Commentary

Signs of stability of the Arctic sea ice thickness from Cryosat-2

Abstract

The latest Cryosat-2 results for the Arctic sea ice thickness are discussed. The signs of stability of the sea ice thickness are shown to be consistent with the Lower Troposphere Temperatures (LTT) and the sea ice extension available since 1979. The correct long term perspective is debated by using time series of sea ice extension and temperatures starting from the 1800s. The current Arctic climate is likely at the start a cooling and recovery phase. This is part of the same quasi-60 years' oscillation that was responsible of most of the warming since the late 1970s. This natural variability is superimposed on a longer-term trend of warming temperatures and shrinking of sea ice that started in the 1800s.

Keywords: Arctic, sea ice, temperature, climate models, simulations, experiments

Introduction

In recent news, one more ship of climate change researchers has been trapped by the Arctic ices. A carefully organised 115-day scientific expedition on board a floating research vessel, the CCGS Amundsen, had its plans wrecked as an icebreaker was called to set free the ship from ice heavier than computed in Hudson Bay [1]. Last year it was the case in Antarctica [2], this year it is in the Arctic. Both results are further indications the sea ices of the Arctic and the Antarctica are still very far from being predictable in the short and the long term.

Tilling and co-authors [3] have published a work showing the existence of some signs of increase recovery in the Arctic ice volume during 2013 from the Cryosat-2 (CRYOgenic SATellite) monitoring. The findings are consistent with the other evidence, such as that of the University of Alabama at Huntsville (UAH) lower troposphere temperatures (LTT) and the National Snow and Ice Data Centre (NSIDC) sea ice extension, and other Arctic ice volume evaluations as Pan-Arctic Ice Ocean Modelling and Assimilation System (PIOMAS).

The present paper examines the consistency of the latest Cryostat-2 results with the other products, and put the latest results in the correct long term perspective. It is well documented that the Arctic warmed up rapidly from 1920 to peak in the early 1940s before temperatures dropped to the mid-1970s, and then rose to today's values that are close to those of the early 1940s. This is part of a quasi-60 years' multi-decadal periodicity superimposed to a longer term trend started in the 1800s [15, 38 and 39]. Natural climate oscillations may therefore be all we are observing.

The paper discusses first the theoretically possible periodicities of the Arctic climate oscillations. Then it proposes data collected over different time scales of subregional and regional Arctic temperatures and sea ice, namely subregional Arctic sea ice extension results since the 1800s, the latest Cryosat-2 monitoring of the Arctic sea ice thickness since 2010, the satellite Arctic temperatures and sea ice extension since 1979 and the Arctic temperature reconstructions since the 1900s, to understand phases, periodicities and amplitude of the oscillations.

Theoretically possible periodicities of the Arctic climate oscillations

The climate oscillations are recurring cyclical fluctuations characterizing global or regional climate patterns. These oscillations may in principle affect any climate parameter, from surface air temperatures to sea surface temperatures, from rainfalls to sea levels, from sea ices to ocean circulations. It is certainly very likely the Arctic climate may have periodic oscillations.

The climate oscillations may occur on inter-annual, multi-annual, decadal and multi-decadal scale, and sometimes with time scales of centuries and millennia. As direct measurements are only partially available over recent years and most of the records of the past climate conditions are inferred from proxies, there is a lack of accurate information to understand the relevance of natural variability in the present climate patterns.

Many oscillations on different time-scales have been hypothesized, although the causes are generally unknown. Known oscillations that may affect the Arctic climate include such climate patterns teleconnections as the North Atlantic Oscillation (NAO) [22, 23], the Northern Oscillation Index (NOI) [24] or the Pacific Decadal Oscillation (PDO), atmospheric oscillations such as the Globally Integrated Angular Momentum [25] or the Arctic oscillation (AO) [26-28], rainfall oscillations such as the El Niño/Southern Ocean (ENSO) oscillations, sea surface temperature (SST) oscillations such as the Atlantic Multi-decadal Oscillation (AMO) [29] and other oscillations such as the Global Mean Land/Ocean Temperature Index [30-33] or the Solar Flux oscillations.

Anomalies in oscillations may occur when they coincide, as it is the case of the Arctic dipole anomaly that is basically the interaction of the Arctic oscillation (AO) with the North Atlantic oscillations (NAO) [34-37].

We know therefore there are very likely natural oscillations in the Arctic, but we do not know how much they explain the recent climate pattern in the Arctic. Data collected over different time scales may help understanding periodicities, phases and strength of the oscillations.

Subregional Arctic sea ice extension results since the 1800s

As shown in [38] and [39], the longer term trend for the Arctic is a shrinking trend that started at the end of the last little ice age. Figure 1 summarizes the findings of [38] and [39]. The shrinking trend is small, as is the warming trend.

On top is the time series of the April ice extent in the Nordic Seas (NS), eastern area (E), and western area (W) (from [38]). The area here referred to as the Nordic Seas comprises the Greenland, Iceland, Norwegian, Barents, and Western Kara Seas. The results show a constant declining trend over 135 years.

On the bottom is the ice extent in the Kara, Laptev, East Siberian, and Chukchi Seas (from [39]). The long term ice extent trend is a small but clear decline over the past 100 years. Trends for shorter records are not indicative of the long-term tendencies due to large-amplitude low-frequency variability. The ice variability in these areas seems to be dominated by a multi-decadal low-frequency oscillation and to a lesser degree by higher-frequency decadal fluctuations.

The Iceland Met Office latest evidence for the temperatures of Iceland [16, 17] shows that the 20th century warming started in the 1920s and peaked in the early 1940s. This warming was followed by a cooling since the late 1970s then followed by about same warming until the end of the 20th century and the very first years of this century.

From 1798 to 2007, the temperatures in Stykkishólmur increased at an average rate of +0.7°C per century. The warming has been very uneven but dominated by three cold periods and two warm ones, showing significant natural variability about the longer term trend.

The comparison of the temperature in Stykkishólmur, Akureyri and Reykjavík from 1950 to 2007 shows significant consistency and a minimal warming despite the fact that starting year is after the mid-1940s peak.

Similarly, the CLIMAS (Climate information access system) project [18] that was a joint effort from the Max Planck Institute, Nansen Environmental and Remote Sensing Center and St Petersburg University to provide climate data for high latitudes, has data showing similar patterns.

Godthaab Nuuk (Greenland), Jan Mayen (Norway) and Akureyri (Iceland) have an early 1940s spike much larger than anything measured up to the year 2000, when unfortunately the CLIMAS data ends.

Latest Cryosat-2 monitoring of Arctic sea ice thickness since 2010

Tilling and co-authors [3] have published a work showing some signs of recovery in the Arctic ice volume during 2013 (though without too much emphasis and with very weak conclusions). In this work, the satellite altimetry from Cryosat-2 is used for the Arctic ice thickness.

This technique is similarly to that a paper [4] on the Antarctic ice thickness, but which reached diametrically opposite conclusions. That paper [4] is critically reviewed in [5].

While the results of the Antarctic paper [4] were inconsistent with the sea ice extension and the lower troposphere temperature (LTT) results from other studies, the findings of Tilling and co-authors [3] are fully consistent with the other evidence of temperature and sea ice extension.

They present an assessment of the changes in Northern Hemisphere sea ice thickness and volume using five years of CryoSat-2 measurements. Between autumn 2010 and 2012, there was a 14% reduction in Arctic sea ice volume, in keeping with the long-term decline in extent. However, we observe 33% and 25% more ice in autumn 2013 and 2014, respectively, relative to the 2010–2012 seasonal mean, which offset earlier losses. The increase is suggested to have been caused by the retention of thick sea ice northwest of Greenland during 2013 associated with a 5% drop in the number of days on which melting occurred, while the springtime Arctic sea ice volume has remained stable. The sharp increase in sea ice volume after just one cool summer suggests that Arctic sea ice may be more resilient than has been previously thought.

Apart from the consistency with other evidence, what makes the results of [3] trustworthy is the fact that the satellite monitoring of the ice thickness for the Arctic does not need to use a Glacial Isostatic Adjustment (GIA) model, as is needed to compute the thickness of the Antarctic ice in [4], as in the Arctic the sea ice is floating while in the Antarctic the ice shelves are mostly on land, the only exception being West Antarctica.

The computational generalised GIA adjustment is unfortunately an argument often used to reverse the results of non-cooperative missions towards compliance with the Catastrophic Anthropogenic

Global Warming (CAGW) narrative. The satellite altimeter or the satellite gravimeter estimation of sea levels are two examples as exposed in [6]. The otherwise increasing thickness of the Antarctic ice was turned into shrinking in [4], even though a trend much smaller than the accuracy error [5], and only achieved by GIA correction.

For a few years the Arctic sea ice thickness turns out to be relatively stable [3]. The likely recovery of the Arctic ice volume is supported by the Arctic sea ice volume anomaly from PIOMAS [19] which shows some signs of recovery over the last few years.

Satellite Arctic temperatures and sea ice extension since 1979

The relatively stable Arctic sea ice volume and the expanding Antarctic sea ice volume during the very last few years are confirmed by other evidence as shown in Figure 2. The most trustworthy are the NSIDC satellite sea ice extension [7], a parameter that is much easier to measure than the ice thickness or the ice volume, and the UAH satellite lower troposphere temperature [8]. These two parameters have not been subjected to arbitrary corrections and are therefore faithful.

Figure 2 shows signs that the Arctic ice volume is becoming stable and possibly on the way to a partial recovery. The Antarctic sea ice volume is still expanding, with the sea ice extension and the temperature behaving consistently.

Even though a few more years are needed to confirm a trend, it seems very likely that the Arctic sea ice has started to recover as the Arctic temperatures have started to cool down. This is part of the strong quasi-60 years' natural oscillation which is unfortunately often neglected in the interpretation of climate parameters.

Arctic temperature reconstructions since the 1900s

Observed climate does not match the prediction of the models of CAGW. A large range of methods have been devised to tamper with the observations and hide the failure of the models. These are applied to lack of any warming of temperatures, lack of any acceleration of sea level rise, and increase in sea ice. The corrupted information of past records does not help to understand how the latest trends are an indication of an Arctic sea ice recovery.

One of the most unreliable data set is certainly the National Aeronautics and Space Administration Goddard Institute for Space Studies (NASA GISS) reconstruction of global temperatures. To compensate for the lack of warmer temperatures today, the temperatures of the past have been repeatedly and arbitrarily made cooler, up to even more than a century ago. For the Arctic, where the temperatures in the early 1940s were even higher than those of the early 2000s, the manipulation of the records is well exposed by Homewood [9].

It is well documented the Arctic warmed up rapidly to peak in the mid-1940s before temperatures dropped to the mid-1970s to start rising up to today's values. NASA GISS previously admitted (under prior managements, [10, 11, 12 and 13]) the existence of the warm Arctic of the mid-1940s. The cooling-the-past adjustments for the Arctic have been enforced in nearly every current station from Greenland to Siberia, from Iceland to Canada. This adjustment is mainly obtained through the removal of most of the 1940s warm records, and most the lower temperatures during the subsequent cold decades. The latest NASA GISS temperature anomalies [14] tell us in 2015 a completely different story for the Arctic.

Figure 3 presents the Arctic temperatures as proposed in the 2003 study of [11], and as claimed in the latest annual mean Land-Ocean Temperature Index (LOTI) data set of [14] (sources Global Historical Climatology Network (GHCN) v3 1880-06/2015 + Sea Surface Temperature (SST) 1880-06/2015 Extended Reconstructed Sea Surface Temperature (ERSST) v4, base period: 1951-1980, from 64N to 90N).

If we look at the UAH LTT Arctic temperatures of Figure 2, the warming over this century is minimal while the warming of the NASA GISS Arctic LOTI product, Figure 3.b is very significant. Similarly, since 1979, the NASA GISS Arctic LOTI product is warming almost 4 times the UAH

LTT Arctic product. Finally, the 2003 reconstruction, Figure 3.a, has a much higher 1940 peak and much less warming over the past century (about 5 times smaller).

Figure 3 also shows why measuring the Arctic ice or temperatures from 1979, Figure 2, is a trick. The latest 1970s are a valley of the peaks and valleys oscillations. Starting from a valley of a peaks & valleys pattern, the rate is always positive for any time window if not exactly a multiple of the periodicity.

Discussion and Conclusions

The Arctic sea ice data for the past century is at least controversial [15], with past data from many references indicating subsequent phases of shrinking and recovery but a latest popular reconstruction assuming a flat Arctic sea ice all over the first half of the 1900s. The Arctic temperature data for the past century is similarly controversial, as the past data from many references and also the 2003 NASA narrative of [11] clearly conflict with the latest NASA narrative of [14]. A proper understanding of the past pattern is needed to predict the future developments.

A recovery of the Arctic sea ice is consistently shown by data from the National Snow and Ice Data Center (NSIDC) sea ice extension, the University of Alabama at Huntsville (UAH) lower troposphere temperature and now sea ice volume from Cryosat-2 [3] and other monitoring products as the Pan-Arctic Ice Ocean Modelling and Assimilation System (PIOMAS).

The Arctic climate pattern is characterised by higher and lower frequency oscillations, with longer periodicities about 60 years, occurring a longer term trend of moderate warming and shrinking of ices started in the 1800s. The pattern appears to be mostly, or even entirely natural.

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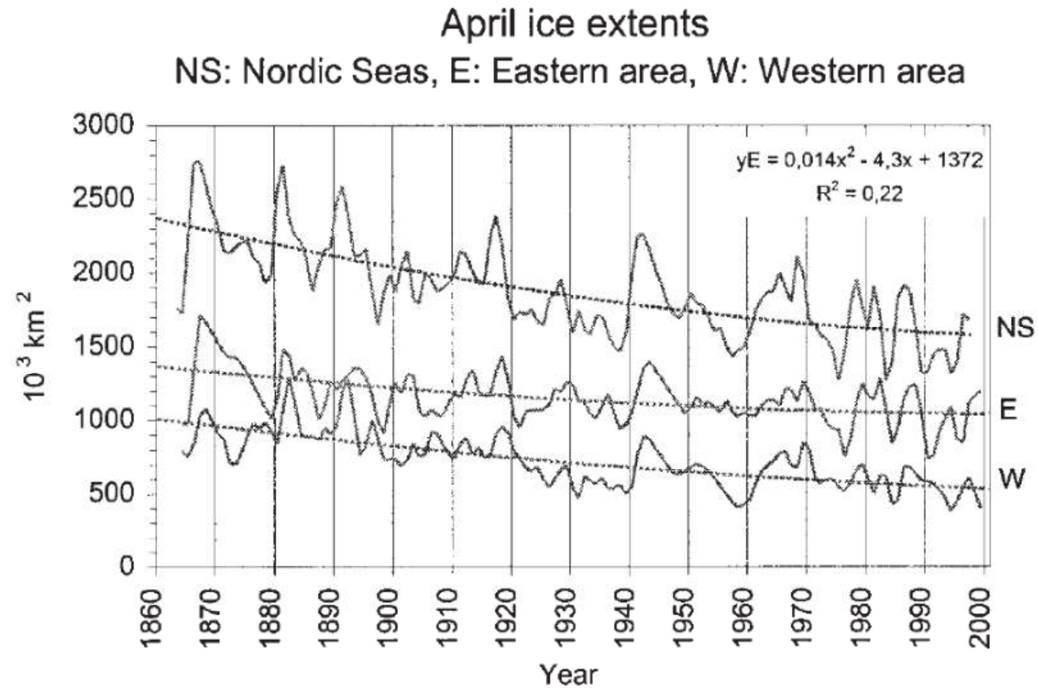


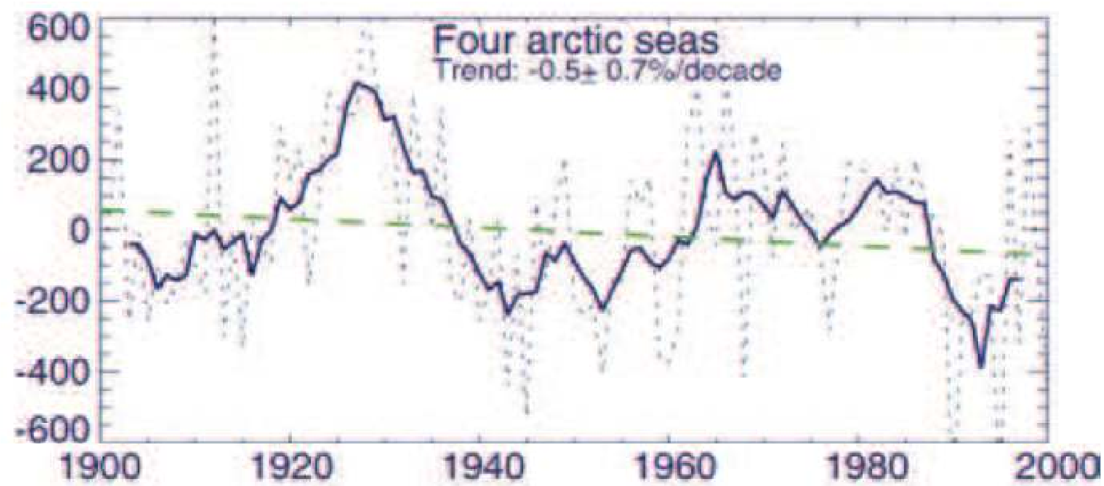


Figure 1 – Top: Time series of the April ice extent (10^3 km^2) in the Nordic Seas (NS), eastern area (E), and western area (W) given by 2-yr running mean and regression lines from [38]. The area here referred to as the Nordic Seas comprises the Greenland, Iceland, Norwegian, Barents, and Western Kara Seas, bounded by 308W, 708E, and 808N. The results show a constant declining trend over 135 years. Bottom: Ice extent in the Kara, Laptev, East Siberian, and Chukchi Seas (10^3 km^2) from [39]. The long term ice extent trends are small but evident over the full century. Trends for shorter records are not indicative of the long-term tendencies due to large-amplitude low-frequency variability. The ice variability in these seas is dominated by a multi-decadal low-frequency oscillation and to a lesser degree by higher-frequency decadal fluctuations. ©American Meteorological Society. Used with permission.

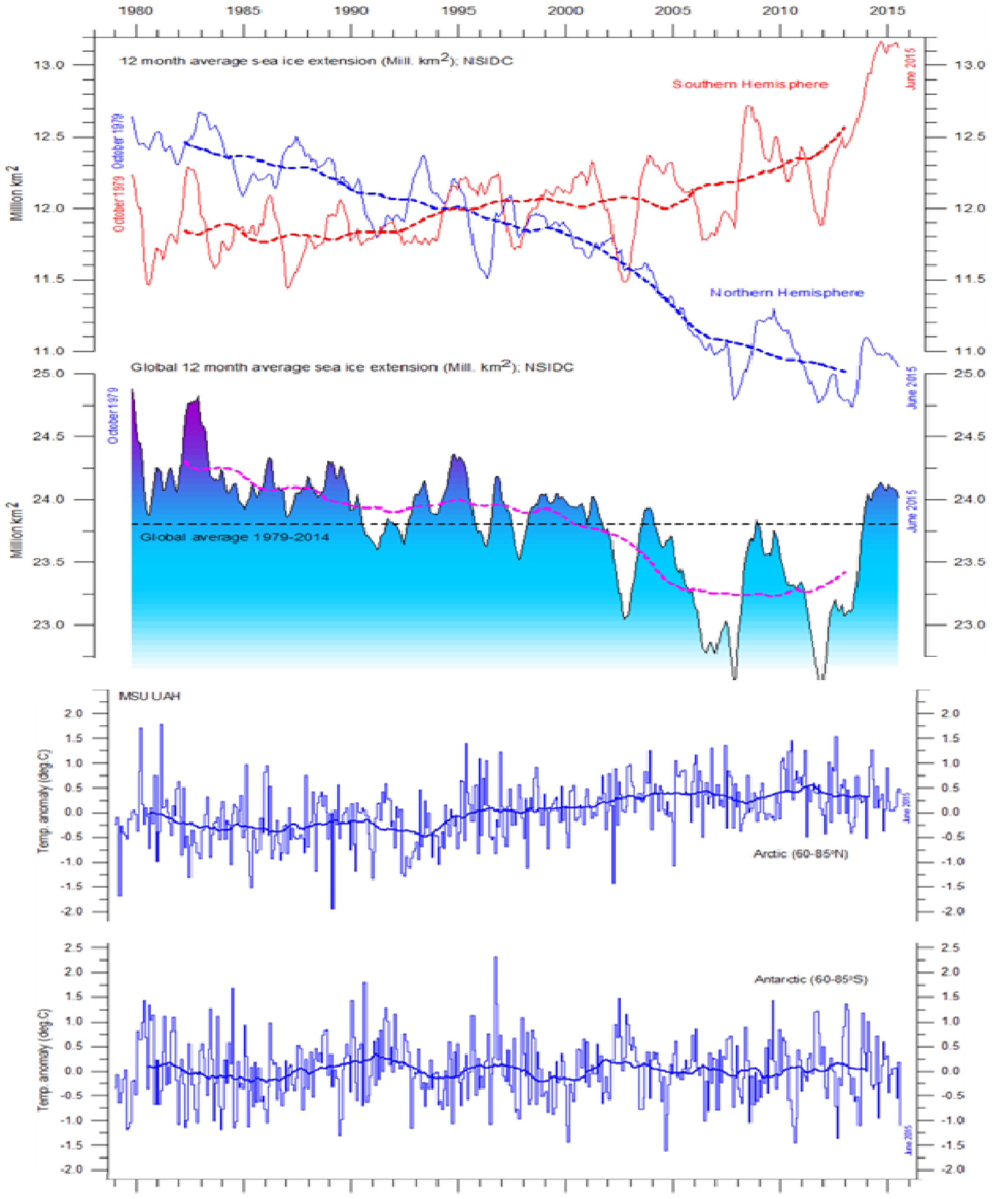
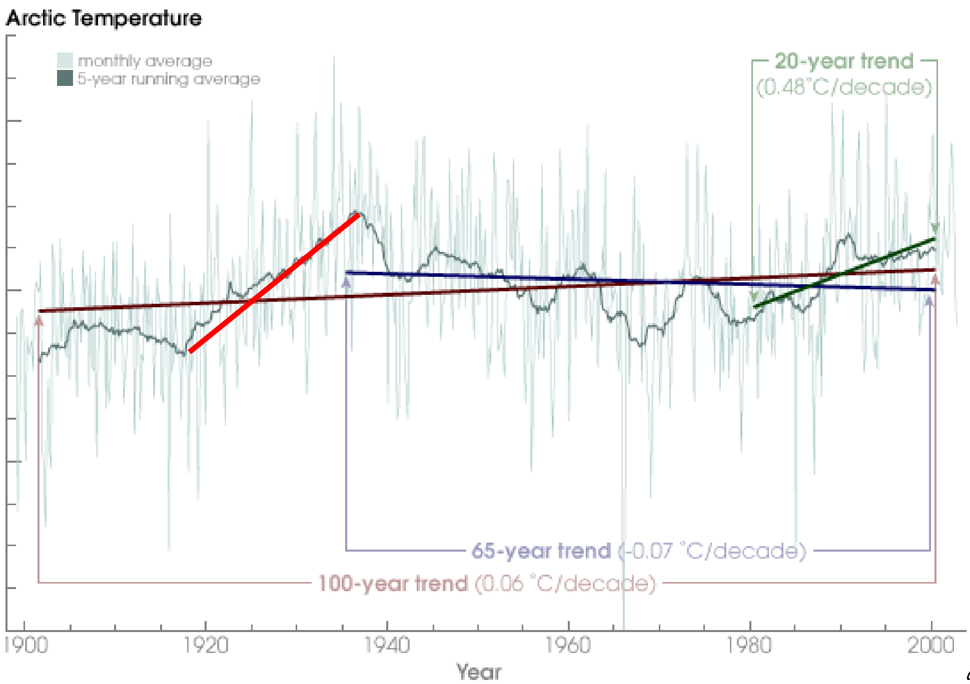


Figure 2 - National Snow and Ice Data Center (NSIDC) sea ice extension for the Arctic and the Antarctic and University of Alabama at Huntsville (UAH) lower troposphere temperatures (LTT) global and for the Arctic and Antarctic regions. The 12 month running average of sea ice extension since 1979 have the stippled lines representing a 61 month average. The thick lines in the lower troposphere temperatures since December 1978 are the simple running 37 month average. The Arctic ice volume is becoming stable and possibly on the way of a partial recovery, and the Antarctic ice volume is expanding, as the sea ice extension and the temperatures are behaving consistently. The images are modified after [20, 21].



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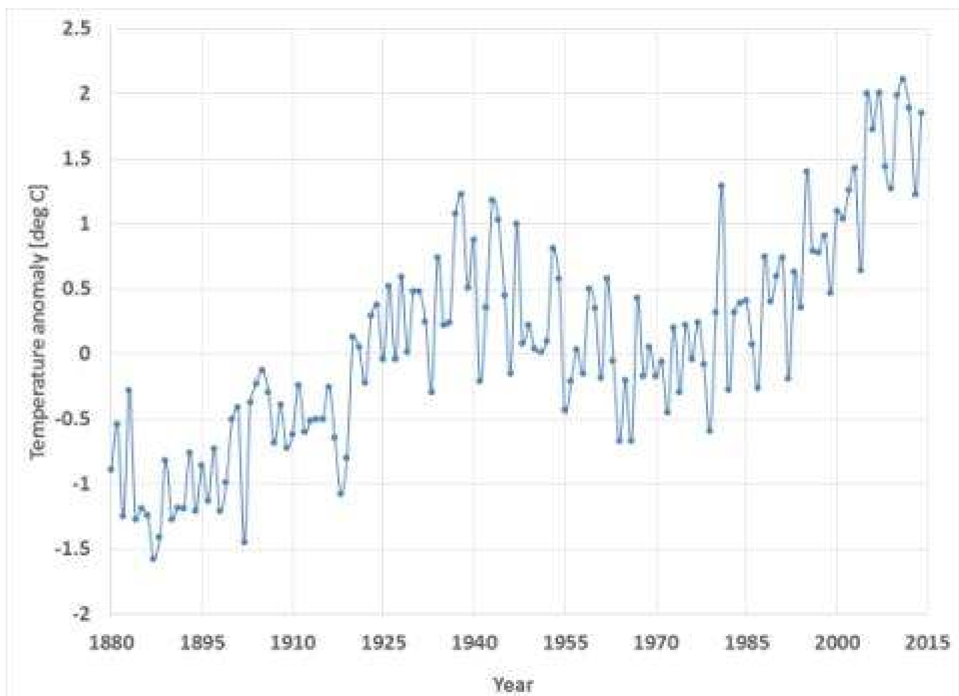

b

Figure 3 –Trickery and Manipulation of data. a) Arctic temperature from [11]. The temperature about 1940 was largest than 2000 temperature. The warming 1920 to 1940 was much stronger than the warming 1980 to 2000. Over one period of an evident quasi 60 years' oscillation there is no warming. Over a century the warming is about 0.6 C, possibly larger than the global average, but far from dramatic, and includes two complete warming phases and only one complete cooling phase. Image modified after [11]. b) Recently manipulated Arctic temperature from [14]. The temperature of 1940 is now smaller than the temperature of 2000 and there is a much stronger warming trend over the past century. By accepting these arbitrary revisions of the past history the opportunity to understand the actual climate patterns reduce drastically.