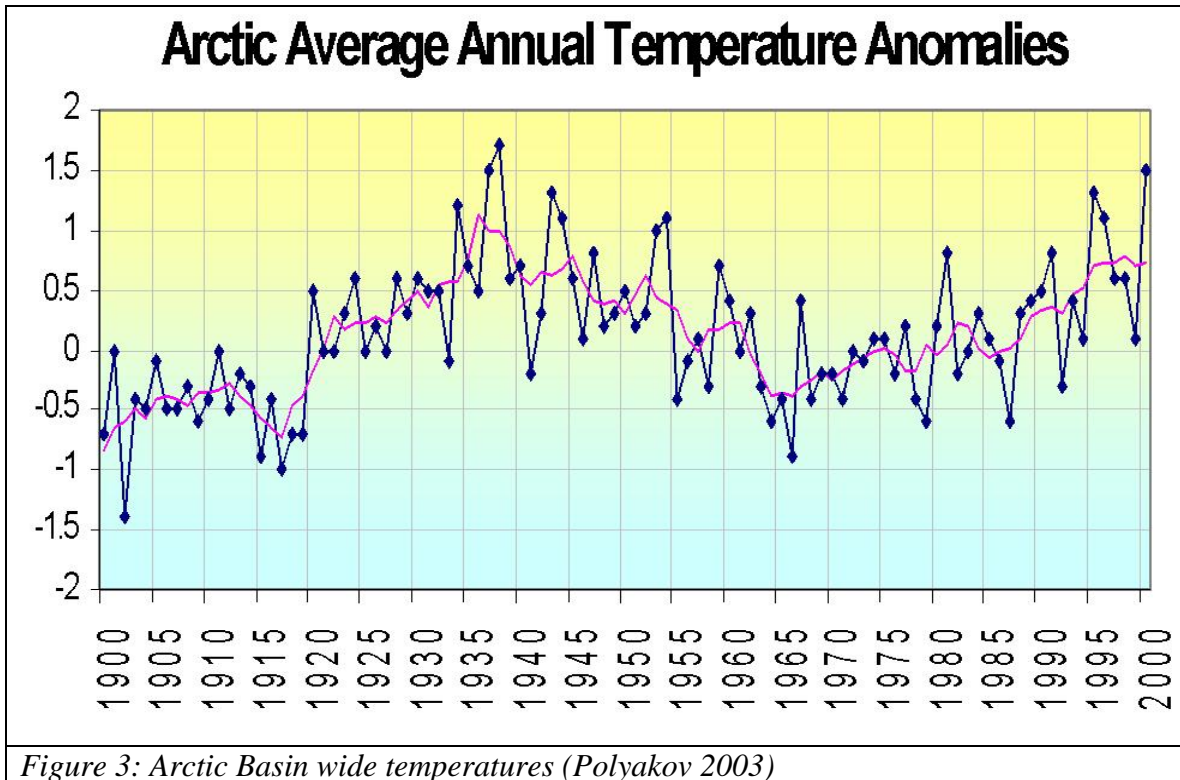


Figure 3: Arctic Basin wide temperatures (Polyakov 2003)

Pryzbylak (2000) says:

“There exists an agreement in estimating temperature tendencies prior to 1950. Practically all (old and new) of the papers which cover this time period concentrate on the analysis of the significant warming which occurred in the Arctic from 1920 to about 1940. Estimates of the areal average Arctic temperature trend in the second half of the 20th century are inconsistent.

“The second phase of contemporary global warming in the Arctic [since 1970] is either very weakly marked or even not seen at all. For example, the mean rate of warming in the last 5-year period in the Arctic was 2–3 times lower than for the globe as a whole.

“In the Arctic, the highest temperatures since the beginning of instrumental observation occurred clearly in the 1930s. Moreover, it has been shown that even in the 1950s the temperature was higher than in the last 10 years.”

In Vinnikov, et al (1999), the authors use the warming in recent decades as supposed verification of the GFDL and Hadley Center models. They acknowledge a lack of data in the 1940s. Polyakov (2003) showed ice extent time series with a combination of decadal and multidecadal tendencies, with lower values prior to the 1920s, in the late 1930s to 1940s and in recent decades. They showed higher values in the 1920s to early 1930s and 1960s-1970s, similar to variability in temperature records. It is impossible to find a consistent long term trend in the data plots

The Japan Agency for Marine-Earth Science and Technology in Yokosuka, Kanagawa Prefecture observed in a [story](#) in Yahoo Asia News in 2005 an ice shrinkage in the western Arctic Ocean from 1997 to 1998 that they attributed to “... *by the flow to the area of warm water from the Pacific Ocean, not by atmospheric impact as previously thought*”. This was related to the super El Nino of 1997/98. JAMSTEC's Koji Shimada, the group's sub-leader, said the shrinkage was particularly severe in the Pacific side of the Arctic Ocean. The ocean's ratio of area covered with ice during the summer stood at about 60-80 percent from the 1980s to mid-1990s, but it went down to 15-30 percent after 1998, he said.

THE IMPORTANCE OF THE ATLANTIC

Of the two oceans, for the larger arctic basin, the Atlantic may be more important. Przybylak (2000) noted that

“For arctic temperature, the most important factor is a change in the atmospheric circulation over the North Atlantic” The influence of the atmospheric circulation changes over the Pacific (both in the northern end and in the tropical parts) is significantly lower”

Rigor, et al (2002) suggest that the Arctic Oscillation (AO) affects surface air temperatures and sea ice thickness over the Arctic in a profound way. Ice thickness responds primarily to surface winds changes caused by the AO. Positive AO values (as have been observed in recent years) correspond to higher wind speeds (and generally thinner ice).

The North Atlantic Oscillation and the Arctic Oscillation (also referred to as the NAM) are related to the AMO as we reported on in the last post [here](#).

As noted in the AR4, the relationship is a little more robust for the cold (negative AMO) phase than with the warm (positive) AMO. There tends to be considerable intraseasonal variability of these indices that relate to other factors (stratospheric warming and cooling events that are correlated with the Quasi-Biennial Oscillation or QBO for example).

Hass and Eicken (2001) and Proshutinsky and Johnson (1997) showed how arctic circulations vary from cyclonic to anticyclonic depending on strength and position of Icelandic low and Siberian highs. The latter paper noting the tendencies for the regimes to last 5-7 years and help explain the basin scale changes in arctic temperatures and the variability of ice conditions in the Arctic Ocean. Vennegas and Mysak (2000) found four dominant signals, with periods of about 6–7, 9–10, 16–20, and 30–50 year. These signals account for about 60%–70% of the variance in their respective frequency bands. All of them appear in the monthly (year-round) data. They noted penetration of Atlantic waters into the arctic is affected by the North Atlantic Oscillation and multidecadal changes in the Norwegian Current.

As was the case for US temperatures, the combination of the PDO and AMO Indexes (PDO+AMO) again has considerable explanatory power for Arctic average temperature, yielding an r-squared of 0.73 (figure 4).

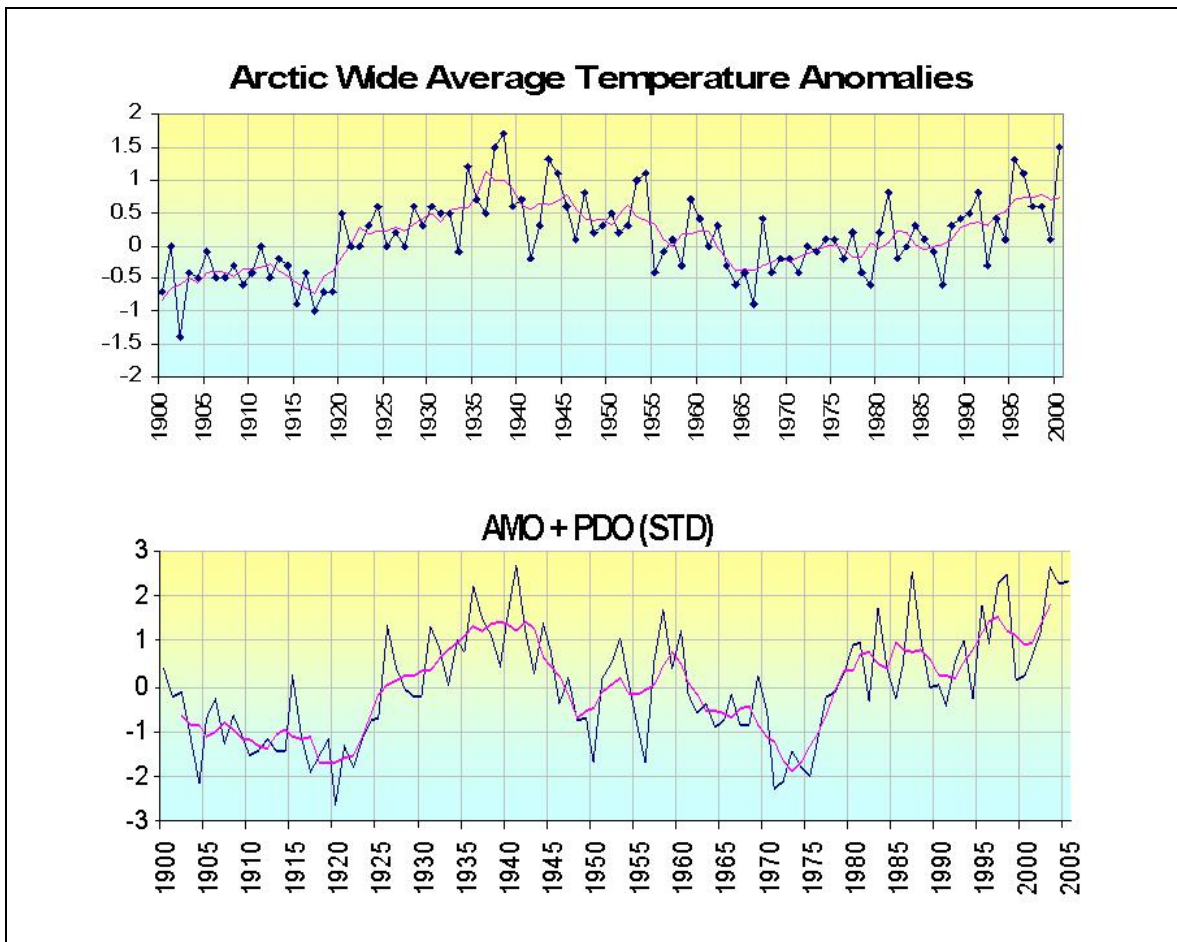


Figure 4: Arctic basin wide temperatures from Polyakov (2003) versus PDO+AMO (STD). Dark blue is annual and purple 5 year running means.

Karlen (2005) reported on historical temperatures in Svalbard (Lufthavn, at 78 deg N latitude), claiming that the area represents a large portion of the Arctic. It is reported that the "mean annual temperature increased rapidly from the 1910s to the late 1930s." Later, temperatures dropped, "and a minimum was reached around 1970." Once again, "Svalbard thereafter became warmer, but the mean temperature in the late 1990s was still slightly cooler than it was in the late 1930s."

Karlen goes on to say that similar trends (warm 1930s, cooling until about 1970, minor warming since) have occurred in Arctic areas of the North Atlantic, in northern Siberia, and in Alaska. At Stockholm, where records go back 250 years, "changes of the same magnitude as in the 1900s occurred between 1770 and 1800, and distinct but smaller fluctuations occurred around 1825."

Finally, in view of the fact that "during the 50 years in which the atmospheric concentration of CO₂ has increased considerably, the temperature has decreased," Karlen concludes that "the Arctic temperature data do not support the models predicting that there will be a critical future warming of the climate because of an increased concentration of CO₂ in the atmosphere."

Drinkwater (2006) concluded that "in the 1920s and 1930s, there was a dramatic warming of the air and ocean temperatures in the northern North Atlantic and the high Arctic, with the largest changes occurring north of 60°N," which "led to reduced ice cover in the Arctic and subarctic regions and higher sea temperatures." This was "the most significant regime shift experienced in the North Atlantic in the 20th century."

During the late 1920s, "average air temperatures began to rise rapidly and continued to do so through the 1930s." In this period, "mean annual air temperatures increased by approximately 0.5-1°C and the cumulative sums of anomalies varied from 1.5 to 6°C between 1920 and 1940 with the higher values occurring in West Greenland and Iceland." Later, "through the 1940s and 1950s air temperatures in the northernmost regions varied but generally remained relatively high." Temperatures declined in the late 1960s in the northwest Atlantic and somewhat earlier in the northeast Atlantic.

Hanna, et al (2006) estimated Sea Surface Temperatures (SSTs) near Iceland over a 119-year period based on measurements made at ten coastal stations located between latitudes 63°N and 67°N. They concluded that there had been "generally cold conditions during the late nineteenth and early twentieth centuries; strong warming in the 1920s, with peak SSTs typically being attained around 1940; and cooling thereafter until the 1970s, followed once again by warming - but not generally back up to the level of the 1930s/1940s warm period."

THE EFFECT ON ICE COVER

Both the Atlantic and Pacific play roles in arctic ice extent. Trenberth in 1994 talked about the warming of the western arctic following El Ninos by warming of the waters from the North Pacific. Joyce et al. also found decadal scale major shifts in hydrological variability in the North Pacific that related to the PDO.

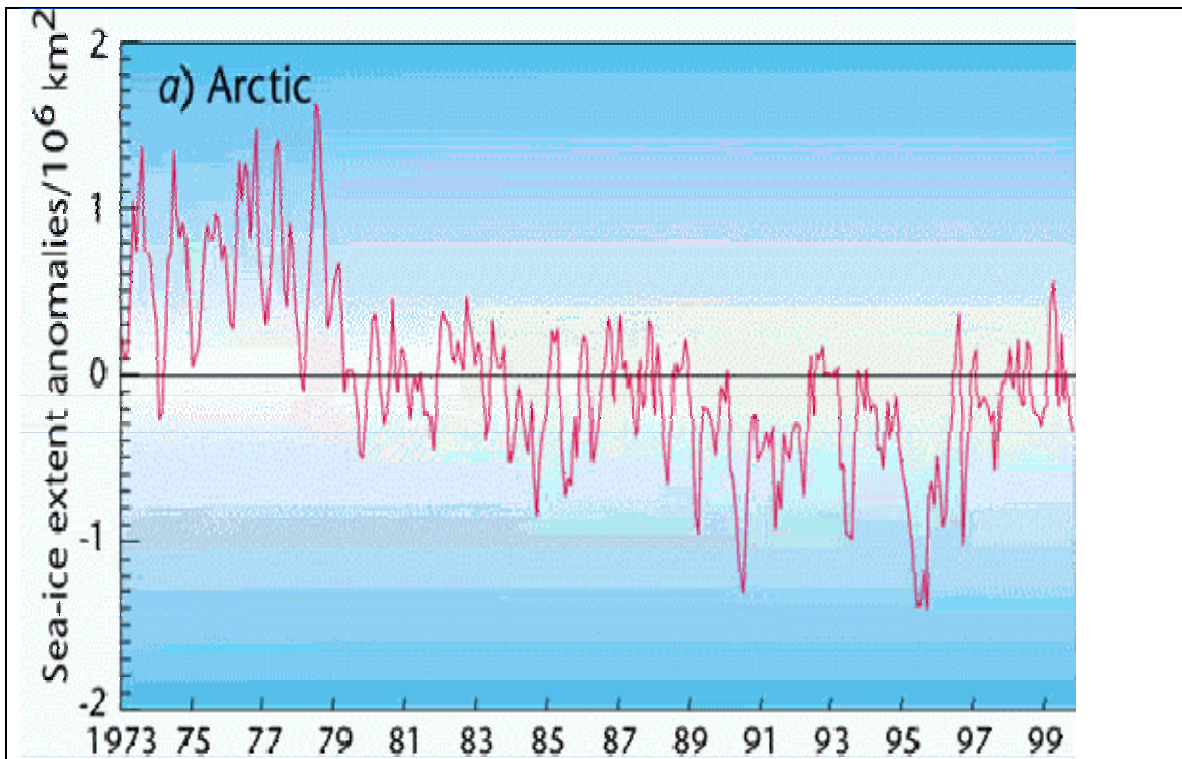


Figure 5: USGCRP Arctic sea ice extent (2000)

The sea ice extent diminished following the Great Pacific Climate Shift (flip of the PDO to positive) in the late 1970s (figure 5). It stayed relatively stable until the last few years when a more precipitous decline began (figure 6), related to a spike in North Atlantic warmth and a positive AO.

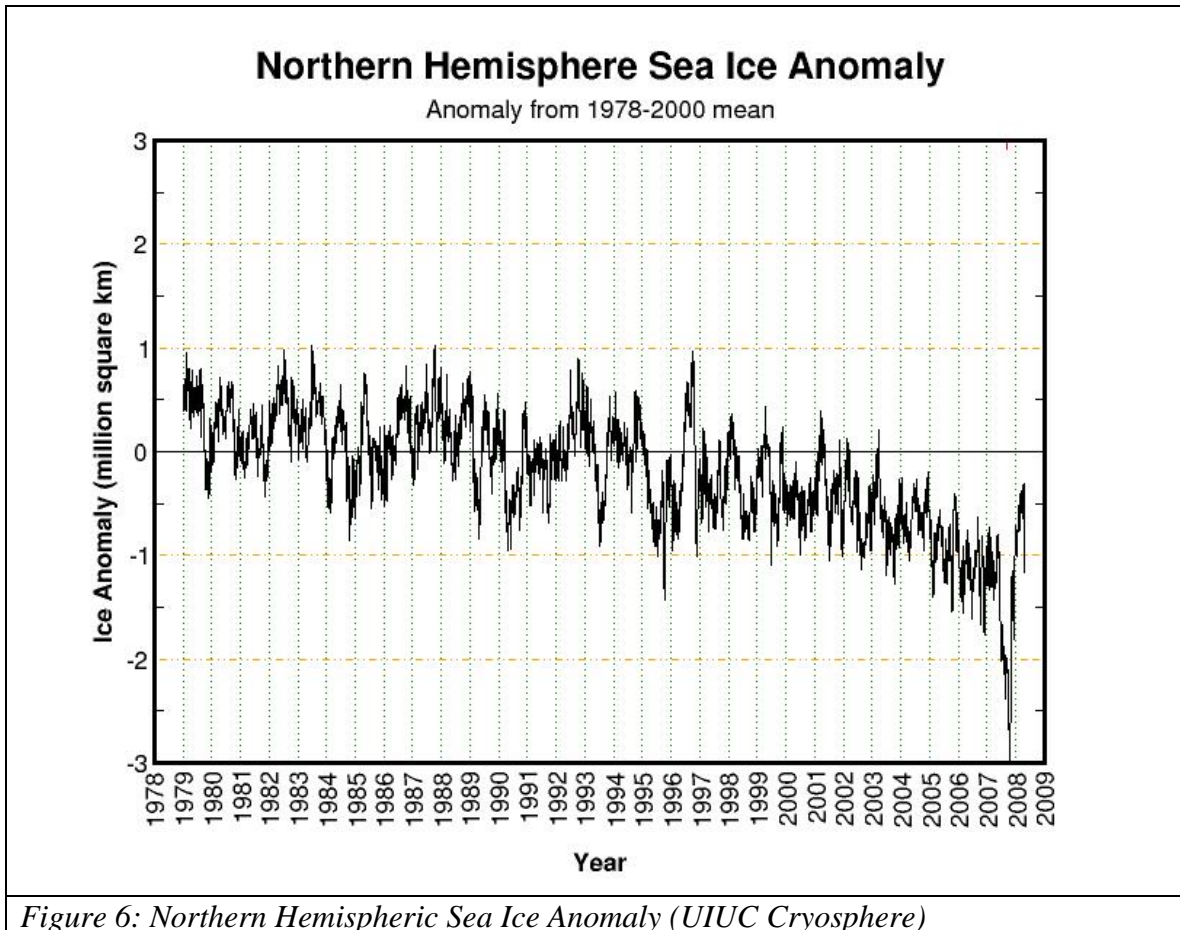


Figure 6: Northern Hemispheric Sea Ice Anomaly (UIUC Cryosphere)

Dmitrenko and Polyakov (2003) observed that warm Atlantic water in the early 2000s from the warm AMO that developed in the middle 1990s had made its way under the ice to off of the arctic coast of Siberia where it thinned the ice by 30% much as it did when it happened in the last warm AMO period from the 1880s to 1930s. Polyakov had previously concluded (2002)

“Arctic and northern hemispheric air-temperature trends during the 20th century (when multi-decadal variability had little net effect on computed trends) are similar, and do not support the predicted polar amplification of global warming. The possible moderating role of sea ice cannot be conclusively identified with existing data. If long-term trends are accepted as a valid measure of climate change, then the SAT and ice data do not support the proposed polar amplification of global warming.”

Rutger’s Jennifer Frances (GRL) in 2007 showed how the warming in the arctic and the enhanced ice melting was in part the result of warm water (+3C) in the Barents Sea in the far North Atlantic moving into the Siberian arctic. The positive feedback of changed “albedo” or reflectivity due to open water then acts to enhance the warming.

We can see in figure 7 how the Atlantic warmth peaked in 2004 and 2005 several years ahead of the major decline. Cooling since suggests the ice may slowly recover year to year.

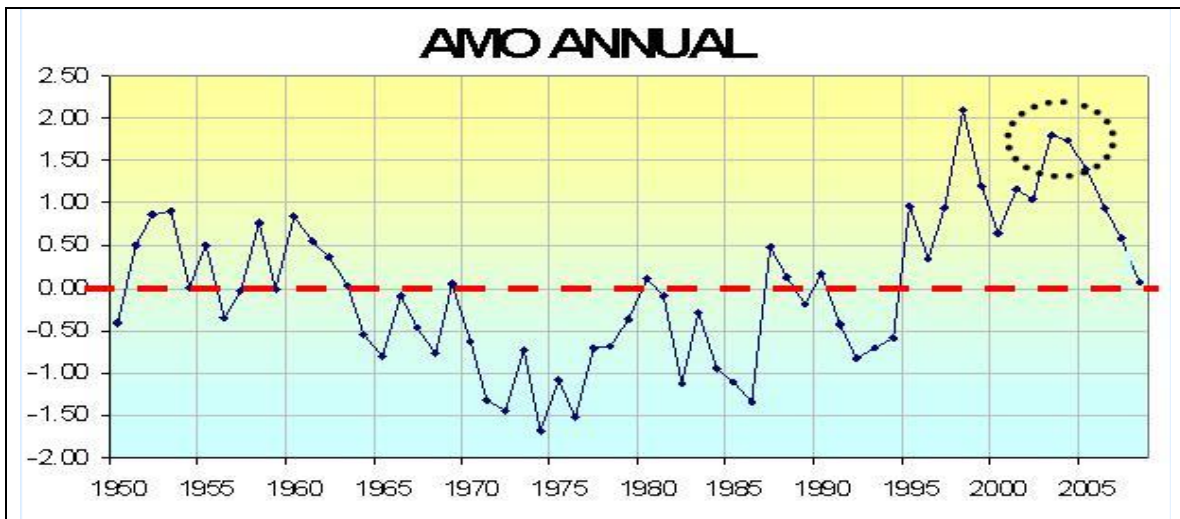


Figure 7: Annual Average AMO

The University of Colorado's National Snow and Ice Data Center (NSIDC) summarized the role of the ocean cycles very well in October 2007 in this way:

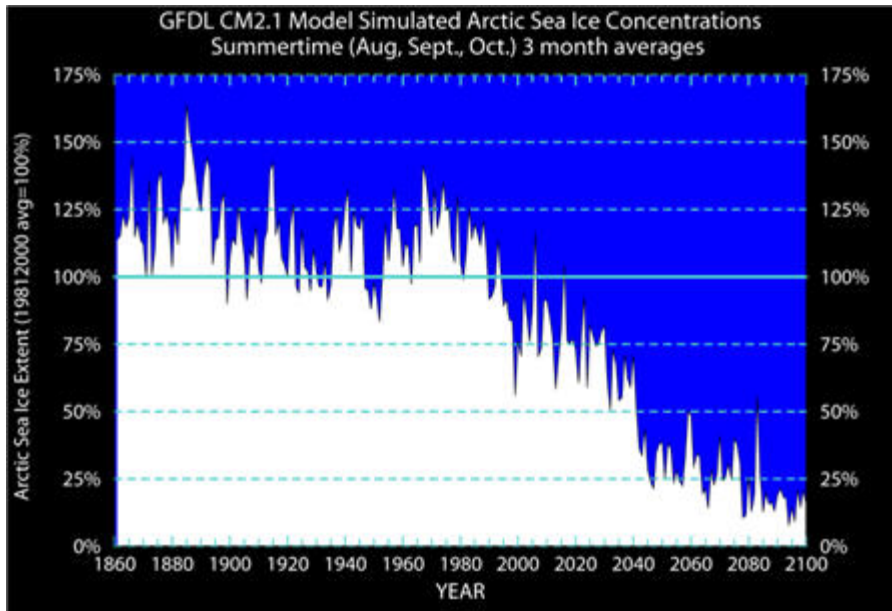
“One prominent researcher, Igor Polyakov at the University of Fairbanks, Alaska, points out that pulses of unusually warm water have been entering the Arctic Ocean from the Atlantic, which several years later are seen in the ocean north of Siberia. These pulses of water are helping to heat the upper 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.”

What they saw was unmistakable evidence of explosive eruptions rather than the gradual secretion of lava bubbling up from Earth's mantle onto the ocean floor...

Scientists at NOAA's [Geophysical Fluid Dynamics Laboratory](#), the amount in ice began to decline precipitously in around 1999, which is when these volcanoes began their eruption.



TUNDRA SHRUB AND SOOT INVASION AND ICE MELT

Strack et al.(2007) in the GRL paper showed how invasive shrubs and soot pollution both have the potential to alter the surface energy balance and timing of snow melt in the Arctic. Shrubs reduce the amount of snow lost to sublimation on the tundra during the winter leading to a deeper end-of-winter snowpack. The shrubs also enhance the absorption of energy by the snowpack during the melt season by converting incoming solar radiation to longwave radiation and sensible heat. Soot deposition lowers the albedo of the snow, allowing it to more effectively absorb incoming solar radiation and thus melt faster.

This study used the Colorado State University Regional Atmospheric Modeling System version 4.4 (CSU-RAMS 4.4), equipped with an enhanced snow model, to investigate the effects of shrub encroachment and soot deposition on the atmosphere and snowpack in the Kuparuk Basin of Alaska during the May–June melt period. The results of the simulations suggest that a complete invasion of the tundra by shrubs leads to a 2.2C warming of 3 m air temperatures and a 108 m increase in boundary layer depth during the melt period. The snow-free date also occurred 11 d earlier despite having a larger initial snowpack. The results also show that a decrease in the snow albedo of 0.1, owing to soot pollution, caused the snow-free date to occur 5 d earlier. The soot pollution caused a 1.0C warming of 3 m air temperatures and a 25 m average deepening of the boundary layer.

SUMMARY

Multidecadal Oscillations in the Pacific and the Atlantic are acknowledged to be the result of natural processes. When you combine the two cycles, you can explain much of the temperature variances of the past 110 years for Greenland and the Arctic. The warm phase of the PDO and of the AMO also produces warming and enhanced ice melt in Greenland and the Arctic. Warm waters from both ocean basins during the ocean's warm modes contribute to periodic summer ice decreases approximately every 60 years going back two hundred years. Volcanic activity in the Gakkel Ridge and the invasion of tundra shrubs and soot pollution may also be altering the melting.

Greenhouse gases are not the causes of these natural cyclical changes.

CHANGES REQUIRED

You need to drop the statements above and state instead:

Arctic ice melt has increased in recent years as a result of warm water intrusion into the arctic from the Pacific and especially most recently from the Atlantic. The role of the undersea volcanic activity in the Gakkel Ridge is an unknown but a major eruption there in 1999 preceded the most recent rapid ice decline. There is evidence that the invasion of tundra shrubs and soot pollution may be altering the fall ice build up and melting and altering albedo. Similar arctic warmings occurred in the 1930s to 1950s as correctly documented by the IPCC AR4 and in the 1800s according to Siberian oceanographers.

Warming in Greenland has not yet reached the levels of the 1930s and 1940s. Temperatures in Greenland were much warmer in prior periods like the Medieval Warm Period (sorry Jonathan, you could not get rid of it – it is real as CO2 Science has documented according to data published by 576 individual scientists from 345 separate research institutions in 38 different countries ... and counting!). The idea that rapid melting and lubrication has been proven to be in error by the most recent research.

Note: The IPCC estimates of sea level rise and of their assessment that the melting of the Antarctic and Greenland ice sheets is unlikely is closer to the truth than your greatly exaggerated ideas and inflated numbers.

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