Climate4you update May 2012

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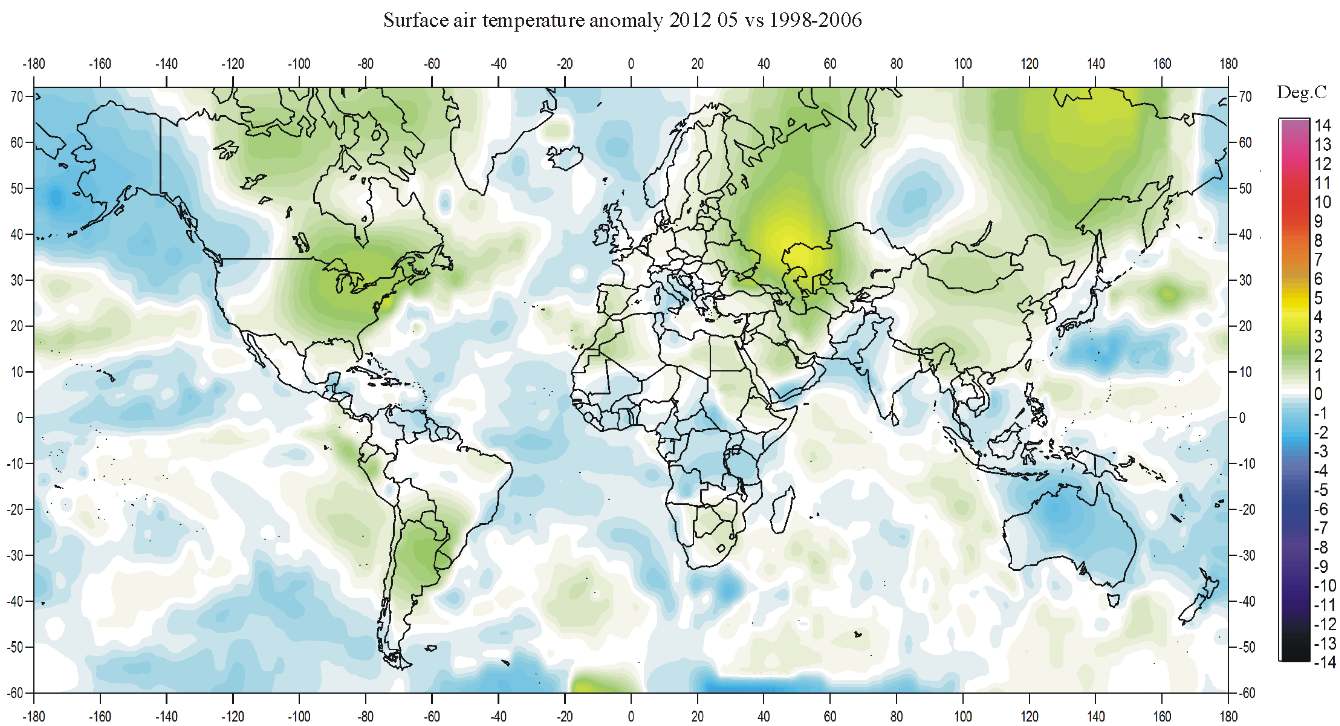
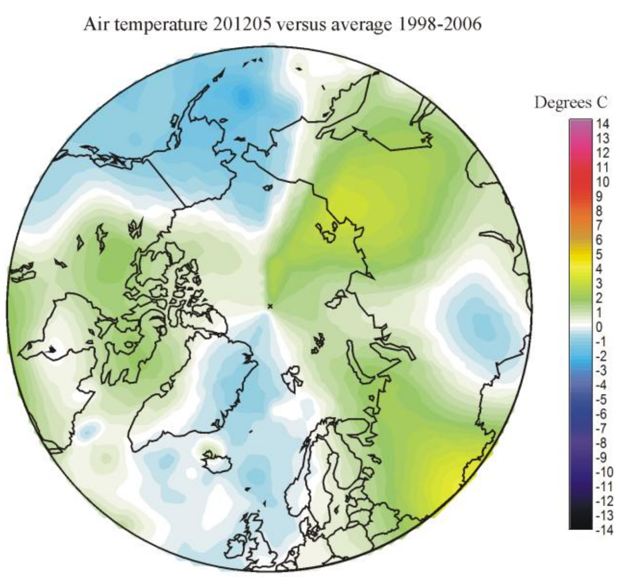
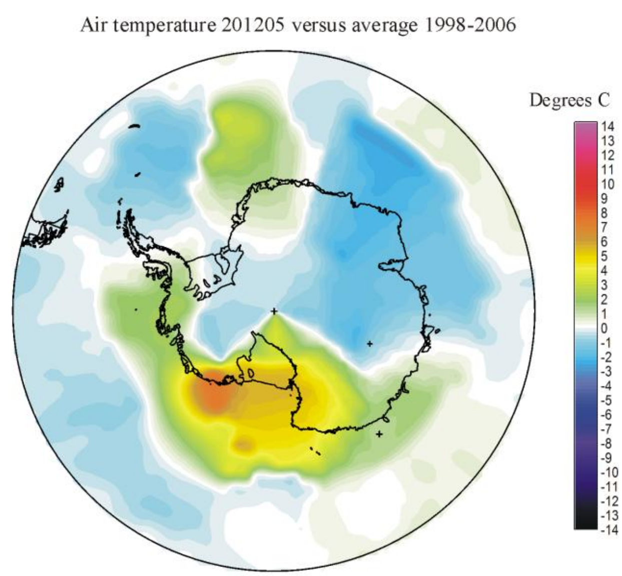
May 2012 global surface air temperature overview







May 2012 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 May 2012 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 grater detail on www.Climate4you.com.

May 2012 average global surface air temperatures

General: Global air temperatures were close to average for the period 1998-2006. Several land areas were somewhat warmer than average, while many ocean regions were below.

The Northern Hemisphere was characterised by relatively high regional variability. Northern and western Europe was relatively cold, as was most of the Northern Atlantic and northern Pacific. Eastern Siberia, western Russia and eastern North America experienced relatively warm conditions. Western Siberia and especially Alaska and parts of western Canada were cold. The Arctic had regions somewhat above as well as below the 1998-2006 average. However, the distribution of temperatures to a high degree reflect the sparse number of observations in the central part of the Arctic, and the GISS procedure of extrapolating temperatures measured at lower latitudes to high latitudes.

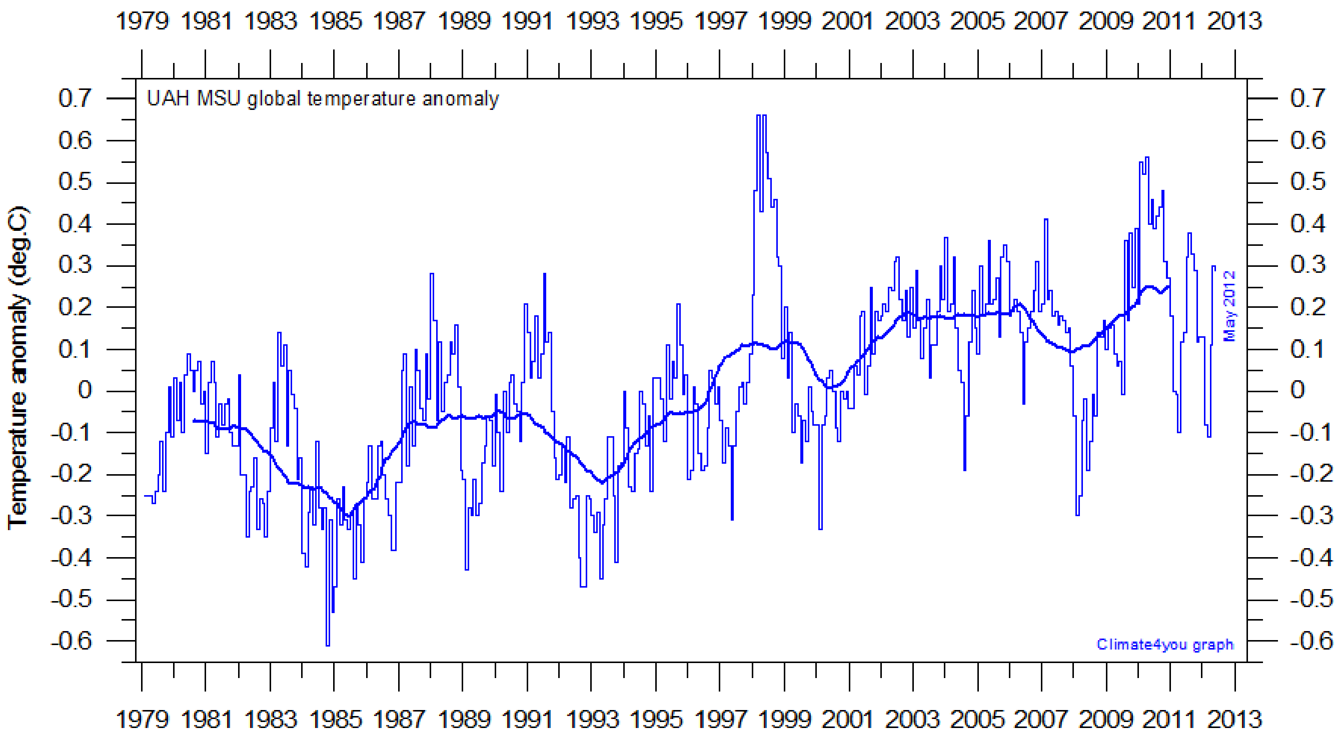
Near Equator temperatures conditions in general were at or below average 1998-2006 temperature conditions, both for land and ocean.

The Southern Hemisphere was below or near average 1998-2006 conditions. No extensive land areas experienced temperatures above the 1998-2006 average, with the exception of northern Argentina. Especially central Africa and Australia had below average temperatures. Most of the oceans in the Southern Hemisphere were near or below average temperature. An El Niño situation is still in progress along the west coast of South America, and the influence of this is recorded by the global temperature. Most of the Antarctic continent experienced below average 1998-2006 temperatures, although a large region centred on the Ross Sea had above average temperatures.

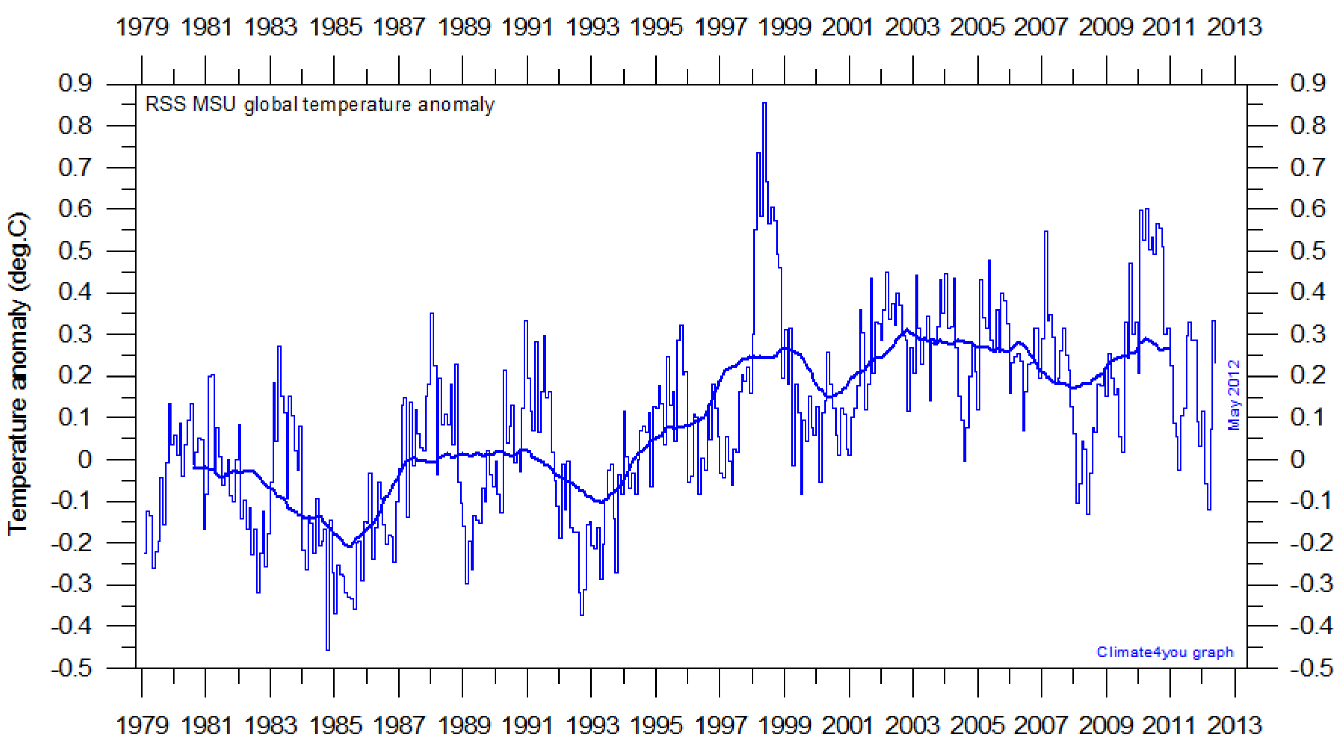
The global oceanic heat content has been almost stable since 2003/2004 (page 10).

All diagrams shown in this newsletter and links to original data are available on www.climate4you.com

Lower troposphere temperature from satellites, updated to May 2012

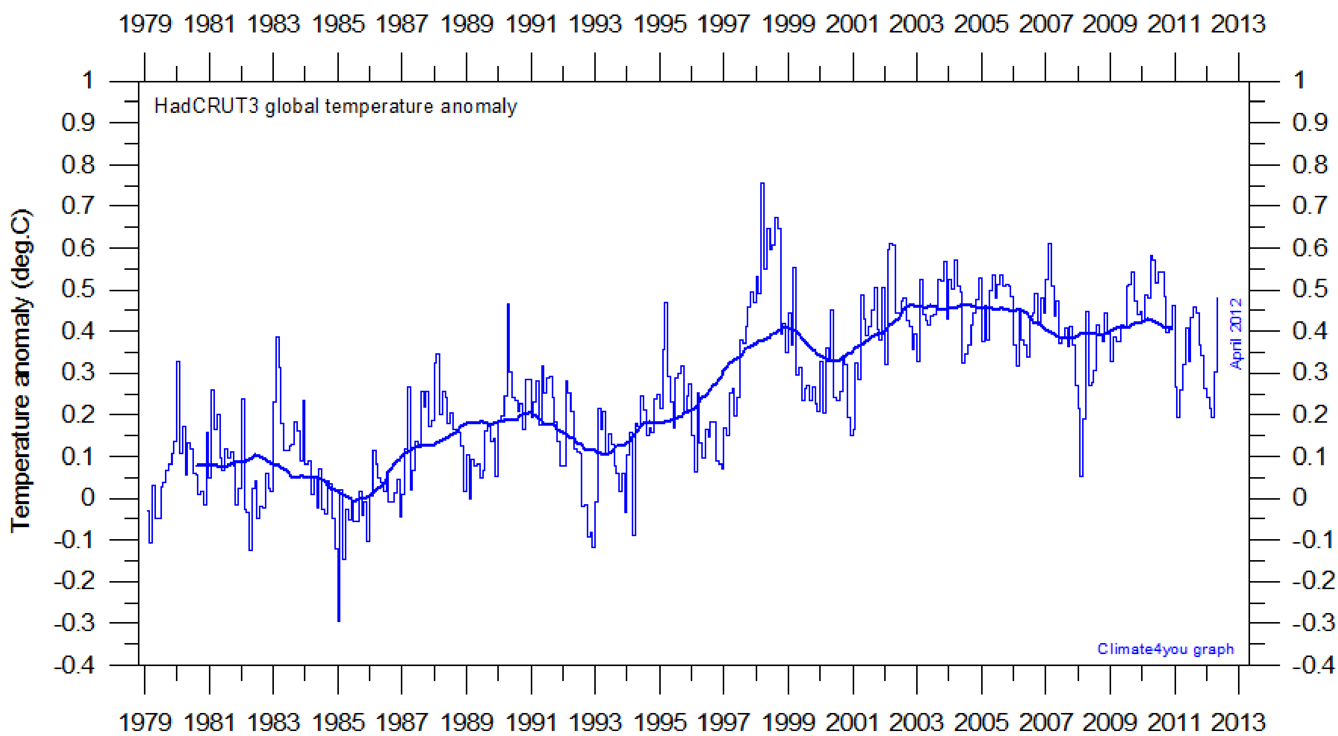


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37 month average.

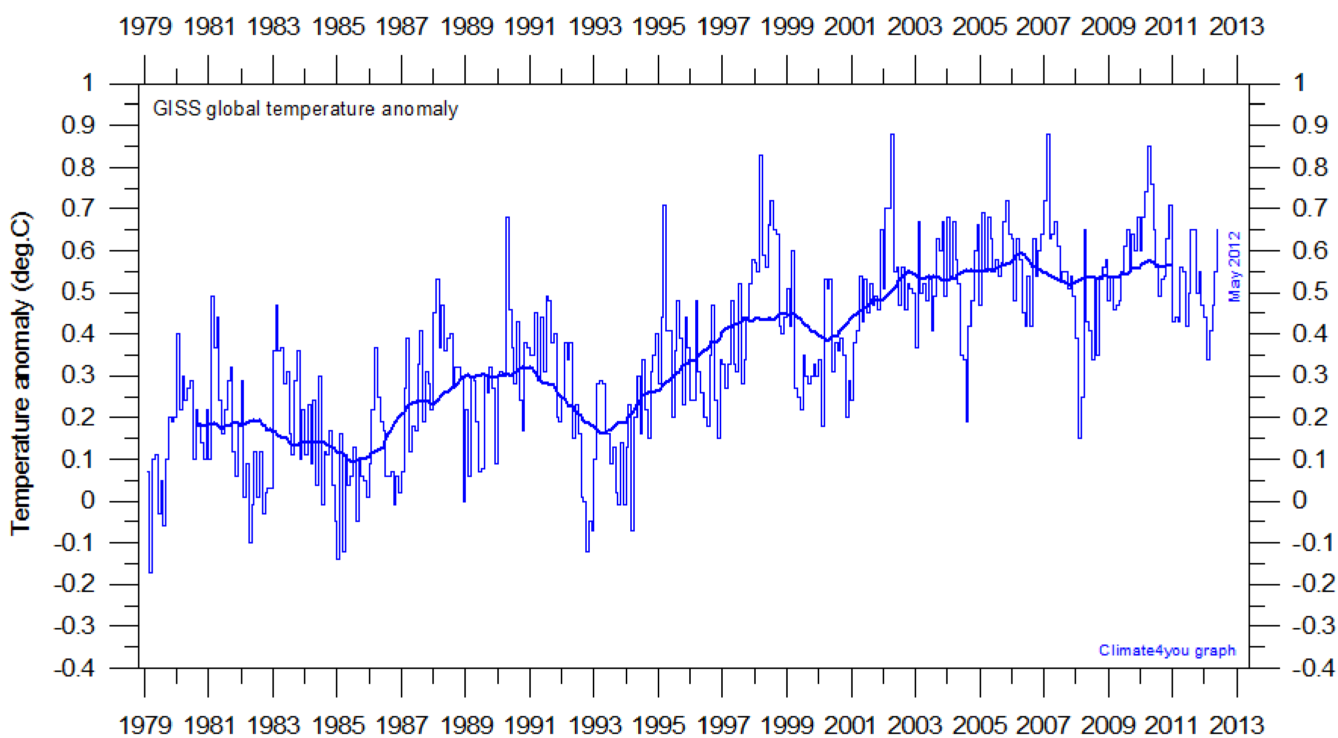


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37 month average.

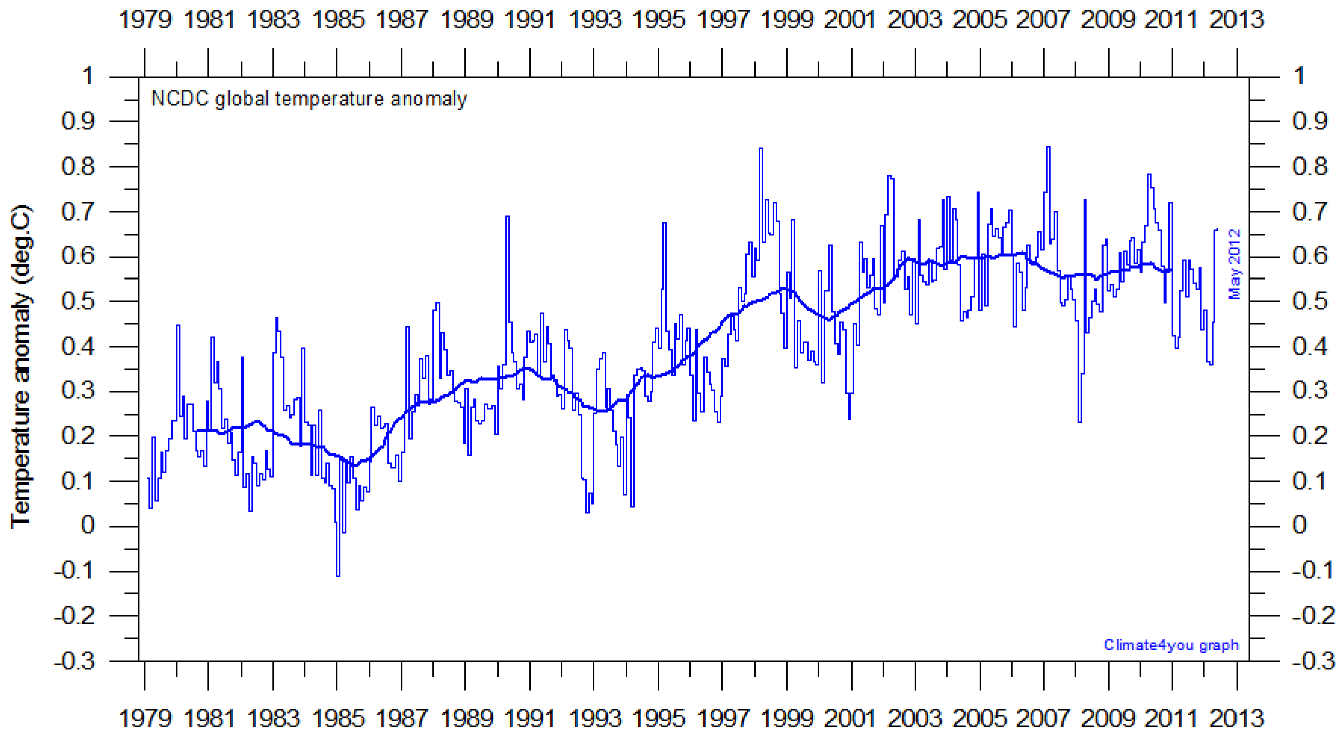
Global surface air temperature, updated to May 2012



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. Please note that this diagram has not been updated beyond April 2012.



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.

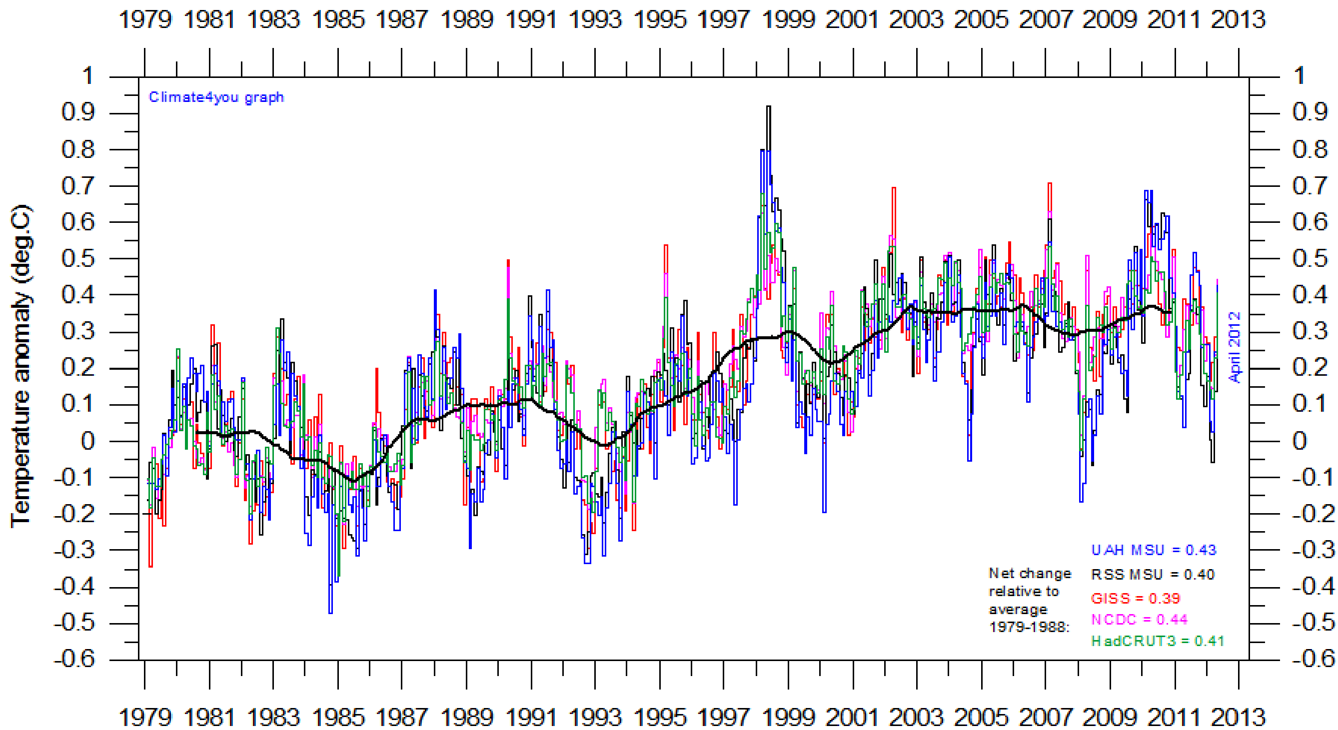
A note on data record stability:

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

Of the five global records shown above the most stable temperature record seen over time (since 2008) is by far the HadCRUT3 series.

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*).

All in one, updated to April 2012

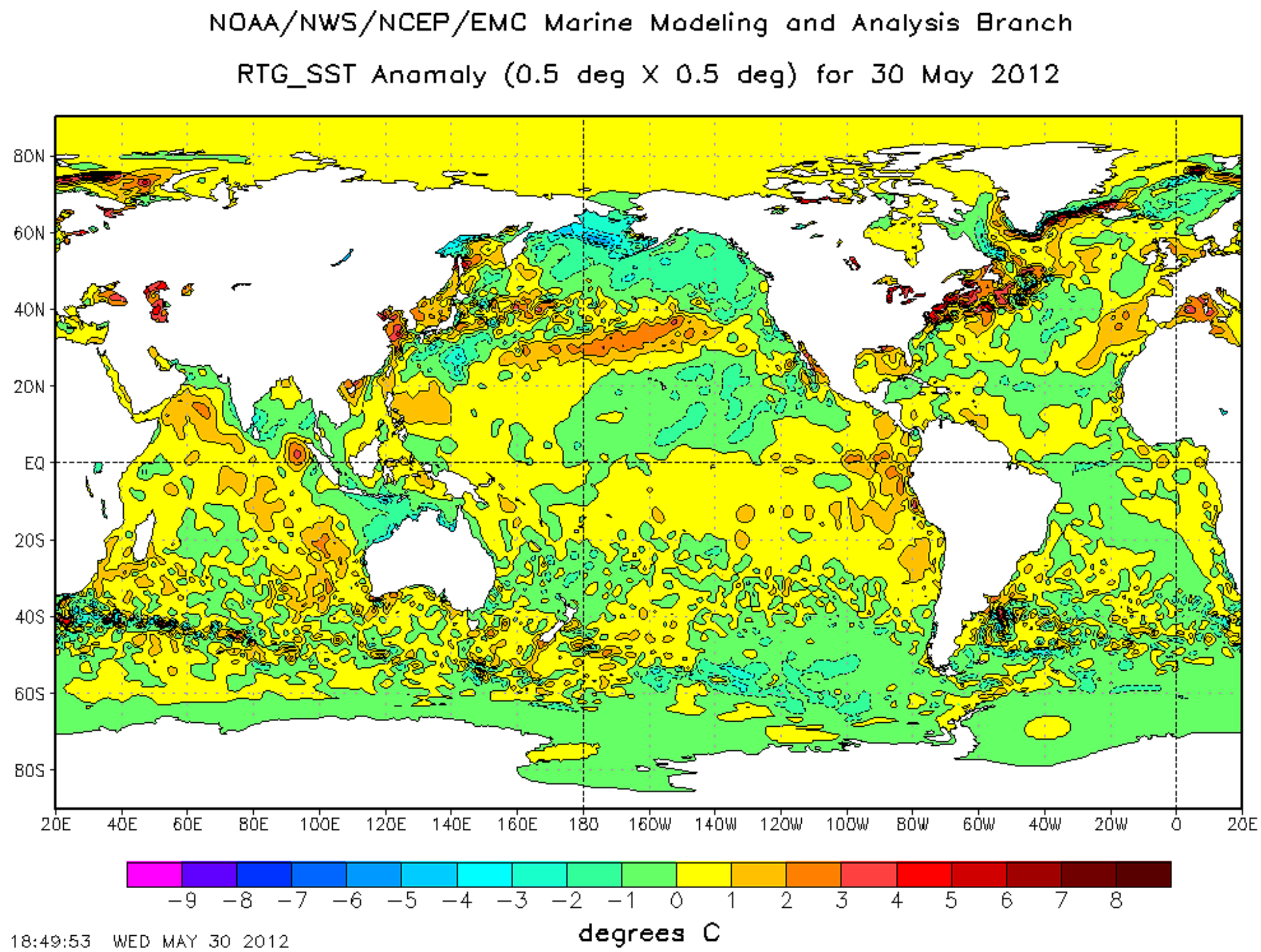


Superimposed plot of all five global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (10 years) from January 1979 to December 1988. The heavy black line represents 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 May 2012

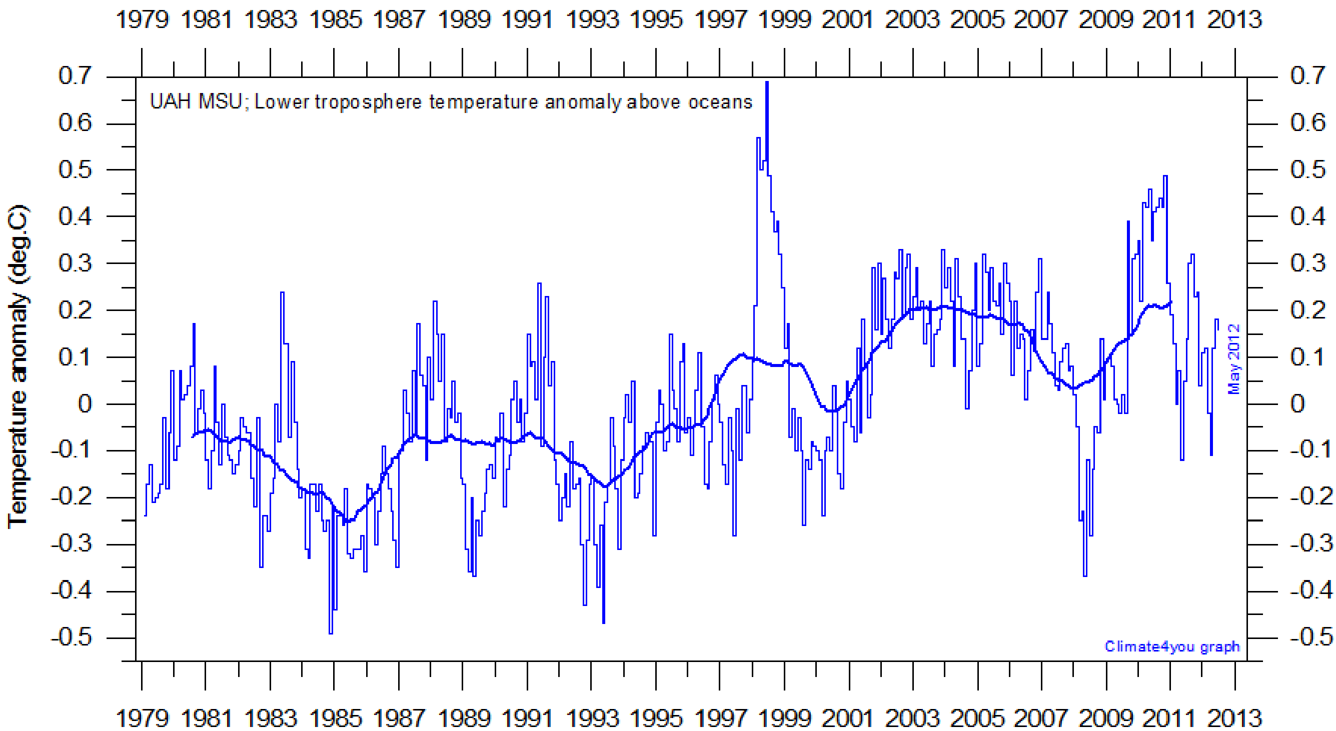


Sea surface temperature anomaly at 30 May 2012. Map source: National Centers for Environmental Prediction (NOAA).

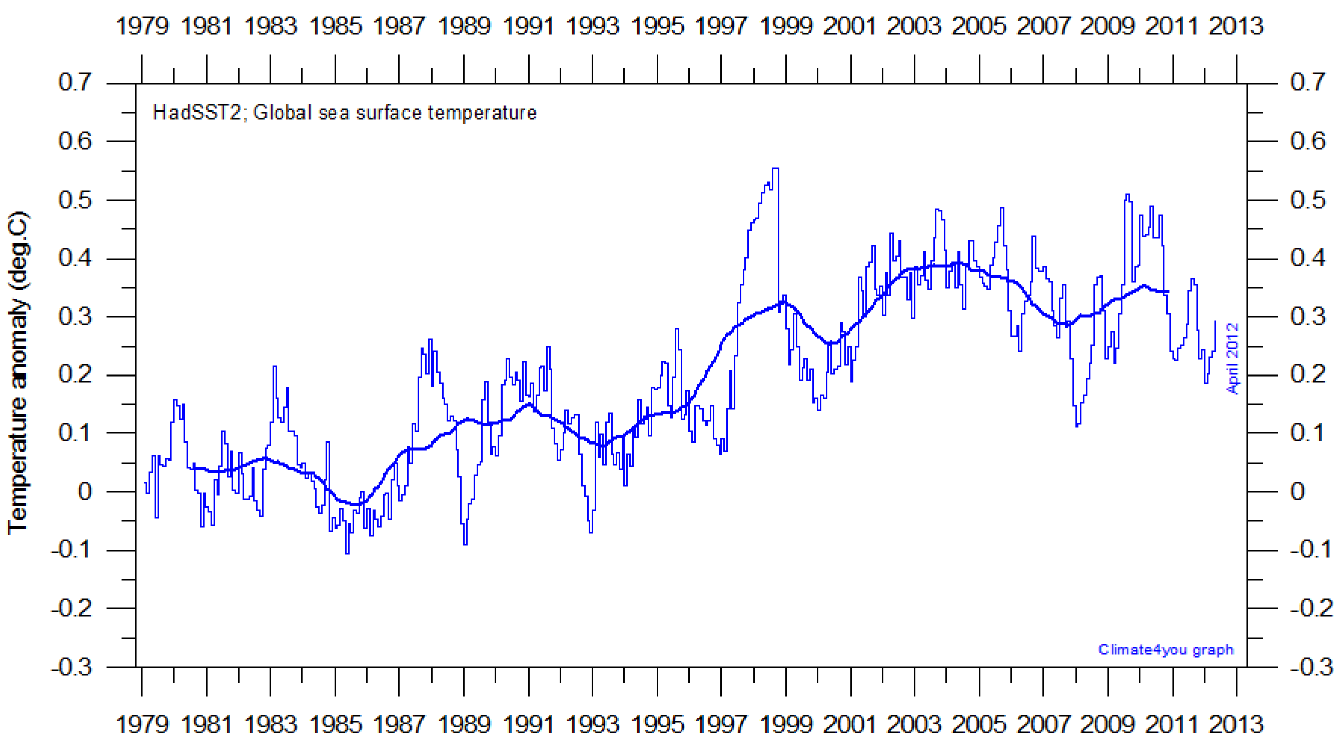
Relative warm sea surface water now dominates the ocean regions near Equator, especially in the Indian Ocean and in the Pacific. Because of the large surface areas involved especially near Equator, the temperature of the surface water in these regions significantly affects the global atmospheric temperature.

An El Niño episode is unfolding along the west coast of South America, and the effect of this is now clearly seen in the global air temperature estimates (p.3-5).

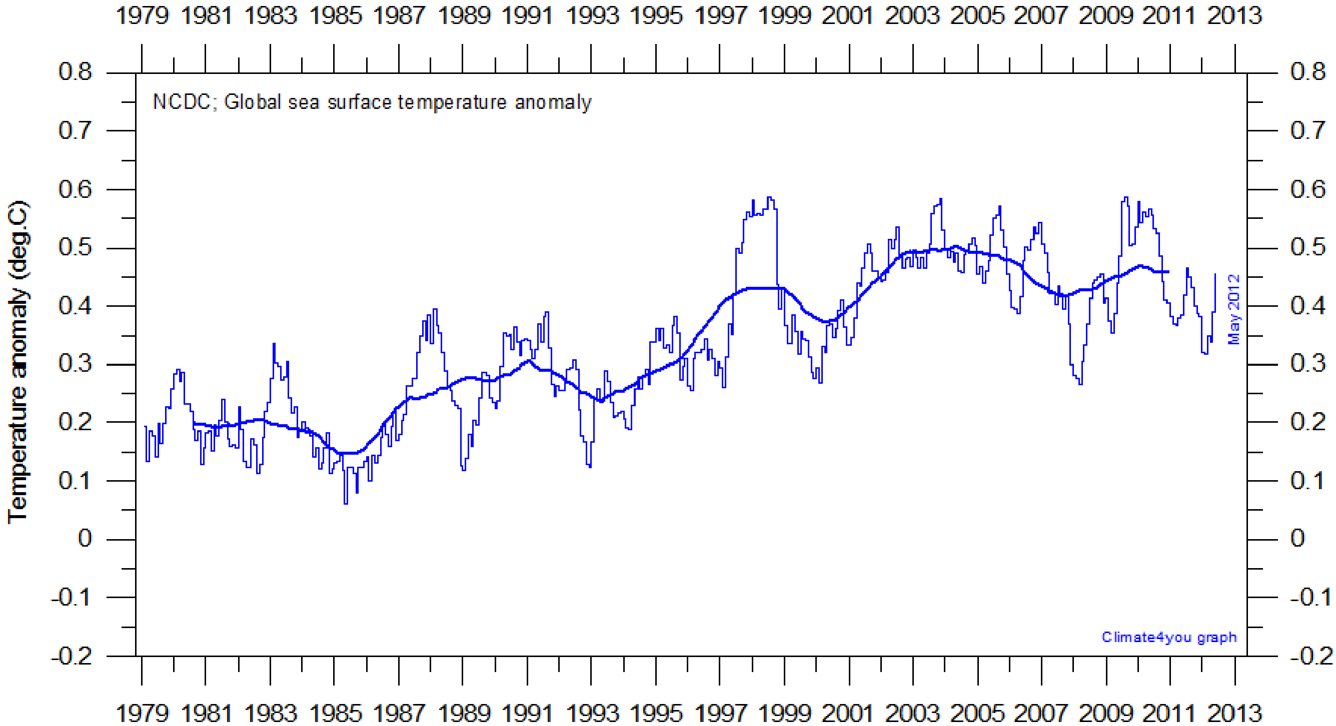
The significance of such short-term warming or cooling seen in air temperatures should not be over stated. Whenever Earth experiences cold La Niña or warm El Niño episodes (Pacific Ocean) major heat exchanges takes place between the Pacific Ocean and the atmosphere above, eventually showing up in estimates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

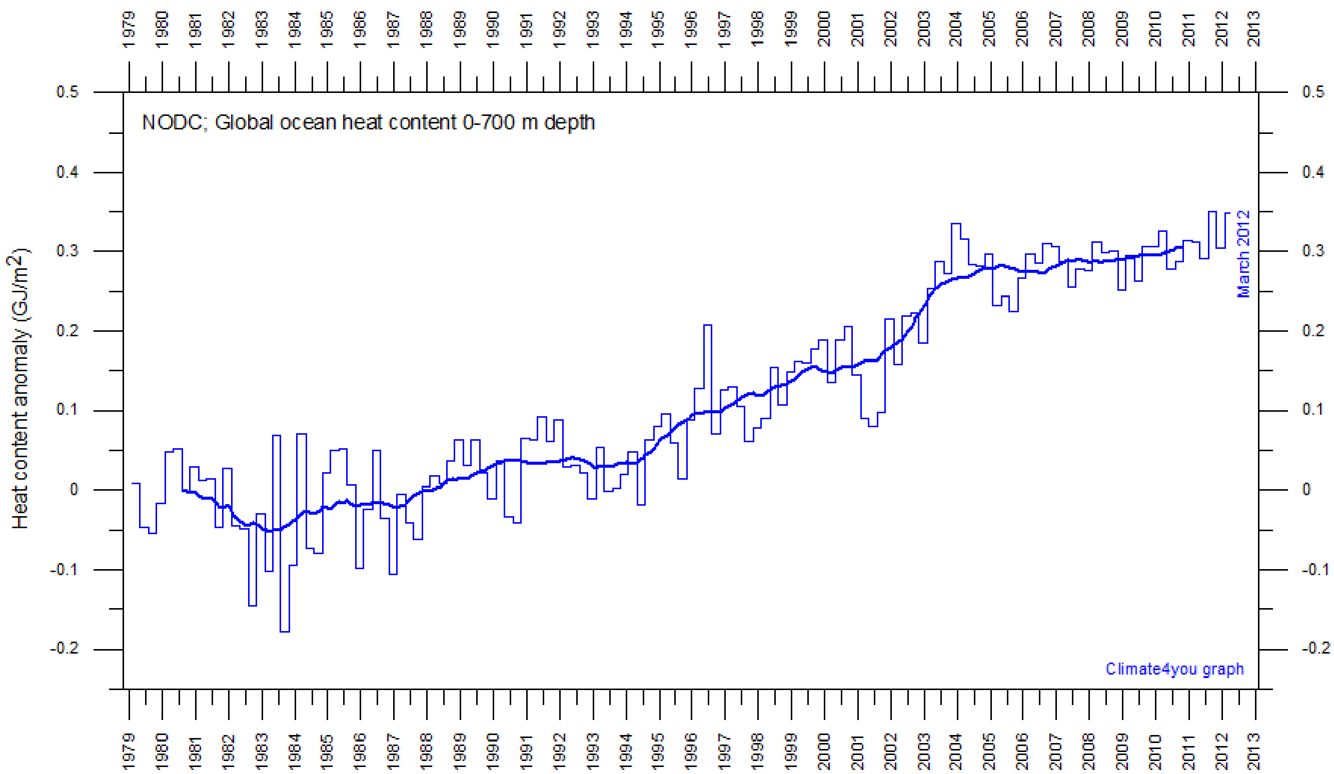


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit](#) ([CRU](#)), UK. Base period: 1961-1990. The thick line is the simple running 37 month average. Please note that no update beyond April 2012 is available at the moment.

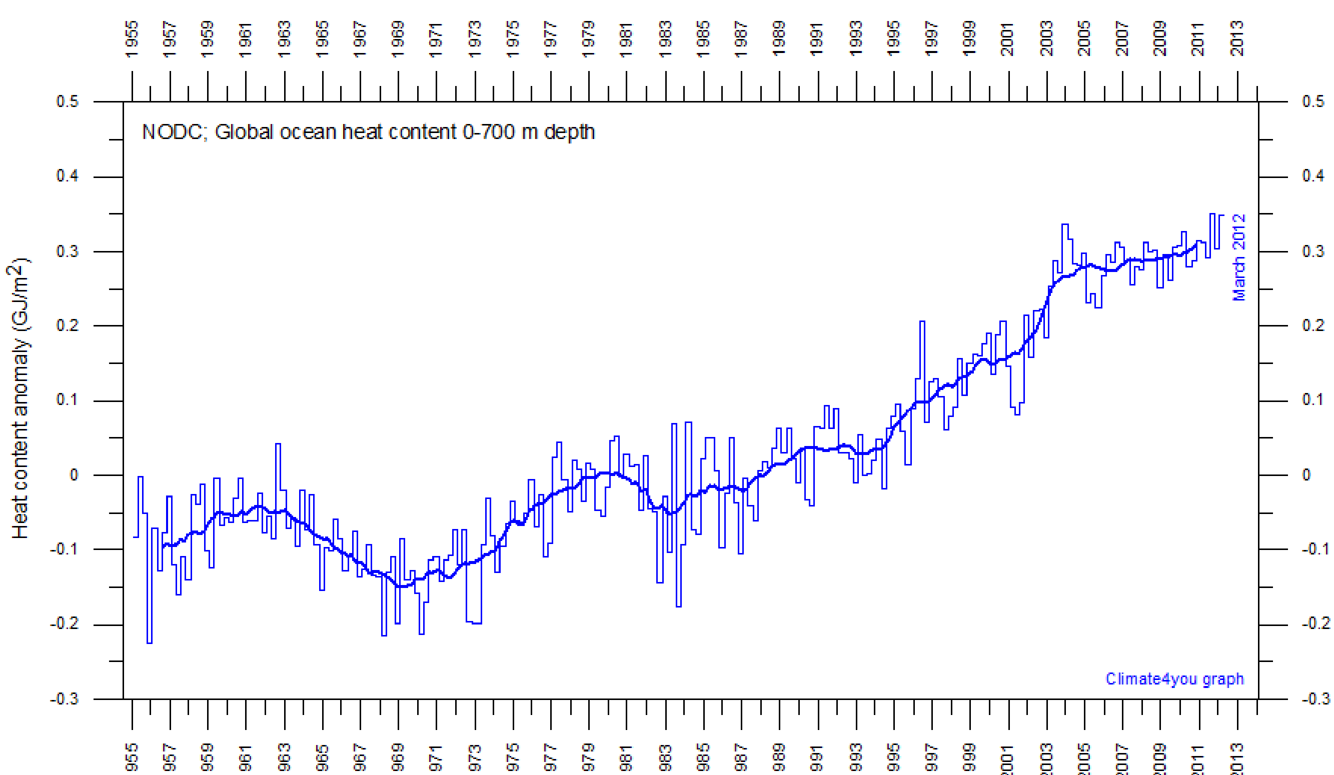


Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center](#) (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37 month average.

Global ocean heat content, updated to March 2012

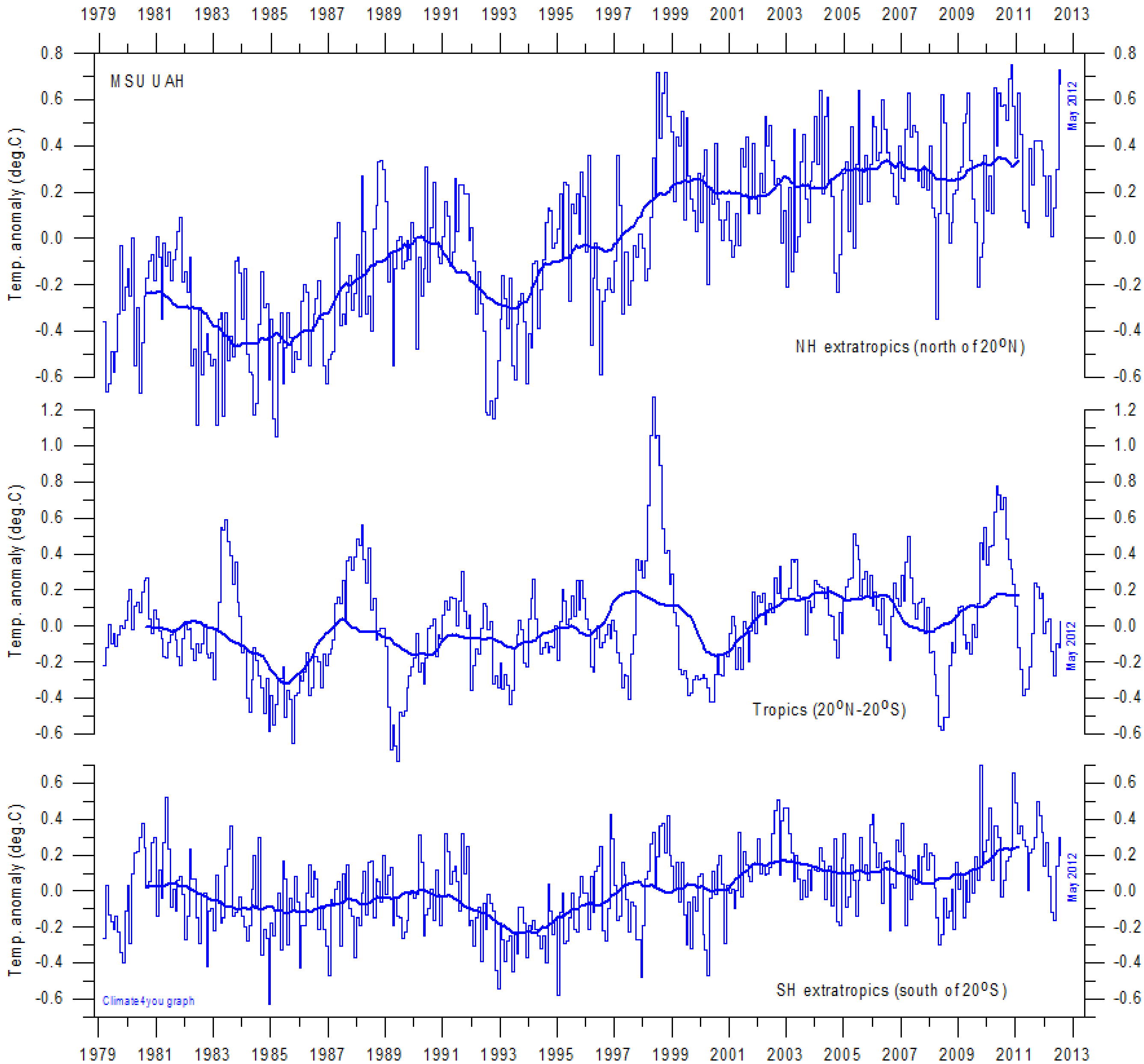


Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



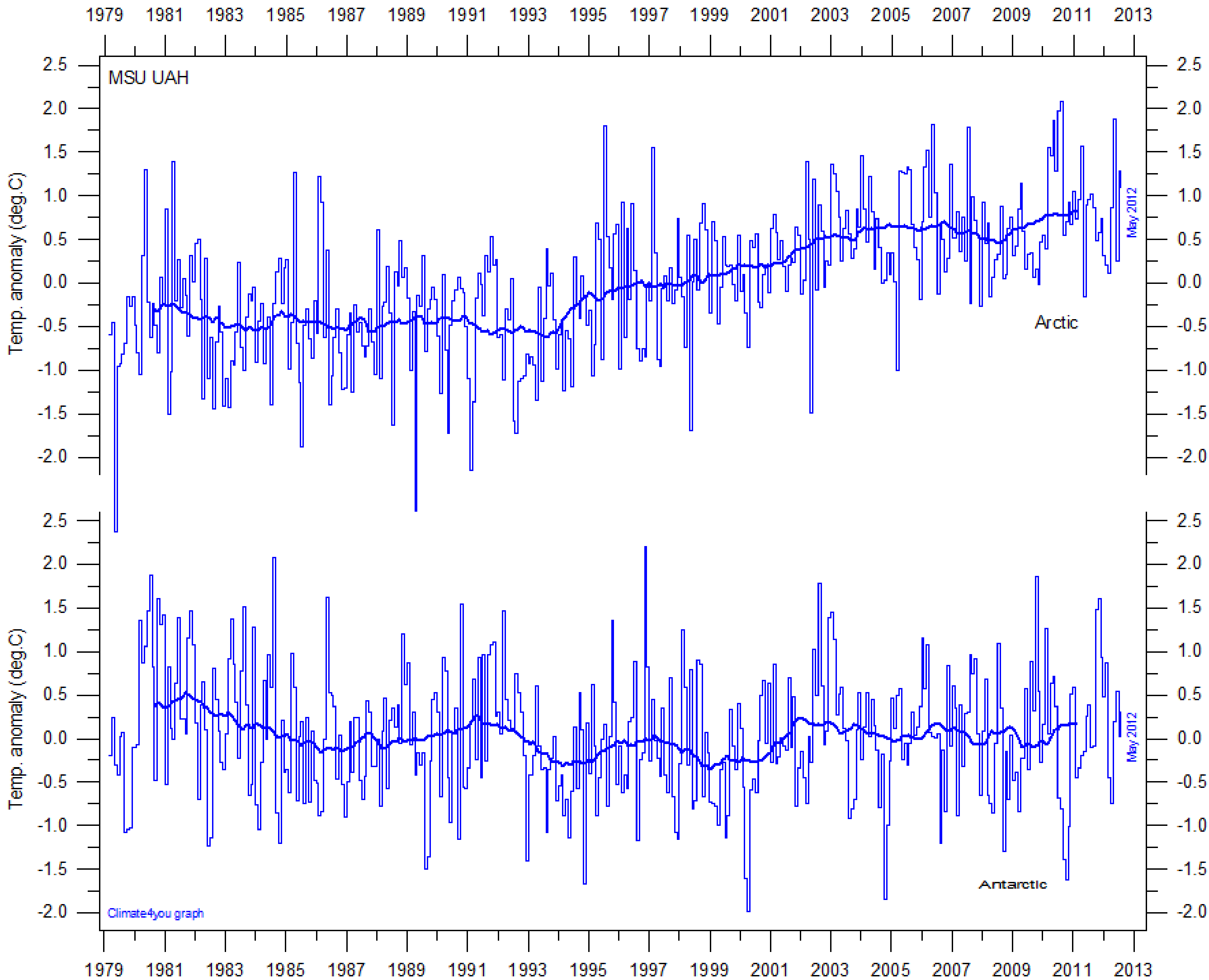
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1955. Data source: National Oceanographic Data Center(NODC).

Zonal air temperatures, updated to May 2012



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 May 2012



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 March 2012

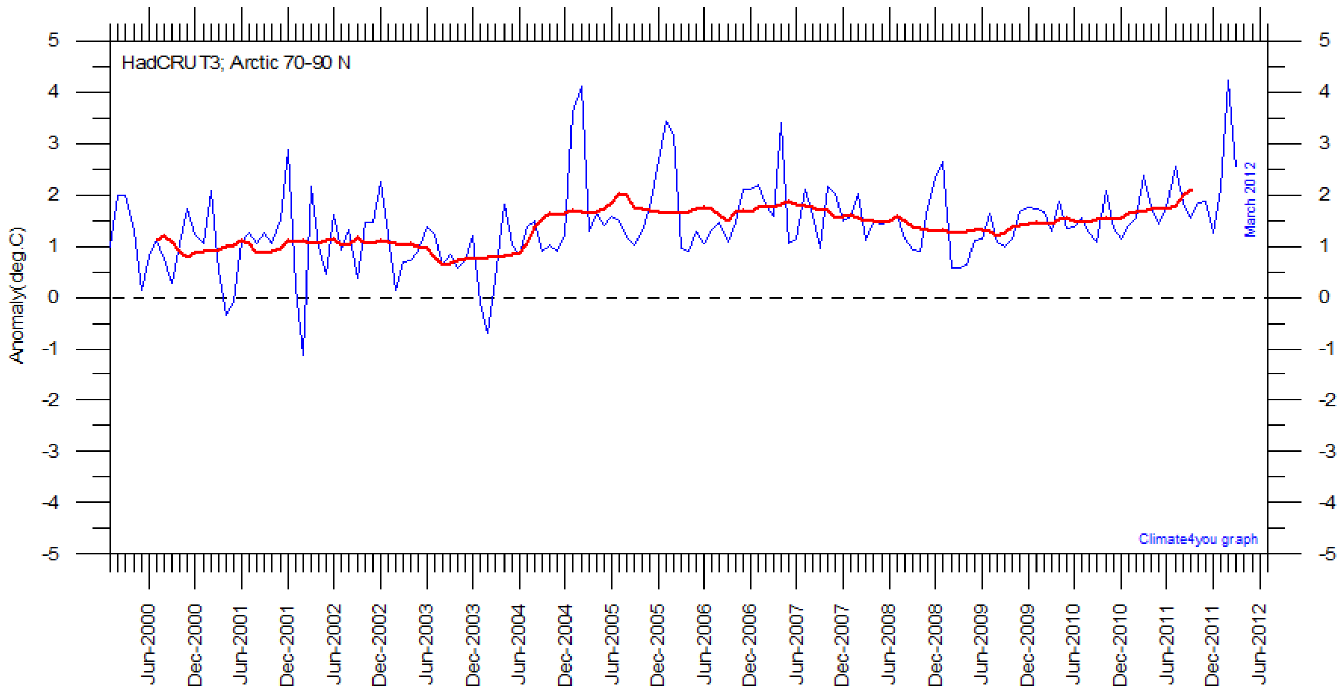


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK.

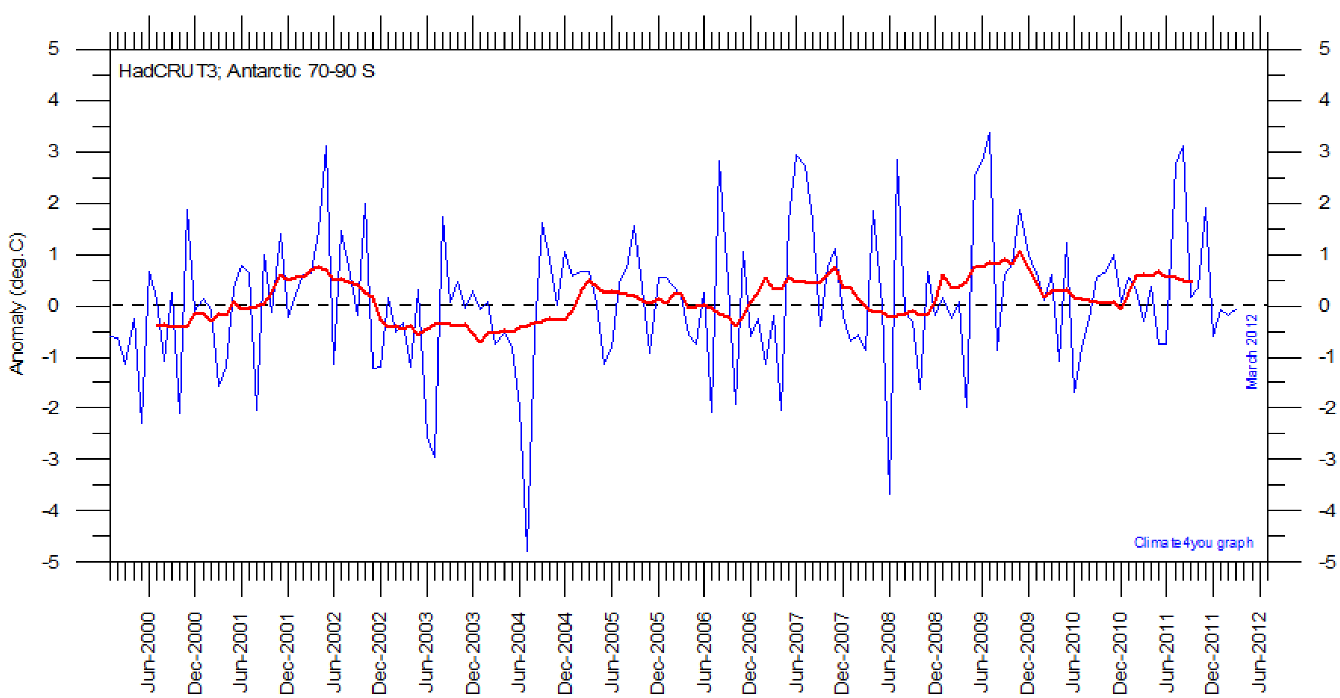


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK.

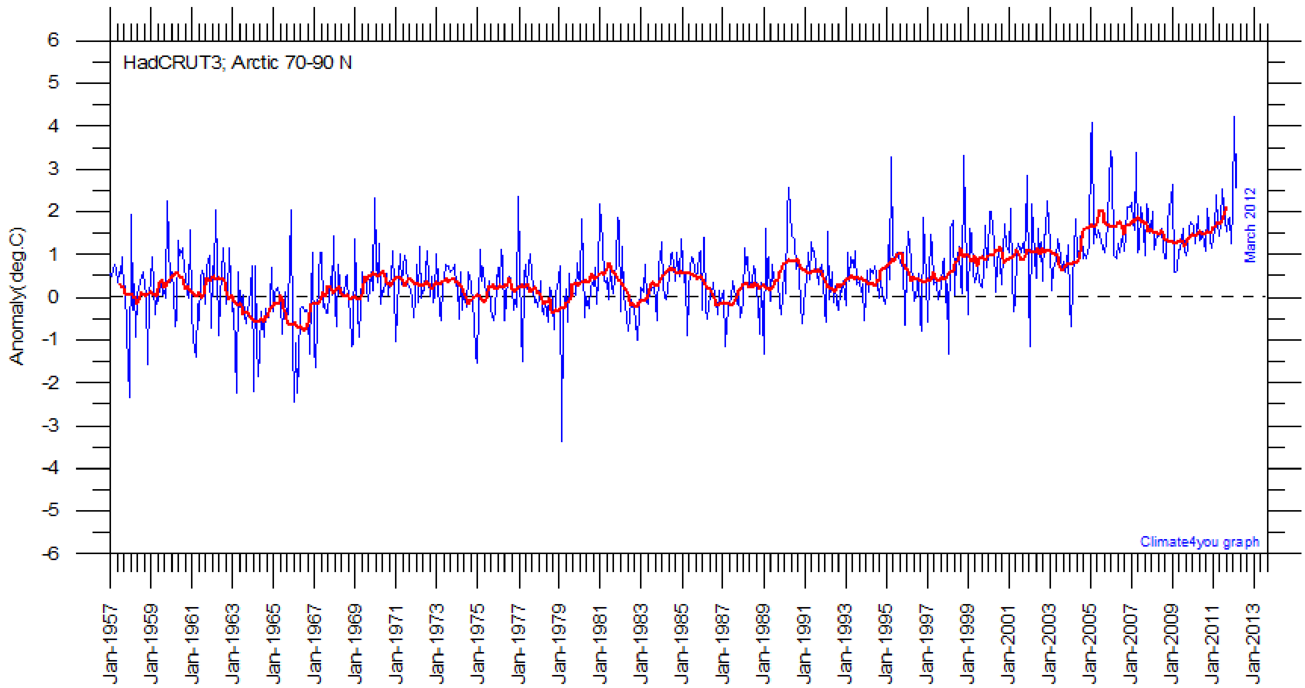


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 has been chosen as starting year, to ensure easy comparison with the maximum length of the realistic Antarctic temperature record shown below. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK.

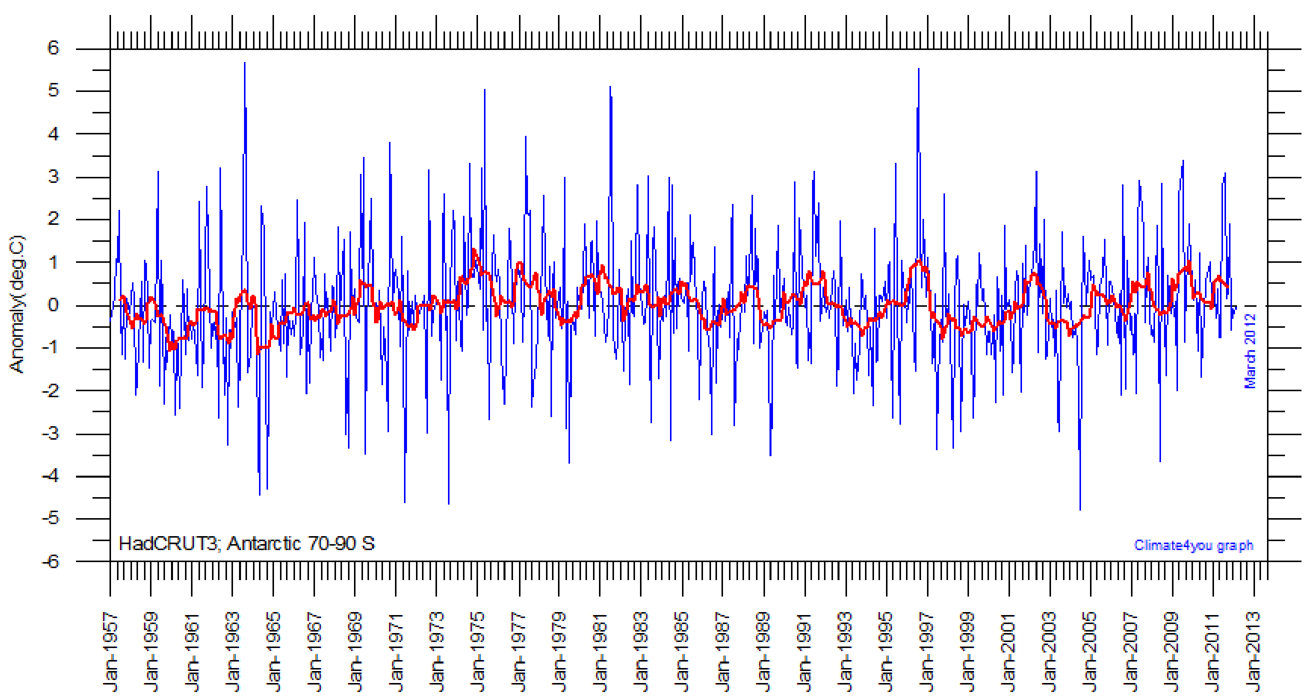


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 was an international geophysical year, and several meteorological stations were established in the Antarctic because of this. Before 1957, the meteorological coverage of the Antarctic continent is poor. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK.

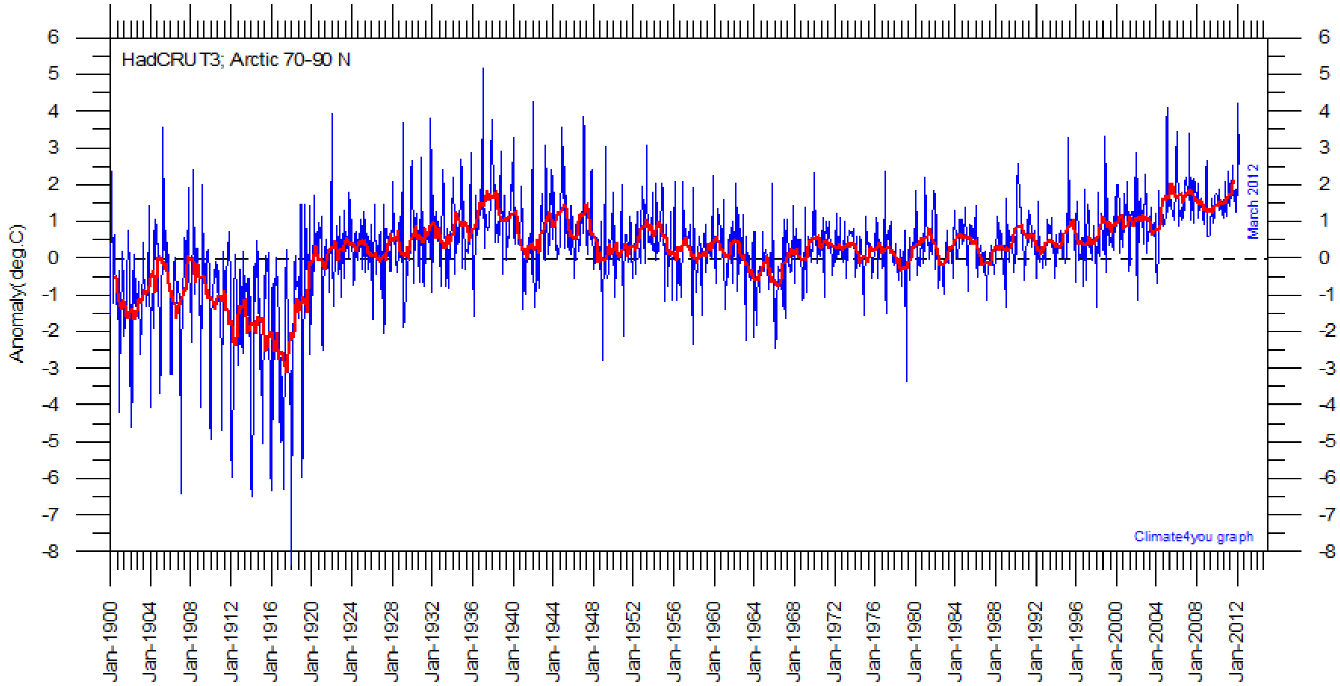


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1900, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. In general, the range of monthly temperature variations decreases throughout the first 30-50 years of the record, reflecting the increasing number of meteorological stations north of 70°N over time. Especially 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. Because of the relatively small number of stations before 1930, details in the early part of the Arctic temperature record should not be over interpreted. The rapid Arctic warming around 1920 is, however, clearly visible, and is also documented by other sources of information. The period since 2000 is warm, about as warm as the period 1930-1940. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK

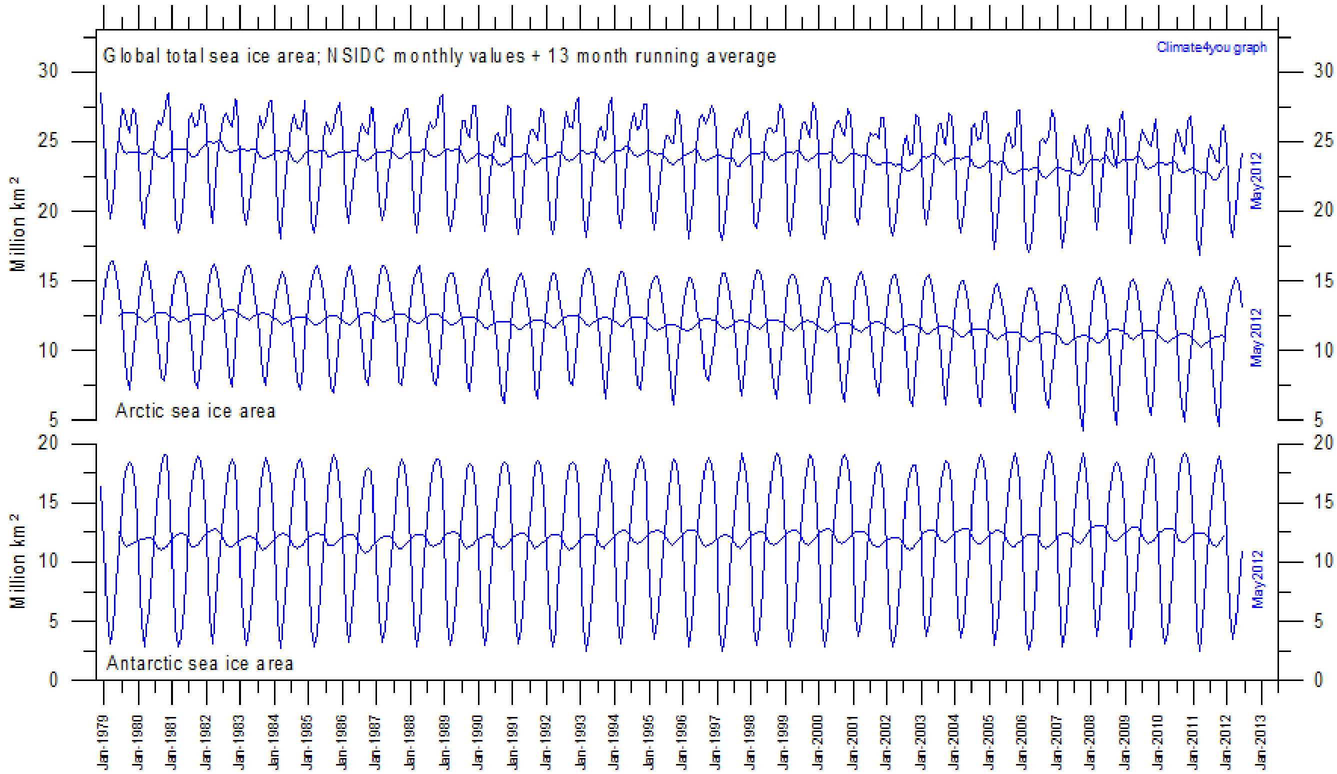
In general, the Arctic temperature record appears to be less variable than the Antarctic record, presumably at least partly due to the higher number of meteorological stations north of 70°N, compared to the number of stations south of 70°S.

As data coverage is sparse in the Polar Regions, the procedure of Gillet et al. 2008 has been followed, giving equal weight to data in each 5°x5° grid cell when calculating means, with no weighting by the surface areas of the individual grid dells.

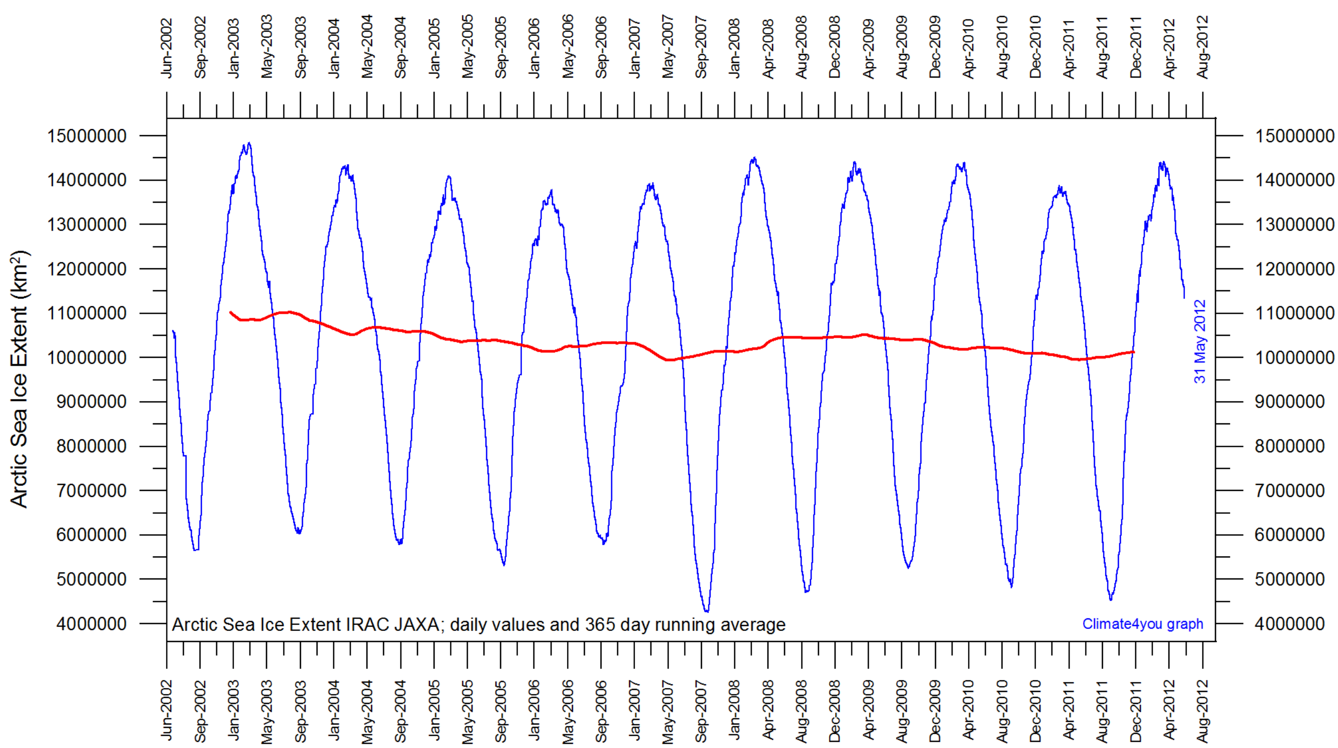
Literature:

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.

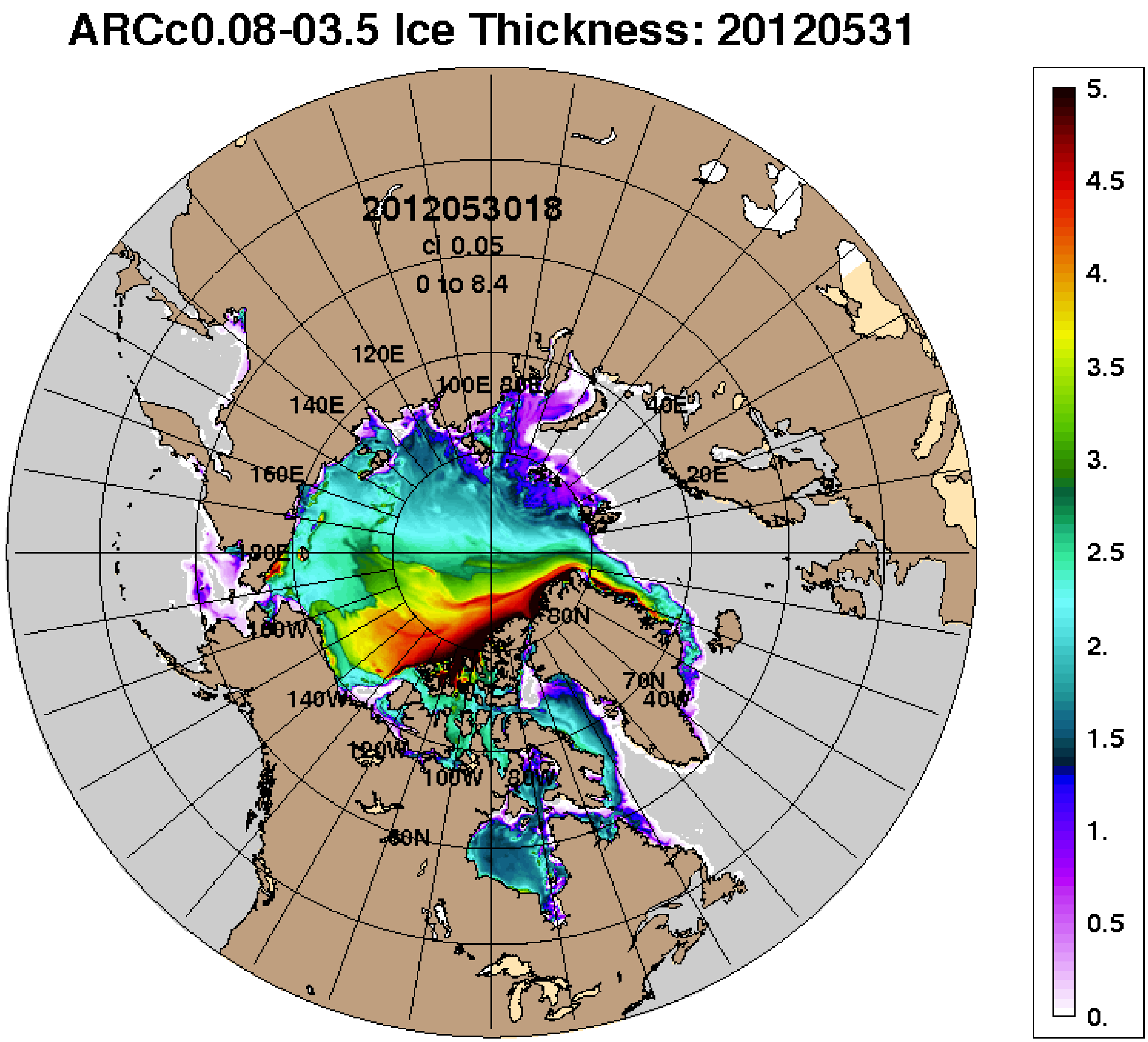
[Arctic and Antarctic sea ice, updated to May 2012]



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

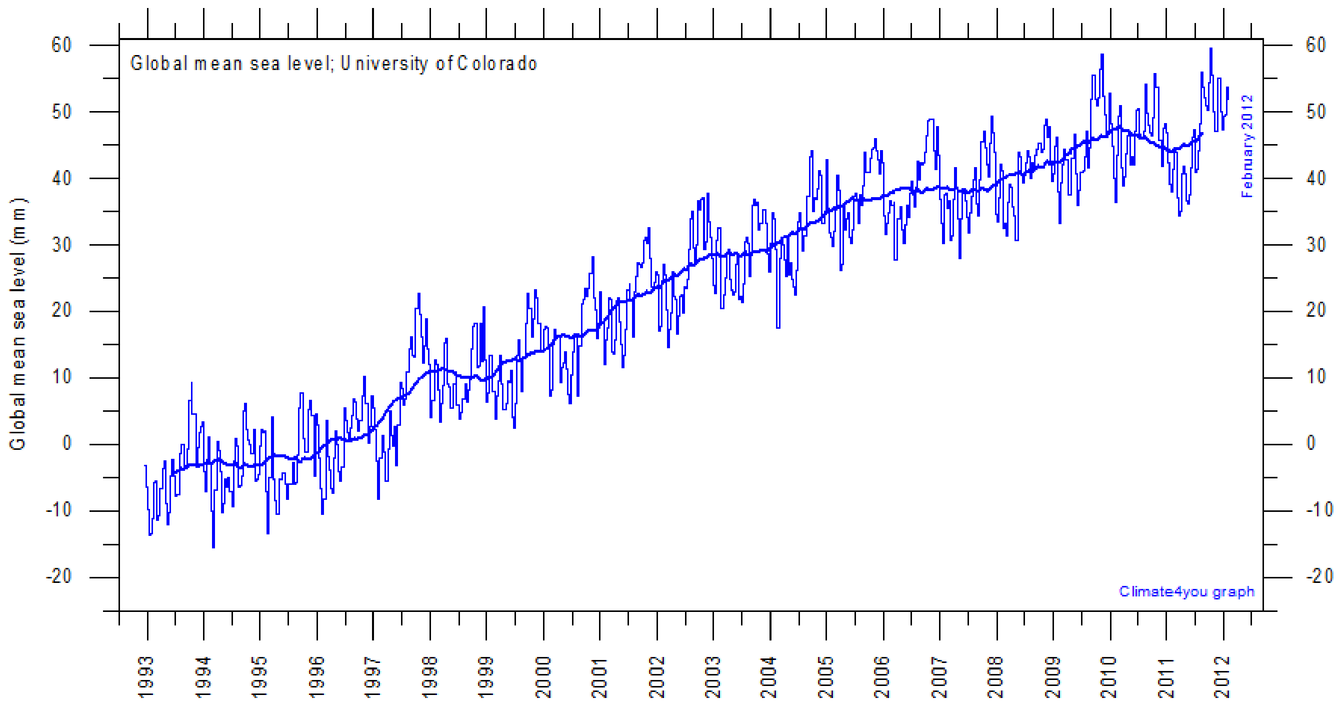


Graph showing daily Arctic sea ice extent since June 2002, to May 31, 2012, by courtesy of [Japan Aerospace Exploration Agency] (JAXA).

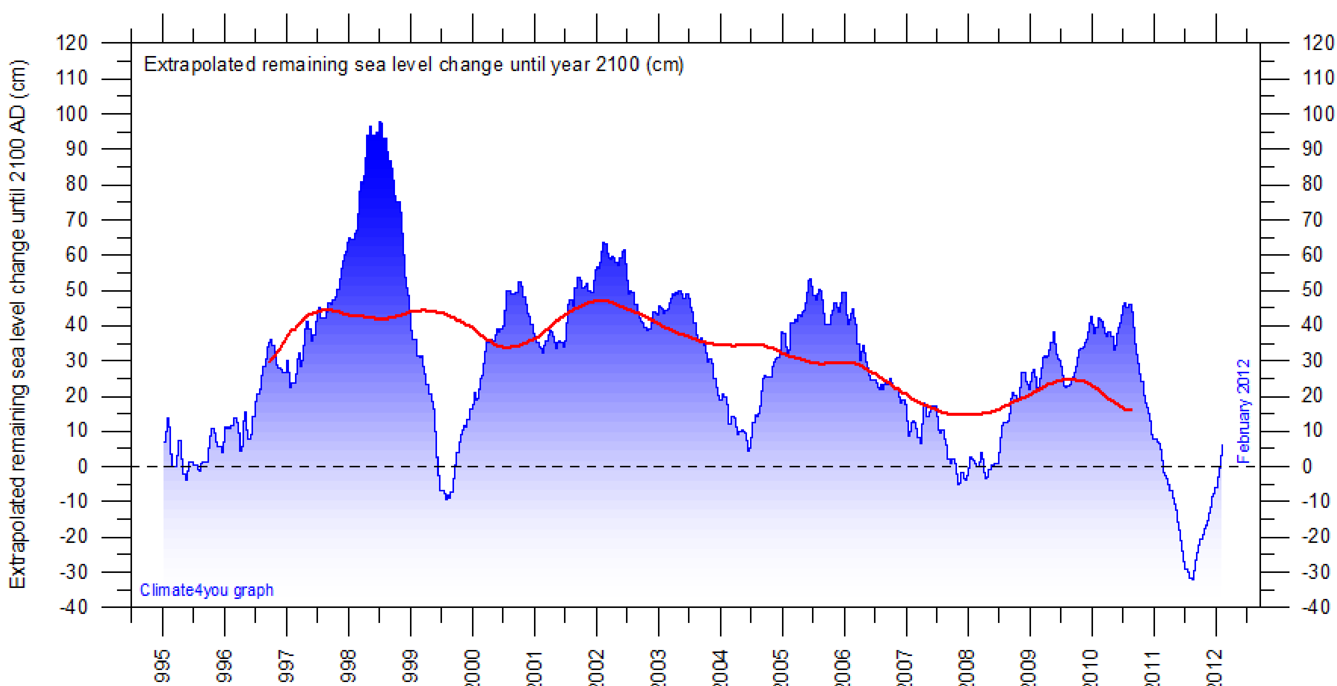


Northern hemisphere sea ice extension and thickness on 31 May 2012 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) is shown to the right.

Global sea level, updated to February 2012

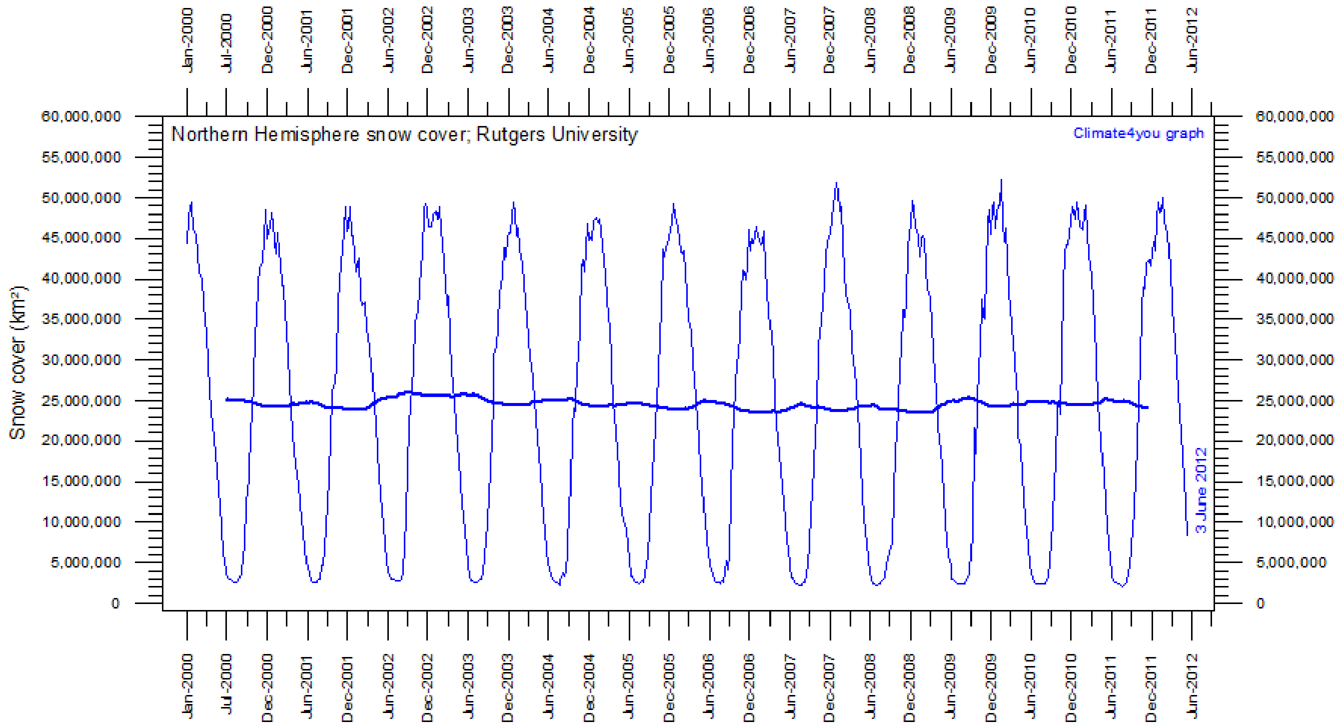


Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

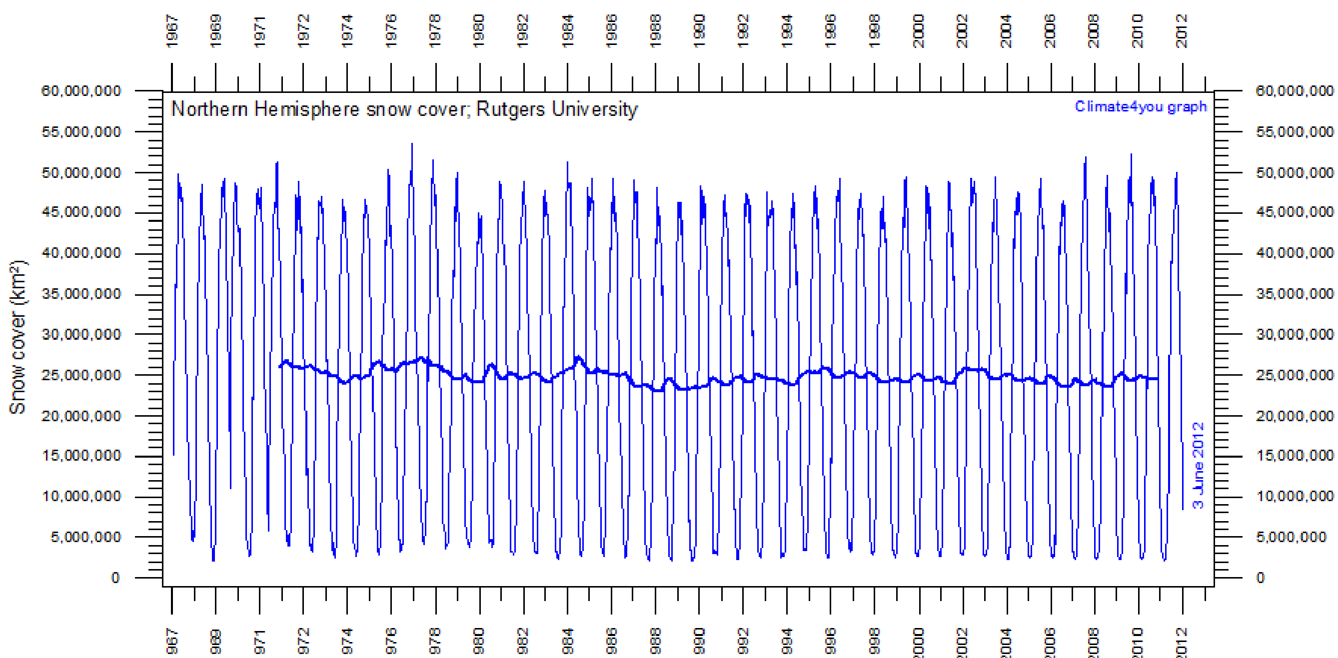


Forecasted change of global sea level until year 2100, based on simple extrapolation of measurements done by the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 3 yr average forecast for sea level change until year 2100. Based on this (thick line), the present simple empirical forecast of sea level change until 2100 is about +18 cm.

Northern Hemisphere weekly snow cover, updated to early June 2012

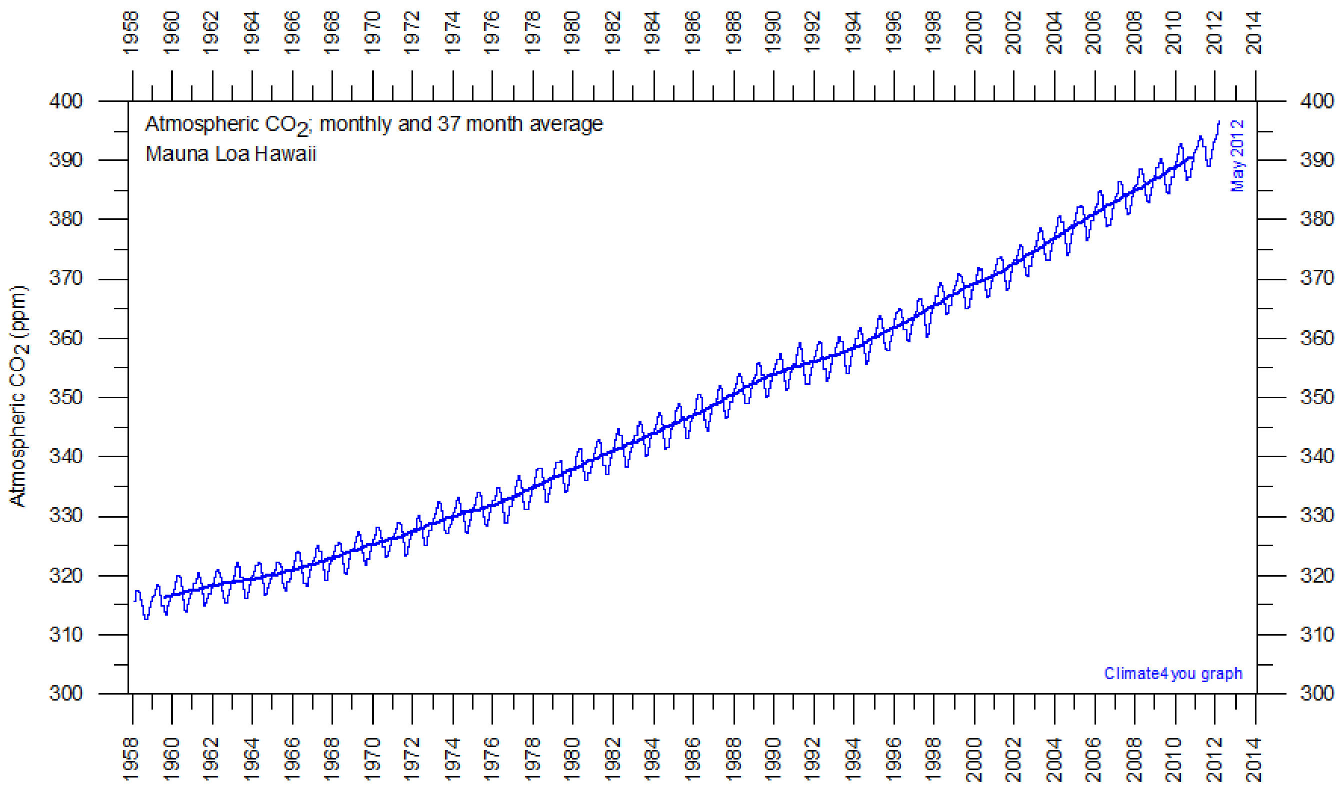


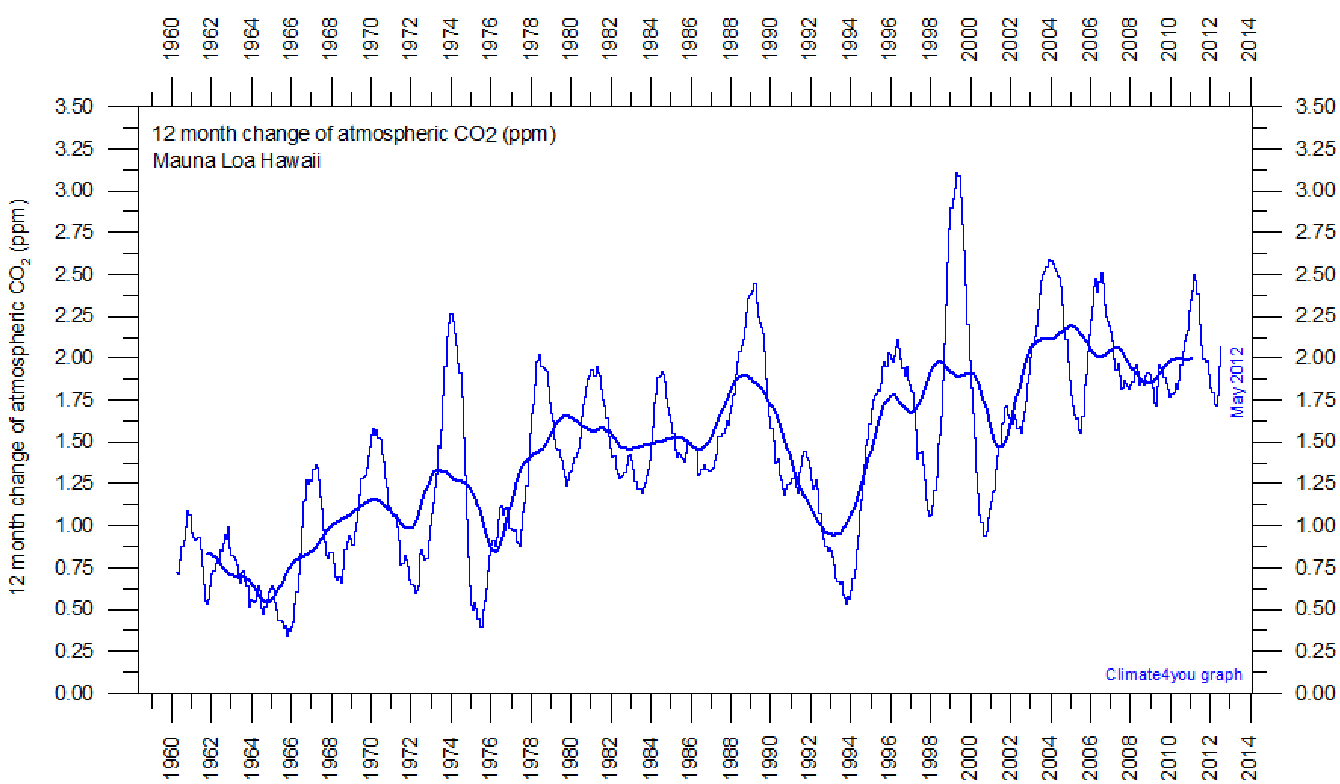
Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin line represents the weekly data, and the thick line is the running 53 week average (approximately 1 year).



Northern hemisphere weekly snow cover since October 1966 according to Rutgers University Global Snow Laboratory. The thin line represents the weekly data, and the thick line is the running 53 week average (approximately 1 year). The running average is not calculated before 1971 because of data gaps in this early period.

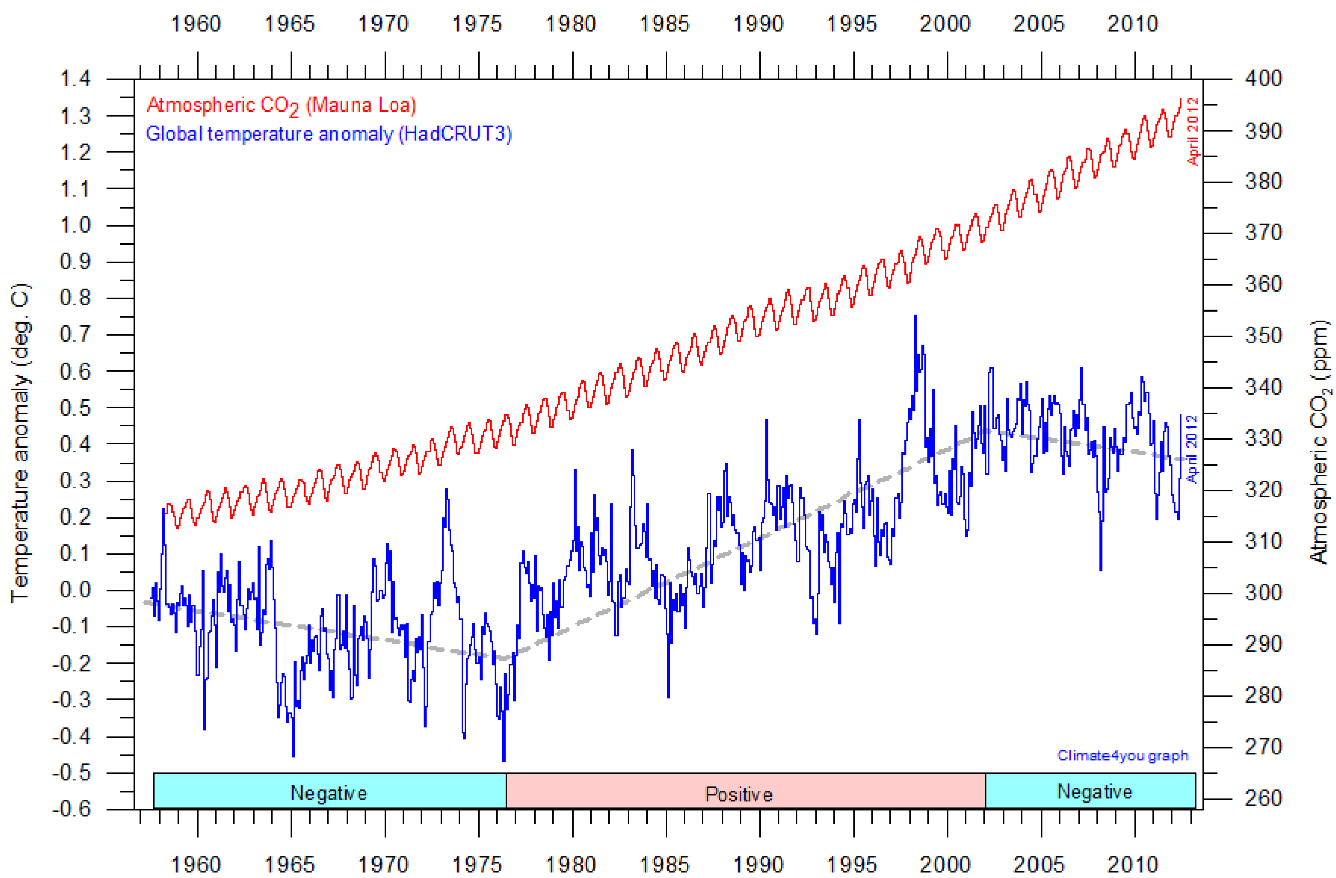
Atmospheric CO_2, updated to May 2012

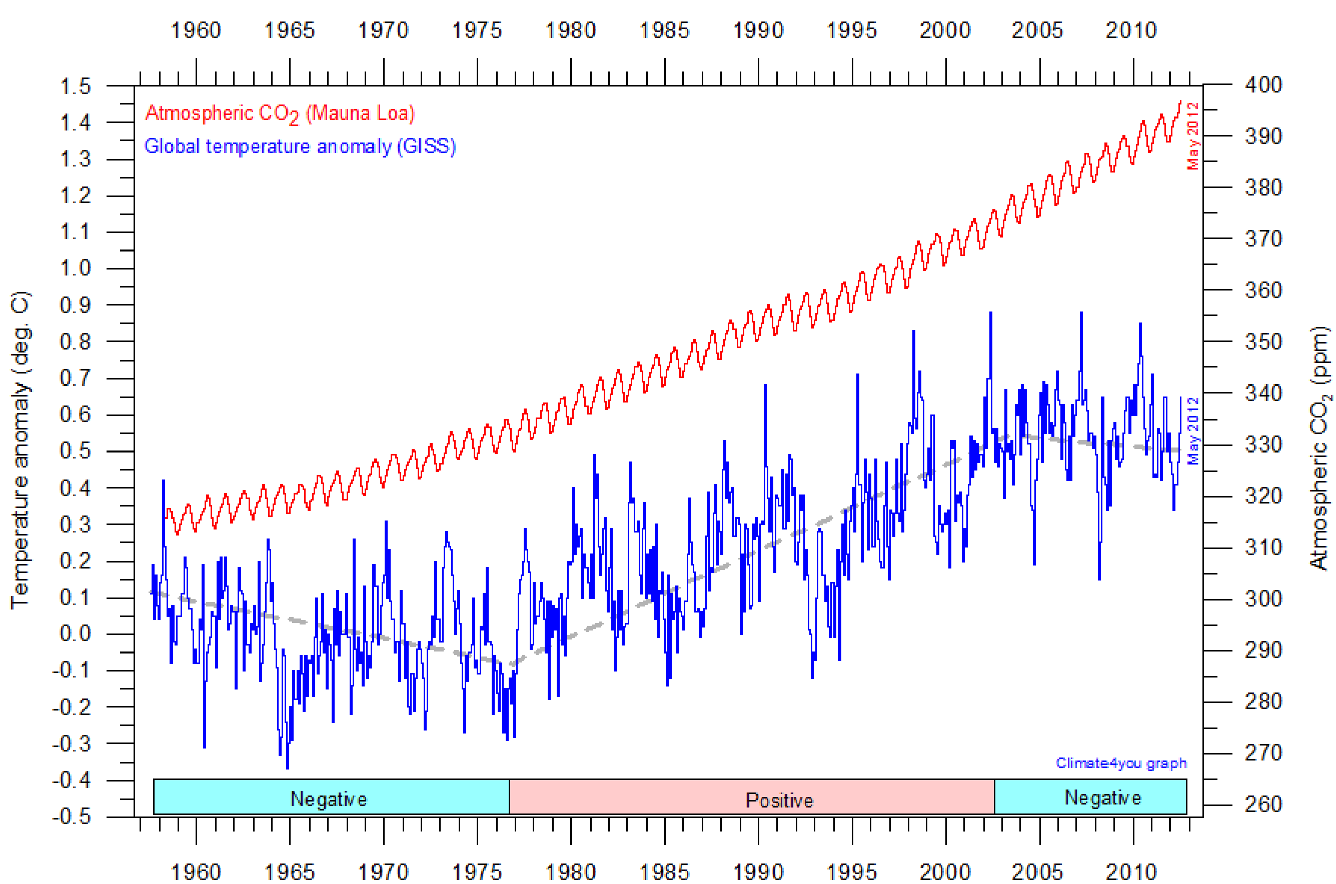


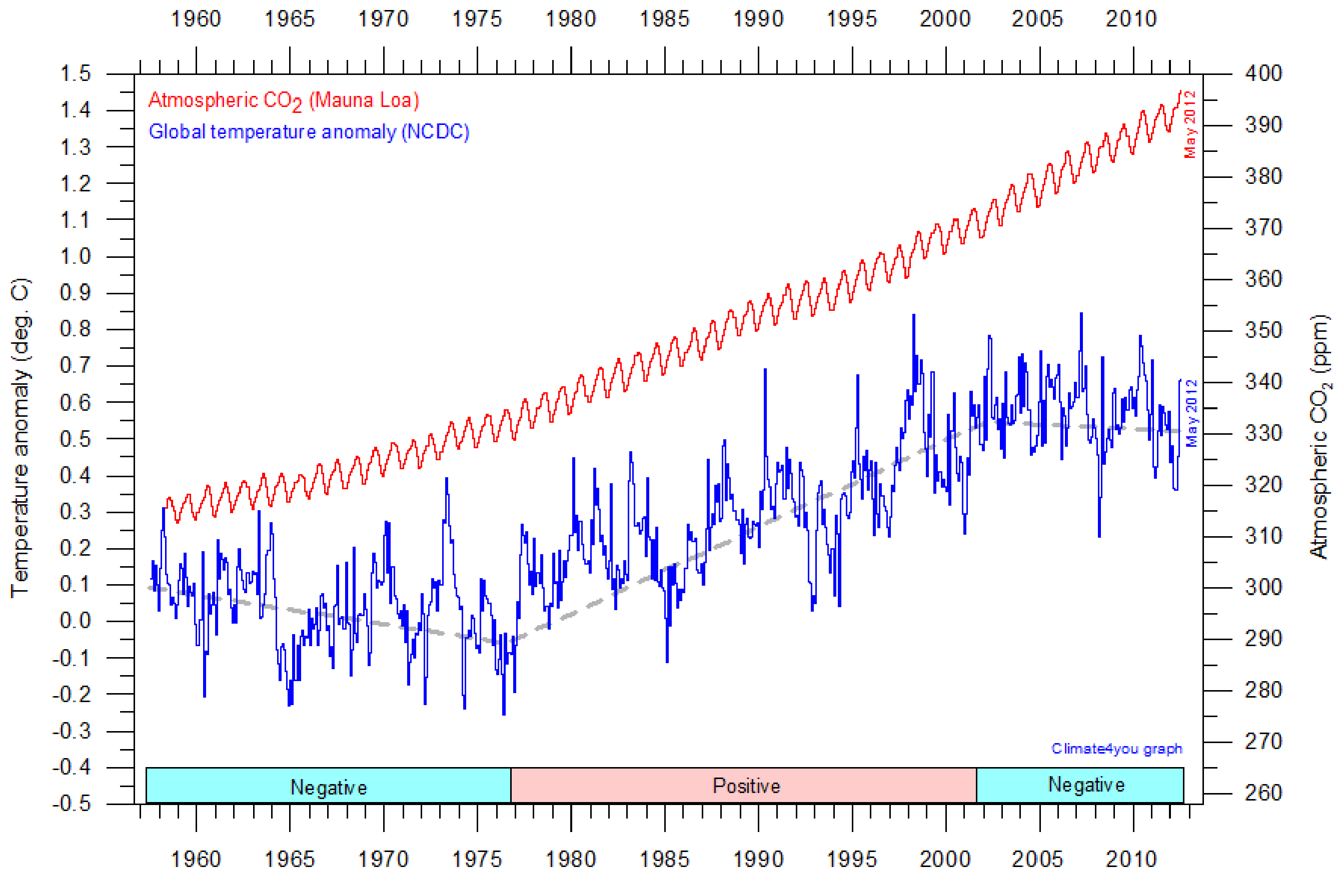


Monthly amount of atmospheric CO_2 (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO_2 since 1959, according to data provided by the [Mauna Loa Observatory](), Hawaii, USA. The thick line is the simple running 37 observation average, nearly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

Global surface air temperature and atmospheric CO_2, updated to May 2012







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 HadCRUT3 diagram has not been updated beyond April 2012.

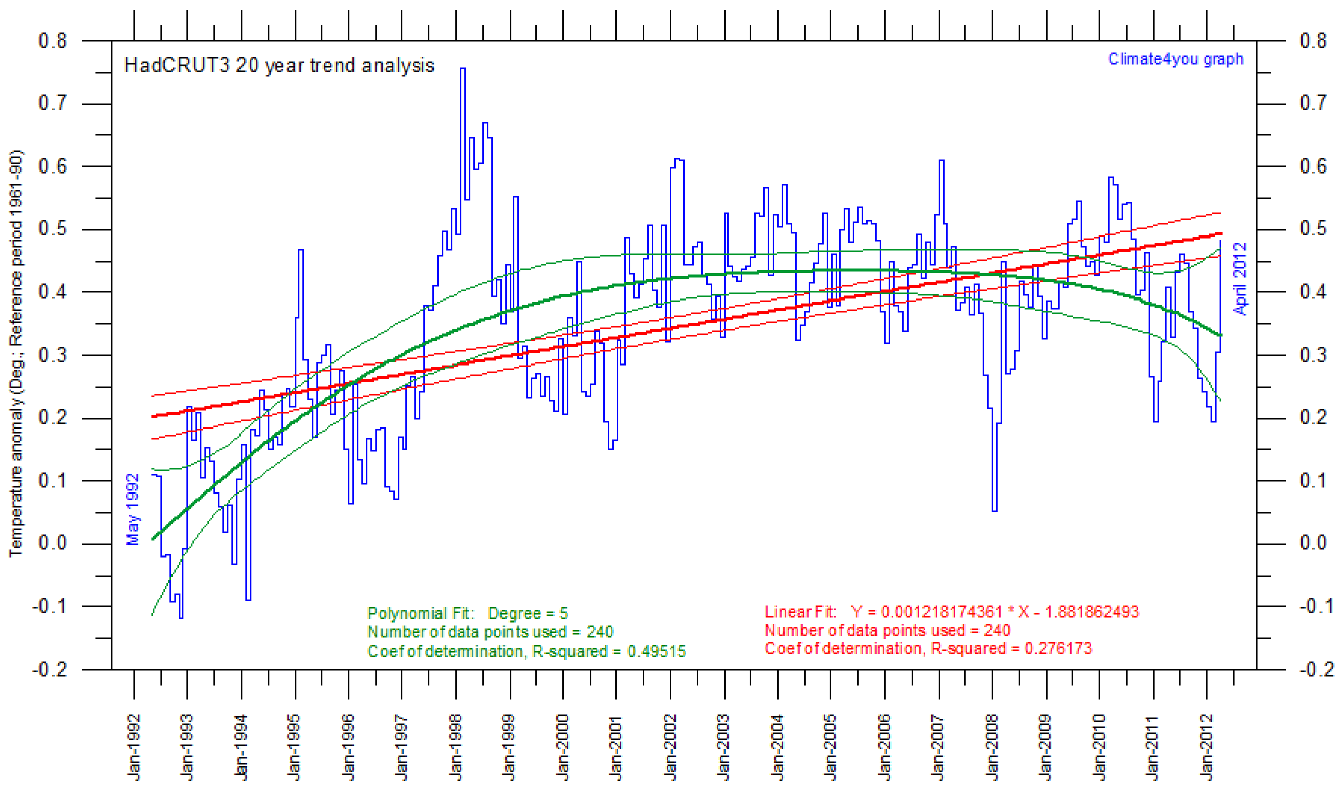
Most climate models assume the greenhouse gas carbon dioxide CO_2 to influence significantly upon global temperature. Thus, it is relevant to compare the different global temperature records with measurements of atmospheric CO_2, as shown in the diagrams above. Any comparison, however, should not be made on a monthly or annual basis, but for a longer time period, as other effects (oceanographic, clouds, volcanic, 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 than atmospheric CO_2.

What exactly defines the critical length of a relevant time period to consider for evaluating the alleged high importance of CO_2 remains elusive. However, the length of the critical period must be inversely proportional to the importance of CO_2 on the global temperature, including possible feedback effects. So if the net effect of CO_2 is strong, the length of the critical period is short, and vice versa.

After about 10 years of global temperature increase following a period of global cooling 1940-1978, IPCC was established in 1988. Presumably, several scientists interested in climate felt intuitively that their empirical and theoretical understanding of climate dynamics in 1988 was sufficient to conclude about the high importance of CO_2 for global temperature. However, for obtaining public and political support for the CO_2-hyphotesis the 10 year warming period leading up to 1988 in all likelihood was very important. Had the global temperature instead been decreasing, political and public support for the CO_2-hypothesis would have been difficult to obtain. Adopting this approach as to critical time length (about 10 years), the varying relation (positive or negative) between global temperature and atmospheric CO_2 has been indicated in the lower panels of the three diagrams above.

Last 20 year surface temperature changes, updated to April 2012

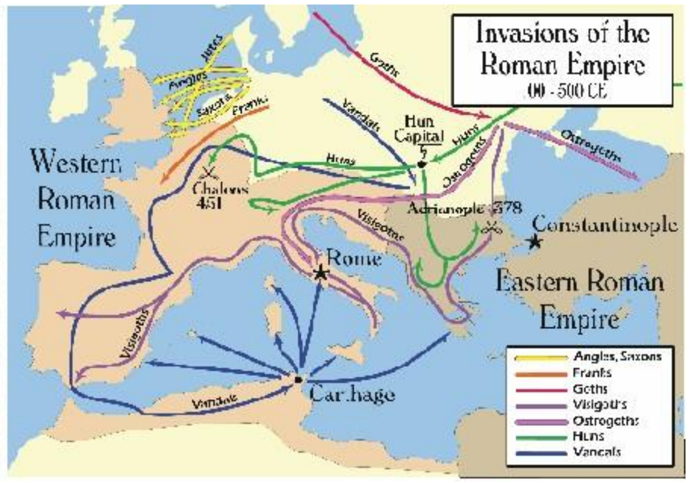


Last 20 years global monthly average surface air temperature according to Hadley CRUT, a cooperative effort between the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK. The thin blue line represents the monthly values. The thick red 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). Last month included in analysis: April 2012.

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 little predictive power.

[Climate and history; one example among many]

AD 476: Collapse of the Roman Empire



Karl Bruillov's 'Sack of Rome' (left). Map of the "barbarian" invasions of the Roman Empire showing the major incursions from 100 to 500 AD (right).

The decline of the Roman Empire refers to the gradual societal collapse of the Western Roman Empire. This slow decline occurred over a period of four centuries, culminating on September 4, 476 AD, when Romulus Augustus, the last Emperor of the Western Roman Empire, was deposed by Odoacer, a Germanic chieftain. The following text is based mainly on Büntgen et al. (2011), Lubick 2011 and Wikipedia.

The decline of the Roman Empire is one of the events traditionally marking the end of Classical Antiquity and the beginning of the European Middle Ages. Throughout the 5th century, the Empire's territories in western Europe and northwestern Africa, including Italy, fell to various invading or indigenous peoples in what is often known as the Migration period, a 250 year period of turmoil in Europe. Although the eastern half of the original Roman Empire still survived with borders essentially intact for several centuries, the Empire as a whole had initiated major cultural and political transformations since the Crisis of the Third Century, with the shift towards a more openly autocratic and ritualized form of government, the adoption of Christianity as the state religion, and a general rejection of the traditions and values of Classical Antiquity.

The European Middle Ages following the decline of the Roman Empire is important, as it witnessed the first sustained urbanisation of northern and western Europe. Many modern European states owe their origins to events unfolding in the Middle Ages; present European political boundaries are, in many regards, the result of the military and dynastic achievements during this tumultuous period.

By the late 3rd century, the city of Rome no longer served as an effective capital for the Emperor and various cities were used as new administrative capitals. Successive emperors, starting with Constantine, privileged the eastern city of Byzantium, which he had entirely rebuilt after a siege. Later renamed Constantinople, and protected by formidable walls in the late 4th and early 5th centuries, it was to become the largest and most powerful city of Christian Europe in the Early Middle Ages. Since the Crisis of the Third

Century, the Roman Empire was intermittently ruled by more than one emperor at once (usually two), presiding over different regions. At first a haphazard form of power sharing, this eventually settled on an East-West administrative division between the Western Roman Empire (centred on Rome, but now usually presided from other seats of power such as Trier, Milan, and especially Ravenna), and the Eastern Roman Empire, also known as the Byzantine Empire.

Throughout the 5th century, Western emperors were usually figureheads, while the Eastern emperors maintained more independence. For most of the time, the actual rulers in the West were military strongmen who took the titles of magister militum (master of the soldiers), patrician, or both. Although Rome was no longer the capital in the West, it remained the West's largest city and its economic centre. But the city was sacked by rebellious Visigoths in 410 AD and by the Vandals in 455 AD, events that shocked contemporaries and signalled the disintegration of Roman authority.

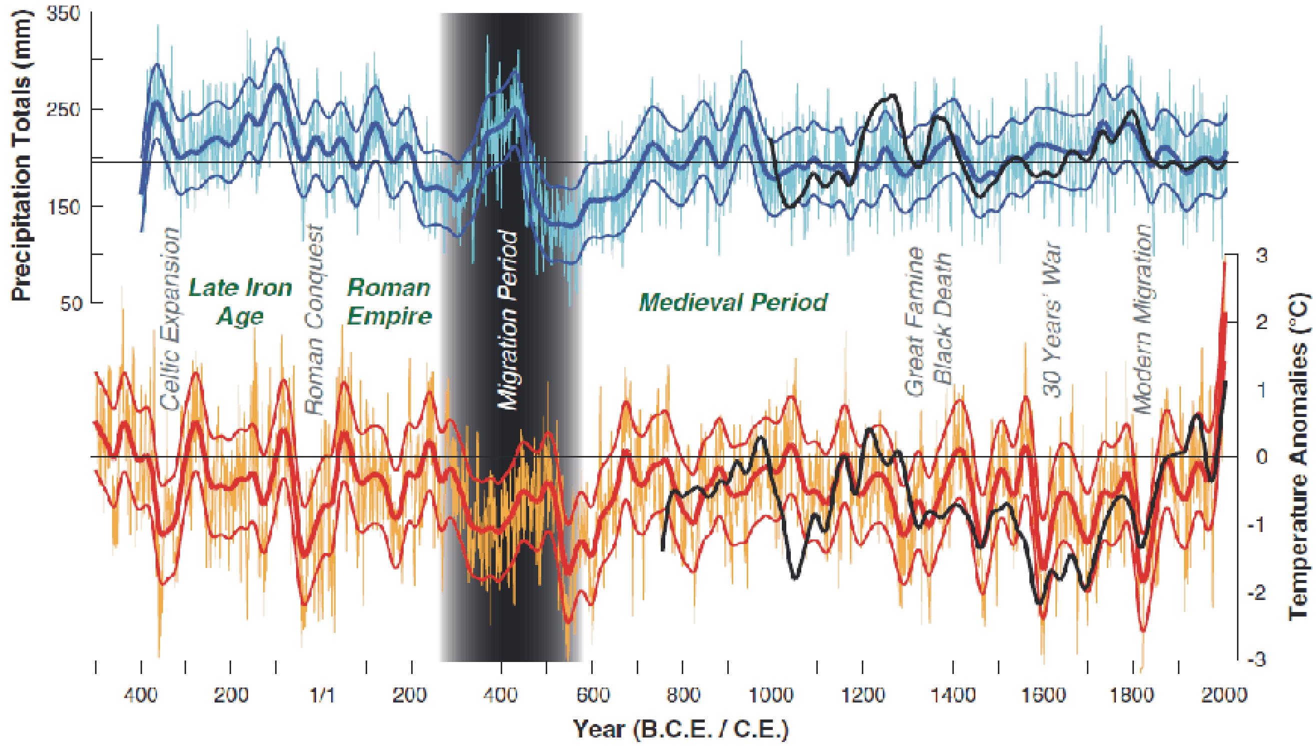
In June 474 AD, Julius Nepos became Western Emperor but in the next year the magister militum Orestes revolted and made his son Romulus Augustus emperor. Romulus, however, was not recognized by the Eastern Emperor Zeno, who used to have good connections to Nepos. Romulus, therefore, was technically a usurper, and Nepos still being the legal Western Emperor. Nevertheless, Romulus Augustus is often known as the last Western Roman Emperor. In 476 AD, after being refused lands in Italy, Orestes' Germanic mercenaries under the leadership of the chieftain Odoacer captured and executed Orestes and took Ravenna, the Western Roman capital at the time, deposing Romulus Augustus. The whole of Italy was quickly conquered, and Odoacer was granted the title of patrician by Zeno, effectively recognizing his rule in the name of the Eastern Empire. Odoacer returned the Imperial insignia to Constantinople and ruled as King in Italy. Although Roman political authority in the West was lost, Roman culture would last in most parts of the former Western provinces into the 6th century and beyond.

The English historian Edward Gibbon, author of The History of the Decline and Fall of the Roman Empire (1776) made the concept of the decline of the Roman Empire part of the framework of the English language. In six volumes, Gibbon painstakingly charted the Empire's final demise, using original reference material where possible. Gibbon blamed the fall on several factors: a loss of civic virtue, the use of barbarians as mercenaries rather than Roman soldiers, and the rise of Christianity, which led to increased pacifism and widespread beliefs that a better life awaited Roman citizens after death.

Gibbon, however, was not the first to speculate on why and when the Empire collapsed. In 1984, the German professor Alexander Demandt published a collection of 210 theories on why Rome fell, and new theories have emerged since then. One of the last was recently proposed by Büntgen et al. (2011).

The Büntgen research team compared modern tree-ring data with instrumental climate records to quantify the relationship between tree-ring growth and climate (precipitation and summer temperature). They used this relationship to reconstruct climate information from the ancient tree rings before instrumental records became available. To avoid getting strong local signals from one or a handful of trees in a particular forest or mountain site, Büntgen et al. (2011) used data for thousands of pieces of oak wood across Central Europe. Precipitation was reconstructed by using over 7000 oak trees across France and Germany. And about 1500 stone pine trees from the Austrian Alps region provided information about temperature.

From these data interesting climate information emerge. From the beginning of the Roman Empire to its peak (c. 50 BC to AD 250), the climate was relatively stable, with warm and dry summers. During the two-and-half centuries or so that followed Europe apparently experienced very unfavourable conditions for agriculture, with summers being wet and cool. This time period corresponds to what today is known as the Migration period - a 250-year-period of turmoil and waves of migration in Europe.



Reconstructed precipitation (upper panel) and summer (JJA) temperature anomaly, with respect to the average of the 1901-2000 period (Büntgen et al. (2011)).

Wet weather apparently may have made harvest conditions very difficult around the end of the Roman Empire in the fifth century. In this way cool and moist summer climate may have contributed to the Decline of the Roman Empire. Later climate then transitioned to an very dry and cold period around AD 550. Better conditions returned again around AD 700, and the subsequent reduced climate variability from AD 1000 to 1200 was coincident with prosperity and a growing population.

Sources and References:

Büntgen, U., Tegel, W., Nicolussi,K., McCormick, M., Frank, D., Trouet, V., Kaplan, J.O., Herzig, F., Heussner, K.-U., Wanner, H., Luterbacher, J. and Esper. J. 2011. 2500 Years of European Climate Variability and Human Susceptibility. *Science* 331 (6017): 578-582, doi: 10.1126/science.1197175.

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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

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