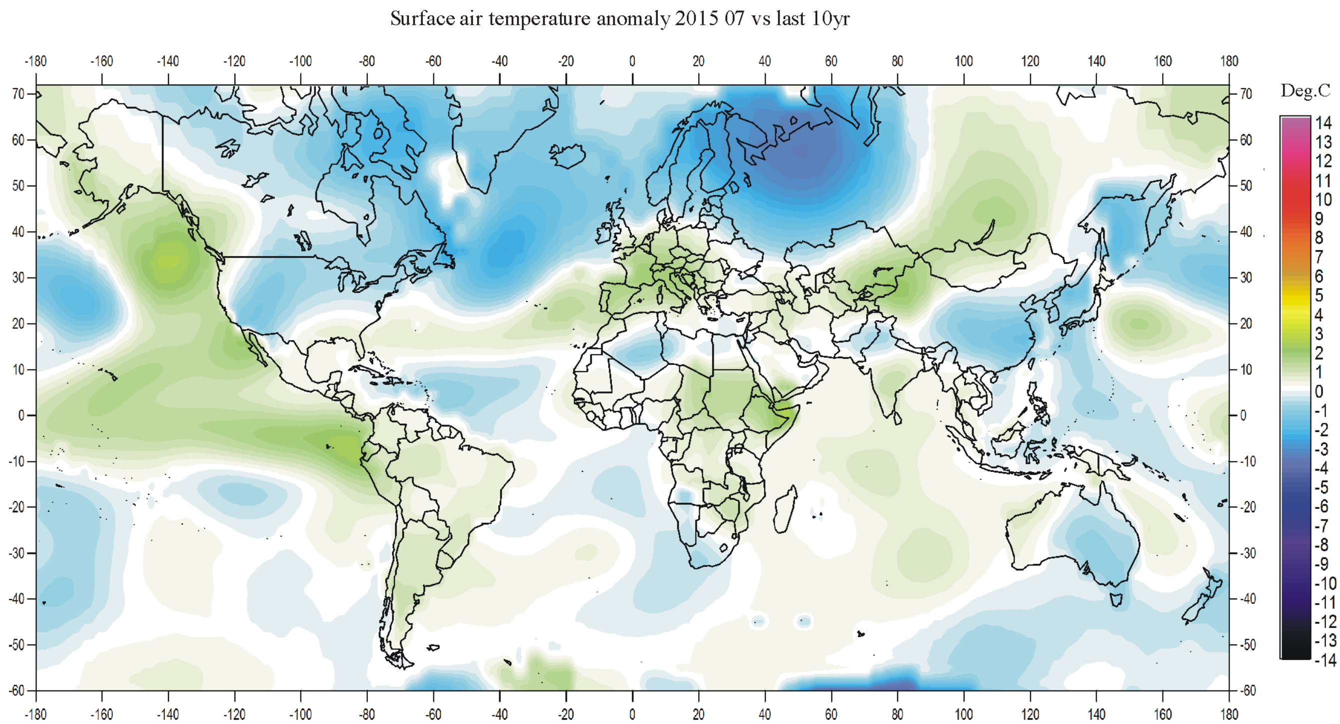
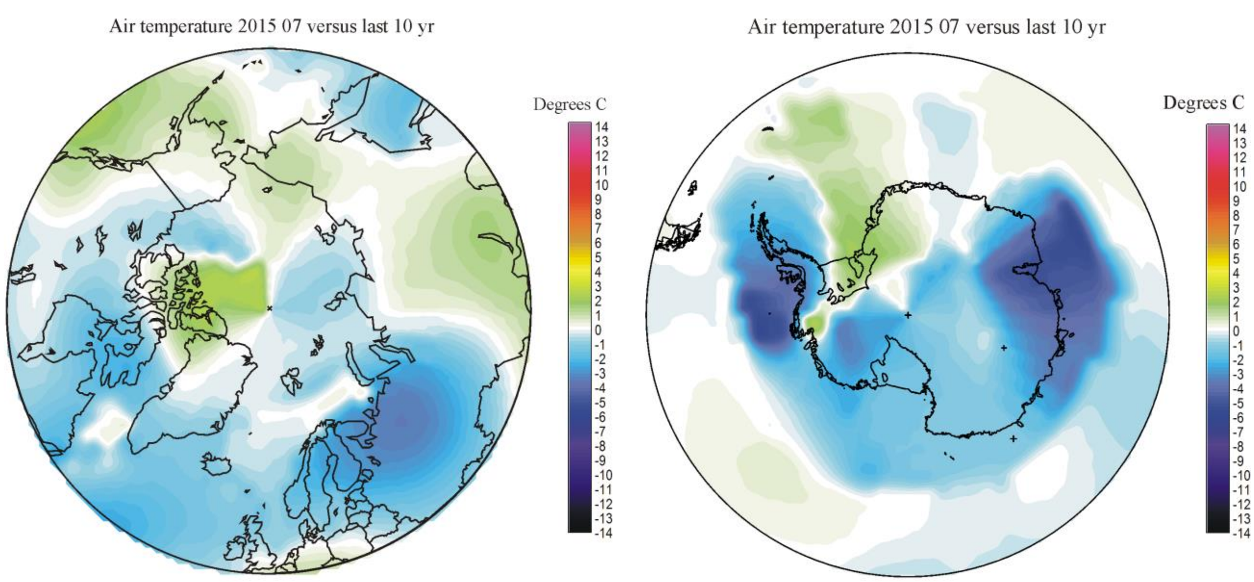
Climate4you update July 2015

Contents:

All diagrams in this newsletter as well as links to the original data are available on www.climate4you.com

July 2015 global surface air temperature overview





July 2015 surface air temperature compared to the average of the last 10 years. Green-yellow-red colours indicate areas with higher temperature than the 10 year average, while blue colours indicate lower than average temperatures. Data source: Goddard Institute for Space Studies (GISS).

Comments to the July 2015 global surface air temperature overview

General: This newsletter contains graphs showing a selection of key meteorological variables for the past month. *All temperatures are given in degrees Celsius*.

In the above maps showing the geographical pattern of surface air temperatures, *the last previous 10 years (2005-2014) are used as reference period*.

The reason for comparing with this recent period instead of the official WMO 'normal' period 1961-1990, is that the latter period is profoundly affected by the cold period 1945-1980. Most comparisons with this time period will obviously appear as warm, and it will be difficult to decide if modern surface air temperatures are increasing or decreasing? Comparing instead with the last previous 10 years overcomes this problem and displays the modern dynamics of ongoing change.

In addition, the GISS temperature data used for preparing the above diagrams display distinct temporal instability for data before the turn of the century (see p. 7). Any comparison with the WMO 'normal' period 1961-1990 is therefore influenced by ongoing monthly changes of the so-called 'normal' period, and is not suited as reference. Comparing with the last previous 10 years is more useful.

In many diagrams shown in this newsletter *the thin line represents the monthly global average value*, and *the thick line indicate a simple running average*, in most cases a simple moving 37-month average, nearly corresponding to a three-year average. The 37-month average is calculated from values covering a range from 18 month before to 18 months after, with equal weight for every month.

The year 1979 has been chosen as starting point in many diagrams, as this roughly corresponds to both the beginning of satellite observations and the onset of the late 20th century warming period. However, several of the data series have a much longer record length, which may be inspected in greater detail on www.Climate4you.com.

July 2015 global surface air temperatures

General: The average global air temperature was close to the average for the last ten years.

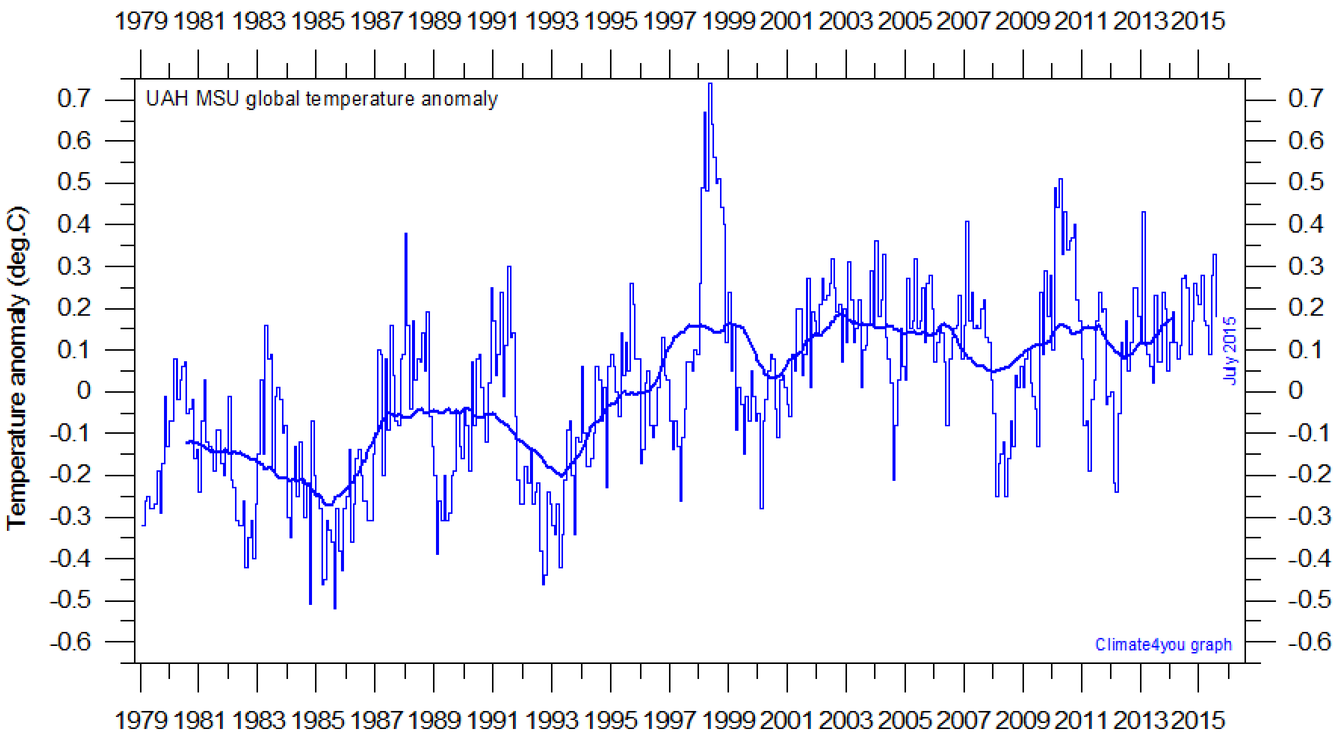
The Northern Hemisphere was characterised by regional air temperature contrasts, especially in the Northern Hemisphere, as usual. Much of North America, the North Atlantic and Europe with western Russia had below average temperatures. Siberia and Alaska had had temperatures near or above average. Most of the Arctic had below average temperatures.

Near the Equator temperatures were above average in most of the Pacific and the Indian Ocean. The western Pacific and the Atlantic sector had below average temperature. Otherwise, this region generally had temperatures near the 1998-2006 average.

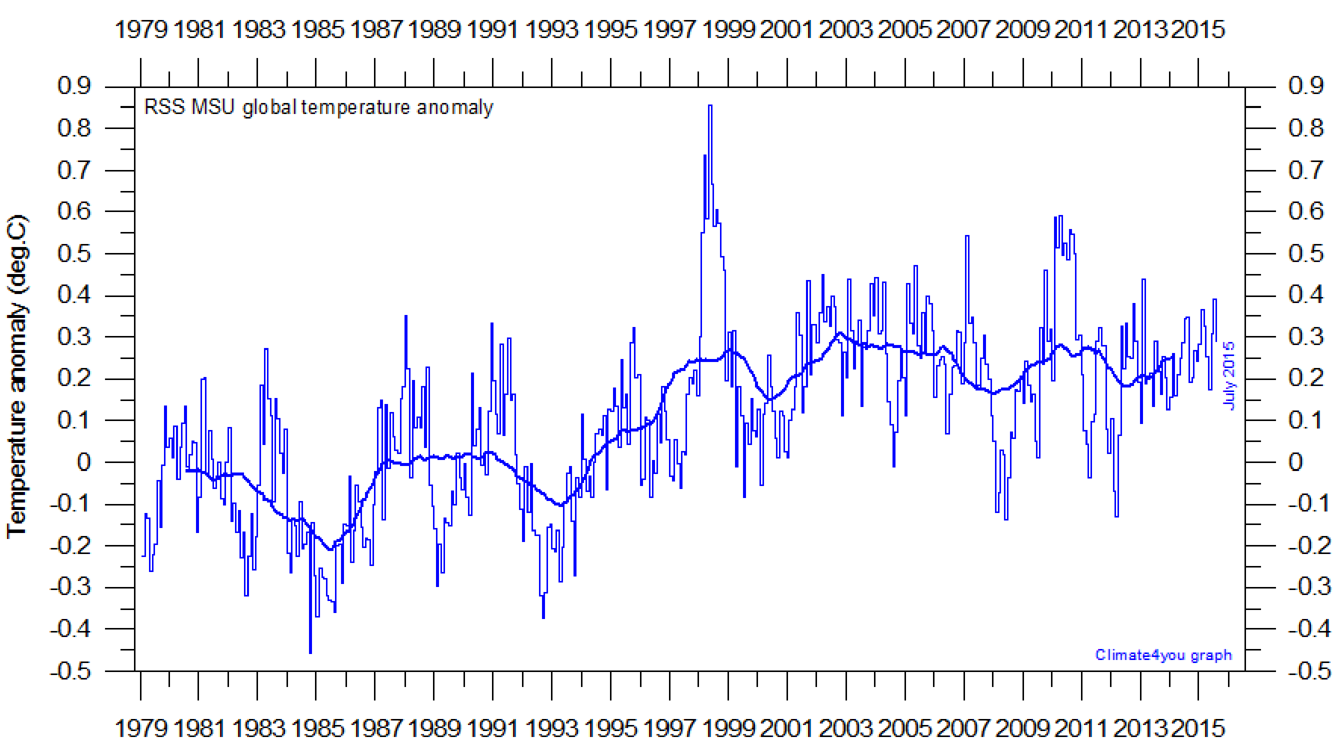
The Southern Hemisphere temperatures were mainly near average 2005-2014 conditions. Most of South America and parts of Africa had above average temperatures, while most of Australia had below average temperature. Most of the Antarctic continent had below average temperatures.

Note on change made June 18, 2015: Please note that NCDC has introduced a number of rather large administrative changes to their sea surface temperature record (p. 12). The overall result is to produce a record giving the impression of a continuous temperature increase, also in the 21st century. As the oceans cover about 71% of the entire surface of planet Earth, the effect of this administrative change is clearly seen in the NCDC record for global surface air temperature (p. 6).

Temperature quality class 1: Lower troposphere temperature from satellites, updated to July 2015

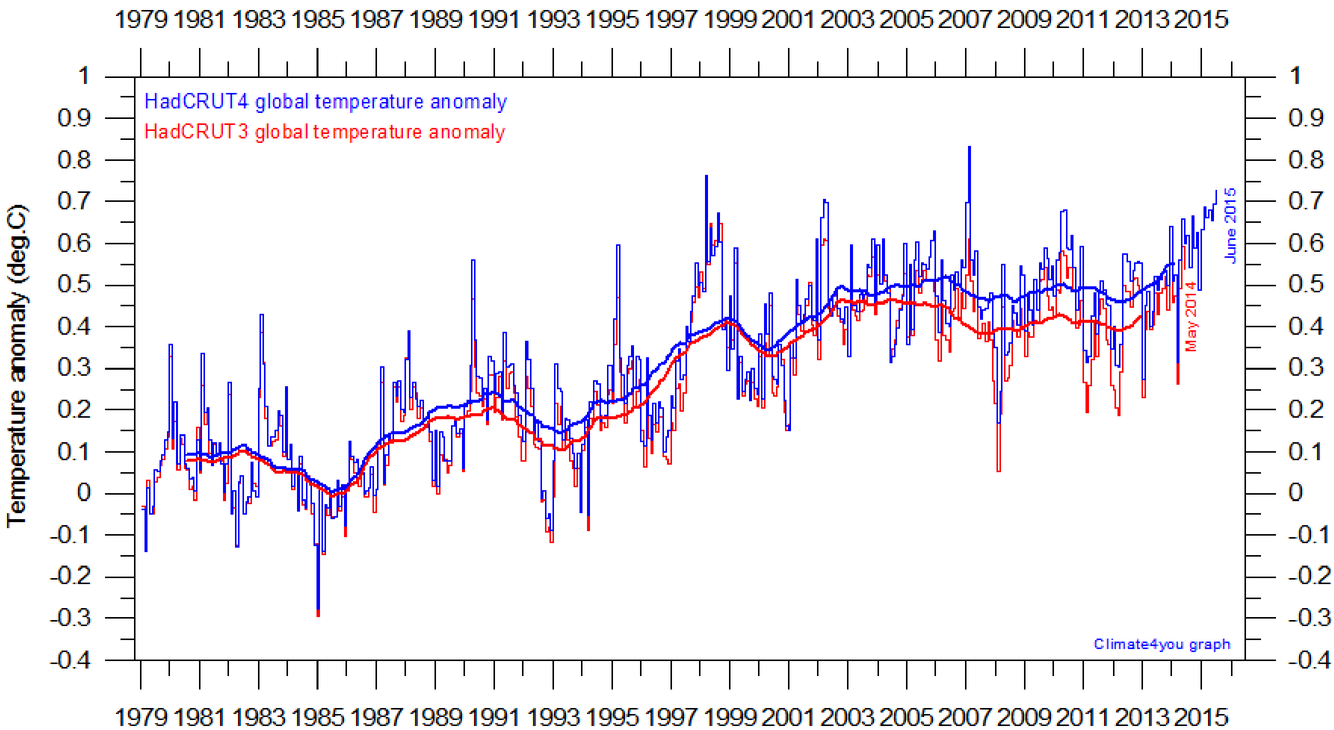


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37-month average.



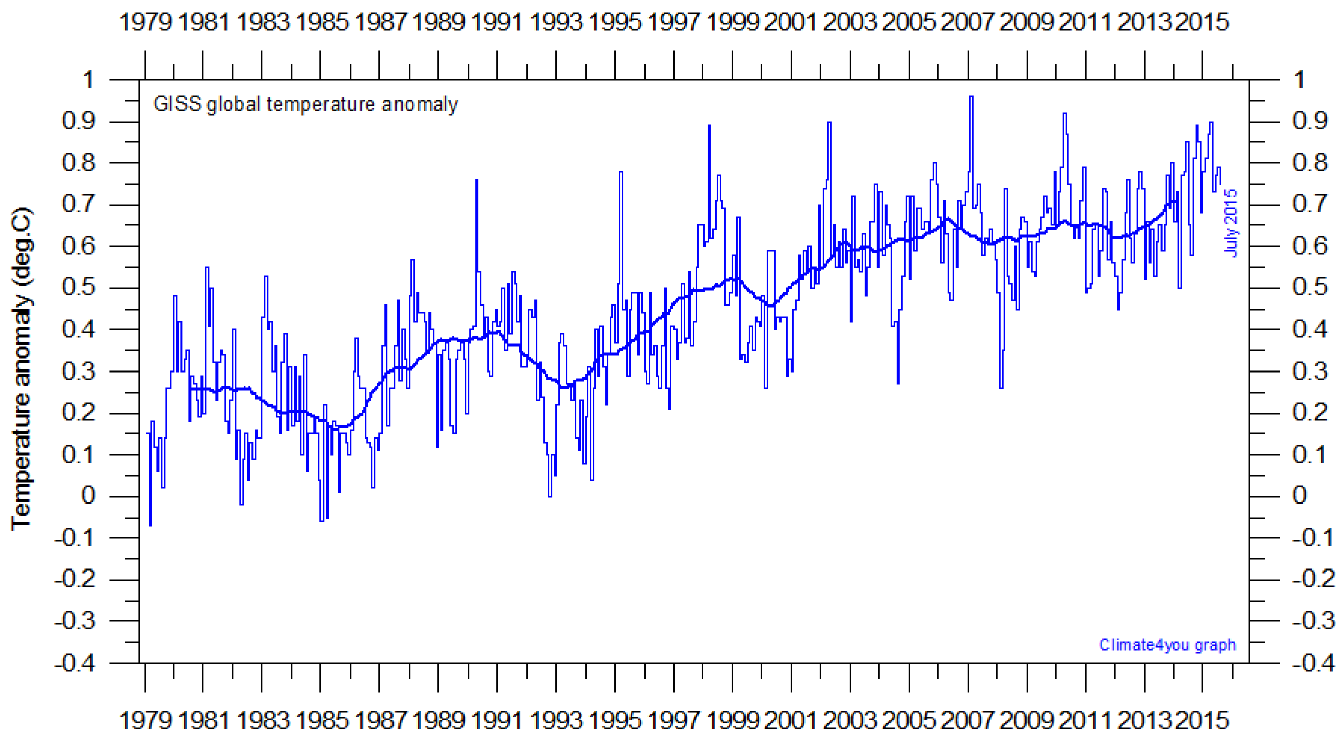
Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37-month average.

Temperature quality class 2: HadCRUT global surface air temperature, updated to June 2015

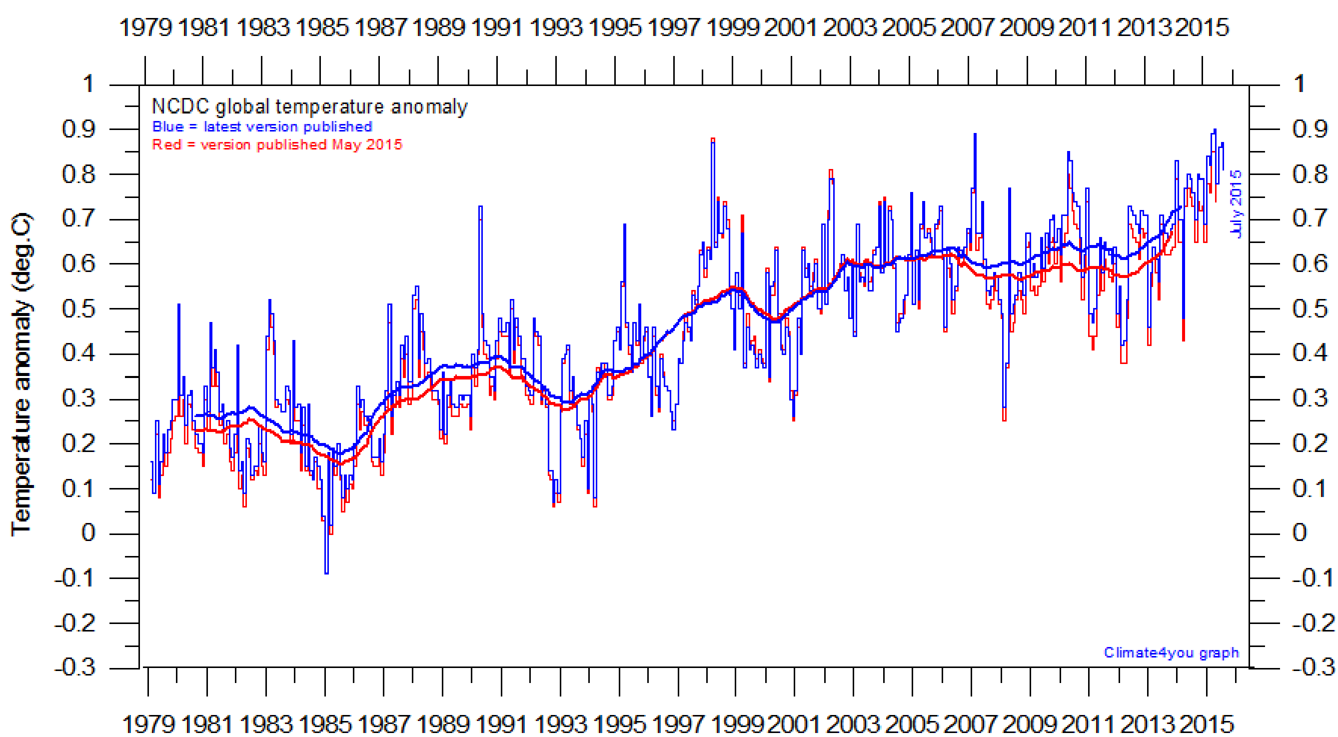


Global monthly average surface air temperature (thin line) since 1979 according to according to the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK. The thick line is the simple running 37-month average. Version HadCRUT4 (blue) is now replacing HadCRUT3 (red). Please note that this diagram is not yet updated beyond June 2015.

Temperature quality class 3: GISS and NCDC global surface air temperature, updated to July 2015



Global monthly average surface air temperature (thin line) since 1979 according to according to the Goddard Institute for Space Studies (GISS), at Columbia University, New York City, USA. The thick line is the simple running 37-month average.



Global monthly average surface air temperature since 1979 according to according to the National Climatic Data Center (NCDC), USA. The thick line is the simple running 37-month average.

June 18, 2015: *NCDC has introduced a number of rather large administrative changes to their sea surface temperature record (p. 12). The overall result is to produce a record giving the impression of a continuous temperature increase, also in the 21st century. As the oceans cover about 71% of the entire surface of planet Earth, the effect of this administrative change is clearly seen in the NCDC record for global surface air temperature above.*

A note on data record stability and -quality:

All temperature diagrams shown above have 1979 as starting year. This roughly marks the beginning of the recent period of global warming, after termination of the previous period of global cooling from about 1940. In addition, the year 1979 also represents the starting date for the satellite-based global temperature estimates (UAH and RSS). For the three surface air temperature records (HadCRUT, NCDC and GISS), they start much earlier (in 1850 and 1880), as can be inspected on www.climate4you.com.

For all three surface air temperature records, but especially NCDC and GISS, administrative changes to anomaly values are quite often introduced, even for observations many years back in time. Some changes may be due to the delayed addition of new station data, while others probably have their origin in a change of technique to calculate average values. It is clearly impossible to evaluate the validity of such administrative changes for the outside user of these records; it is only possible to note that such changes appear very often (se example diagram next page). In addition, the three surface records represent a blend of sea surface data collected moving ships or by other means, plus data from land stations of partly unknown quality and unknown degree of representativeness for their region. Many of the land stations have also moved geographically during their existence, and their instrumentation changed.

The satellite temperature records also have their problems, but these are generally of a more technical nature and therefore correctable. In addition, the temperature sampling by satellites is more regular and complete on a global basis than that represented by the surface records.

All interested in climate science should gratefully acknowledge the big efforts put into maintaining all temperature databases referred to in the present newsletter. At the same time, however, it is also realistic to understand that all temperature records cannot be of equal scientific quality. The simple fact that they to some degree differ clearly signals that they are not all correct.

On this background, and for practical reasons, Climate4you has decided to operate with three quality classes (1-3) for global temperature records, with 1 representing the highest quality level:

Quality class 1: The satellite records (UAH and RSS).

Quality class 2: The HadCRUT surface record.

Quality class 3: The NCDC and GISS surface records.

The main reasons for discriminating between the three surface records are the following:

1) While both NCDC and GISS often experience quite large administrative changes, and therefore essentially are unstable temperature records, the changes introduced to HadCRUT are fewer and smaller. For obvious reasons, as the past do not change, an unstable record cannot describe the past correctly all the time.

2) A comparison with the superior Argo float sea surface temperature record shows that while HadCRUT uses a sea surface record (HadSST3) nicely in concert with the Argo record, this is apparently not the case for the other two records, see, e.g., the diagram on page 14.

You can find more on the issue of lack of temporal stability on www.climate4you.com (go to: *Global Temperature*, followed by *Temporal Stability*).

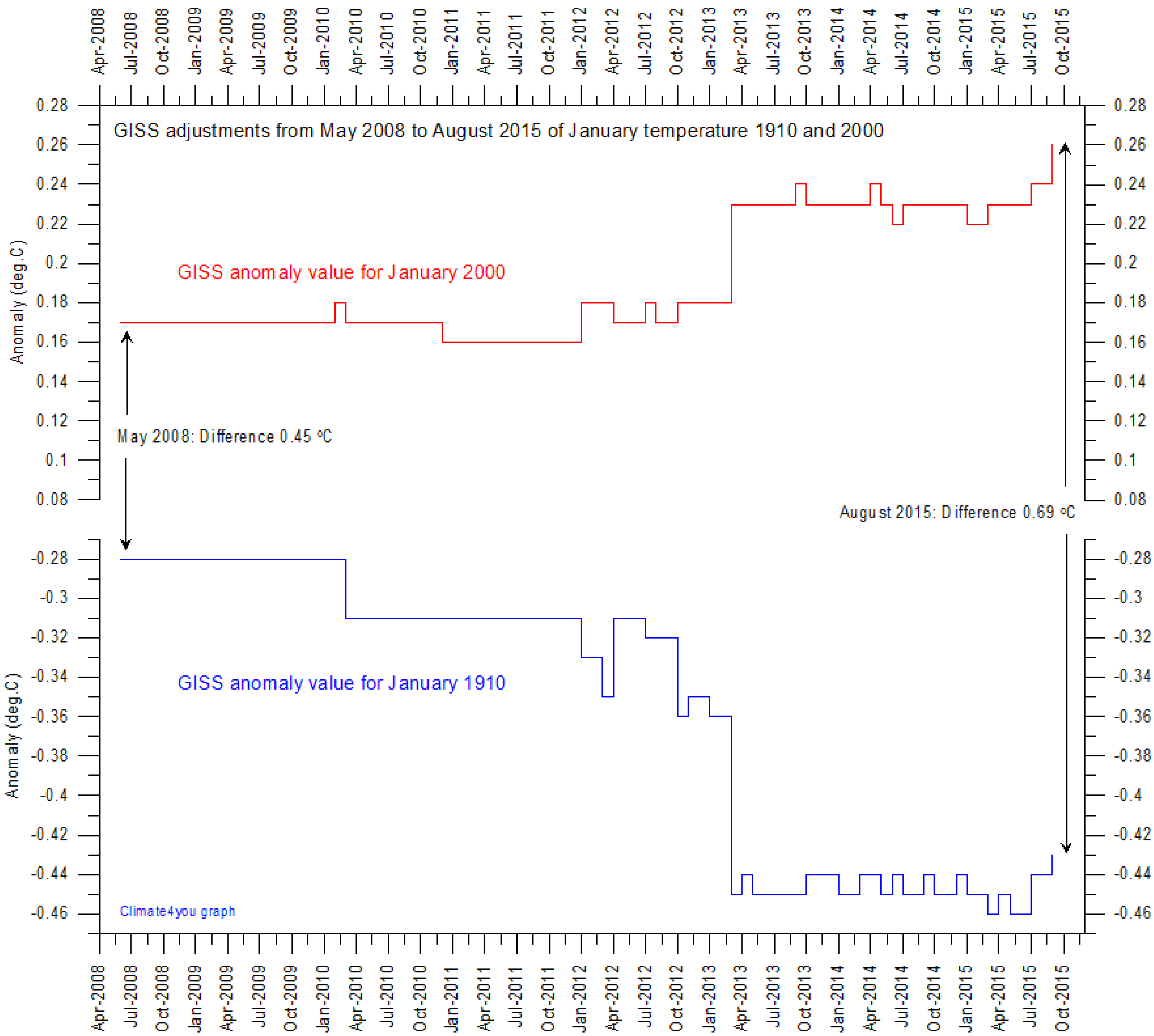


Diagram showing the adjustment made since May 2008 by the [Goddard Institute for Space Studies](#) (GISS), USA, in anomaly values for the months January 1910 and January 2000.

Note: The administrative upsurge of the temperature increase between January 1915 and January 2000 has grown from 0.45 (reported May 2008) to 0.69°C (reported August 2015), representing an about 55% administrative temperature increase over this period, meaning that more than half of the apparent temperature increase from January 1910 to January 2000 is due to administrative changes of the original data since May 2008.

Global air temperature linear trends updated to June 2015

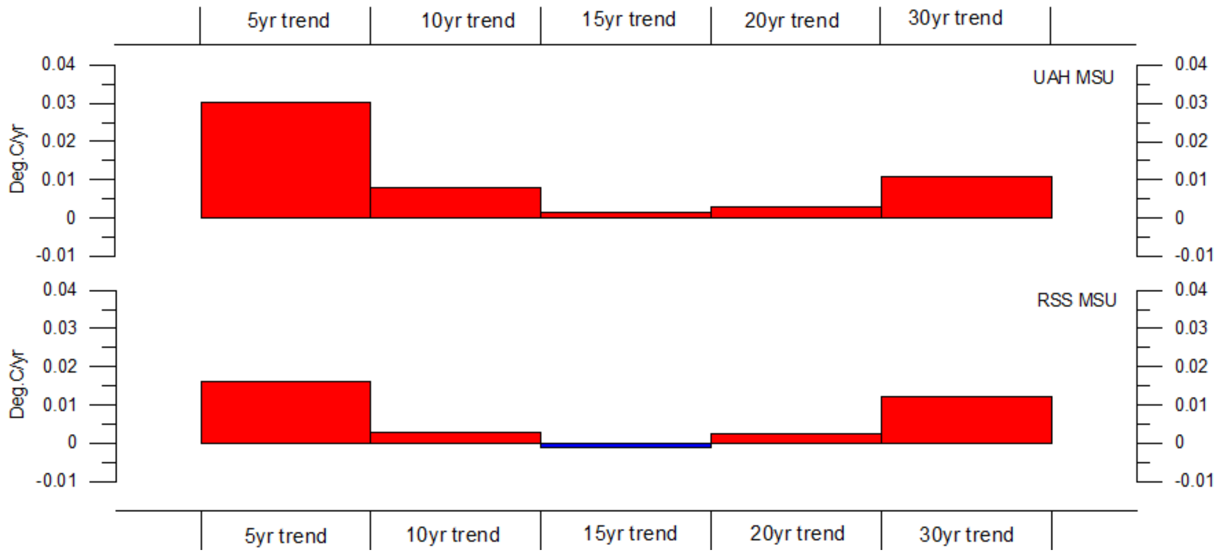


Diagram showing the latest 5, 10, 20 and 30 yr linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for two satellite-based temperature estimates (UAH MSU and RSS MSU).

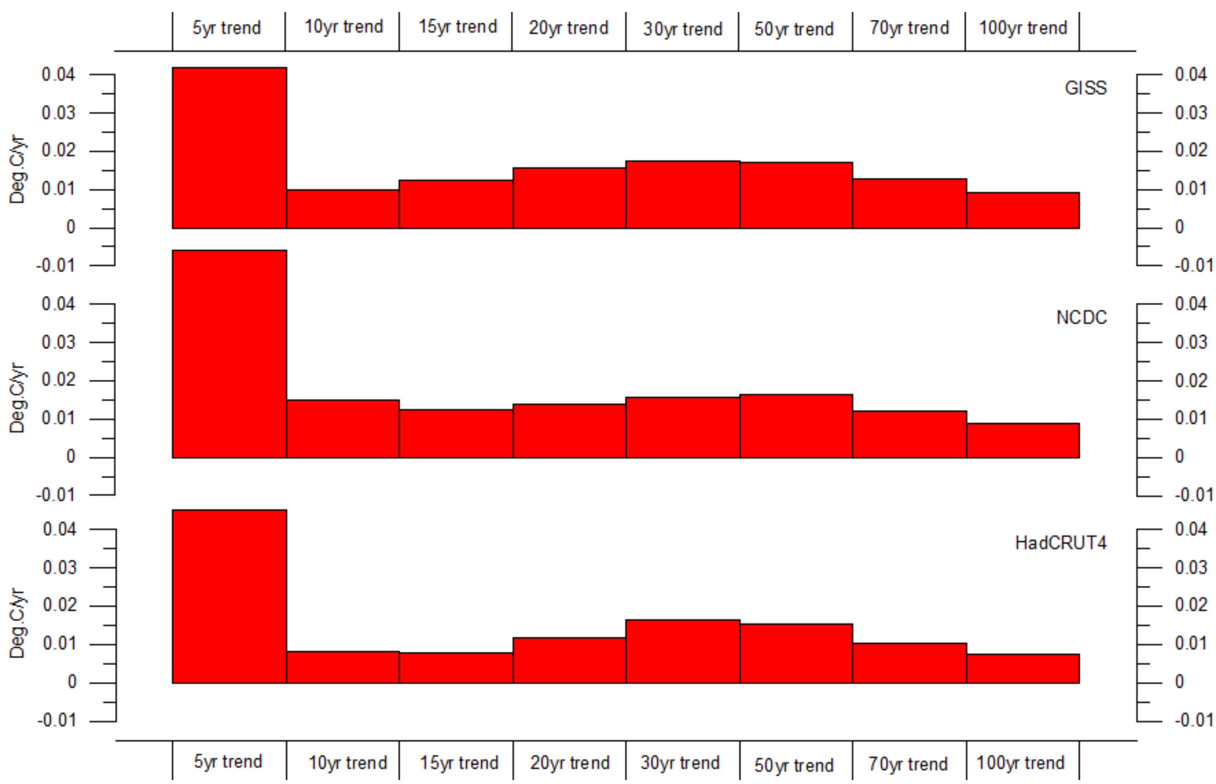
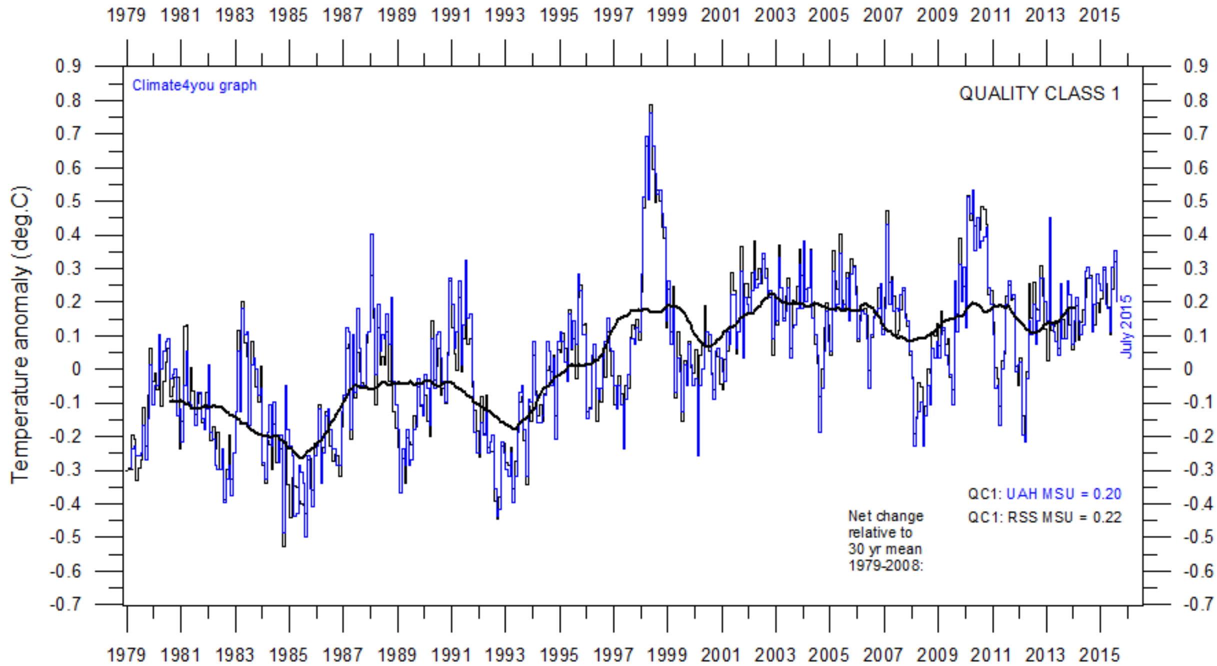
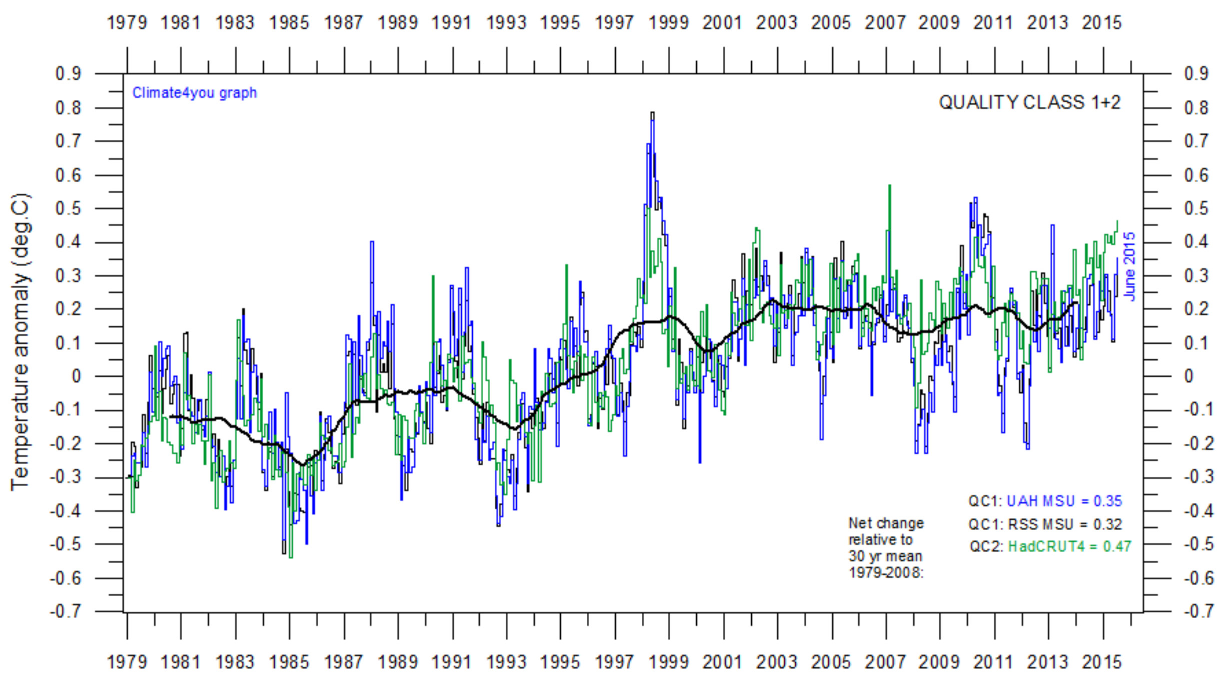


Diagram showing the latest 5, 10, 20, 30, 50, 70 and 100 year linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for three surface-based temperature estimates (GISS, NCDC and HadCRUT4).

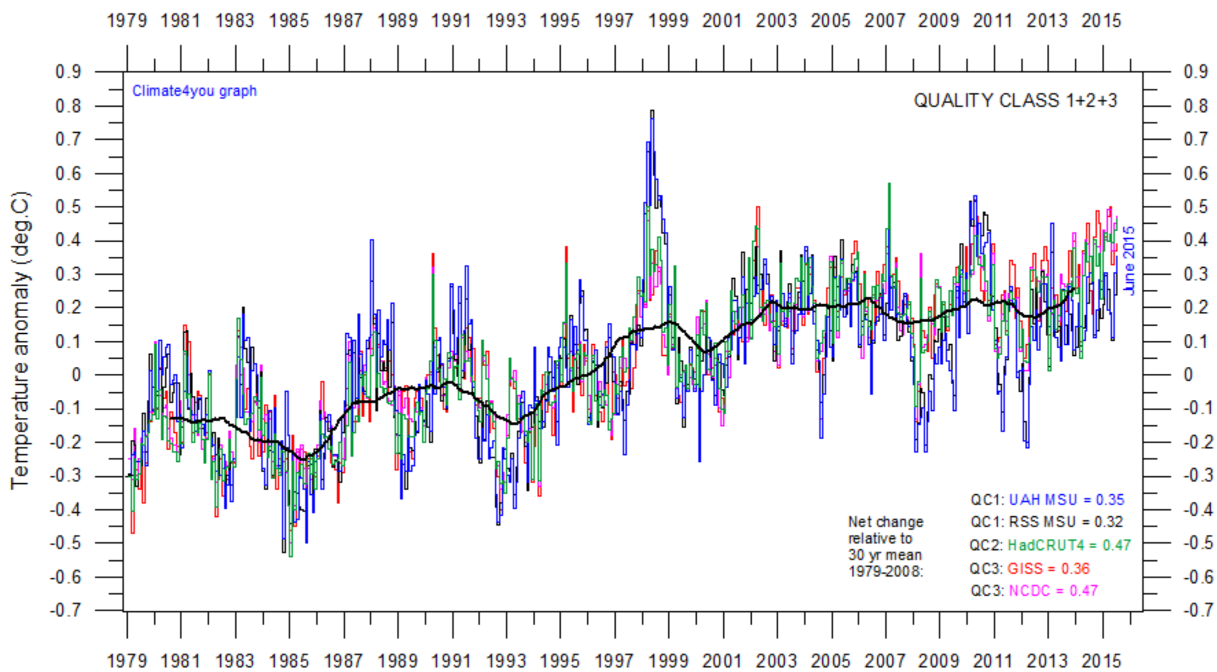
All in one, Quality Class 1, 2 and 3; updated to June 2015



Superimposed plot of Quality Class 1 (UAH and RSS) global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (30 years) from January 1979 to December 2008. The heavy black line represents the simple running 37 month (c. 3 year) mean of the average of all five temperature records. The numbers shown in the lower right corner represent the temperature anomaly relative to the individual 1979-1988 averages.



Superimposed plot of Quality Class 1 and 2 (UAH, RSS and HadCRUT4) global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (30 years) from January 1979 to December 2008. The heavy black line represents the simple running 37 month (c. 3 year) mean of the average of all five temperature records. The numbers shown in the lower right corner represent the temperature anomaly relative to the individual 1979-1988 averages.



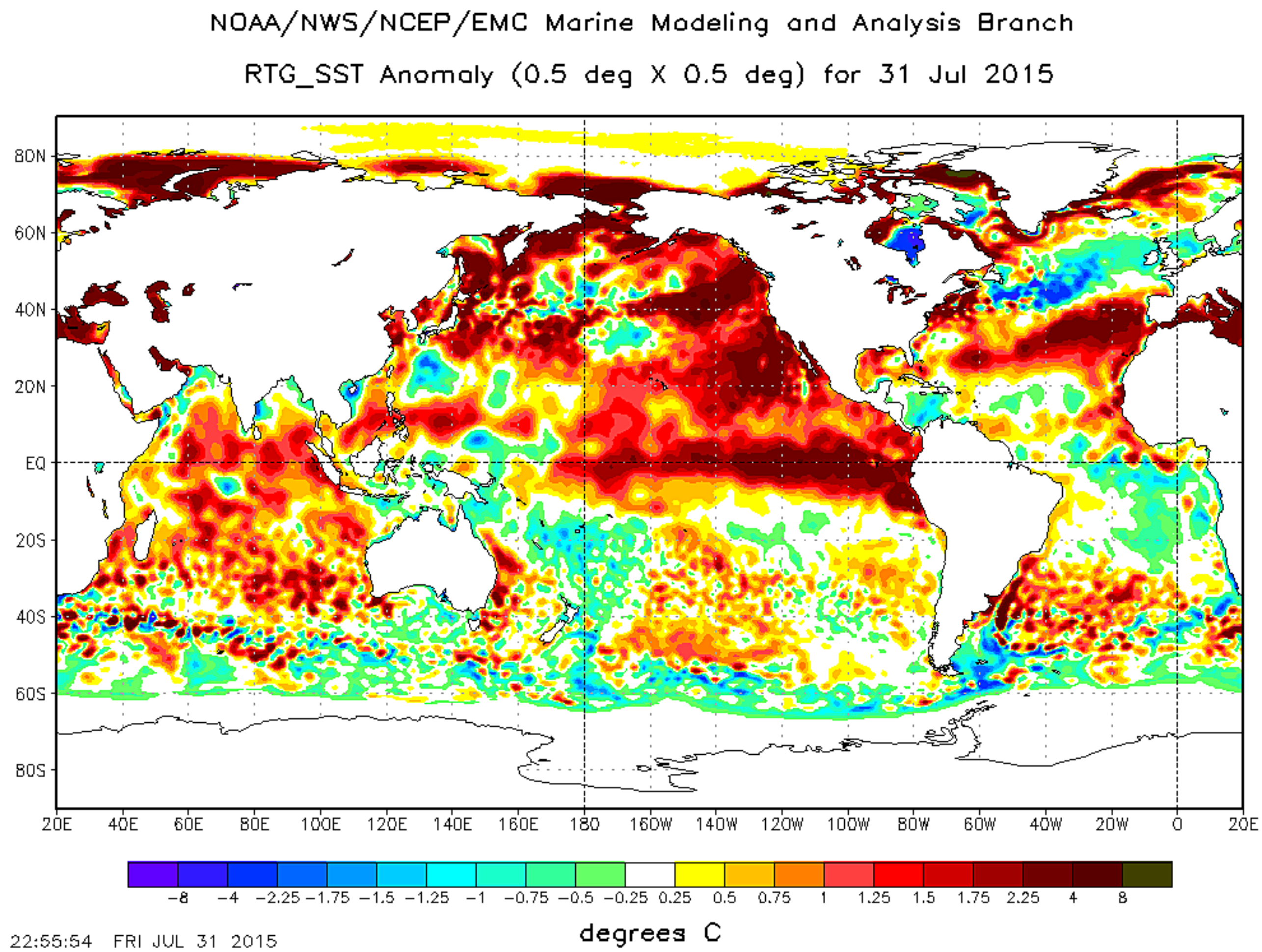
Superimposed plot of Quality Class 1, 2 and 3 global monthly temperature estimates (UAH, RSS, HadCRUT4, GISS and NCDC). As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (30 years) from January 1979 to December 2008. The heavy black line represents the simple running 37 month (c. 3 year) mean of the average of all five temperature records. The numbers shown in the lower right corner represent the temperature anomaly relative to the individual 1979-1988 averages.

Please see notes on page 7 relating to the above three quality classes.

It should be kept in mind that satellite- and surface-based temperature estimates are derived from different types of measurements, and that comparing them directly as done in the diagram above therefore may be somewhat problematical. However, as both types of estimate often are discussed together, the above diagram may nevertheless be of some interest. In fact, the different types of temperature estimates appear to agree quite well as to the overall temperature variations on a 2-3 year scale, although on a shorter time scale there are often considerable differences between the individual records.

All five global temperature estimates presently show an overall stagnation, at least since 2002. There has been no increase in global air temperature since 1998, which however was affected by the oceanographic El Niño event. This stagnation does not exclude the possibility that global temperatures will begin to increase again later. On the other hand, it also remain a possibility that Earth just now is passing a temperature peak, and that global temperatures will begin to decrease during the coming years. Time will show which of these two possibilities is correct.

Global sea surface temperature, updated to July 2015



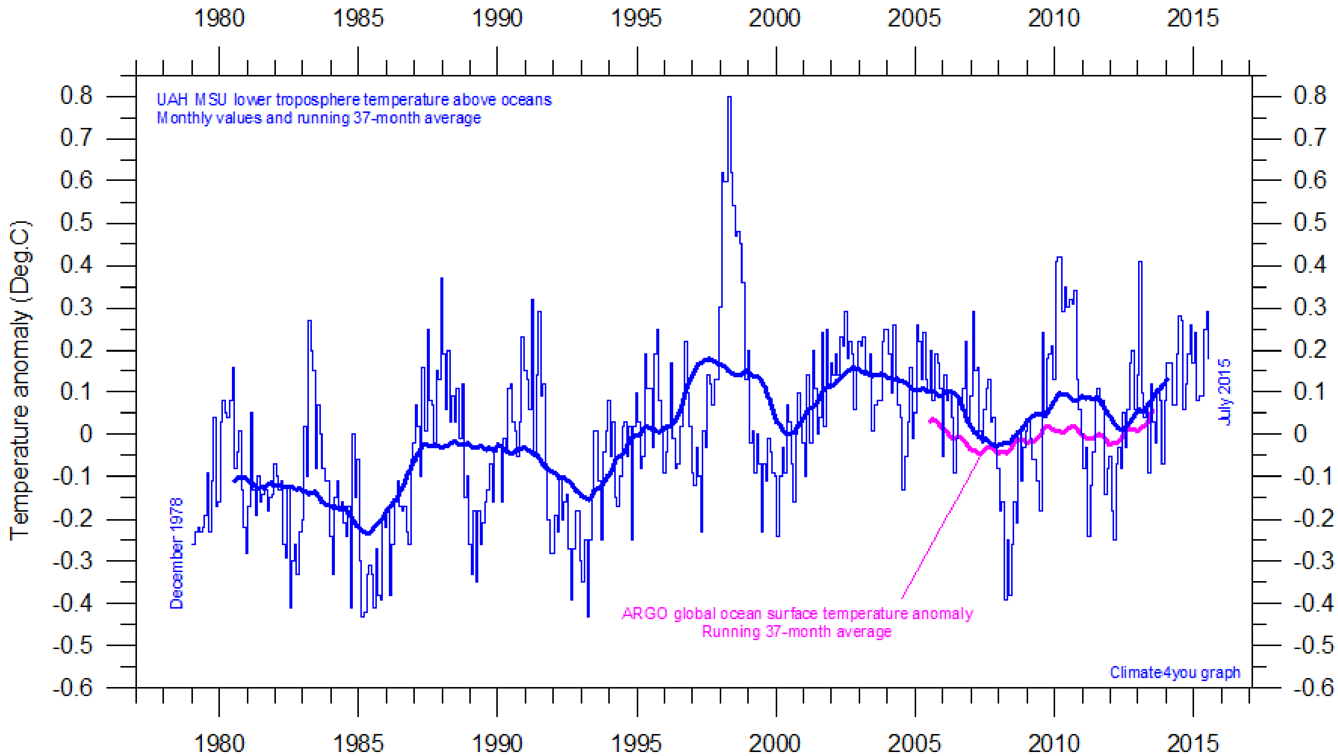
Sea surface temperature anomaly on 31 July 2015. Map source: National Centers for Environmental Prediction (NOAA).

Because of the large surface areas near Equator, the temperature of the surface water in these regions is especially important for the global atmospheric temperature (p.4-6).

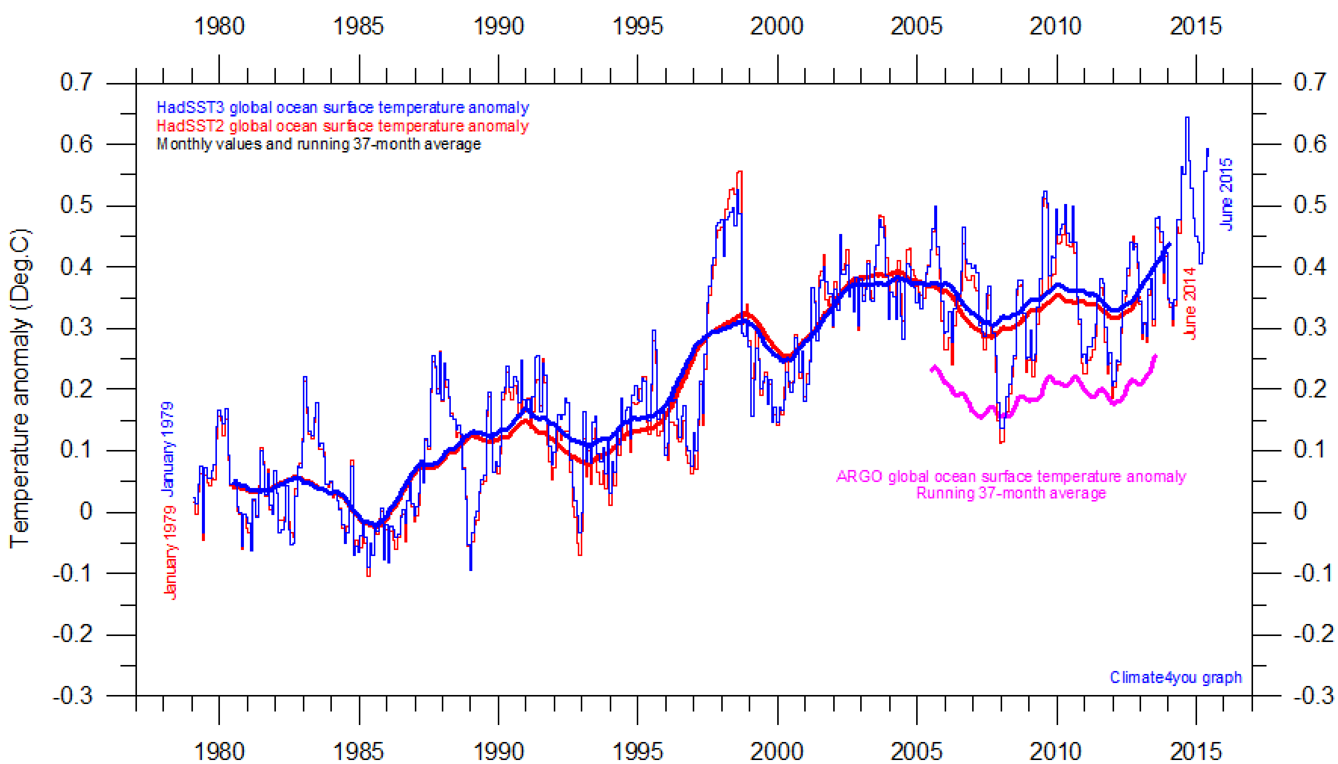
Relatively warm water is dominating the oceans near the Equator, and is influencing global air temperatures now and in the months to come.

The significance of any such short-term cooling or warming reflected in air temperatures should not be over stated. Whenever Earth experiences cold La Niña or warm El Niño episodes (Pacific Ocean) major heat exchanges takes place between the Pacific Ocean and the atmosphere above, eventually showing up in estimates of the global air temperature.

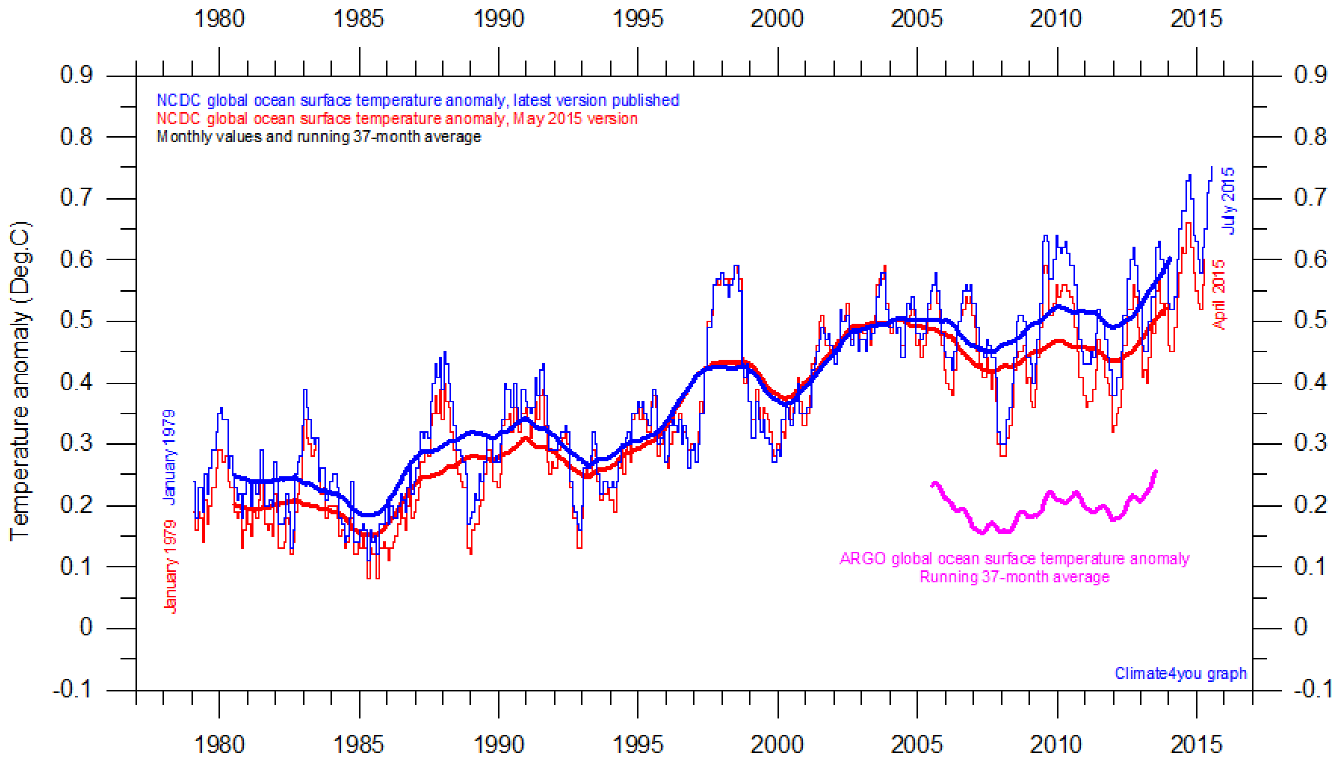
However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, global net changes can be small and such heat exchanges may mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when seen over a number of years.



Global monthly average lower troposphere temperature over oceans (thin line) since 1979 according to [University of Alabama](#) at Huntsville, USA. The thick line is the simple running 37 month average. Insert: Argo global ocean temperature anomaly from floats.



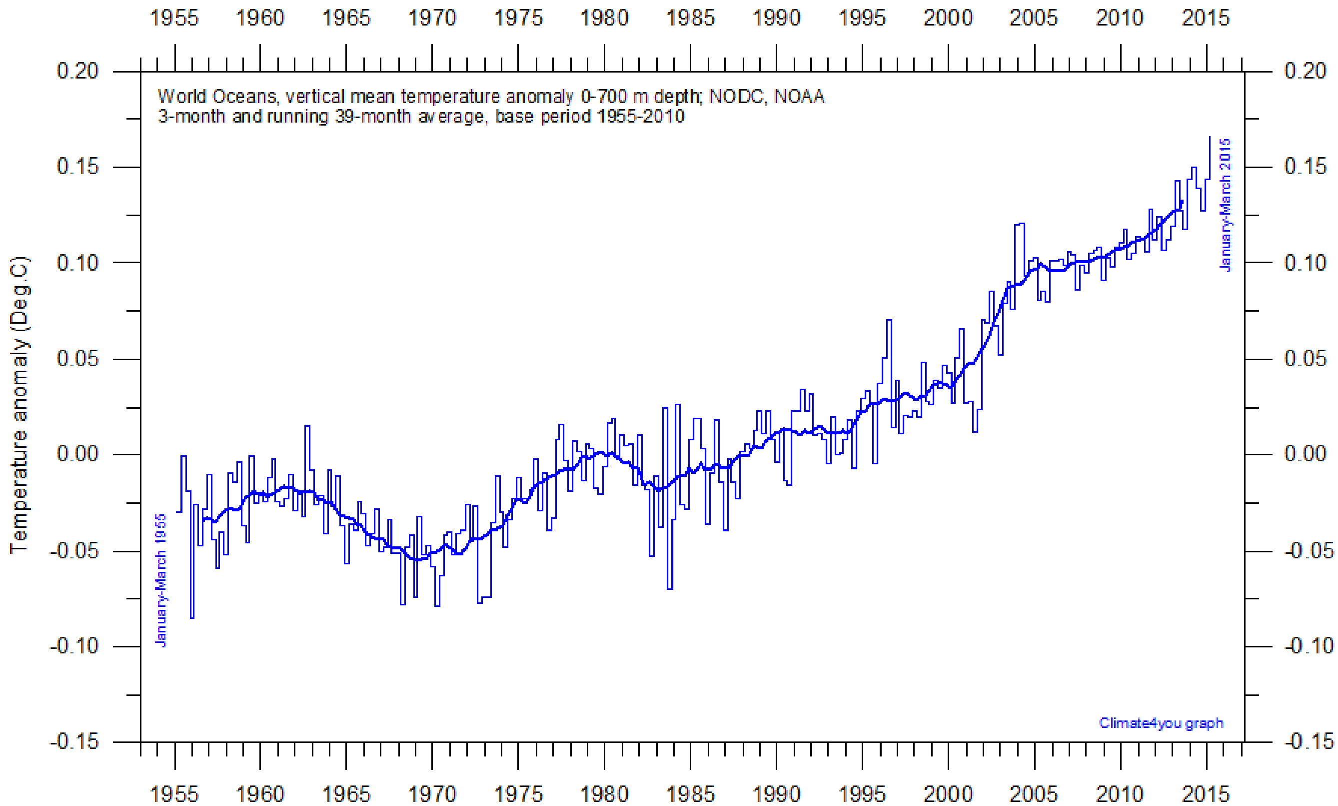
Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit](#) ([CRU](#)), UK. Base period: 1961-1990. The thick line is the simple running 37-month average. Insert: Argo global ocean temperature anomaly from floats.



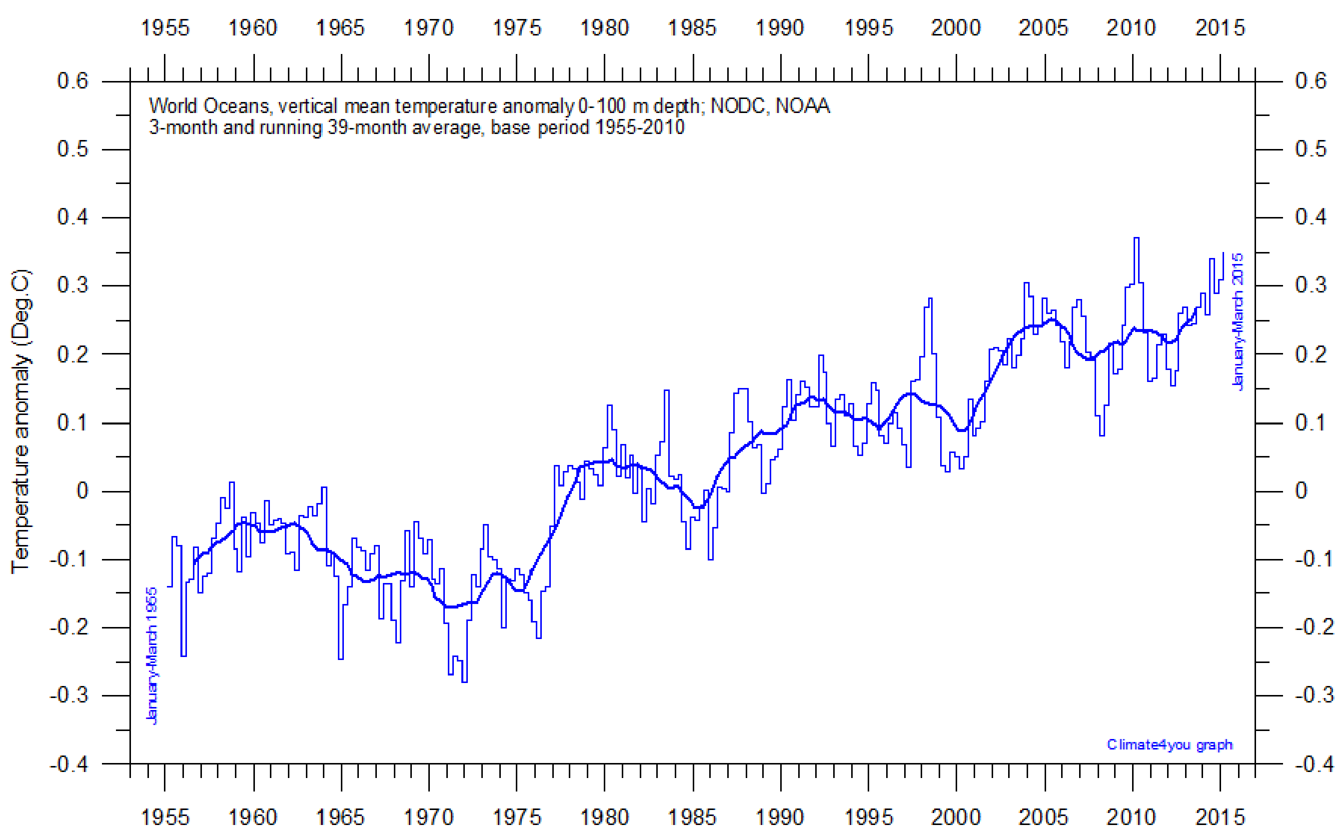
Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center](#) (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37-month average. Insert: Argo global ocean temperature anomaly from floats.

June 18, 2015: *NCDC has introduced a number of rather large administrative changes to their sea surface temperature record. The overall result is to produce a record giving the impression of a continuous temperature increase, also in the 21st century. As the oceans cover about 71% of the entire surface of planet Earth, the effect of this administrative change is clearly seen in the NCDC record for global surface air temperature (p. 6).*

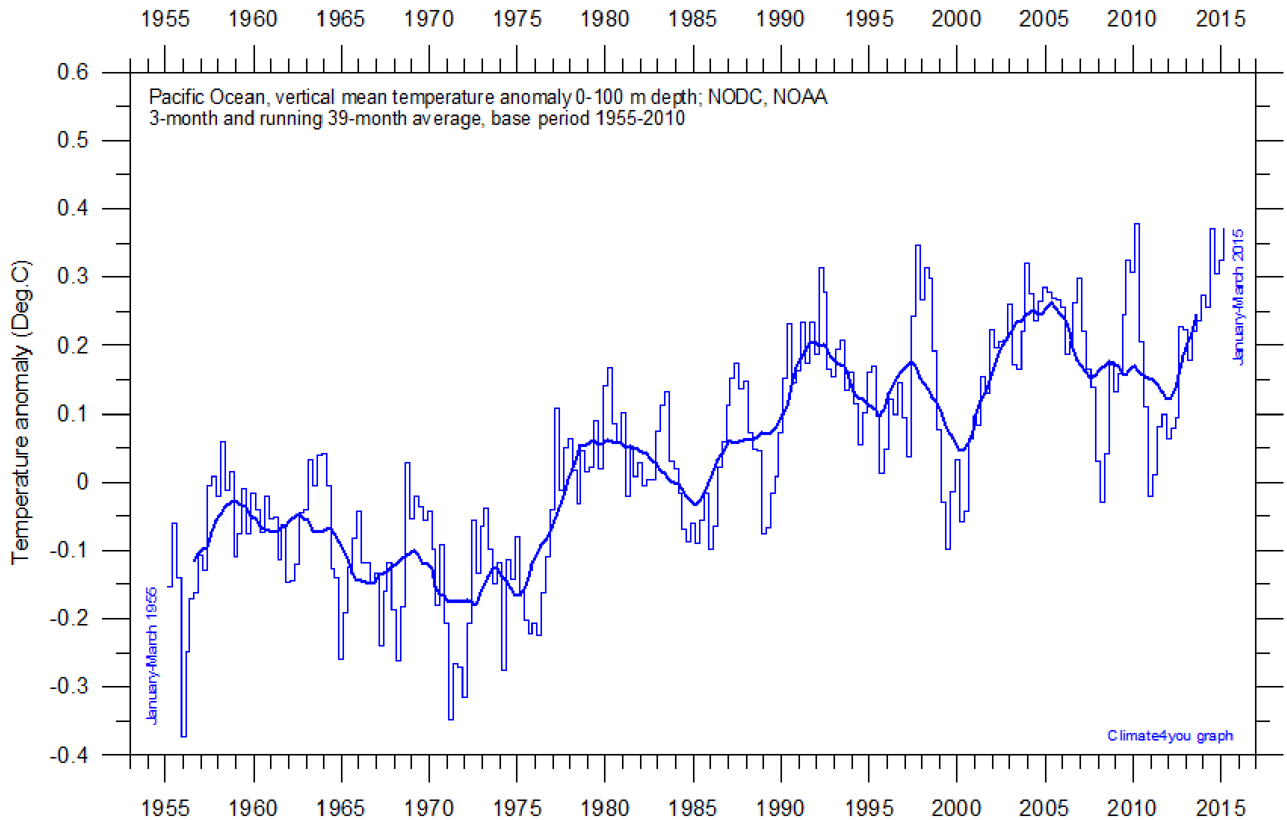
Ocean heat content uppermost 100 and 700 m, updated to March 2015



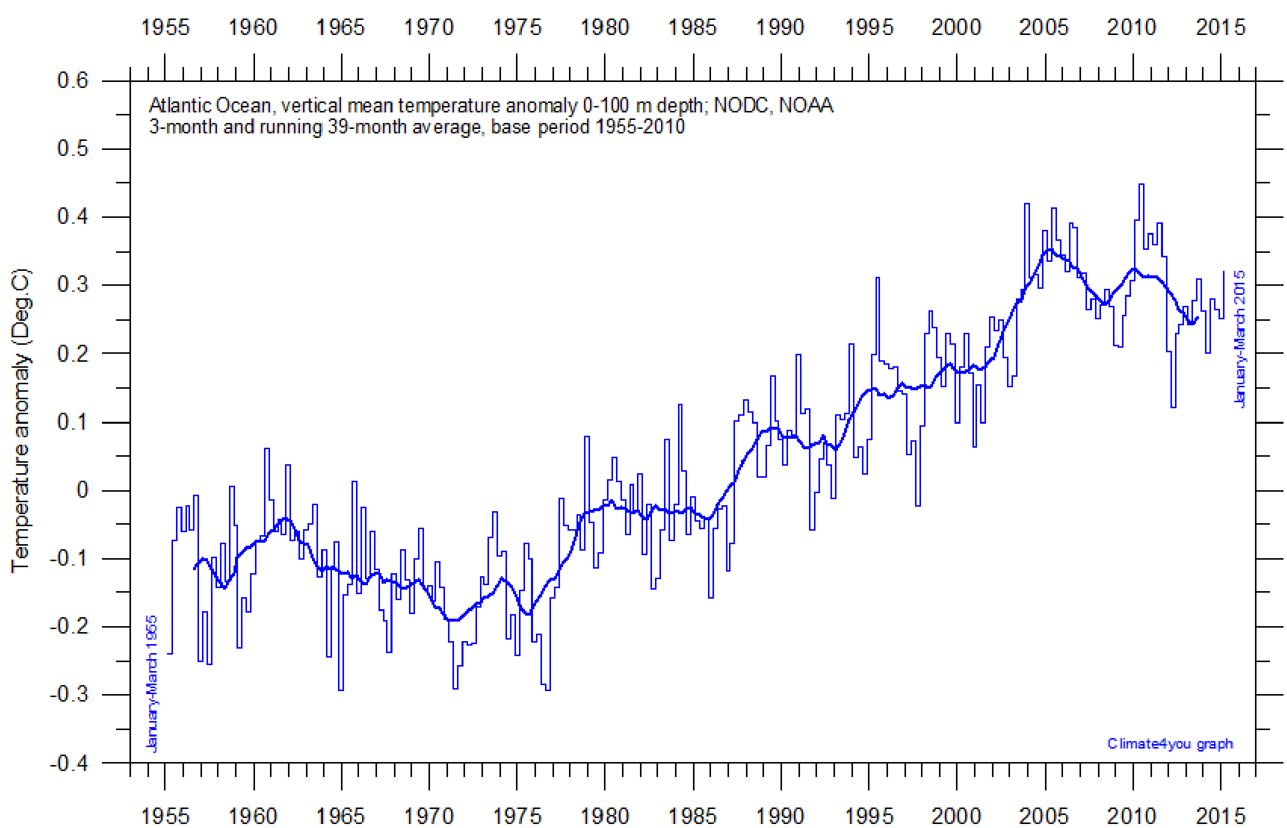
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1955. Data source: National Oceanographic Data Center(NODC).



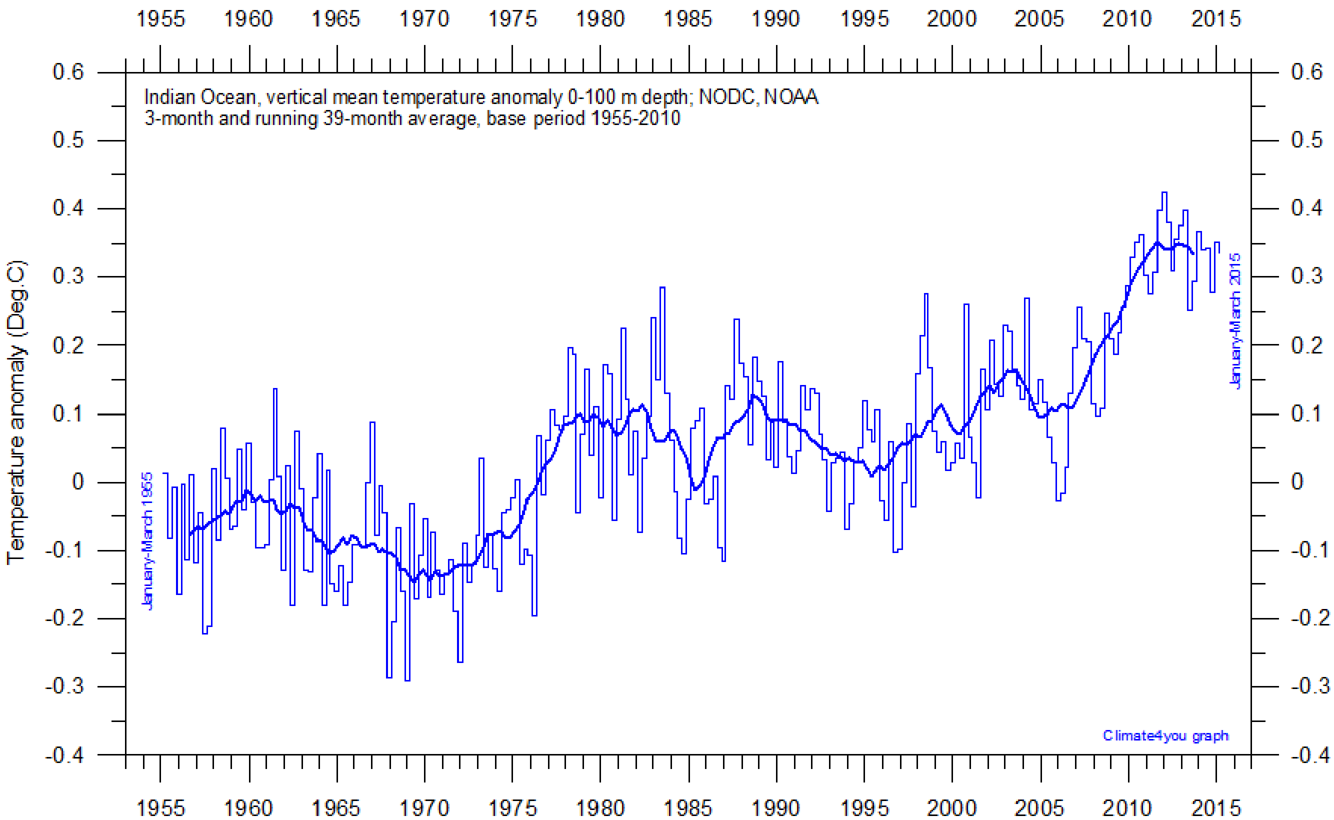
World Oceans vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: [NOAA National Oceanographic Data Center](#) (NODC). Base period 1955-2010.



Pacific Ocean vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: NOAA National Oceanographic Data Center (NODC). Base period 1955-2010.

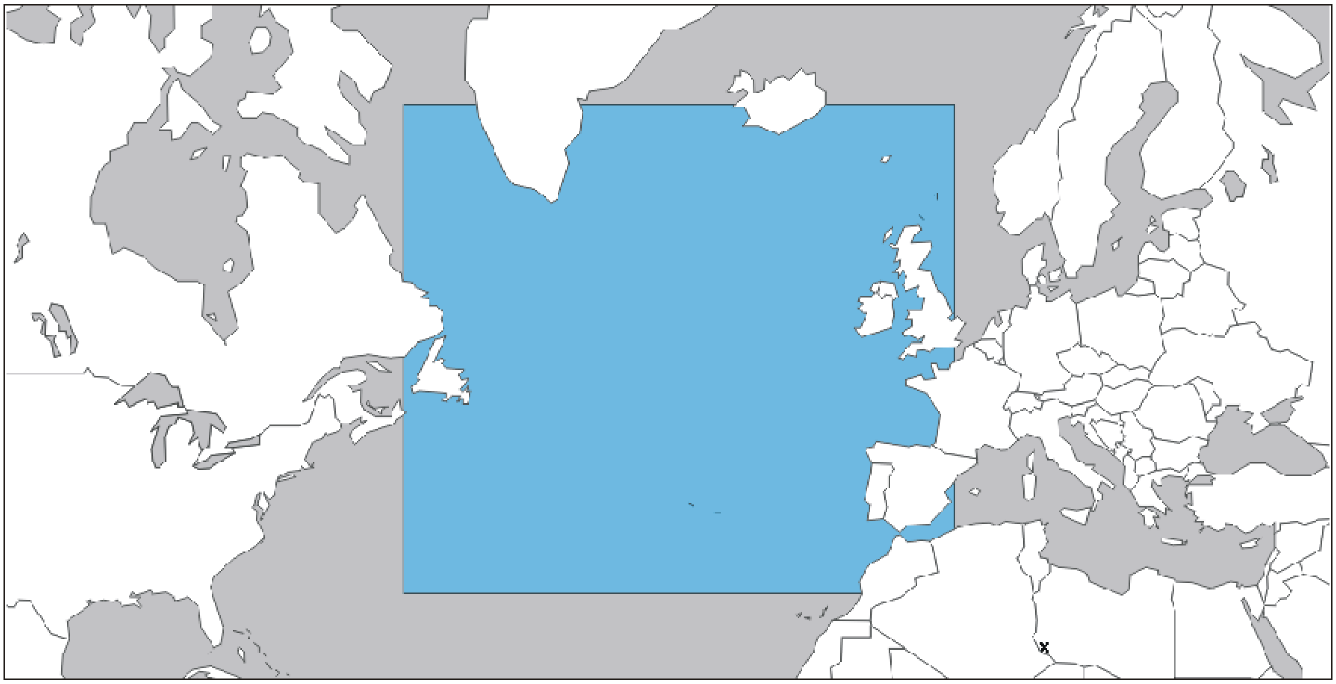


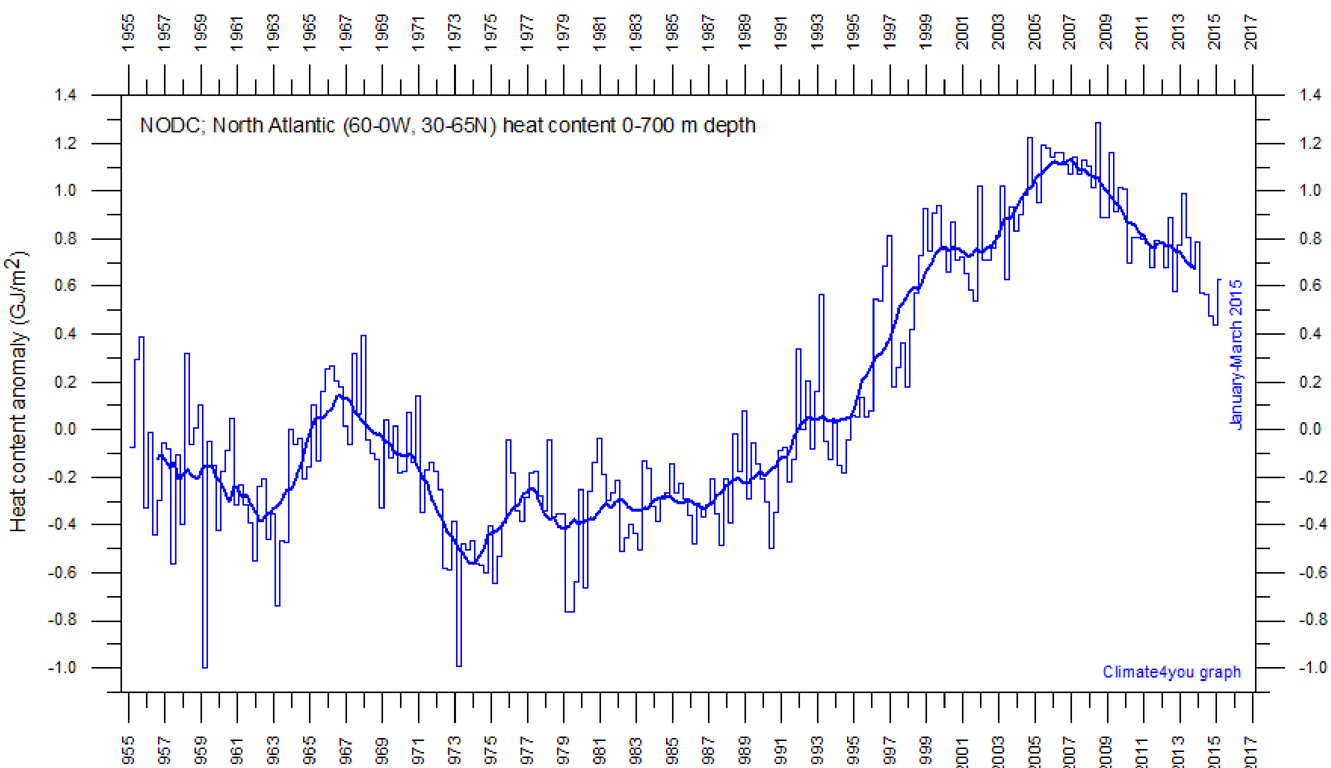
Atlantic Ocean vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: NOAA National Oceanographic Data Center (NODC). Base period 1955-2010.



Indian Ocean vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: [NOAA National Oceanographic Data Center](#) (NODC). Base period 1955-2010.

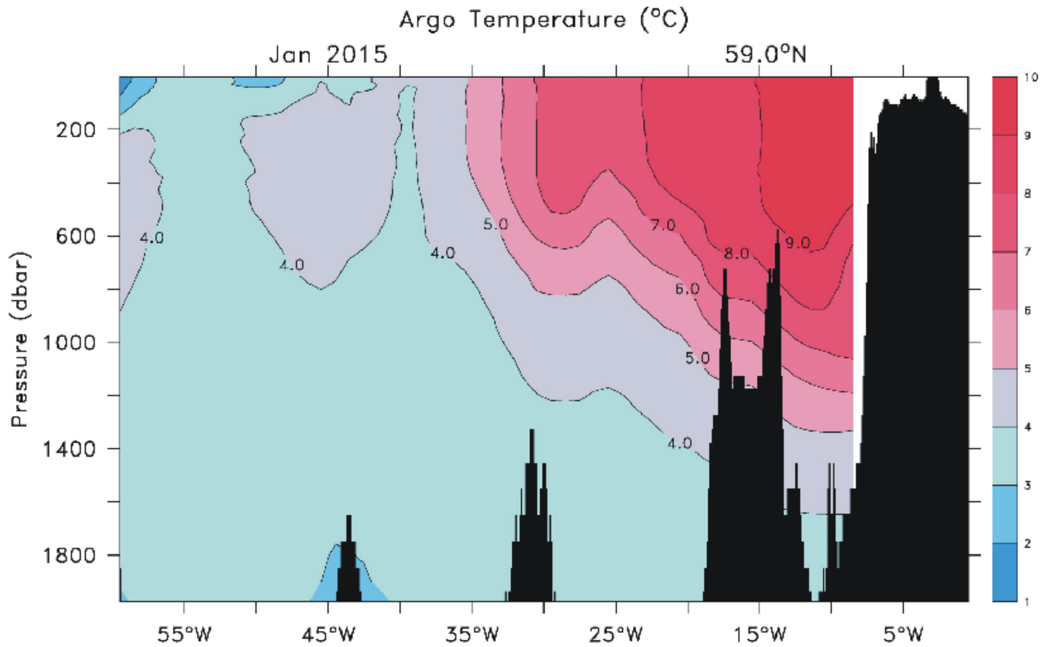
[North Atlantic heat content uppermost 700 m, updated to March 2015]

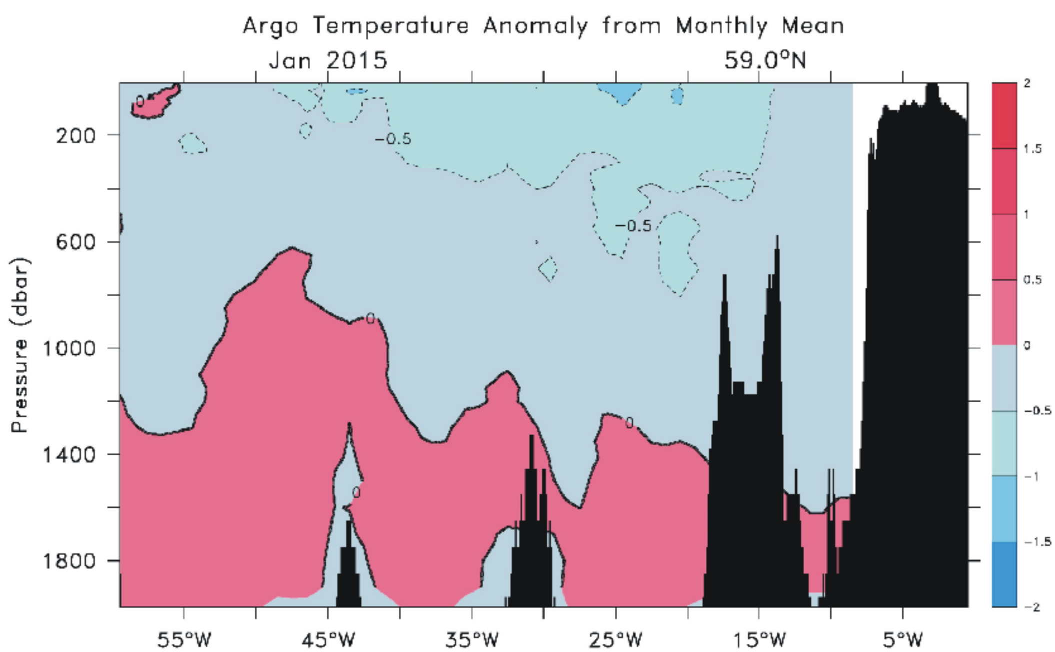




Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the North Atlantic (60-0W, 30-65N; see map above) *ocean since January 1955. The thin line indicates monthly values, and the thick line represents the simple running 37 month (c. 3 year) average. Data source: [National Oceanographic Data Center](#) (NODC).*

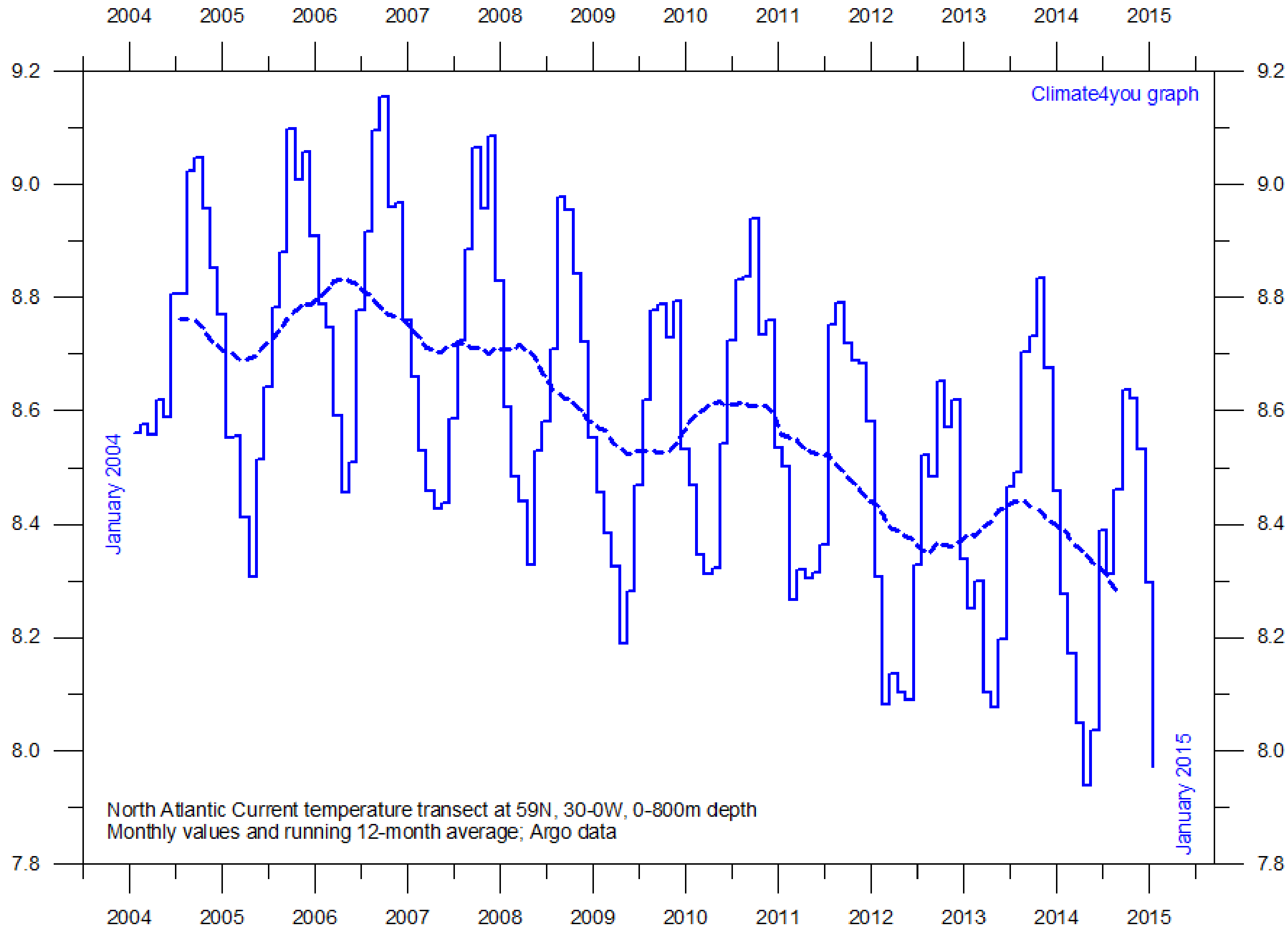
North Atlantic sea temperatures along 59N, updated to January 2015





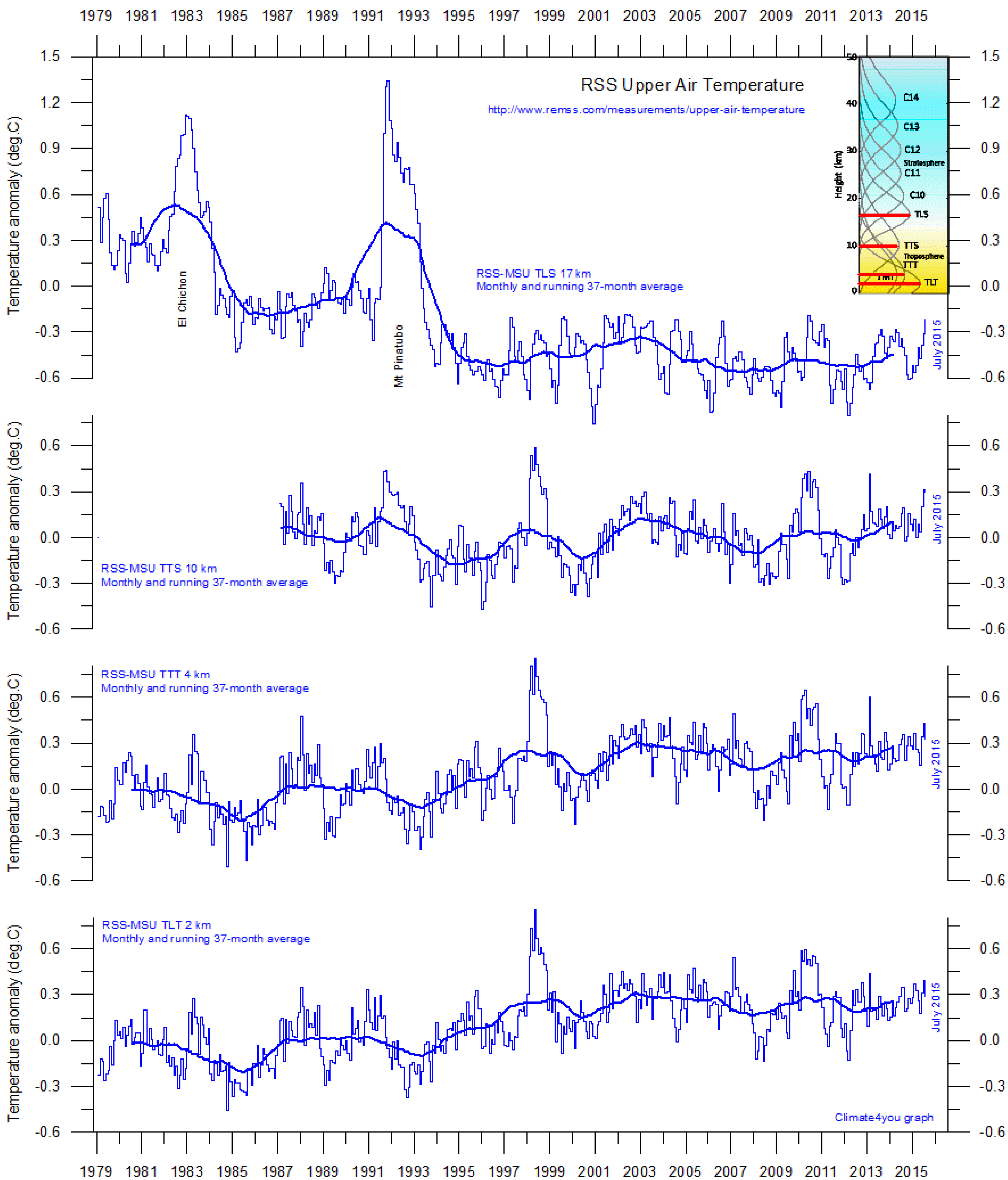
Depth-temperature diagram along 59 N across the North Atlantic, extending from northern Labrador in the west to northern Scotland in the east, using [Argo](#)-data. The uppermost panel shows the absolute temperature, and the lower diagram shows the temperature anomaly, using the monthly average temperature 2004-2013 as reference. Source: [Global Marine Argo Atlas](#).

North Atlantic sea temperatures 30-0W at 59N, updated to January 2015



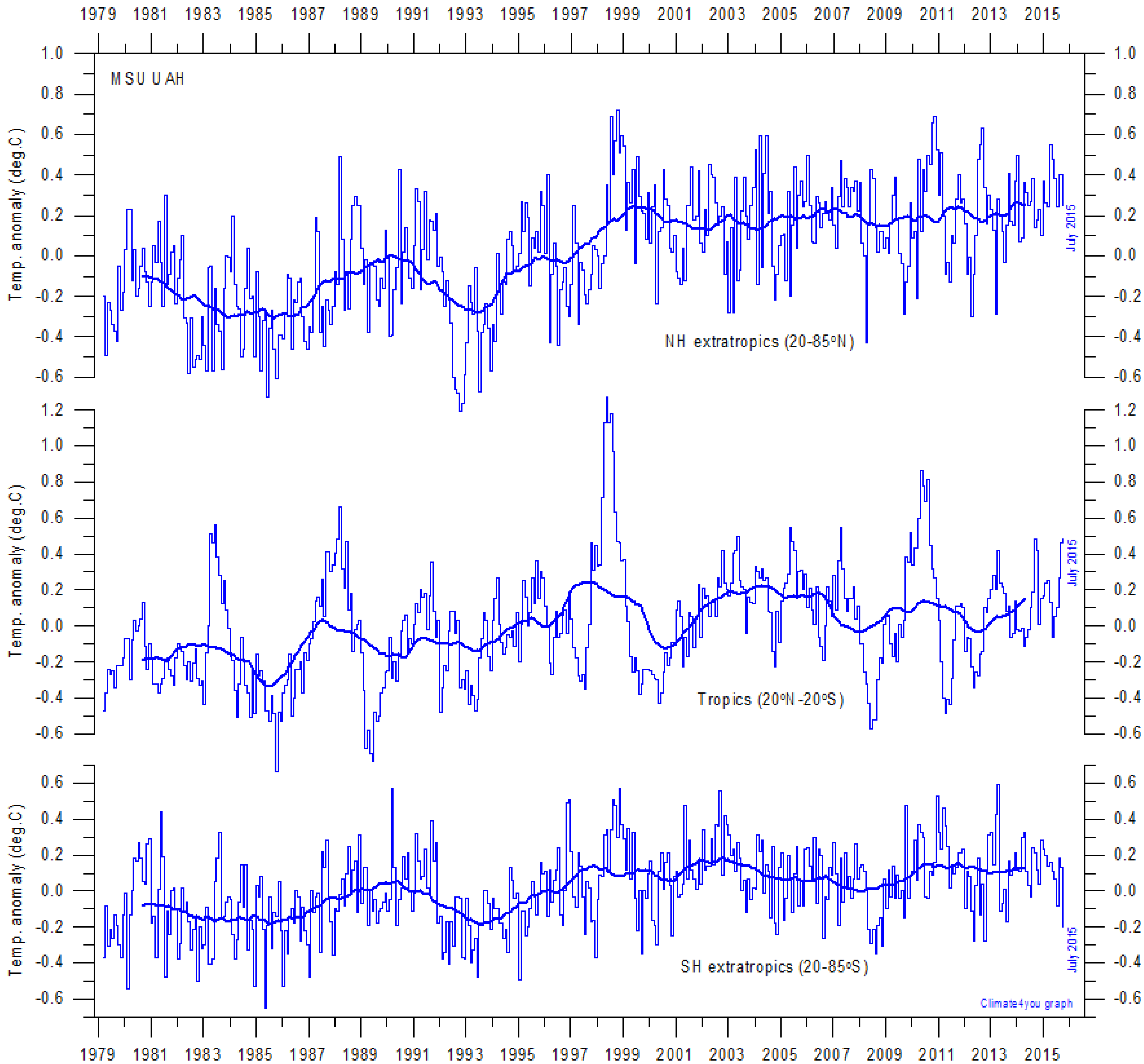
Average temperature along 59 N, 30-0W, 0-800m depth, corresponding to the main part of the North Atlantic Current, using Argo-data. Source: Global Marine Argo Atlas. Additional information can be found in: Roemmich, D. and J. Gilson, 2009. The 2004-2008 mean and annual cycle of temperature, salinity, and steric height in the global ocean from the Argo Program. Progress in Oceanography, 82, 81-100.

[Troposphere and stratosphere temperatures from satellites, updated to July 2015](#)



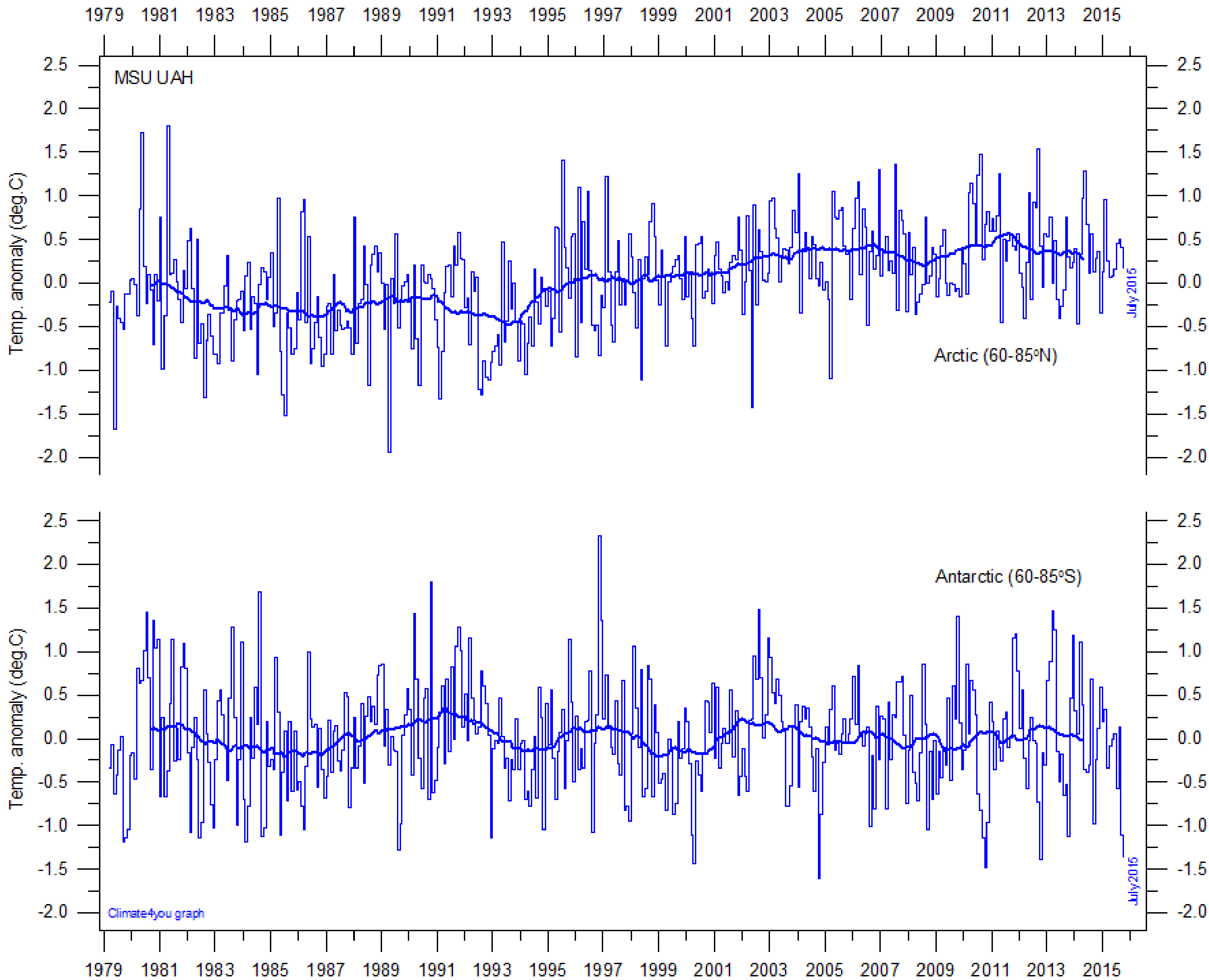
Global monthly average temperature in different altitudes according to [Remote Sensing Systems](#) (RSS). The thin lines represent the monthly average, and the thick line the simple running 37 month average, nearly corresponding to a running 3 year average.

Zonal lower troposphere temperatures from satellites, updated to July 2015



Global monthly average lower troposphere temperature since 1979 for the tropics and the northern and southern extratropics, according to University of Alabama at Huntsville, USA. Thin lines show the monthly temperature. Thick lines represent the simple running 37-month average, nearly corresponding to a running 3 year average. Reference period 1981-2010.

[Arctic and Antarctic lower troposphere temperature, updated to July 2015]



Global monthly average lower troposphere temperature since 1979 for the North Pole and South Pole regions, based on satellite observations ([University of Alabama] at Huntsville, USA). Thin lines show the monthly temperature. The thick line is the simple running 37-month average, nearly corresponding to a running 3 year average. Reference period 1981-2010.

Arctic and Antarctic surface air temperature, updated to June 2015

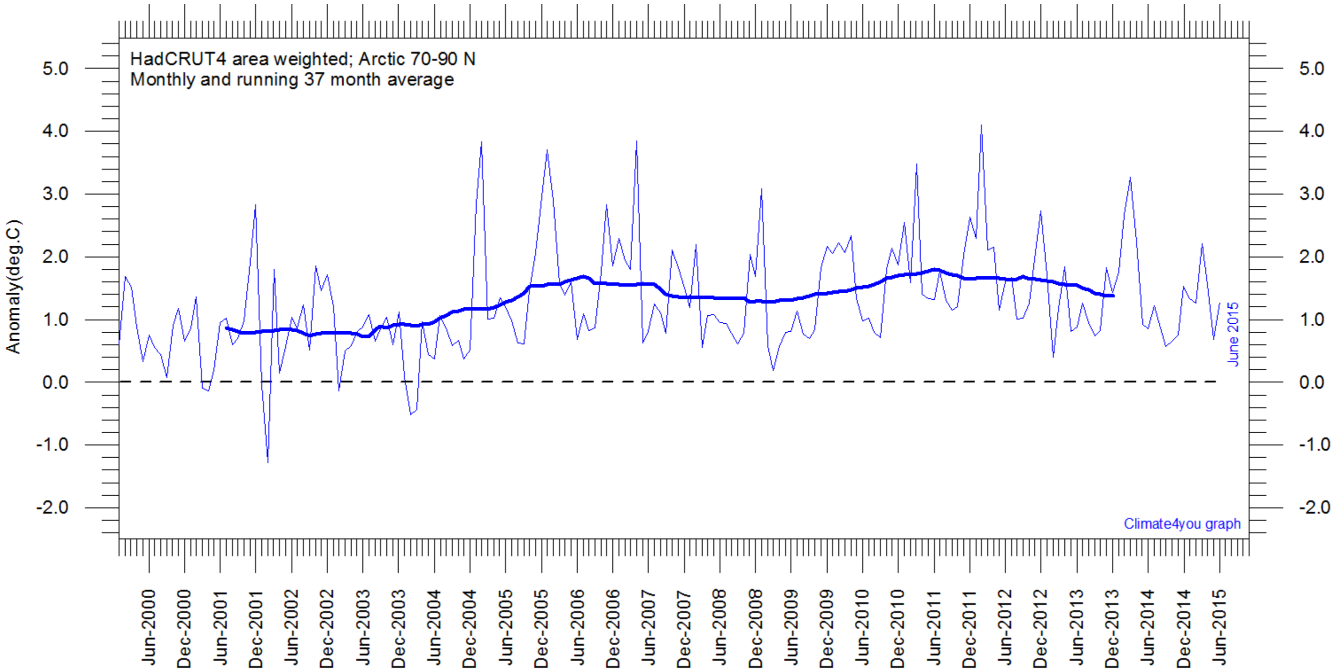


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.

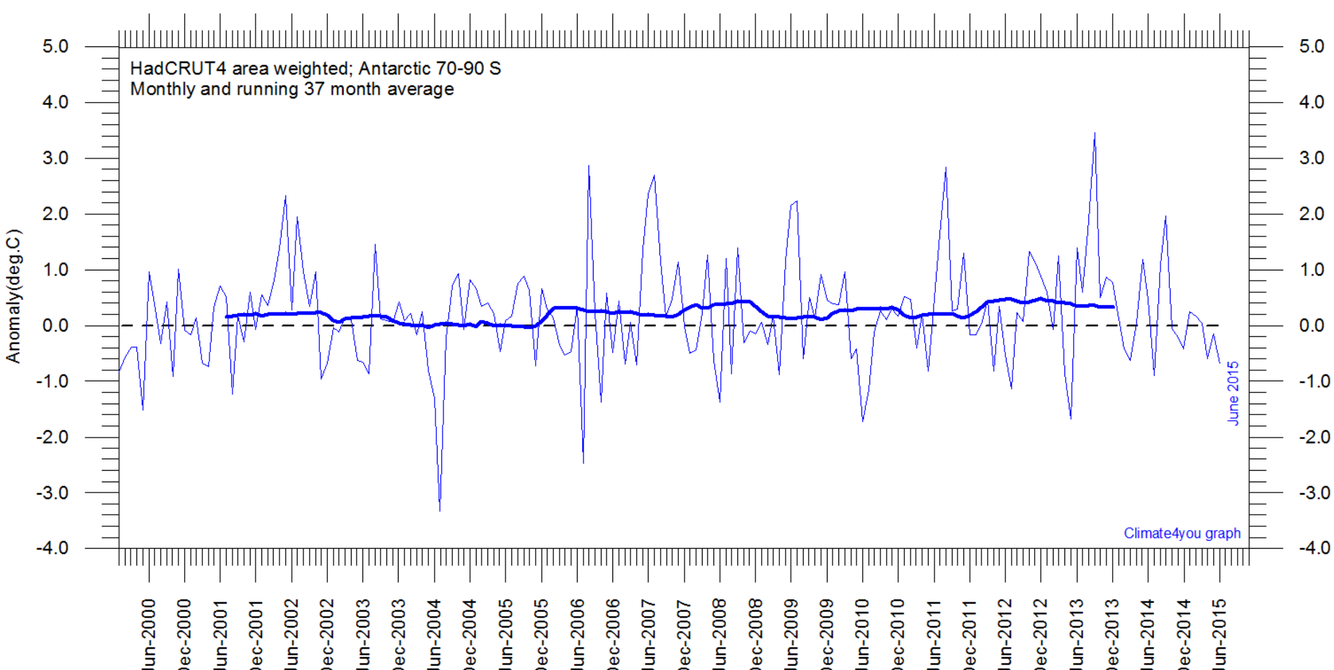


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.

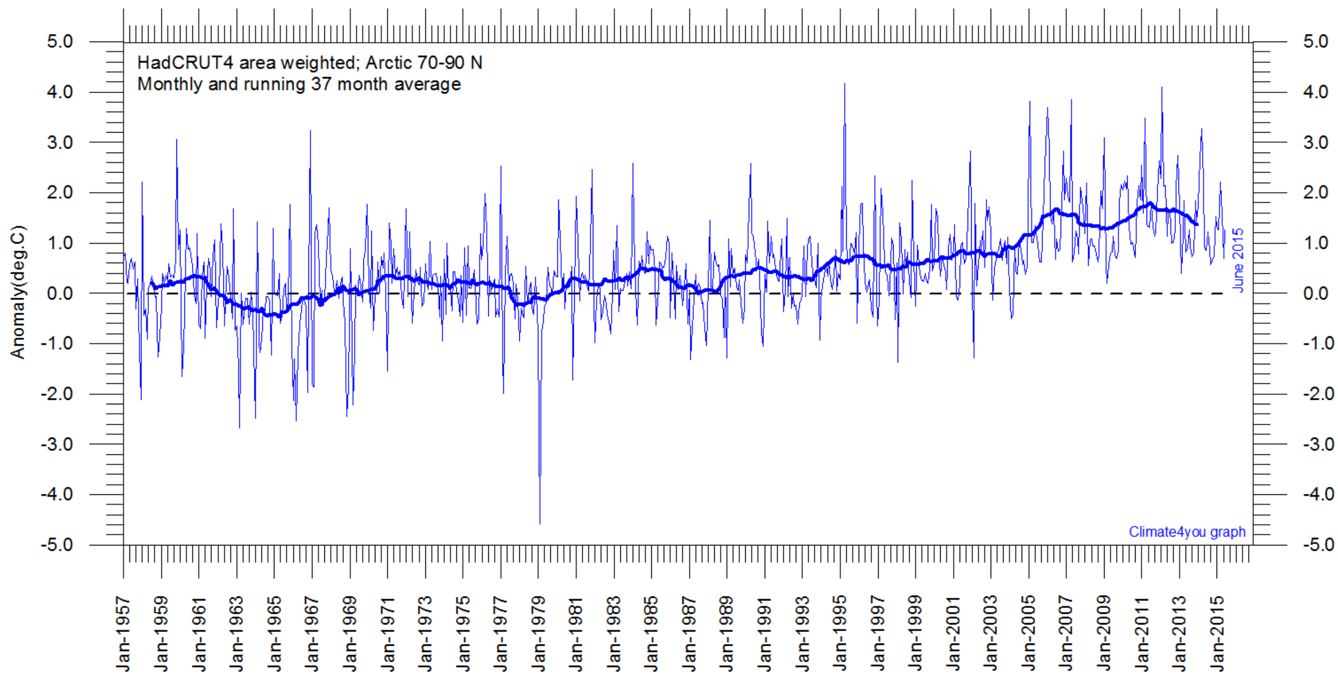


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.

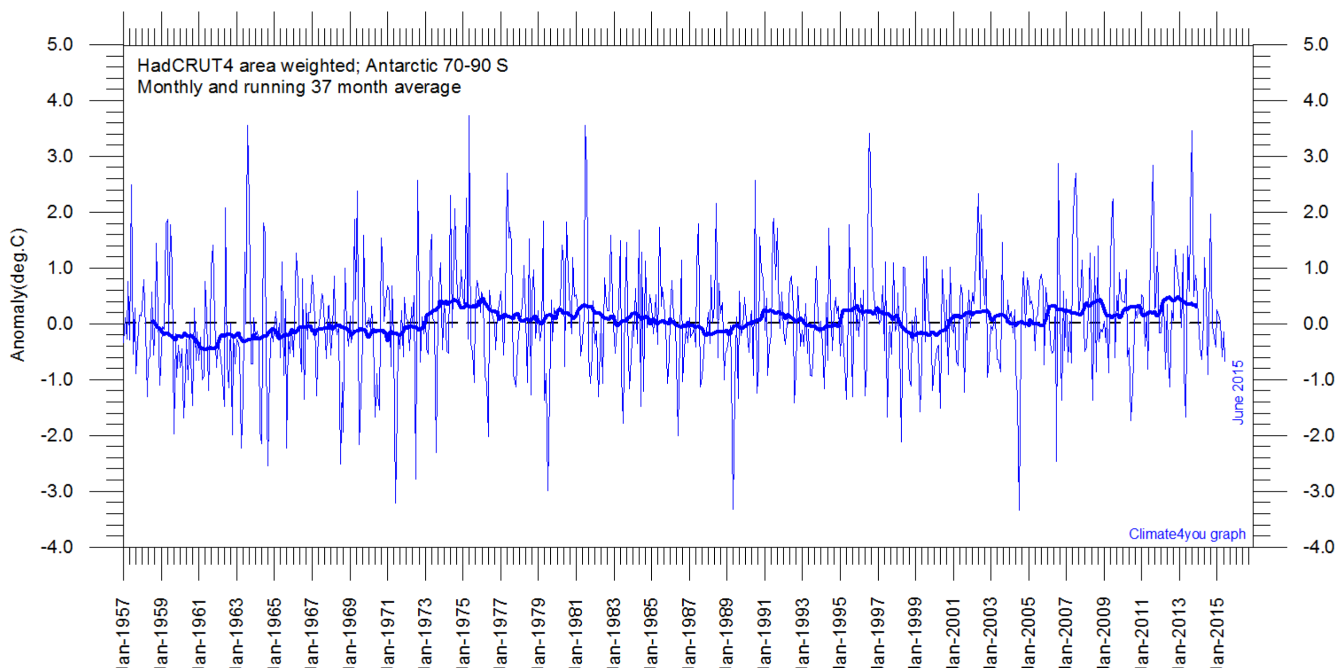


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.

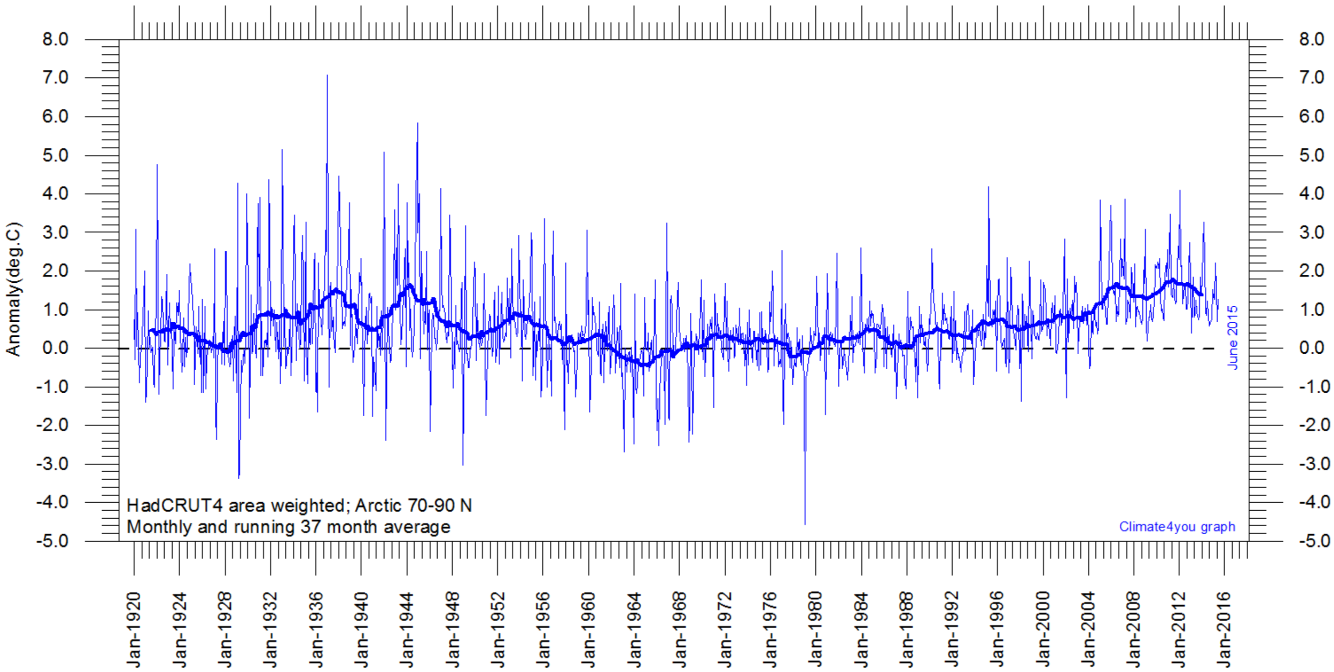


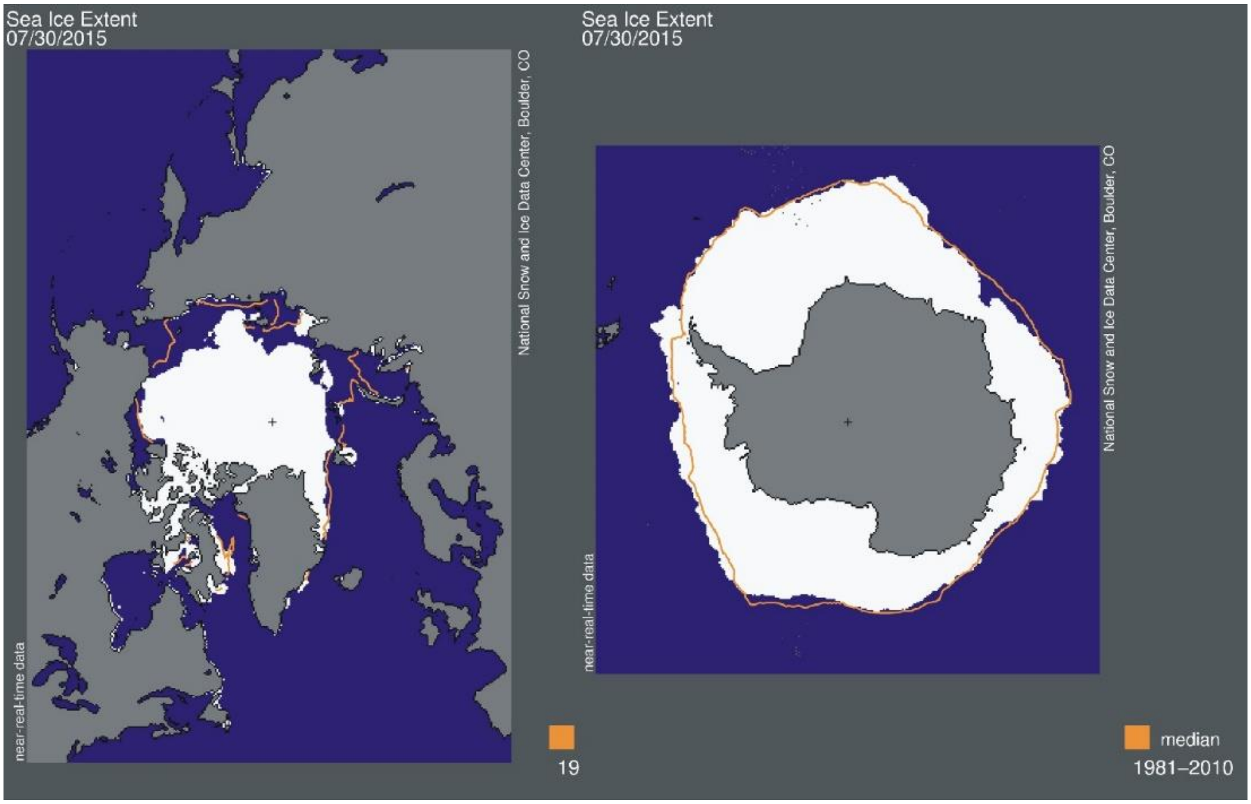
Diagram showing area-weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1920, in relation to the WMO [normal period] 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average. Because of the relatively small number of Arctic stations before 1930, month-to-month variations in the early part of the temperature record are larger than later. The period from about 1930 saw the establishment of many new Arctic meteorological stations, first [in Russia and Siberia], and following the 2nd World War, also in North America. The period since 2000 is warm, about as warm as the period 1930-1940.

As the HadCRUT4 data series has improved high latitude coverage data coverage (compared to the HadCRUT3 series) the individual 5°x5° grid cells has been weighted according to their surface area. This is in contrast to Gillet et al. 2008 which calculated a simple average, with no consideration to the surface area represented by the individual 5°x5° grid cells.

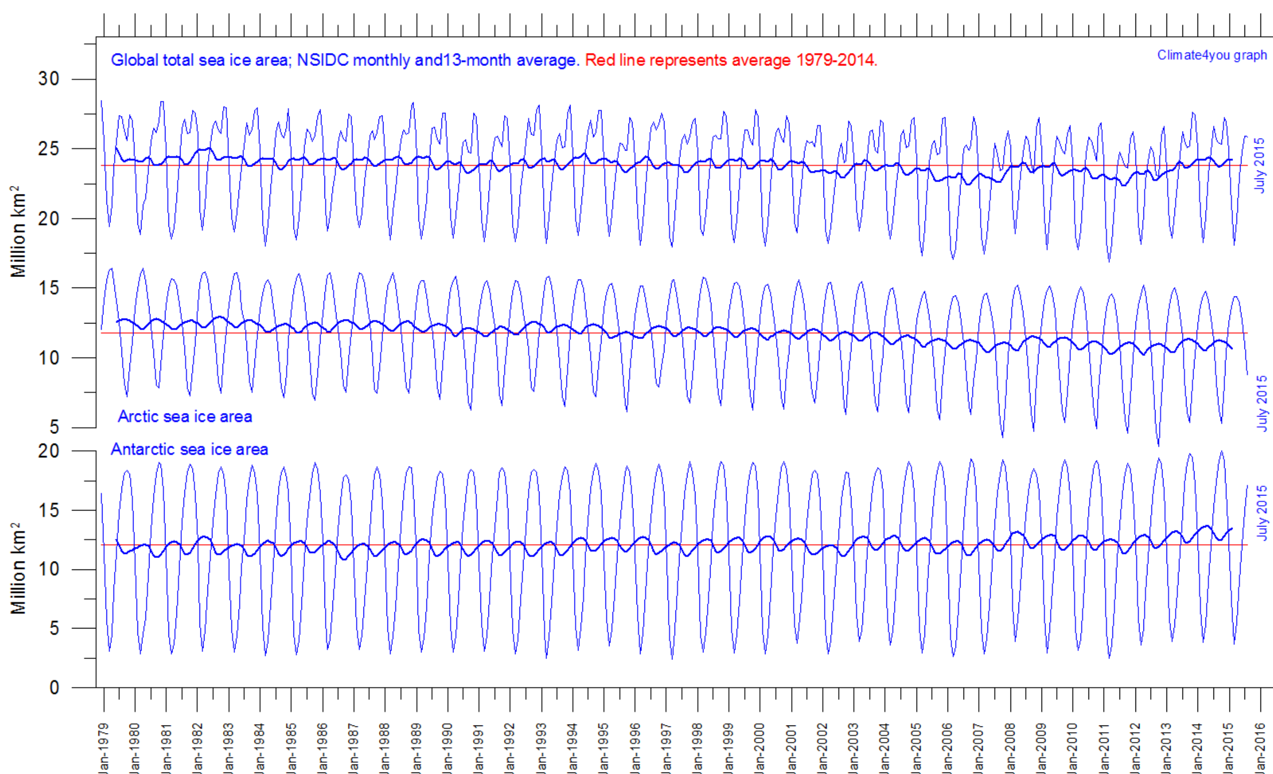
Literature:

Gillett, N.P., Stone, D.A., Stott, P.A., Nozawa, T., Karpechko, A.Y.U., Hegerl, G.C., Wehner, M.F. and Jones, P.D. 2008. Attribution of polar warming to human influence. *Nature Geoscience* 1, 750-754.

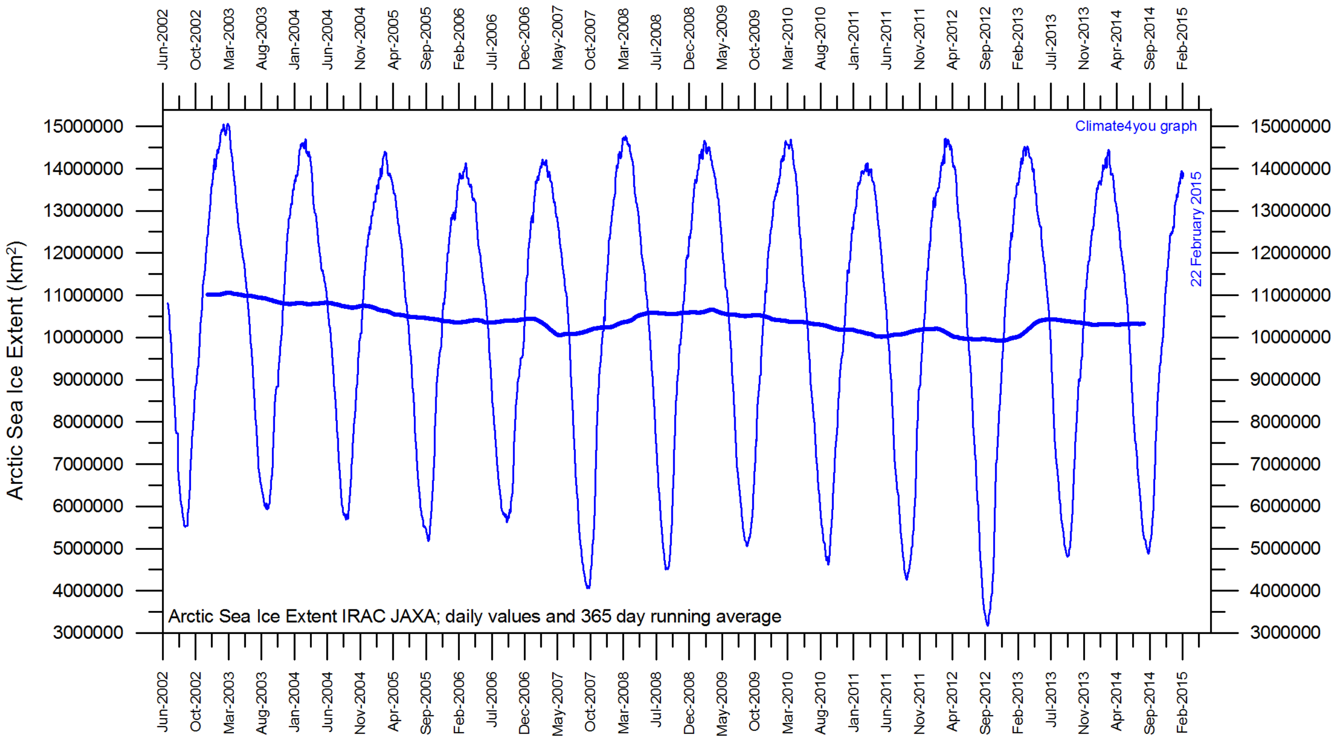
[Arctic and Antarctic sea ice, updated to July 2015]



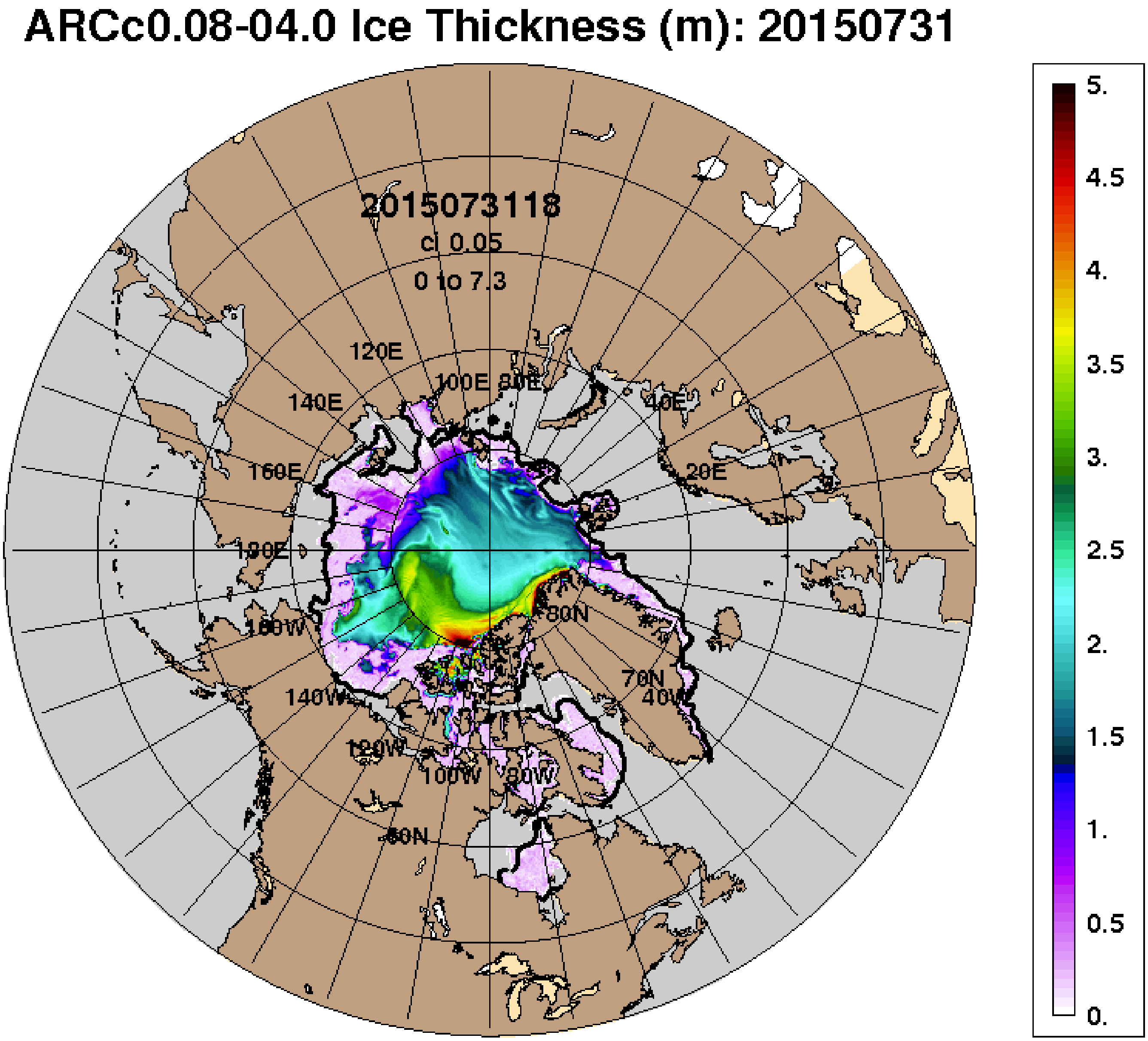
Sea ice extent 30 July 2015. The 'normal' or average limit of sea ice (orange line) is defined as 15% sea ice cover, according to the average of satellite observations 1981-2010 (both years inclusive). Sea ice may therefore well be encountered outside and open water areas inside the limit shown in the diagrams above. Map source: National Snow and Ice Data Center (NSIDC).



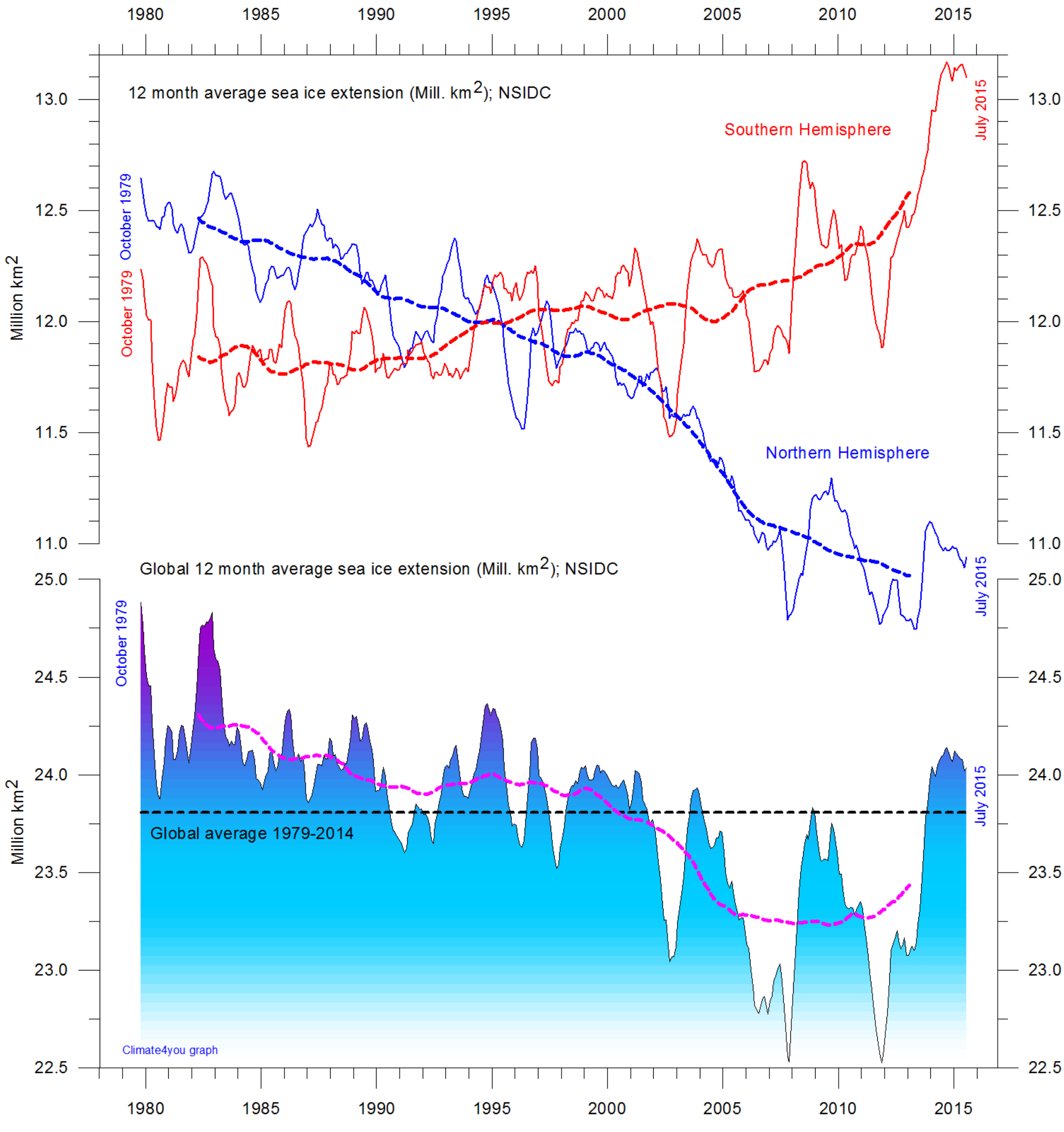
Graphs showing monthly Antarctic, Arctic and global sea ice extent since November 1978, according to the [National Snow and Ice data Center] (NSIDC).



Graph showing daily Arctic sea ice extent since June 2002, to 22 February 2015, by courtesy of [Japan Aerospace Exploration Agency](#) (JAXA). Please note that this diagram has not been updated beyond February 2015. Website inactive at the moment.

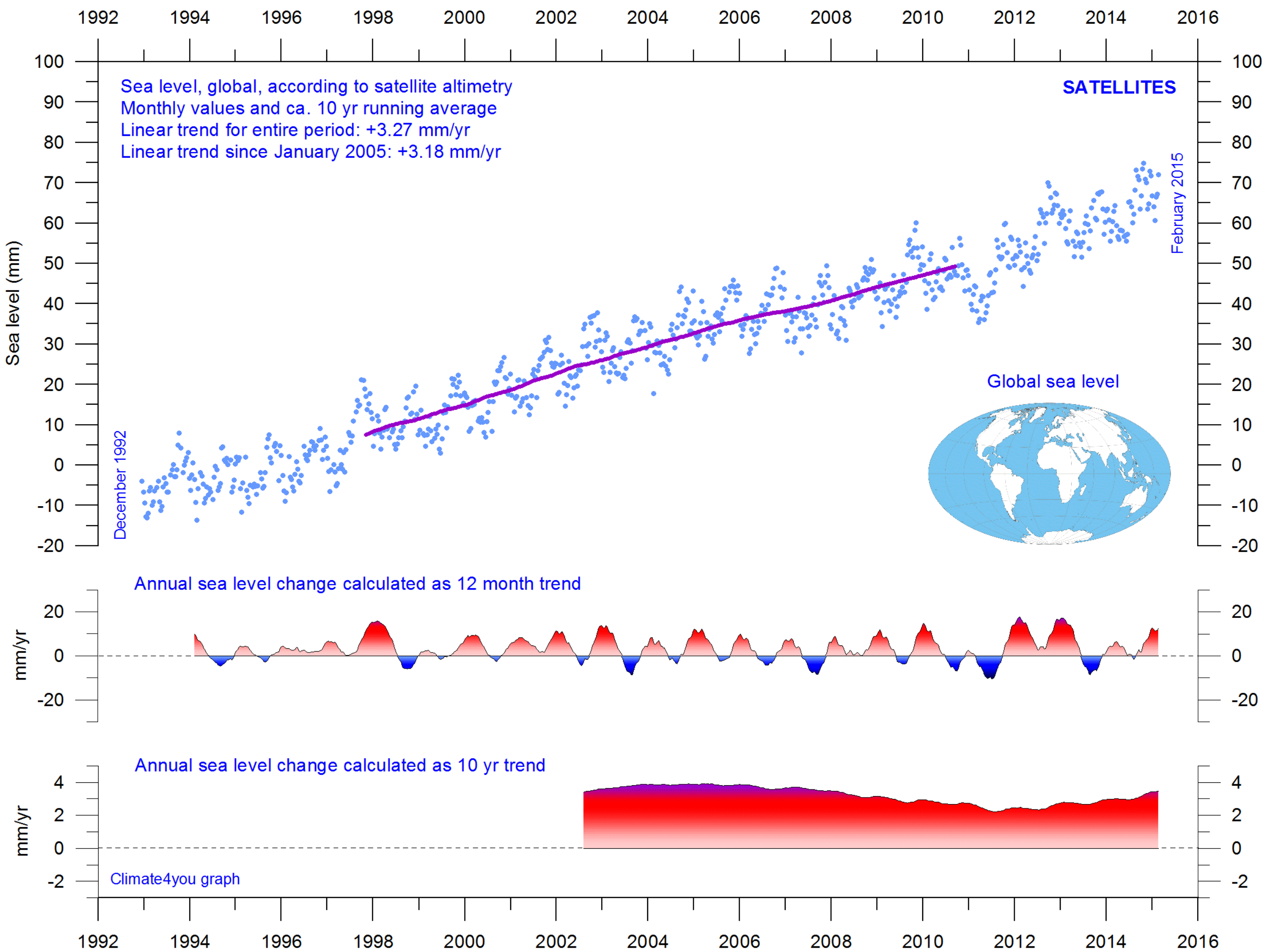


Northern hemisphere sea ice extension and thickness on 31 July 2015 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) to the right.



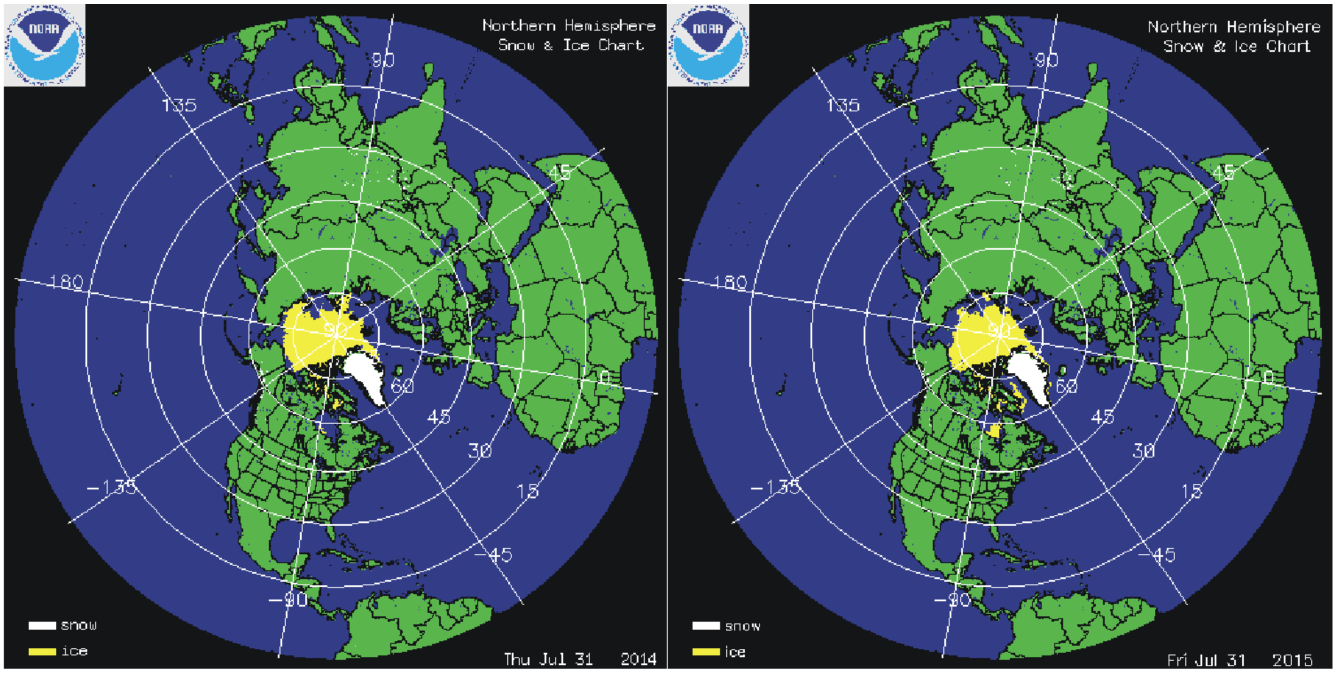
12 month running average sea ice extension, global and in both hemispheres since 1979, the satellite-era. The October 1979 value represents the monthly 12-month average of November 1978 - October 1979, the November 1979 value represents the average of December 1978 - November 1979, etc. The stippled lines represent a 61-month (ca.5 years) average. Data source: National Snow and Ice Data Center (NSIDC).

Global sea level from satellite altimetry, updated to February 2015

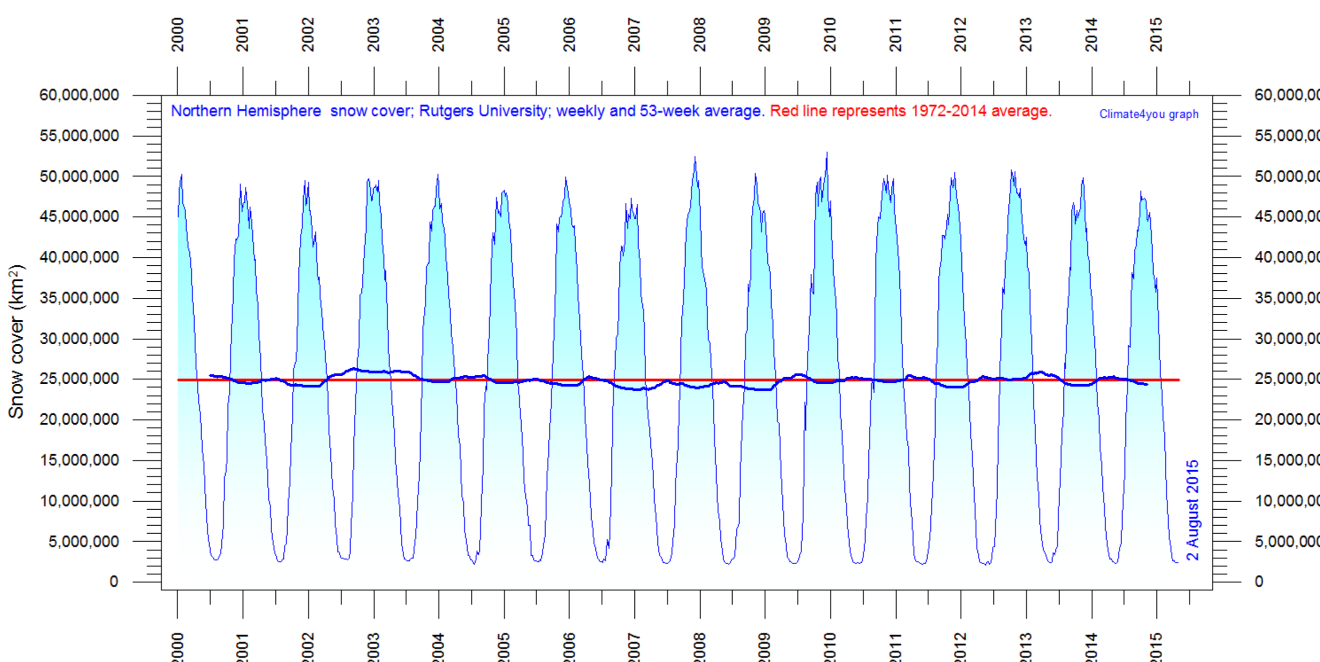


Global sea level since December 1992 according to the Colorado Center for Astrodynamics Research at University of Colorado at Boulder. The blue dots are the individual observations, and the purple line represents the running 121-month (ca. 10 year) average. The two lower panels show the annual sea level change, calculated for 1 and 10 year time windows, respectively. These values are plotted at the end of the interval considered. Data from the TOPEX/Poseidon mission have been used before 2002, and data from the Jason-1 mission (satellite launched December 2001) after 2002.

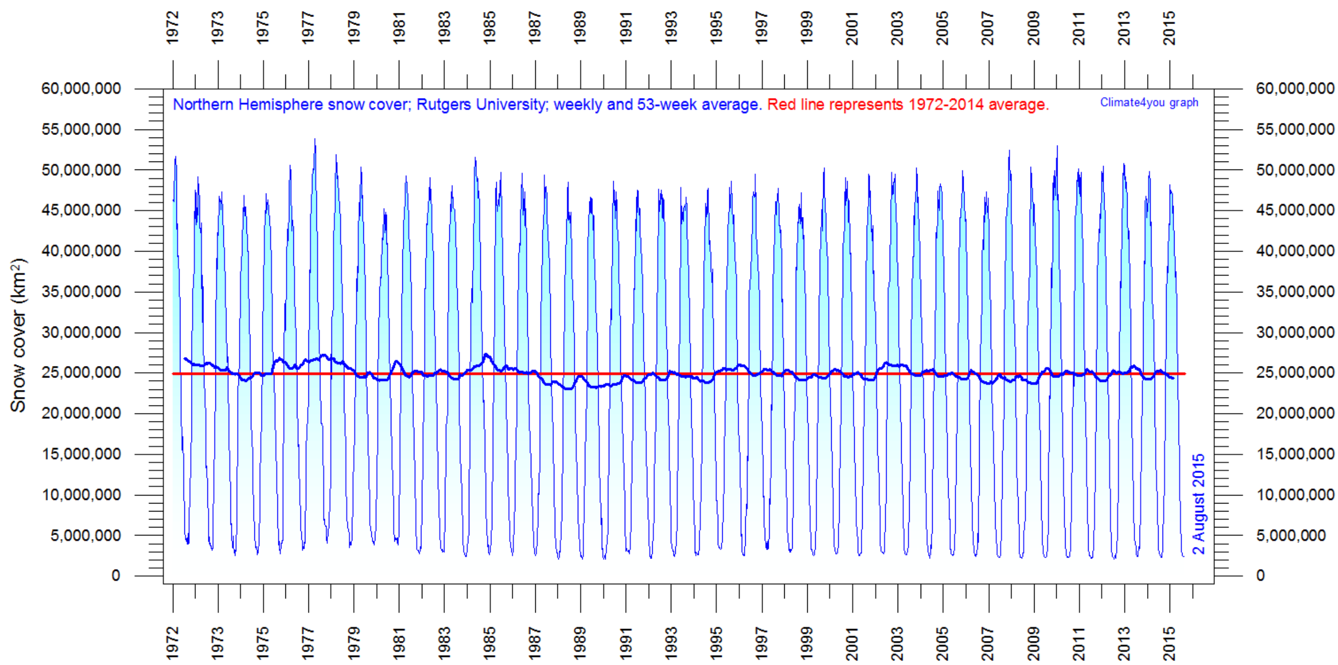
Northern Hemisphere weekly snow cover, updated to July 2015



Northern hemisphere snow cover (white) and sea ice (yellow) 31 July 2014 (left) and 2015 (right). Map source: [National Ice Center](#) (NIC).

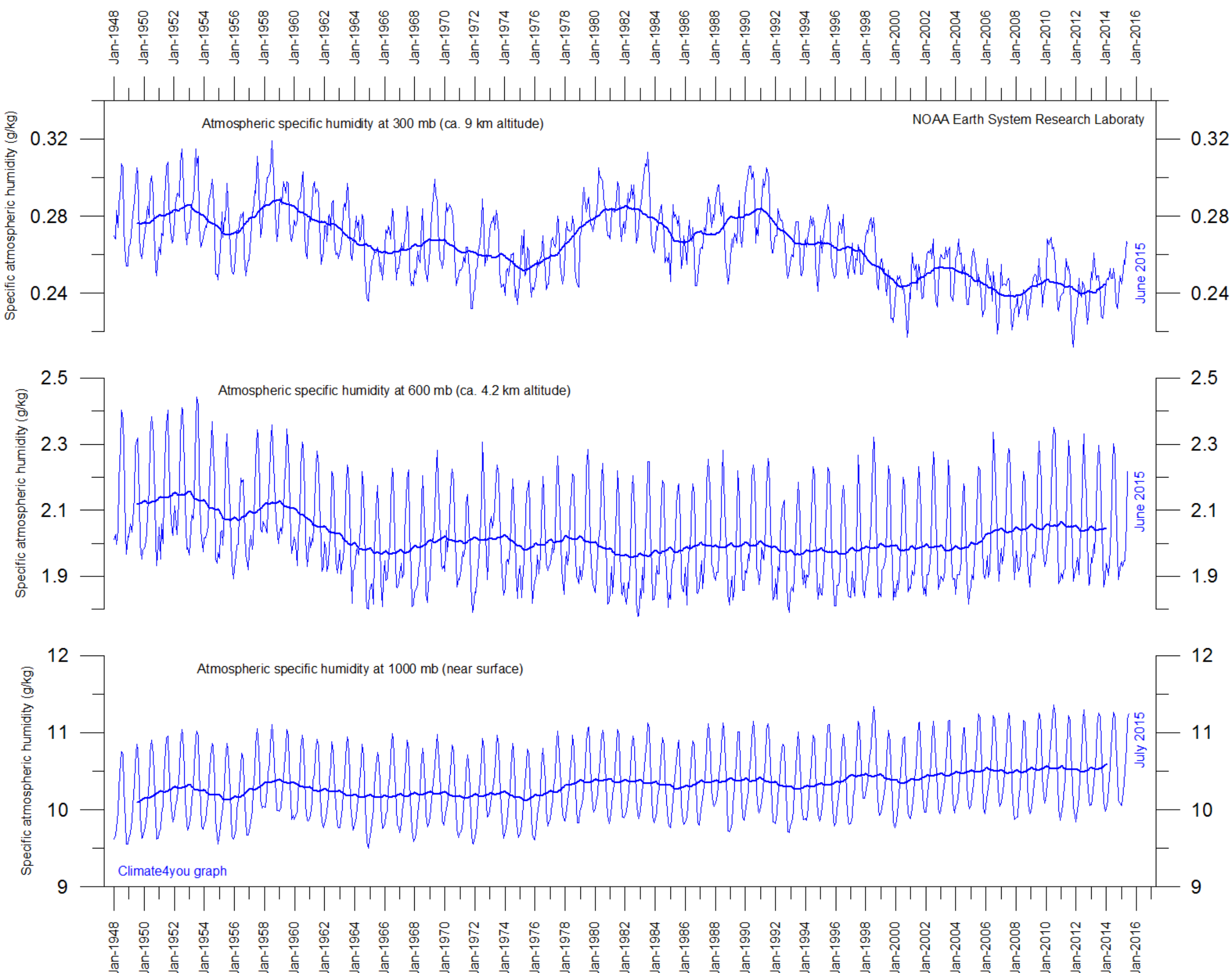


Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53-week average (approximately 1 year). The horizontal red line is the 1972-2014 average.



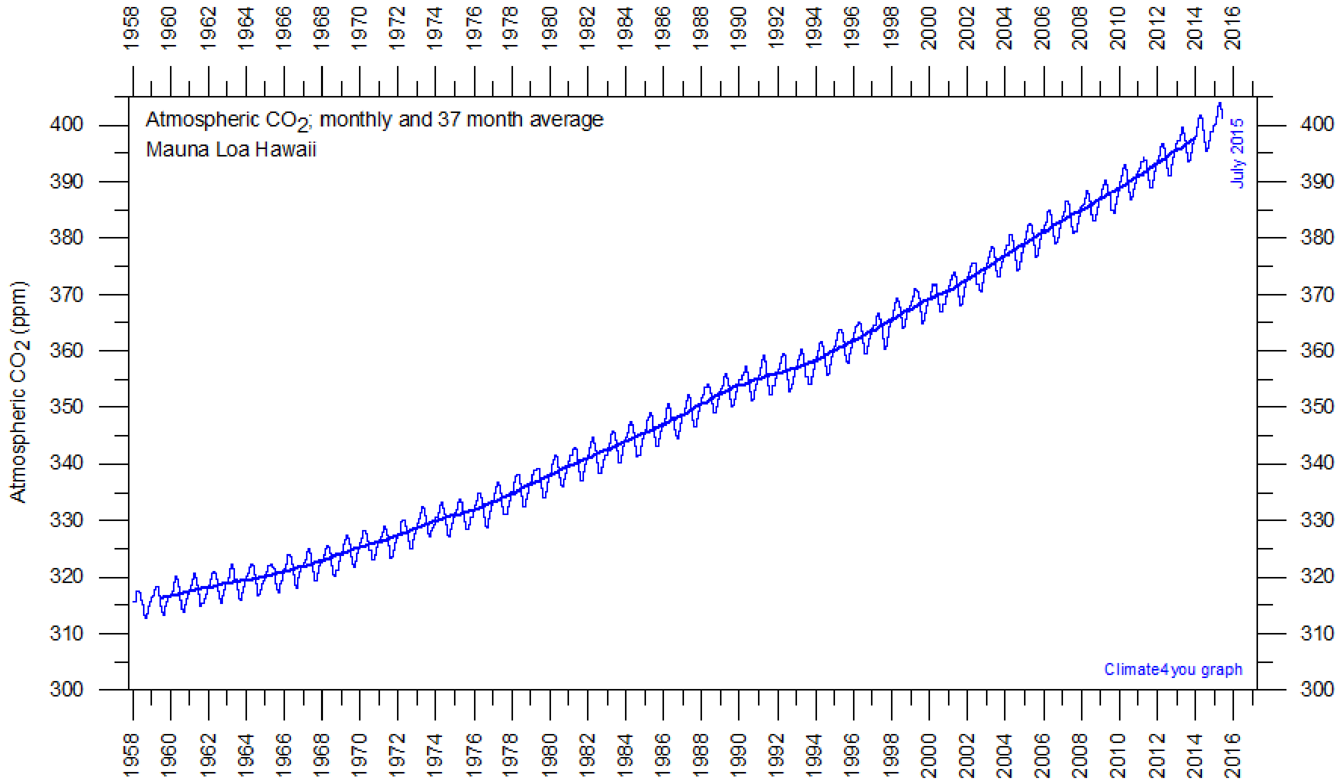
Northern hemisphere weekly snow cover since January 1972 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53-week average (approximately 1 year). The horizontal red line is the 1972-2014 average.

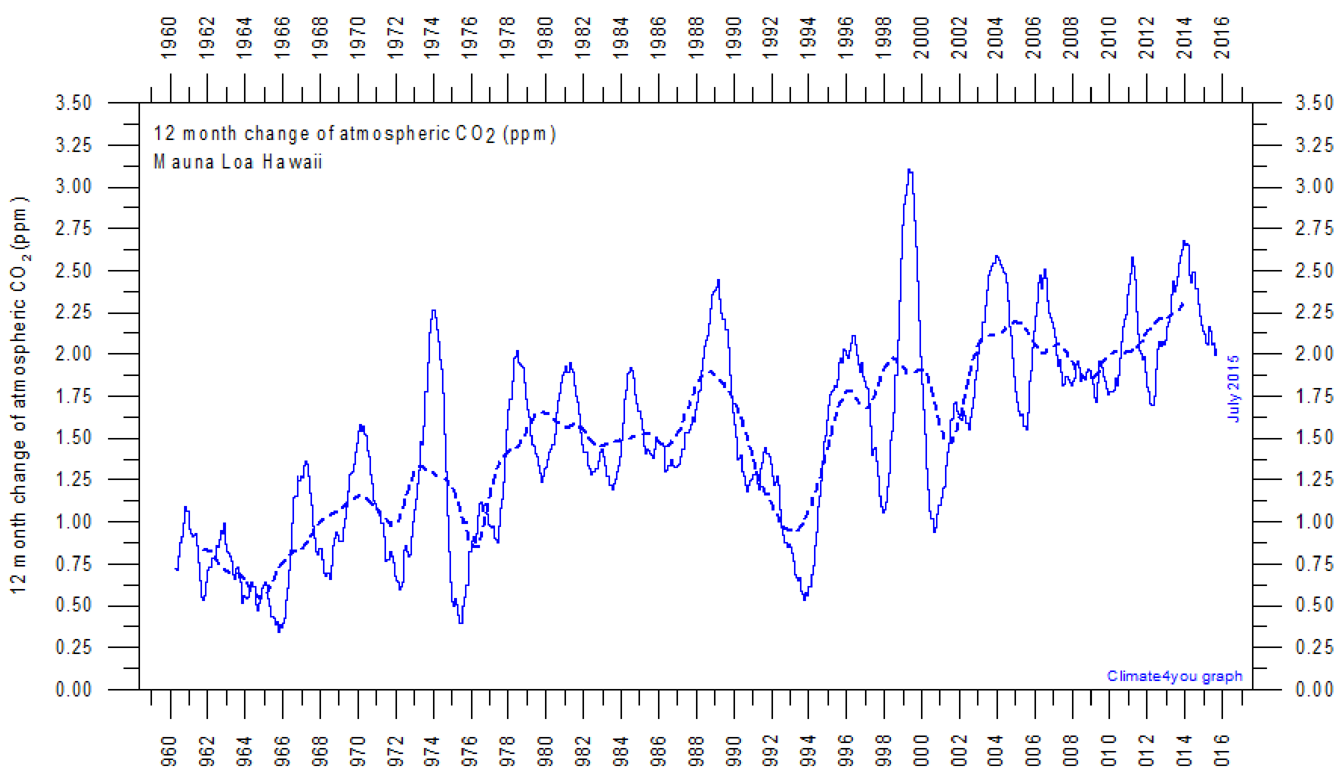
Atmospheric specific humidity, updated to July 2015



Specific atmospheric humidity (g/kg) at three different altitudes in the lower part of the atmosphere (the Troposphere) since January 1948 (Kalnay et al. 1996). The thin blue lines shows monthly values, while the thick blue lines show the running 37-month average (about 3 years). Data source: Earth System Research Laboratory (NOAA).

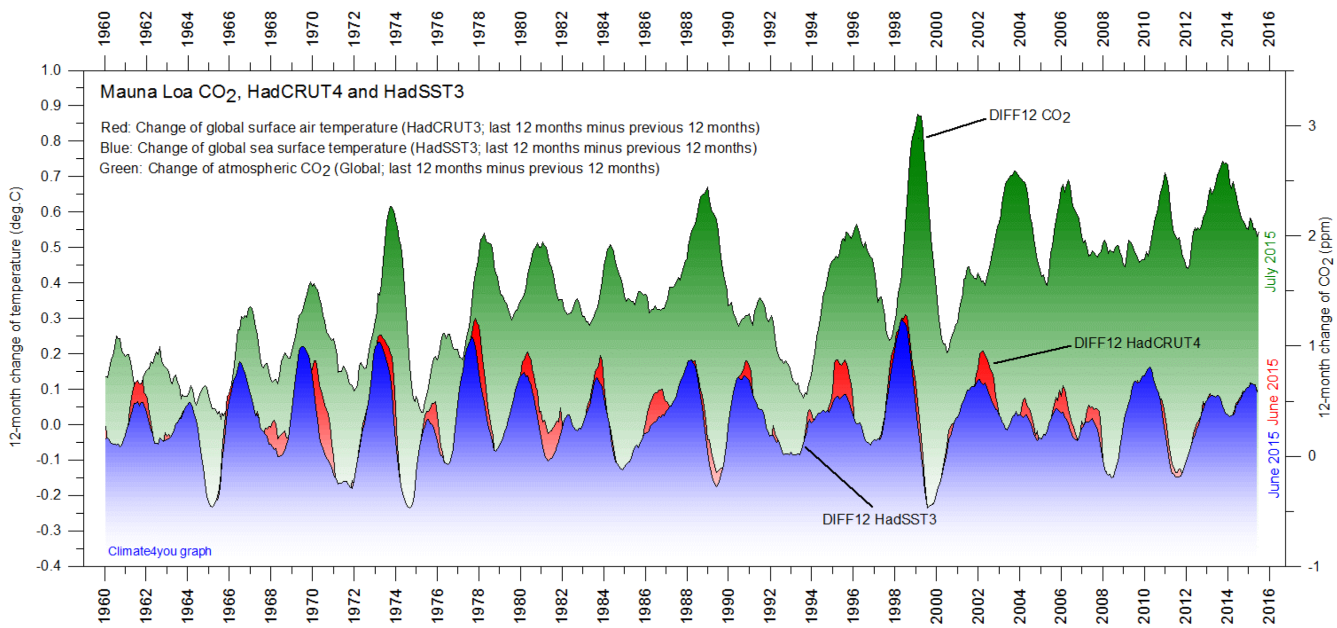
Atmospheric CO_2, updated to July 2015





Monthly amount of atmospheric CO_2 (upper diagram) and annual growth rate (lower diagram); average last 12 months minus average preceding 12 months, thin line) of atmospheric CO_2 since 1959, according to data provided by the Mauna Loa Observatory, Hawaii, USA. The thick, stippled line is the simple running 37-observation average, nearly corresponding to a running 3 year average.

The phase relation between atmospheric CO_2 and global temperature, updated to July 2015

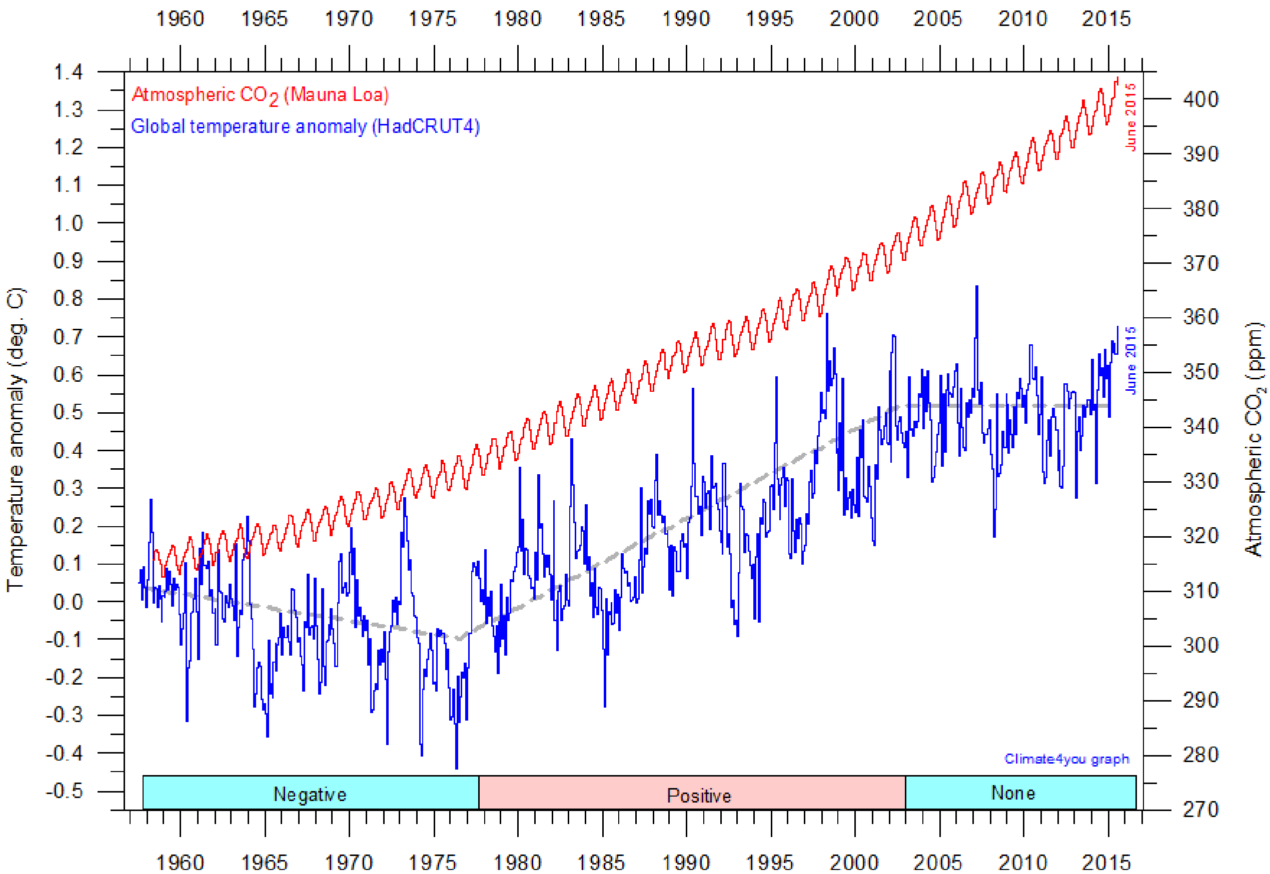


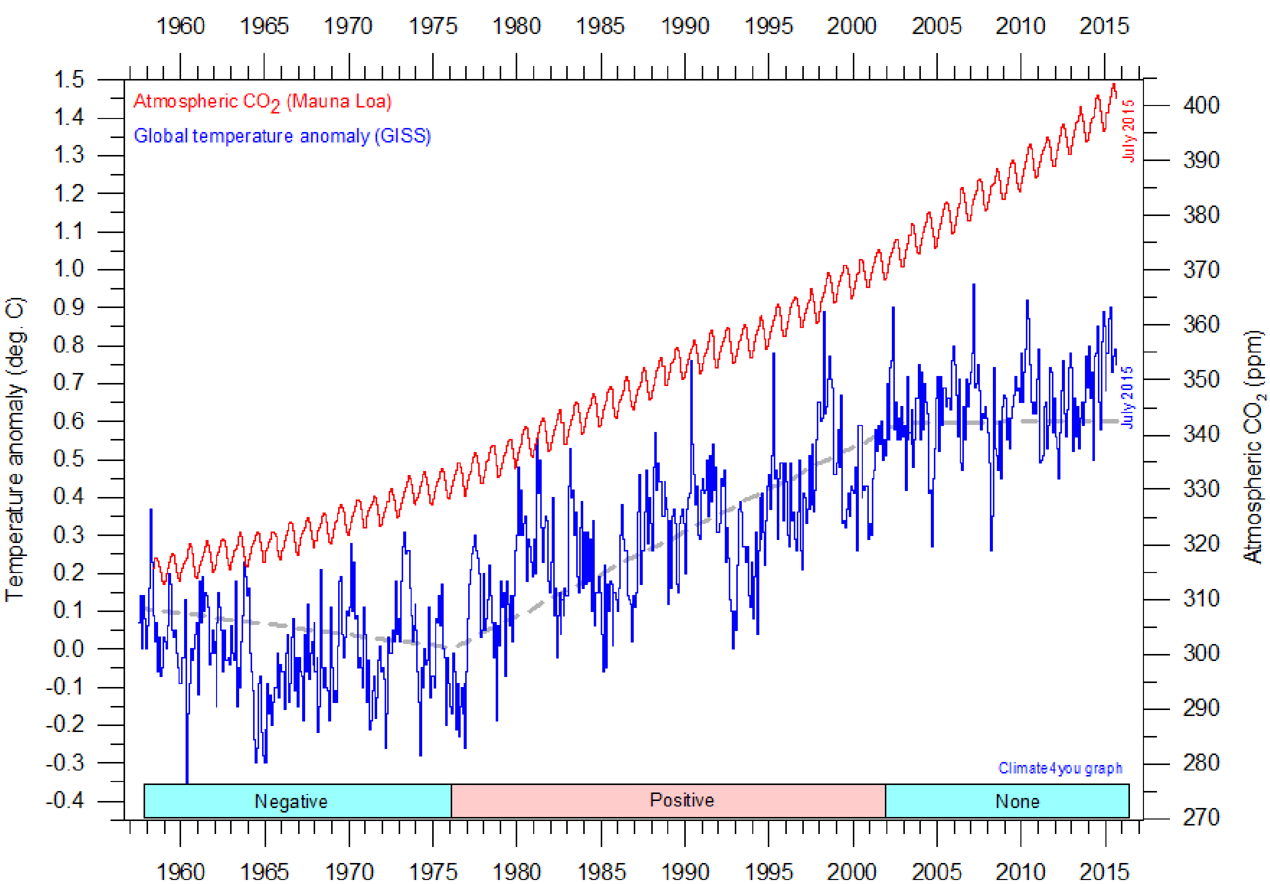
12-month change of global atmospheric CO_2 concentration (Mauna Loa; green), global sea surface temperature (HadSST3; blue) and global surface air temperature (HadCRUT4; red dotted). All graphs are showing monthly values of DIFF12, the difference between the average of the last 12 month and the average for the previous 12 months for each data series.

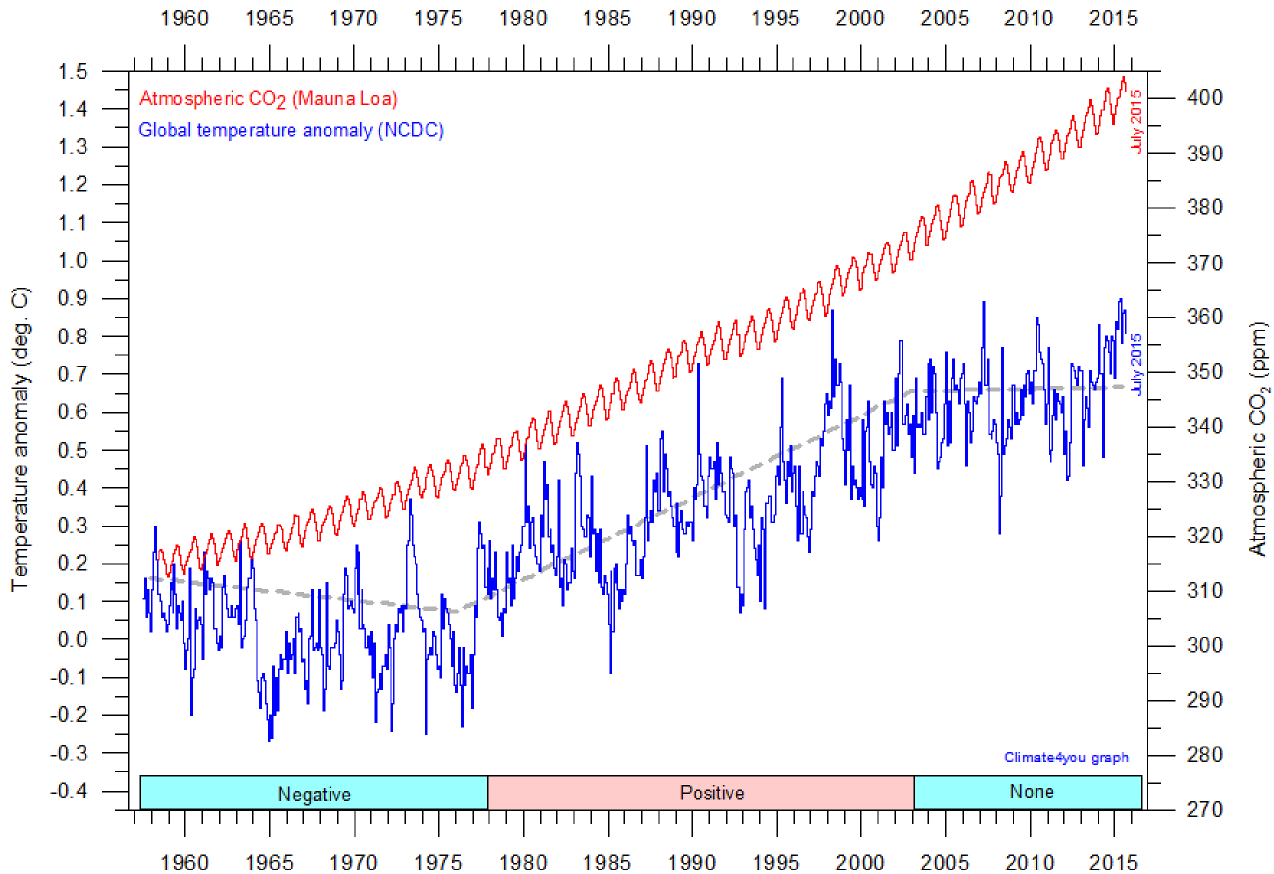
References:

Humlum, O., Stordahl, K. and Solheim, J-E. 2012. The phase relation between atmospheric carbon dioxide and global temperature. Global and Planetary Change, August 30, 2012.
http://www.sciencedirect.com/science/article/pii/S0921818112001658?v=s5

Global surface air temperature and atmospheric CO_2, updated to July 2015







Diagrams showing HadCRUT4, GISS, and NCDC monthly global surface air temperature estimates (blue) and the monthly atmospheric CO_2 content (red) according to the Mauna Loa Observatory, Hawaii. The Mauna Loa data series begins in March 1958, and 1958 was therefore chosen as starting year for the diagrams. Reconstructions of past atmospheric CO_2 concentrations (before 1958) are not incorporated in this diagram, as such past CO_2 values are derived by other means (ice cores, stomata, or older measurements using different methodology), and therefore are not directly comparable with direct atmospheric measurements. The dotted grey line indicates the approximate linear temperature trend, and the boxes in the lower part of the diagram indicate the relation between atmospheric CO_2 and global surface air temperature, negative or positive. Please note that the HadCRUT4 diagram is not yet updated beyond June 2015.

Most climate models assume the greenhouse gas carbon dioxide CO_2 to influence significantly upon global temperature. It is therefore relevant to compare different temperature records with measurements of atmospheric CO_2, as shown in the diagrams above. Any comparison, however, should not be made on a monthly or annual basis, but for a longer time period, as other effects (oceanographic, etc.) may well override the potential influence of CO_2 on short time scales such as just a few years. It is of cause equally inappropriate to present new meteorological record values, whether daily, monthly or annual, as support for the hypothesis ascribing high importance of atmospheric CO_2 for global temperatures. Any such meteorological record value may well be the result of other phenomena.

What exactly defines the critical length of a relevant time period to consider for evaluating the alleged importance of CO_2 remains elusive, and is still a topic for discussion. However, the critical period length must be inversely proportional to the temperature sensitivity of CO_2, including feedback effects. If the net temperature effect of atmospheric CO_2 is strong, the critical time period will be short, and vice versa.

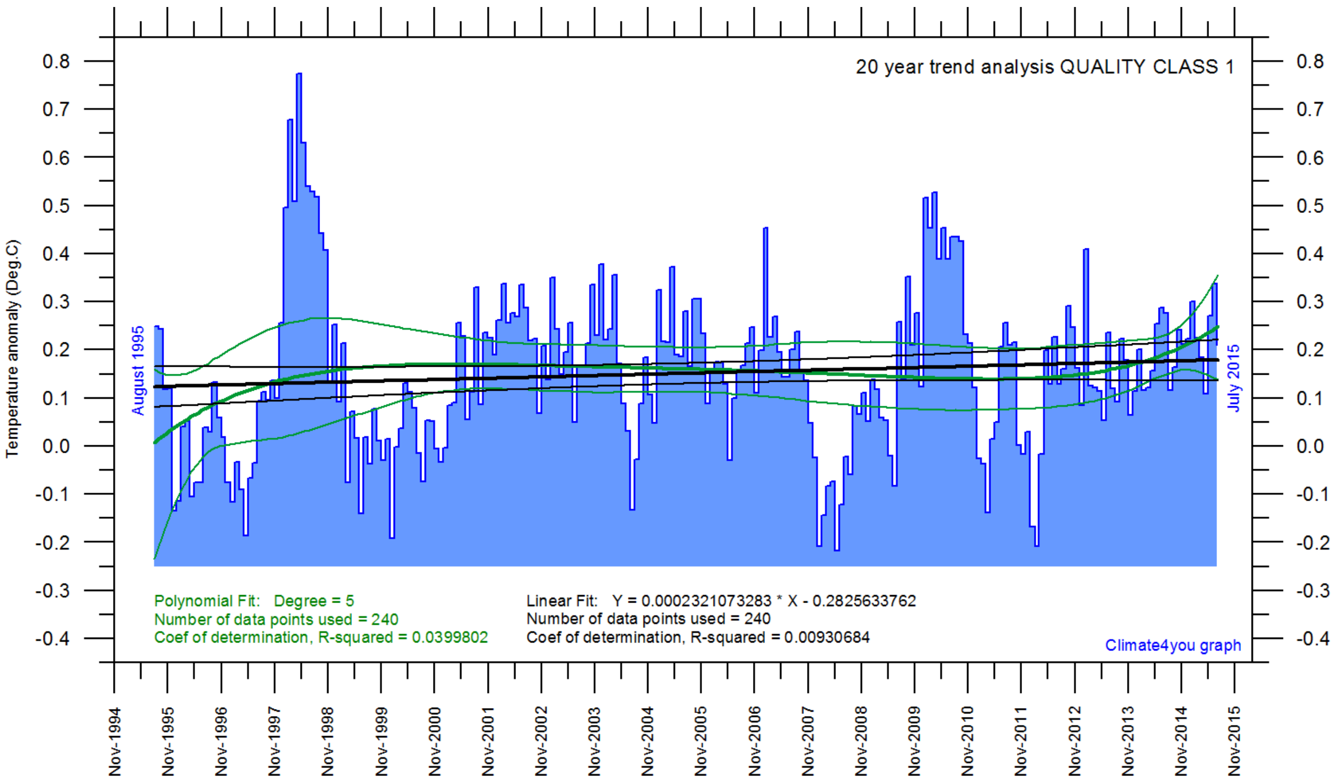
However, past climate research history provides some clues as to what has traditionally been considered the relevant length of period over which to compare temperature and atmospheric CO_2.

After about 10 years of concurrent global temperature- and CO_2-increase, IPCC was established in 1988. For obtaining public and political support for the CO_2-hyphotesis the 10 year warming period leading up to 1988 in all likelihood was important. Had the global temperature instead been decreasing, politic support for the hypothesis would have been difficult to obtain.

Based on the previous 10 years of concurrent temperature- and CO_2-increase, many climate scientists in 1988 presumably felt that their understanding of climate dynamics was sufficient to conclude about the importance of CO_2 for global temperature changes. From this it may safely be concluded that 10 years was considered a period long enough to demonstrate the effect of increasing atmospheric CO_2 on global temperatures.

Adopting this approach as to critical time length (at least 10 years), the varying relation (positive or negative) between global temperature and atmospheric CO_2 has been indicated in the lower panels of the diagrams above.

Last 20-year QC1 global monthly air temperature changes, updated to July 2015



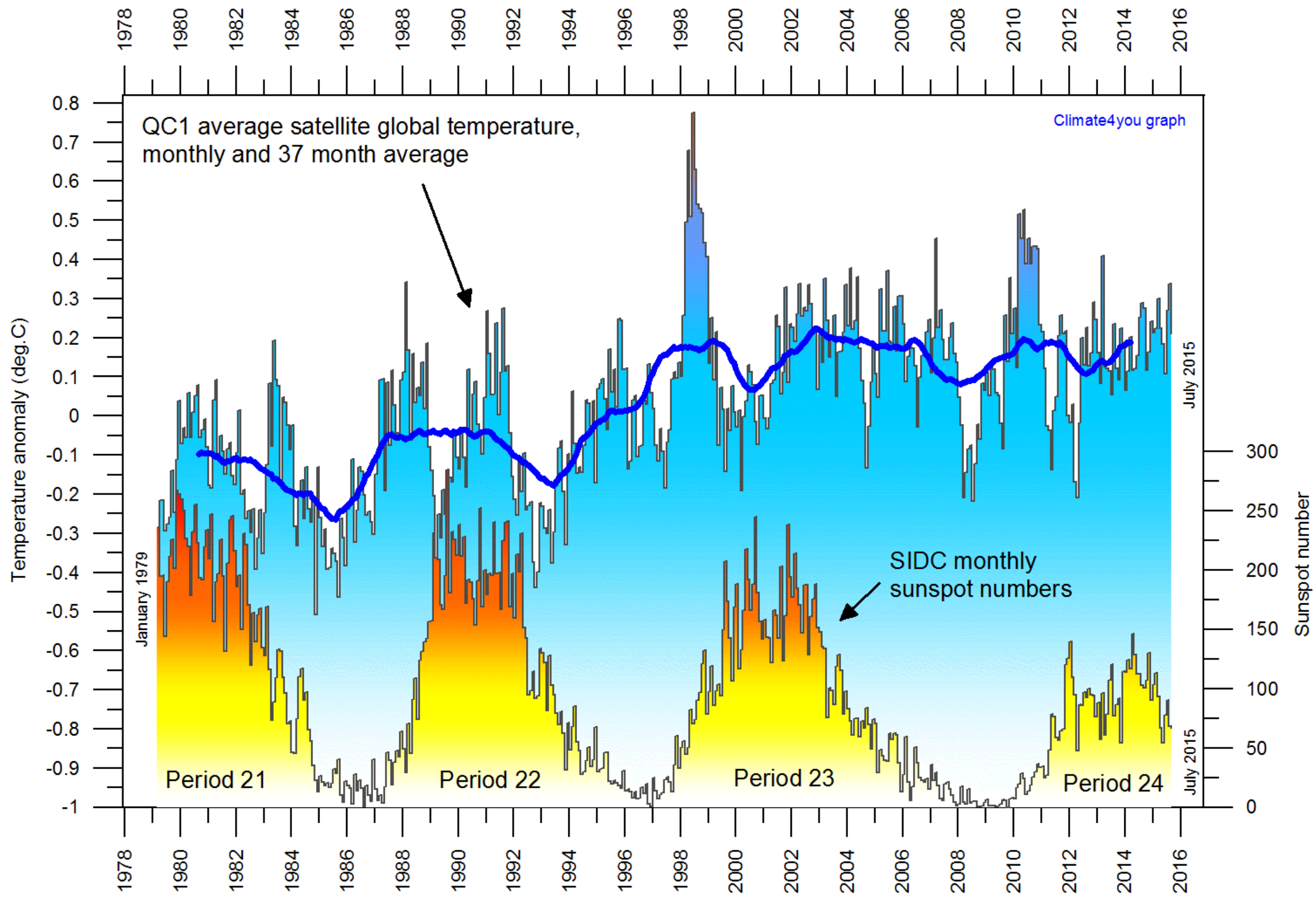
Last 20 years global monthly average air temperature according to Quality Class 1 (UAH and RSS; see p.10) global monthly temperature estimates. The thin blue line represents the monthly values. The thick black line is the linear fit, with 95% confidence intervals indicated by the two thin black lines. The thick green line represents a 5-degree polynomial fit, with 95% confidence intervals indicated by the two thin green lines. A few key statistics are given in the lower part of the diagram (please note that the linear trend is the monthly trend).

The question if the global surface air temperature still increases, or if the temperature has levelled out during the last 15-18 years, is often mentioned in the current climate debate. The above diagram may be useful in this context, and demonstrates the differences between two often used statistical approaches to determine recent temperature trends. Please also note that such fits only attempt to describe the past, and usually have limited predictive power. In addition, before using any linear trend (or other) analysis of time series a proper statistical model should be chosen, based on statistical justification.

For temperature time series there is no *a priori* physical reason why the long-term trend should be linear in time. In fact, climatic time series often have trends for which a straight line is not a good approximation, as can clearly be seen from several of the diagrams in the present report.

For an excellent description of problems often encountered by analyses of temperature time series analyses please see Keenan, D.J. 2014: Statistical Analyses of Surface Temperatures in the IPCC Fifth Assessment Report.

Sunspot activity and QC1 average satellite global air temperature



Variation of global monthly air temperature according to Quality Class 1 (UAH and RSS; see p.10) and observed sunspot number as provided by the Solar Influences Data Analysis Center (SIDC), since 1979. The thin lines represent the monthly values, while the thick lines is the simple running 37-month average, nearly corresponding to a running 3 yr average. The asymmetrical temperature 'bump' around 1998 are influenced by the oceanographic El Niño phenomenon in 1998.

Climate and history; one example among many

1950: Significance of the early 20th century Arctic warming in Greenland

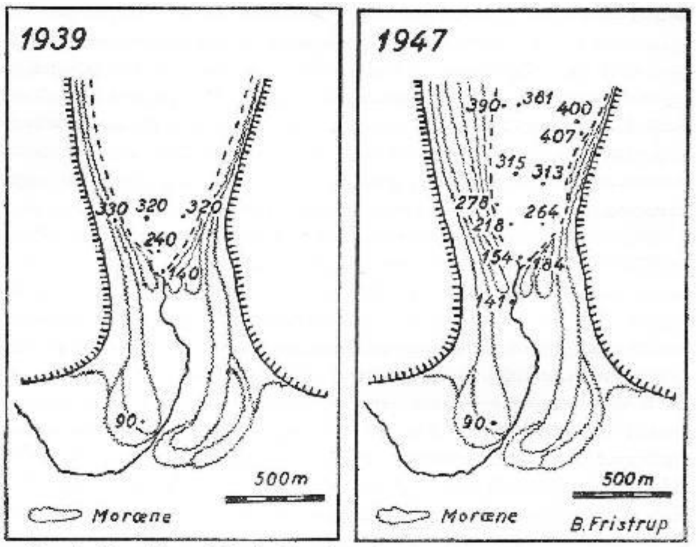
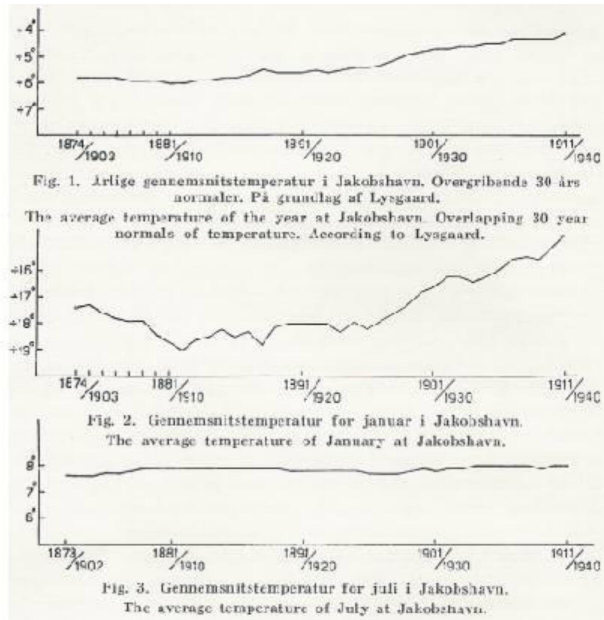


Fig. 4. Kortskitse af Freja Gletscher på Clavering Øen på grundlag af Ahlmann (1941–42).
Map of Freja Glacier on Clavering Island. According to Ahlmann (1941–42).



Maps showing retreat of Freja glacier on Clavering Island, NE Greenland, between 1939 and 1947 (north is towards left). In front of the glacier the terminal moraine from the Little Ice Age is seen (left; Figure 4 in Jensen and Fristrup (1950), based on Ahlmann (1941-1942). The distance from the moraine to the glacier front is about 900-1000 m. The numbers on the glacier indicate the altitude of the glacier surface in meters above sea level. Meteorological diagrams showing air temperature (deg. C) in Jakobshavn (now Ilulissat) 1874-1940, upper panel shows mean annual air temperature, mid panel shows January air temperature, and the lower panel shows July air temperature (right; Figure 3 in Jensen and Fristrup (1950)).

Ongoing Arctic climate change and its significance for Greenland was discussed by Jensen and Fristrup in an publication from 1950. The publication is in Danish, but in translation, part of their introduction states the following:

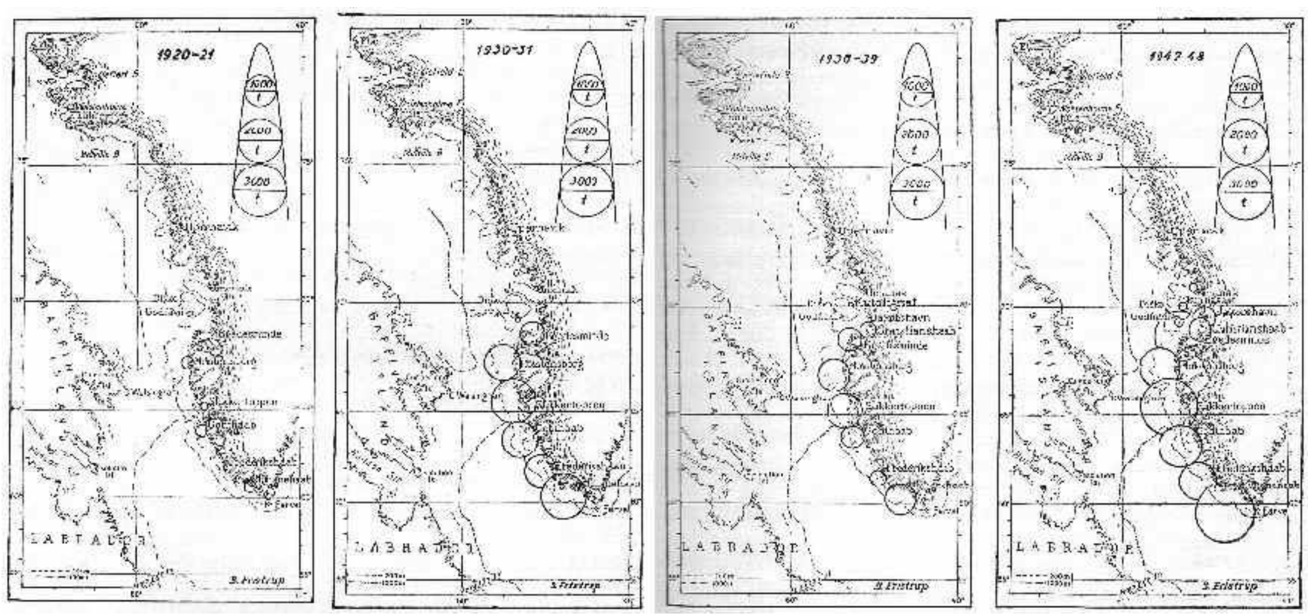
"Meteorological measurements in all regions of the Arctic show that a significant climatic change is taking place, and that this change is especially pronounced at high latitudes. The climate is becoming milder, especially during the winter. There is a larger number of publications addressing the reasons for this climatic change, and many theories for explanation have been suggested, however, without any of these has been proved correct".

Jensen and Fristrup (1950) draws attention to the long Greenlandic meteorological record from Jakobshavn (now: Ilulissat), initiated back in the year 1873. Here the average January air temperature 1874-1903 was -17.4ºC, while it has increased to -14.6ºC for the period 1911-1940. They also state that the winters especially around 1920 became warmer, and that the present January temperature now is 3.4ºC above the normal (at that time the so-called 'normal' period was 1891-1920). During the same period, there have only been small changes recorded for the summer (lower right panel in figure above).

See also the temperature diagram on page 26 in the present newsletter for an overview.

Many glaciers in Greenland were observed to retreat significantly since the onset of the early 20th century Arctic warming (Jensen and Fristrup 1950), and the Freia glacier map above is one example on this. Another example is the large calving Jakobshavn Isbræ in central West Greenland, which retreated no less than 10 km from 1888 to 1925 (Jensen and Fristrup 1950).

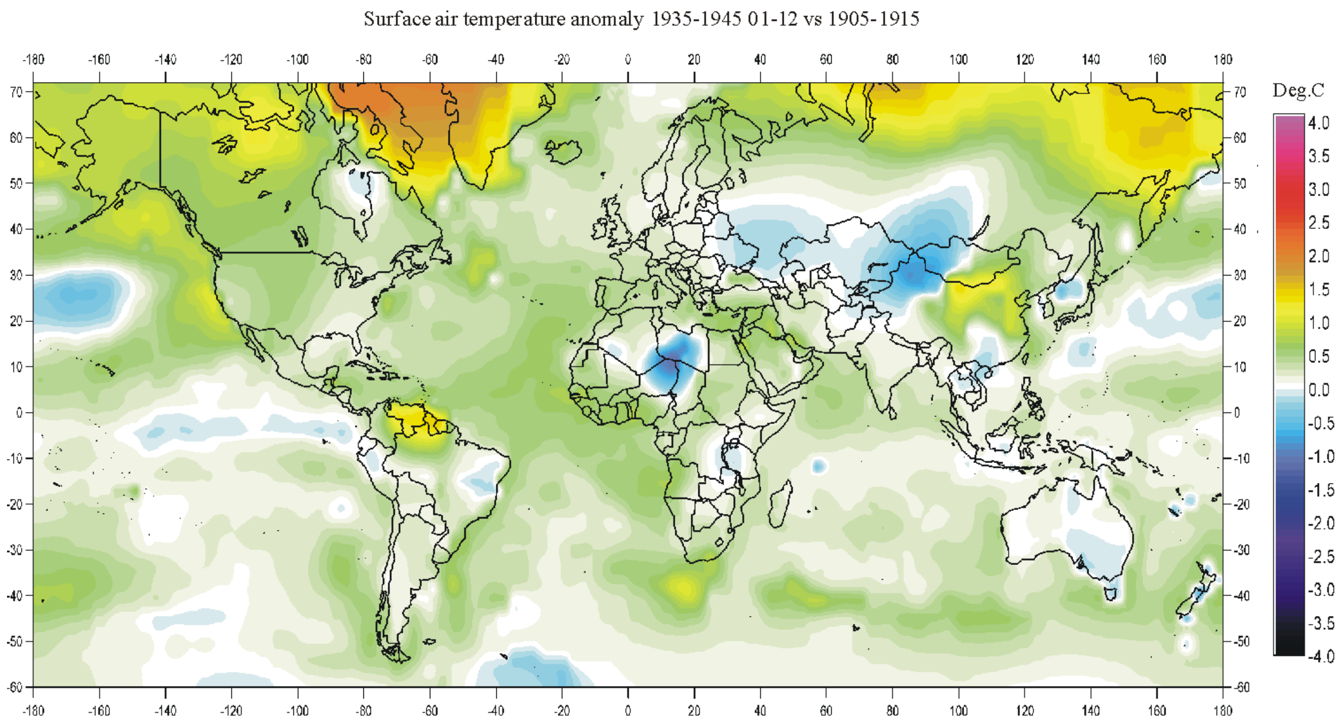
In addition to the widespread glacier retreat, Jensen and Fristrup (1950) also note that the Greenland sea ice now (1950) comes later and disappears earlier than previously. In southern Greenland, the quality of the fjord ice is reported being so bad in the years leading up to 1950, that the important seal hunting tradition with nets hanging below the ice have been abandoned. The amount of sea ice around South Greenland is now (1950) smaller than ever seen before during the period with regular observations (back to 1820). The change in sea ice was, however, especially rapid around 1920.



Map series showing development of cod fishing along the coast of SW Greenland in 1920-21, 1930-31, 1938-39 and 1947-48, from left to right. The diameter of the three scale-circles indicate 1000, 2000 and 3000 tonnes, respectively. These maps were originally published as figures 5-8 in Jensen and Fristrup (1950).

Finally, Jensen and Fristrup (1950) also draws attention to the fact, that along with the climatic change to warmer conditions, the cod fishing in Greenland has improved very much, especially in the years following 1920 (see diagrams below). Apparently, the Greenlandic cod immigrated from Icelandic waters within few years, shortly after 1920.

To illustrate the geographical extent of the early 20th century climatic warming described by Jensen and Fristrup (1950) the diagram on the following page shows the change in mean annual air temperature from the period 1900-1915 to the period 1930-1945. The temperature data are insufficient in the Polar Regions to allow good interpolation in the highest latitudes, but the available data clearly suggests a widespread Arctic warming in the early 20th century, and certainly pronounced in the West Greenland - Baffin Island region.



Map showing the change of the annual surface air temperature from 1900-1915 to 1930-1945; calculated by subtracting the 1900-1915 average from the 1930-1945 average. Green-yellow-red colours indicate warming during the period, and blue colours indicate cooling. Much of the northern hemisphere experienced warming during the early 20th century, but less so south of Equator. Temperature scale in degrees Celsius. Data source: NASA Goddard Institute for Space Studies (GISS).

Freja glacier in northern Clavering Island on August 15, 2012 (picture source: Google Earth). The 'F' is located over the upper, snow-covered part of the glacier. Further down the exposed grey glacier extends to about 1100 m from the Little Ice Age moraines, which are seen shortly beyond the mouth of the valley. Compare with Ahlmann's two maps from 1937 and 1947 above. The total length of the glacier (in 2012) is about 3.5 km. Please note that north is located down, to avoid the visual impression of inverted relief.

References:

Jensen, A.D.S. and Fristrup, B. 1950. Den arktiske klimaforandring og dens betydning, særligt for Grønland. *Geografisk Tidsskrift* 50, 20-47.

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All diagrams is this report, along with any supplementary information, including links to data sources and previous issues of this newsletter, are available on www.climate4you.com

Yours sincerely,

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August 20, 2015.