Climate4you update March 2013

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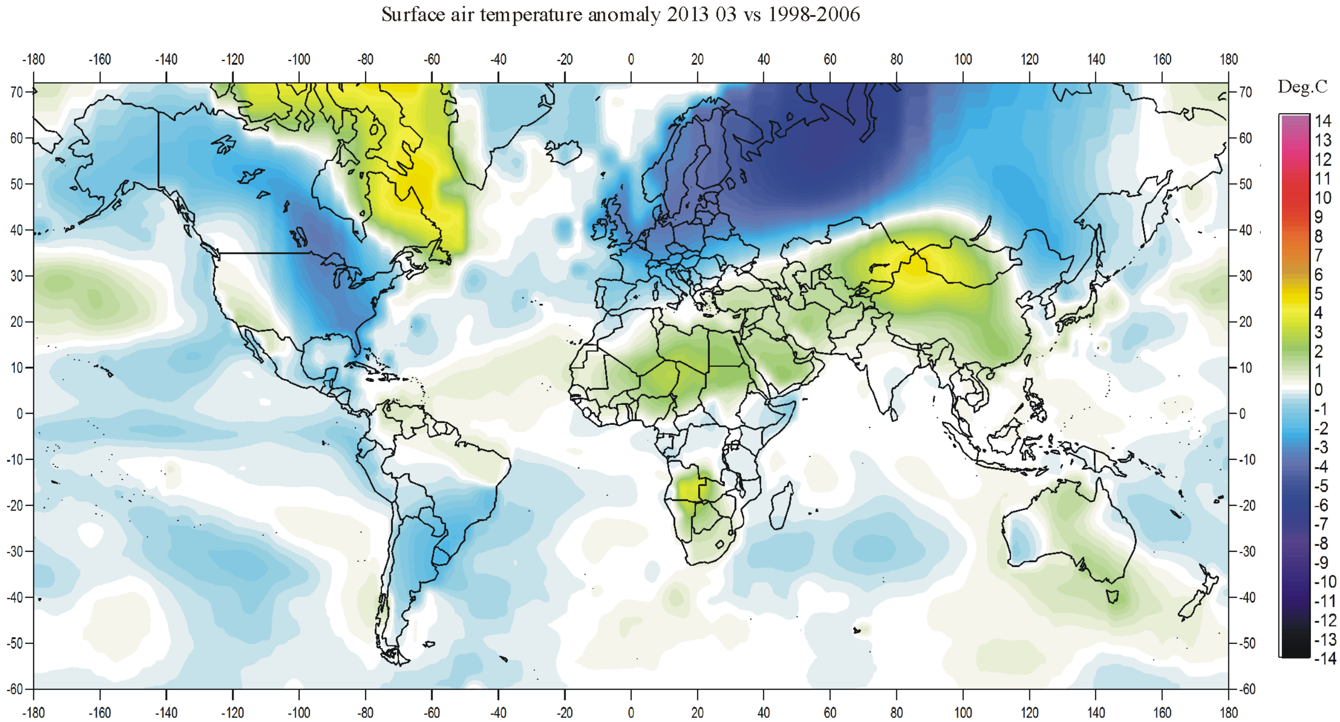
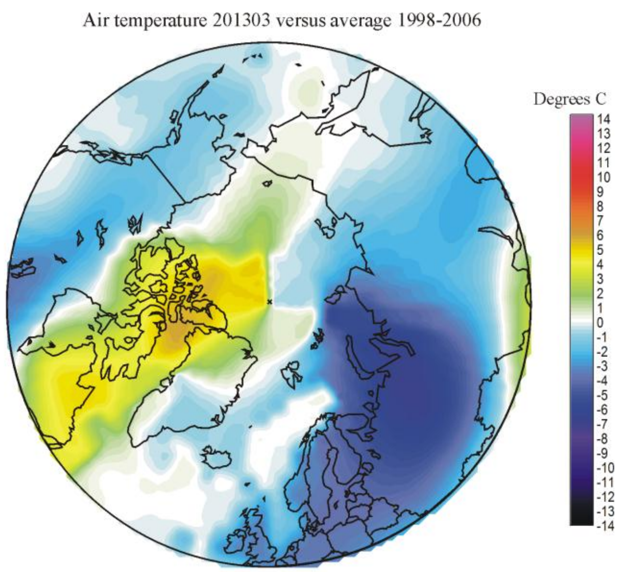
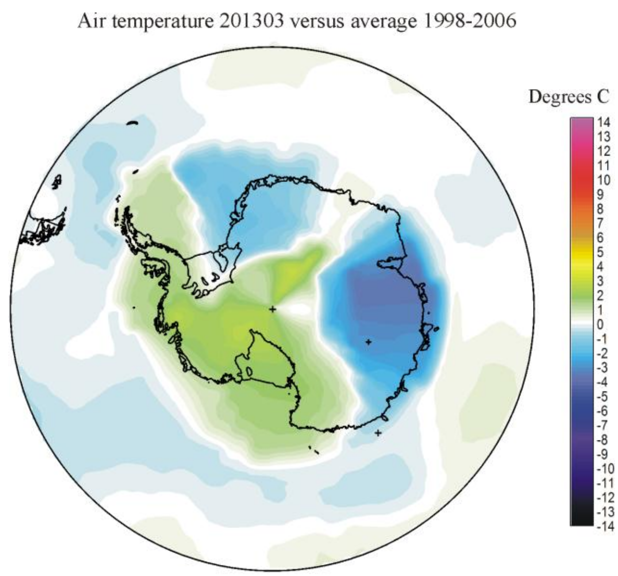
All diagrams in this newsletter as well as links to the original data are available on www.climate4you.com

March 2013 global surface air temperature overview







March 2013 surface air temperature compared to the 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 March 2013 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 relatively cold period 1945-1980. Almost any comparison with such a low average value will therefore appear as high or warm, and it will be difficult to decide if and where modern surface air temperatures are increasing or decreasing at the moment. Comparing with a more recent period overcomes this problem. In addition to this consideration, the recent temperature development suggests that the time window 1998-2006 may roughly represent a global temperature peak. If so, negative temperature anomalies will gradually become more and more widespread as time goes on. However, if positive anomalies instead gradually become more widespread, this reference period only represented a temperature plateau.

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.

March 2013 global surface air temperatures

General: On average, global air temperatures were somewhat below the 1998-2006 average, although with large regional differences

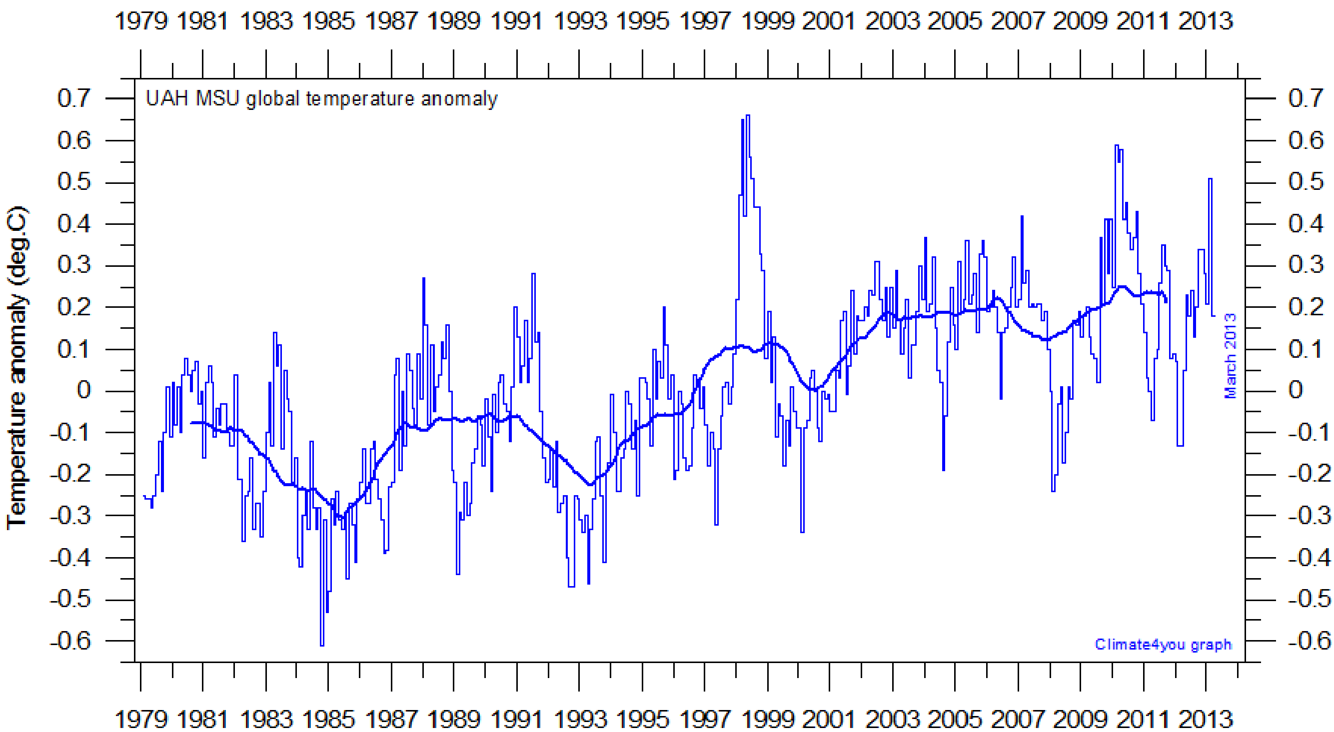
The Northern Hemisphere was characterised by big temperature contrast between individual regions. Most land areas in the Northern Hemisphere experienced below average temperatures, the only major exception from this being the area extending from central North Africa to western China. Especially northern Russia and northern Europe was unseasonally cold. Most of the Arctic had below average temperatures, with the exception of Labrador and the Canadian Arctic Archipelago. The marked limit between warm and cold areas over the Arctic Ocean represents an artefact derived from the GISS interpolation technique and should be ignored.

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

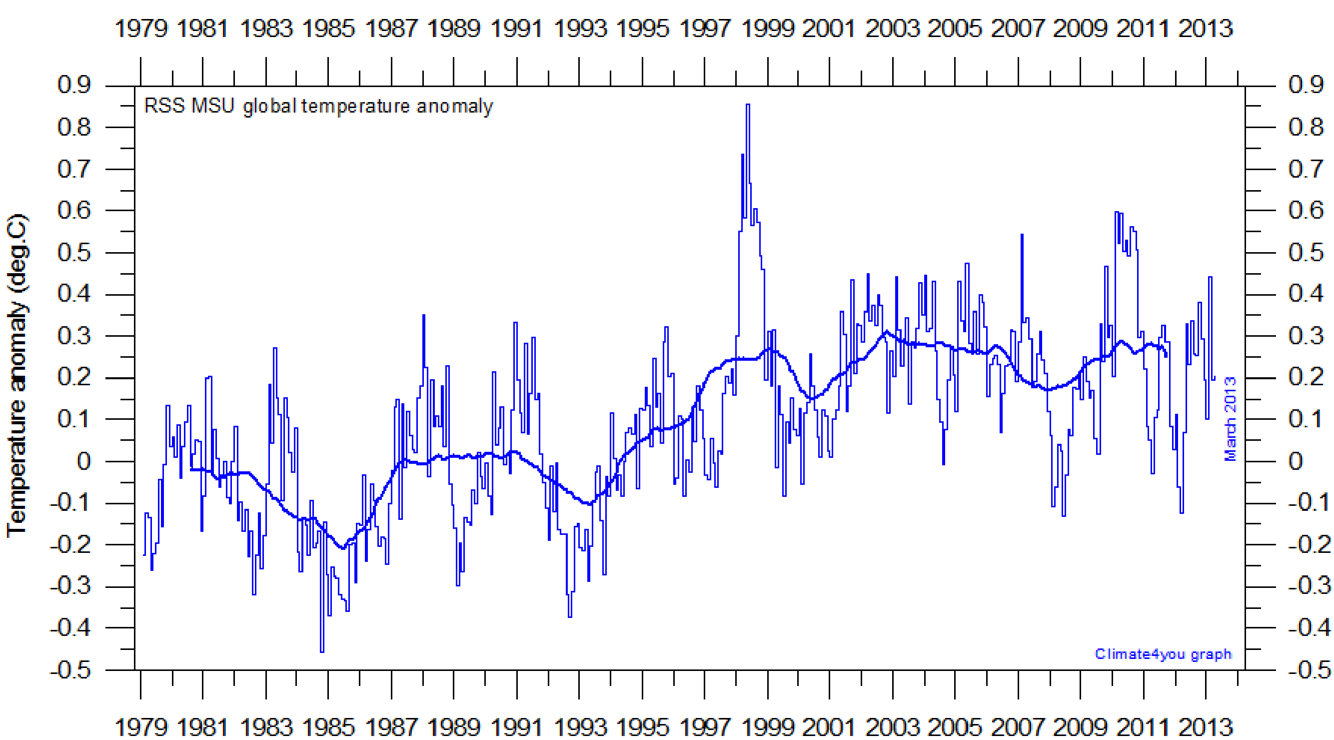
The Southern Hemisphere was mainly at or below average 1998-2006 conditions. The only important exception from this was parts of Australia and southern Africa, which experienced temperatures slightly above the 1998-2006 average. Most of South America was cold. The Antarctic continent was divided in a relatively warm 'western' part and a relatively cold 'eastern' part.

The global oceanic heat content has been rather stable since 2003/2004 (page 13).

Lower troposphere temperature from satellites, updated to March 2013

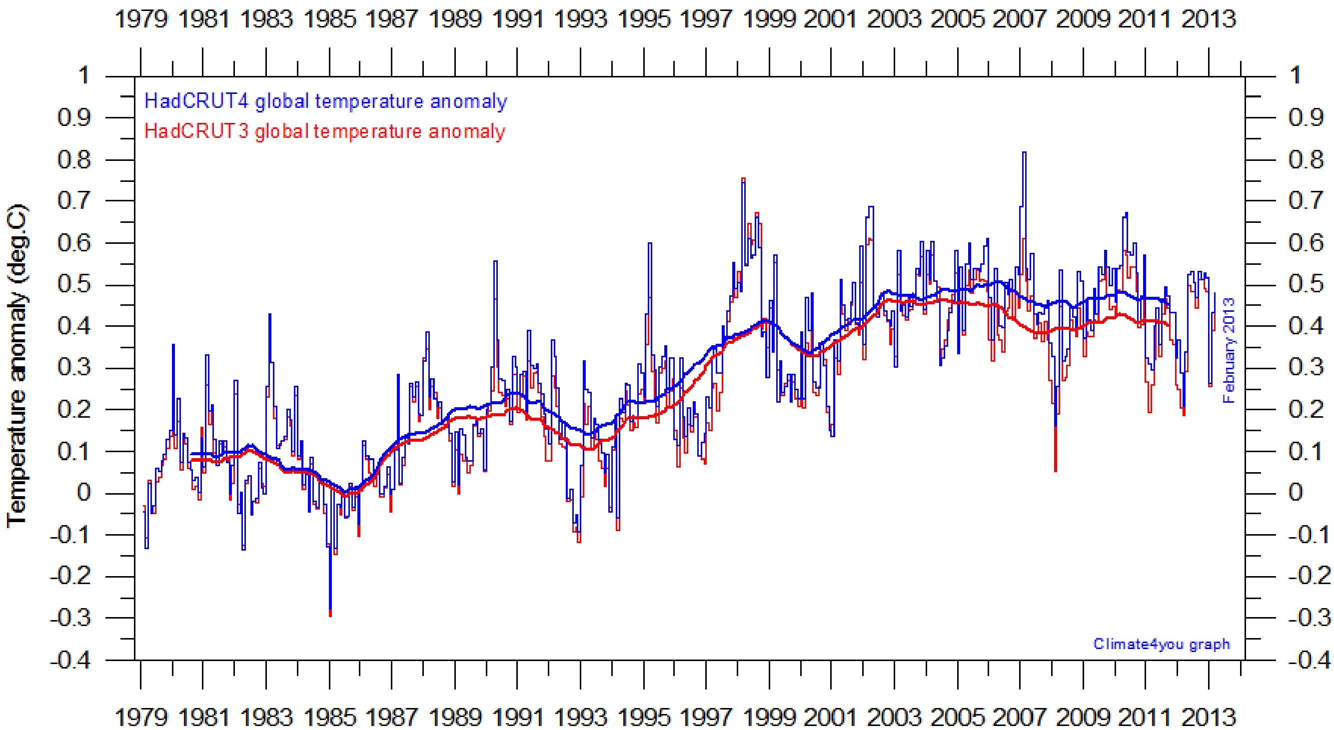


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37 month average.

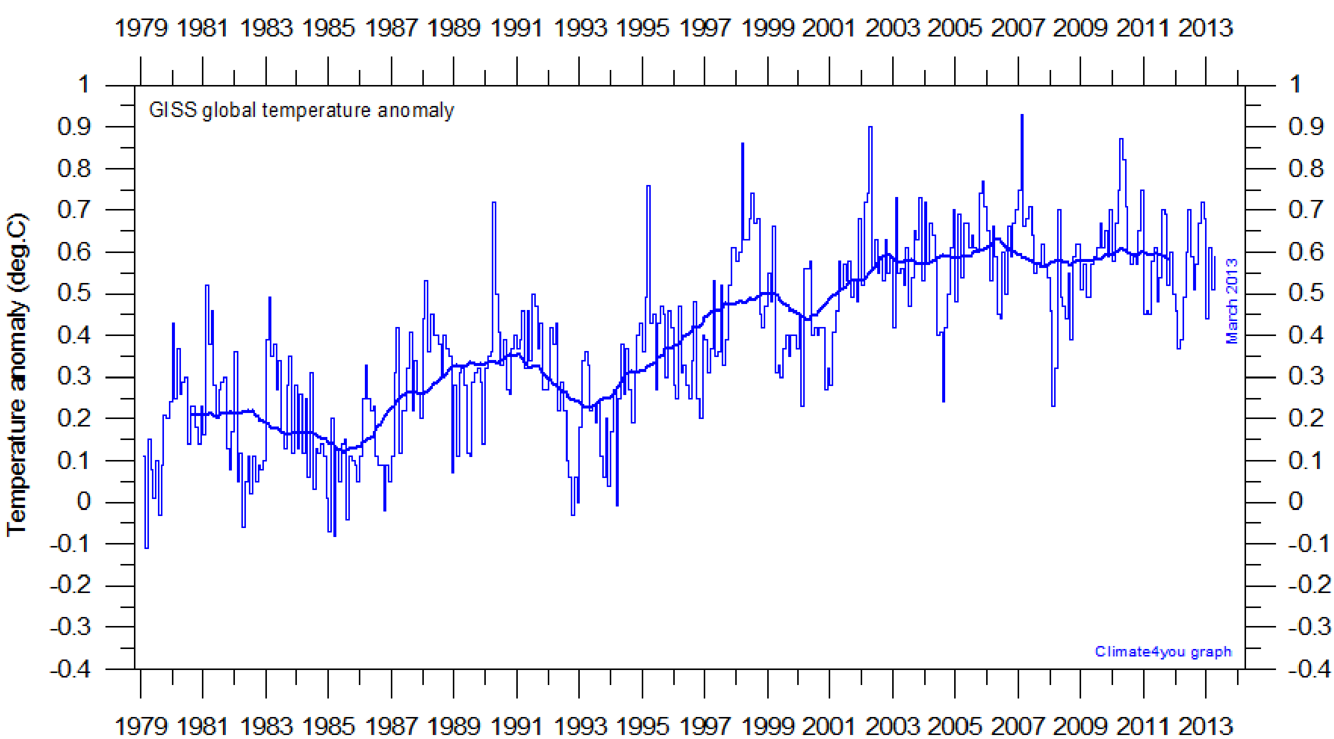


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37 month average.

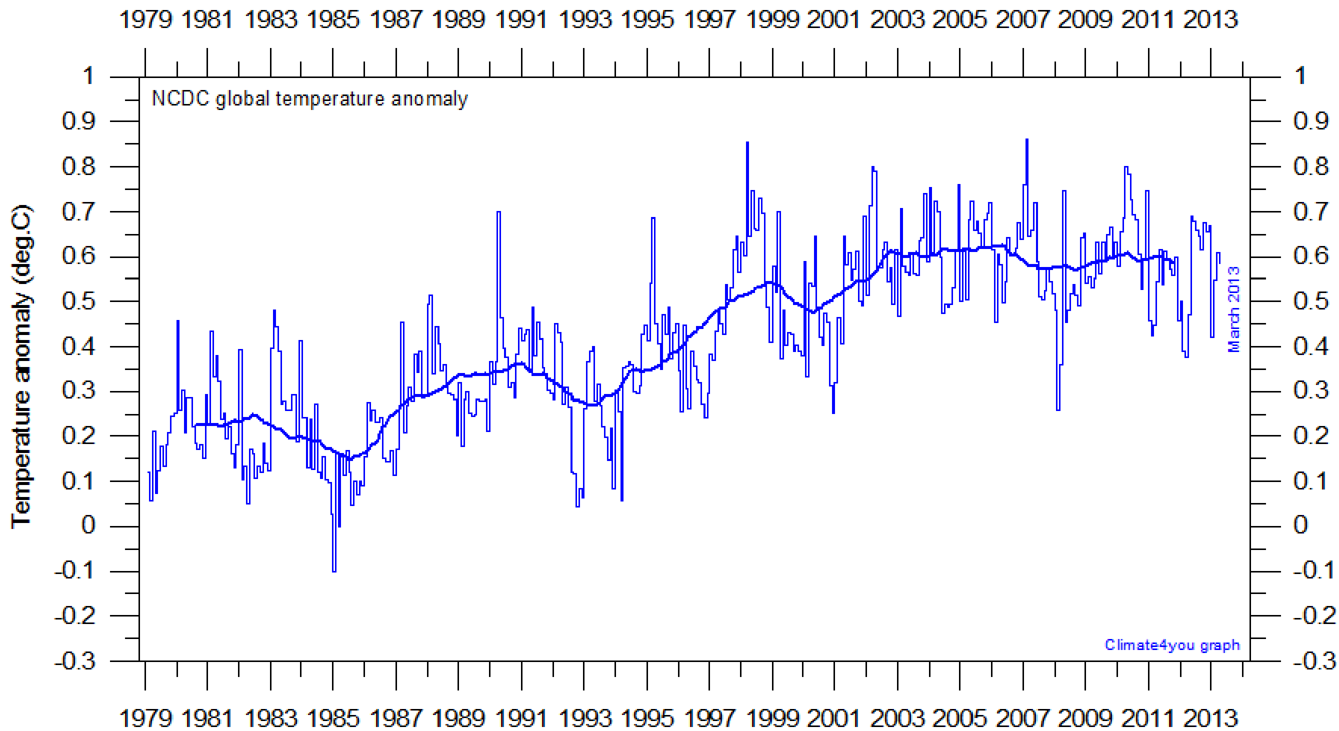
Global surface air temperature, updated to March 2013



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) ([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 has not been updated beyond February 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.

<u>A note on data record stability:</u>

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. Presumably this reflects recognition of errors, changes in the averaging procedure, and the influence of other 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 means.

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

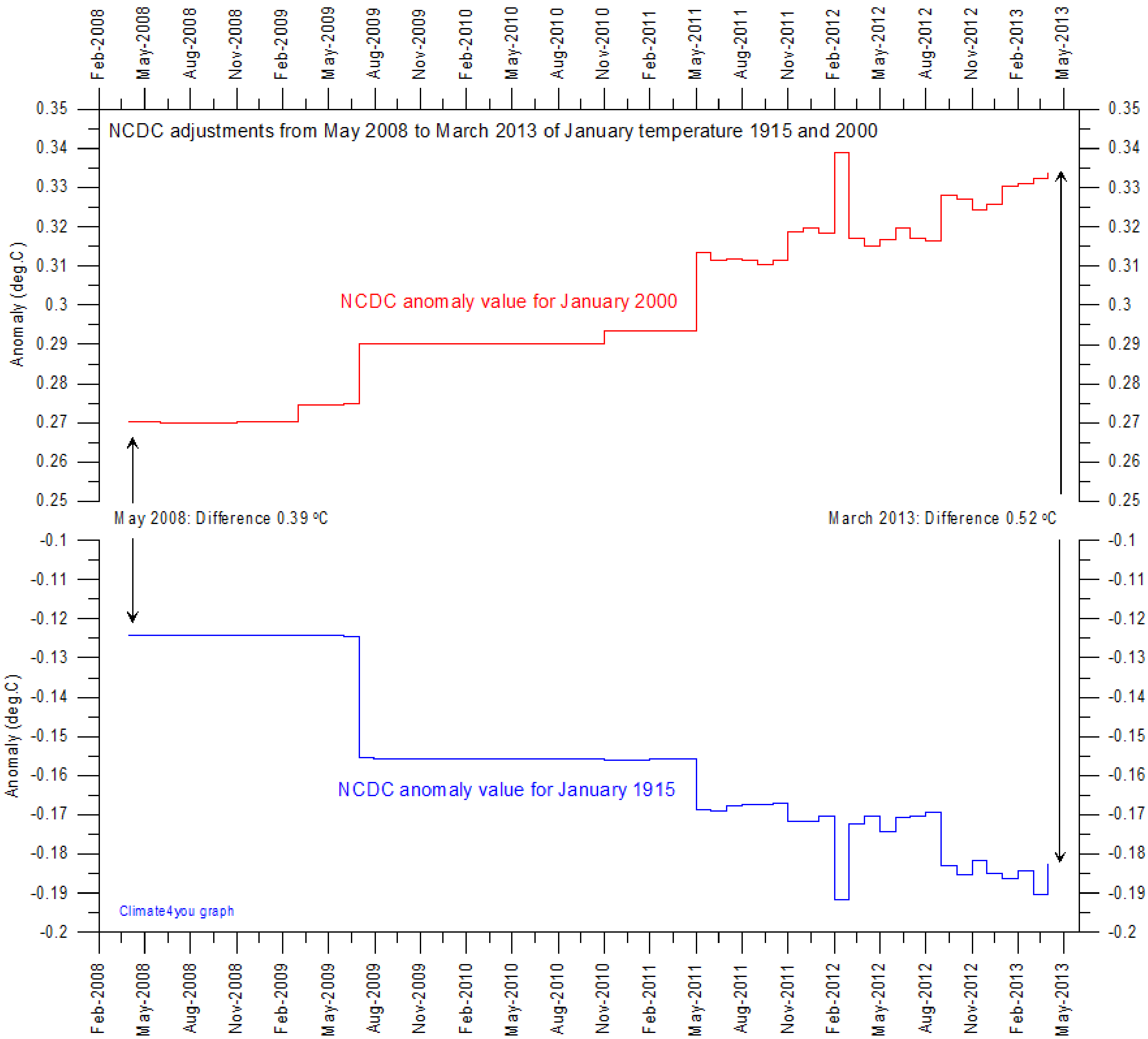


Diagram showing the adjustment made since May 2008 by the [National Climatic Data Center](#) (NCDC) in the anomaly values for the two months January 1915 and January 2000.

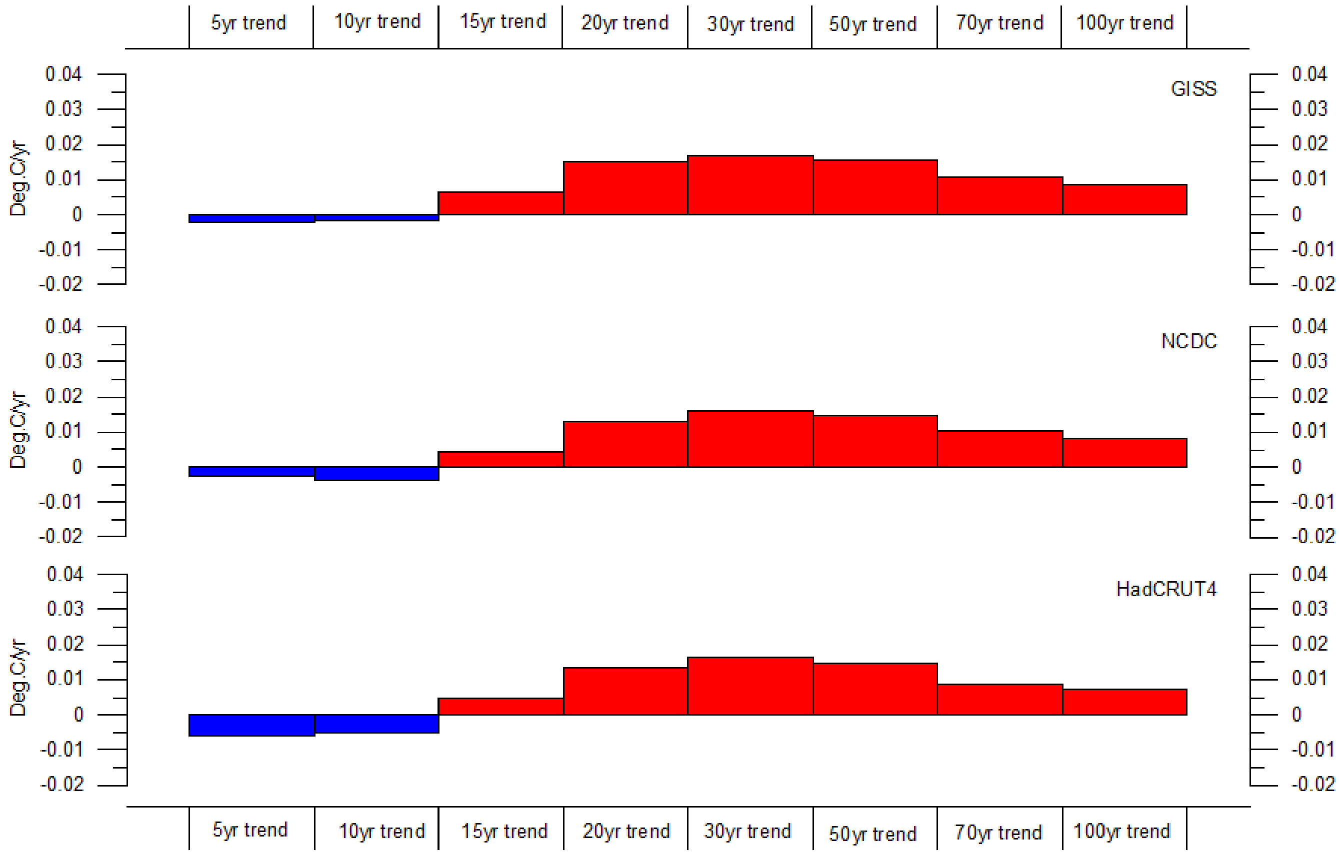


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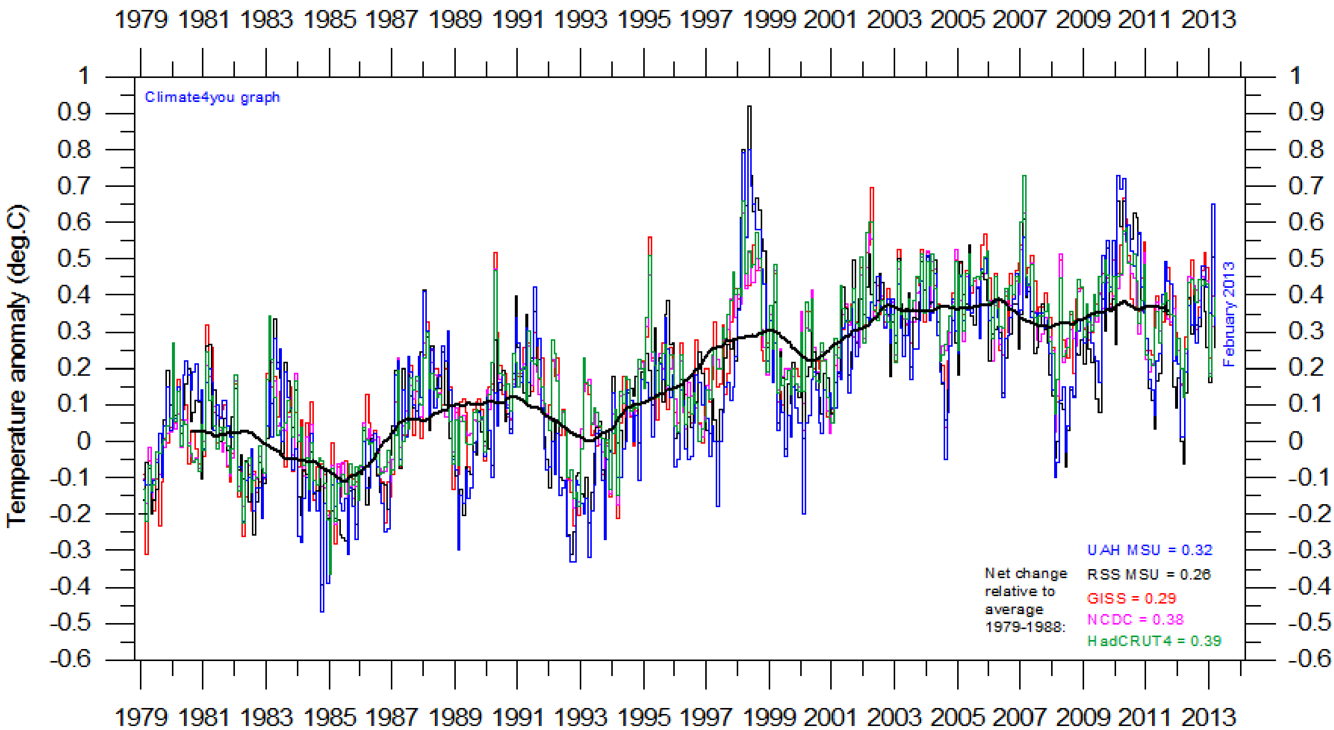
Diagram showing the latest 5, 10, 20, 30, 50, 70 and 100 yr linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for three surface-based temperature estimates (GISS, NCDC and HadCRUT4). Last month included in all analyses: February 2013.

All in one, updated to February 2012

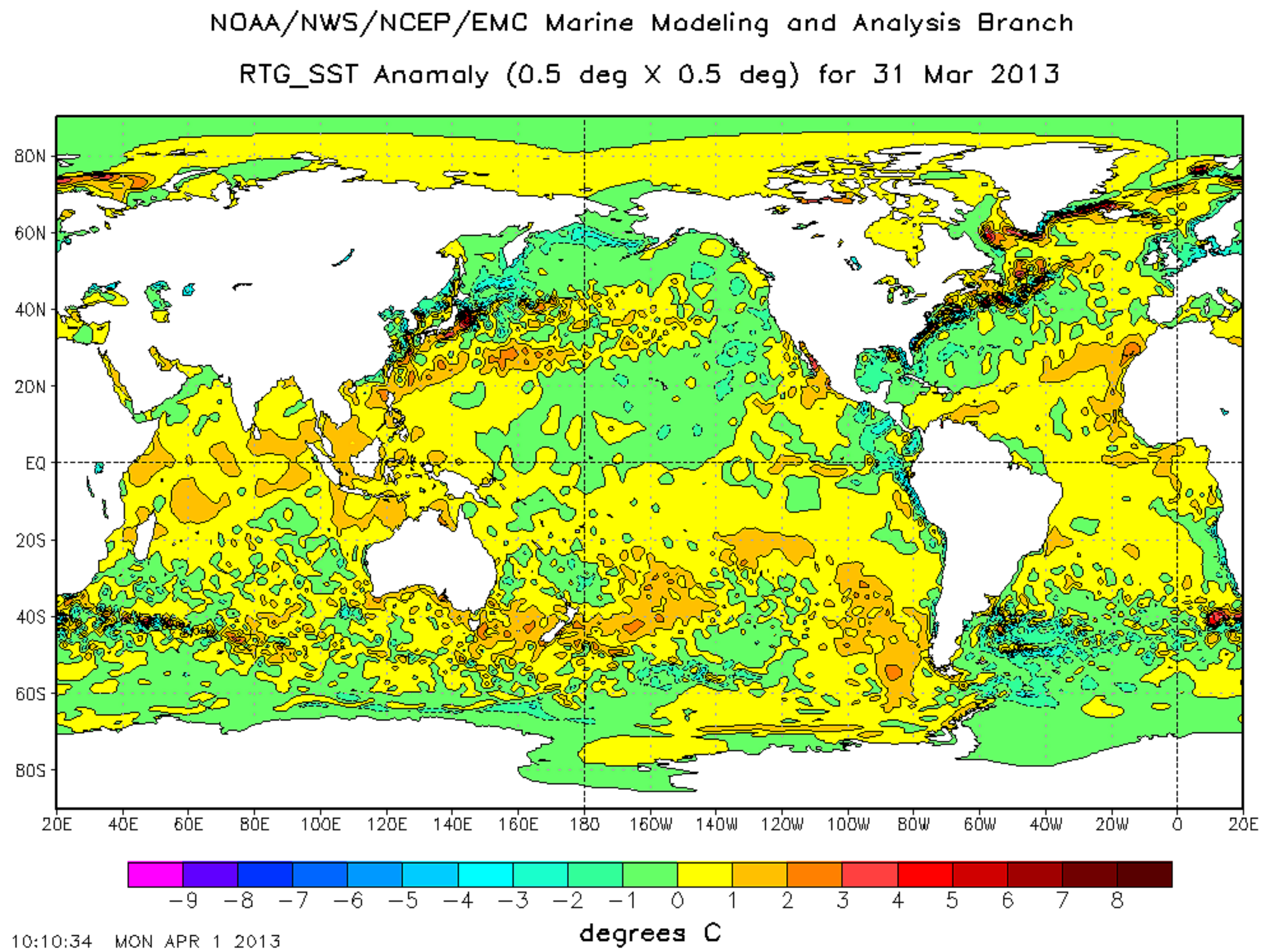


Superimposed plot of all five global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (10 years) from January 1979 to December 1988. The heavy black line represents 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 in principle may be 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 within the coming years. Time will show which of these two possibilities is correct.

Global sea surface temperature, updated to late March 2013



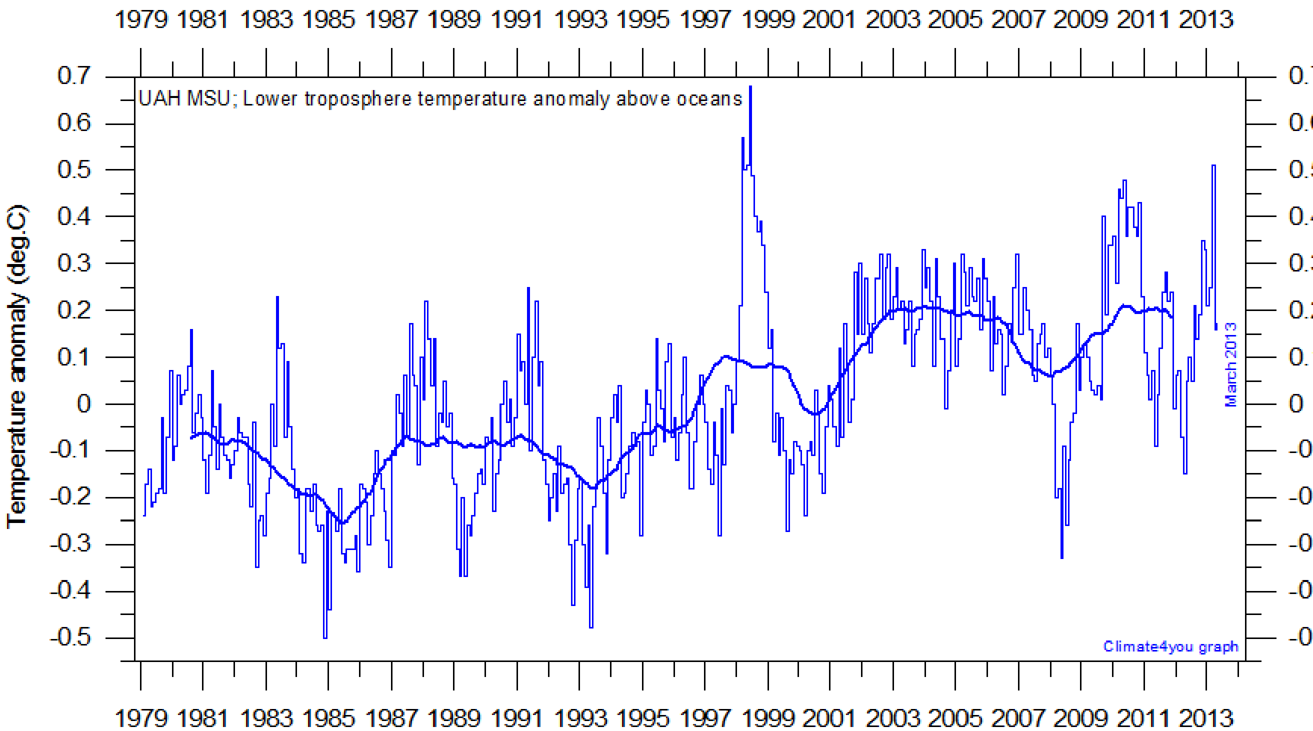
Sea surface temperature anomaly on 31 March 2013. Map source: National Centers for Environmental Prediction (NOAA).

A clear ocean surface temperature asymmetry is apparent between the two hemispheres, with relatively warm conditions in the northern hemisphere, and relatively cold conditions in the southern hemisphere, but with large regional differences.

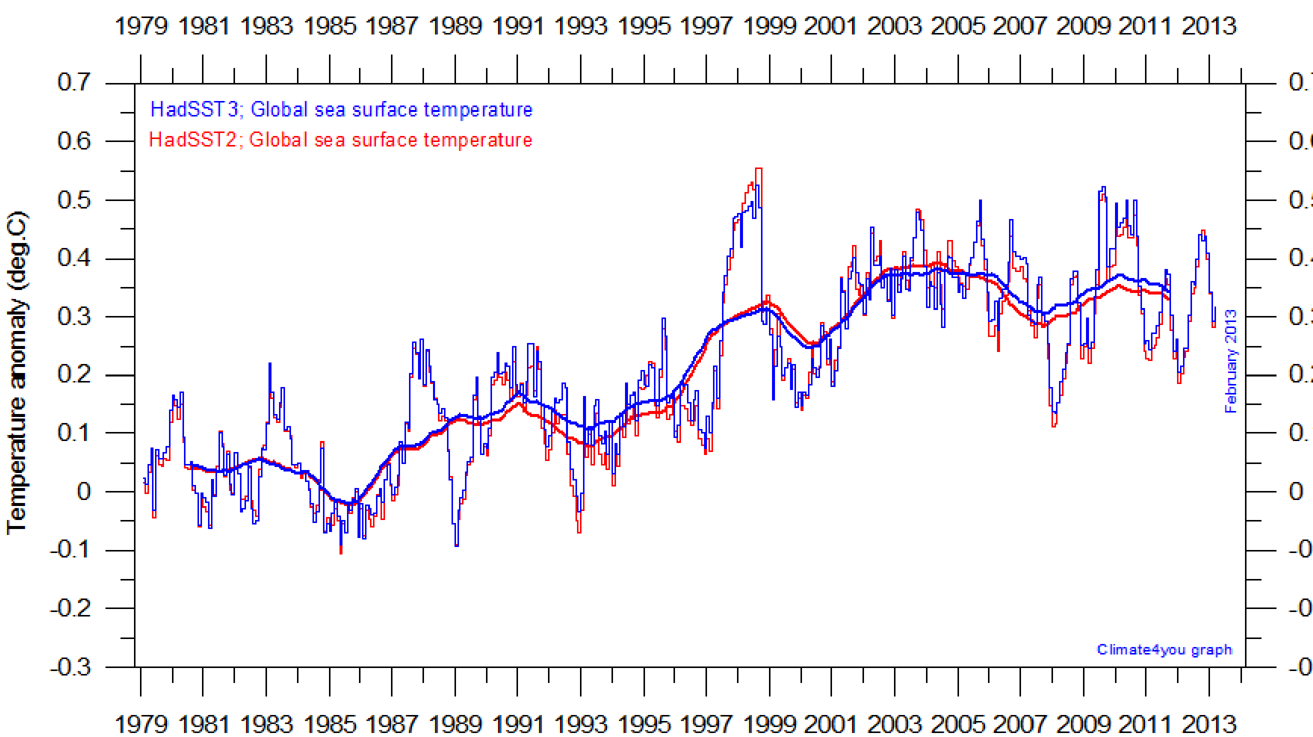
Because of the large surface areas involved especially near Equator, the temperature of the surface water in these regions clearly affects the global atmospheric temperature (p.3-5).

The significance of any such short-term warming or cooling seen 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.

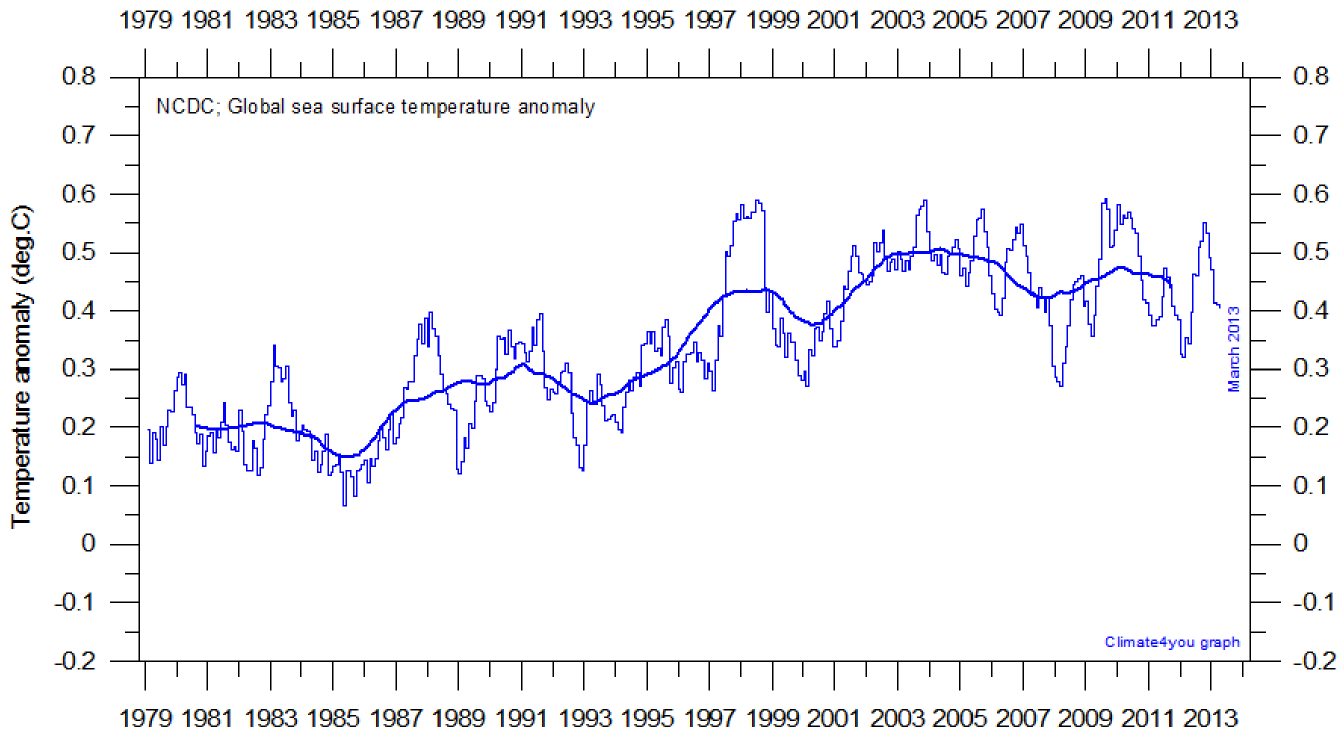
However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, net changes may be small, as heat exchanges as the above mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when seen 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. Please note that this diagram is not updated beyond February 2013.



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.

What causes the large variations in global satellite temperature compared to global surface air temperature? A good explanation was provided by Roy Spencer in March 2012:

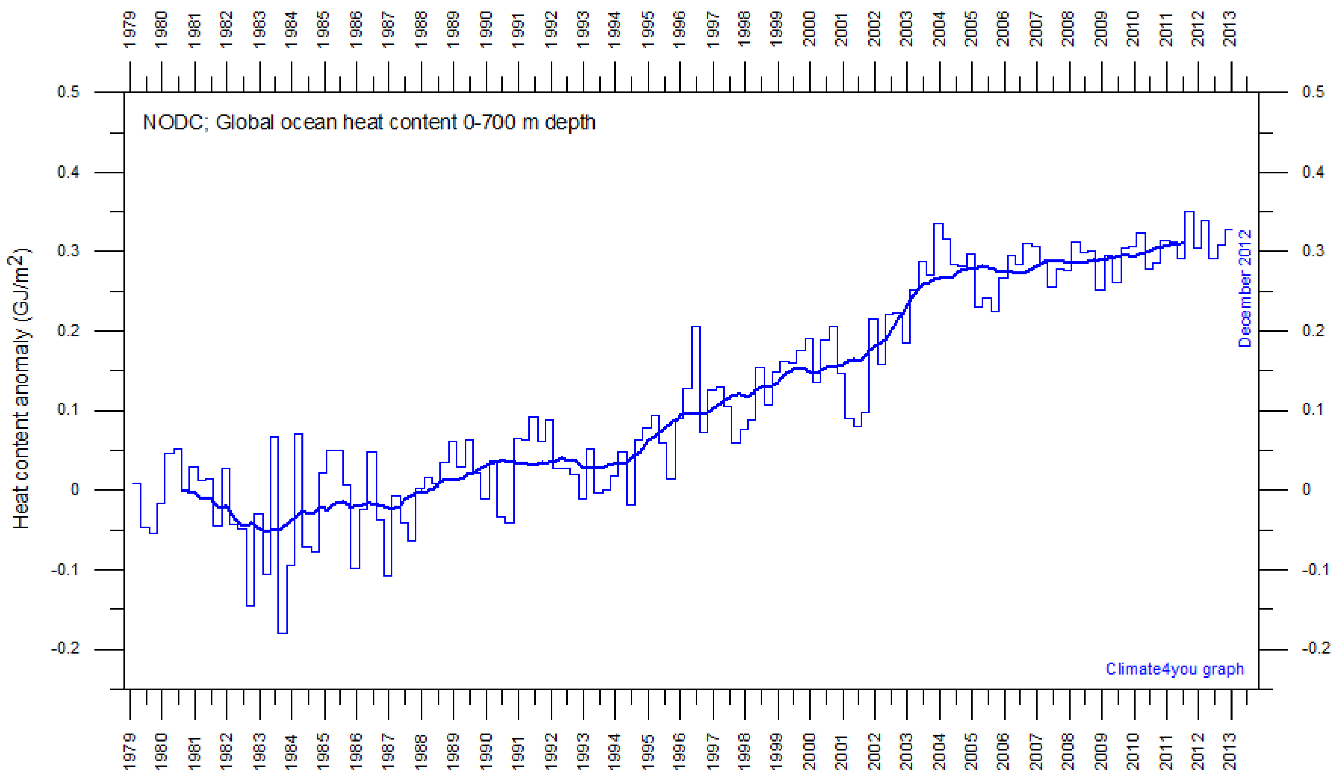
"These temperature swings are mostly the result of variations in rainfall activity. Precipitation systems, which are constantly occurring around the world, release the latent heat of condensation of water vapor which was absorbed during the process of evaporation from the Earth's surface.

While this process is continuously occurring, there are periods when such activity is somewhat more intense or widespread. These events, called Intra-Seasonal Oscillations (ISOs) are most evident over the tropical Pacific Ocean.

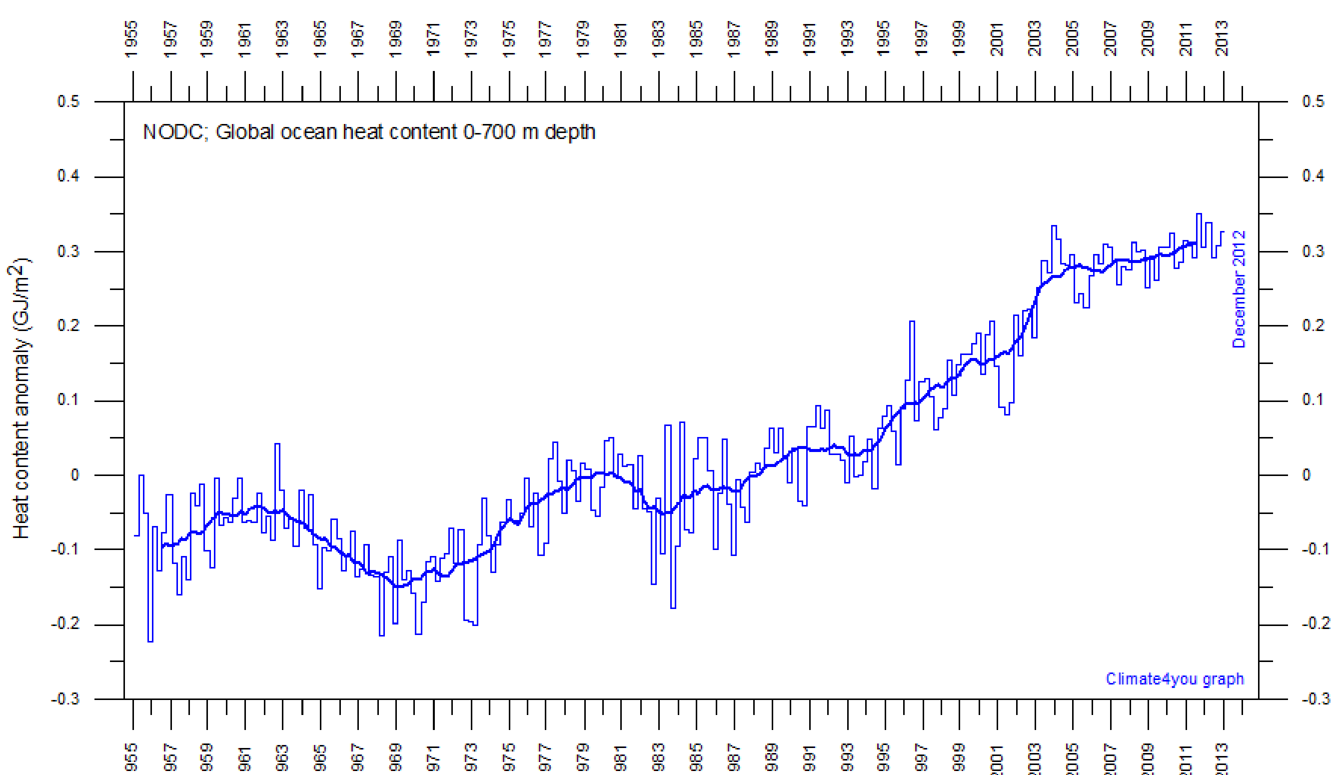
During the convectively active phase of the ISO, there are increased surface winds of up to 1 to 2 knots averaged over the tropical oceans, which causes faster surface evaporation, more water vapor in the troposphere, and more convective rainfall activity. This above-average release of latent heat exceeds the rate at which the atmosphere emits infrared radiation to space, and so the resulting energy imbalance causes a temperature increase.

During the convectively inactive phase, the opposite happens: a decrease in surface wind, evaporation, rainfall, and temperature, as the atmosphere radiatively cools more rapidly than latent heating can replenish the energy."

Global ocean heat content uppermost 700 m, updated to December 2012

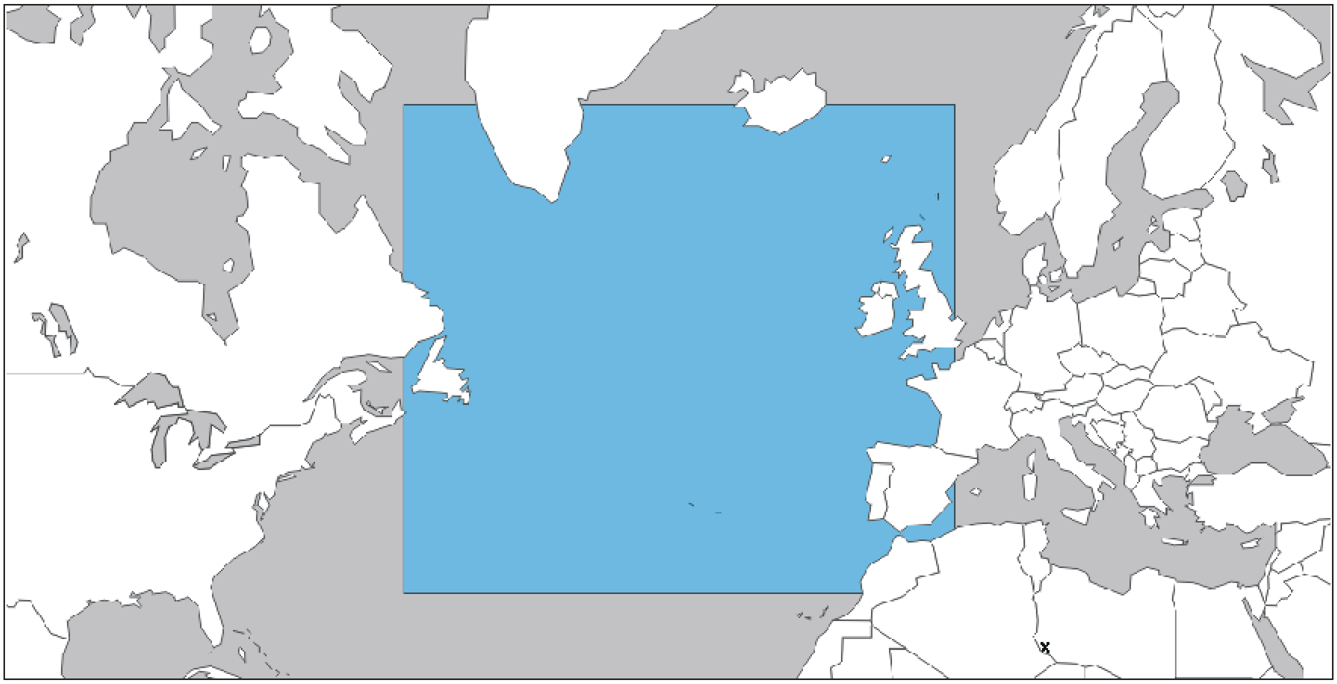


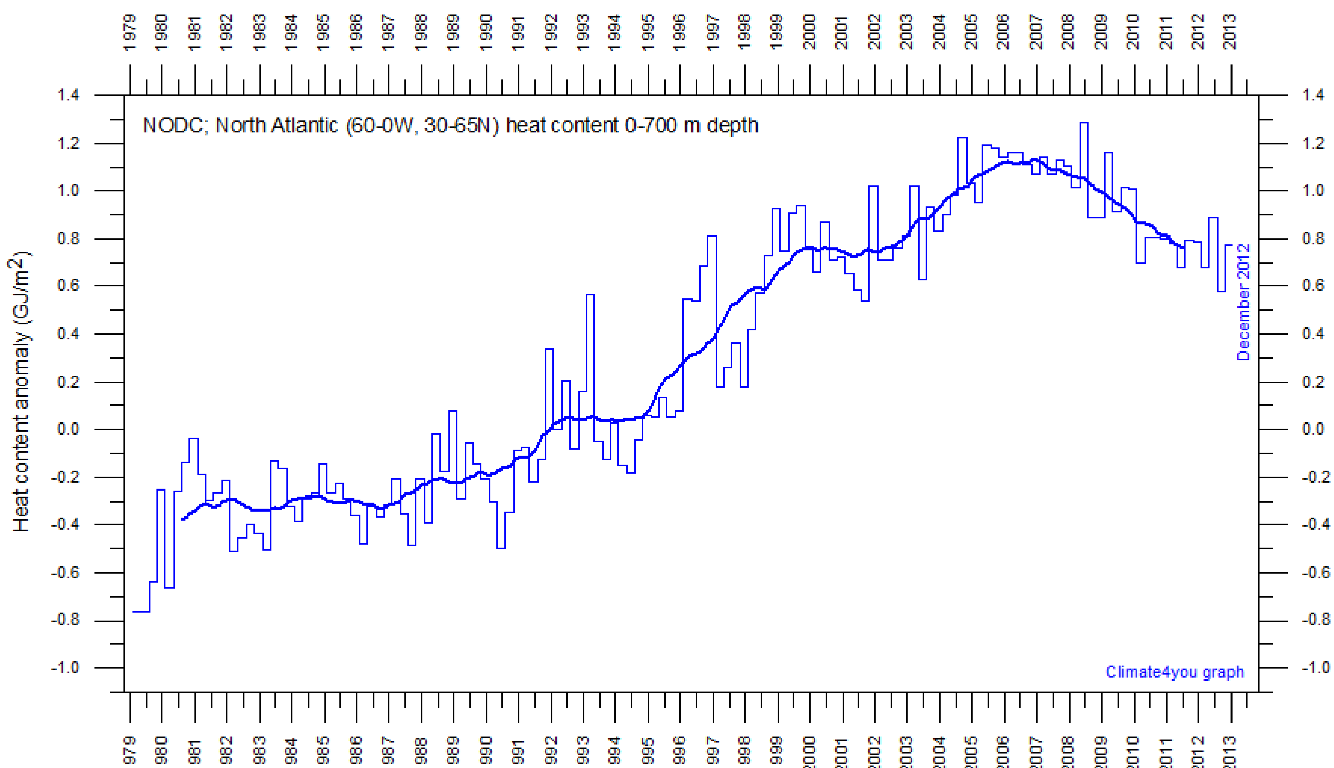
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



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).

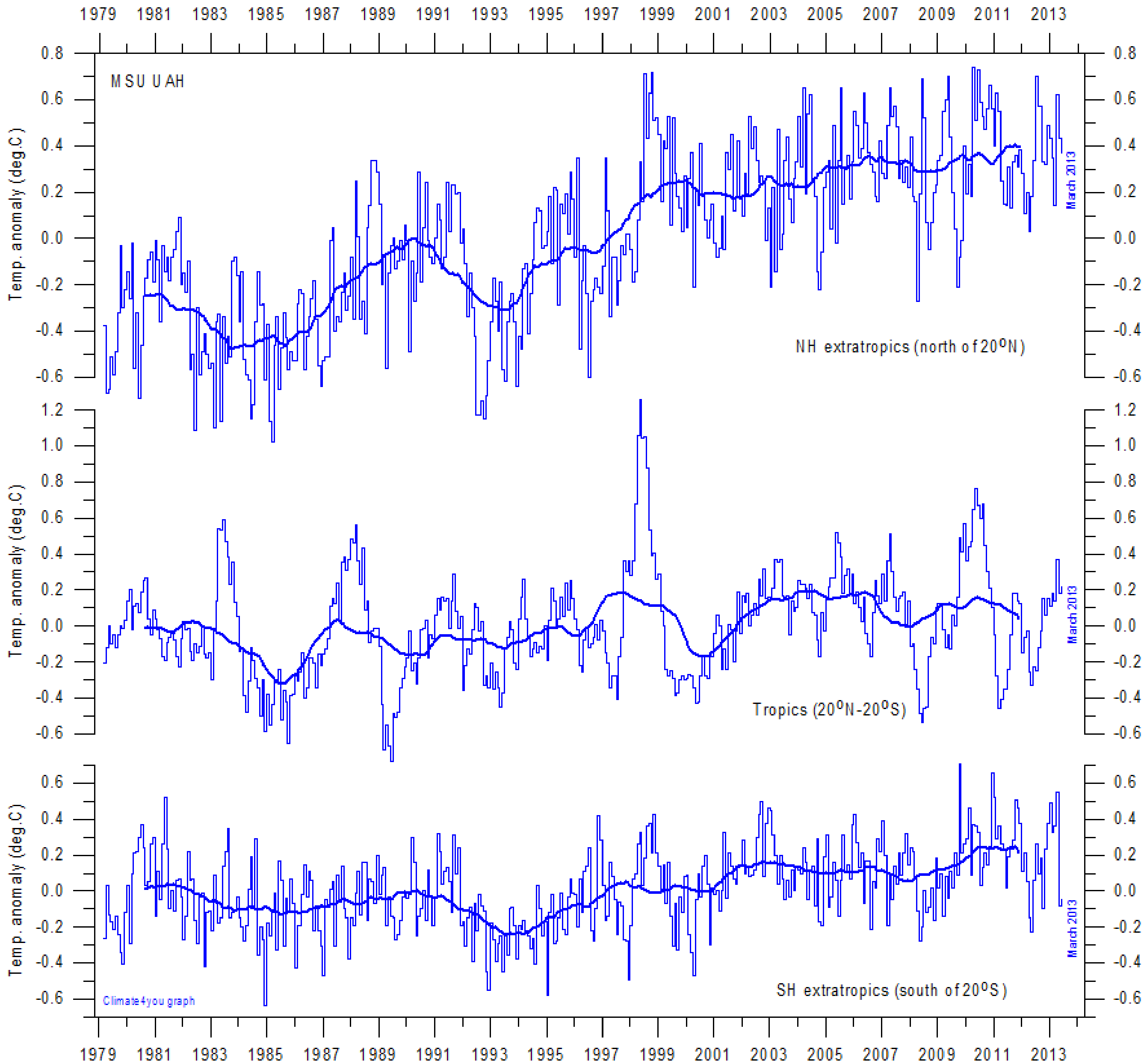
North Atlantic heat content uppermost 700 m, updated to December 2012





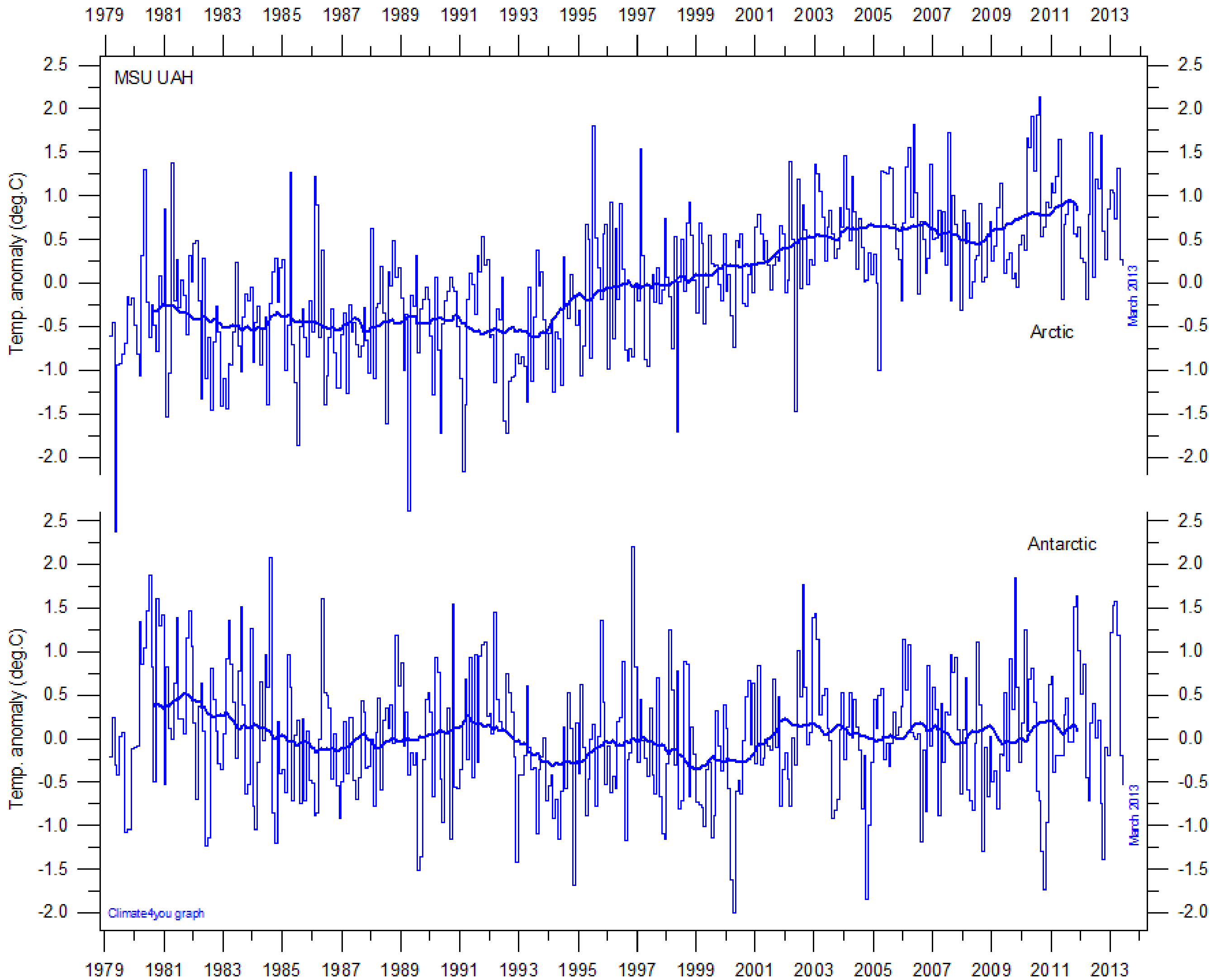
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the North Atlantic (60-0W, 30-65N; see map above) *ocean since January 1979. The thin line indicates monthly values, and the thick line represents the simple running 37 month (c. 3 year) average. Data source: National Oceanographic Data Center (NODC). Last month shown: December 2012.*

Zonal lower troposphere temperatures from satellites, updated to March 2013



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 March 2013



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 February 2013]()

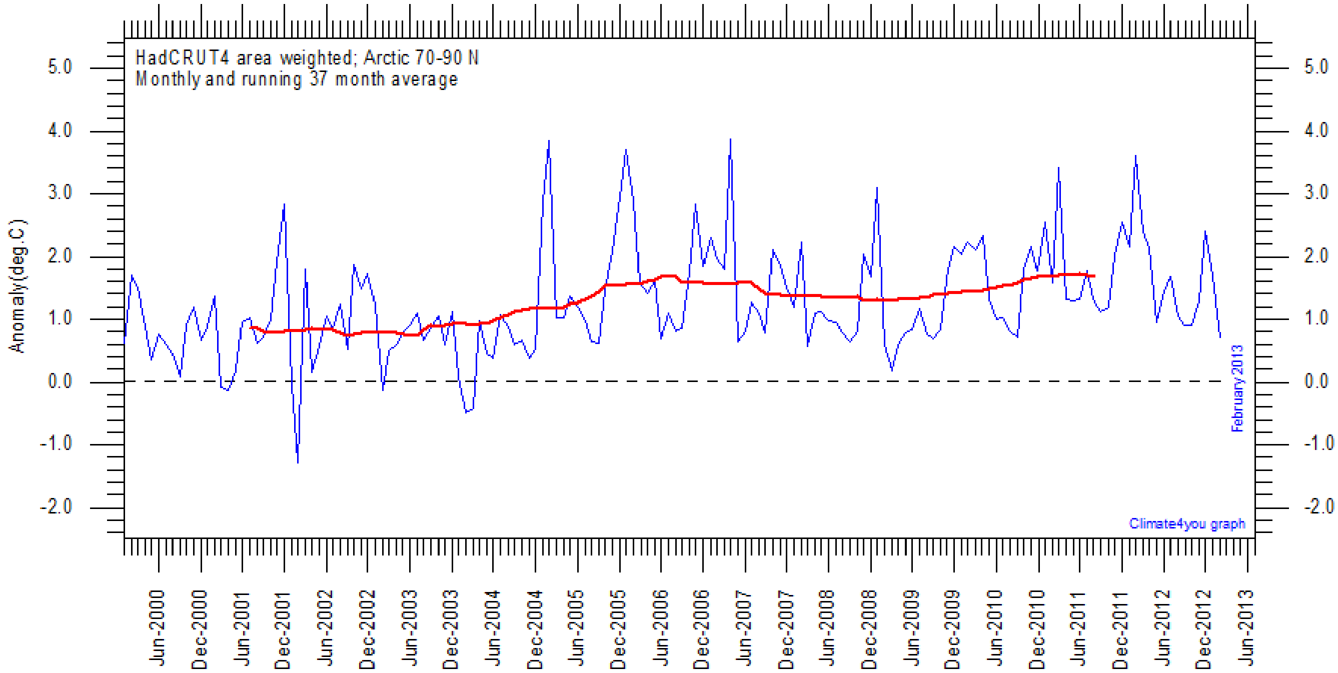


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]()) since January 2000, in relation to the WMO [normal period]() 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

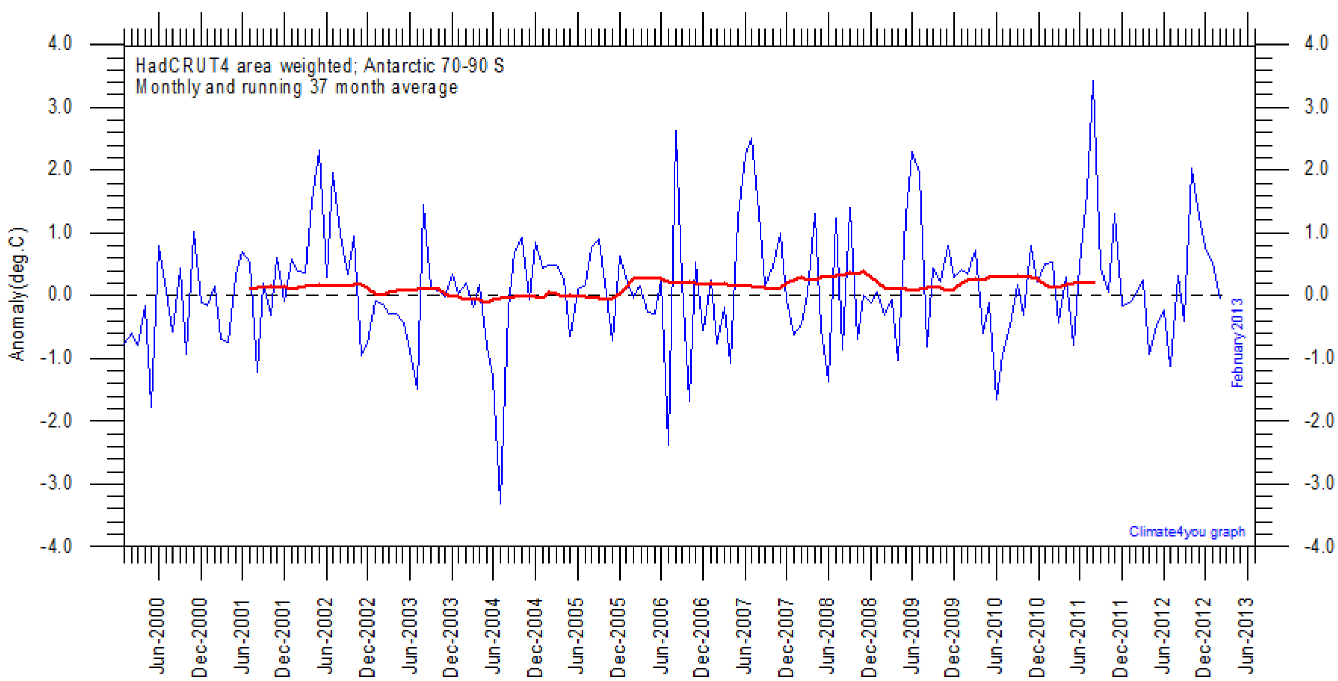


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]()) since January 2000, in relation to the WMO [normal period]() 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

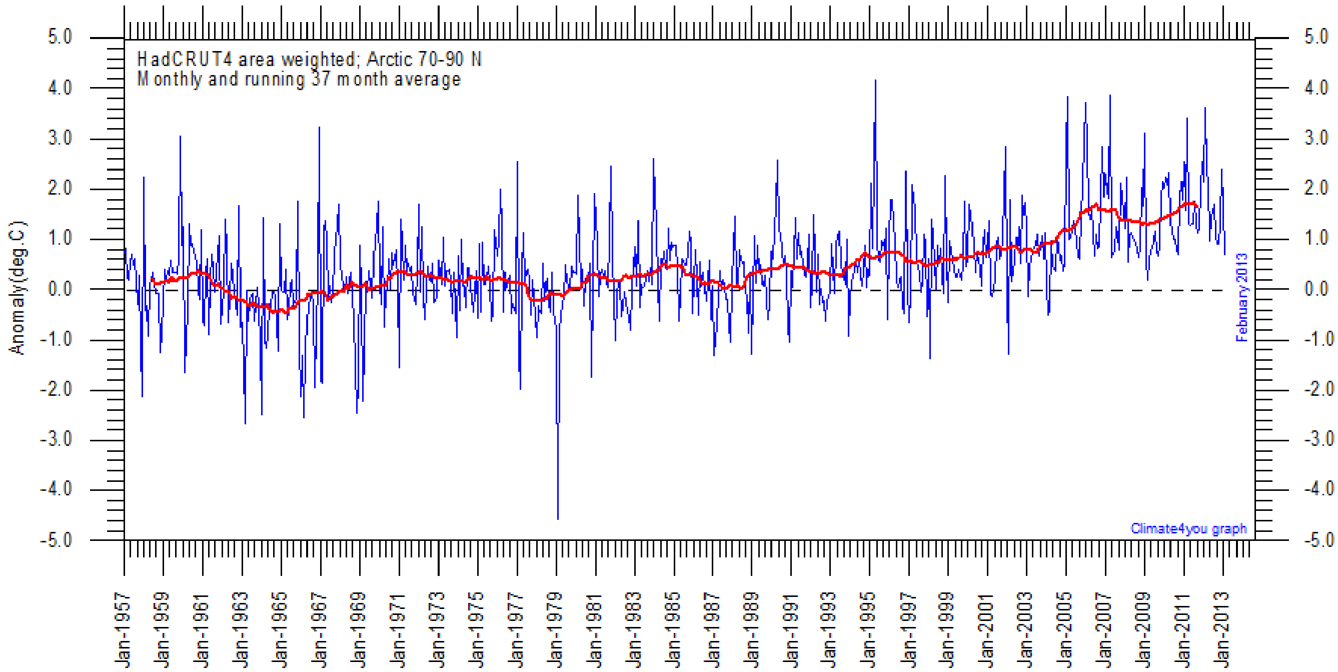


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

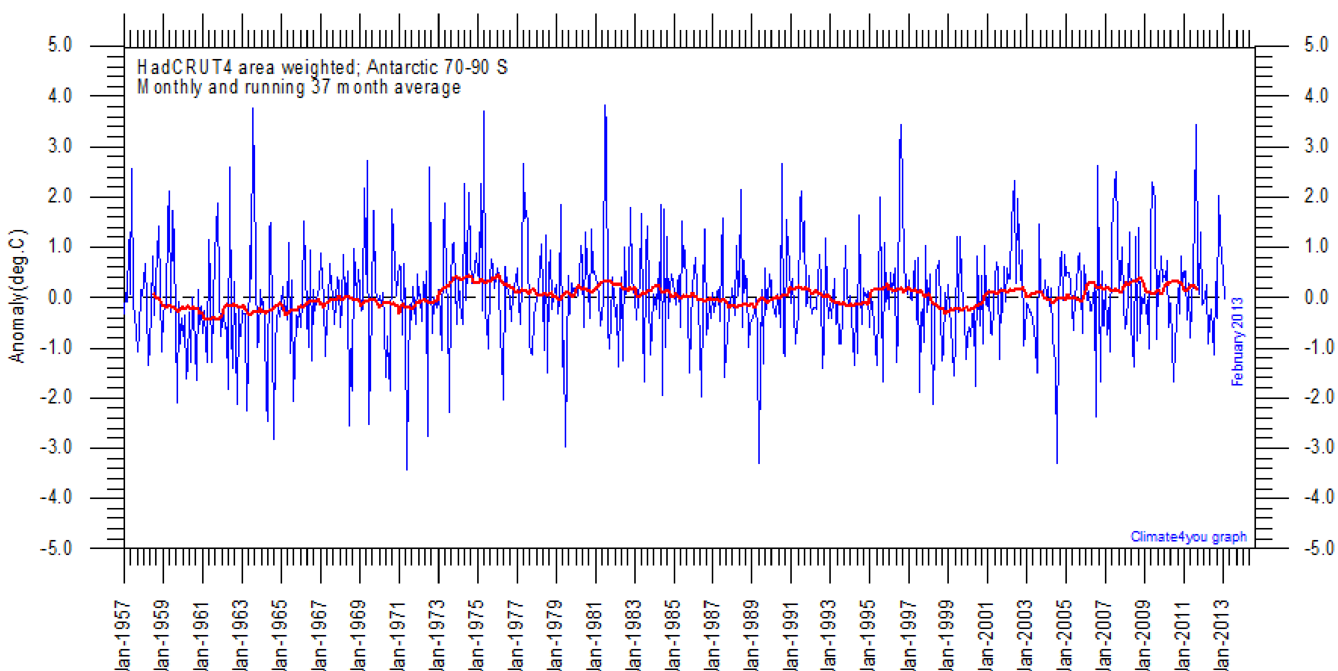


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

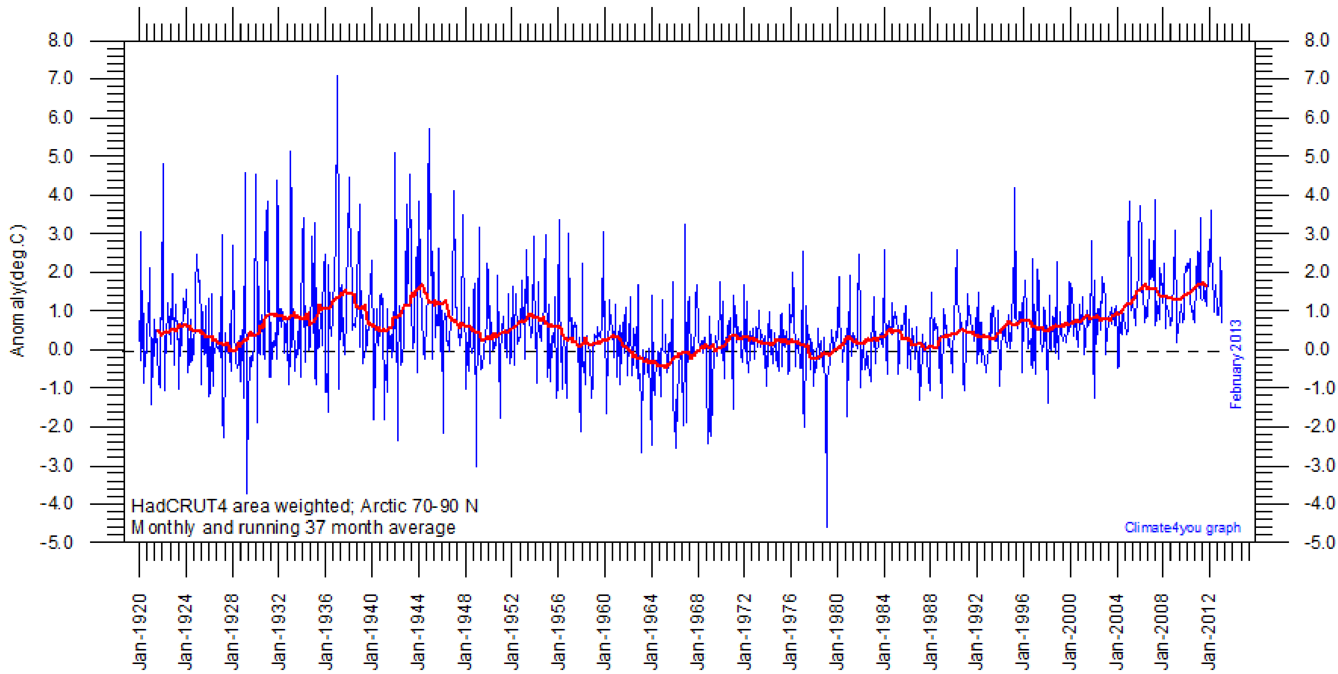


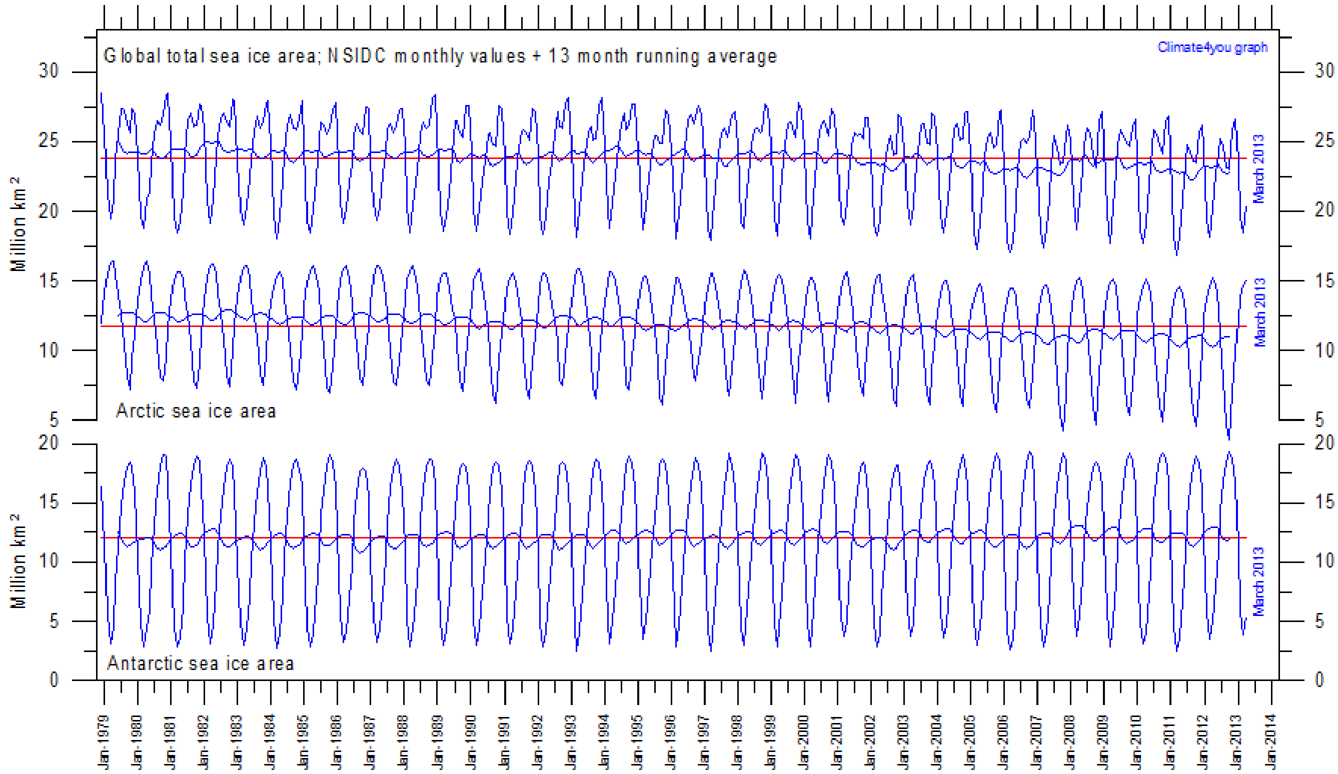
Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1920, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.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

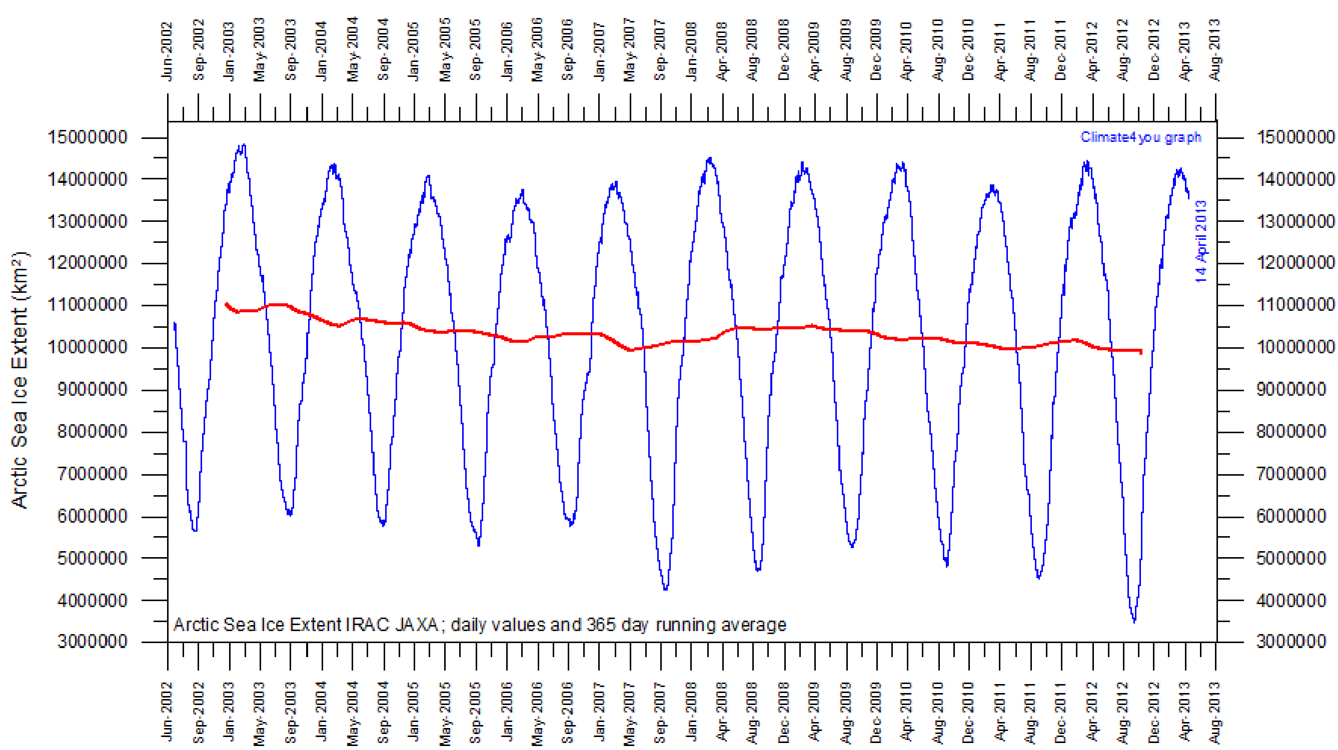
Literature:

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.

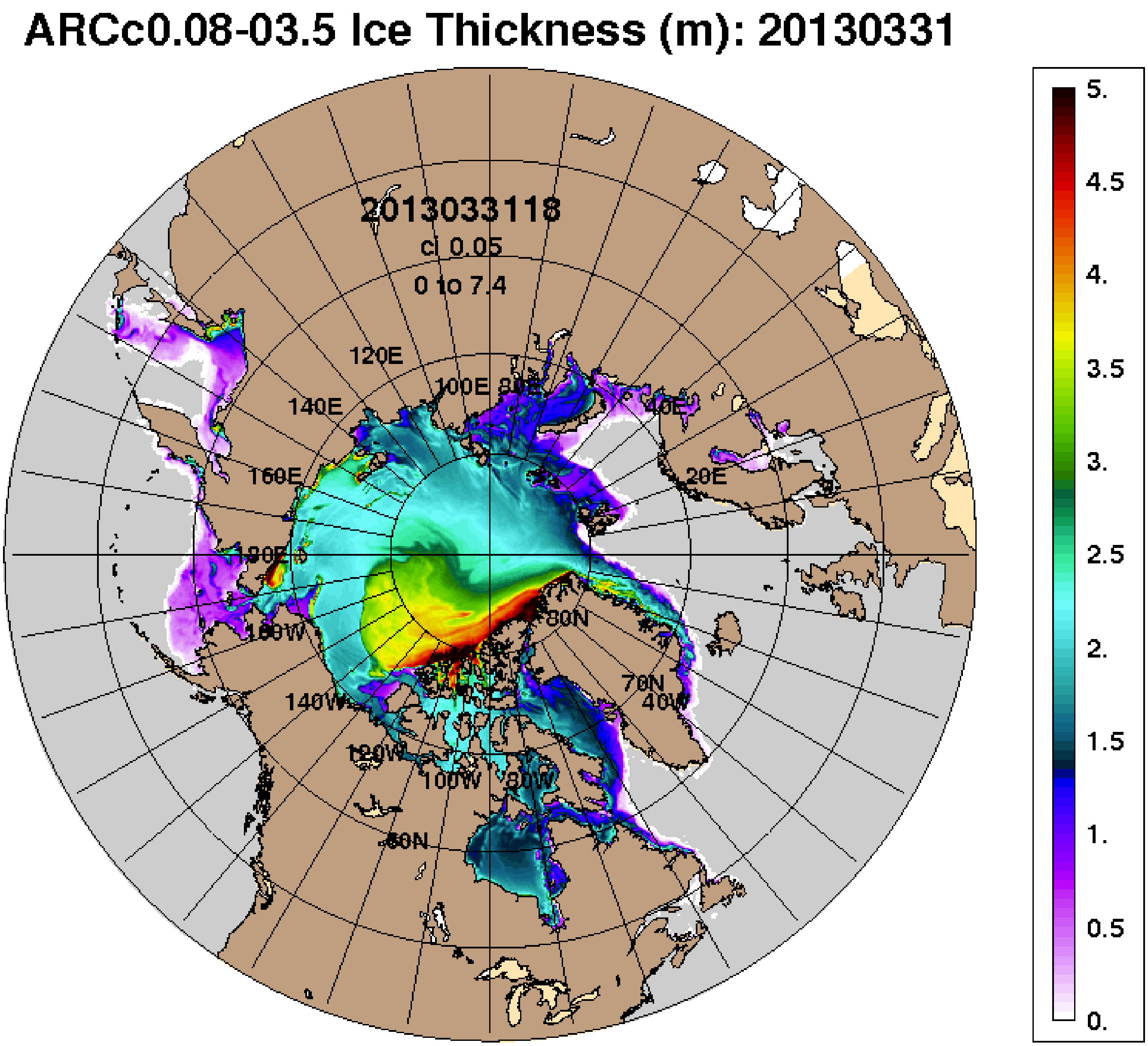
Arctic and Antarctic sea ice, updated to March 2013



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

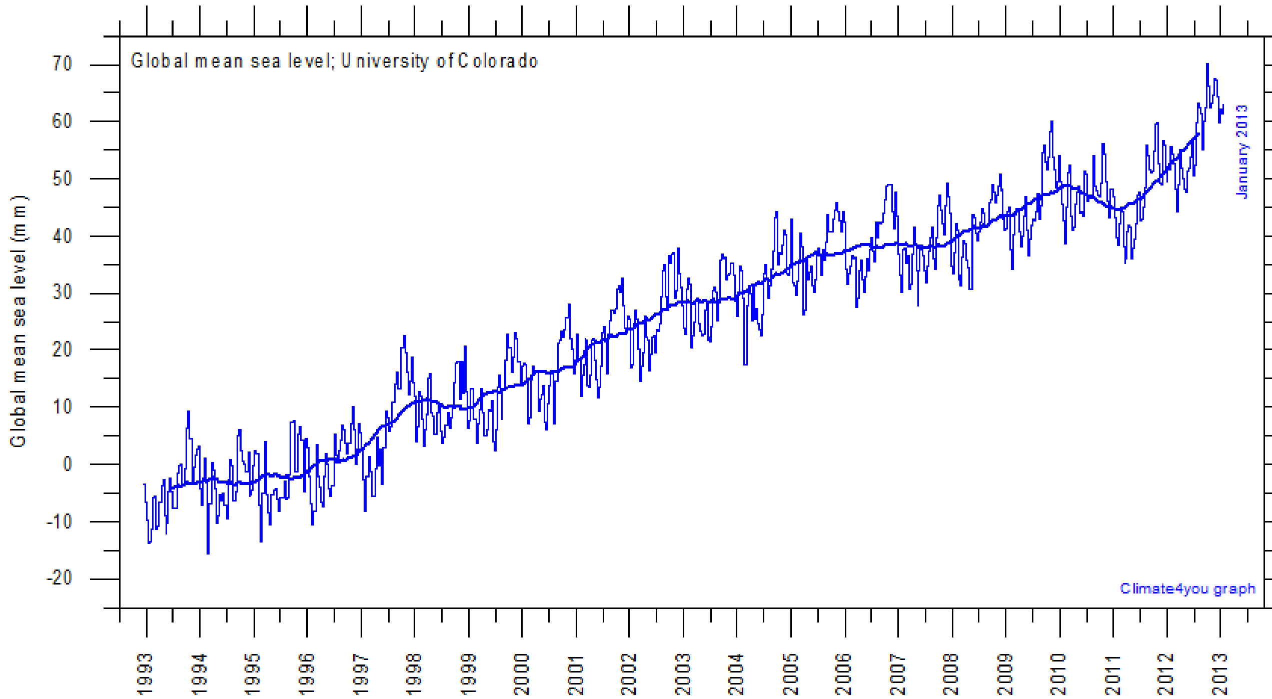


Graph showing daily Arctic sea ice extent since June 2002, to April 14, 2013, by courtesy of [Japan Aerospace Exploration Agency](#) (JAXA).

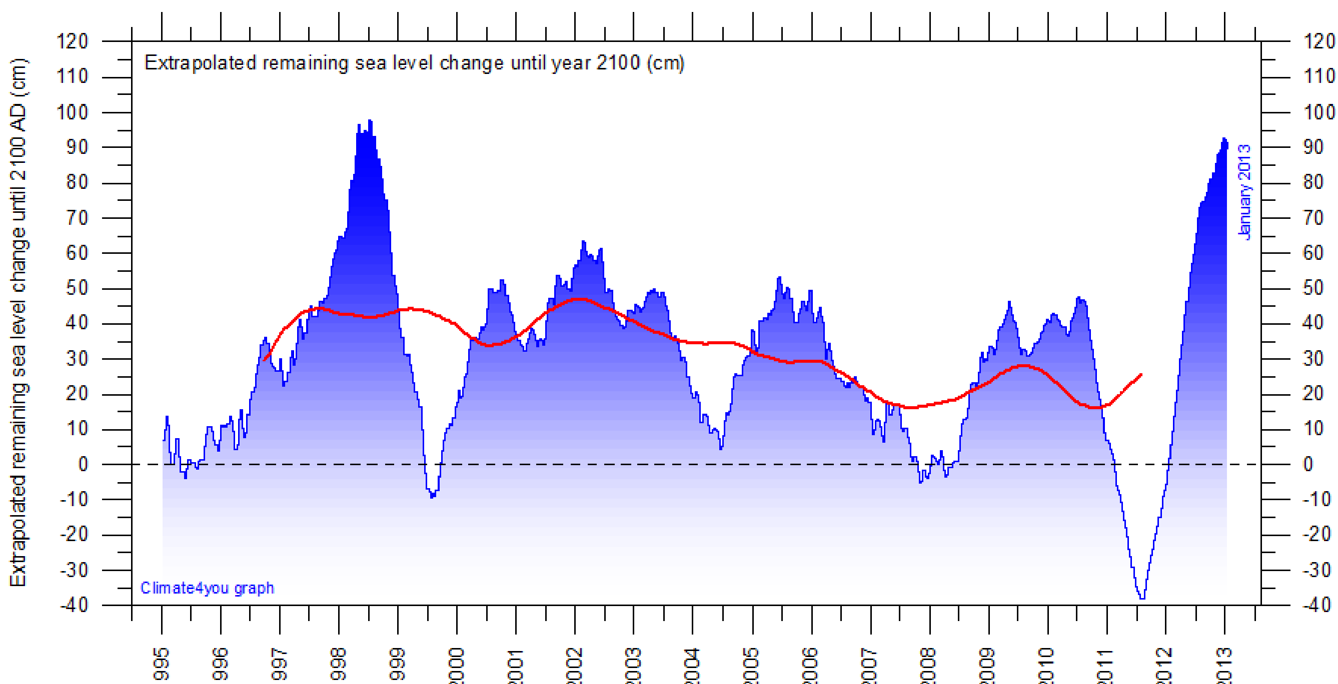


Northern hemisphere sea ice extension and thickness on 31 March 2013 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) is shown to the right.

Global sea level, updated to January 2013

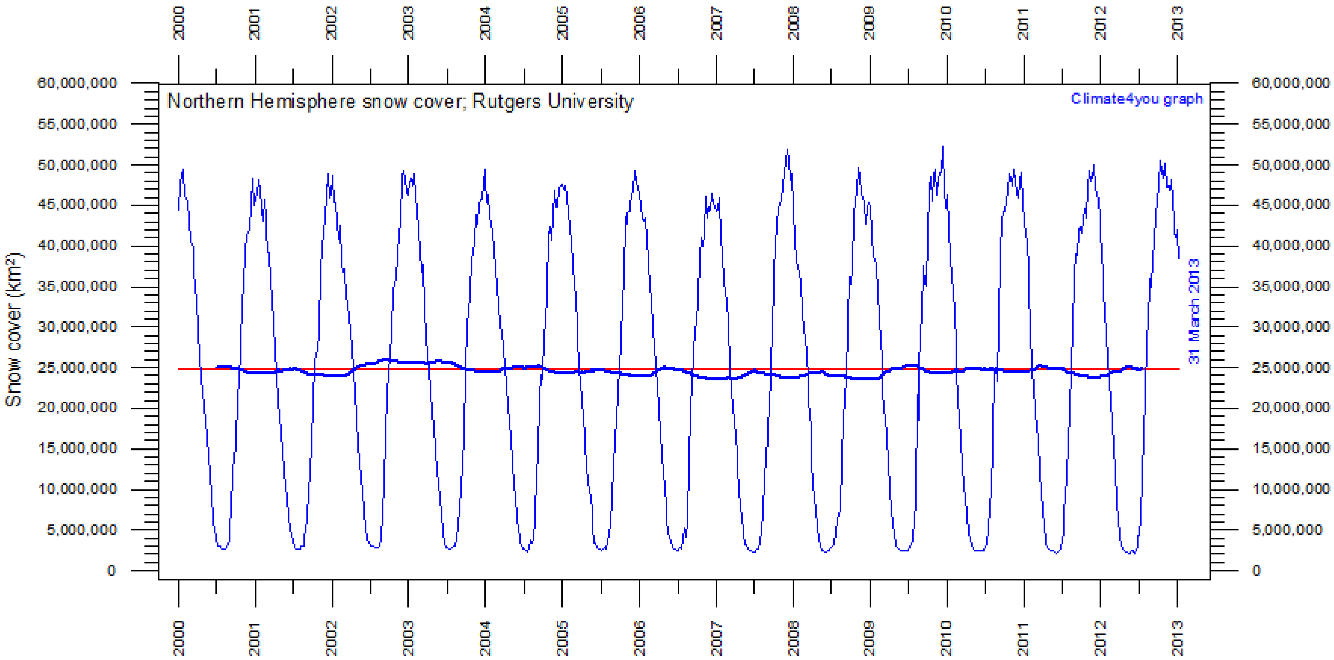


Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at University of Colorado at Boulder, USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

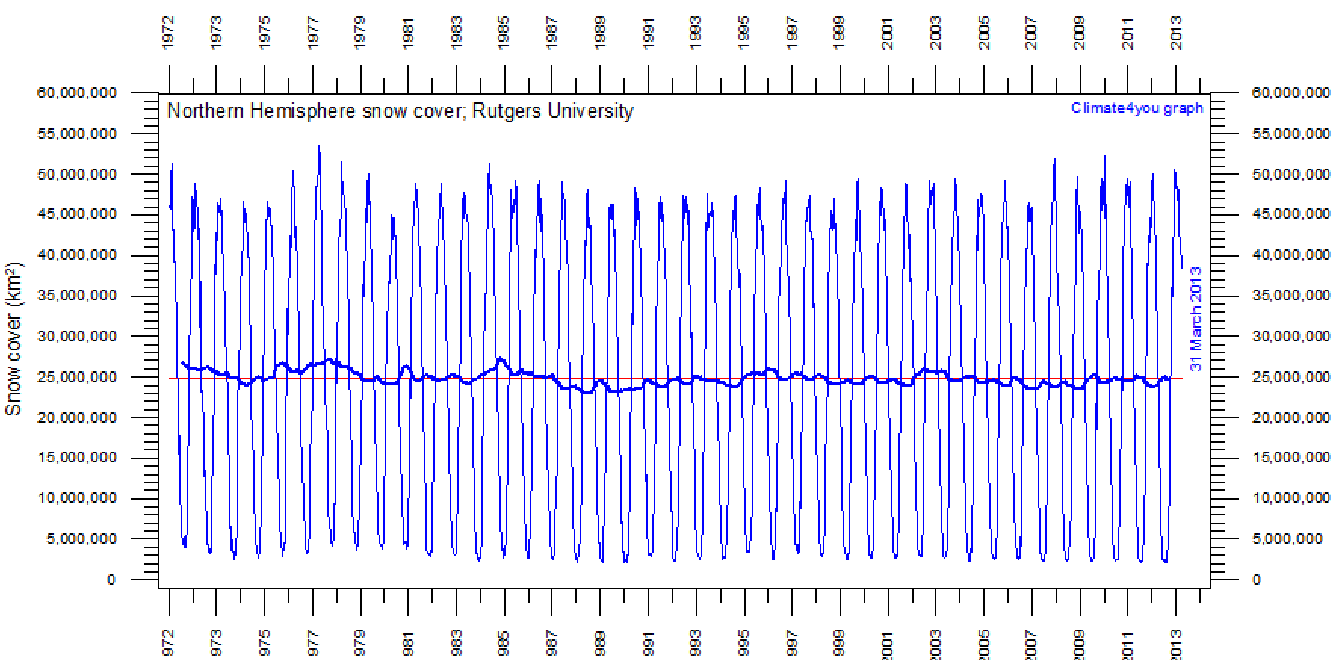


Forecasted change of global sea level until year 2100, based on simple extrapolation of measurements done by the Colorado Center for Astrodynamics Research at University of Colorado at Boulder, USA. The thick line is the simple running 3 yr average forecast for sea level change until year 2100. Based on this (thick line), the present simple empirical forecast of sea level change until 2100 is about +27 cm.

Northern Hemisphere weekly snow cover, updated to late March 2013

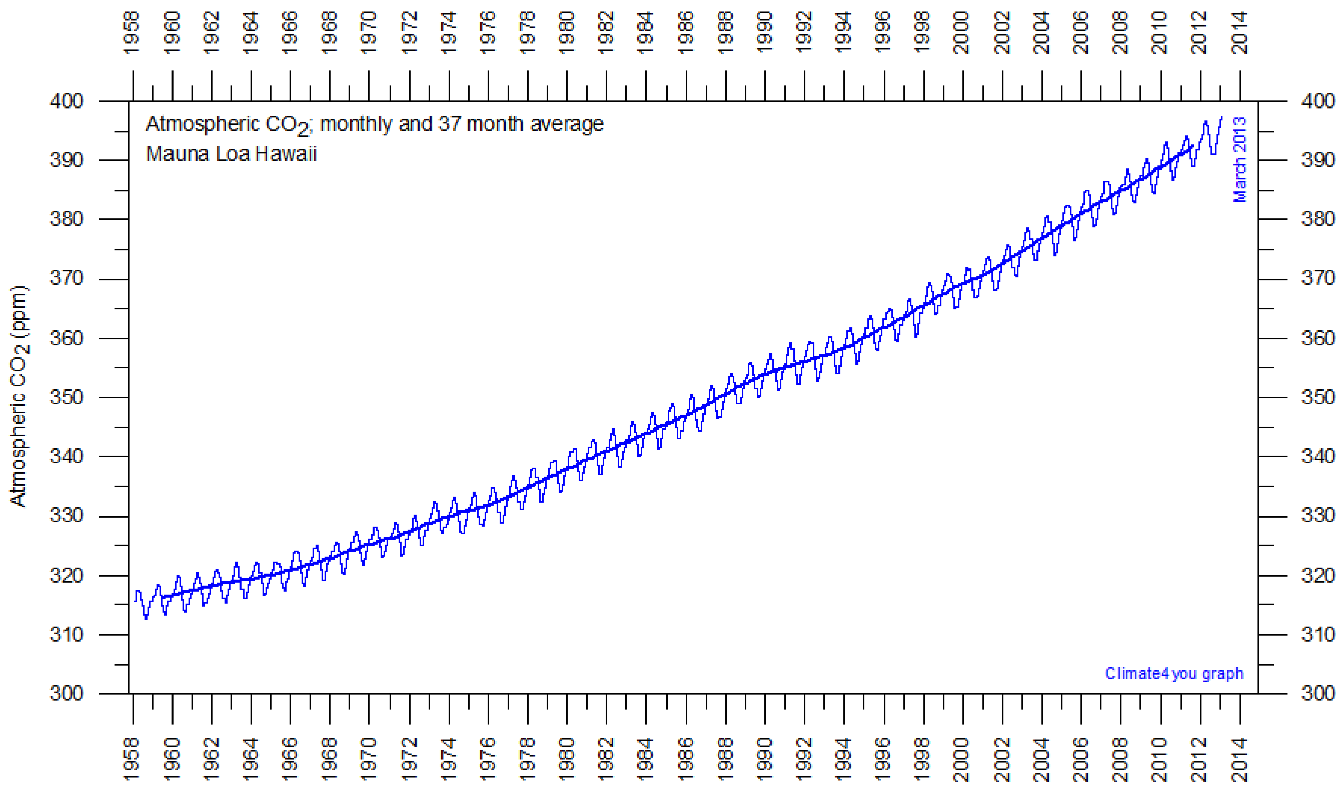


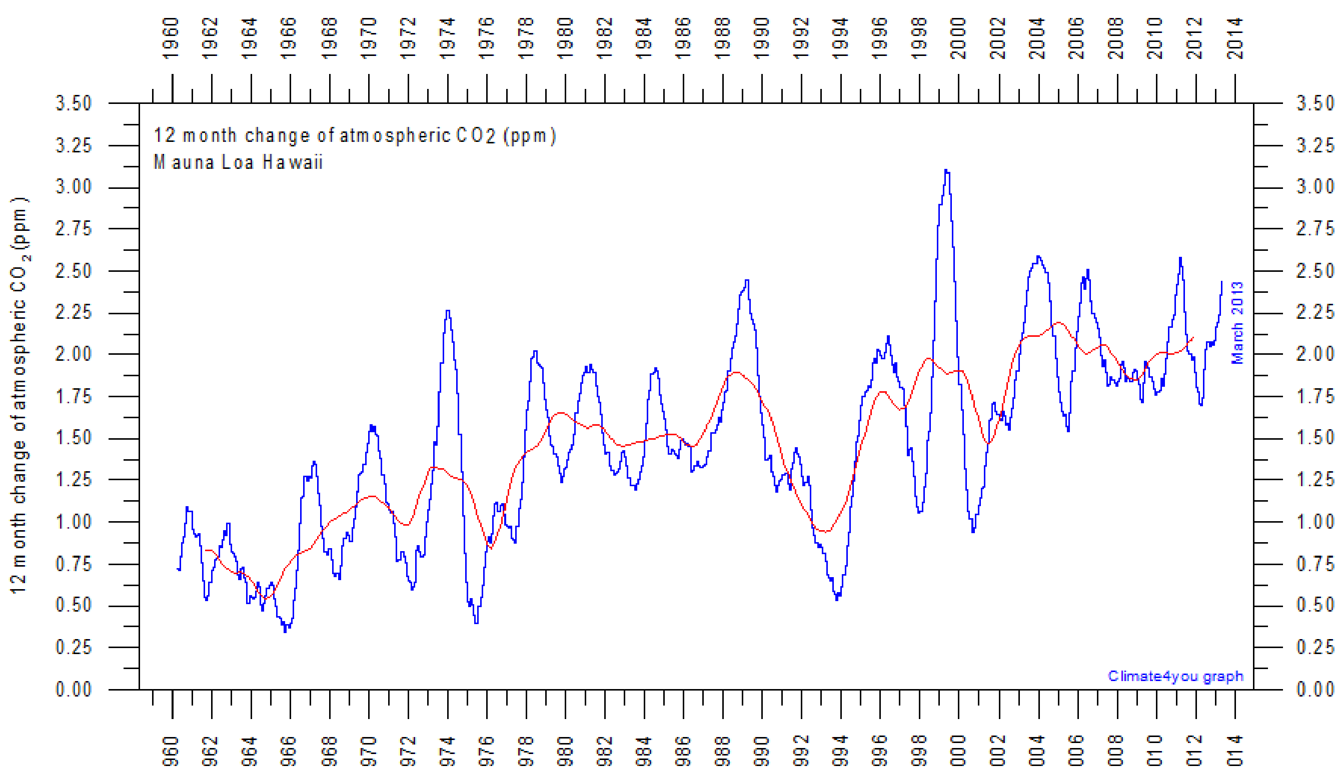
Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53 week average (approximately 1 year). The horizontal red line is the 1972-2012 average.



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 1972-2012 average.

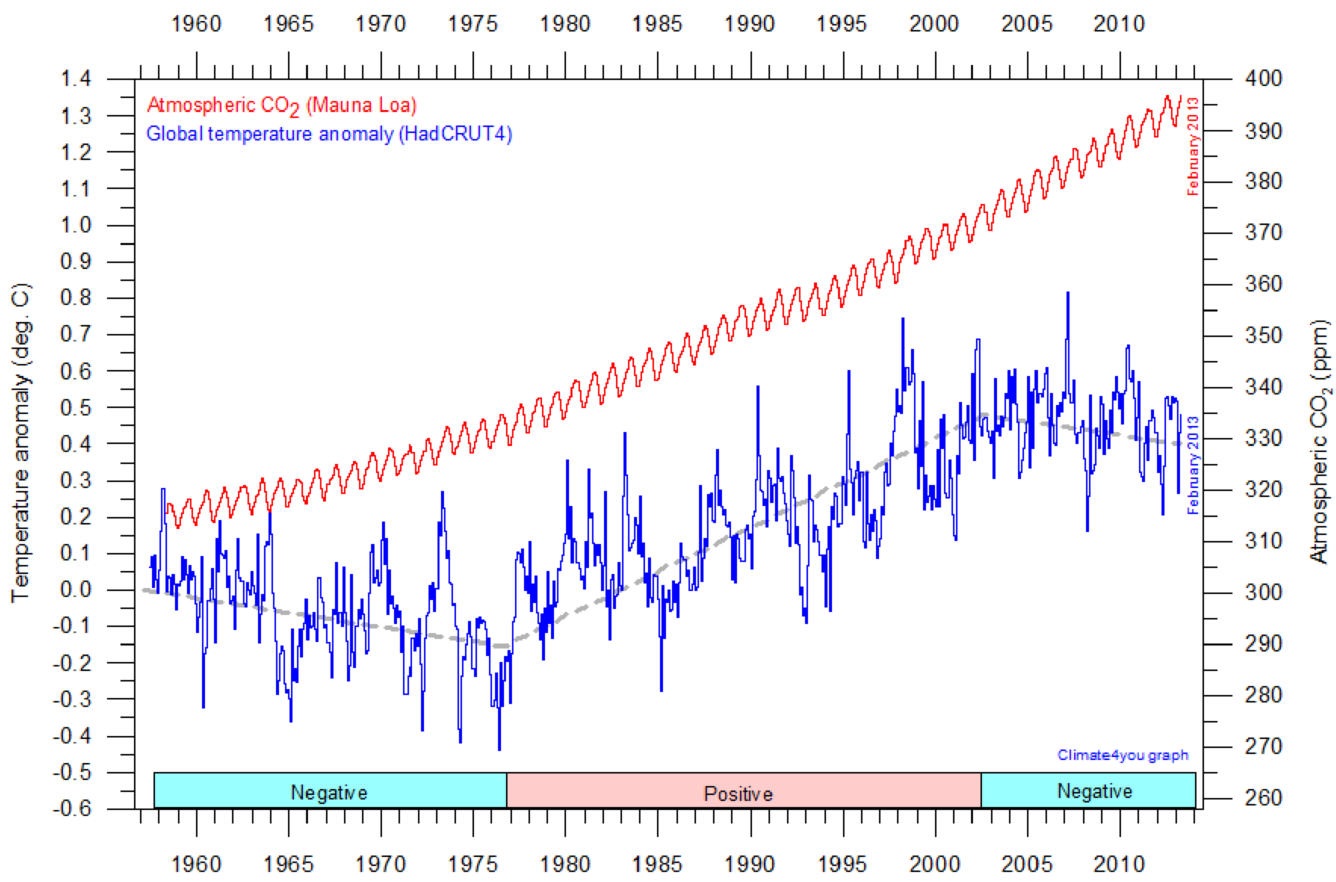
Atmospheric CO_2, updated to March 2013

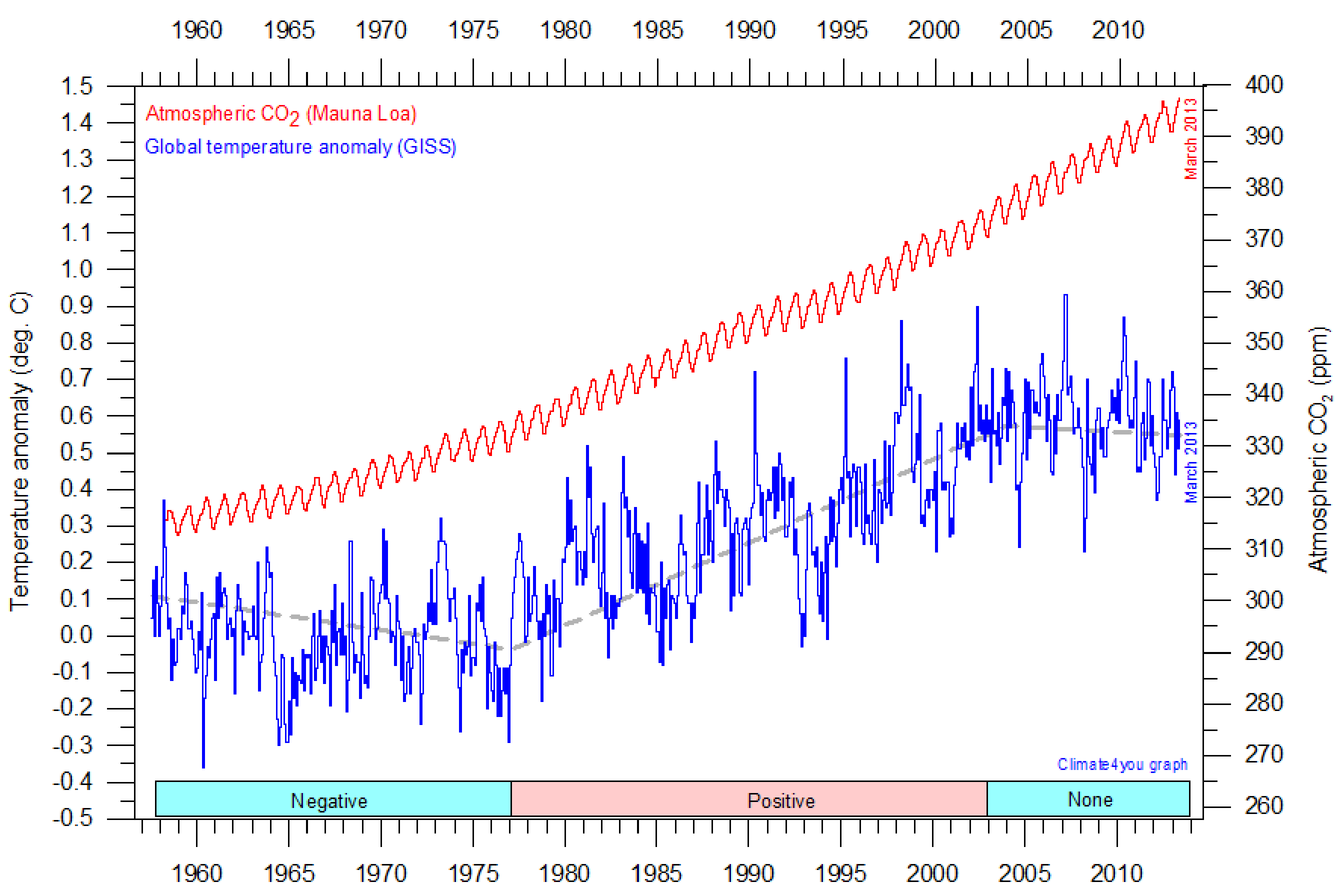


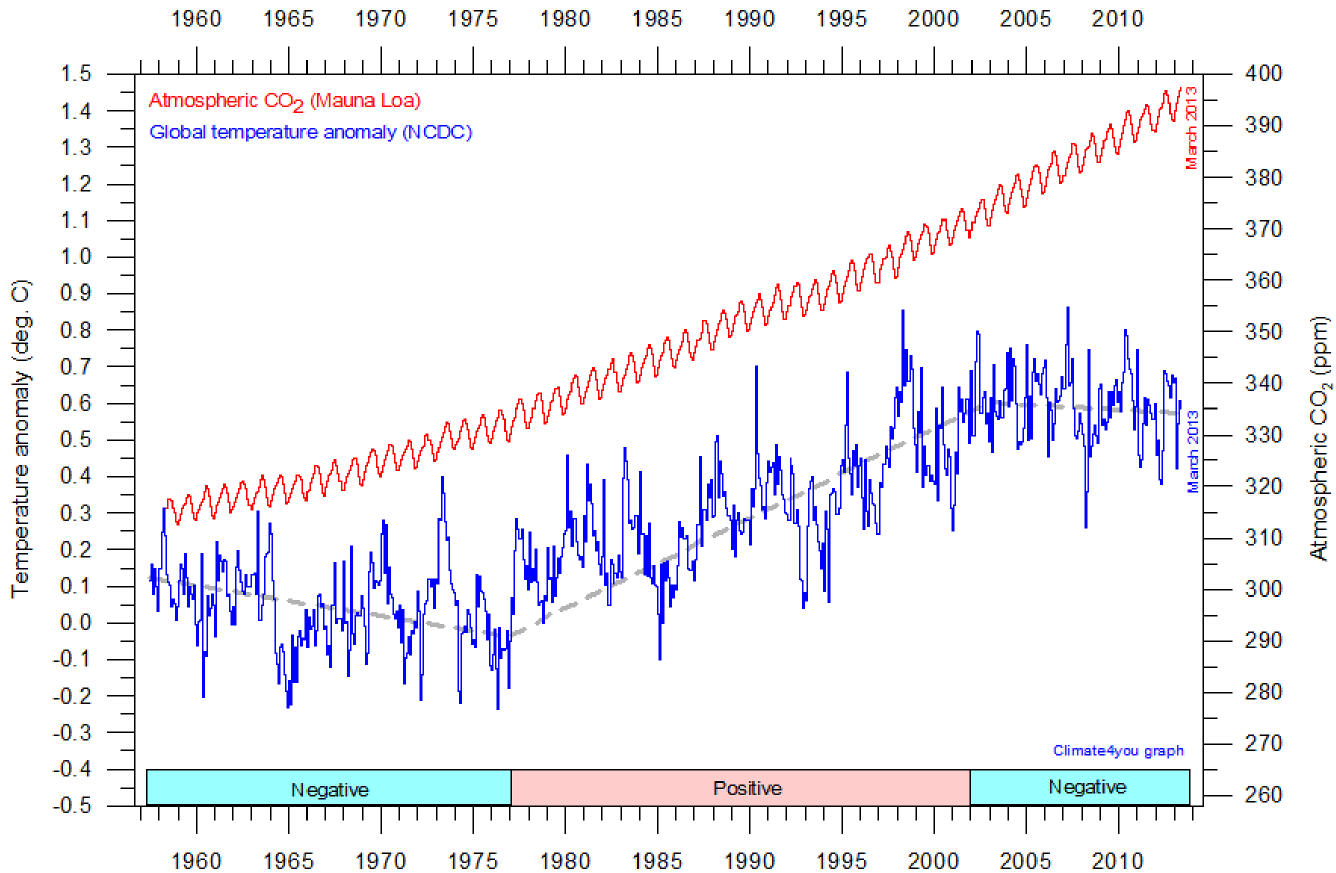


Monthly amount of atmospheric CO_2 (upper diagram) and annual growth rate (lower diagram); average last 12 months minus average preceding 12 months, blue line) of atmospheric CO_2 since 1959, according to data provided by the Mauna Loa Observatory, Hawaii, USA. The red line is the simple running 37 observation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

Global surface air temperature and atmospheric CO_2, updated to March 2013







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 has not been updated beyond February 2013.

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 short-period meteorological record value may well be the result of other phenomena.

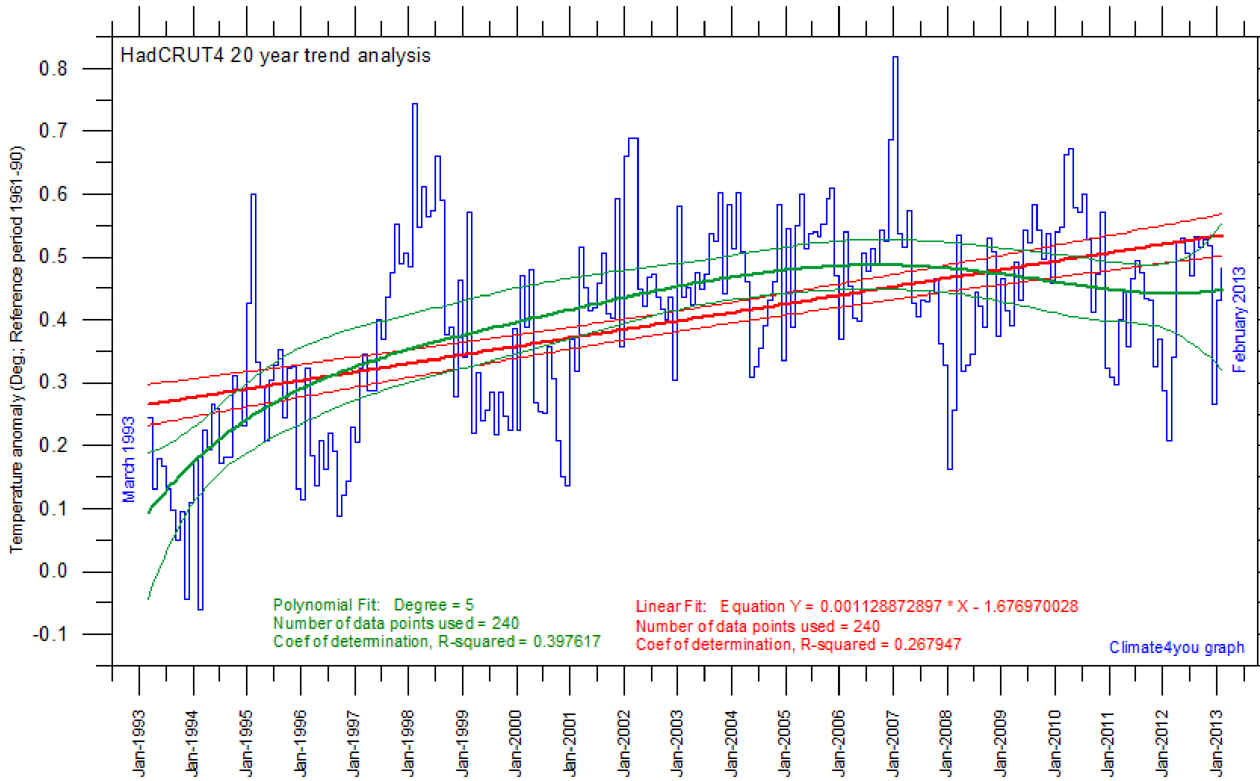
What exactly defines the critical length of a relevant time period to consider for evaluating the alleged importance of CO_2 remains elusive, and is still a topic for discussion. However, the critical period length must be inversely proportional to the temperature sensitivity of CO_2, including feedback 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 CO2 has been indicated in the lower panels of the diagrams above.

Last 20 year monthly surface air temperature changes, updated to February 2012



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).

From time to time it is debated if the global surface temperature is increasing, or if the temperature has levelled out during the last 10-15 years. The above diagram may be useful in this context, and it clearly 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.

February 1941: German battleship 'Bismarck' stuck in Hamburg because of sea ice

The German battleship Bismarck undergoing sea trials in the Baltic after raising flag in August 1940. Picture source: www.Wehrkunst.de.

The German battleship *Bismarck* and her sister-ship *Tirpitz* were the largest warships to be constructed by the German Navy before and during World War II. By the terms of the 1935 Anglo-German Naval Treaty Germany was obliged to observe the naval treaties signed in 1922 and 1930, as well as any treaty which might be negotiated in the future.

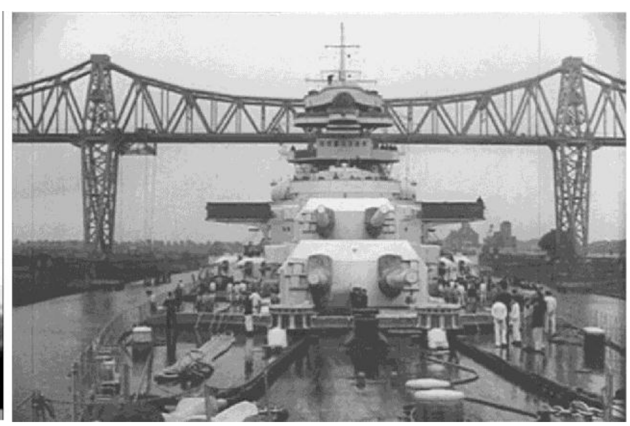
When the final design of *Bismarck* was found to substantially exceed the 35,000 ton standard displacement limit set by the 1936 London Treaty, several alternatives to reduce the displacement to meet the requirements specified in the Naval Treaty were evaluated by the German naval authorities. However, it turned out that sufficient reductions could only be accomplished by radical design alterations; modifying the twin main battery turret arrangement to feature either triple or quadruple turrets, altering the main battery to a smaller calibre, changing the split secondary battery to a dual-purpose type, or reducing the thickness and extent of the ships armour protection (Garzke and Dulin 1994). All of these changes were opposed by the German naval authorities.

It was therefore decided to proceed with ships of 42,000 tons standard displacement and to attempt to deceive the British and Americans regarding their real size. The draft of these "35,000 ton" ships was therefore officially reported to be only 7.9 m, while the full battle draft in reality exceeded 10 m. In any event, the German naval authorities were convinced that Japan would reject the 1936 London Naval Treaty and thereby invoke an escalator clause, to take effect on 1 April 1937, permitting the construction of up to 45,000 ton ships. So they decided to go ahead with the planning. American and British naval constructors were however rightfully sceptical of the shallow draft and the reported total displacement of the Bismarck when she was launched in February 1939. In reality, *Bismarck* turned out to have a total displacement of 50,956 tons when battle ready in 1941 (Whitley 2003).

Bismarck (and *Tirpitz*) featured a three-shaft propulsion plant which was subdivided into separate engine and fire room complexes by an arrangement of longitudinal and transverse bulkheads. The propulsion arrangement resulted in a large beam and a large metacentric height, as compared to that of most contemporary battleships, which resulted in high stability with short periods of roll, providing at stable platform for artillery, as desired by the German Navy. In addition these ships acquired a low, elegant silhouette, and several of the German World War II warships therefore from the distance displayed almost similar profiles, a fact that in May 1941 would have fatal consequences for the famous British battleship *Hood*, when she met Bismarck between Iceland and Greenland.

However, fitting a centreline shaft and necessary sized propellers for the more than 150,000 metric horsepowers provided by *Bismarck's* three turbines required a much different stem form than was traditionally used by previous German battleships in World War I. At the centreline of Bismarck the stem had to be configured to give sufficient tip clearance to the large centreline propeller to avoid troublesome vibration in the ship. This resulted in a loss of underwater lateral area at the stem and a shift of the lateral centre of effort forward, which created problems with the directional stability of Bismarck. The need to provide sufficient clearance for the centreline propeller also resulted in a longer than usual overhang in which the two heavy rudders, their likewise heavy steering gear and the protective armour for the steering gear were located (Garzke and Dulin 1994). This particular design type led to problems for several World War II German cruisers and battleships with triple-screw arrangement when they were damaged in the stem, as they then were more prone to serious damage from the whipping phenomena which occur whenever the extremities of a ship are subjected to explosion-induced forces.

Otherwise, *Bismarck* was an extremely well-constructed battleship for its time. Presumably, Bismarck and other German warships constructed up to and during World War II were among the most advanced warships ships at their time. After the war, when inspecting the only heavy German warship to survive World war II operational, the heavy cruiser *Prinz Eugen*, the leading Royal Navy inspector, after having thoroughly investigated the cruiser for no less than two weeks, expressed that he now had the difficult task to explain to the Admiralty in London that the British Navy would not be able to construct a ship as advanced as *Prinz Eugen* (Schmalenbach 1998, p. 201). Interesting, *Prinz Eugen* was the only other German ship to accompany *Bismarck* on her dramatic first and last sortie into the North Atlantic, in May 1941.

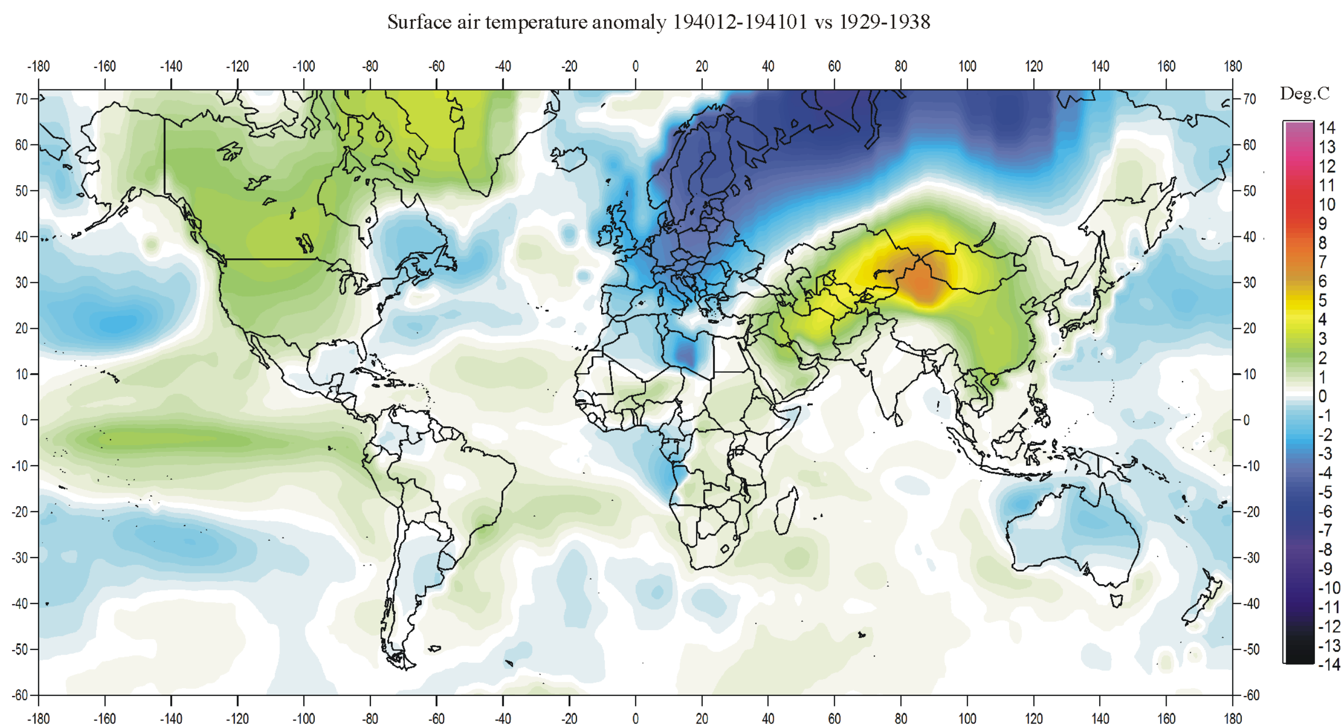
Bismarck in the Nord-Ostsee-Kanal (today the Kiel Canal), September 1940. The bridge seen in the picture to the right is the Rendsburger Hochbrücke which was built from 1911 to 1913 and has a height of 41 meters. Picture source: www.KBismarck.com

Bismarck raised flag on August 24, 1940, under Captain (Kapitän zur See) Ernst Lindemann, 45 years old and one of the navy's ablest officers. In September she moved from the shipyard in Hamburg to the Baltic, where the following sea trials were supposed to take place. During these *Bismarck* managed to reach a top speed of no less than 30.8 knots, thereby exceeding the design top speed of 30.1 knots (Müllenheim-Rechberg 2005).

However, the otherwise efficient three-propeller arrangement turned out to create serious problems with *Bismarck's* directional stability whenever the crew attempted to steer the ship by the propellers alone, simulating a failure of both rudders. Even with the rudders in a neutral, mid ship position, it was virtually impossible to control the ship by the propellers alone, and eventually it always ended up by turning into the wind. Later, in May 1941, this lack of directional stability would turn out to have fatal consequences for *Bismarck*, enhanced by the meteorological situation at that time.

The total crew of *Bismarck* numbered more than 2,200, and the sea trials were supposed to take several months, perhaps lasting until the summer of 1941. The British Royal Navy followed the progress with keen interest, but did not expect *Bismarck* to be ready for battle before June 1941 (Berthold 2005). Nevertheless, by using an efficient training scheme Captain Lindemann hoped to have his ship ready before that.

In early December 1940 *Bismarck* headed back from the Baltic to Hamburg, where the ship was to be equipped with additional important gear at the shipyard Blohm & Voss, the construction site of *Bismarck* 1937-39.



Surface air temperature anomalies December 1940 – January 1941, compared to the average of December-January 1929-1938. Compare with similar map for March 2013 on page 2. Data source: NASA Goddard Institute for Space Studies (GISS).

To ensure a safe journey *Bismarck* was ordered to use the Nord-Ostsee-Kanal (previously Kaiser Wilhelm-Kanal, today often called the Kiel Canal) across Schleswig-Holstein north of Hamburg, thereby avoiding the dangerous passage of Skagerrak between Denmark and Norway, not to mention the even more dangerous North Sea crossing to Hamburg. In both areas *Bismarck* would have been exposed to the might of both the British Royal Navy and the Royal Air Force. Using the Nord-Ostsee-Kanal *Bismarck* arrived safely in Hamburg on December 9, 1940. On January 24 the remaining work on *Bismarck* was successfully completed, and the ship ready to return to the Baltic for the final training of the crew, again planning to use the Nord-Ostsee-Kanal for a safe passage. But now serious problems arose, which were to force Captain Lindemann to abolish his plans.

Just like the previous winter 1939-40, the winter 1940-41 turned out to be very cold in Europe and Russia, although very mild in entire North America. The cold winter 1939-40 had well-known significant effects on the Finnish-USSR winter war, and it also forced the German Führer and Reichkansler Hitler to postpone his planned attack on France in November-December 1939, until May 1940 (Manstein 2004).

These cold winters came as a surprise for most meteorologists, as winters during the previous 10-15 years used to be much milder, and most climate scientists expected this warming trend to continue. This was only few years after Callendar (1938) published his work on atmospheric CO_2, thereby reviving the CO_2-temperature hypothesis originally proposed by the electrochemist Arrhenius (1896) and in 1918 put to rest by the geologist Chamberlain (Fleming 1998).

Nevertheless, the fact that also the winter 1940-41 turned out abnormally cold in Europe and Russia, eventually prompted Hitler to call for a climate workshop in Germany to evaluate the possible risk of experiencing third cold winter 1941-42 in Europe and Russia, as he rightfully feared that this would influence negatively on his plans for a successful, rapid war against USSR, supposed to be initiated in May or June 1941. The German climatologists correctly pointed out that the likelihood of having a third very cold winter in a row 1941-42 was extremely low, as this had never been seen before during the previous observational period.

However, because of the intense cold, when *Bismarck* on January 24, 1941, was ready for its return journey to the Baltic, the Nord-Ostsee-Kanal was blocked by ice. And worse, a ship transporting iron ore had recently sunk in the channel, blocking it entirely (Müllenheim-Rechberg 2005). Usually, German salvage teams would have been able to remove the sunken ship rapidly, but the severe ice conditions made this work extremely difficult. Captain Lindemann therefore applied for permission to take his ship around Jutland (Denmark) instead, but the German Naval High Command estimated the risks by this crossing to be too high, and ordered Lindemann to remain with *Bismarck* in Hamburg until the Nord-Ostsee-Kanal again was clear.

On February 5, 1941, the Nord-Ostsee-Kanal was declared open, and *Bismarck* immediately prepared to leave harbour. Then the message arrived that the Nord-Ostsee-Kanal was still blocked by ice, and in addition, it turned out that due to the intense cold while lying inoperative in Hamburg, a number of water tubes and conduits were frozen and damaged. Especially in the boiler rooms all water tubes, pressure gauges and water level instruments turned out to be destroyed by freezing when mounted near the opening of ventilators, which had been feeding below-freezing outside air into the rooms (Whitley 2007). So *Bismarck* now had to remain in Hamburg for even longer, much to Captain Lindemann’s despair. On February 16 the frost repair works were completed, but the Nord-Ostsee-Kanal was still blocked, as the cold weather continued.

First on March 6, 1941, *Bismarck* was able to leave Hamburg, and the ship then finally arrived safely in Kiel on March 8, delayed for almost one and a half month because of the harsh winter conditions.

Bismarck spend a few days in Kiel, to take on board provisions, fuel, ammunitions and two of the battleships planned four airplanes. Then the ship proceeded east to Gotenhafen (now Gedynia, Poland) in East Pommeren, where it would have its base during the final sea trials. However, because of the heavy sea ice still covering the western Baltic Sea in March 1941, and to avoid ice damage to its propellers, *Bismarck* had to follow the old warship *Schlesien*, which now by the German navy was used as an icebreaker (Müllenheim-Rechberg 2005). *Schlesien* was not exactly a rapid ship by 1941 standards, neither did the sea ice add to its speed, so it was first in the afternoon of March 17, 1941, that *Bismarck* finally arrived in Gotenhafen.

These different temperature-induced delays were later to have their serious effects on the coming operations of *Bismarck*. Instead of being able to leave early in 1941 on its planned North Atlantic raid 'Rheinübung' (Rhine Exercise), at a time where northern nights still were long and dark, this operation had to be postponed considerably. When 'Rheinübung' eventually was carried out in late May 1941, the northern nights were short and providing only little visual protection for a ship attempting unseen to break out in the open Atlantic ocean south of Iceland.

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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,

Ole Humlum (Ole.Humlum@geo.uio.no)

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