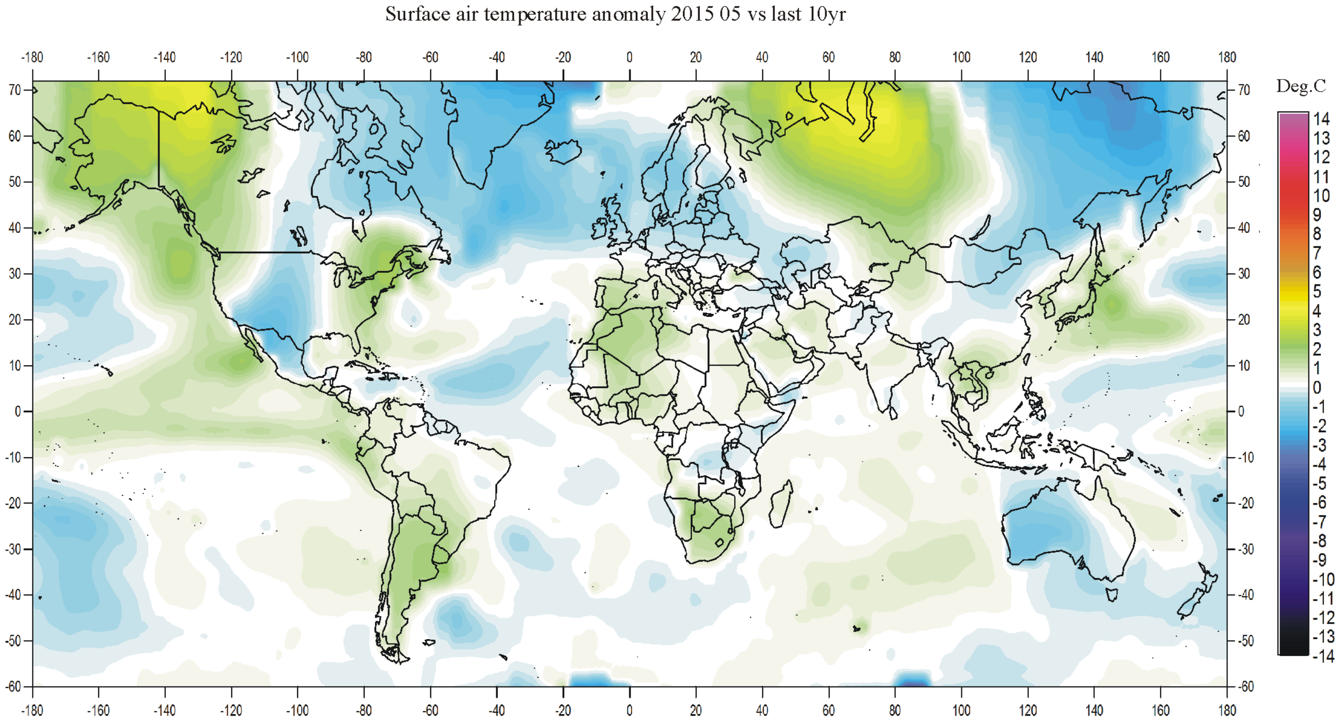
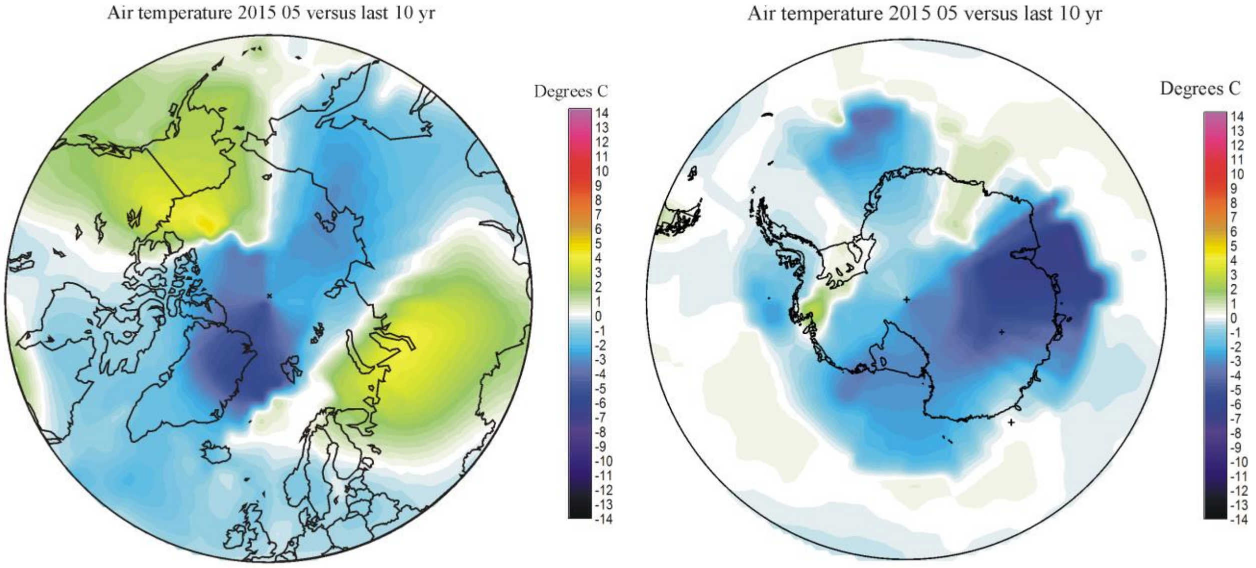
# Climate4you update May 2015

Contents:

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

## May 2015 global surface air temperature overview





*May 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 May 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 with a recent period overcomes this problem and displays the modern dynamics of ongoing change.

In addition, the GISS temperature data used for preparing the above diagrams display pronounced 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.

In 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 data series have a much longer record length, which may be inspected in greater detail on www.Climate4you.com.

## May 2015 global surface air temperatures

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

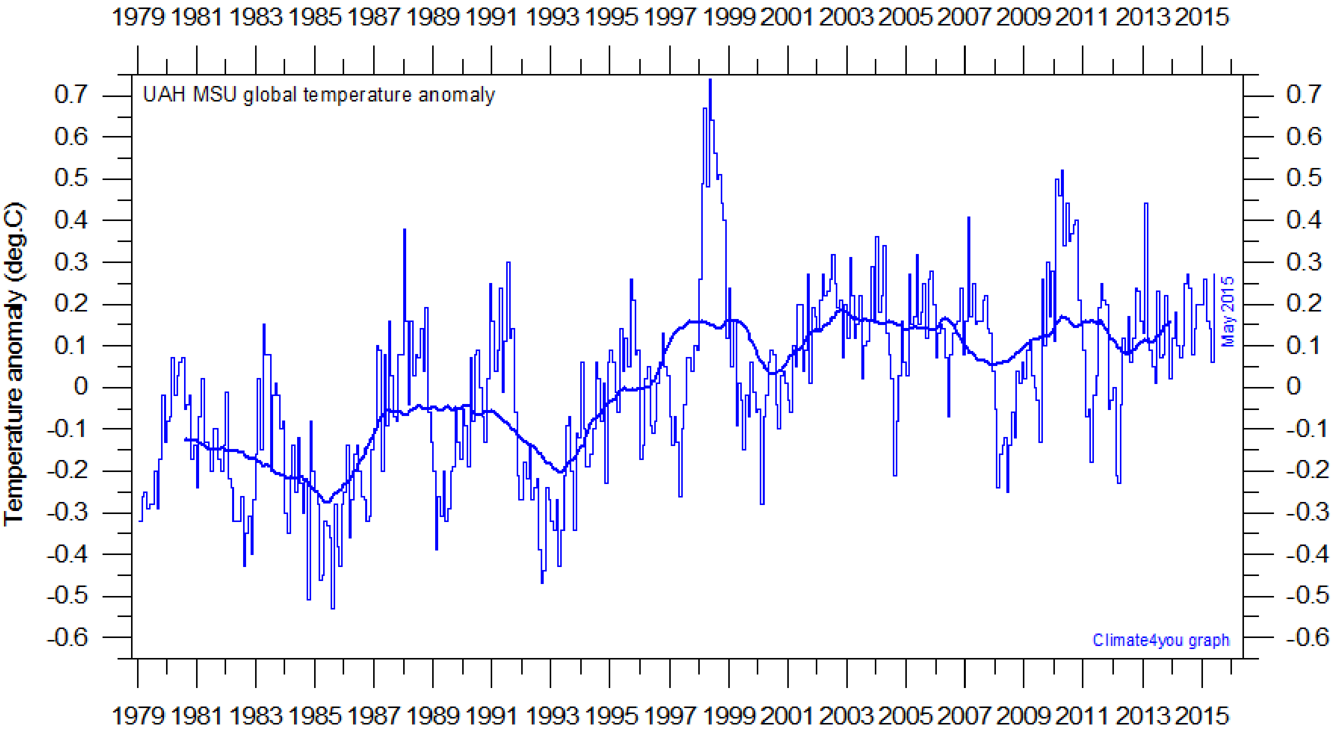
*The Northern Hemisphere* was characterised by regional air temperature contrasts, especially in the Northern Hemisphere, as usual. Western Canada, Alaska and Northern Russia had above average temperatures. Eastern Canada, Greenland, most of the North Atlantic, Europe and most of Siberia had below average temperatures. The Arctic had generally below average temperatures, although the GISS interpolation technique makes any detailed interpretation impossible.

*Near the Equator* temperatures were above average in most of the Pacific Ocean. Otherwise, this region generally had temperatures near or somewhat below the 1998-2006 average.

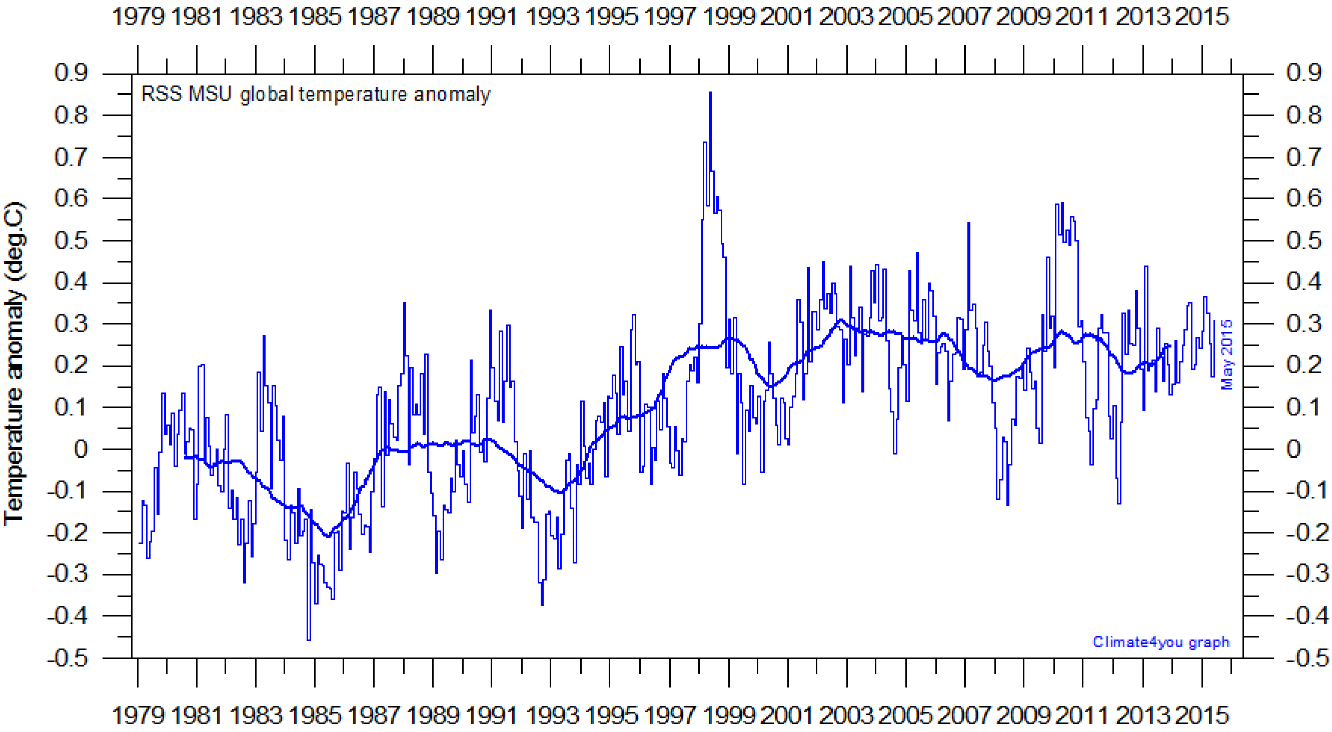
*The Southern Hemisphere* temperatures were mainly near or below average 1998-2006 conditions. Most of the Australian continent had below average temperatures. In South America only Argentina had above average temperatures. The Antarctic continent generally had below average temperatures.

**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).

## Lower troposphere temperature from satellites, updated to May 2015

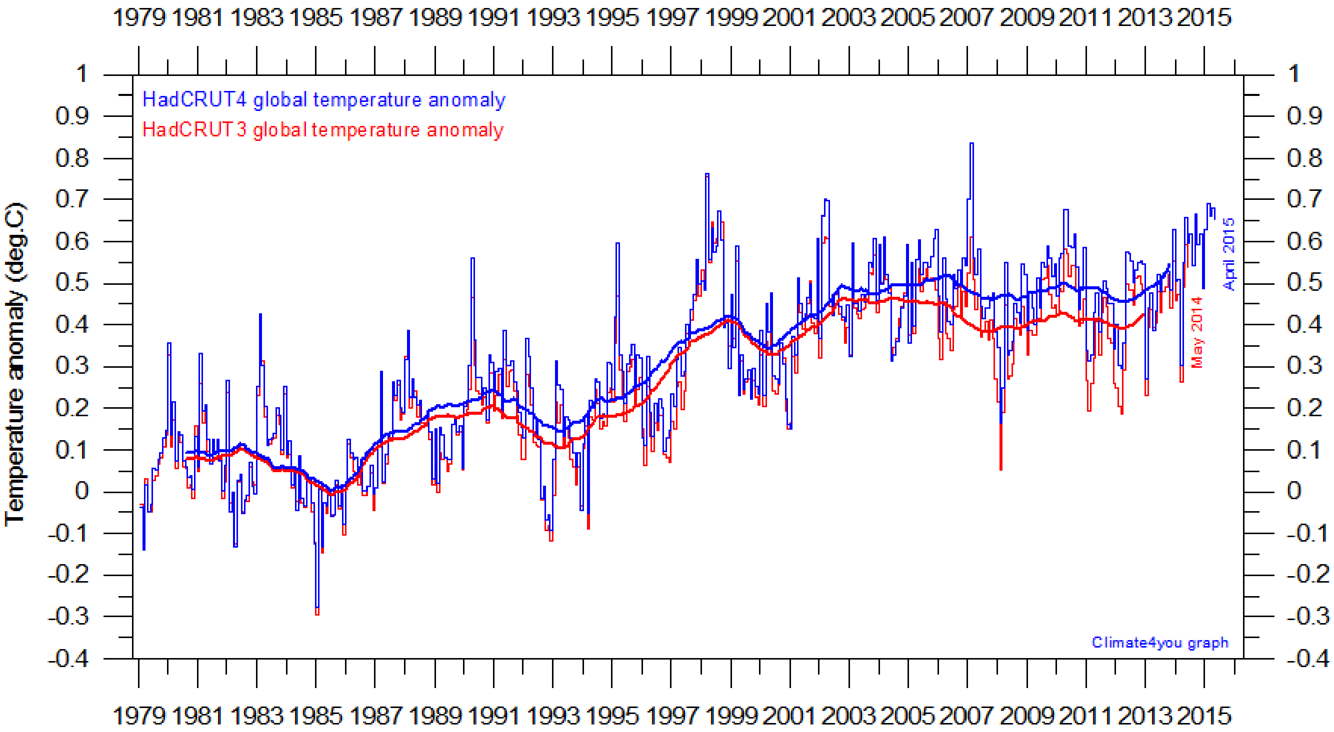


*Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37-month average.*

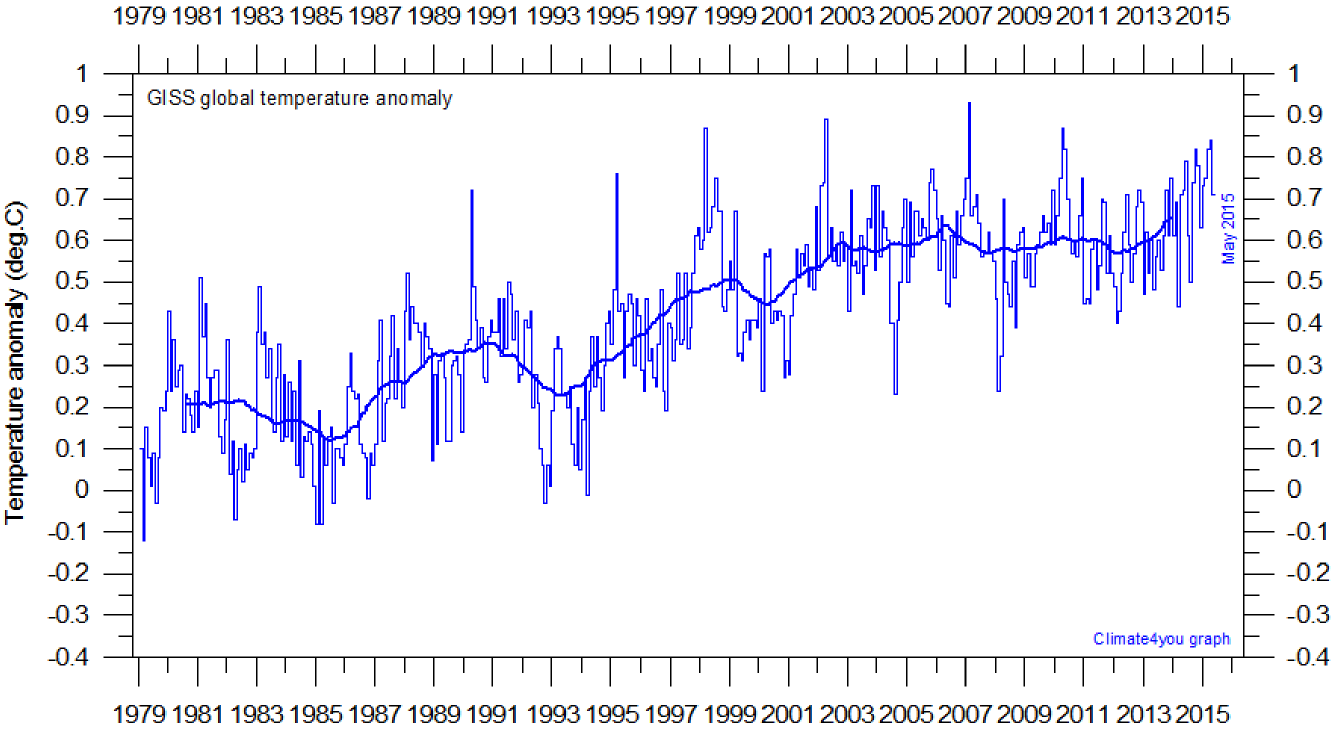


*Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37-month average.*

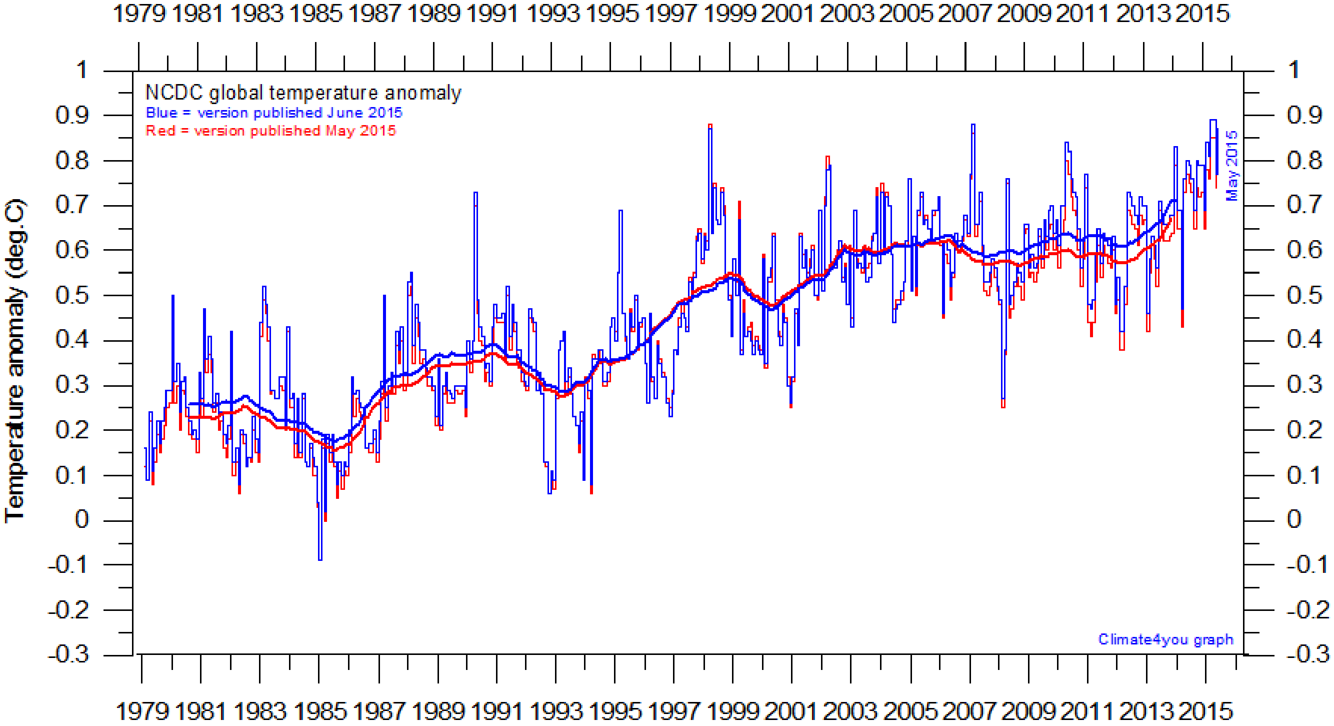
## Global surface air temperature, updated to May 2015



*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 April 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:

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 entirely 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 such 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*).

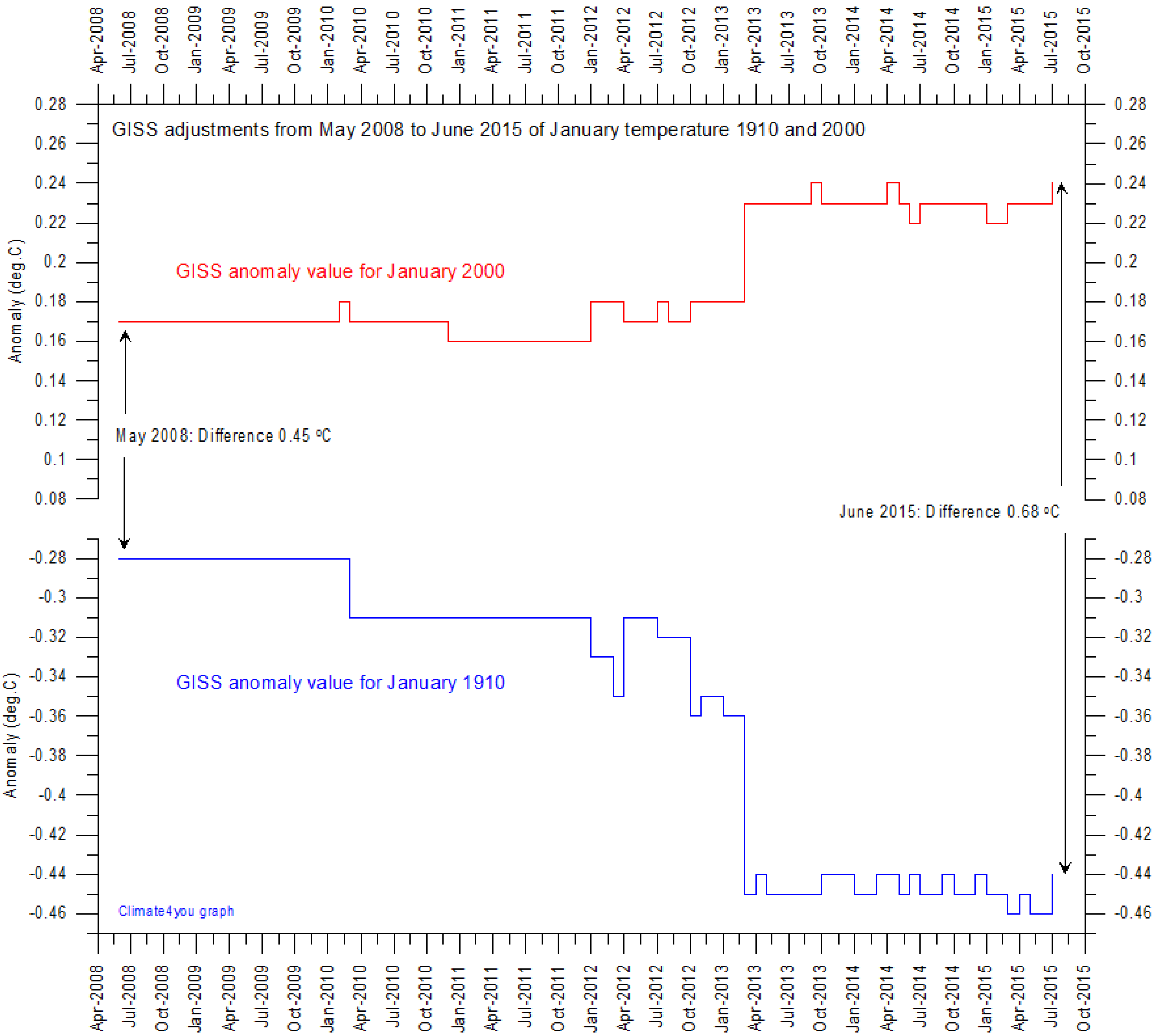


*Diagram showing the adjustment made since May 2008 by the Goddard Institute for Space Studies (GISS), USA, in anomaly values for the months January 1910 and January 2000.*

Note: The administrative upsurge of the temperature increase between January 1915 and January 2000 has grown from 0.45 (reported May 2008) to 0.68$^{o}$C (reported June 2015), representing an about **51%** 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 manipulations of the original data since May 2008.

## Global air temperature linear trends updated to April 2015

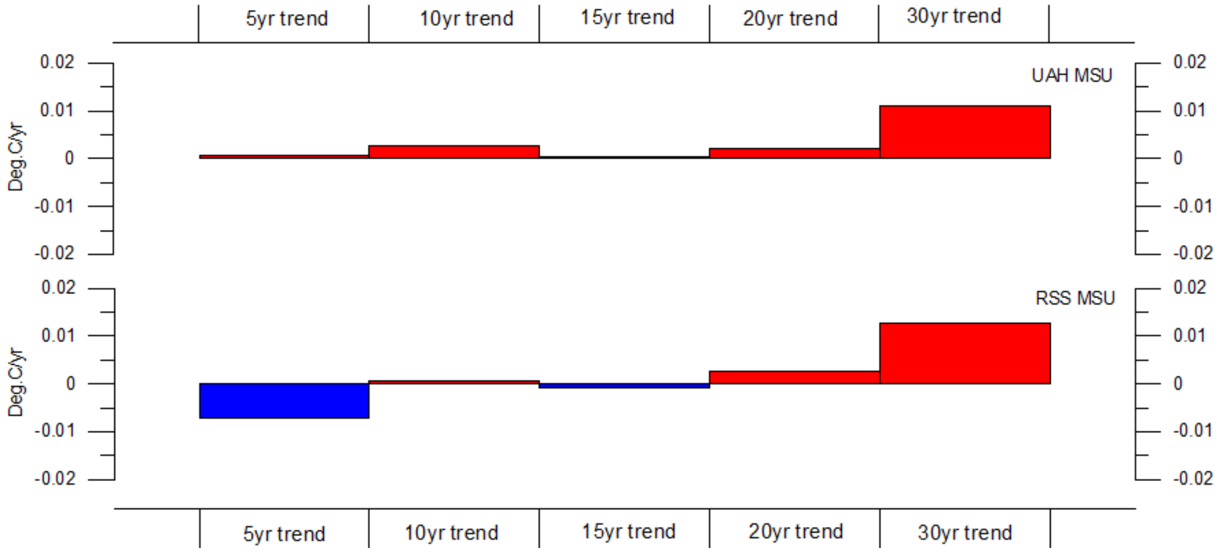


*Diagram showing the latest 5, 10, 20 and 30 yr linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for two satellite-based temperature estimates (UAH MSU and RSS MSU). Last month included in analysis: April 2015.*

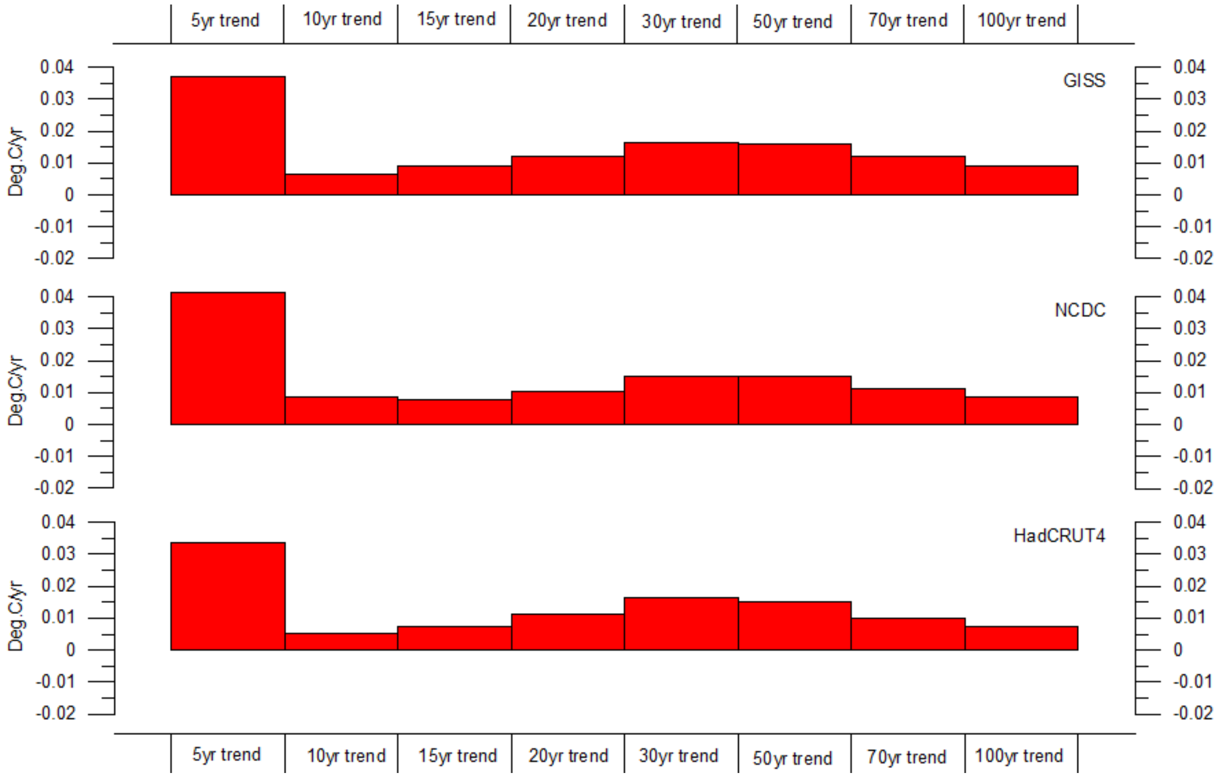
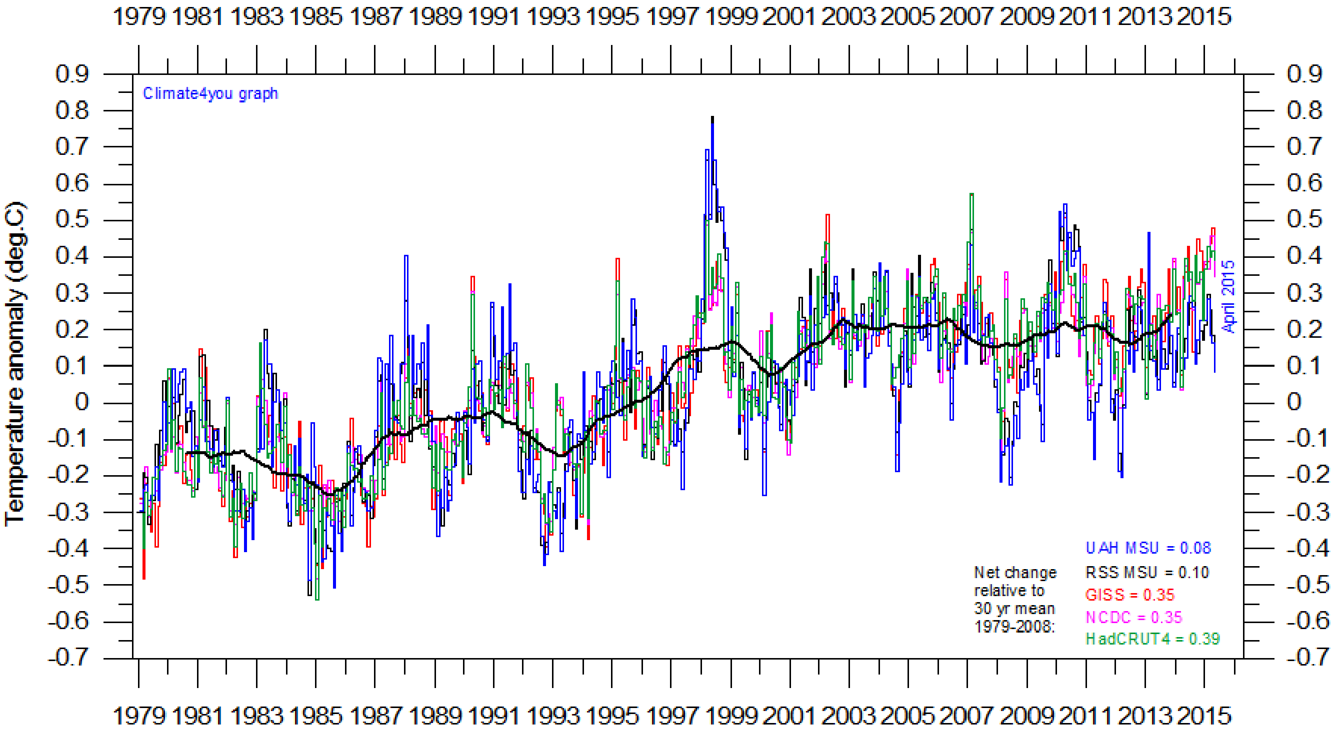


*Diagram showing the latest 5, 10, 20, 30, 50, 70 and 100 year linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for three surface-based temperature estimates (GISS, NCDC and HadCRUT4). Last month included in all analyses: April 2015.*

## All in one, updated to April 2015

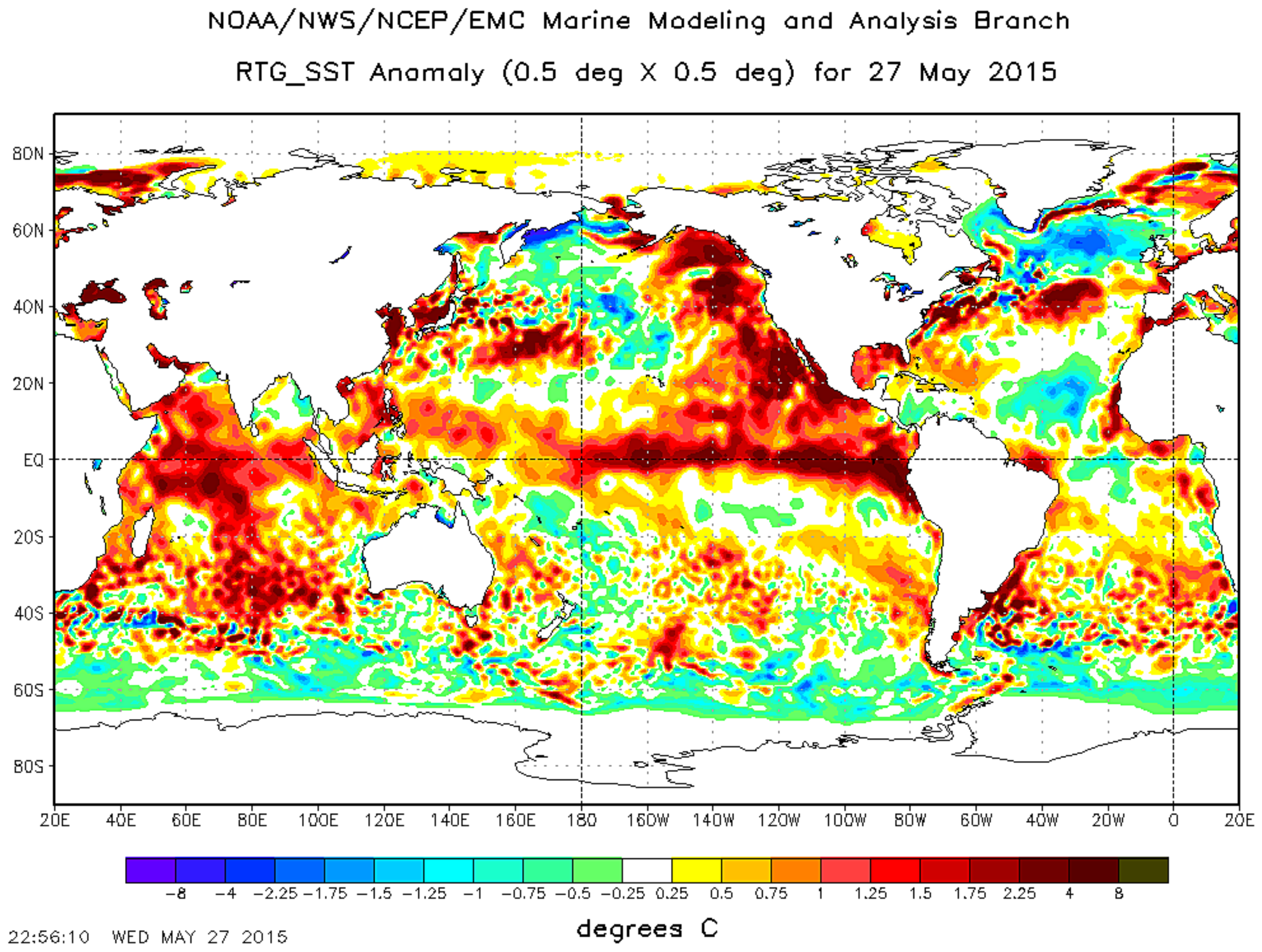


*Superimposed plot of all five global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (30 years) from January 1979 to December 2008. The heavy black line represents 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.*

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 May 2015



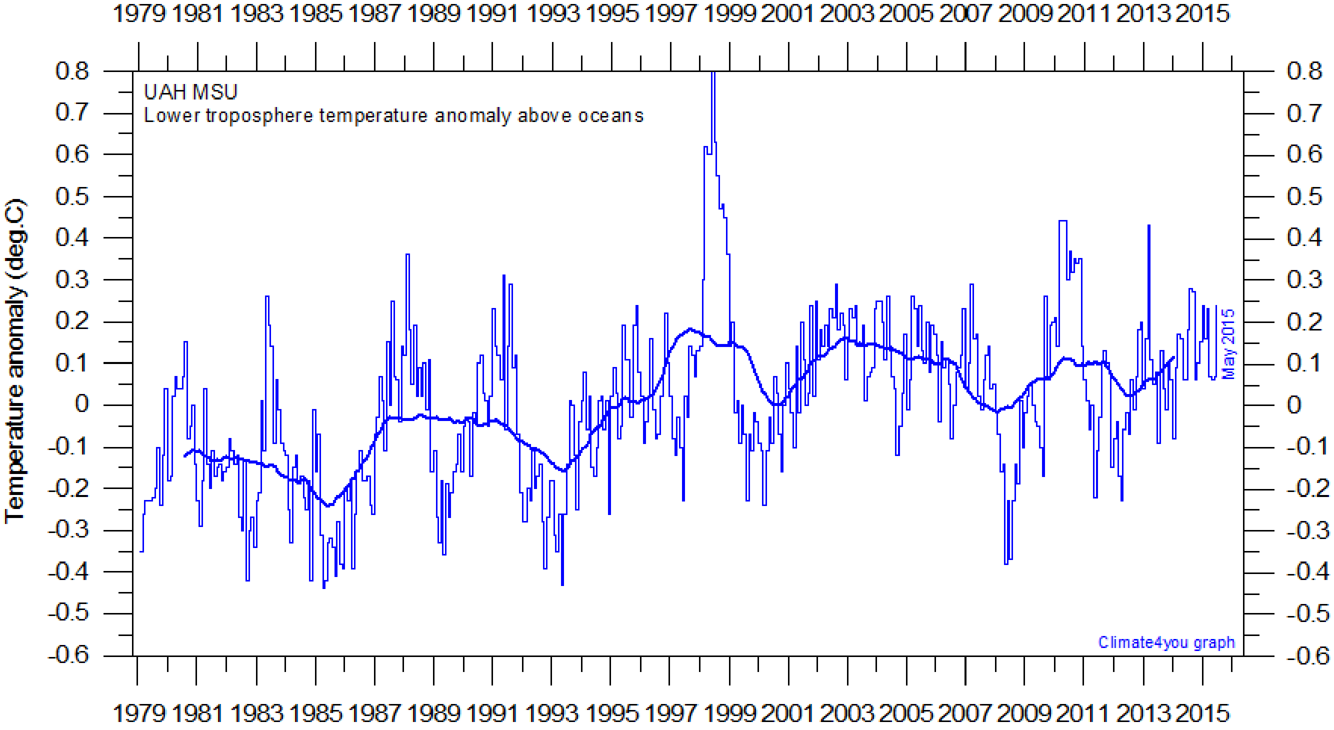
*Sea surface temperature anomaly on 27 May 2015. Map source: National Centers for Environmental Prediction (NOAA).*

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).

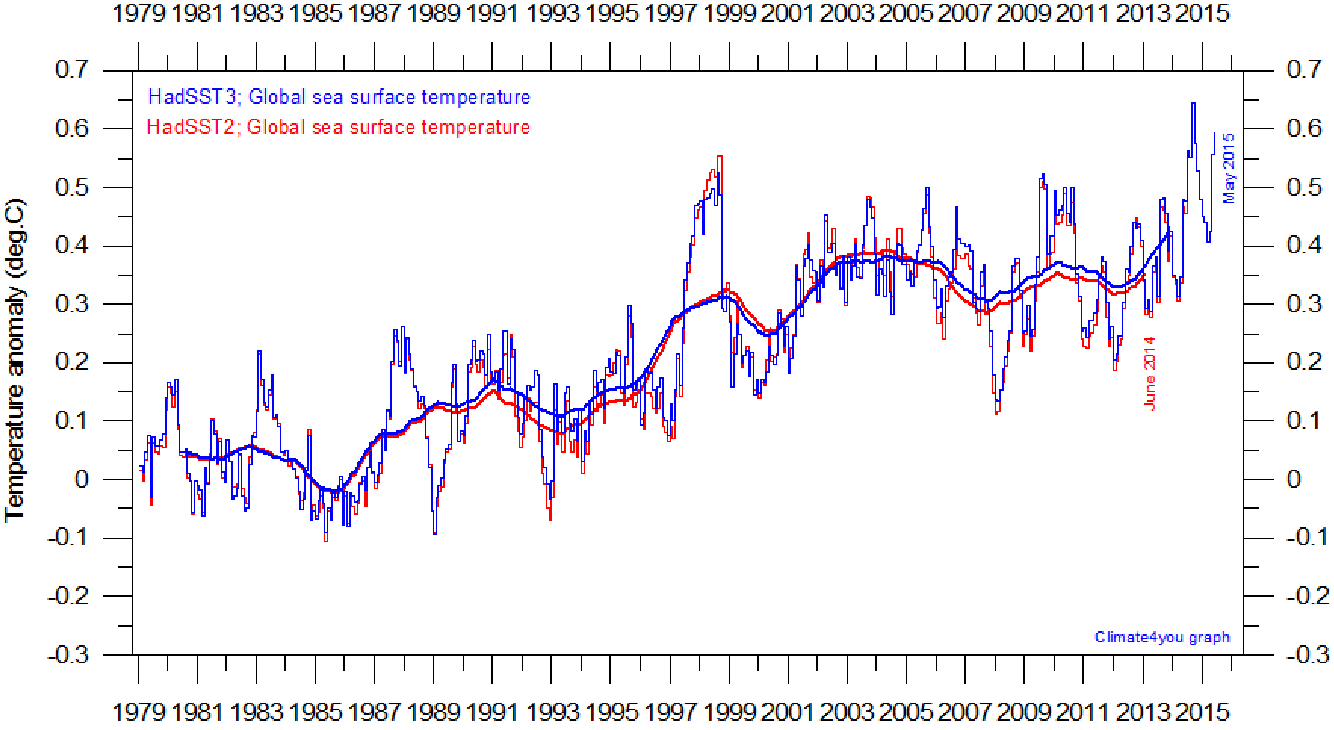
Relatively warm water is dominating the oceans near the Equator, and is influencing global air temperatures now and in the months to come.

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.

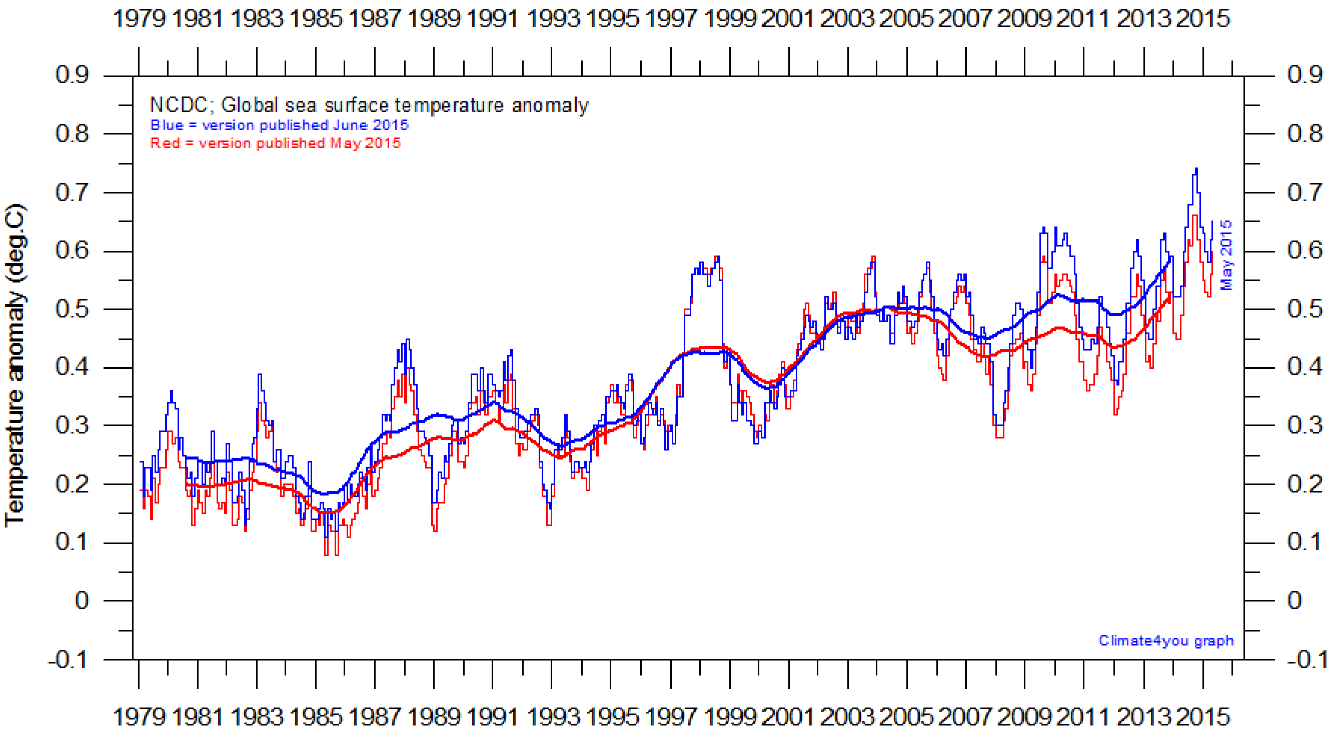
However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, global net changes can be small and such heat exchanges may mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when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



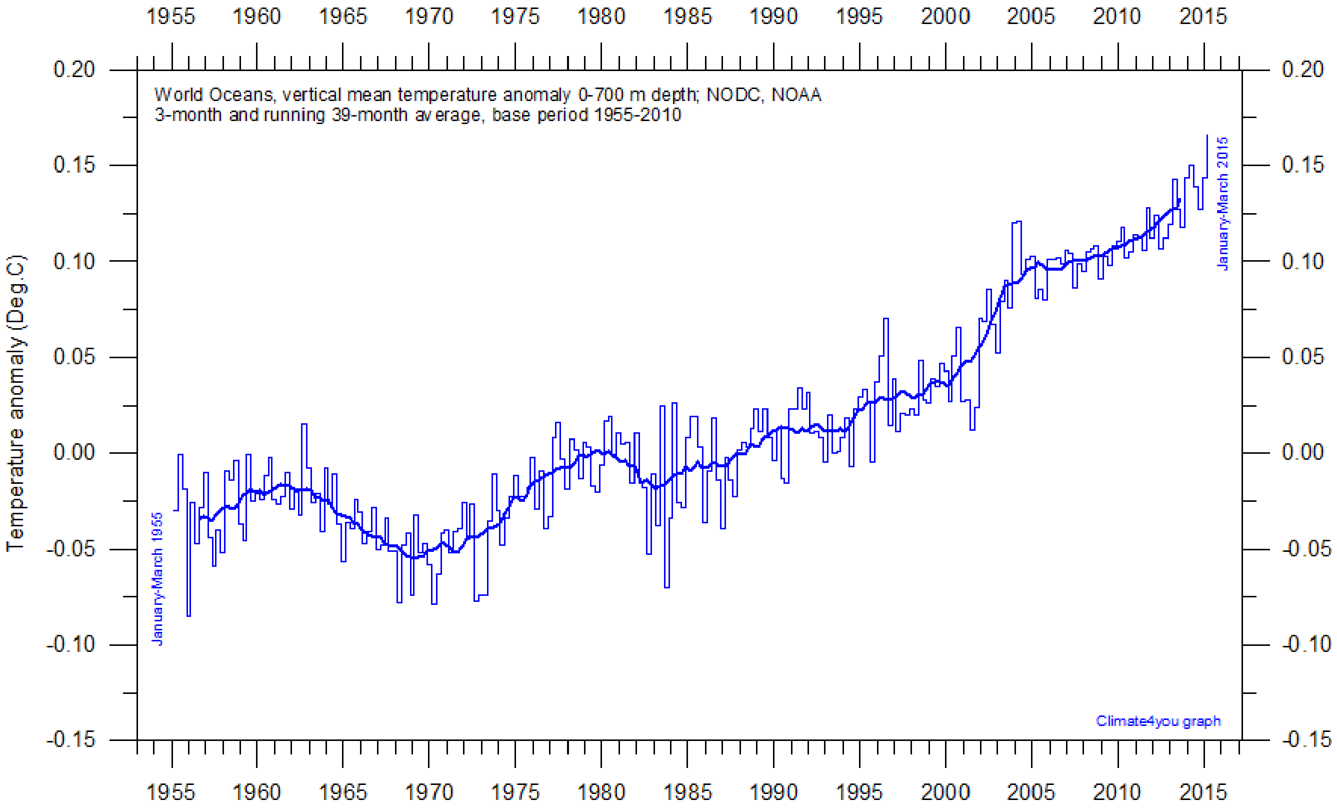
*Global monthly average sea surface temperature since 1979 according to University of East Anglia's Climatic Research Unit (CRU), UK. Base period: 1961-1990. The thick line is the simple running 37-month average.*



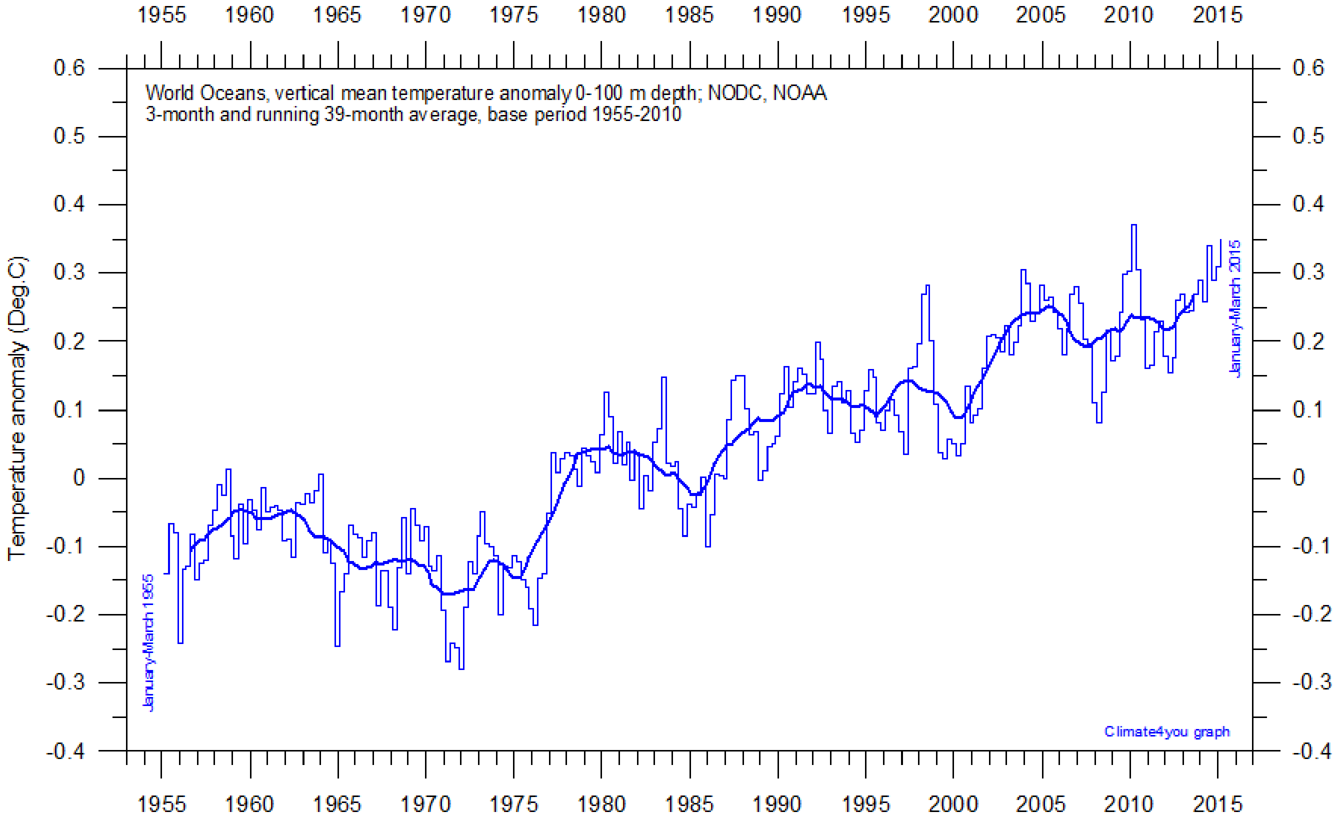
*Global monthly average sea surface temperature since 1979 according to the National Climatic Data Center (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37-month average.*

***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).*

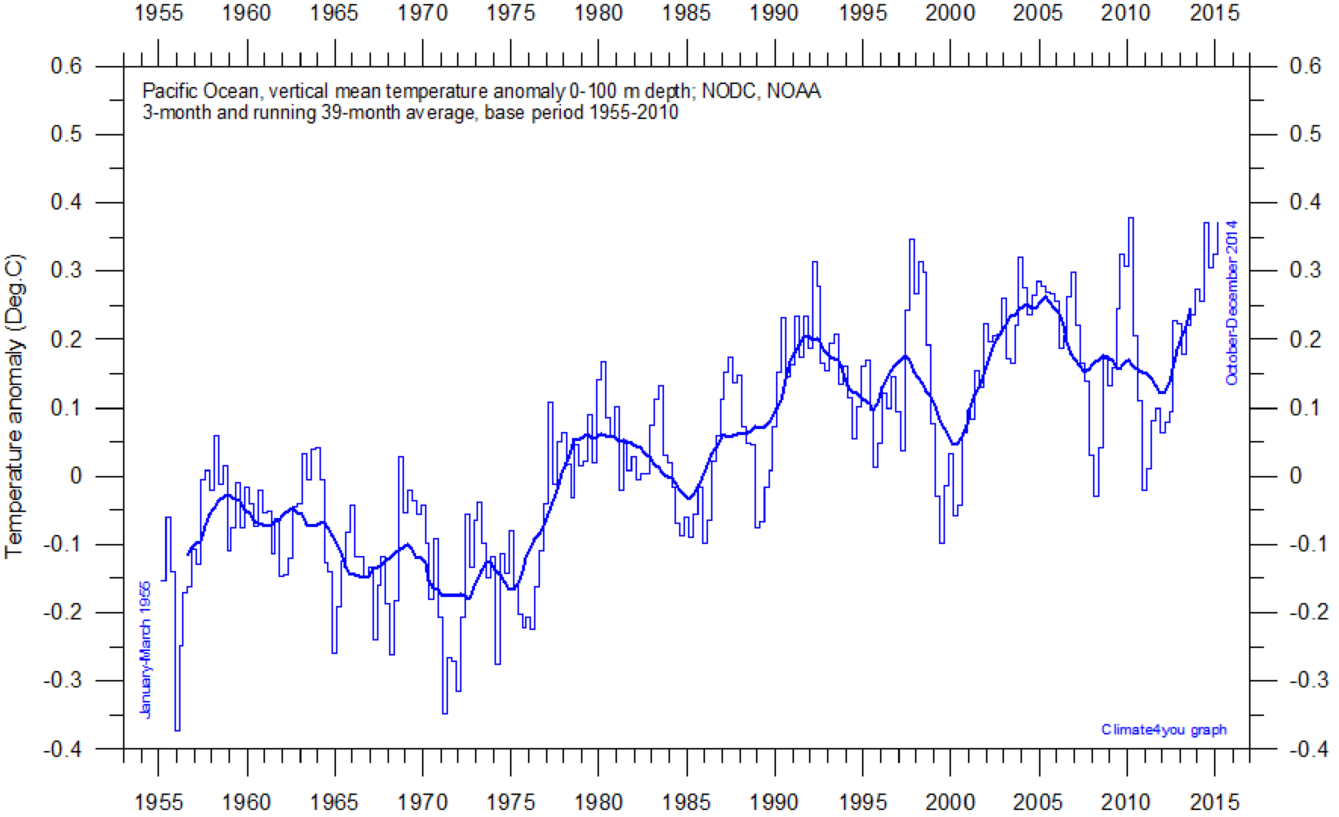
## Ocean heat content uppermost 100 and 700 m, updated to March 2015



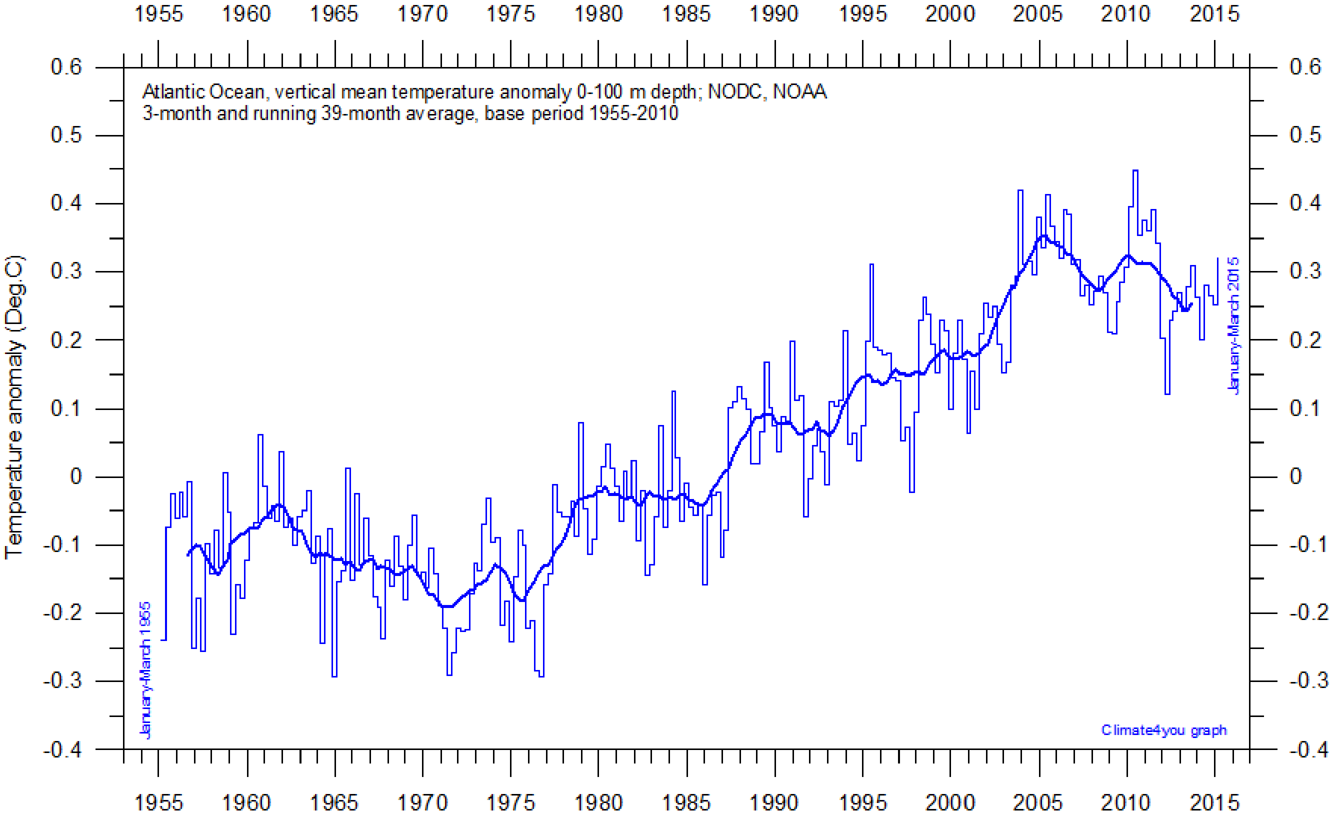
*Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1955. Data source: National Oceanographic Data Center(NODC).*



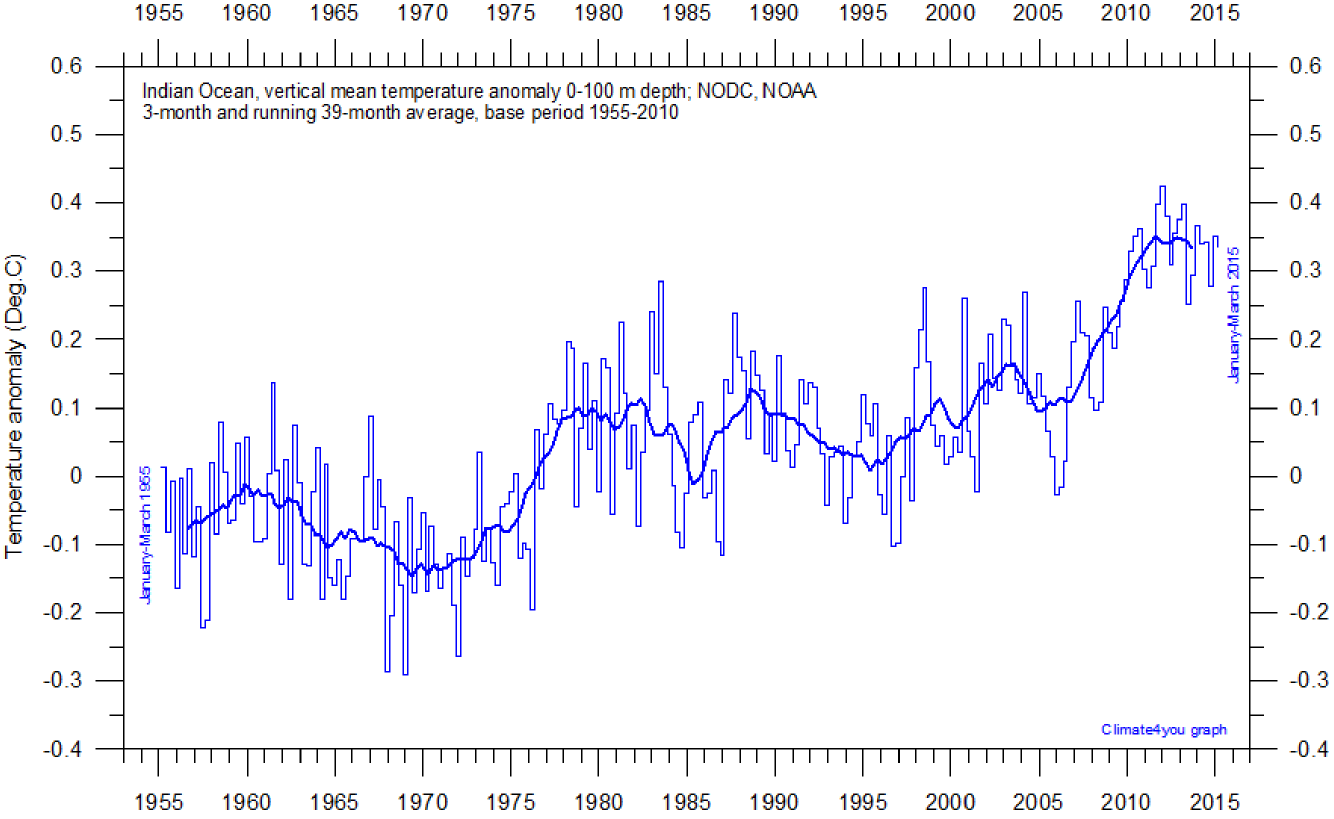
*World Oceans vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: [NOAA National Oceanographic Data Center](#) (NODC). Base period 1955-2010.*



*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.*

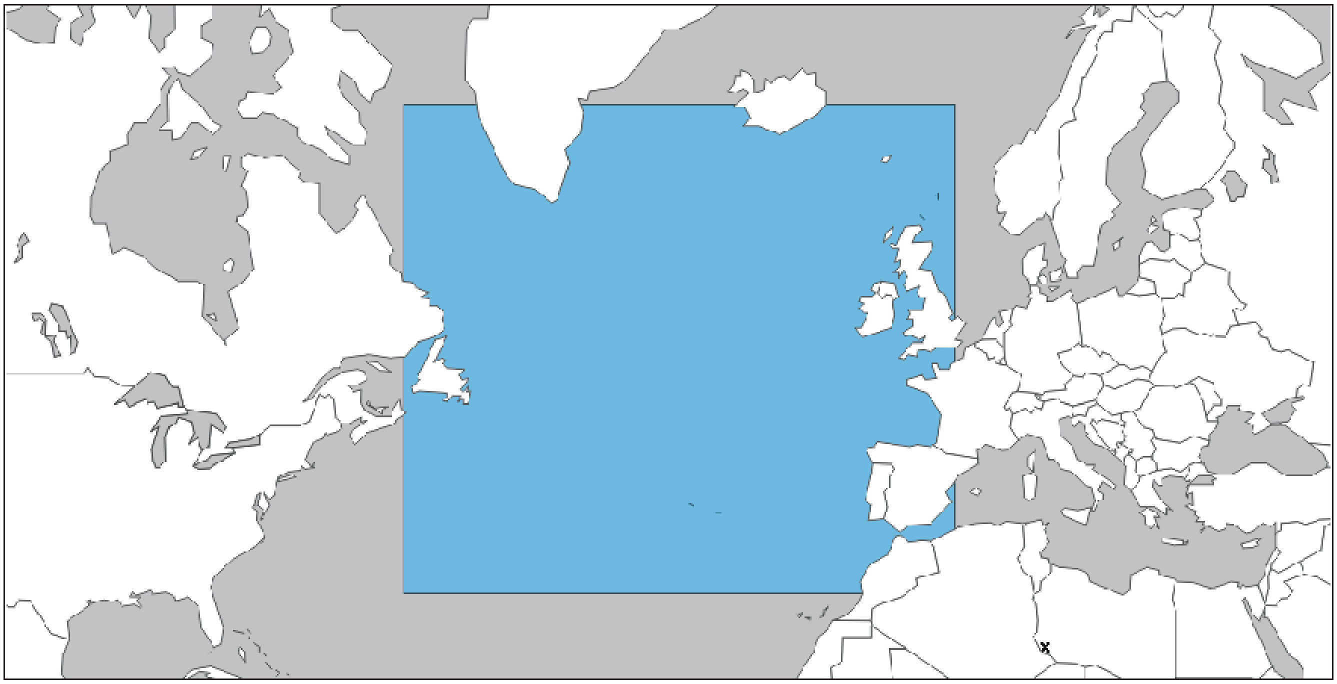


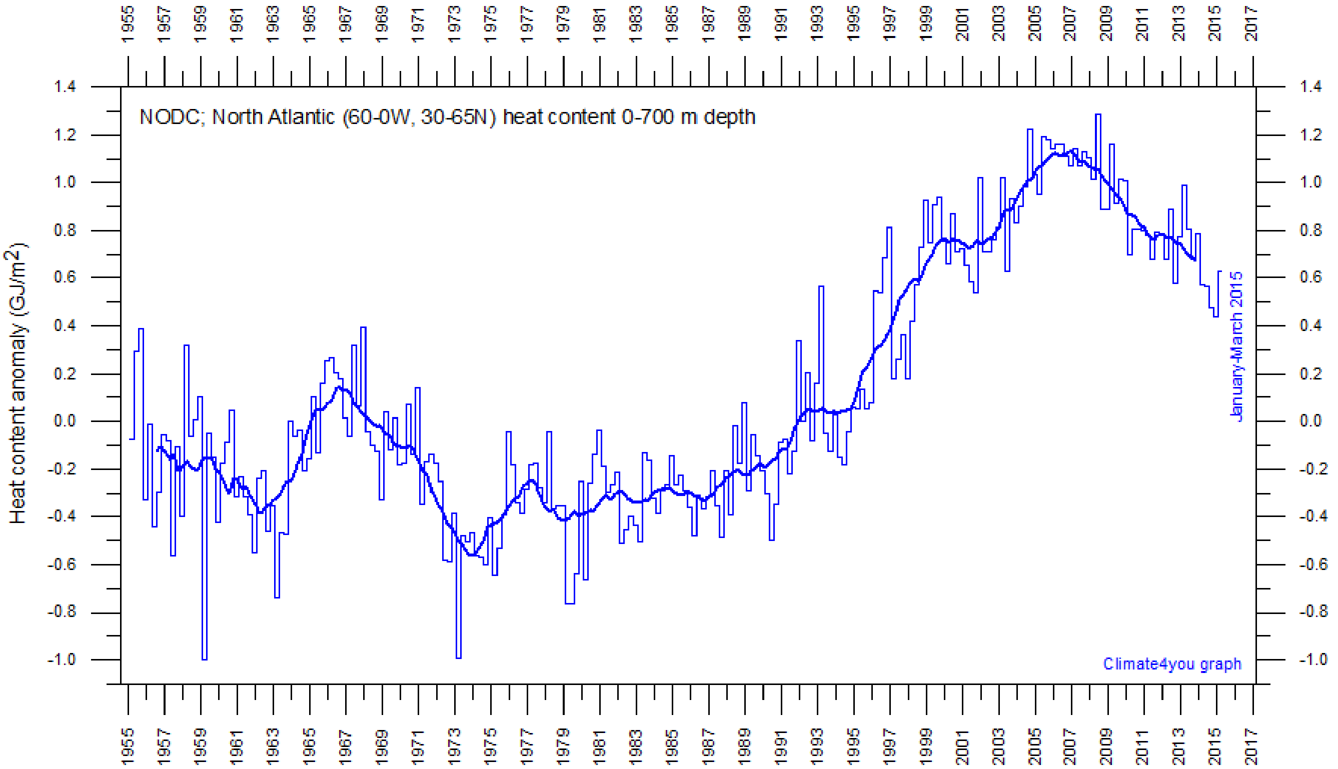
*Atlantic Ocean vertical average temperature 0-100 m depth since 1955. The thin line indicate 3-month values, and the thick line represents the simple running 39-month (c. 3 year) average. Data source: [NOAA National Oceanographic Data Center]() (NODC). Base period 1955-2010.*



*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.*

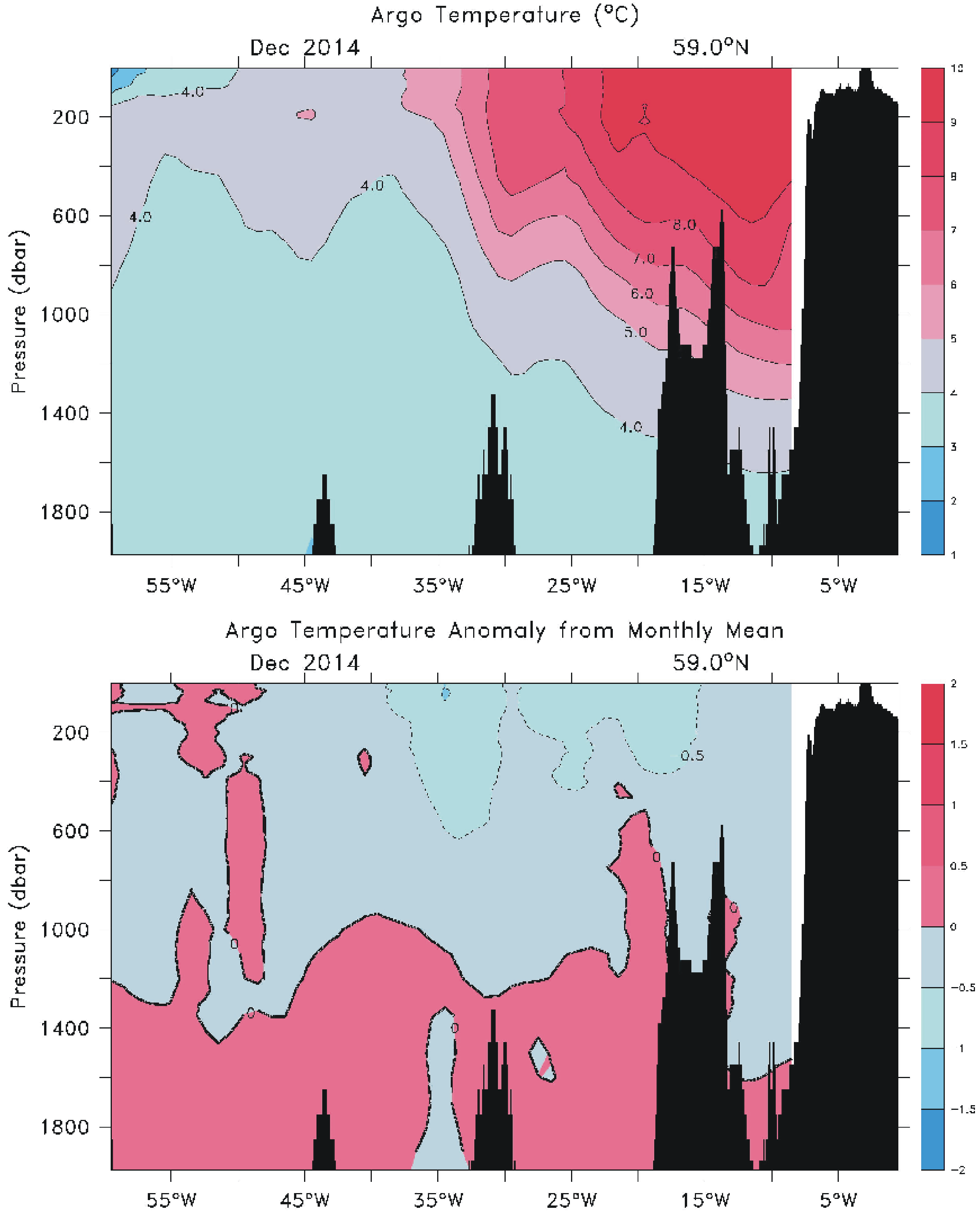
## North Atlantic heat content uppermost 700 m, updated to March 2015





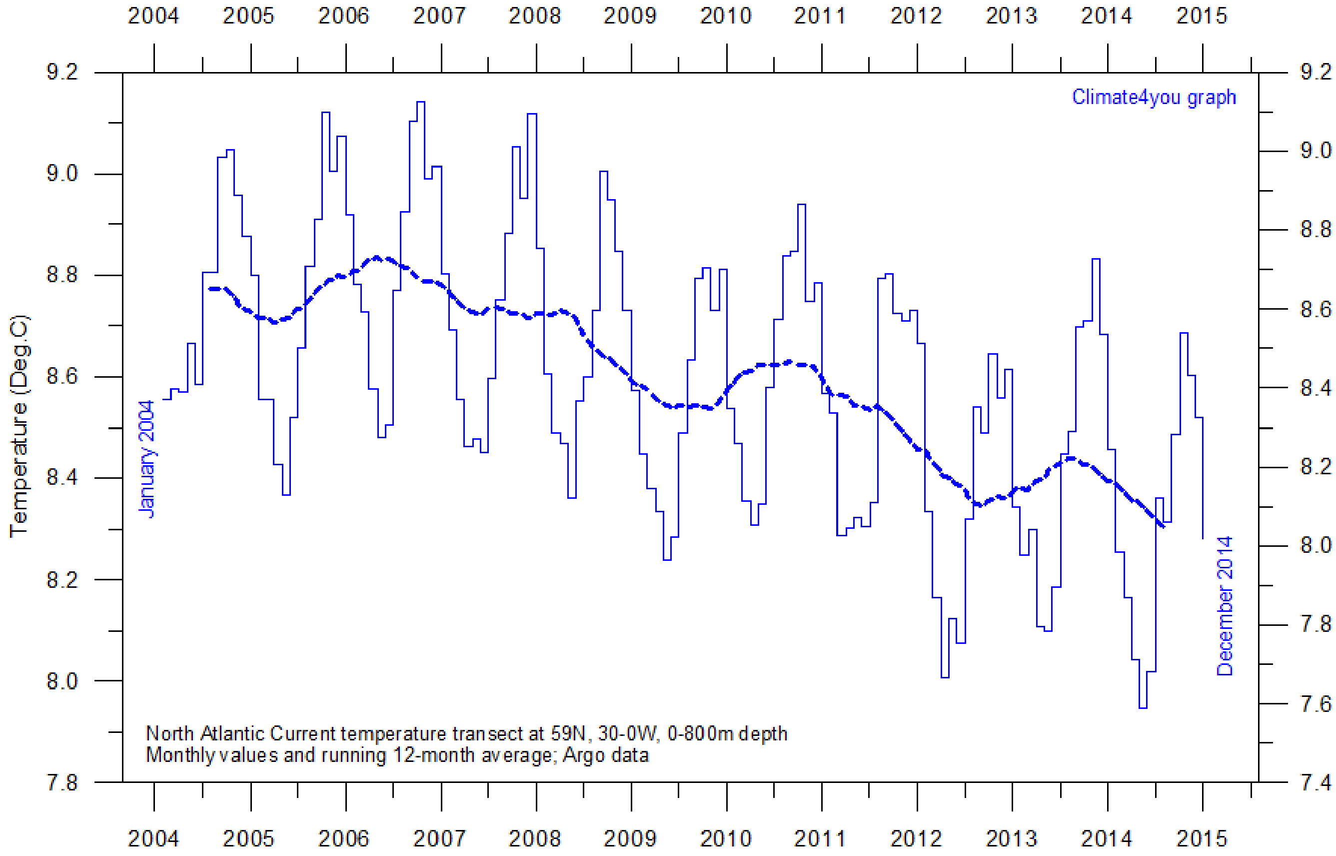
*Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the* North Atlantic (60-0W, 30-65N; see map above) *ocean since January 1955. The thin line indicates monthly values, and the thick line represents the simple running 37 month (c. 3 year) average. Data source:* *National Oceanographic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

## North Atlantic sea temperatures along 59N, updated to December 2014



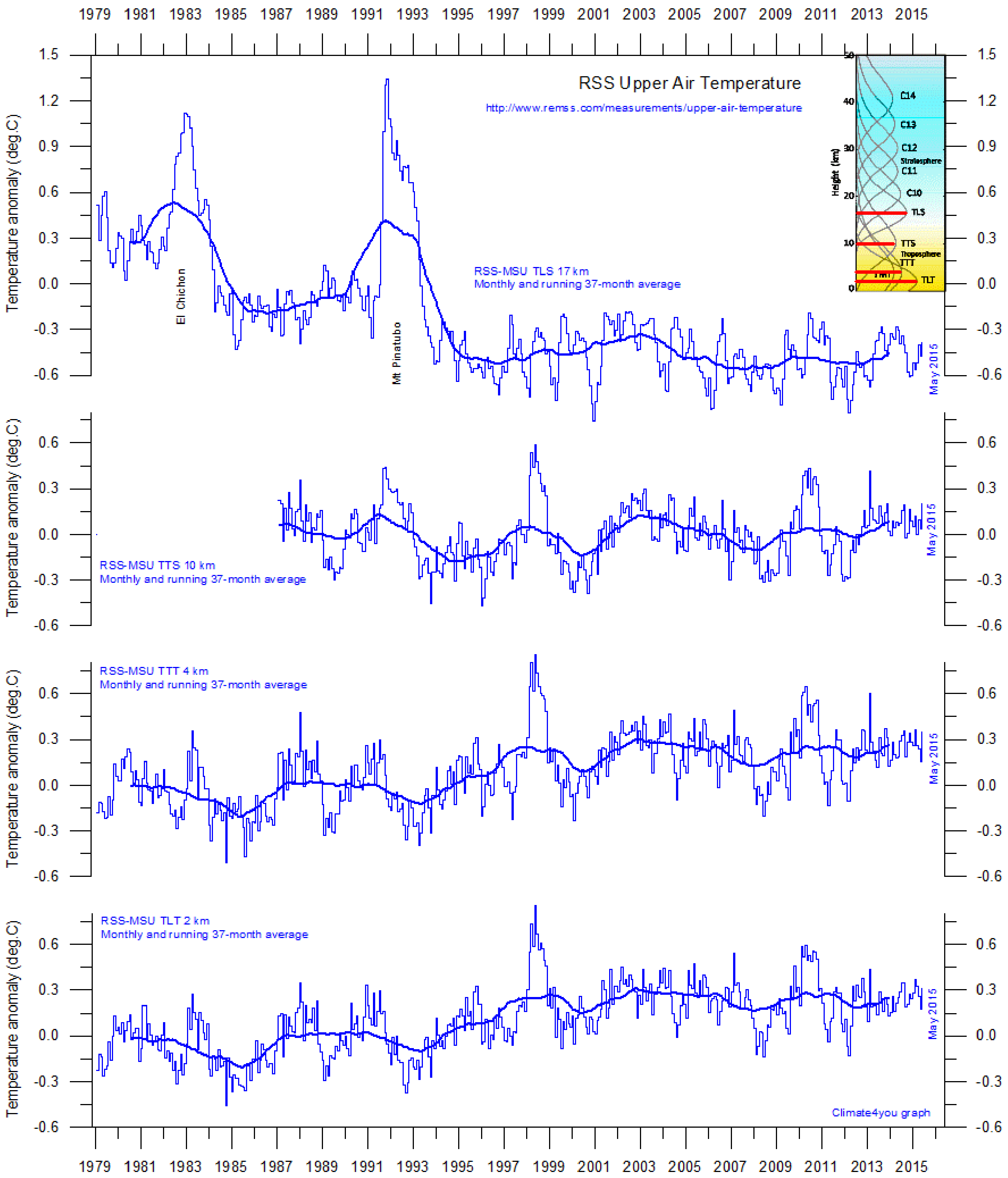
*Depth-temperature diagram along 59 N across the North Atlantic, extending from northern Labrador in the west to northern Scotland in the east, using Argo-data. The uppermost panel shows the absolute temperature, and the lower diagram shows the temperature anomaly, using the monthly average temperature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

## North Atlantic sea temperatures 30-0W at 59N, updated to December 2014



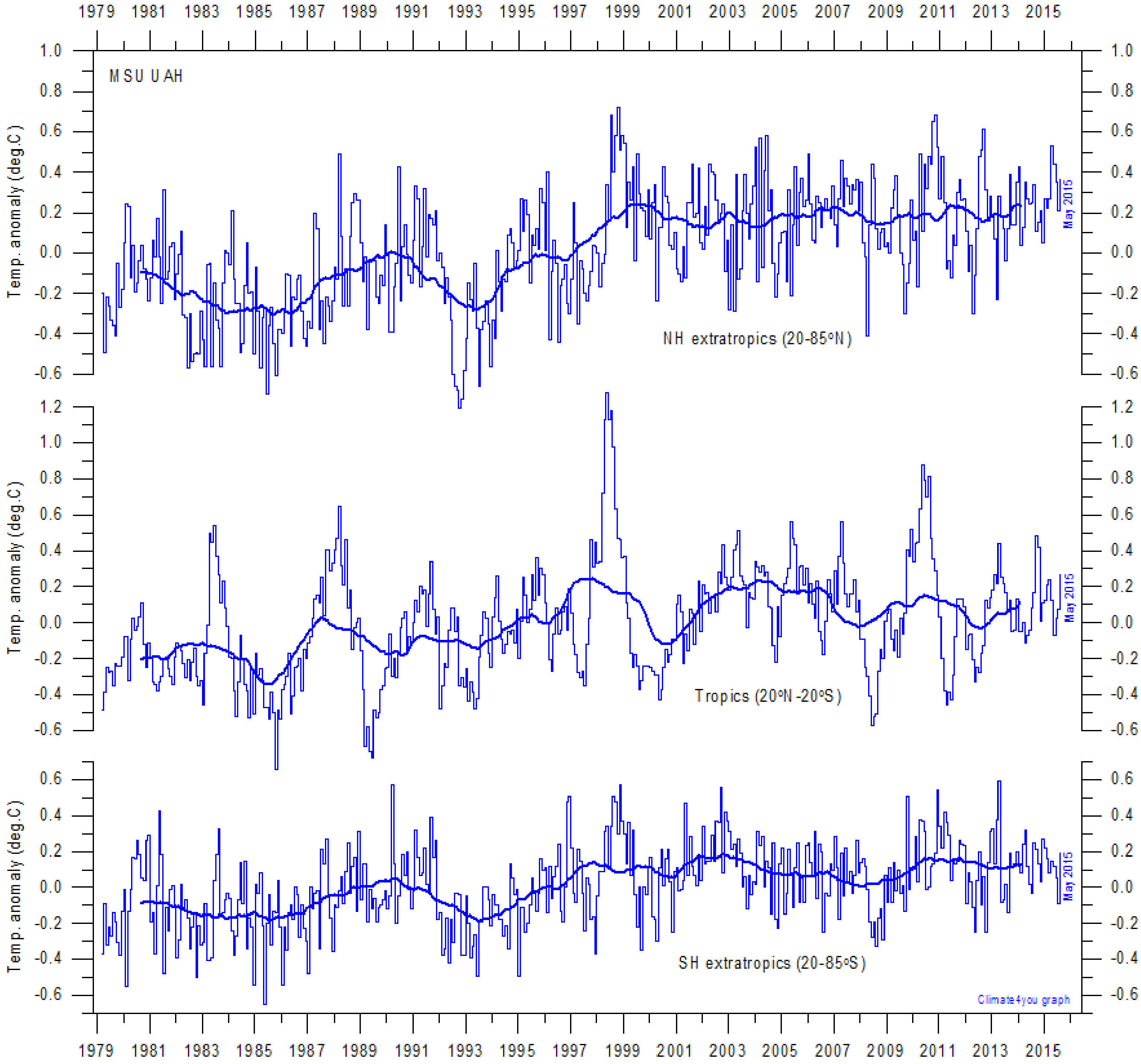
*Average temperature along 59 N, 30-0W, 0-800m depth, corresponding to the main part of the North Atlantic Current, using Argo-data. Source: Global Marine Argo Atlas. Additional information can be found in: Roemmich, D. and J. Gilson, 2009. The 2004-2008 mean and annual cycle of temperature, salinity, 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 May 2015



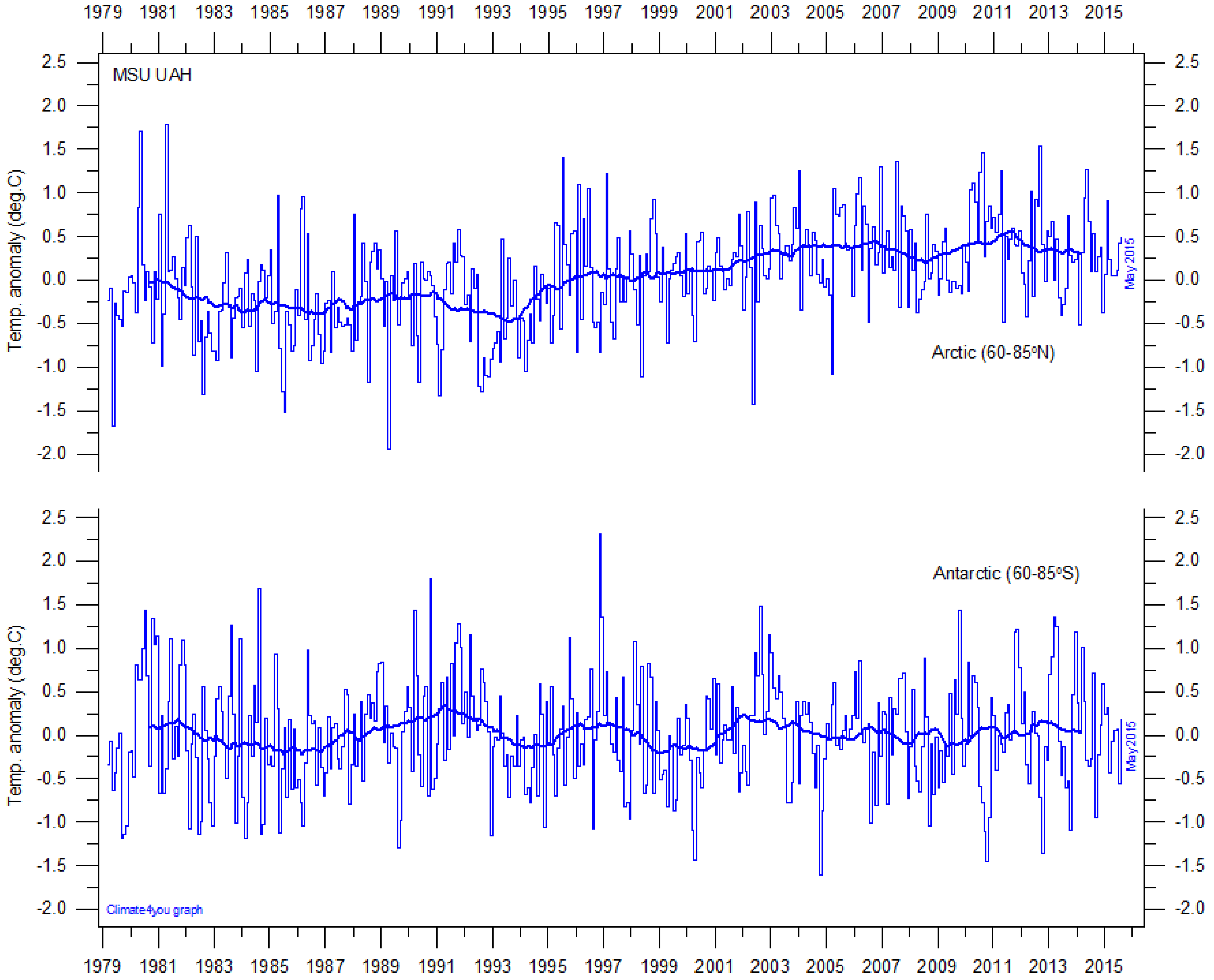
*Global monthly average temperature in different altitudes according to Remote Sensing Systems (RSS). The thin lines represent the monthly average, and the thick line the simple running 37 month average, nearly corresponding to a running 3 year average.*

## Zonal lower troposphere temperatures from satellites, updated to May 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 May 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 April 2015

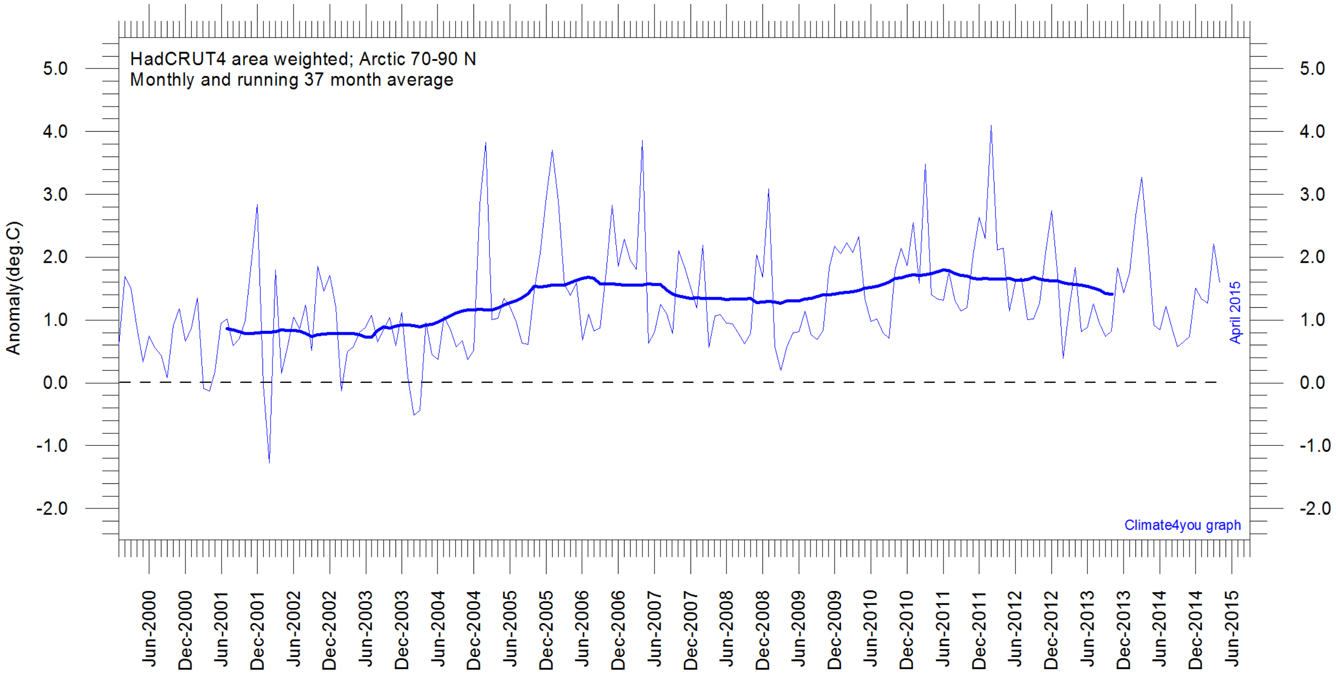


*Diagram showing area weighted Arctic (70-90$^o$N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.*

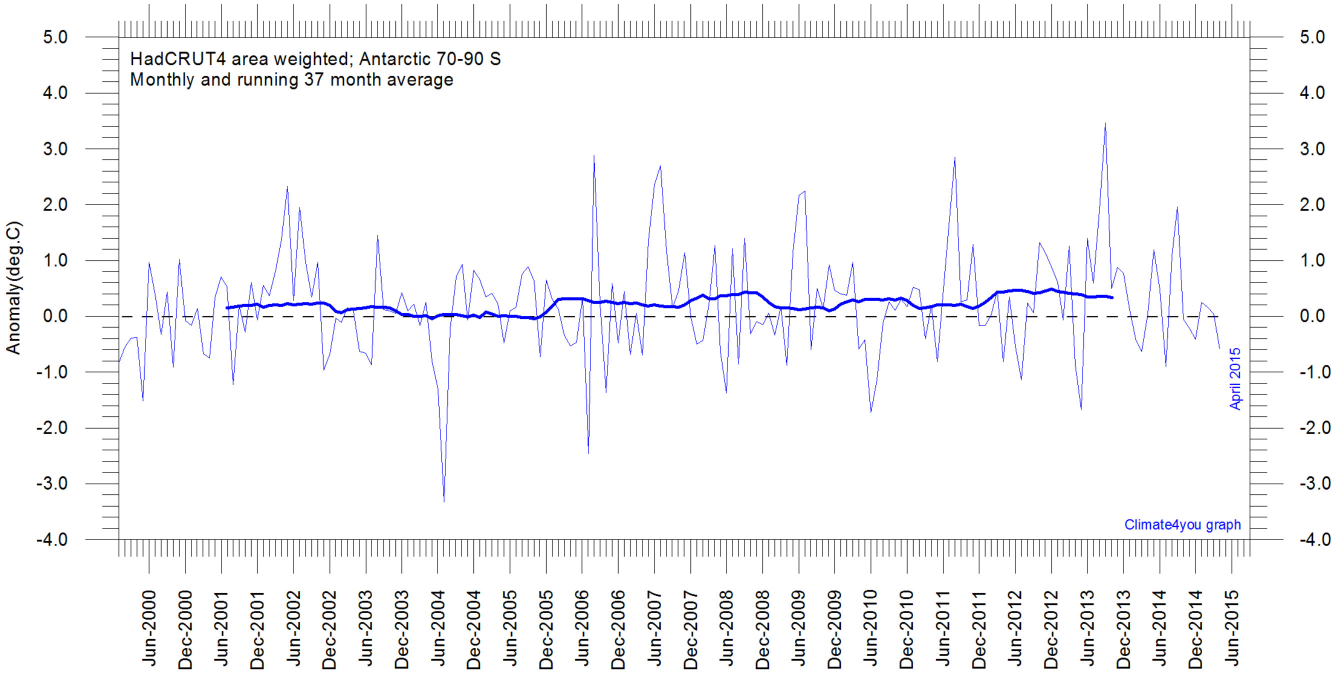


*Diagram showing area weighted Antarctic (70-90$^o$N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.*

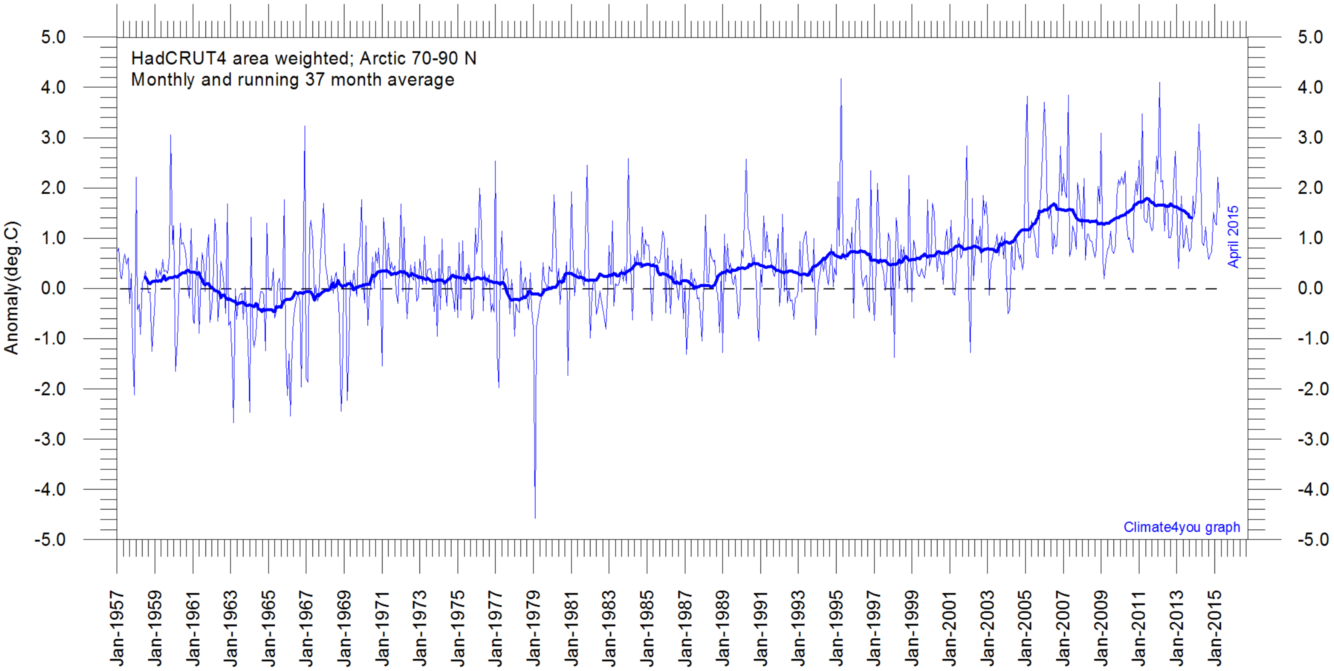


*Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 1957, in relation to the WMO normal period 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.*

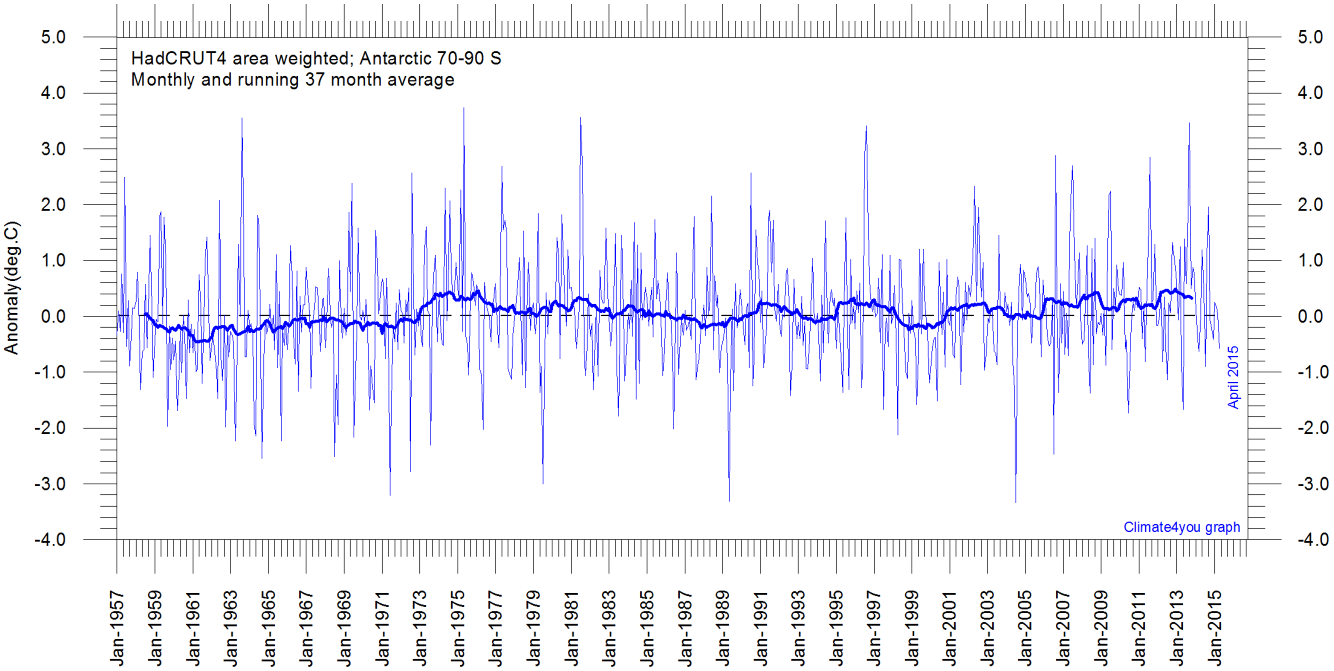


*Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 1957, in relation to the WMO normal period 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average.*

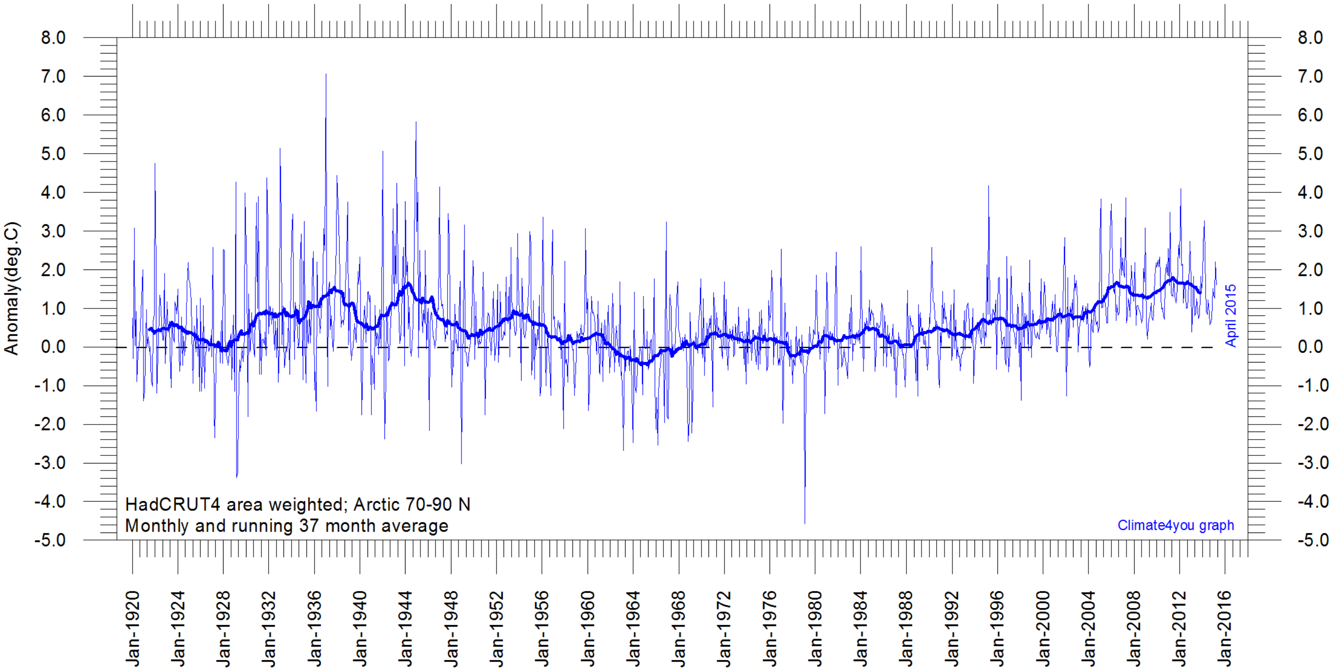


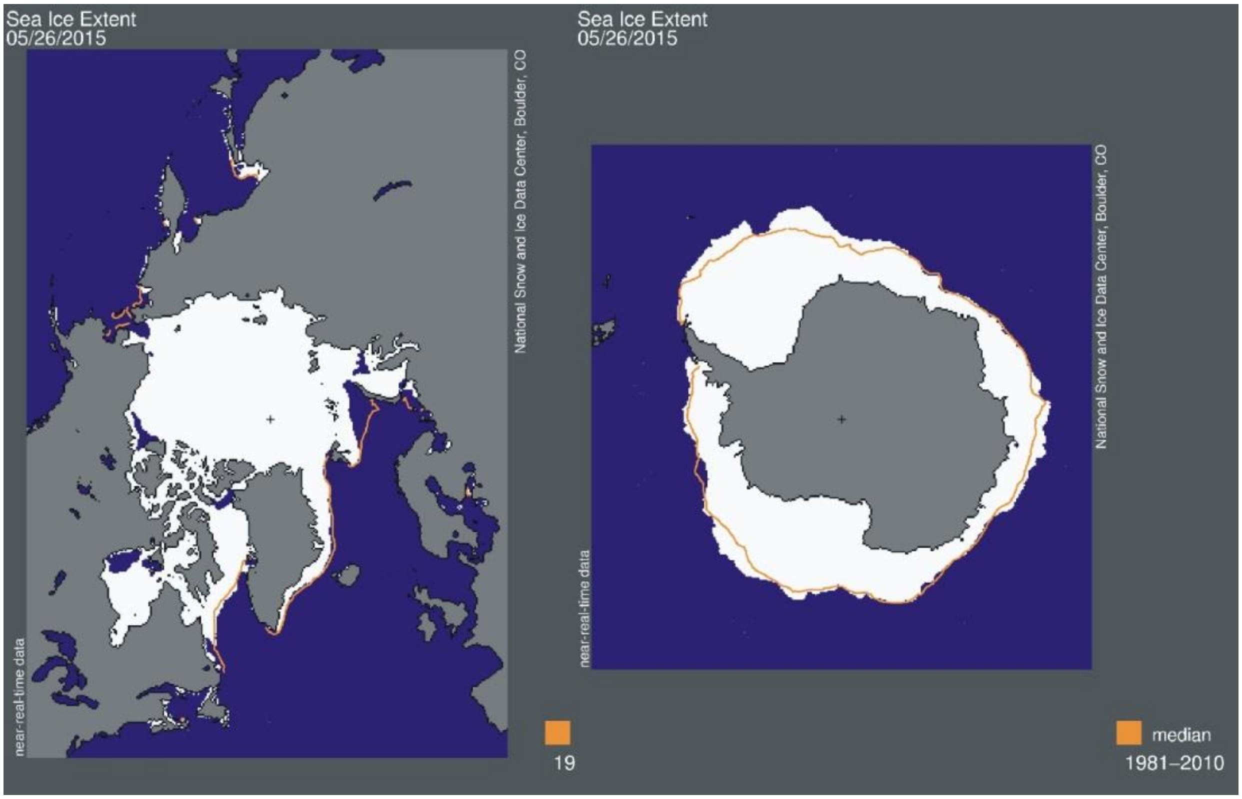
*Diagram showing area-weighted Arctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 1920, in relation to the WMO normal period 1961-1990. The thin line shows the monthly temperature anomaly, while the thicker line shows the running 37 month (c. 3 year) average. Because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

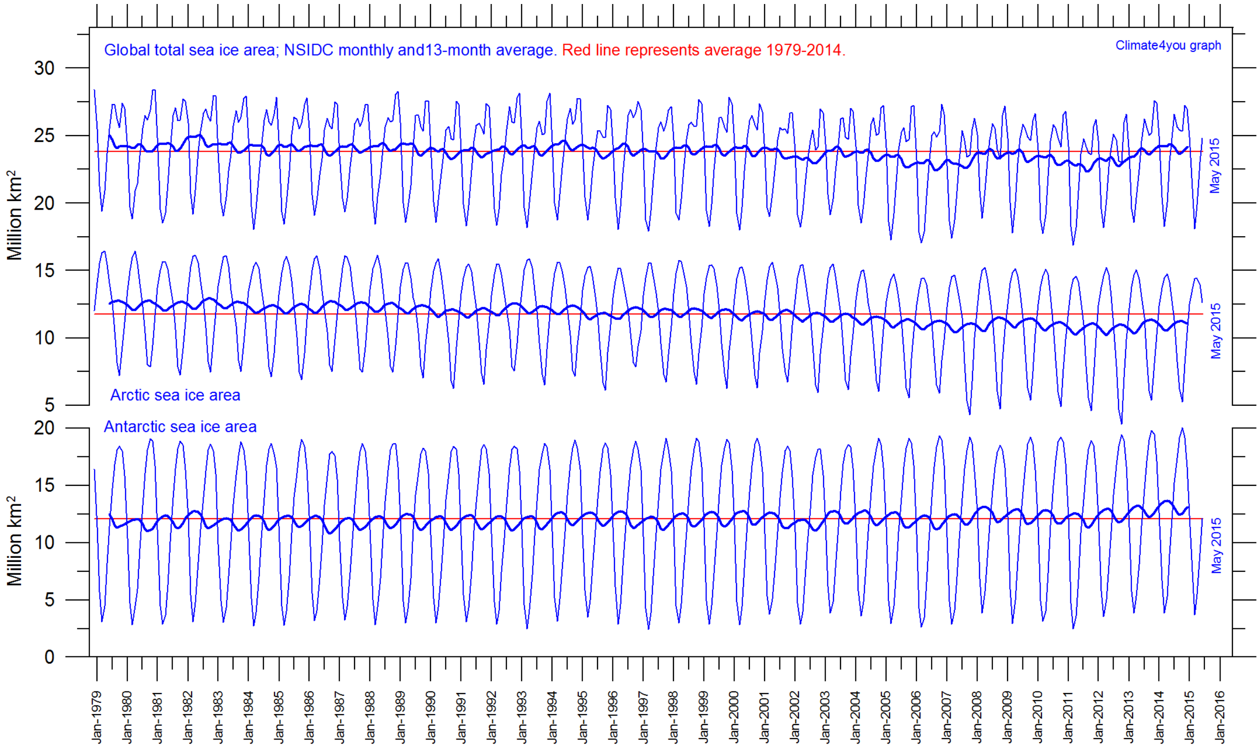
Literature:

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.

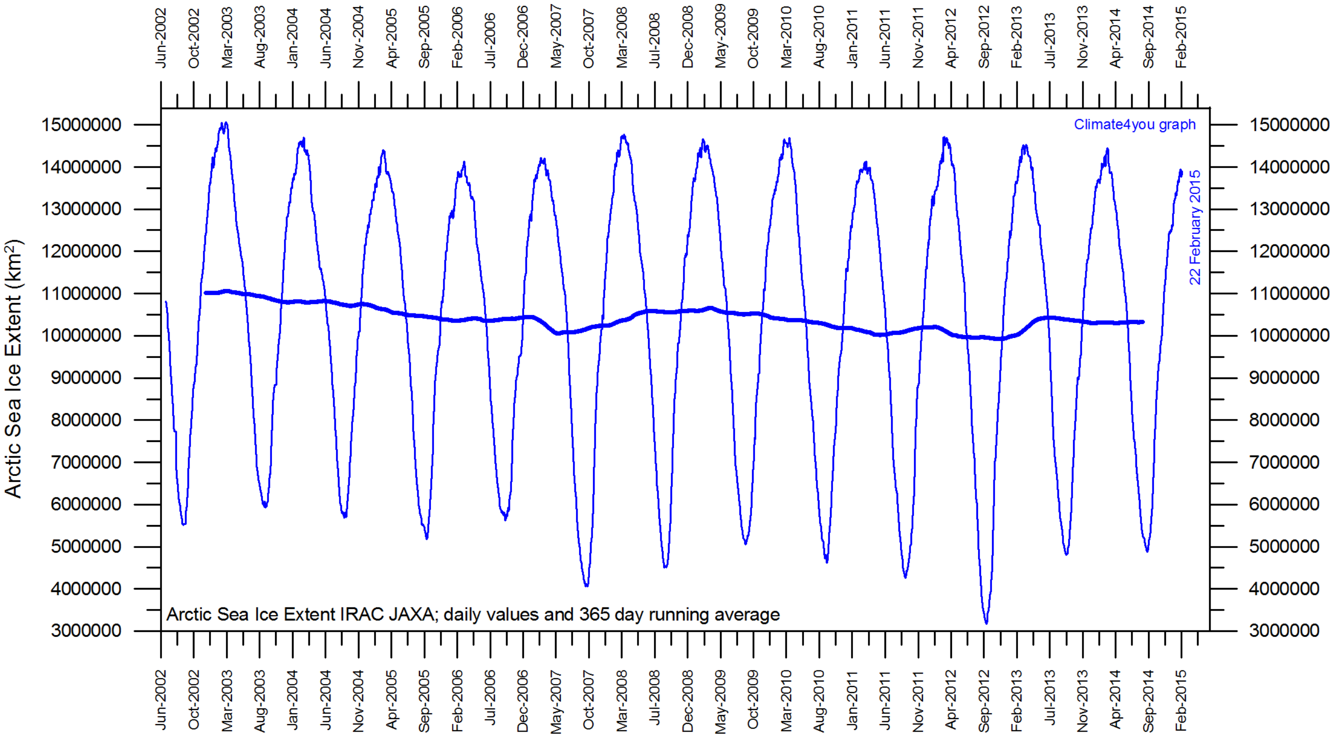
## Arctic and Antarctic sea ice, updated to May 2015



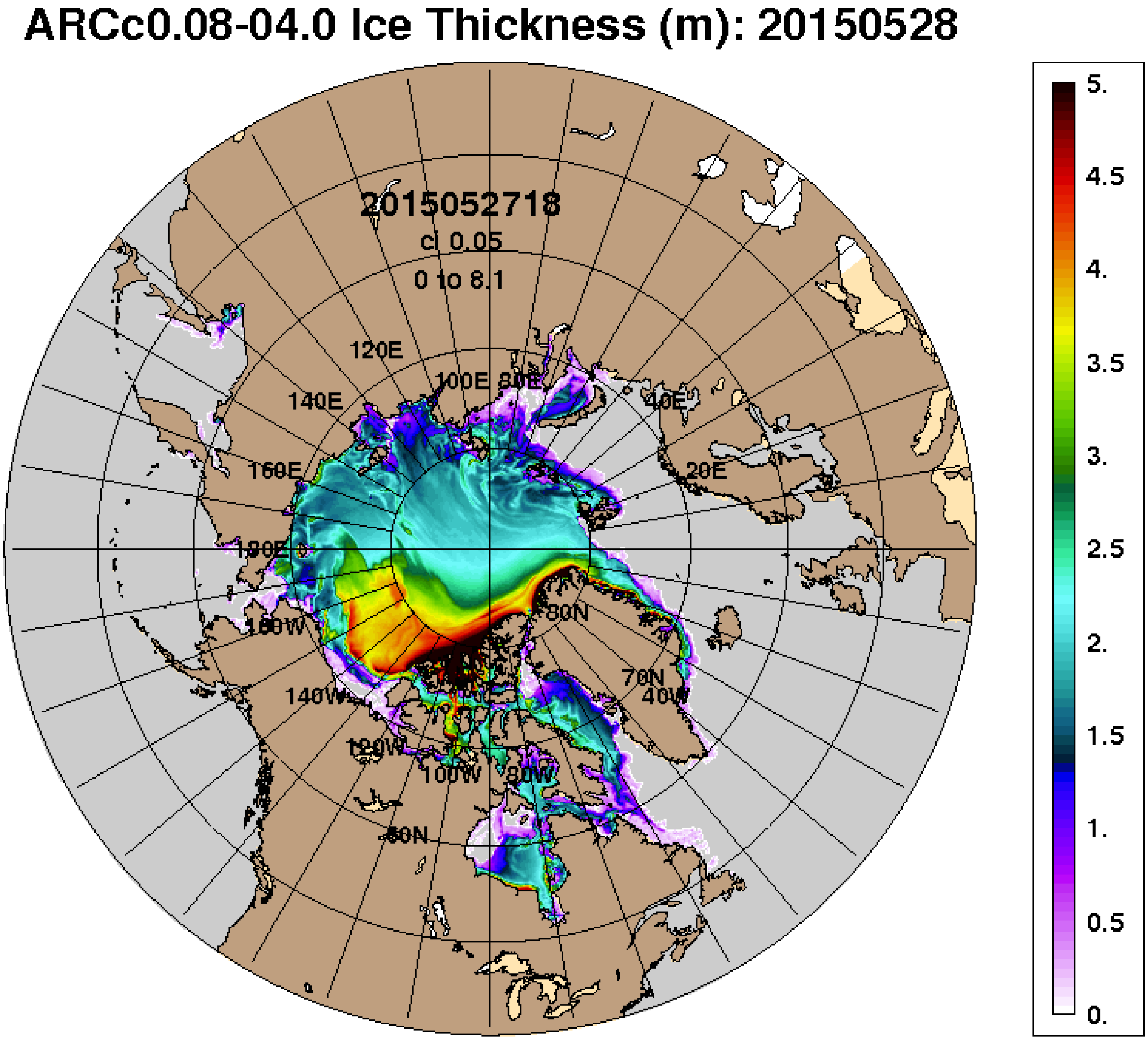
*Sea ice extent 25 May 2015. The 'normal' or average limit of sea ice (orange line) is defined as 15% sea ice cover, according to the average of satellite observations 1981-2010 (both years inclusive). Sea ice may therefore well be encountered outside and open water areas inside the limit shown in the diagrams above. Map source: National Snow and Ice Data Center (NSIDC).*



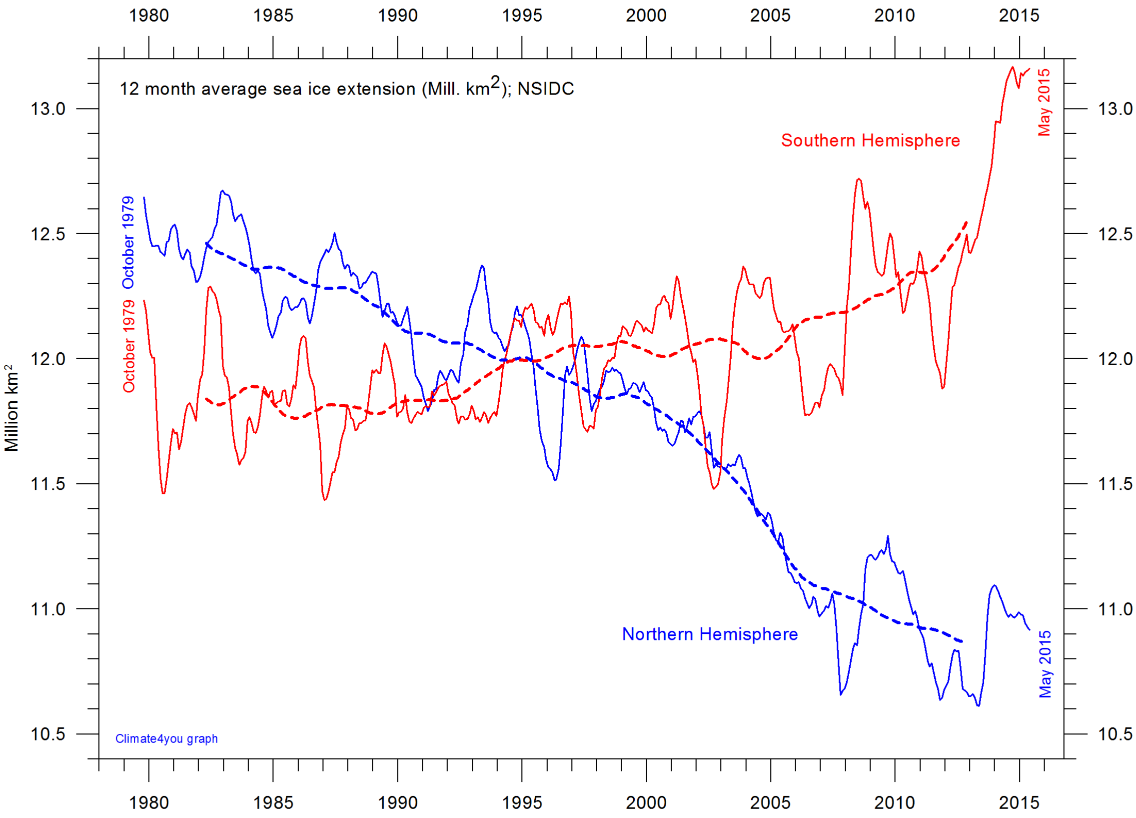
*Graphs showing monthly Antarctic, Arctic and global sea ice extent since November 1978, according to the [National Snow and Ice data Center](#) (NSIDC).*



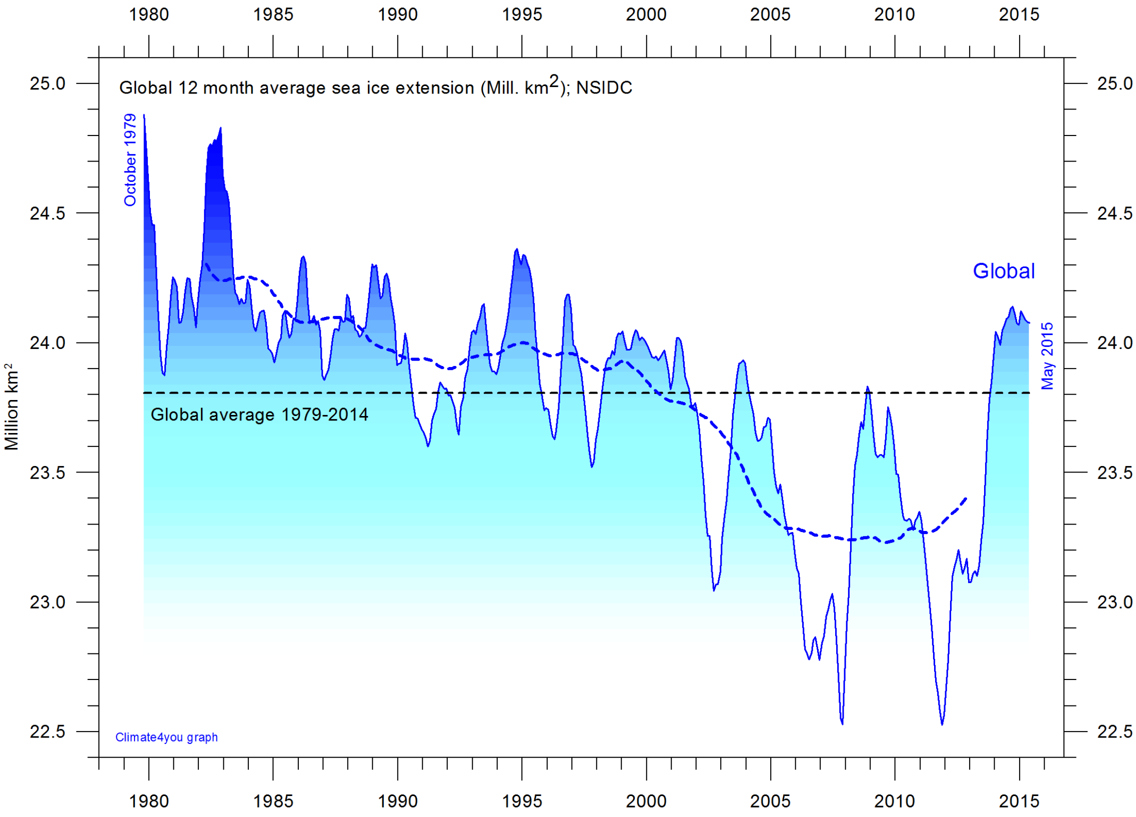
*Graph showing daily Arctic sea ice extent since June 2002, to 22 February 2015, by courtesy of Japan Aerospace Exploration Agency (JAXA). Please note that this diagram has not been updated beyond February 2015. Website inactive at the moment.*



*Northern hemisphere sea ice extension and thickness on 28 May 2015 according to the Arctic Cap Nowcast/Forecast System (ACNFS), US Naval Research Laboratory. Thickness scale (m) to the right.*

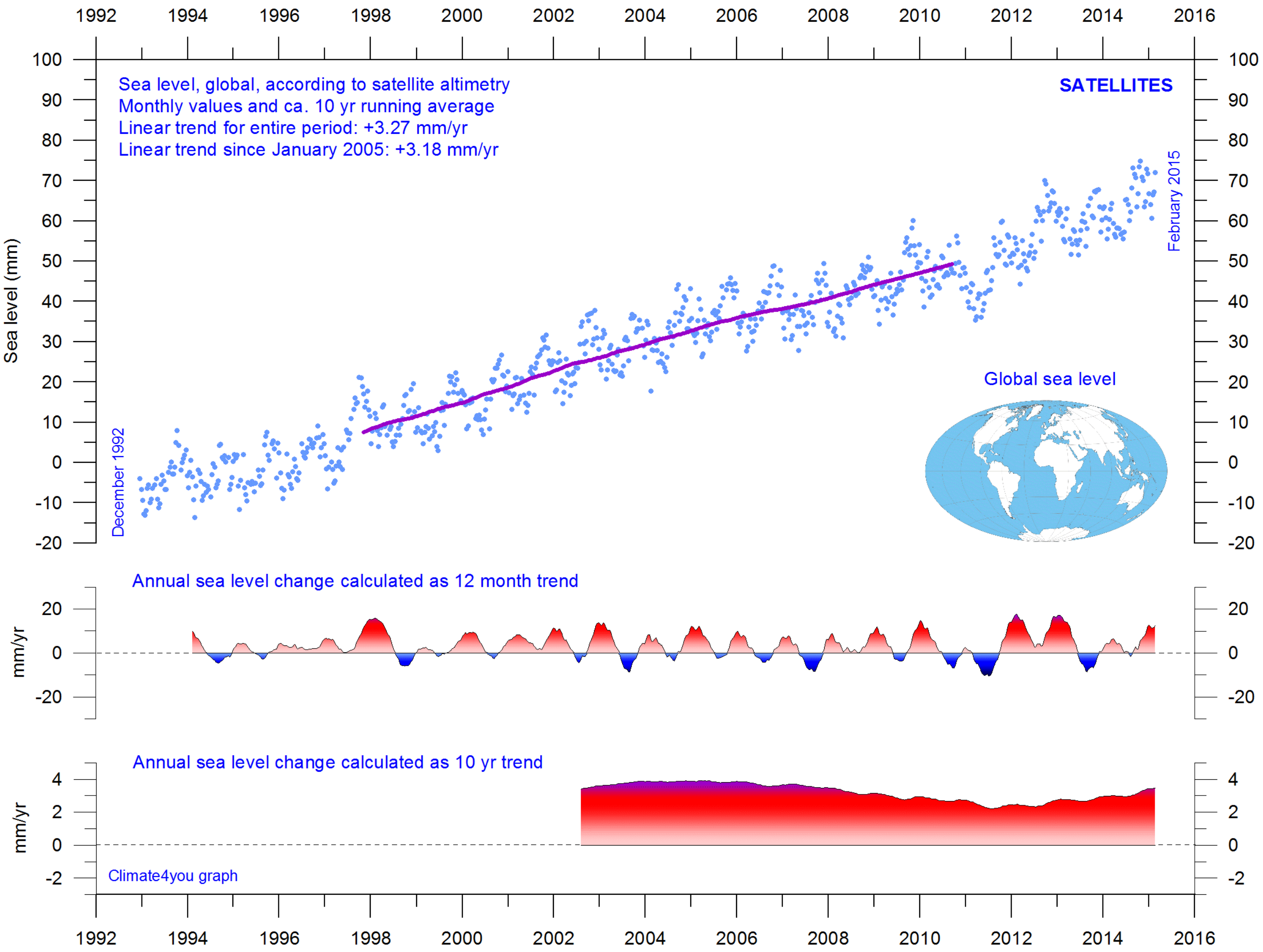


*12 month running average sea ice extension in both hemispheres since 1979, the satellite-era. The October 1979 value represents the monthly average of November 1978 - October 1979, the November 1979 value represents the average of December 1978 - November 1979, etc. The stippled lines represent a 61-month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



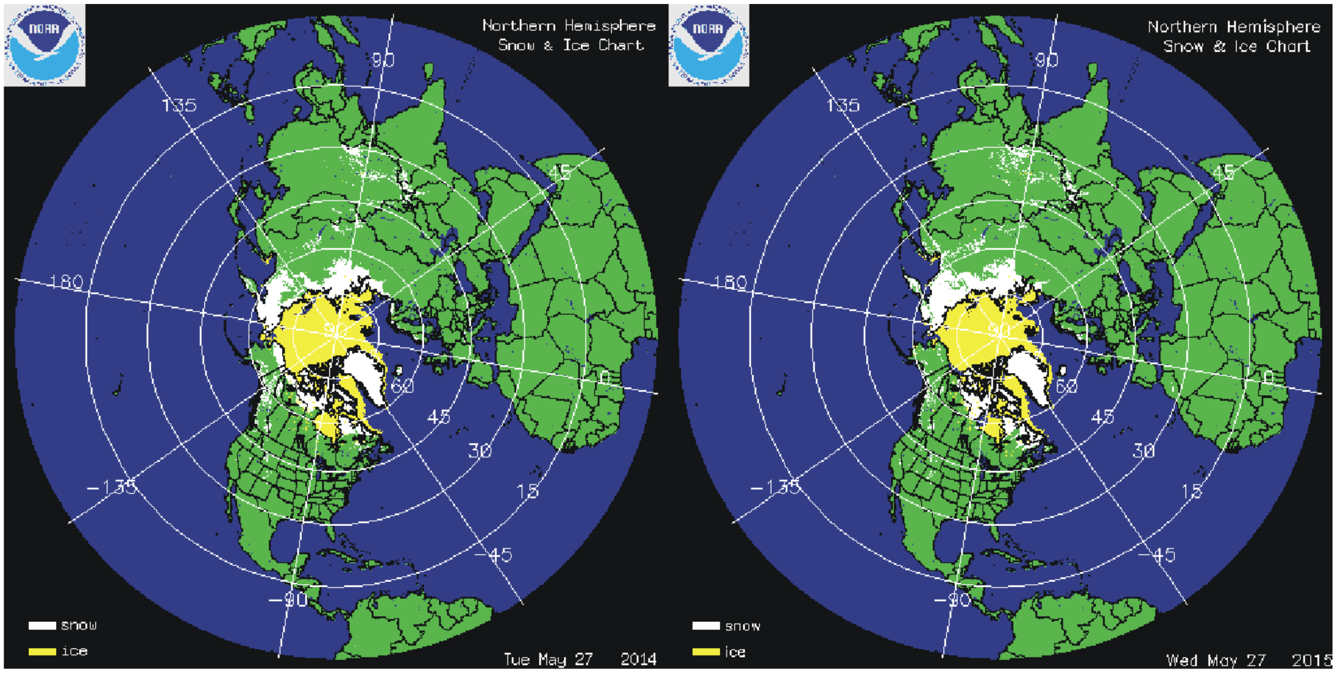
*Global 12 month running average sea ice extension since 1979, the satellite-era. The October 1979 value represents the monthly average of November 1978 - October 1979, the November 1979 value represents the average of December 1978 - November 1979, etc. The stippled line represents a 61-month (ca.5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

## Global sea level from satellite altimetry, updated to February 2015

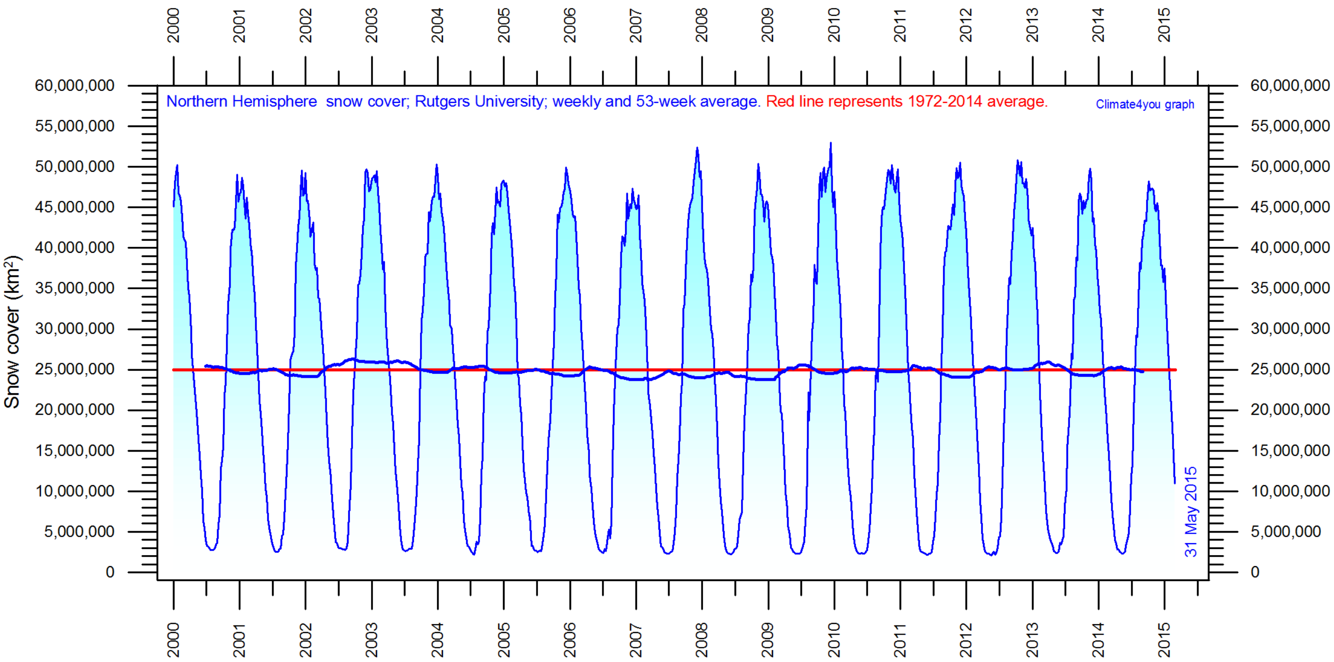


*Global sea level since December 1992 according to the Colorado Center for Astrodynamics Research at University of Colorado at Boulder. The blue dots are the individual observations, and the purple line represents the running 121-month (ca. 10 year) average. The two lower panels show the annual sea level 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.*

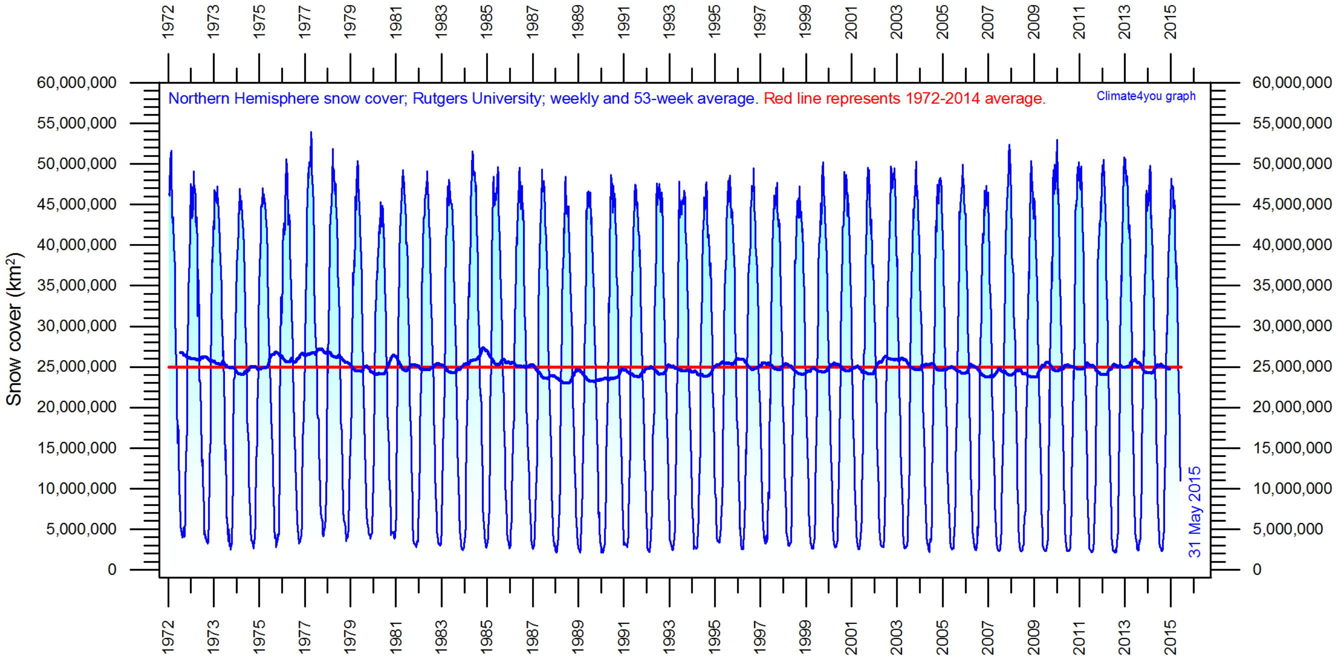
## Northern Hemisphere weekly snow cover, updated to May 2015



*Northern hemisphere snow cover (white) and sea ice (yellow) 27 May 2014 (left) and 2015 (right). Map source: National Ice Center (NIC).*

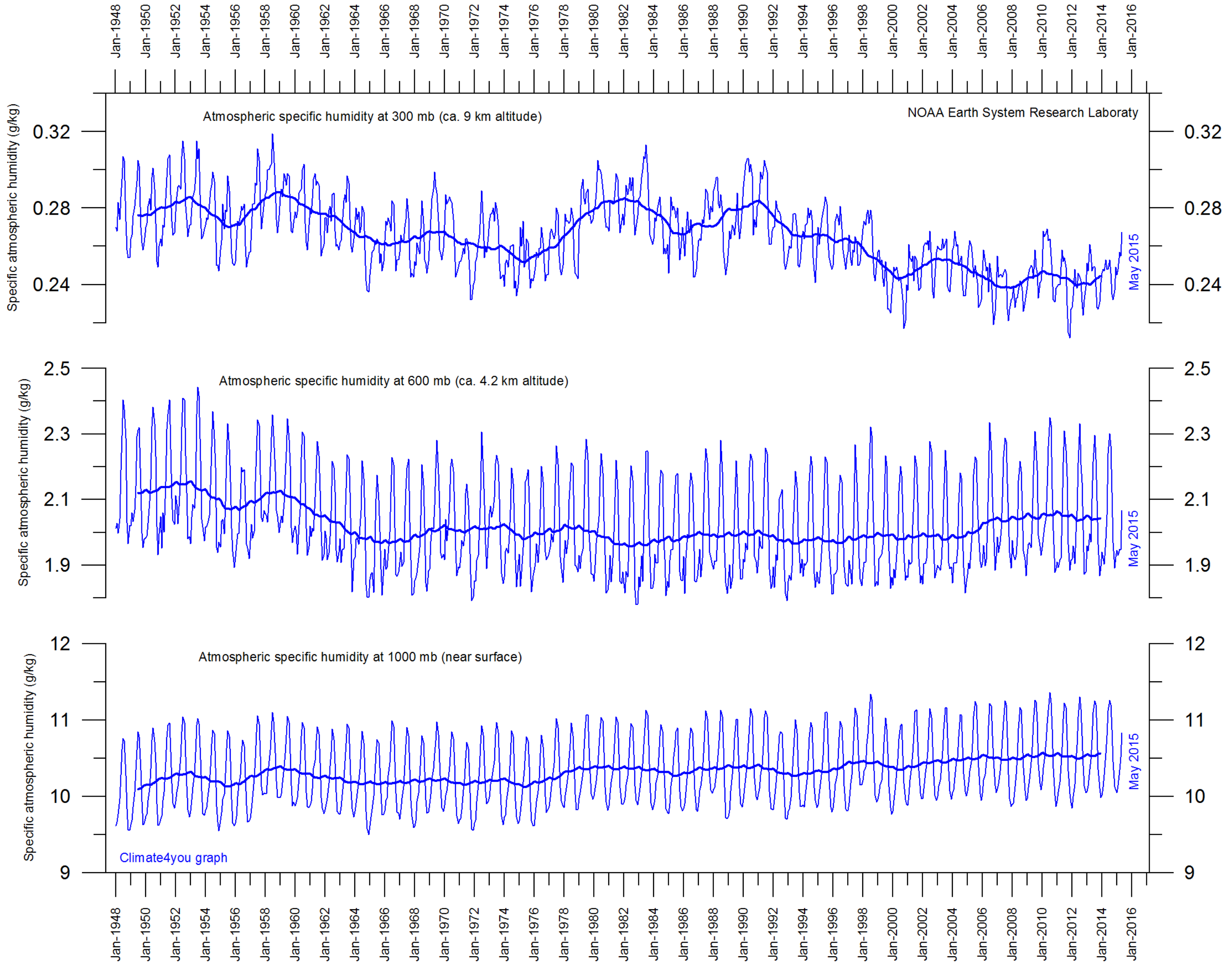


*Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53-week average (approximately 1 year). The horizontal red line is the 1972-2014 average.*



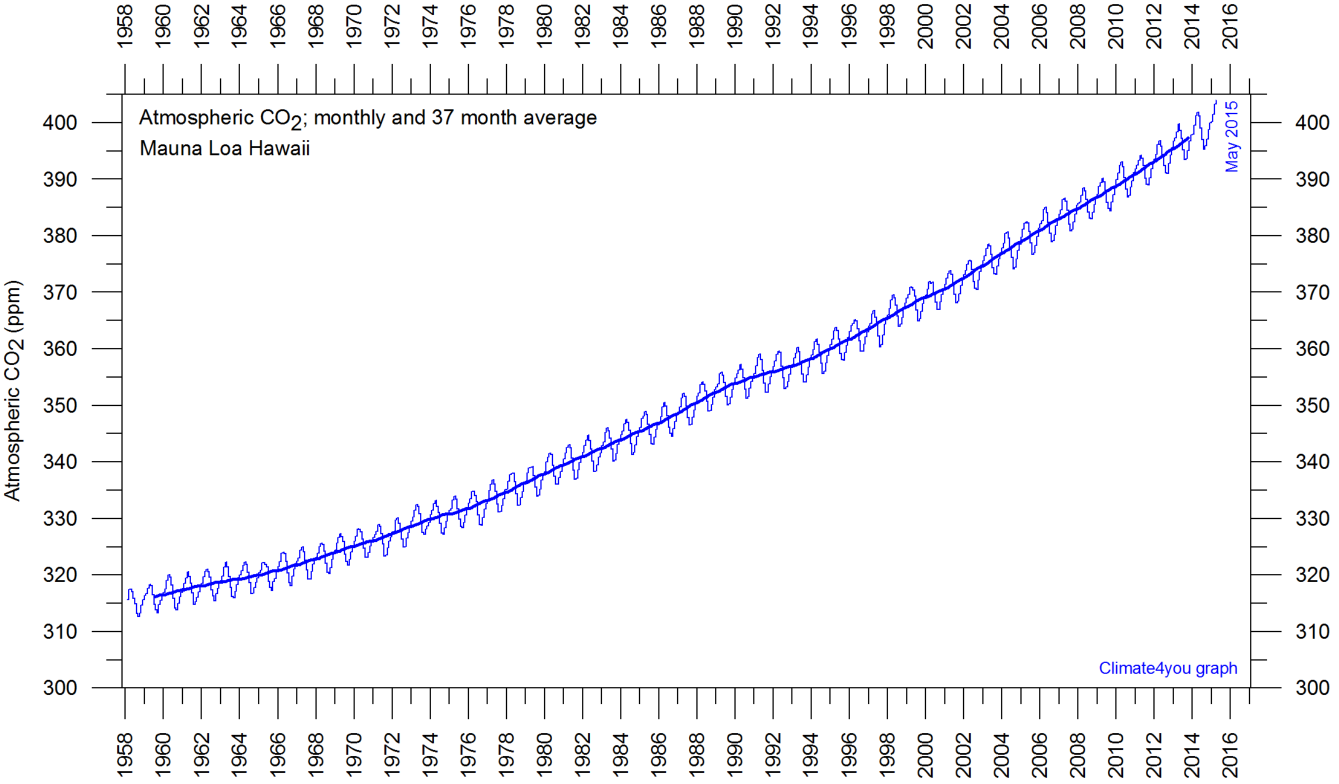
*Northern hemisphere weekly snow cover since January 1972 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53-week average (approximately 1 year). The horizontal red line is the 1972-2014 average.*

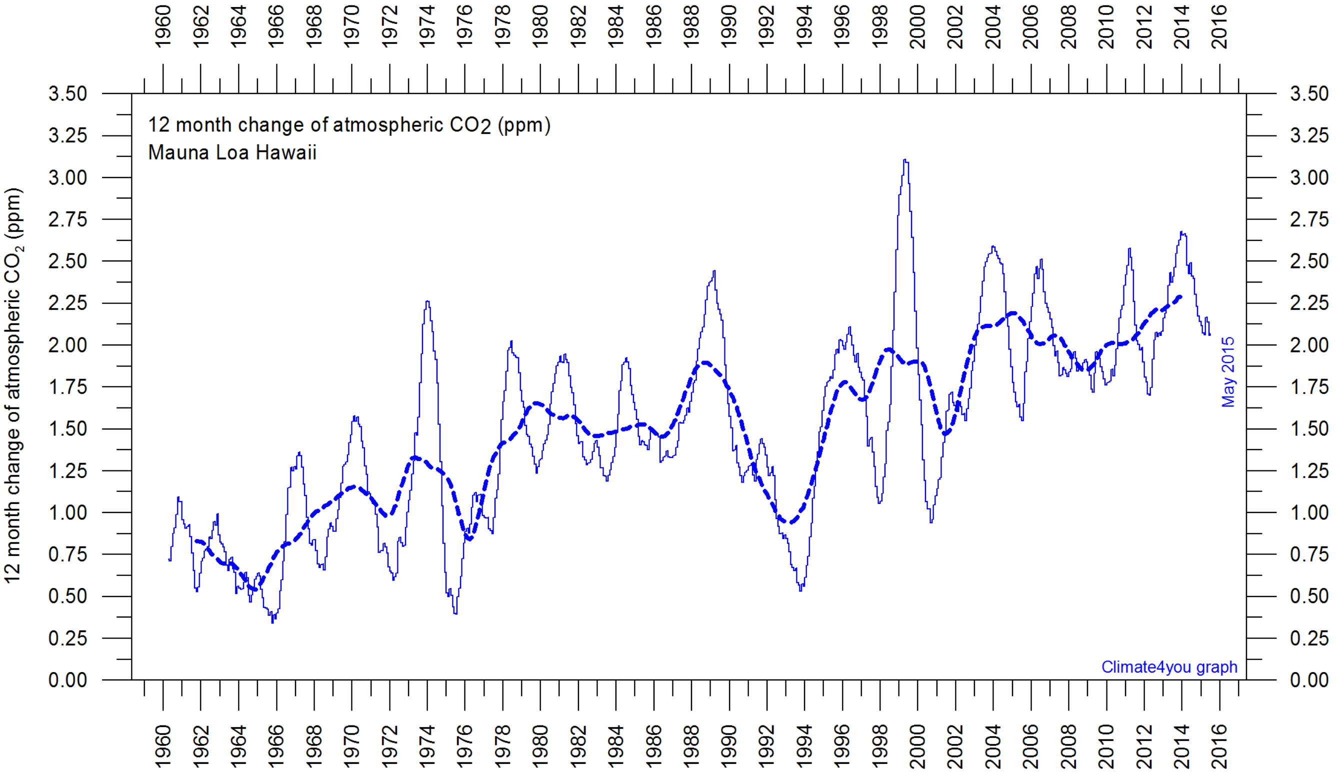
## Atmospheric specific humidity, updated to May 2015



*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).*

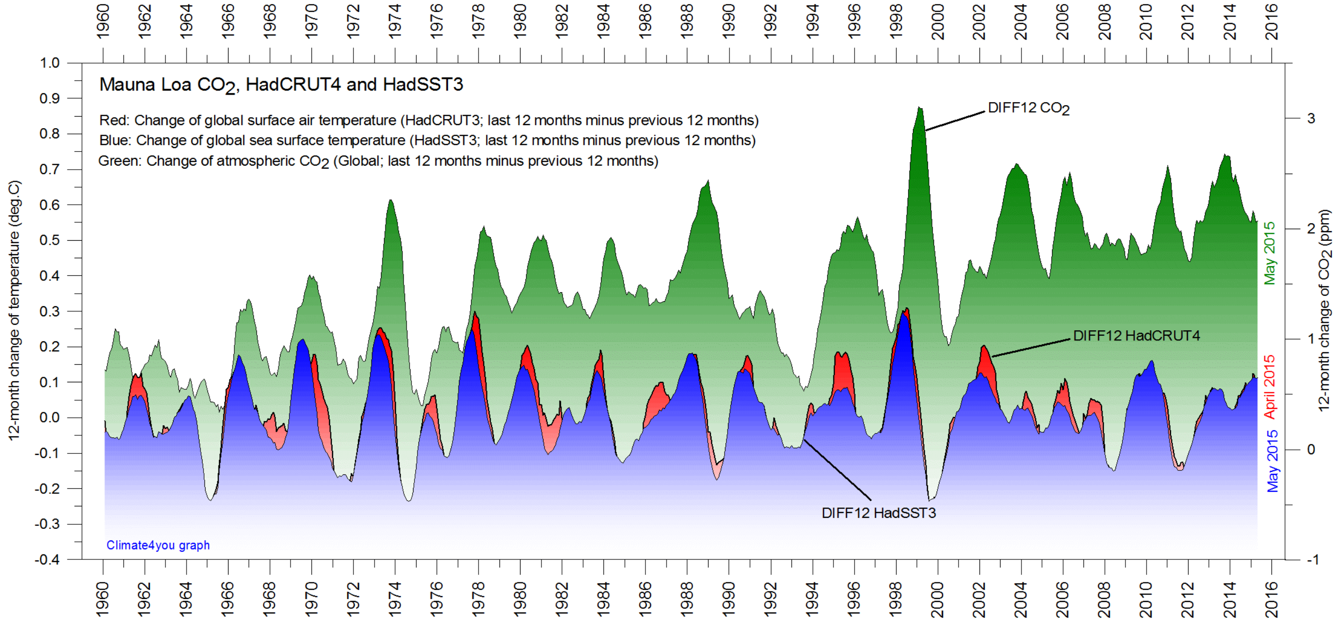
## Atmospheric $CO_2$, updated to May 2015





*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 May 2015

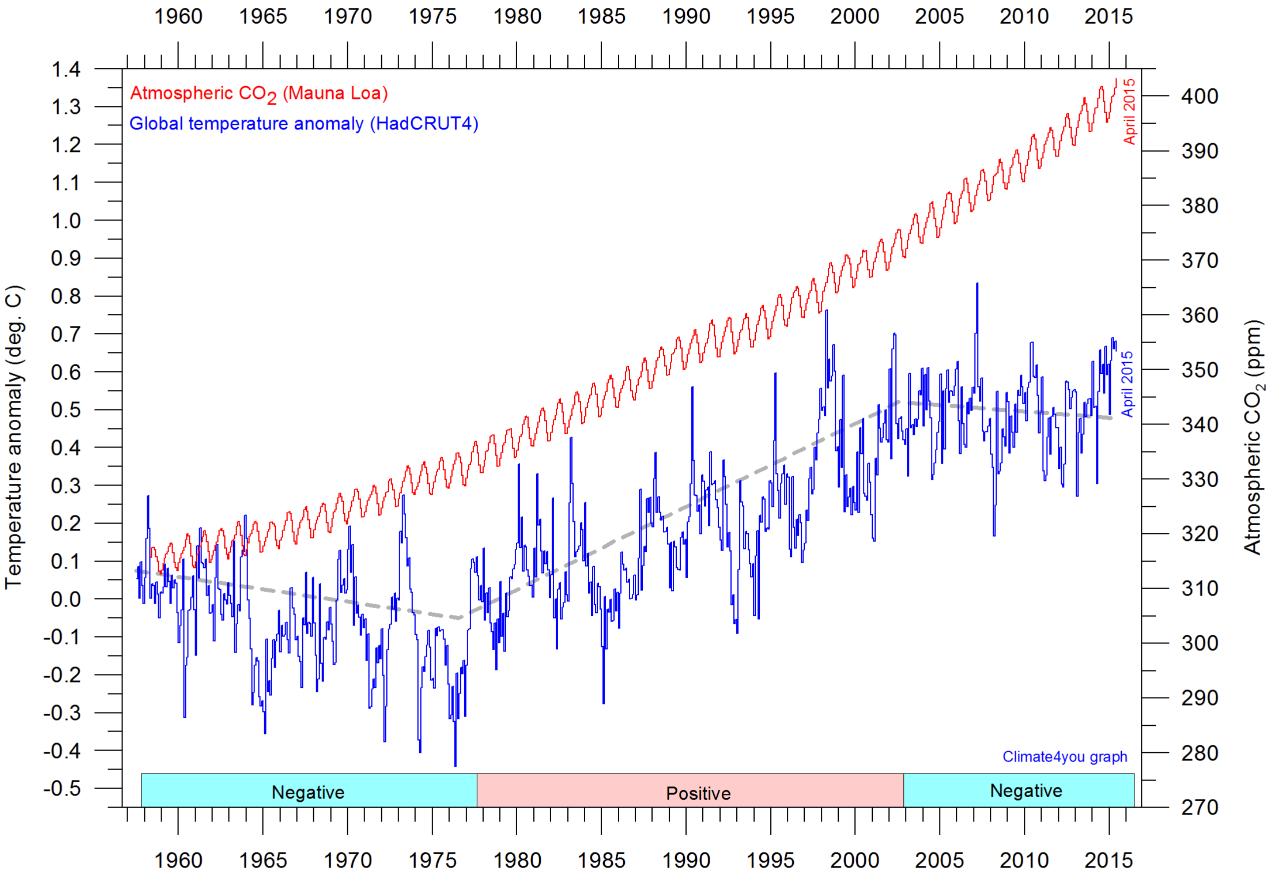


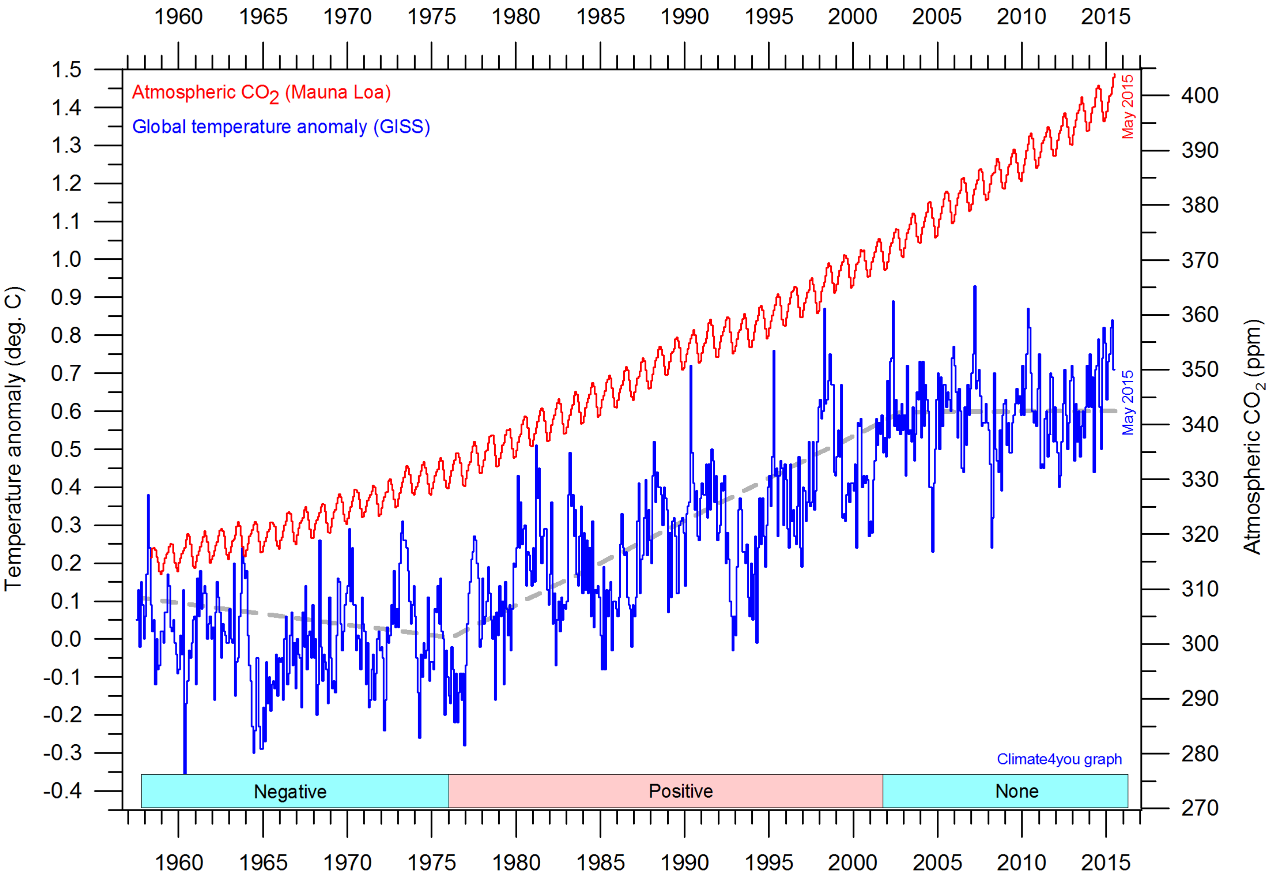
*12-month change of global atmospheric $CO_2$ concentration (Mauna Loa; green), global sea surface temperature (HadSST3; blue) and global surface air temperature (HadCRUT4; red dotted). All graphs are showing monthly values of DIFF12, the difference between the average of the last 12 month and the average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

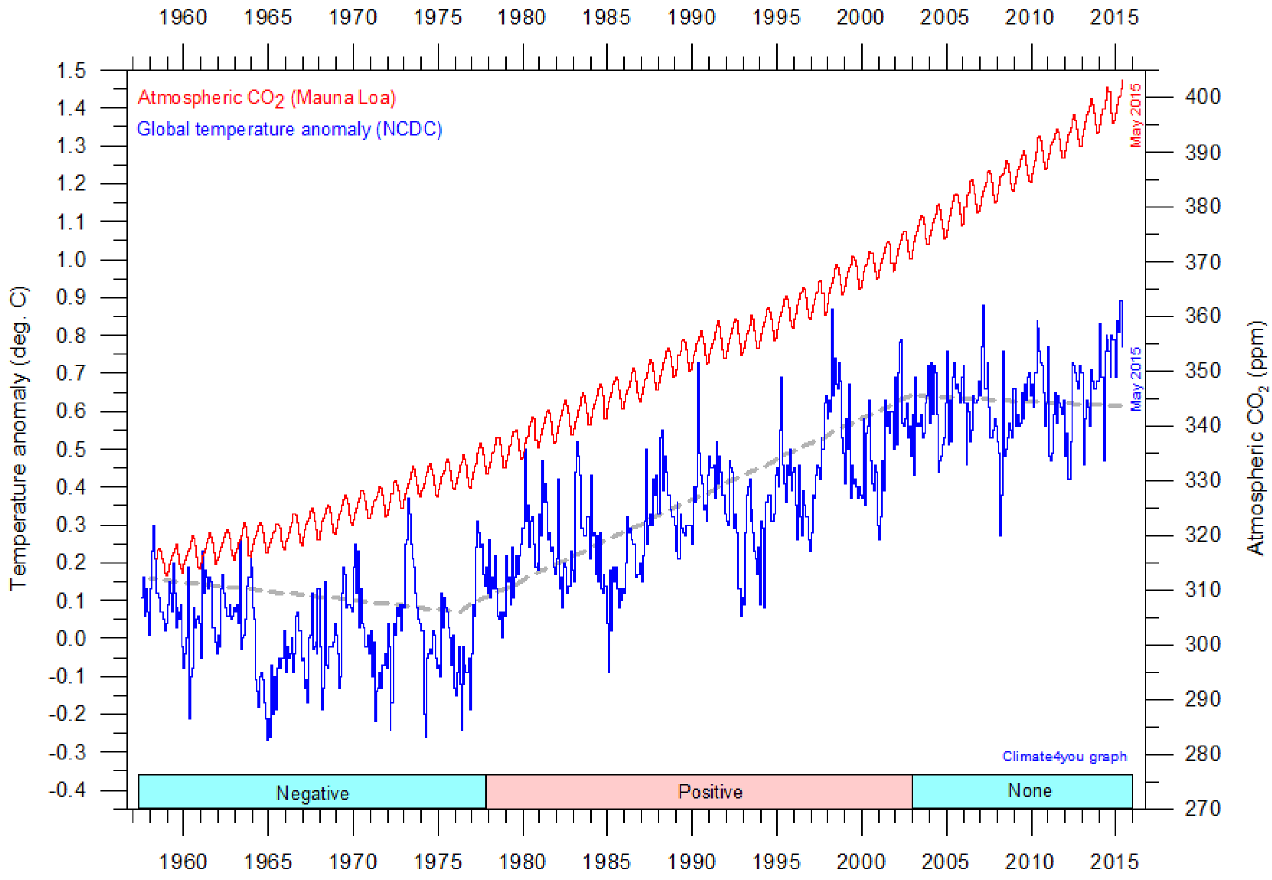
## References:

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 May 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 April 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.

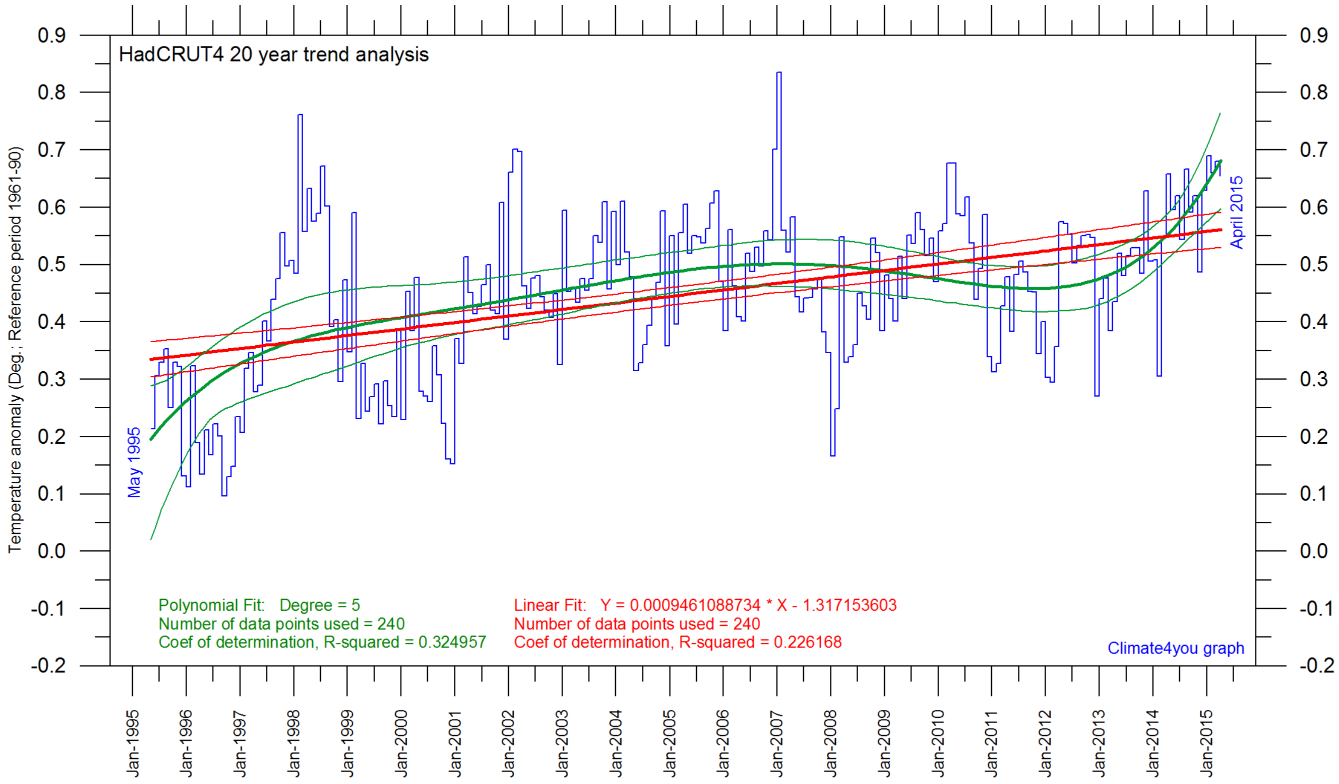
What exactly defines the critical length of a relevant time period to consider for evaluating the alleged importance of $CO_2$ remains elusive, and is still a topic for discussion. However, the critical period length must be inversely proportional to the temperature sensitivity of $CO_2$, including feedback 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 monthly surface air temperature changes, updated to April 2015



*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.*

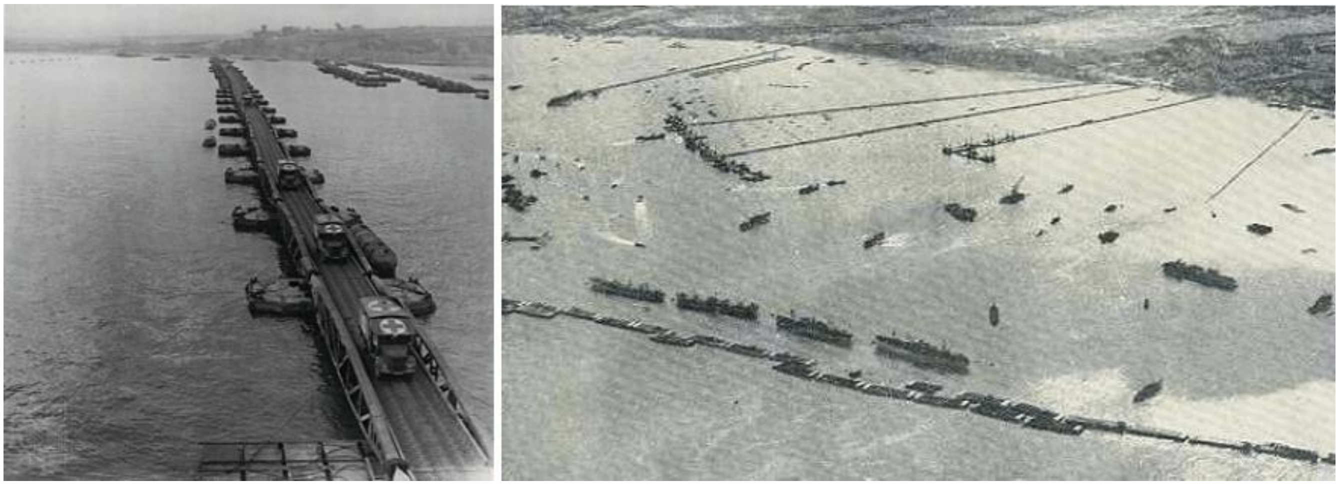
It is quite often debated if the global surface air temperature still increases, or if the temperature has levelled out during the last 15-18 years. The above diagram may be useful in this context, and demonstrates the differences between two often used statistical approaches to determine recent temperature 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

# 1944: Worst June storm in 40 years destroys Allied harbours in Normandy



*Mulberry Harbour at Arromanches, 1944 (left), Photo courtesy of Encyclopedia Britannica. Aerial view showing Mulberry Harbors at Normandy, June 1944 (right).*

For the first few weeks following D-Day, the Allied forces were not able to move the front significantly inland, and danger arose that they would be boxed into Normandy until autumn and winter. This danger was enhanced when on 19 June the worst storm in nearly 40 years unexpectedly lashed Normandy (D'Este 1994).

Allied shipping between England and Normandy suffered heavy losses. About 800 ships of all sizes were beached or lost. The mobile Mulberry harbour at Omaha beach was totally destroyed and never replaced. The British Mulberry harbour at Arromanches (see photo above) was damaged, but not lost.

The storm continued for three full days. Few men or supplies could be landed in the invasion area during this period, and the 'Great Storm' in three days destroyed more vessels than the German army managed to take out during the entire campaign (D'Este 1994). The losses in material amounted to more than 140,000 tons and seriously interfered with the planned build up of the Allied military strength in Normandy.

At the time when the storm hit Normandy, Field Marshal Rommel was attempting to assemble a powerful panzer force for a counterstroke against the Second British Army near Caen, in the western part of the invasion area. With much of the Allied air forces largely grounded during the storm, it would have been the ideal moment for Rommel to strike. However, because of the divided German command over forces in France (see Climate4you update April 2015), he was unable to do so.

When the storm subsided late June 22, the damage was easy to see. On D-Day + 16, the harbour that had served Omaha Beach, was simply no more. The 75 concrete caissons called “Phoenixes” that had been linked together to form the breakwater was an indecipherable, half-sunken mash of concrete and steel. The floating pontoons and the flexible steel roadways six miles in length that had connected the piers to the beaches were tangled up like so much steel wool. Salvageable parts, including a caisson that was an impressive 20 m wide by 20 m tall and 70 m long, weighing 6,000 tons, were simply towed down to the British beaches and used to reinforce their Mulberry Harbour also known as Port Winston (cf. Douglas Keeney 2011).


Photo # 80-G-359462 Pontoon causeway wrecked by the storm of 19-22 June 1944

Photo # 80-G-359463 Pontoon causeway wrecked by the storm of 19-22 June 1944

*Mulberry Harbor after the storm of 19-22 June 1944. Credit: Official U.S. Navy Photograph, now in the collections of the National Archives.*

What emerged from this near-disaster, however, was an elegant idea that in the years to come would help open the Gulf of Mexico and other ocean sites to oil exploration (cf. Douglas Keeney 2011).

What all ocean-based operations had in common was a susceptibility to the wave fronts generated by storm surges. The problem was that one could never predict wave heights and in the battle between Man-made structures and the ocean, the ocean invariably won. Leon DeLong, an engineer on Omaha Beach in June 1944, saw the twisted wreckage of the Mulberry and envisioned a pier that could be elevated before a storm hit thus allowing waves to sweep harmlessly beneath it. DeLong's idea would become known as a "jack-up" pier or, in the case of offshore oil exploration, a "jack-up" oil rig. Massive jacks would grip the sides of steel legs and lift up above the waterline a platform or a pier. The idea was an instant success and height was scarcely a problem. Oil rigs in the Gulf of Mexico used DeLong's invention and platforms were jacked-up 15 m above the water (cf. Douglas Keeney 2011).

References:

D'Este, C. 1994. *Decision in Normandy*. Harper Perennial, 335 pp.

Douglas Keeney, L. 2011. http://www.thehistoryreader.com/modern-history/storm-destroyed-d-day-harbor-inspired-innovation/

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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](http://www.climate4you.com)

Yours sincerely,

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