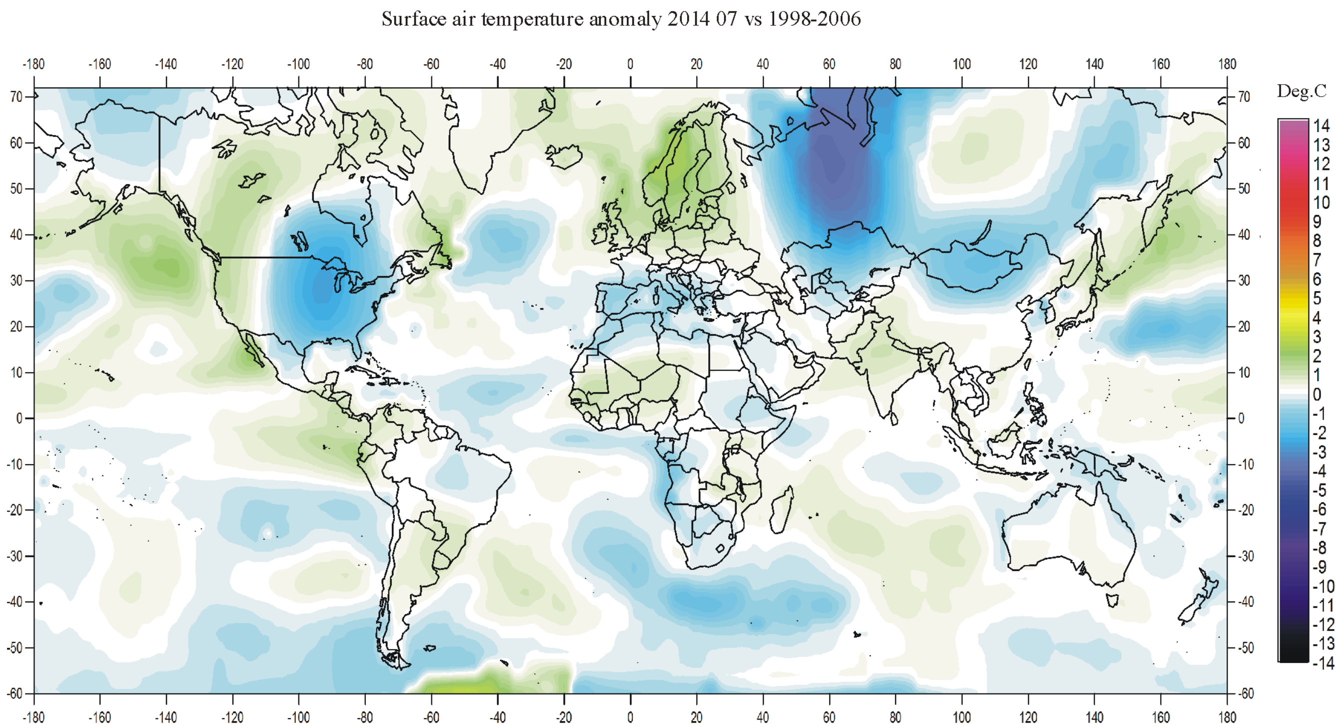
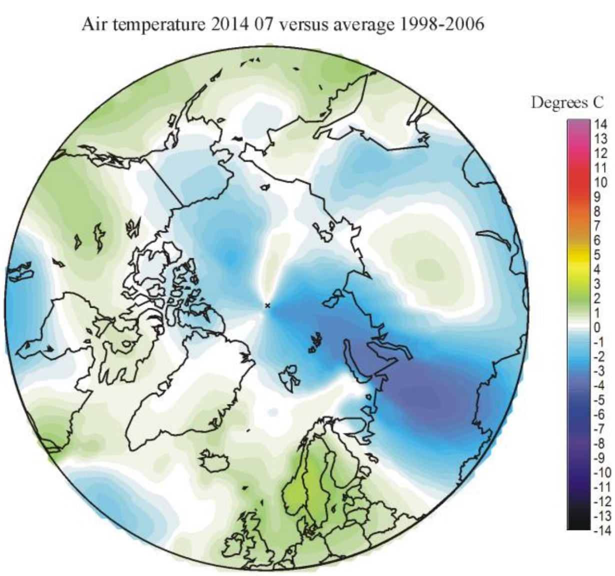
Climate4you update July 2014

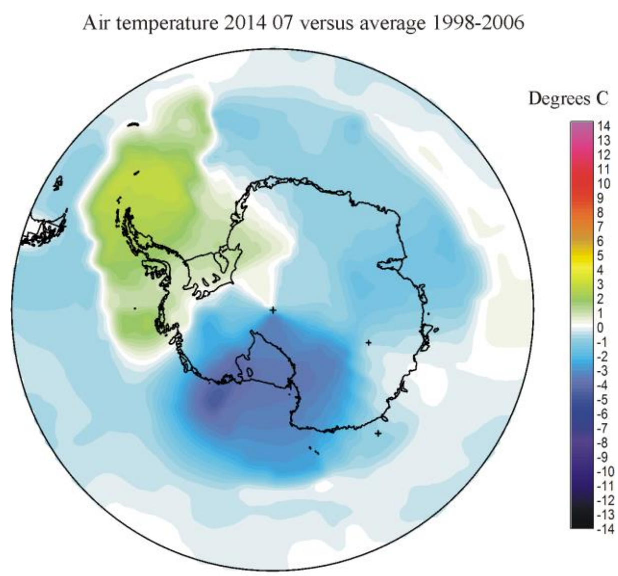
Contents:

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

[July 2014 global surface air temperature overview]







July 2014 surface air temperature compared to the June average 1998-2006. Green-yellow-red colours indicate areas with higher temperature than the 1998-2006 average, while blue colours indicate lower than average temperatures. Data source: [Goddard Institute for Space Studies] (GISS).

Comments to the July 2014 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 period 1998-2006 is 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 affected by the cold period 1945-1980. Most comparisons with such a low average value will therefore appear as warm, and it will be difficult to decide if modern surface air temperatures are increasing or decreasing. Comparing with a more recent period overcomes this problem.

In addition to the above consideration, the recent temperature development suggests that the time window 1998-2006 may roughly represent a global temperature peak (see, e.g., p. 4-6). However, it might be argued that the time interval 1999-2006 or 2000-2006 would better represent a possible temperature peak period. However, by starting in 1999 (or 2000) the cold La Niña period 1999-2000 would result in a unrealistic low reference temperature by excluding the previous warm El Niño in 1998. These two opposite phenomena must be considered together to obtain a representative reference average, and this why the year 1998 is included in the adopted reference period.

Finally, the GISS temperature data used for preparing the above diagrams show a pronounced temporal instability for data before 1998 (see p. 7). Any comparison with the WMO 'normal' period 1961-1990 is therefore influenced by monthly changing values for the so-called 'normal' period, which is therefore not suited as reference.

In the other diagrams 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 records have a much longer record length, which may be inspected in greater detail on www.Climate4you.com.

July 2014 global surface air temperatures

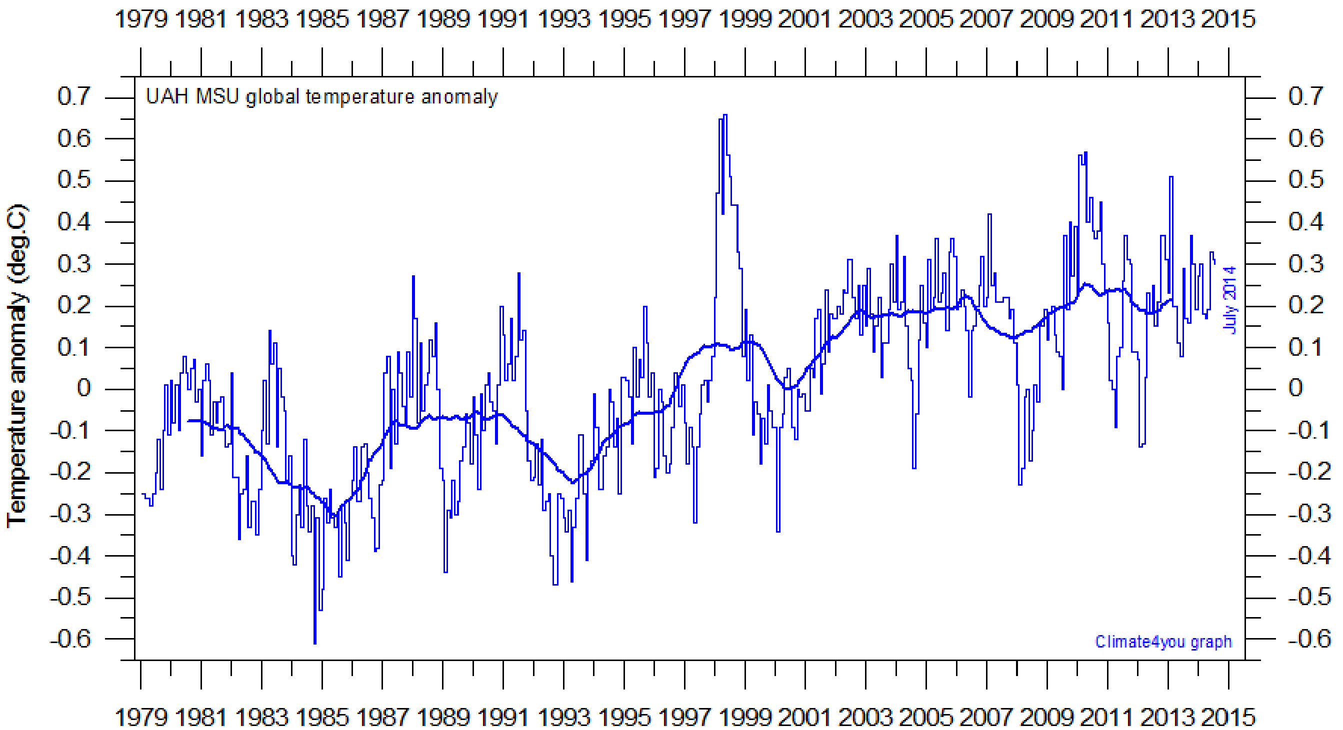
General: In general, the global air temperature was near the 1998-2006 July average.

The Northern Hemisphere was characterised by clear regional air temperature contrasts, although much smaller than during the NH-winter. Norway and Sweden experienced the largest positive anomaly compared to the 1998-2006 average, while western Russia experienced the largest negative anomaly. Alaska and eastern N America had relatively cold conditions, while NW Canada had relatively warm conditions. Most of Siberia had temperatures near or below the 1998-2006 average. Greenland was near average conditions. Most of the Arctic had below average temperatures, and the warm zones extending towards the North Pole are mainly the result of the GISS interpolation technique, and should not be over interpreted.

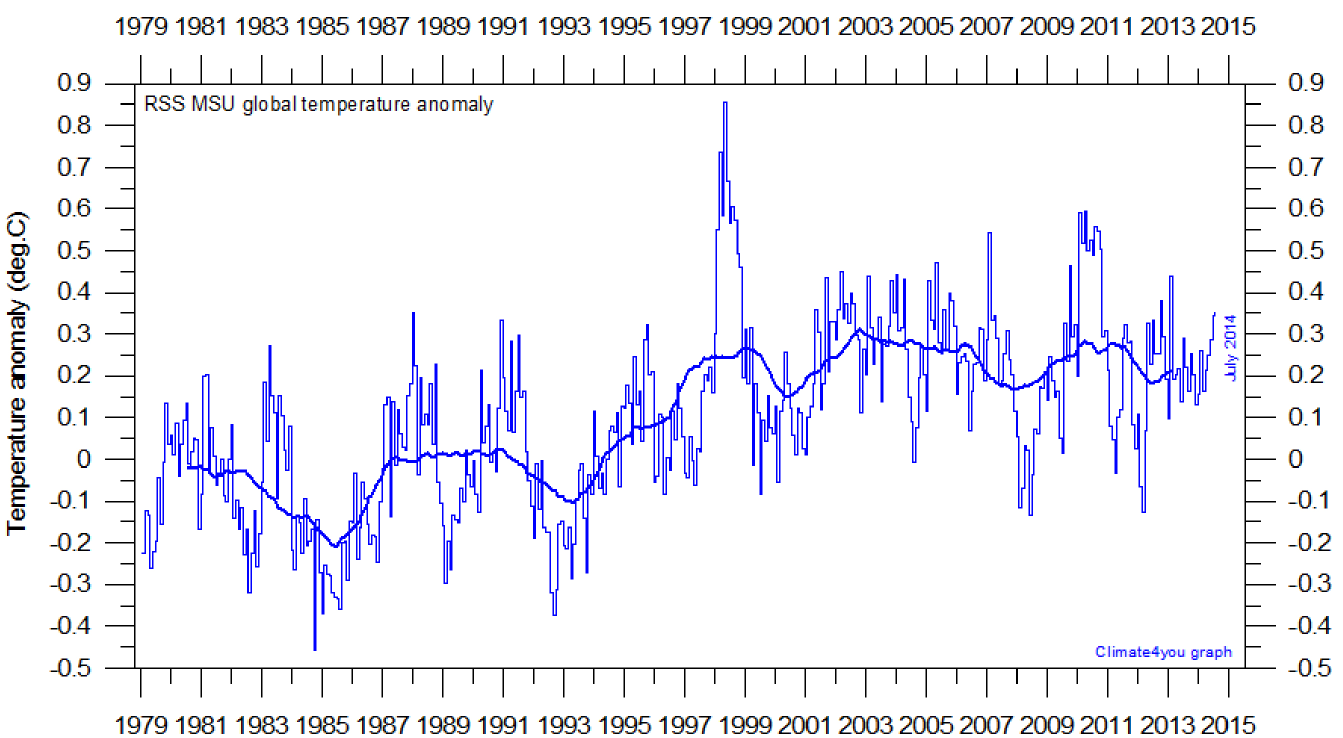
Near the Equator temperatures conditions were generally near the 1998-2006 average.

The Southern Hemisphere temperatures were mainly near or below average 1998-2006 conditions. The only major exception from this was the region surrounding the Antarctic Peninsula.

Lower troposphere temperature from satellites, updated to July 2014

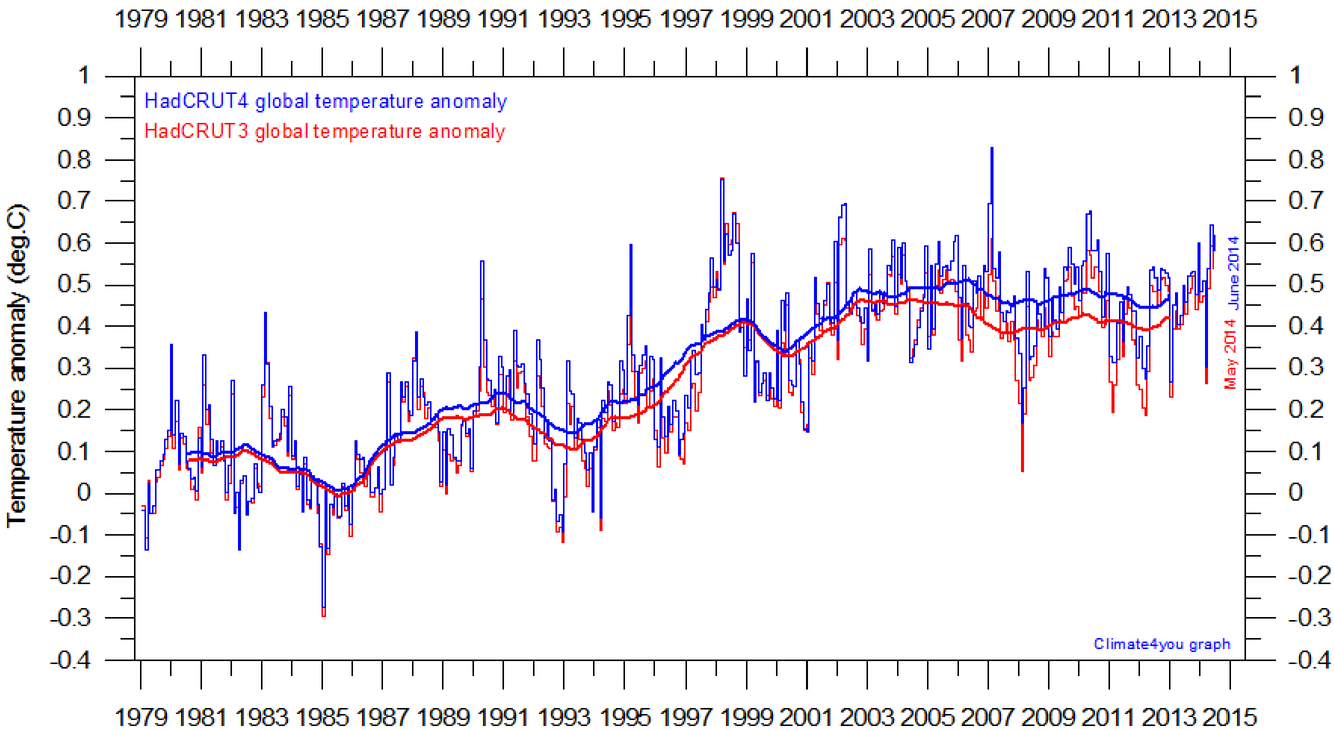


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37-month average.

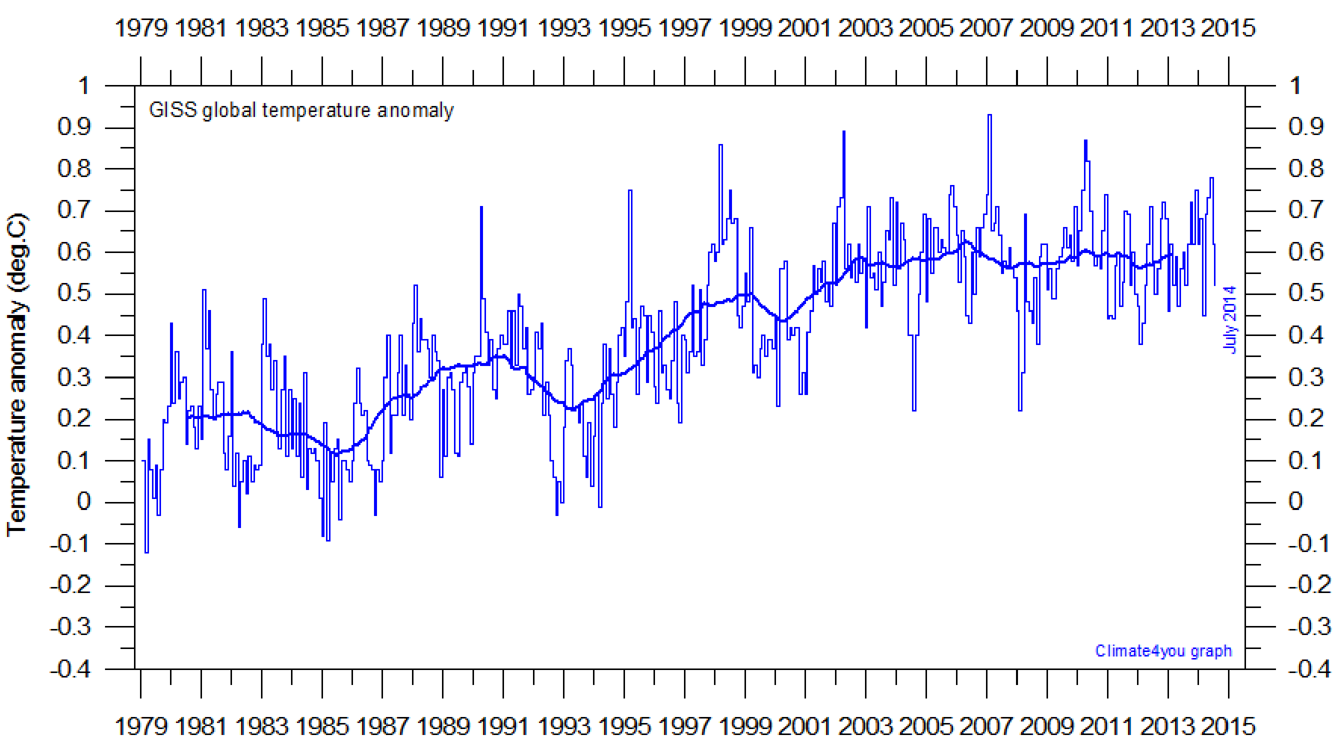


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37-month average.

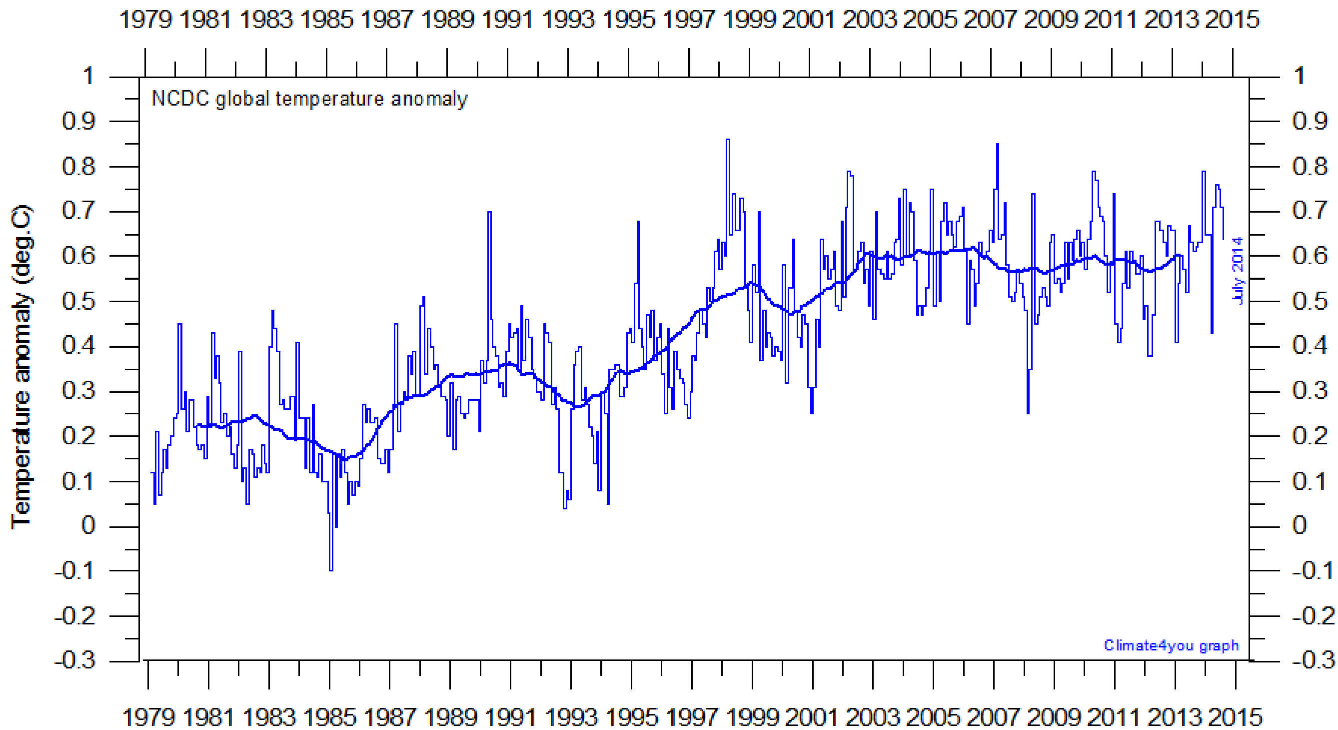
Global surface air temperature, updated to July 2014



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 2013.



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.

A note on data record stability:

All the above temperature estimates display changes when one compare with previous monthly data sets, not only for the most recent months as a result of supplementary data being added, but actually for all months back to the very beginning of the records, more than 100 years ago. Presumably this reflects recognition of errors, changes in the averaging procedure, and the influence of other unknown phenomena.

None of the temperature records are stable over time (since 2008). The two surface air temperature records, NCDC and GISS, show apparent systematic changes over time. This is exemplified the diagram on the following page showing the changes since May 2008 in the NCDC global surface temperature record for January 1915 and January 2000, illustrating how the difference between the early and late part of the temperature records gradually is growing by administrative adjustments.

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

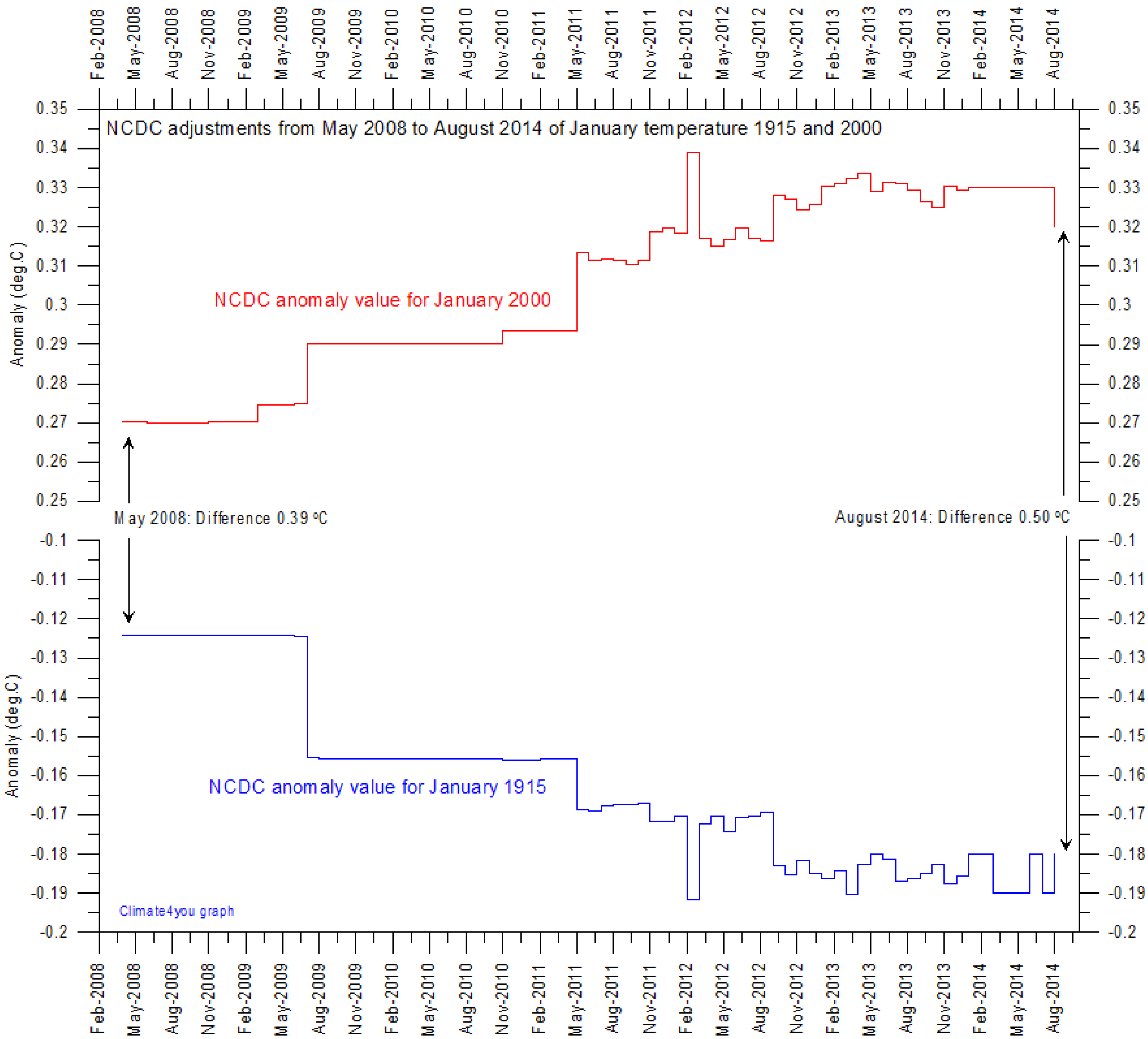


Diagram showing the adjustment made since May 2008 by the [National Climatic Data Center](#) (NCDC) in the anomaly values for the two months January 1915 and January 2000.

<u>Note:</u> The administrative upsurge of the temperature increase between January 1915 and January 2000 has grown from 0.39 (May 2008) to 0.50 °C (August 2014), representing an about 28% administrative temperature increase over this period.

[Global air temperature linear trends updated to June 2014]

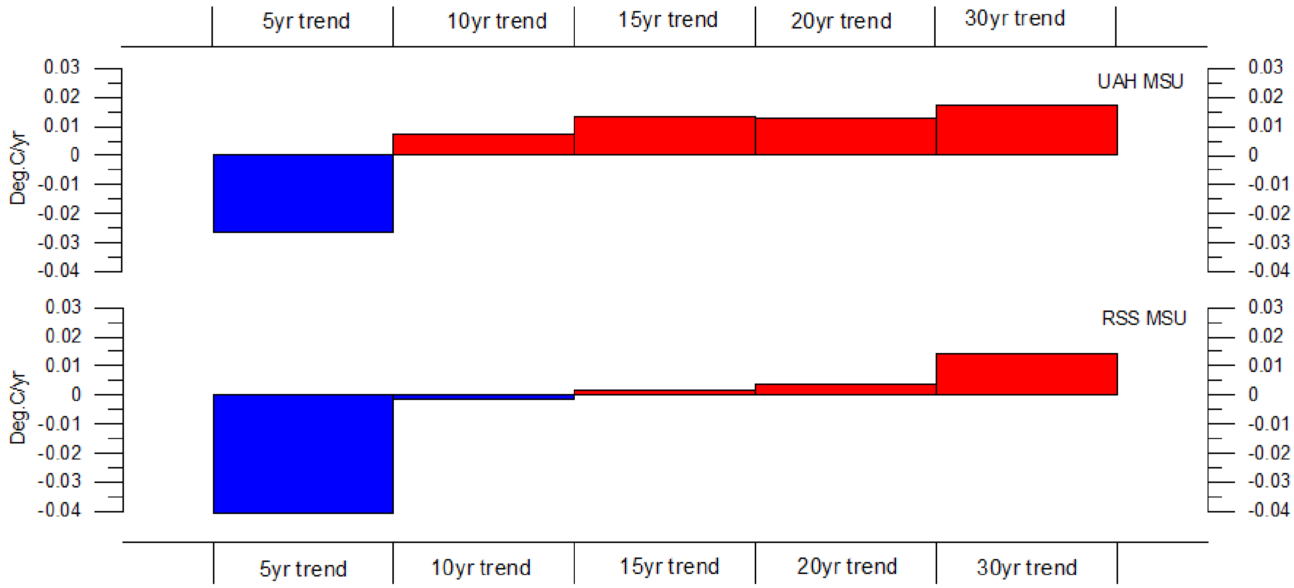


Diagram showing the latest 5, 10, 20 and 30 yr linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for two satellite-based temperature estimates (UAH MSU and RSS MSU). Last month included in analysis: June 2014.

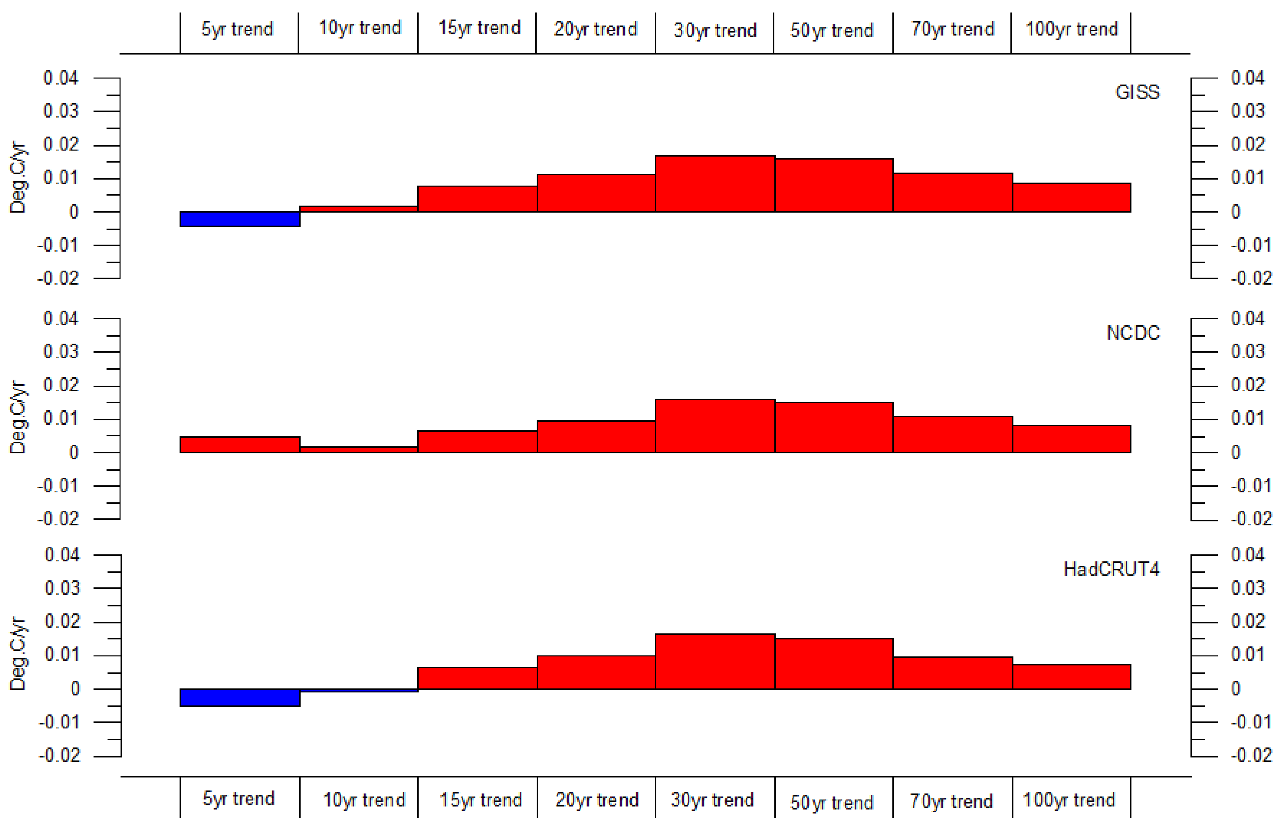
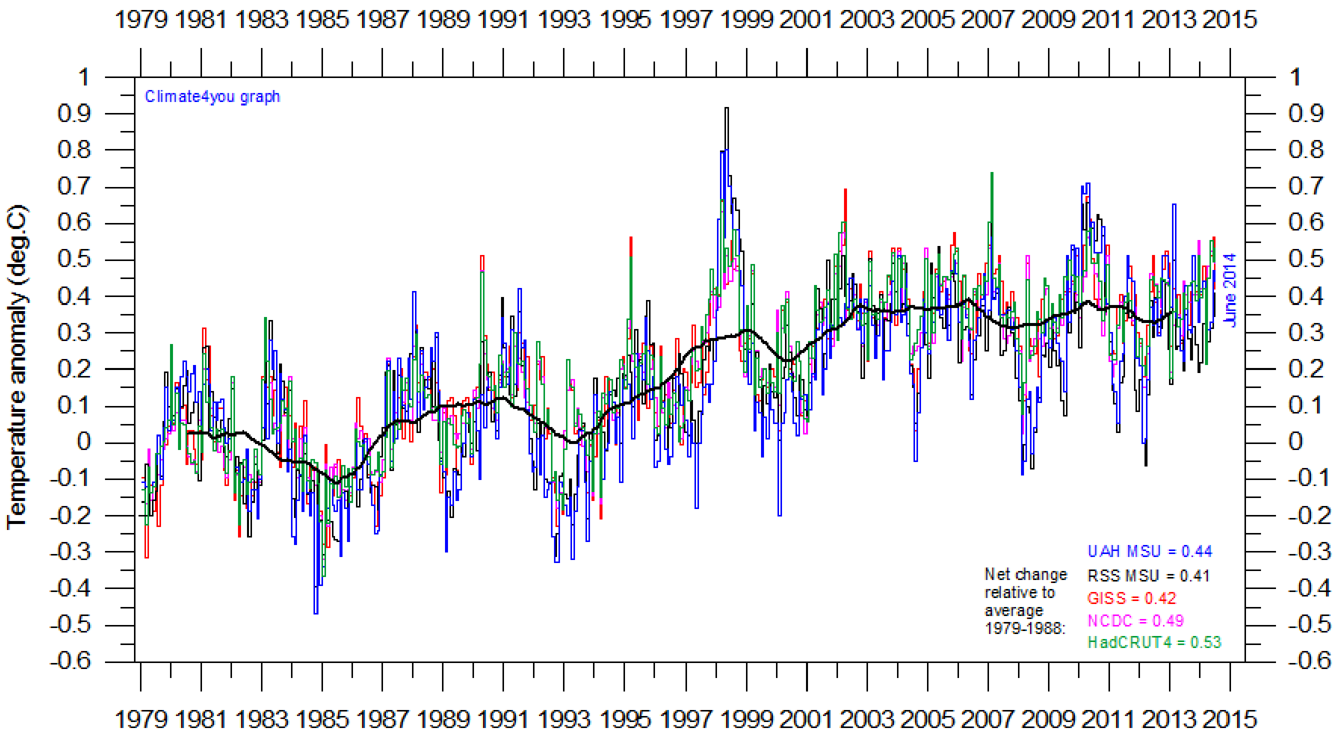


Diagram showing the latest 5, 10, 20, 30, 50, 70 and 100 year linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for three surface-based temperature estimates (GISS, NCDC and HadCRUT4). Last month included in all analyses: June 2014.

All in one, updated to June 2014

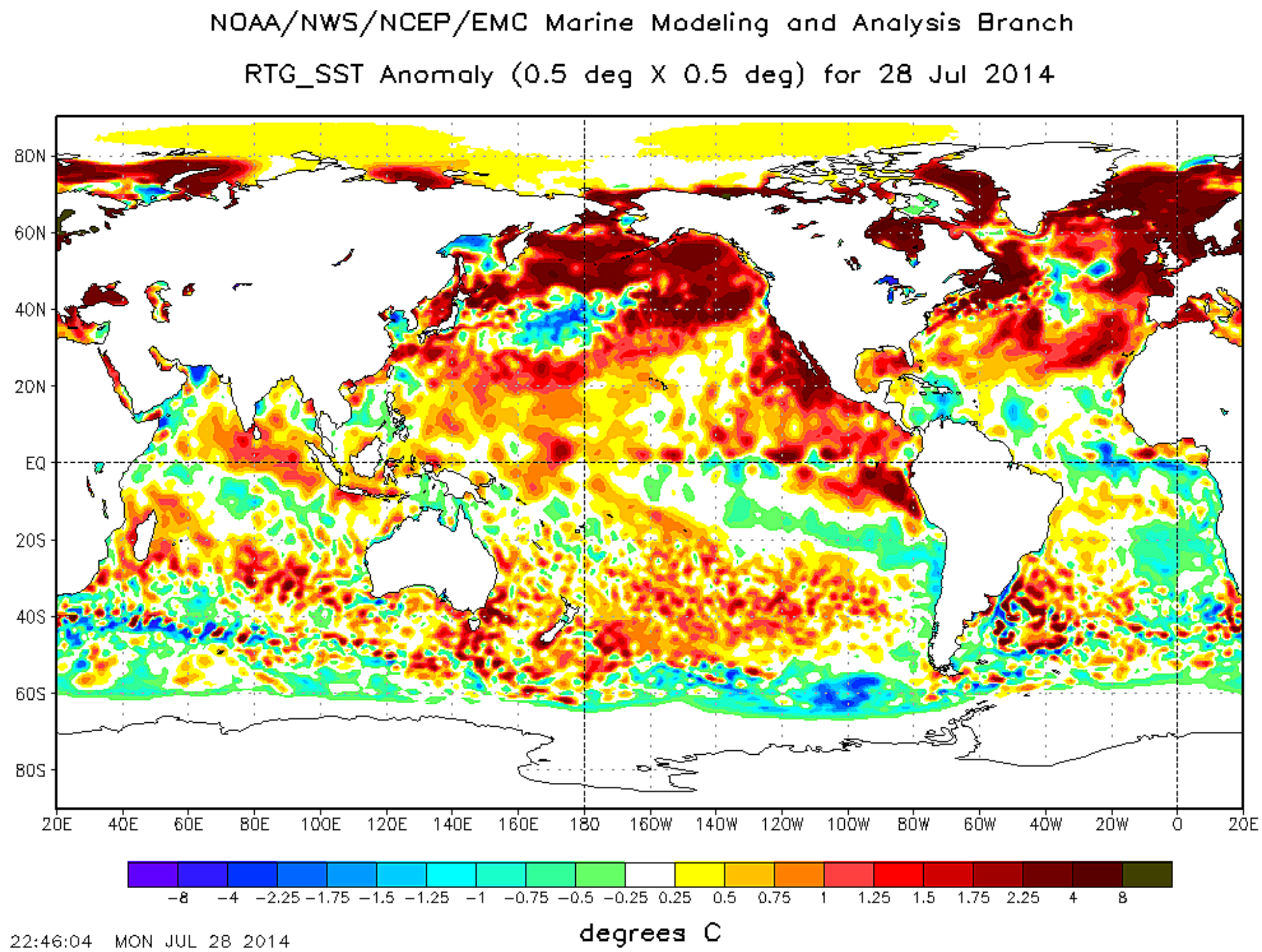


Superimposed plot of all five global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (10 years) from January 1979 to December 1988. The heavy black line represents 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.

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 late July 2014



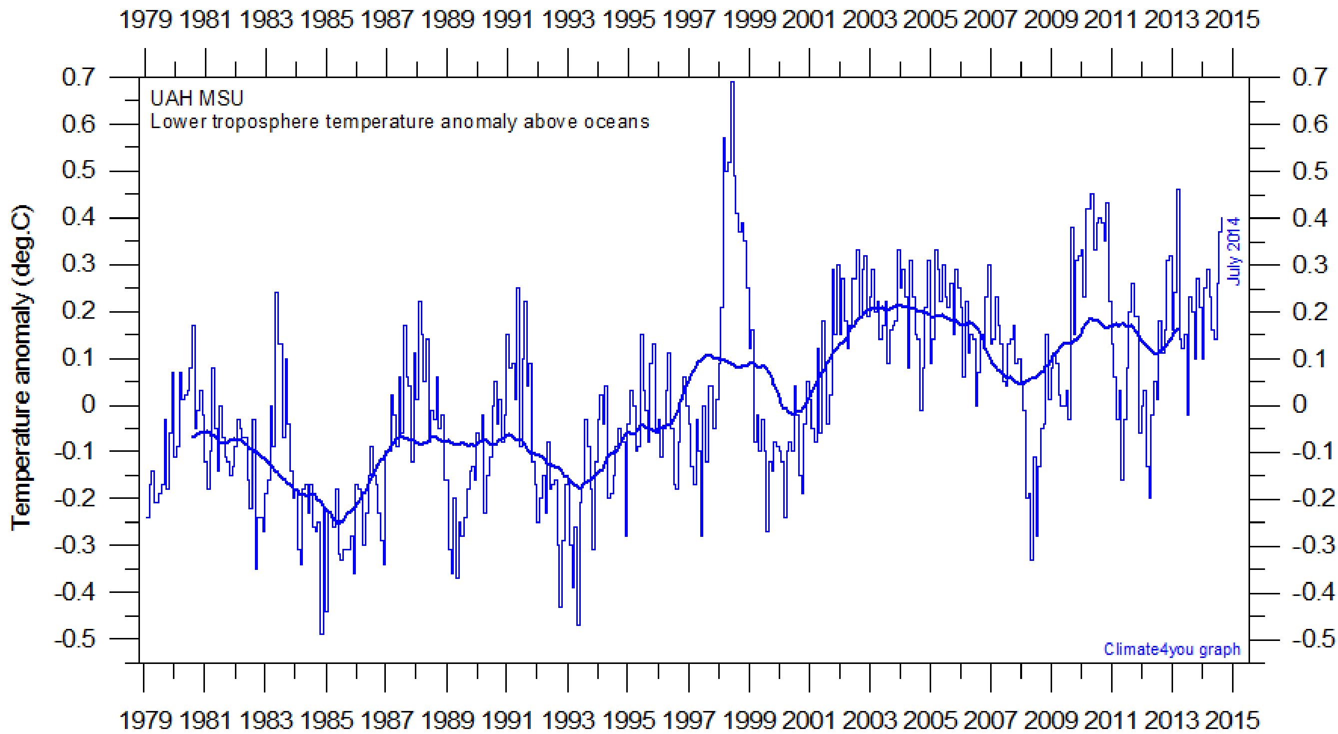
Sea surface temperature anomaly on 28 July 2014. Map source: National Centers for Environmental Prediction (NOAA).

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).

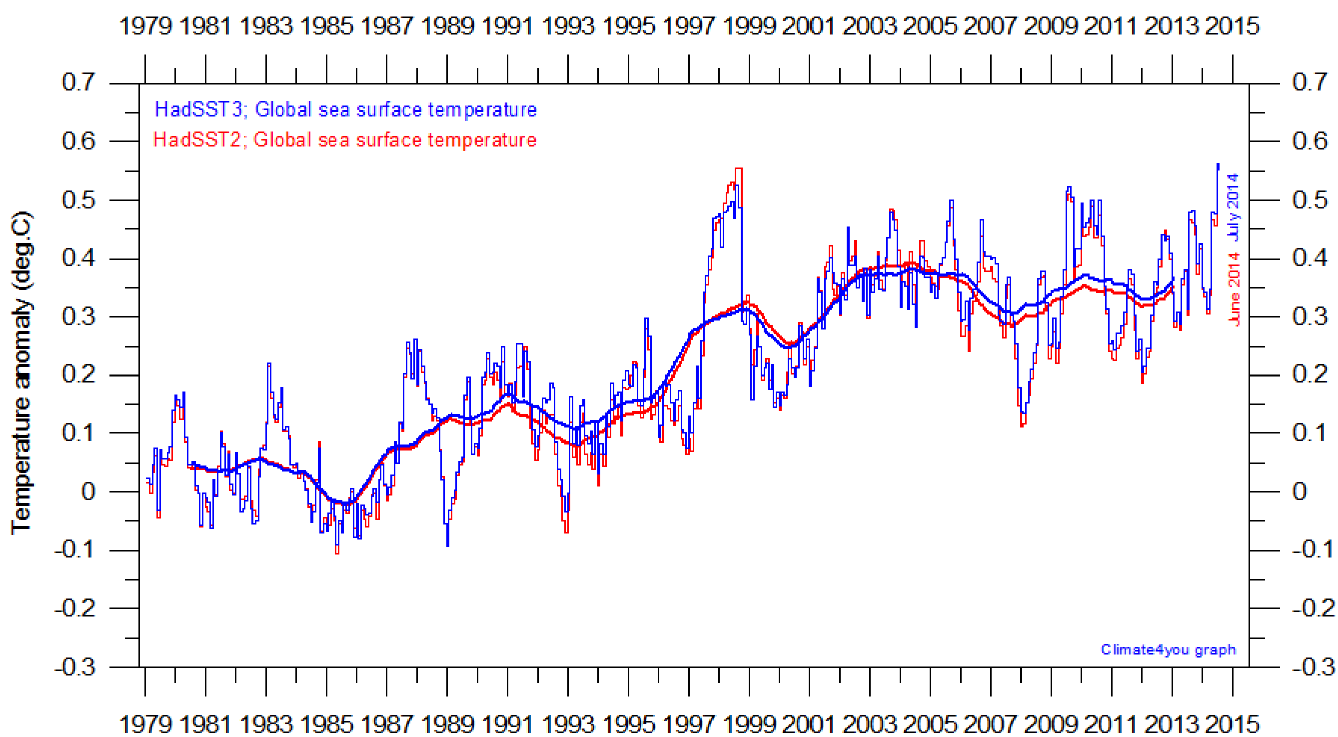
Relatively warm water is dominating the Pacific Ocean and Indian Ocean near the Equator, and is influencing global air temperatures now and in the months to come.

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.

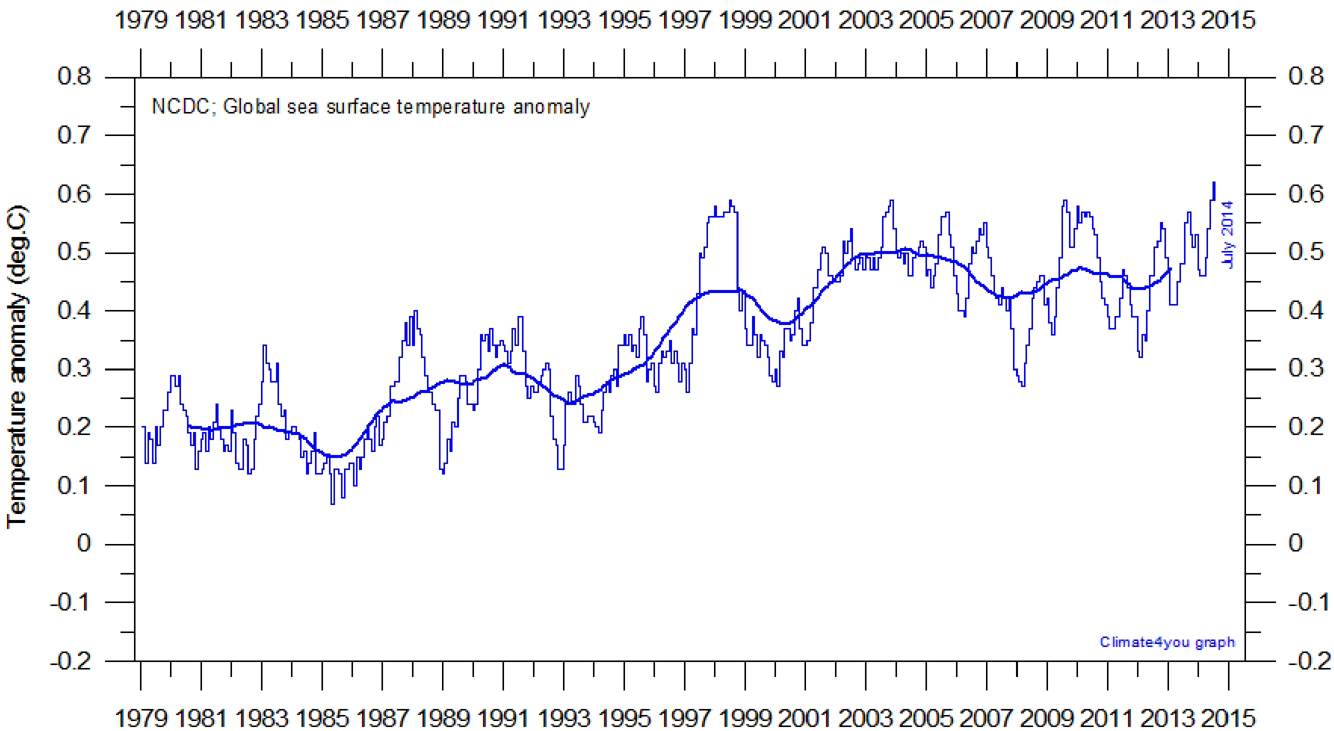
However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, global net changes can be small and such heat exchanges may mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when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

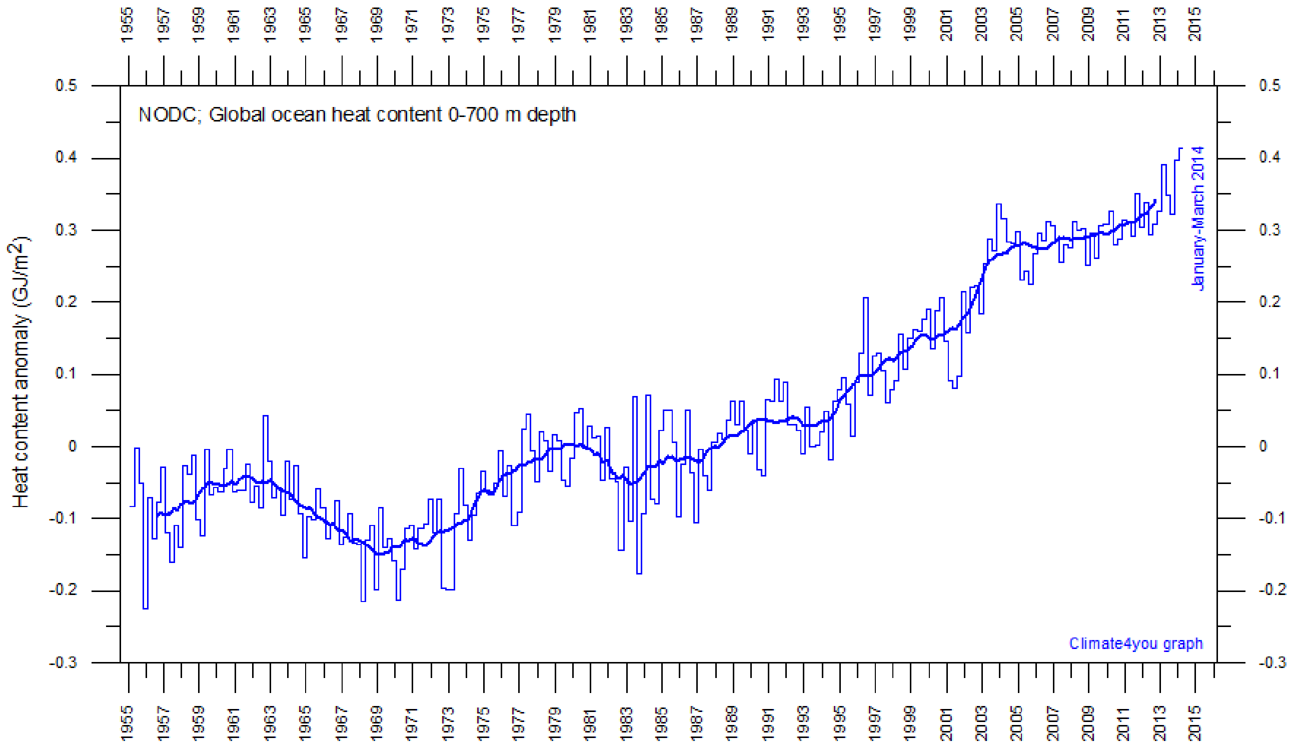


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit](#) ([CRU](#)), UK. Base period: 1961-1990. The thick line is the simple running 37-month average.

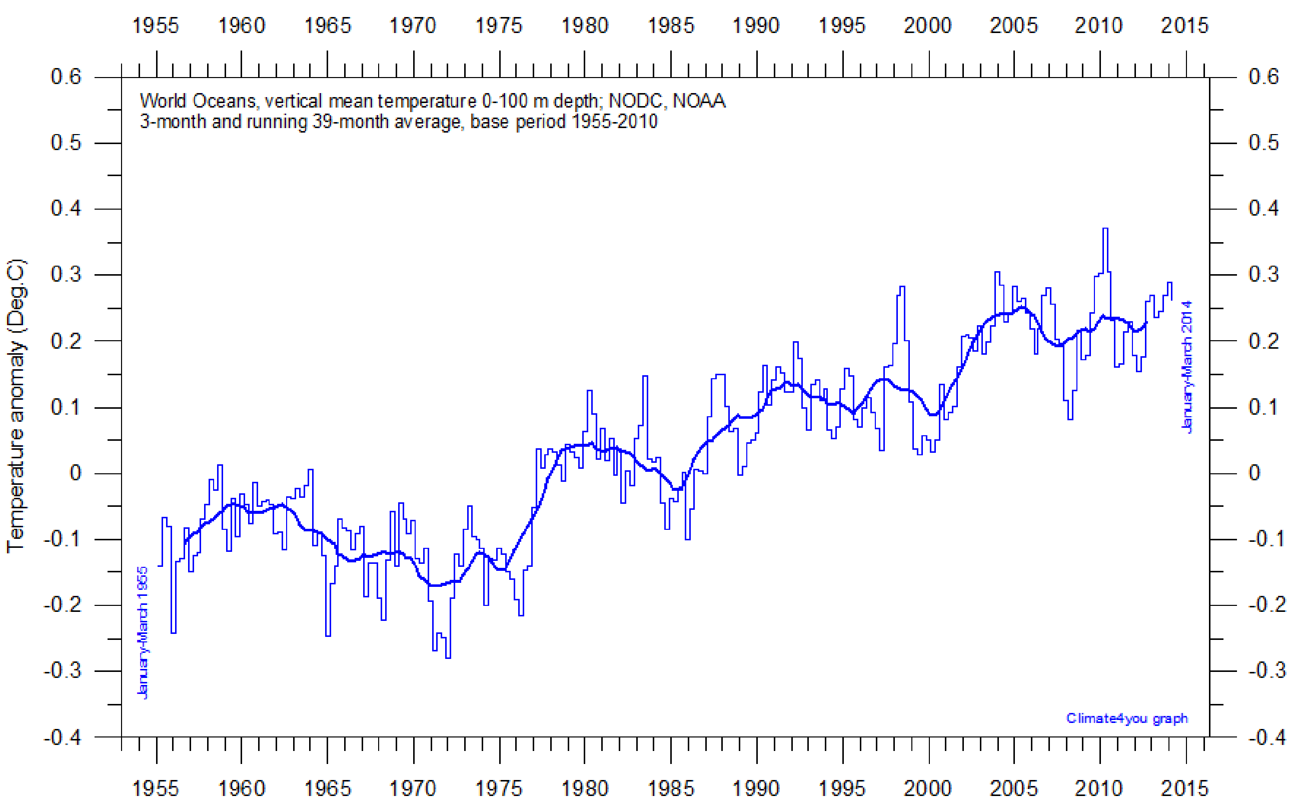


Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center](#) (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37-month average.

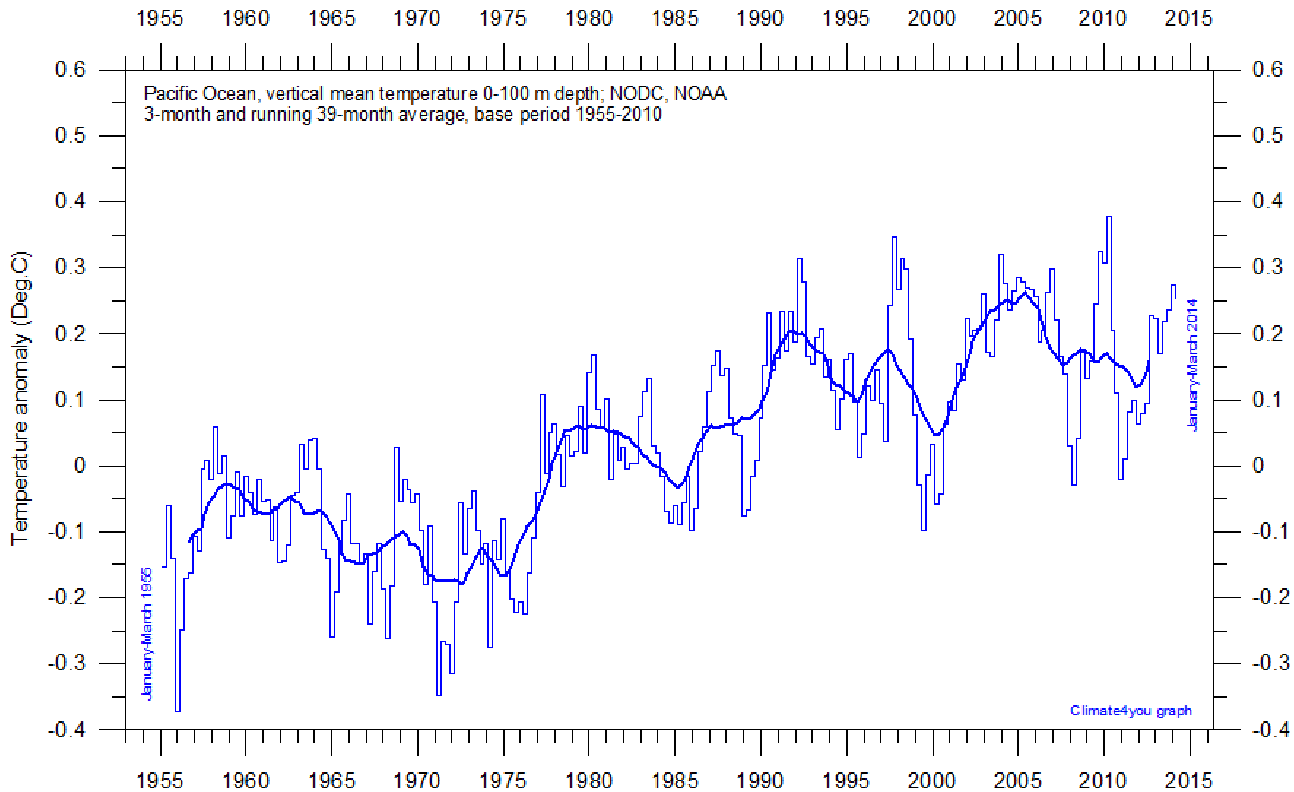
Ocean heat content uppermost 100 and 700 m, updated to March 2014



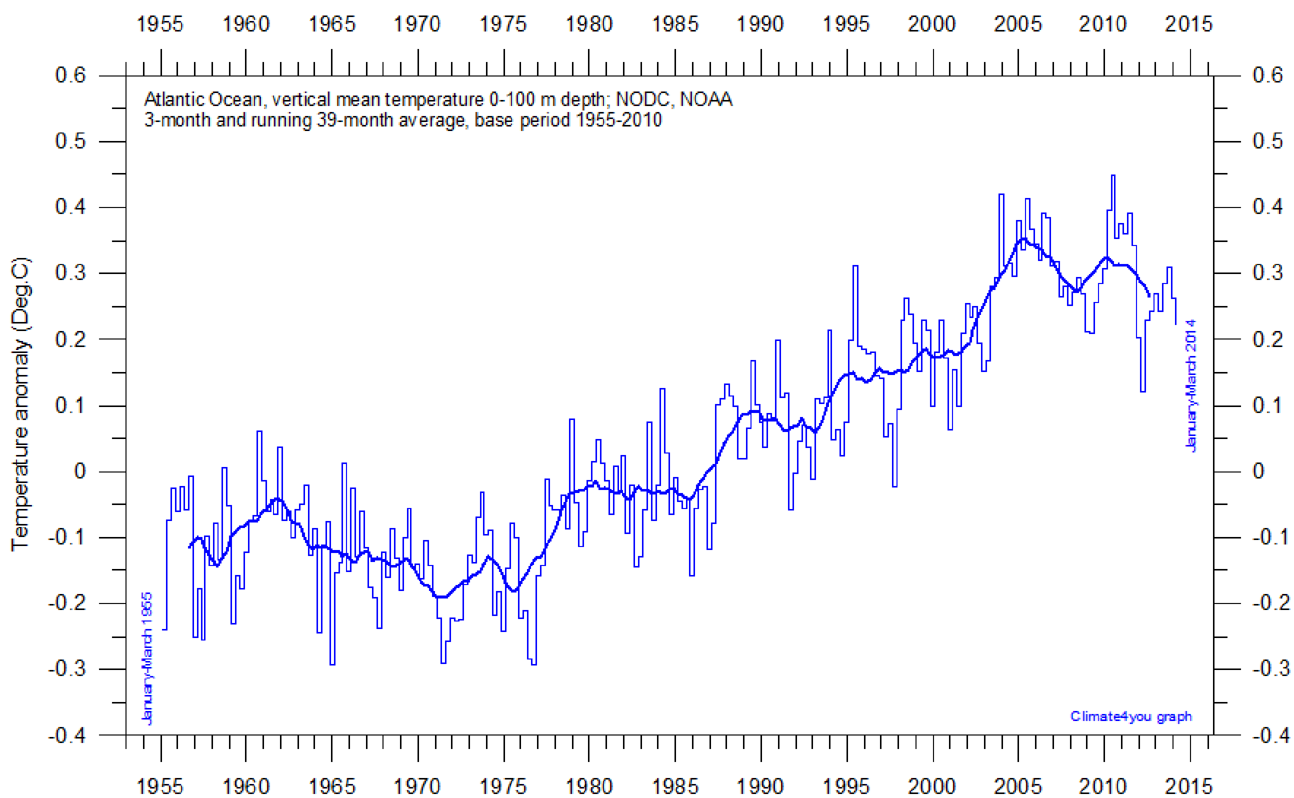
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1955. Data source: National Oceanographic Data Center(NODC).



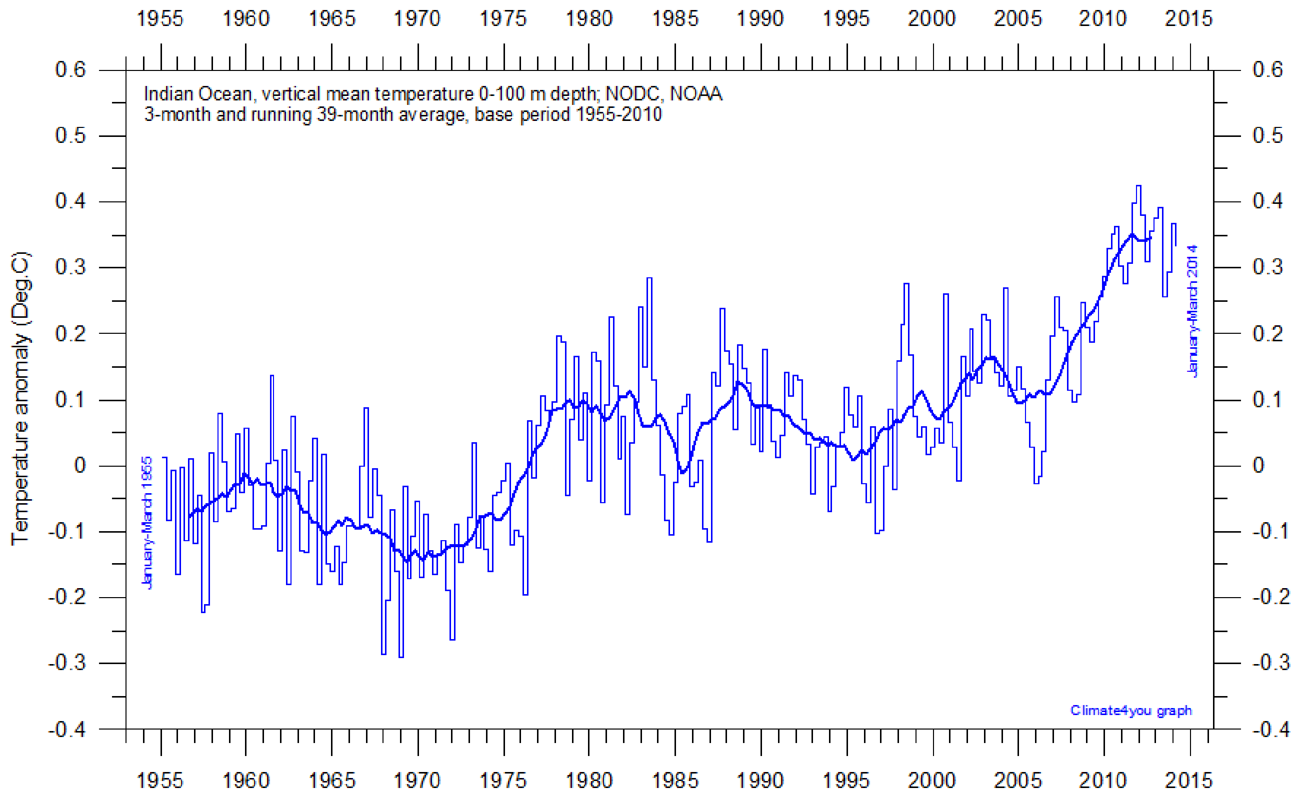
World Oceans vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: [NOAA National Oceanographic Data Center] (NODC). Base period 1955-2010.



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.

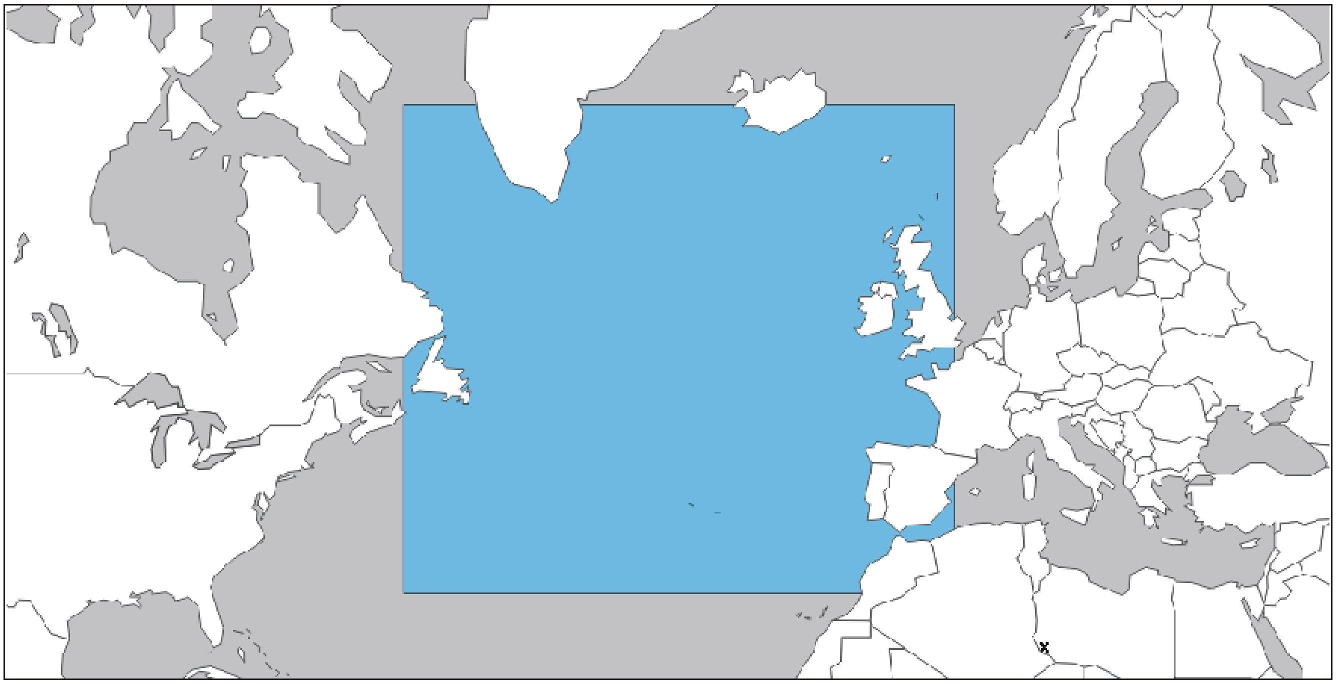


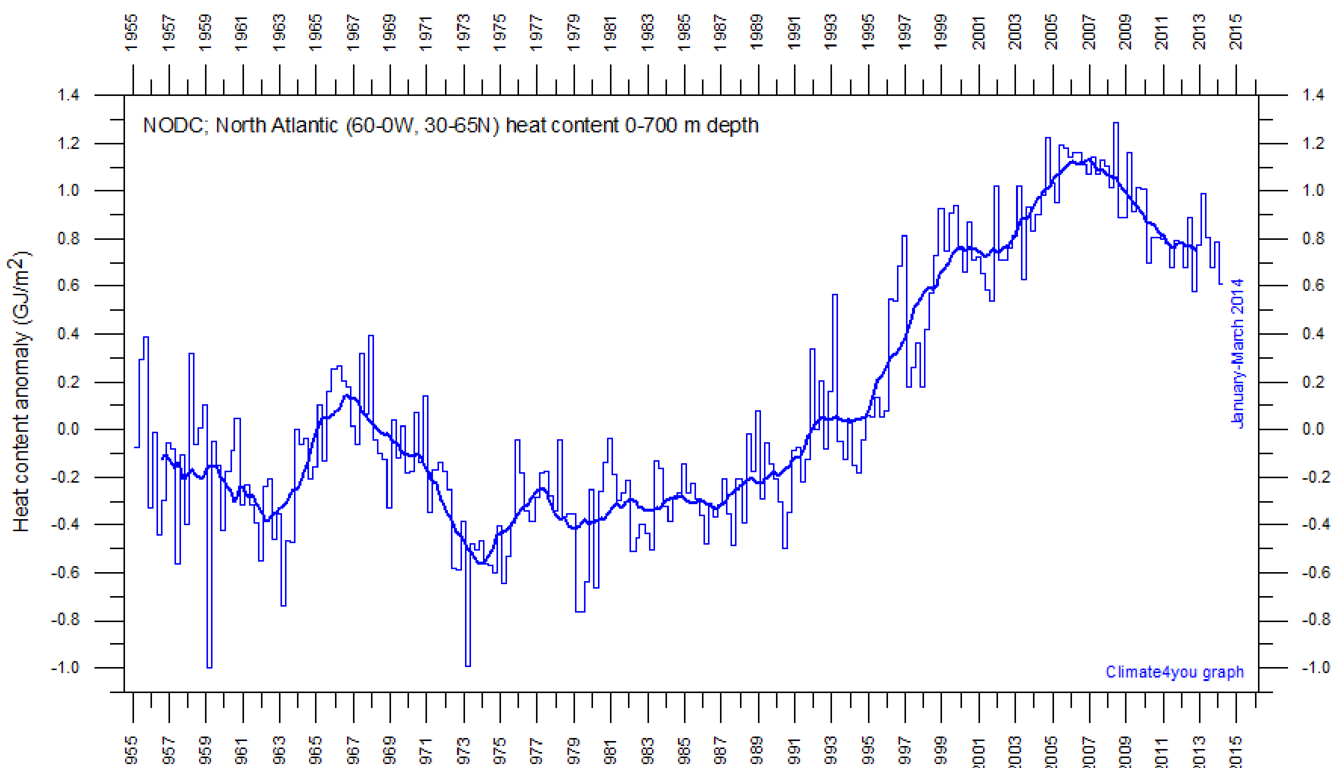
Atlantic Ocean vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: [NOAA National Oceanographic Data Center](#) (NODC). Base period 1955-2010.



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.

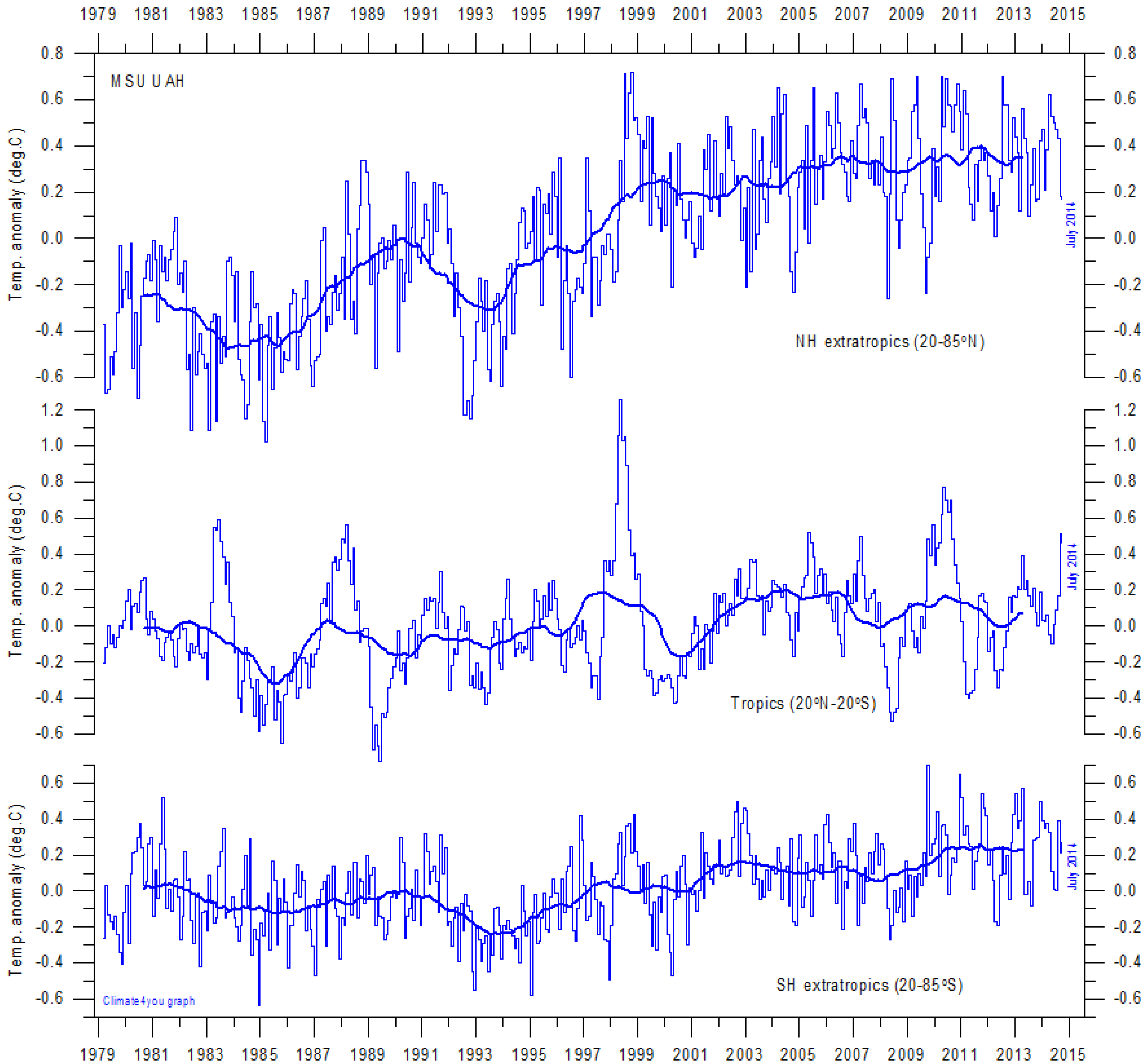
North Atlantic heat content uppermost 700 m, updated to March 2014





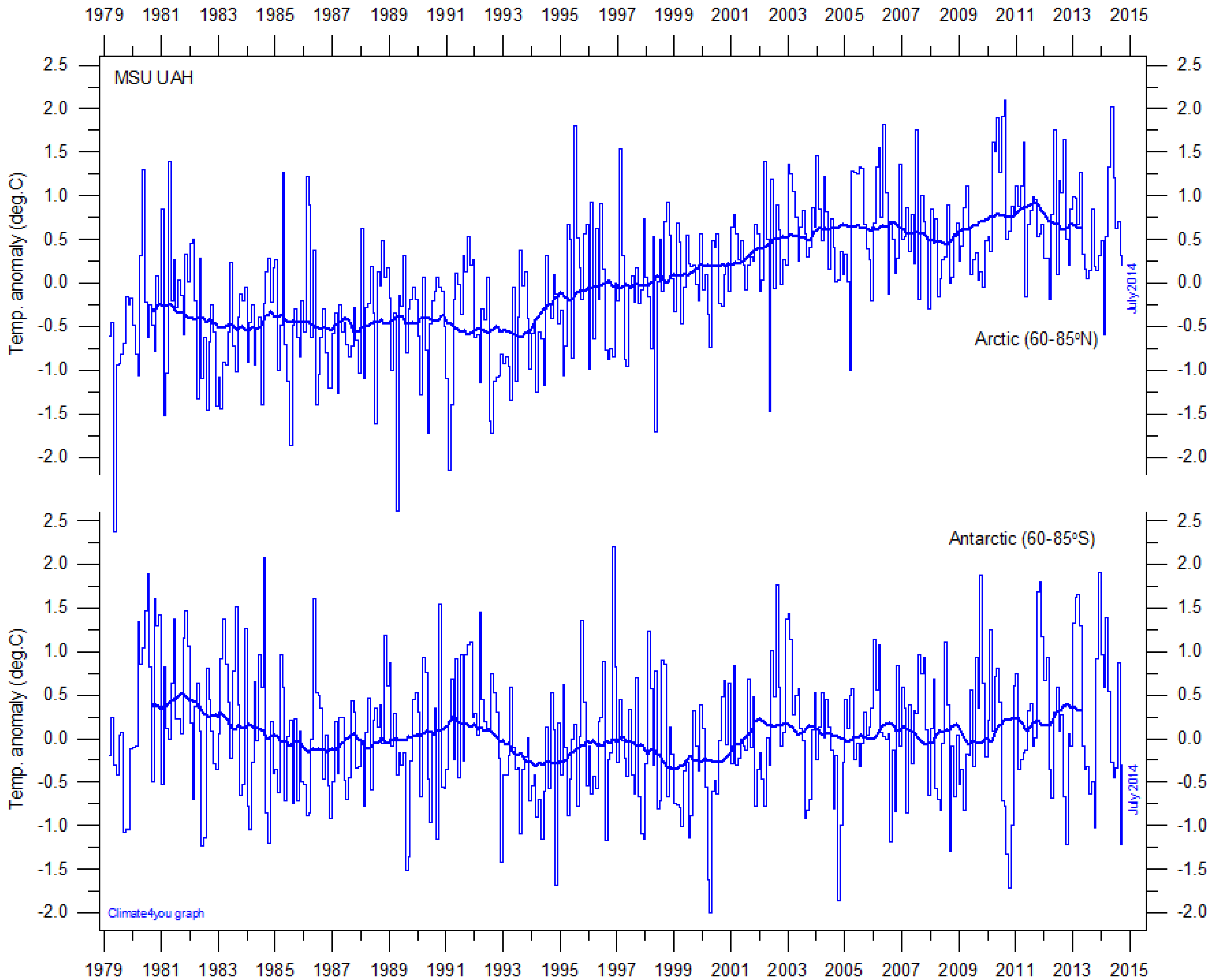
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the North Atlantic (60-0W, 30-65N; see map above) *ocean since January 1955. The thin line indicates monthly values, and the thick line represents the simple running 37 month (c. 3 year) average. Data source: [National Oceanographic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

Zonal lower troposphere temperatures from satellites, updated to July 2014



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 yr average. Reference period 1981-2010.

Arctic and Antarctic lower troposphere temperature, updated to July 2014



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 yr average.

Arctic and Antarctic surface air temperature, updated to May 2014

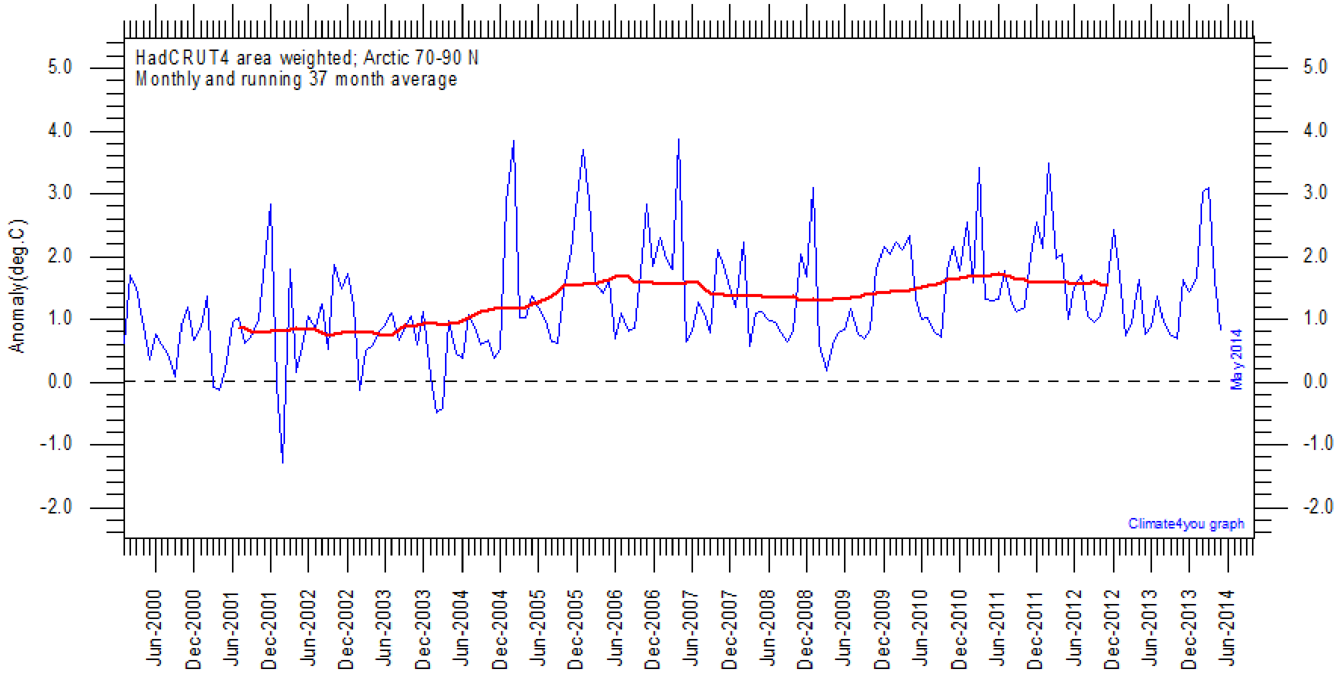


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 2000, in relation to the WMO normal period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

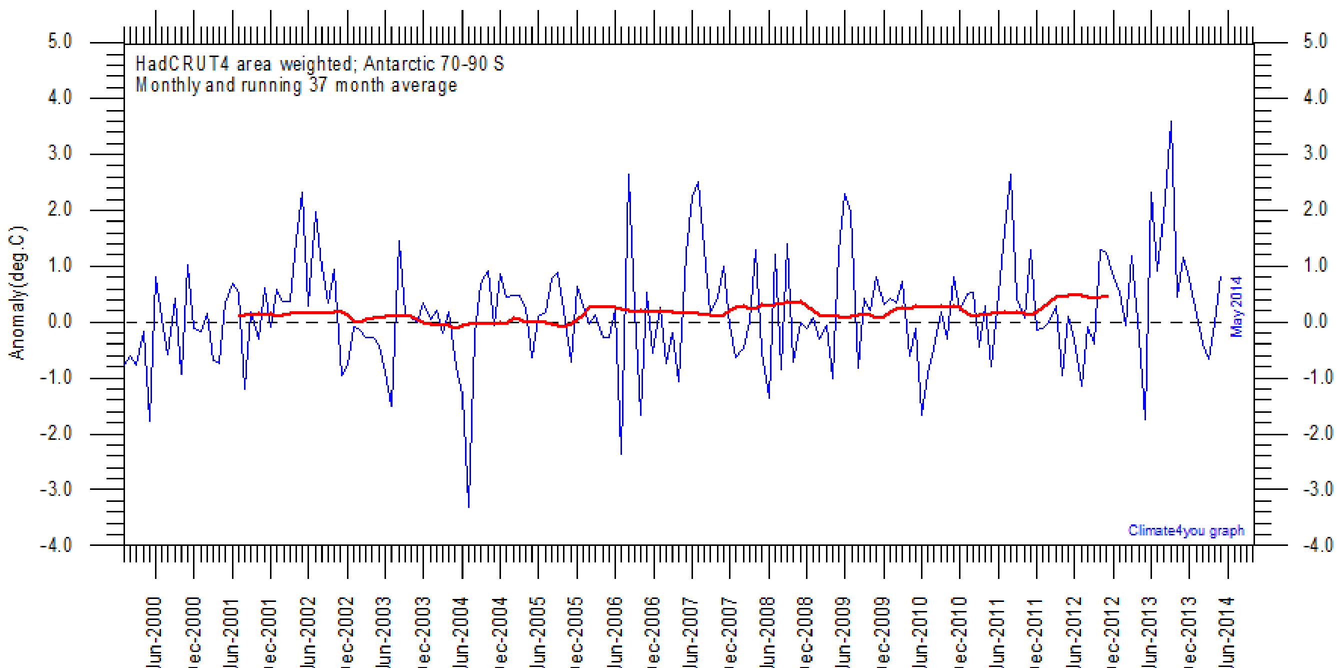


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 2000, in relation to the WMO normal period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

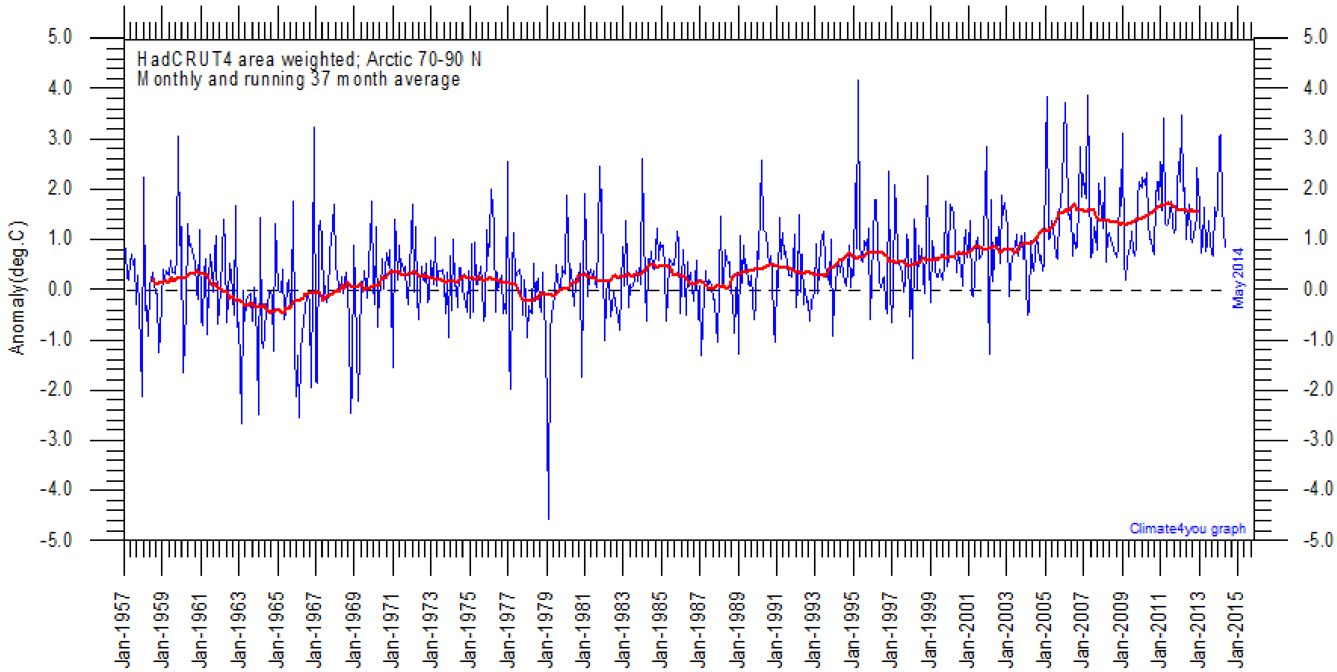


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

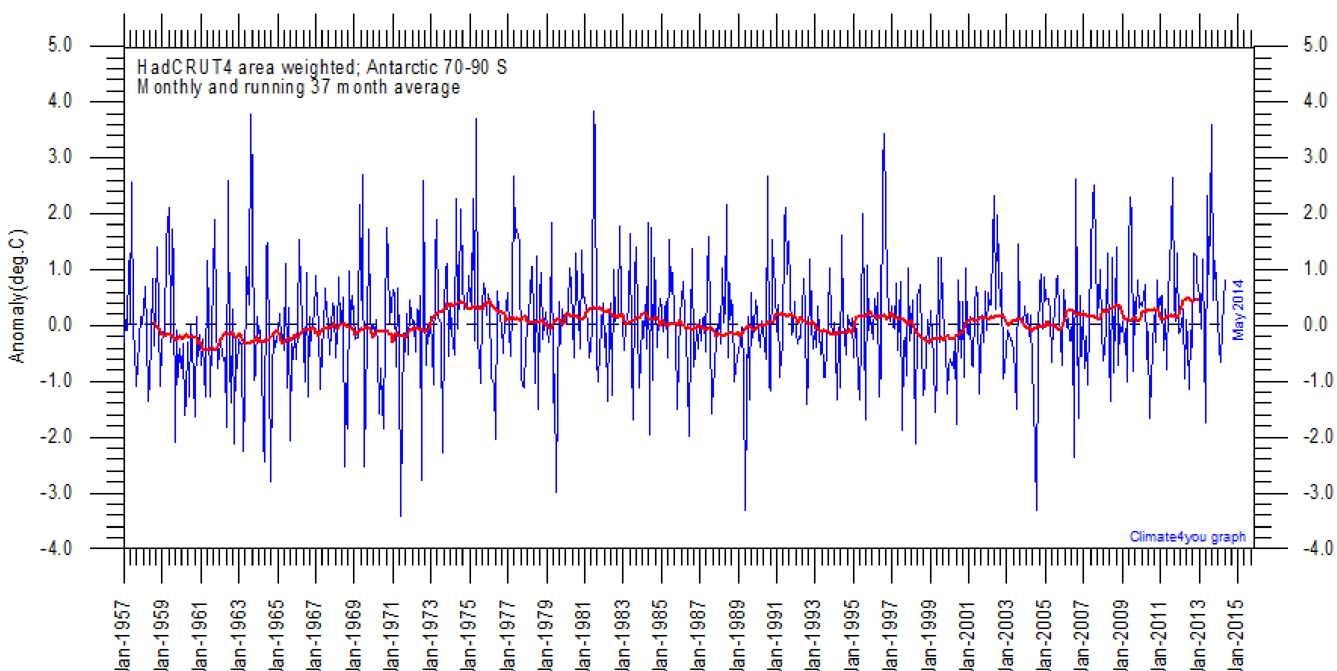


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

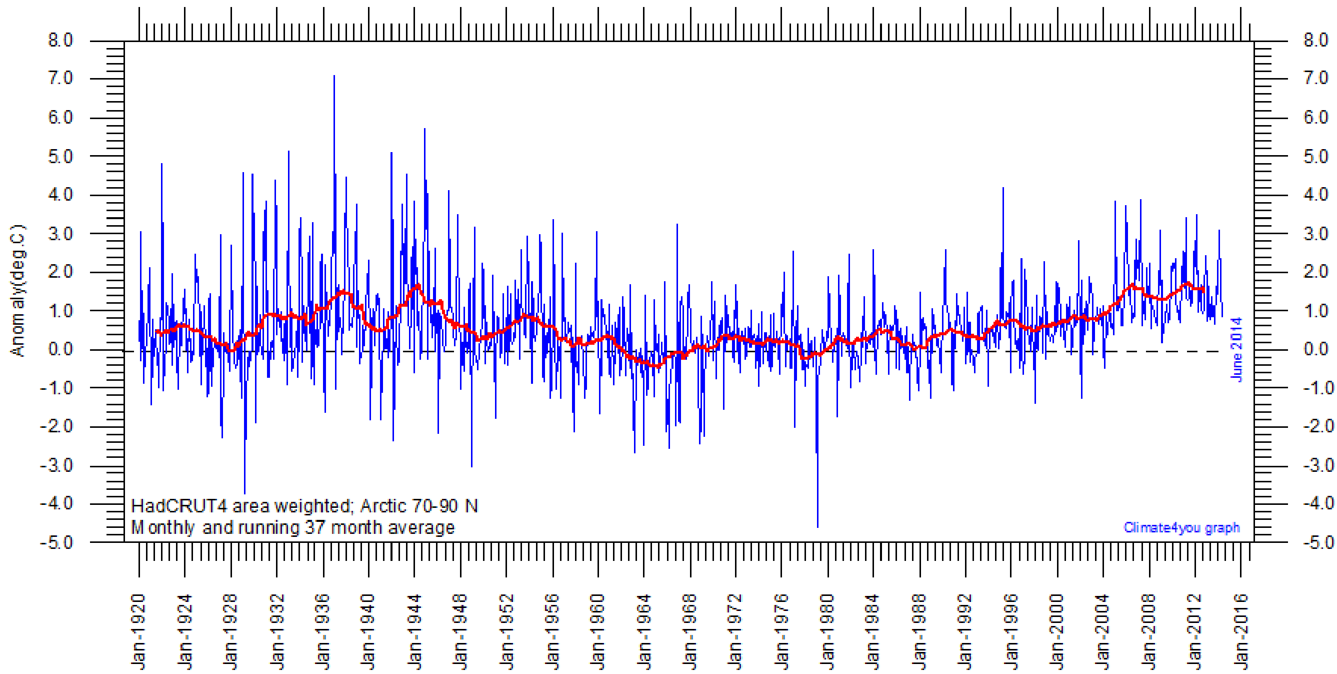


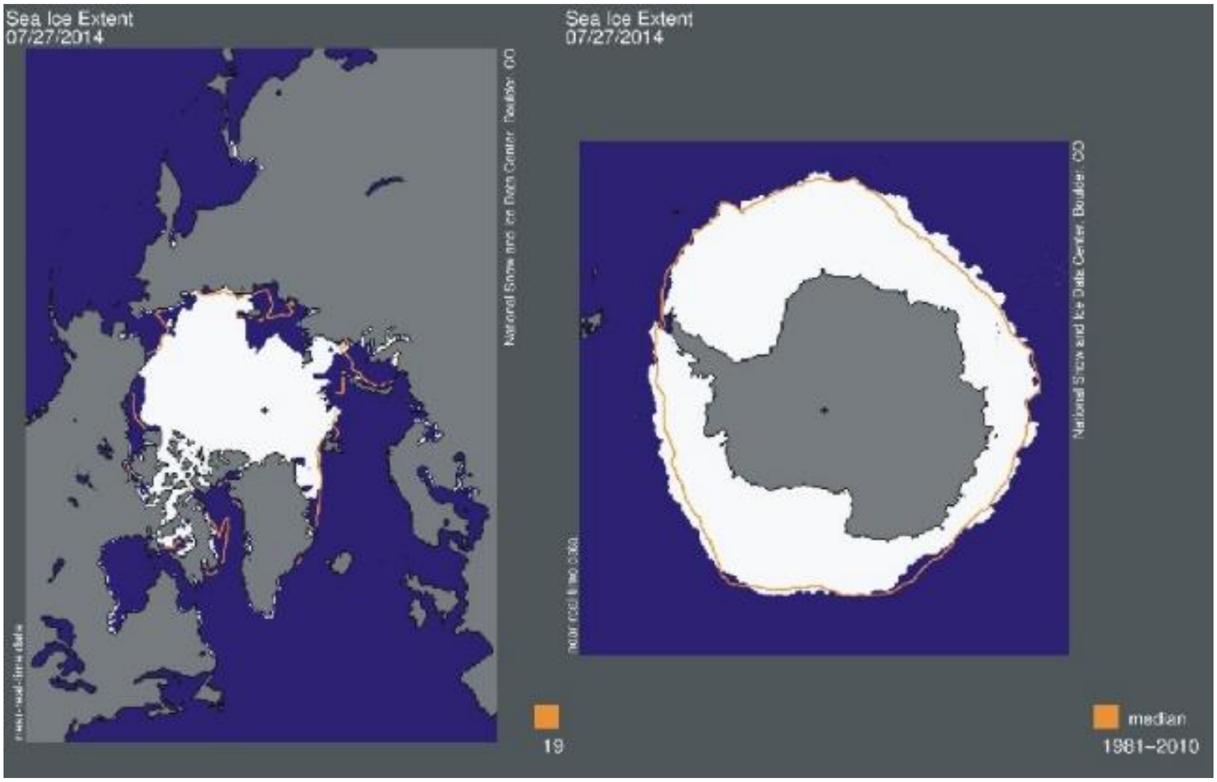
Diagram showing area-weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1920, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average. 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.

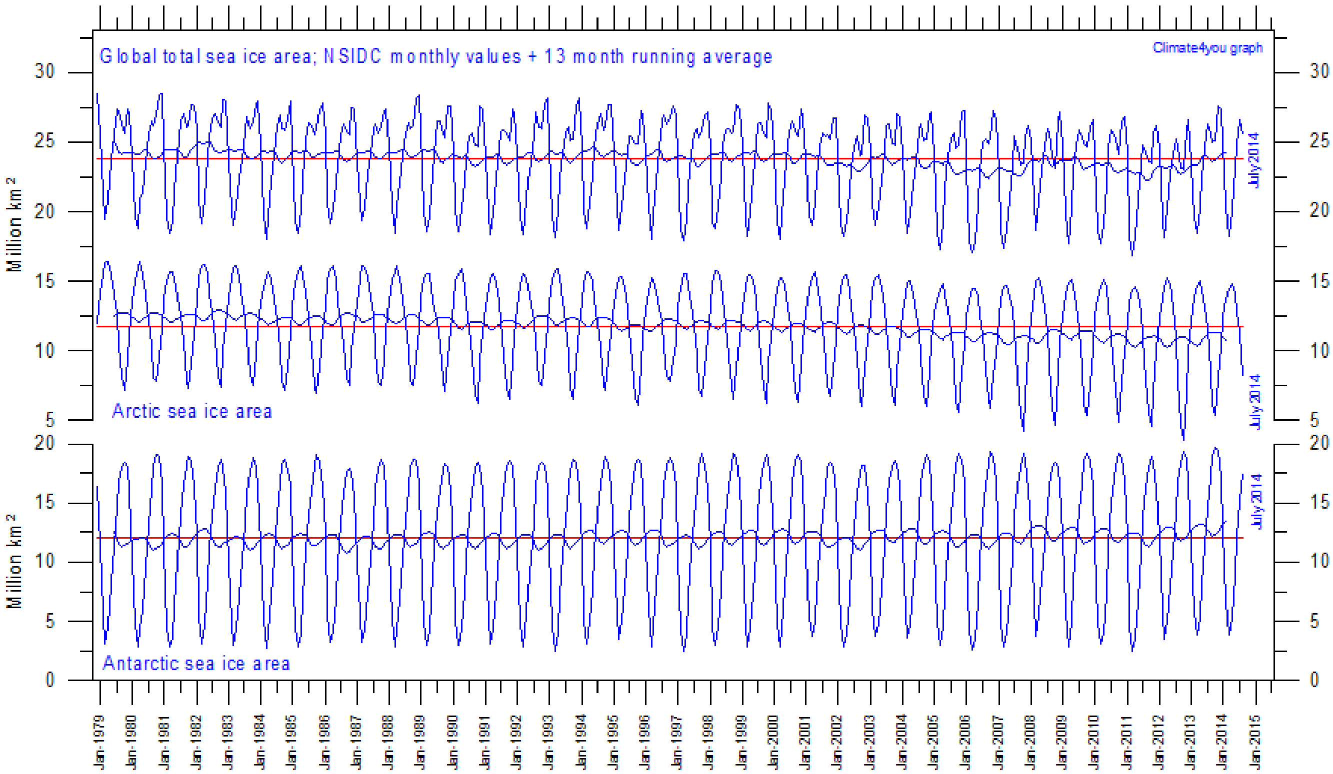
Literature:

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.

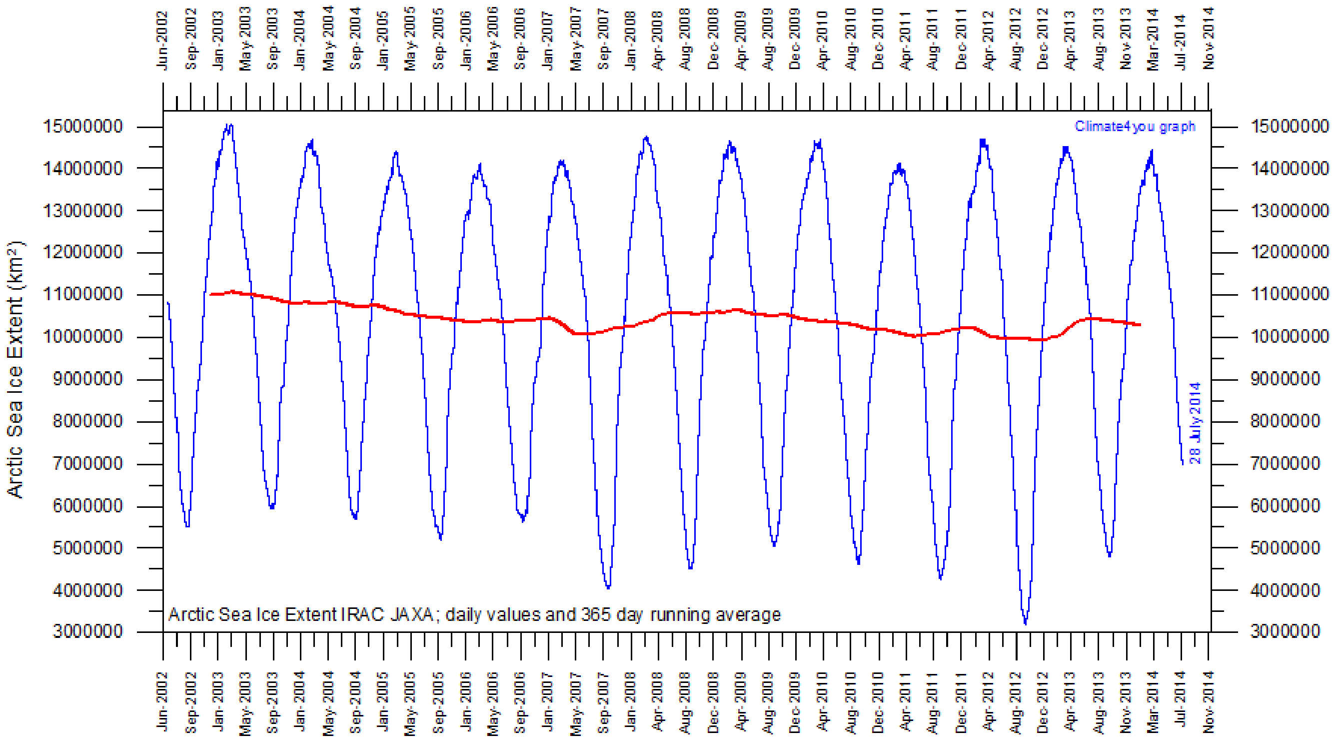
Arctic and Antarctic sea ice, updated to July 2014



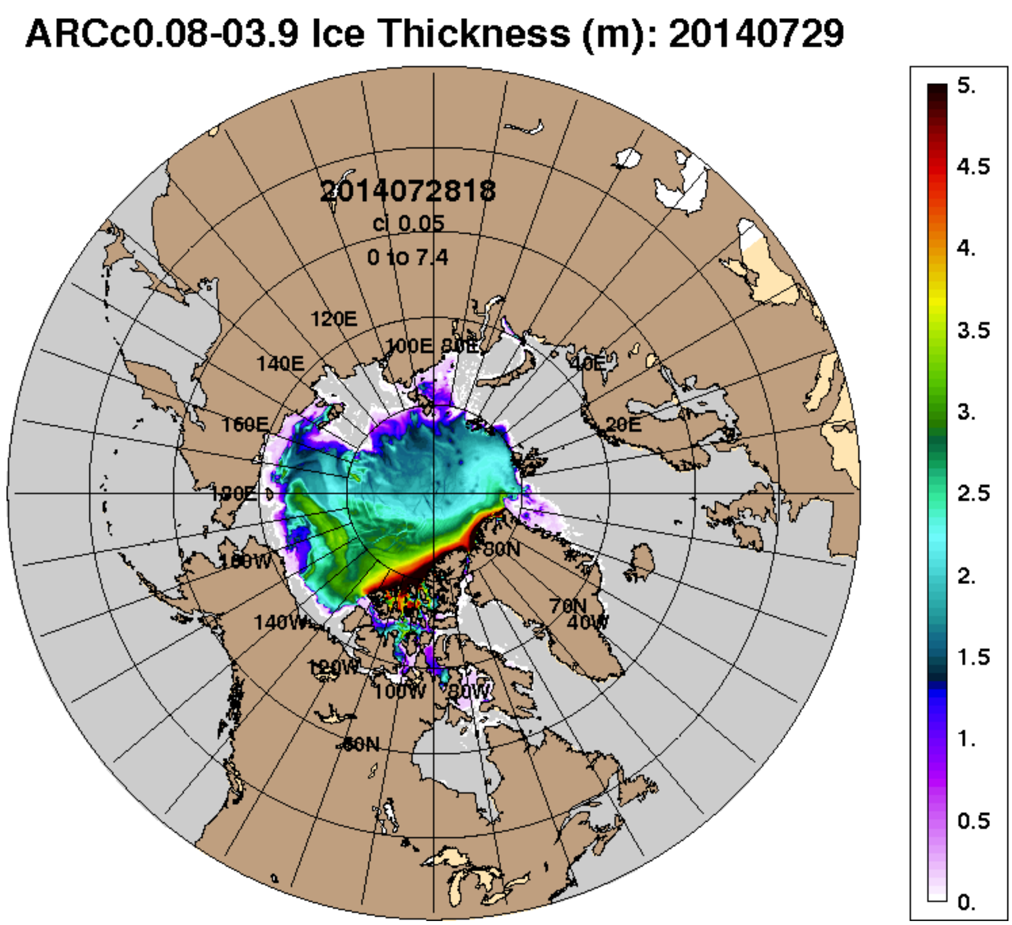
Sea ice extent 27 July 2014. The 'normal' or average limit of sea ice (orange line) is defined as 15% sea ice cover, according to the average of satellite observations 1981-2010 (both years inclusive). Sea ice may therefore well be encountered outside and open water areas inside the limit shown in the diagrams above. Map source: National Snow and Ice Data Center *(NSIDC).*



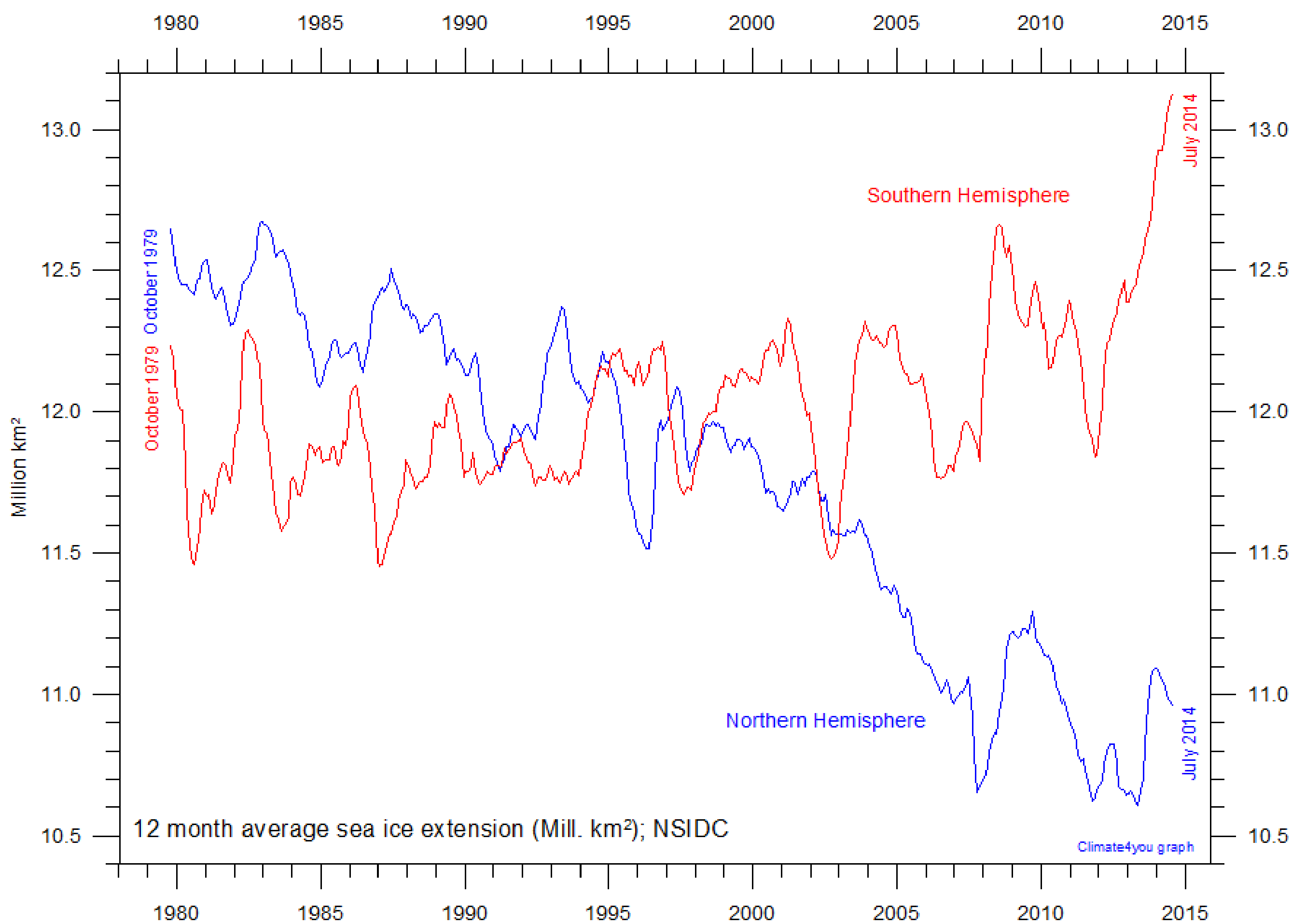
Graphs showing monthly Antarctic, Arctic and global sea ice extent since November 1978, according to the [National Snow and Ice data Center](#) (NSIDC).



Graph showing daily Arctic sea ice extent since June 2002, to 28 July 2014, by courtesy of [Japan Aerospace Exploration Agency](#) (JAXA).

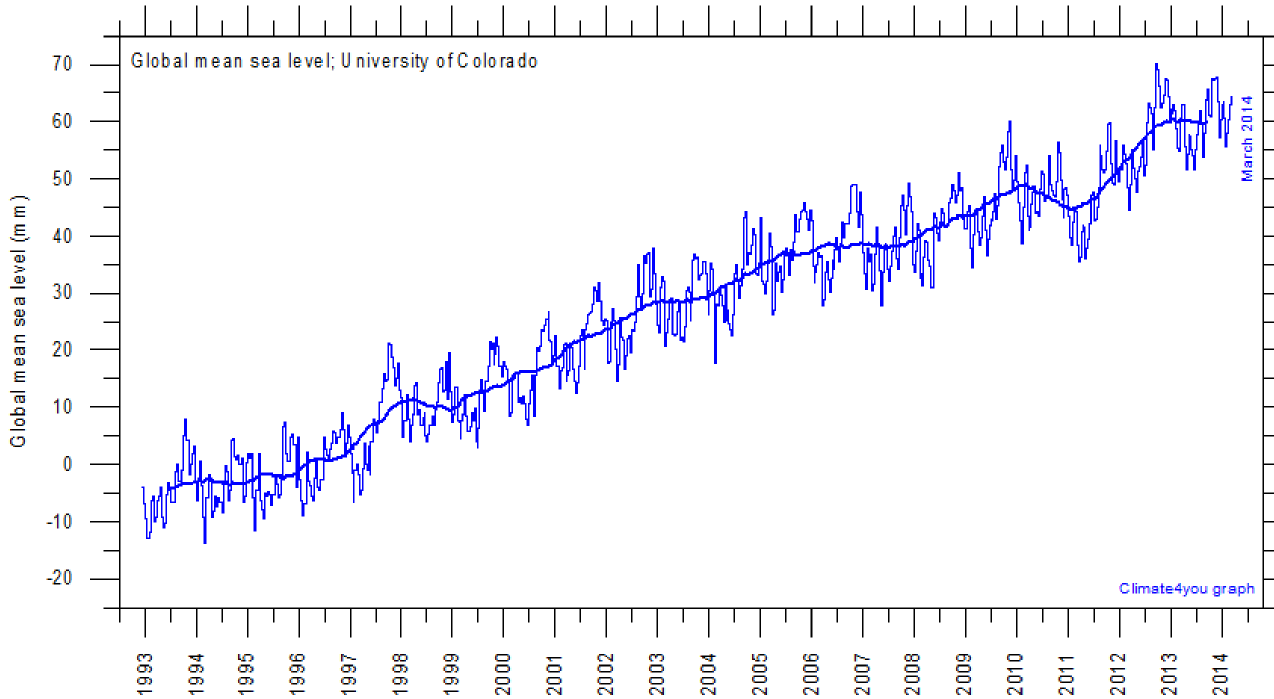


Northern hemisphere sea ice extension and thickness on 29 July 2014 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) is shown to the right.

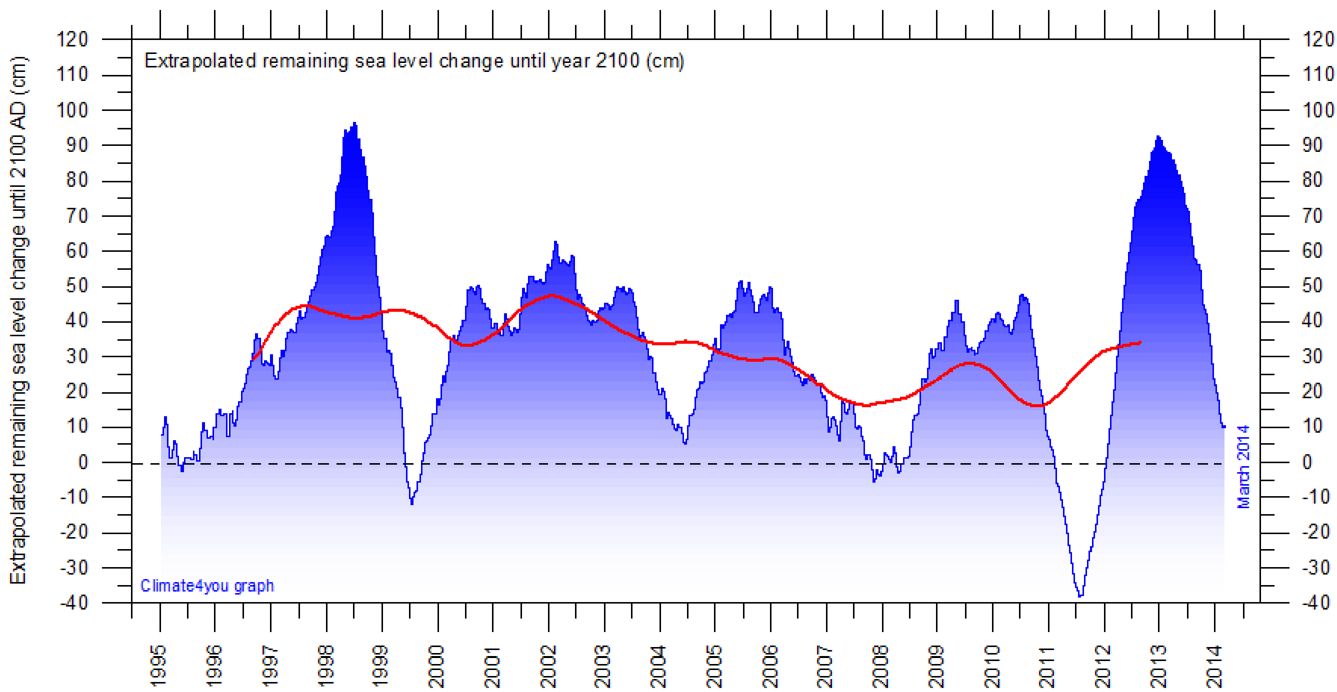


12 month running average sea ice extension in both hemispheres since 1979, the satellite-era. The October 1979 value represents the monthly average of November 1978 - October 1979, the November 1979 value represents the average of December 1978 - November 1979, etc. Last month included in the 12-month calculations: July 2014. Data source: National Snow and Ice Data Center (NSIDC).

Global sea level, updated to March 2014

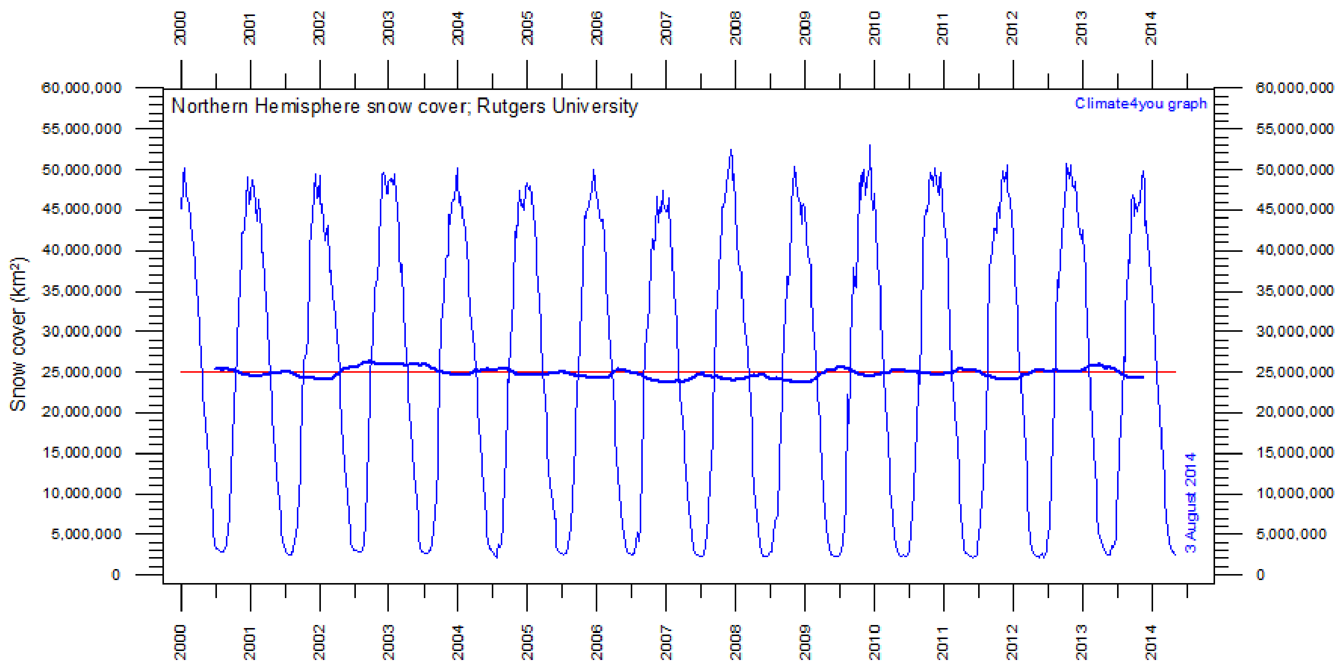


Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at University of Colorado at Boulder, USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

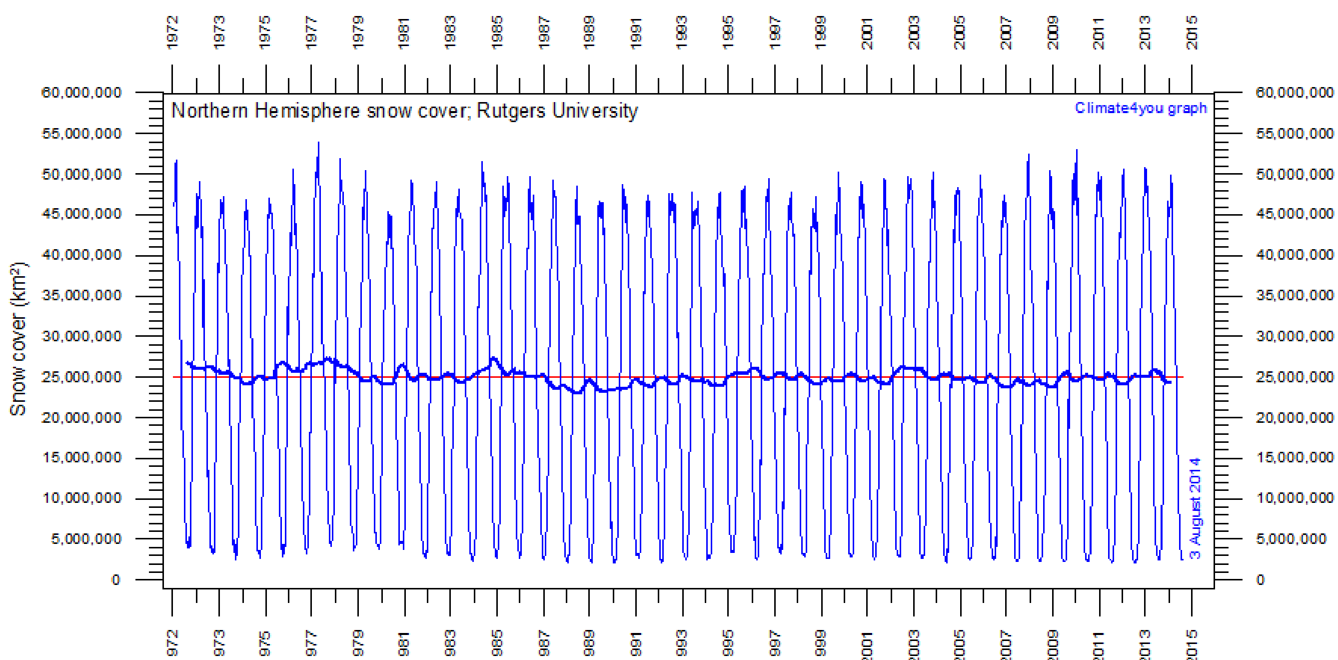


Forecasted change of global sea level until year 2100, based on simple extrapolation of measurements done by the Colorado Center for Astrodynamics Research at University of Colorado at Boulder, USA. The thick line is the simple running 3 yr average forecast for sea level change until year 2100. Based on this (thick line), the present simple empirical forecast of sea level change until 2100 is about +34 cm.

Northern Hemisphere weekly snow cover, updated to early August 2014

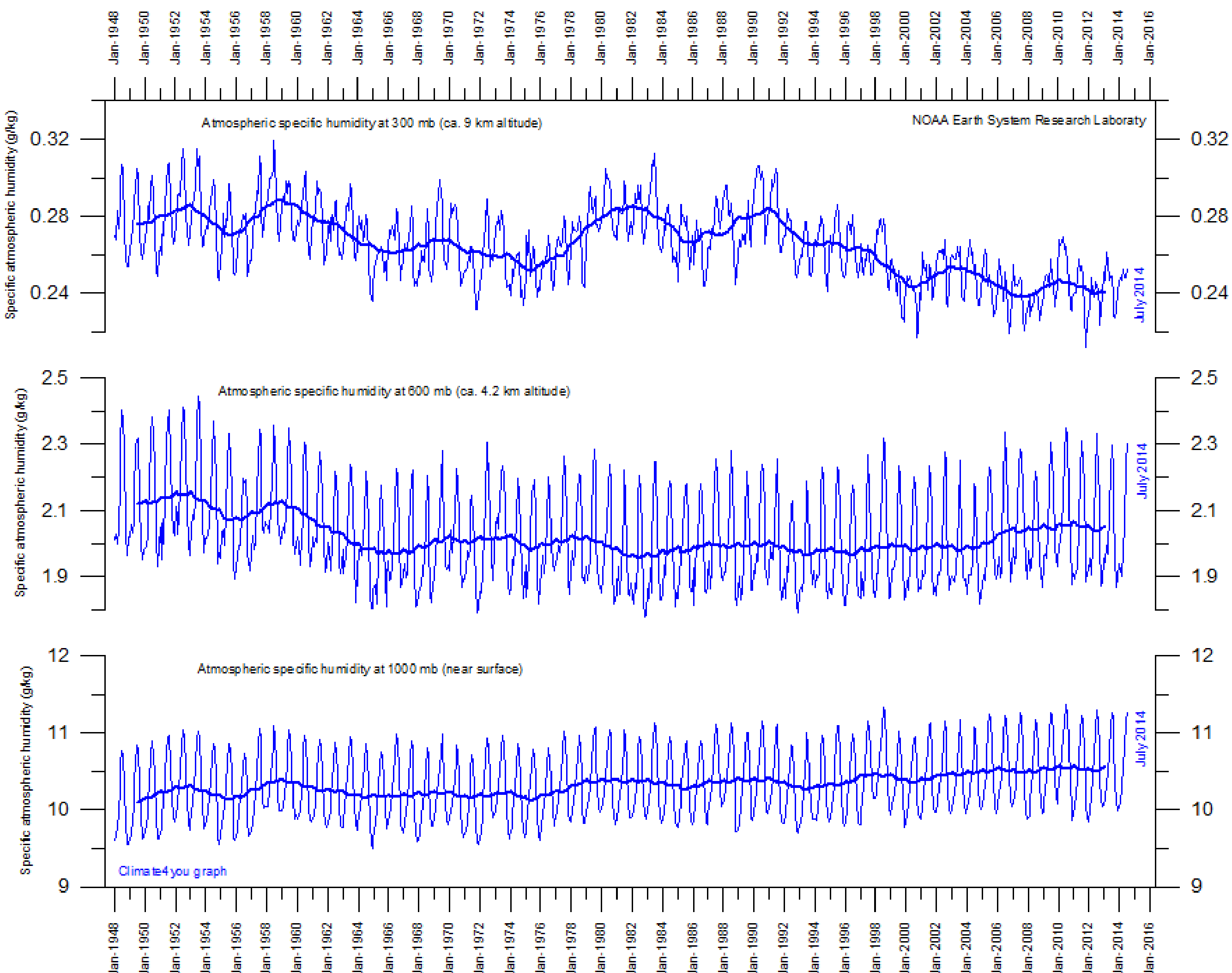


Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53-week average (approximately 1 year). The horizontal red line is the 1972-2013 average.



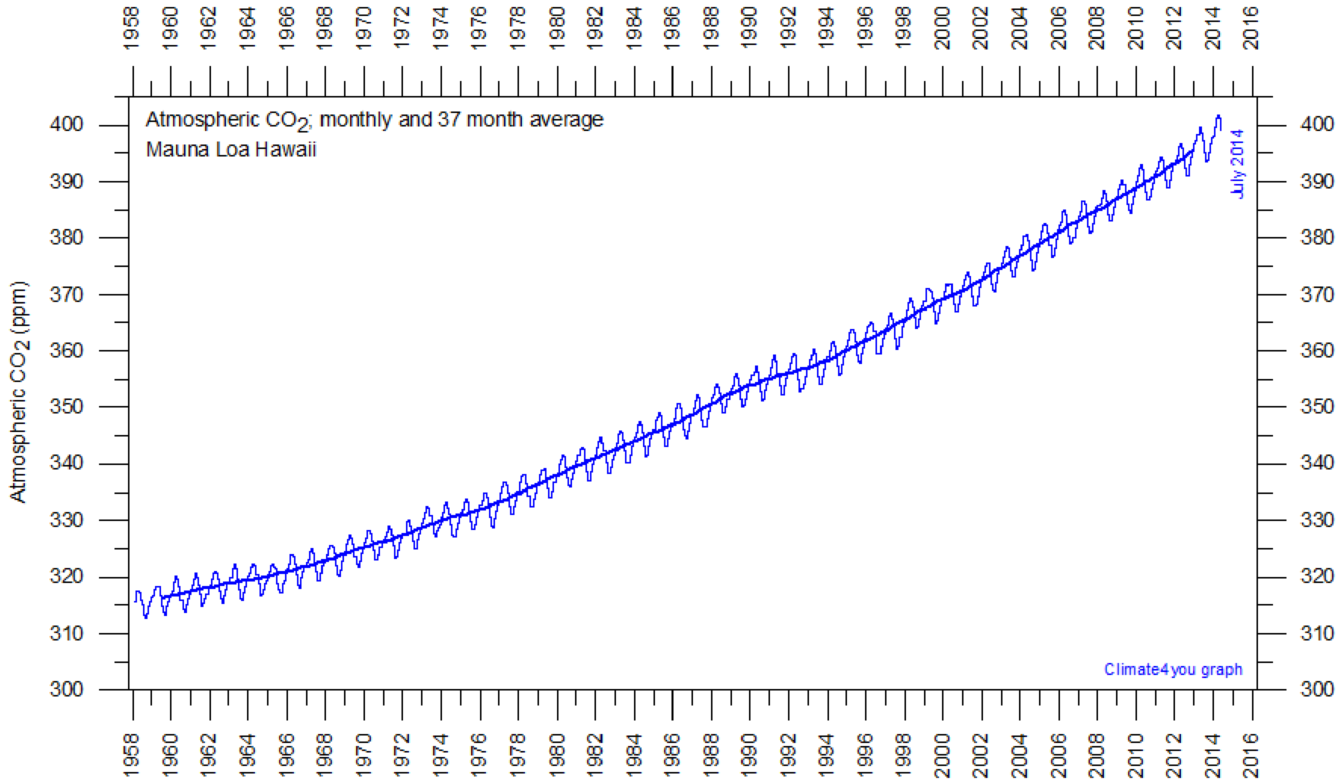
Northern hemisphere weekly snow cover since January 1972 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53-week average (approximately 1 year). The horizontal red line is the 1972-2013 average.

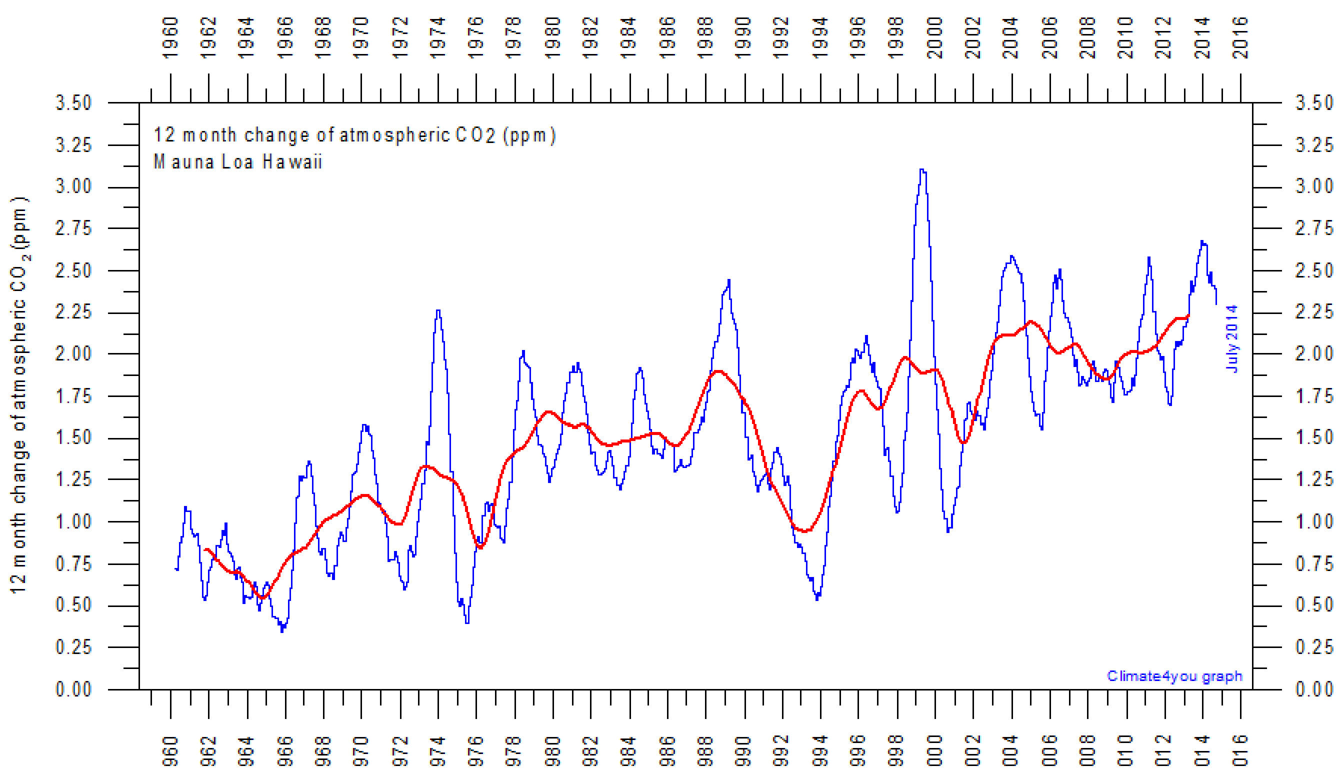
Atmospheric specific humidity, updated to July 2014



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).

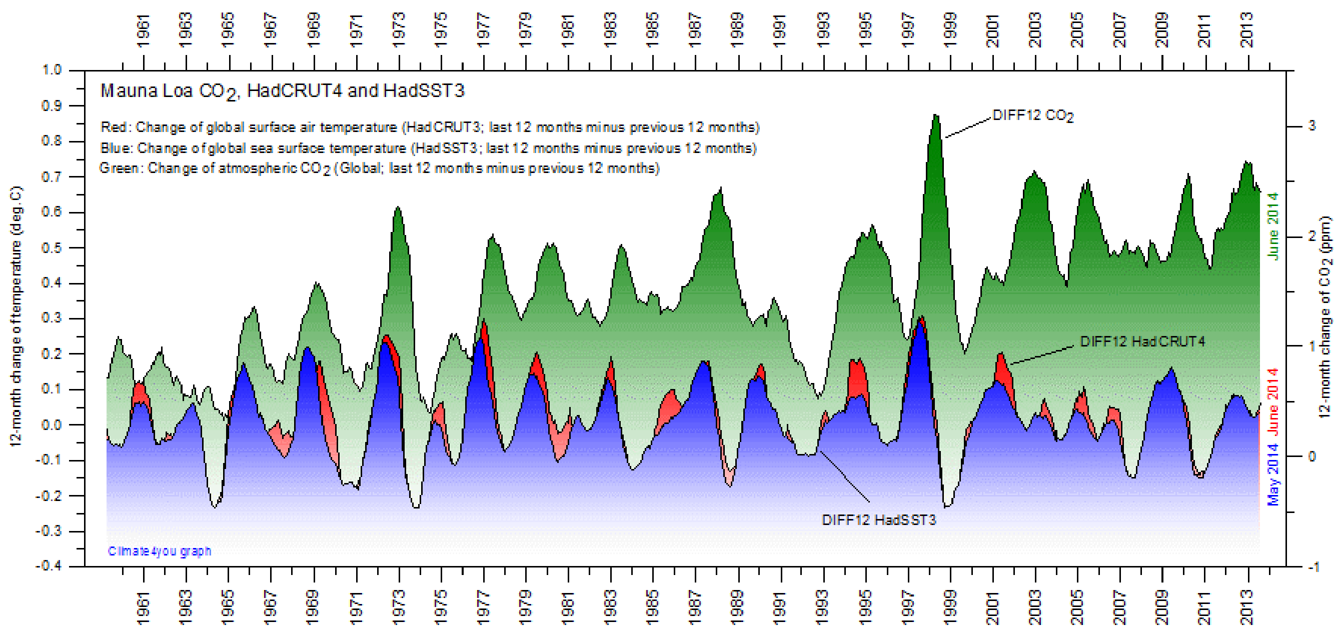
Atmospheric CO_2, updated to July 2014





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

The phase relation between atmospheric CO_2 and global temperature, updated to June 2014

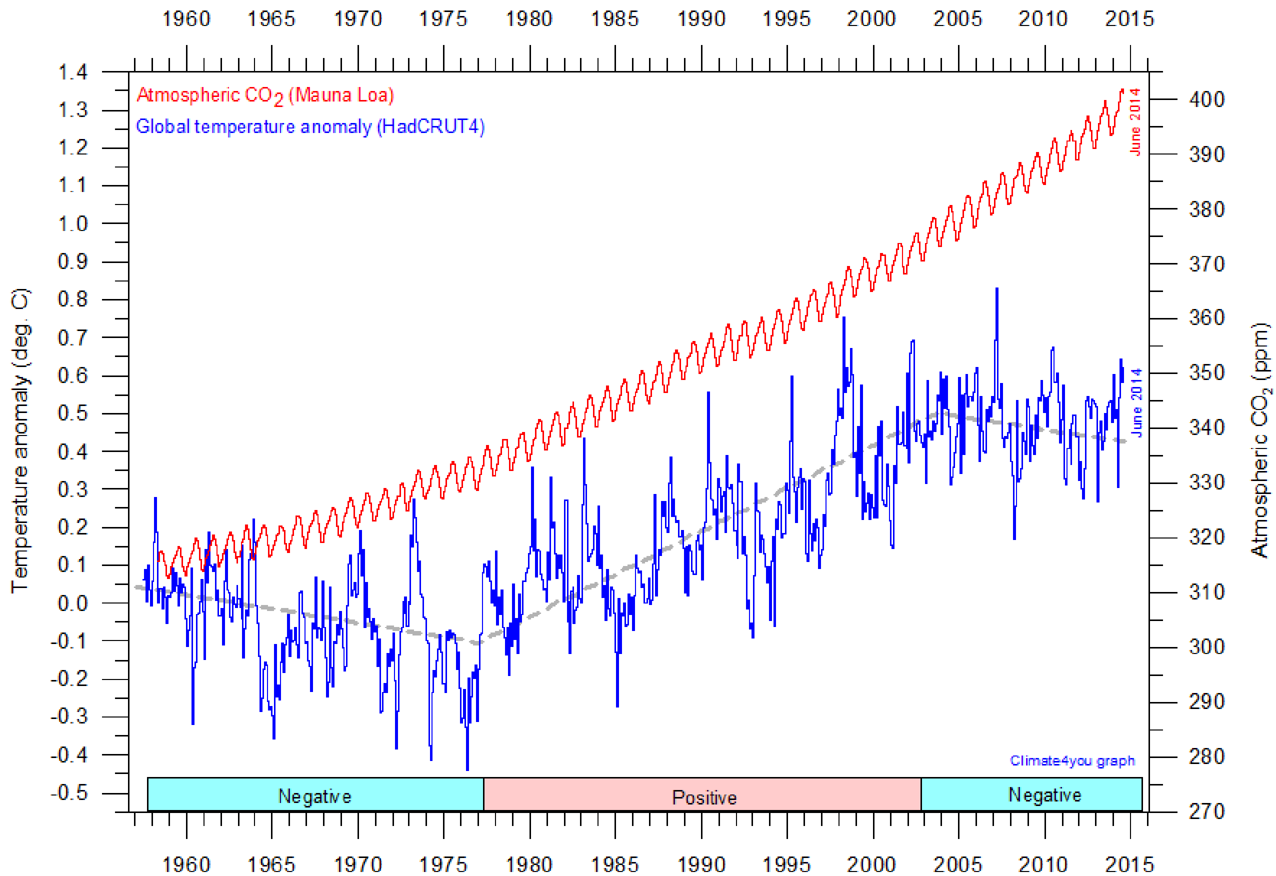


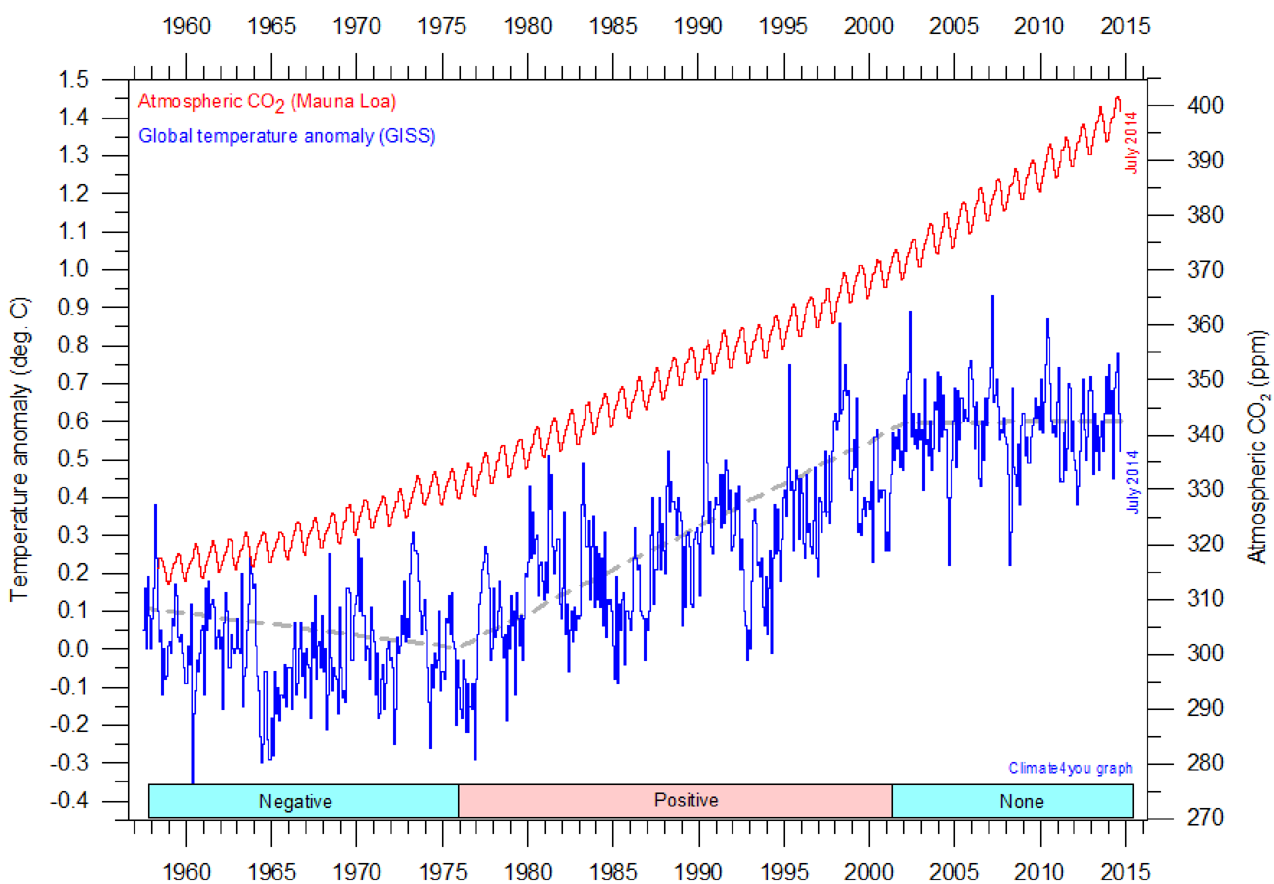
12-month change of global atmospheric CO_2 concentration (Mauna Loa; green), global sea surface temperature (HadSST3; blue) and global surface air temperature (HadCRUT4; red dotted). All graphs are showing monthly values of DIFF12, the difference between the average of the last 12 month and the average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

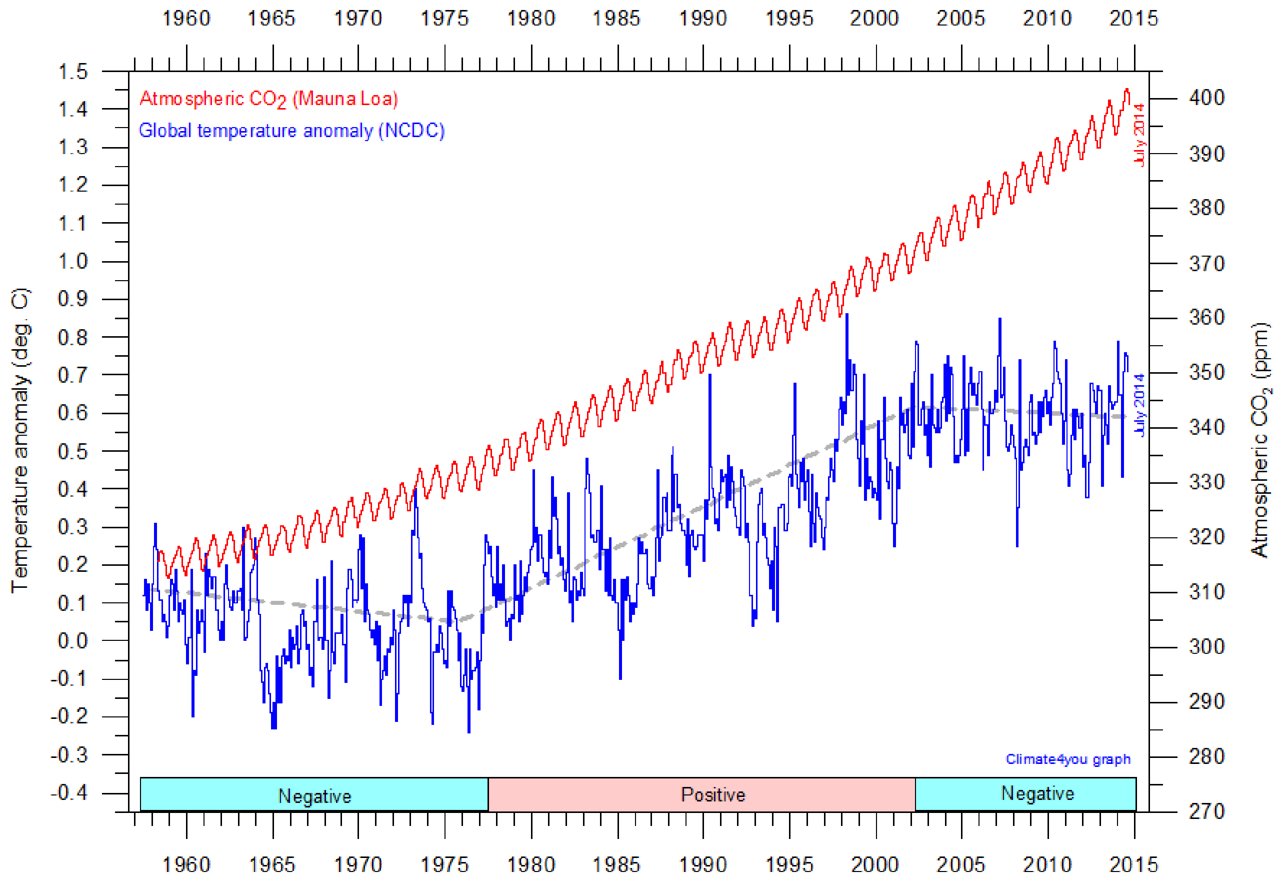
References:

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 June 2014







Diagrams showing HadCRUT3, 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 has therefore been 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 2014.

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.

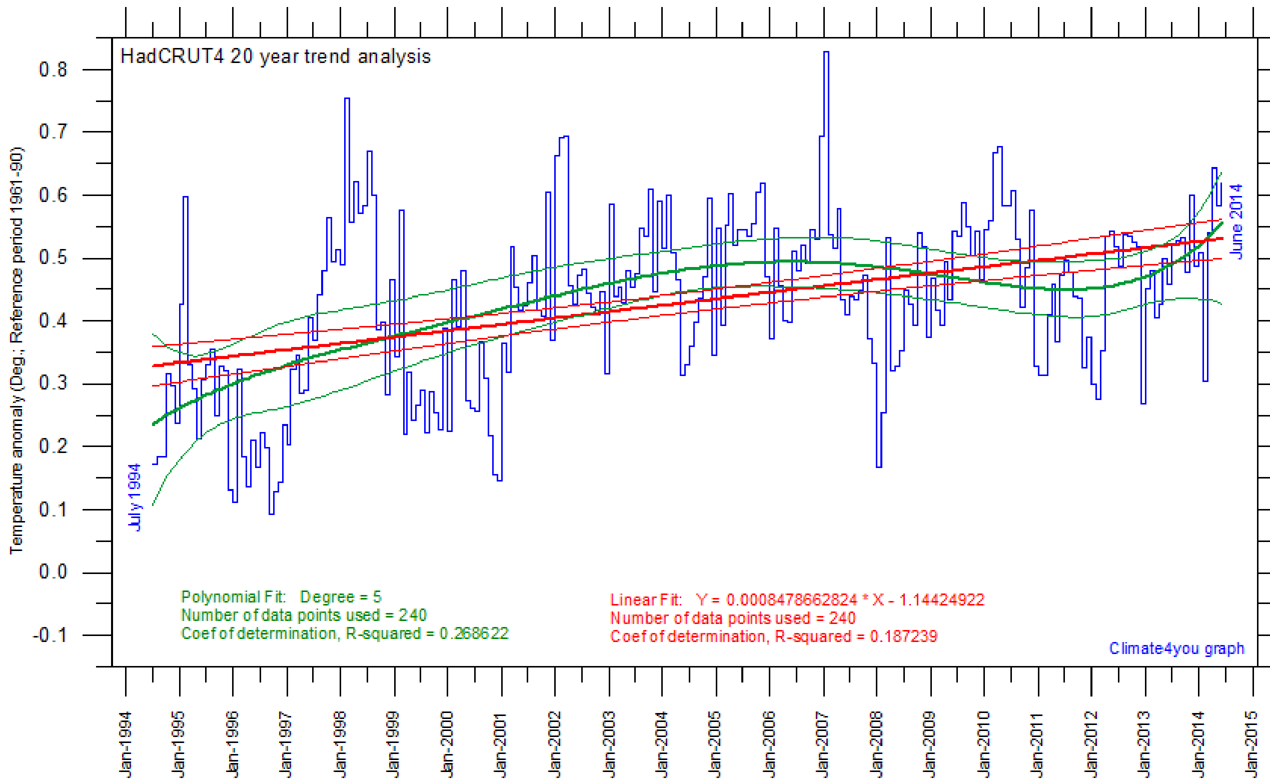
However, past climate research history provides some clues as to what has traditionally been considered the relevant length of period over which to compare temperature and atmospheric CO_2.

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 monthly surface air temperature changes, updated to June 2014



Last 20 years global monthly average surface air temperature according to Hadley CRUT, a cooperative effort between the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK. The thin blue line represents the monthly values. The thick red line is the linear fit, with 95% confidence intervals indicated by the two thin red 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 is given in the lower part of the diagram (note that the linear trend is the monthly trend). Please note that the linear regression is done by month, not year.

It is quite often debated if the global surface air temperature still increases, or if the temperature has levelled out during the last 15-18 years. 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.

Climate and history; one example among many

1807: The Second Battle of Copenhagen

The culmination of the bombardment of Copenhagen in the night between 4 and 5 September 1807 (oil paintings by C.V. Eckersberg).

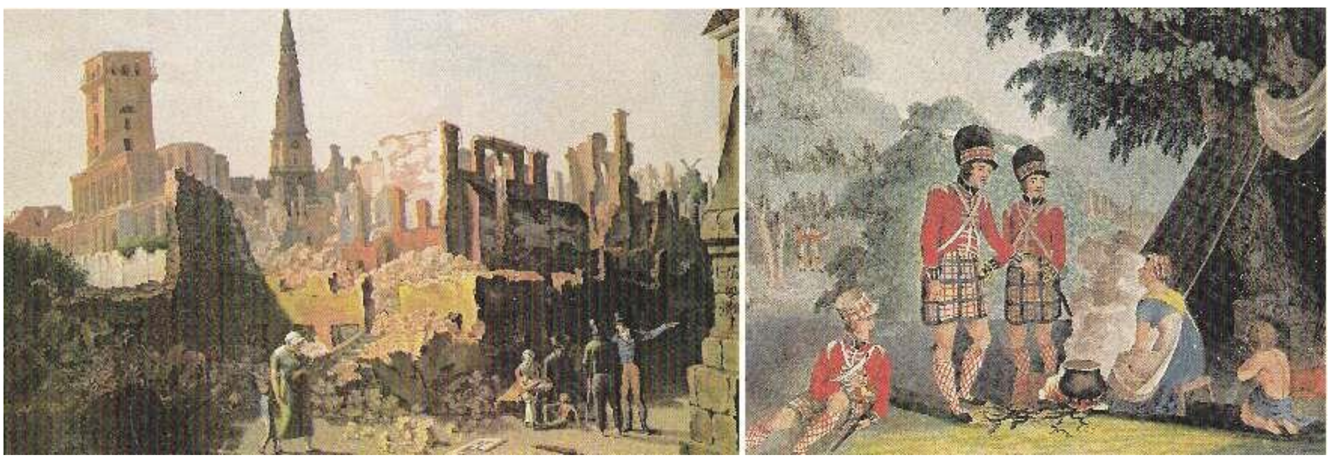
In Europe, the political landscape had changed again in 1807. On 14 June a Russian army had been defeated by Napoleon at the Battle of Friedland, and on 7 July Napoleon met the Russian Tsar Alexander I at Tilsit, a small town on the Polish-Lithuanian border. Here a peace treaty was signed between France and Russia, and it was obvious that with Russia under the sway of Napoleon the Continental System would soon begin to have a serious effect on Britain (Adkins and Adkins 2006). Of more immediate concern for Britain was the planned amalgamation of the French and Russian fleets, a part of the peace treaty meant to be hidden. The combined French-Russian fleet were then to be increased by more shipbuilding and also by seizing the fleets of Portugal and Denmark-Norway, both neutral states with significant fleets.

The secret treaty was known almost instantly in Britain, and the government realized that it had to act quickly to pre-empt Napoleons plan. The most dangerous part of the treaty lay with the powerful Danish-Norwegian fleet, the fifth strongest in Europe at that time (Glenthøj and Ottosen 2014). The Danish Army was moved to southern Jutland, to be in a position to defend this part of the country from a possible French invasion from northern Germany.

The British government followed these developments with great interest, because if Napoleon gained control of Denmark, Britain would rapidly be excluded from essential trade with the Baltic States, and the Danish-Norwegian fleet could be used to renew the possibility of invading Britain (Adkins and Adkins 2006). The British Government decided that they had to forestall this possibility swiftly. Within weeks 17 battleships and 21 frigates commanded by Admiral Lord Gambier sailed for the capital Copenhagen in Denmark as the first wave of an expeditionary force. Other battleships, frigates and transports for 29,000 troops were to follow.

The lessons of the First Battle of Copenhagen in 1801 had apparently been taken to heart. The expedition was dispatched more quickly this time, and did not rely on naval fire-power alone. Troops were landed 16 August 1807 north of Copenhagen, and quickly laid siege to the city of Copenhagen, to back up British demands that the Denmark-Norwegian kingdom surrender their fleet and naval stores. By this the Danish-Norwegian state immediately became a friend of Napoleon's France.

The major part of the army in Denmark was far away in southern Jutland and in no position to hinder the British occupation of the eastern part of the island Zealand, partly sourrounding Copenhagen, and only small Danish forces were present within the city limits. The Danish-Norwegian fleet was not prepared for a major battle either, and most ships was still lying in the harbor of Copenhagen. However, the British demands were rejected after diplomatic negotiations by the Danish-Norwegian Crown Prince, which relied on the relatively strong and modern fortifications constructed around Copenhagen during the previous years.



Gråbrødre Plads in Copenhagen, after the bombardment in September 1807 (left). Scottish soldiers in their camp shortly west of Copenhagen (right).

So even though the British forces had occupied the eastern part of Zealand, they were in no position to take Copenhagen easily. On the other hand, the British army and navy were rapidly beginning to feel the pressure of time. The previous years in northern Europe had been characterized by very cold winters, and the prospect of keeping the British occupation forces and the navy in the field in enemy country during the coming winter 1807-08 was not a viable option. Supplying and housing the forces during the winter would definitely represent a major problem, and, in addition, strong autumn and winter storms would represent a very real danger for the navy. A way of forcing a rapid surrender of Copenhagen had to be found.

A direct attack from the sea, as was done in 1801, was not considered possible, because of the improved fortifications around Copenhagen. These fortifications also made the possibility of a successful attack from land look very small, even though the defense forces inside Copenhagen was relatively limited in numbers. Since the invasion 16. August many of the inhabitants in Copenhagen had been trained and armed, and these new forces was steadily growing in strength.

A bombardment with rockets was therefore considered. The British general Cathcart, however, was not supporting this, as he feared to damage a scool for girls inside the city (Glenthøj and Ottosen 2014), which might not be considered civilized by other countries. General sir Arthur Wellesby (better known as the Duke of Wellington after the Battle of Waterloo in 1815) therefore argued that the city should be forced to surrender by imposing a tight blockade of any supplies, including food. It might of cause be debated if this represented a more civilized approach. However, this would take time and was not considered useful because of the coming winter. In addition to the likely winter supply problems arising for both the British army and navy, there was the realistic possibility of the sea between the Danish islands freezing up (as had happened several times during the previous winters), and thereby offering the Danish army in Jutland a possibility of marching directly across the sea ice to the rescue of Copenhagen. Perhaps the Danish army would even be reinforced by troops from Denmark's new found alley, France. A bombardment was therefore decided.

At the evening of September 2, 1807, the British began to bombard Copenhagen, both from land and from the sea, using bombs and rockets. The British army and navy had a new weapon at their disposal, Congreves rocket, which could fire about 3,000 m, and later was to be used against the United States in the War of 1812. The bombardment continued with short breaks for several days, and culminated in the night between 4 and 5 September, where about 6,000 bombs and rockets hit the city (see illustrations above). Large parts of the city was now burning, and more than 1600 persons lost their life. In total, about 14,000 bombs and rockets were fired at the besieged city (Lindebjerg 1974).

The bombardment continued through 5 September, but was then interrupted because of new negotiations. The next day, 6 September, the Danish commanding general in Copenhagen, general Peymann agreed to give up the fleet and naval stores in Copenhagen, in return for a British withdrawal and an exchange of prisoners. The Danish Crown Prince was himself not present in Copenhagen, but was with the army in southern Jutland. General Peymann had been wounded during the previous battle, and was being treated in the former '*Raus Hotel*', which paradoxically later was renamed '*Hotel d'Angleterre*' (Glenthøj and Ottosen 2014), and still exists today. The siege and bombardment of Copenhagen also furnished the name for the horse that the Duke of Wellington later would ride at the Battle of Waterloo in 1815.

Together with the also partly climatically influenced First Battle of Copenhagen in 1801 (see *Climate4you update May 2014*), this marked the end of Denmark's long role as a strong naval nation.

The almost complete loss of naval power meant that the state of Denmark-Norway was unable to control the sea between Denmark and Norway, and the independence of Norway from Denmark then became only a matter of time, but very much influenced by Napoleon's military fortune. Napoleon's catastrophic winter campaign in Russia 1812 accelerated this development, eventually leading to Norway's independence in 1814, before entering a union with Sweden shortly after.

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Glenthøj, R. and Ottosen, M.N. 2014: *Krig, nederlag, frihed*. Gads Forlag, Copenhagen, 391 pp. ISBN 978-87-12-04922-7.

Lindeberg, L. 1974. *De så det Ske. Englandskrigene 1801-14.* Lademann Forlagsaktieselskab, Copenhagen, 244 pp.

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All the above diagrams with 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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