Climate4you update May 2013

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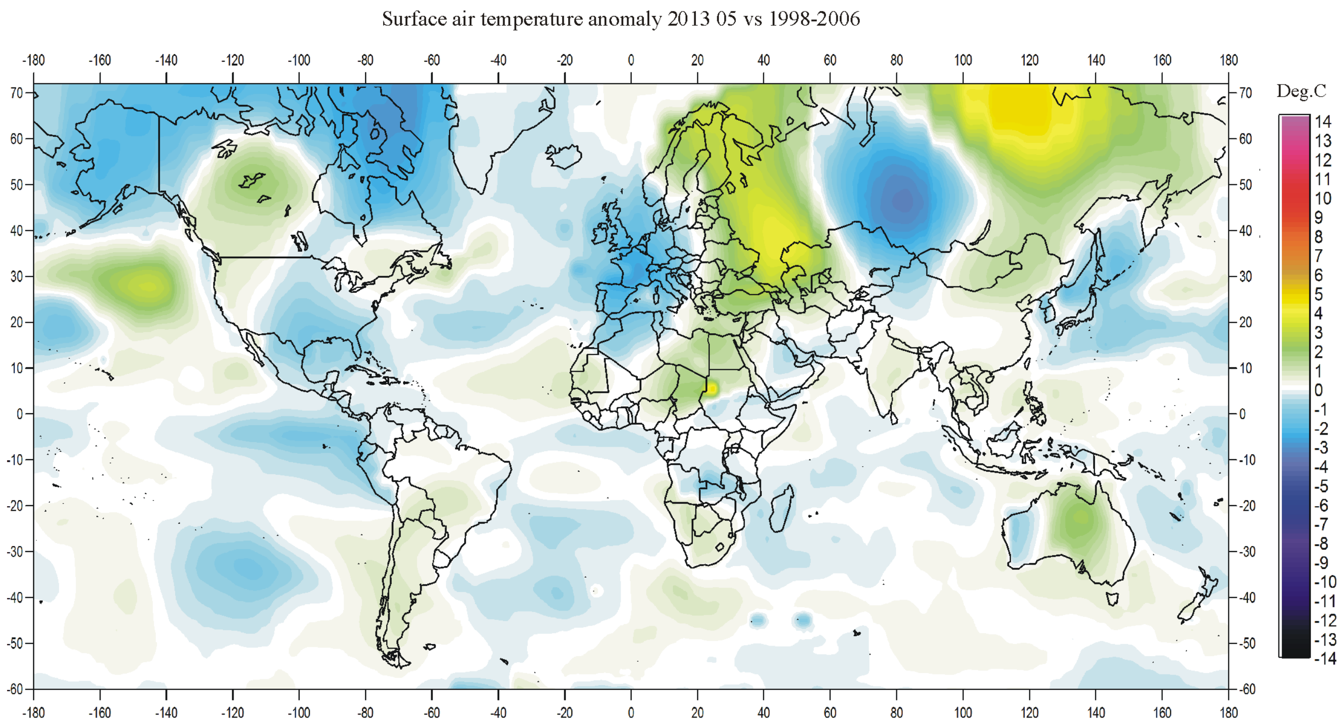
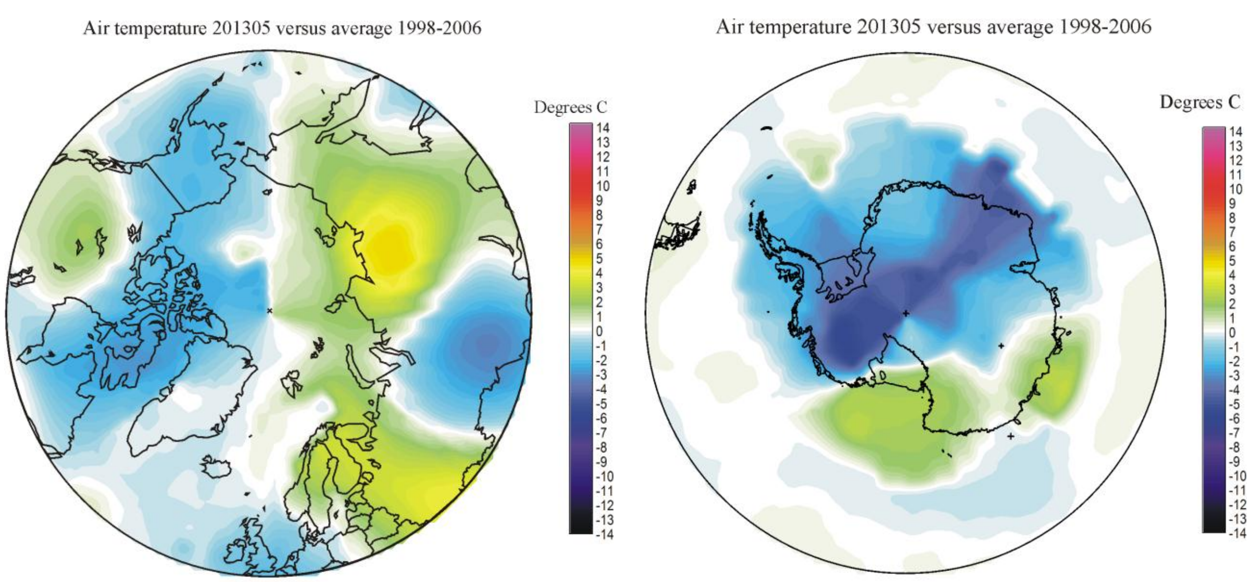
All diagrams in this newsletter as well as links to the original data are available on www.climate4you.com

[May 2013 global surface air temperature overview]





May 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 May 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.

May 2013 global surface air temperatures

General: On average, *g*lobal air temperatures were near the 1998-2006 average, although with large regional differences. For the first time all three surface air temperature records show negative temperature trend for the last 5 and 10 years (page 8).

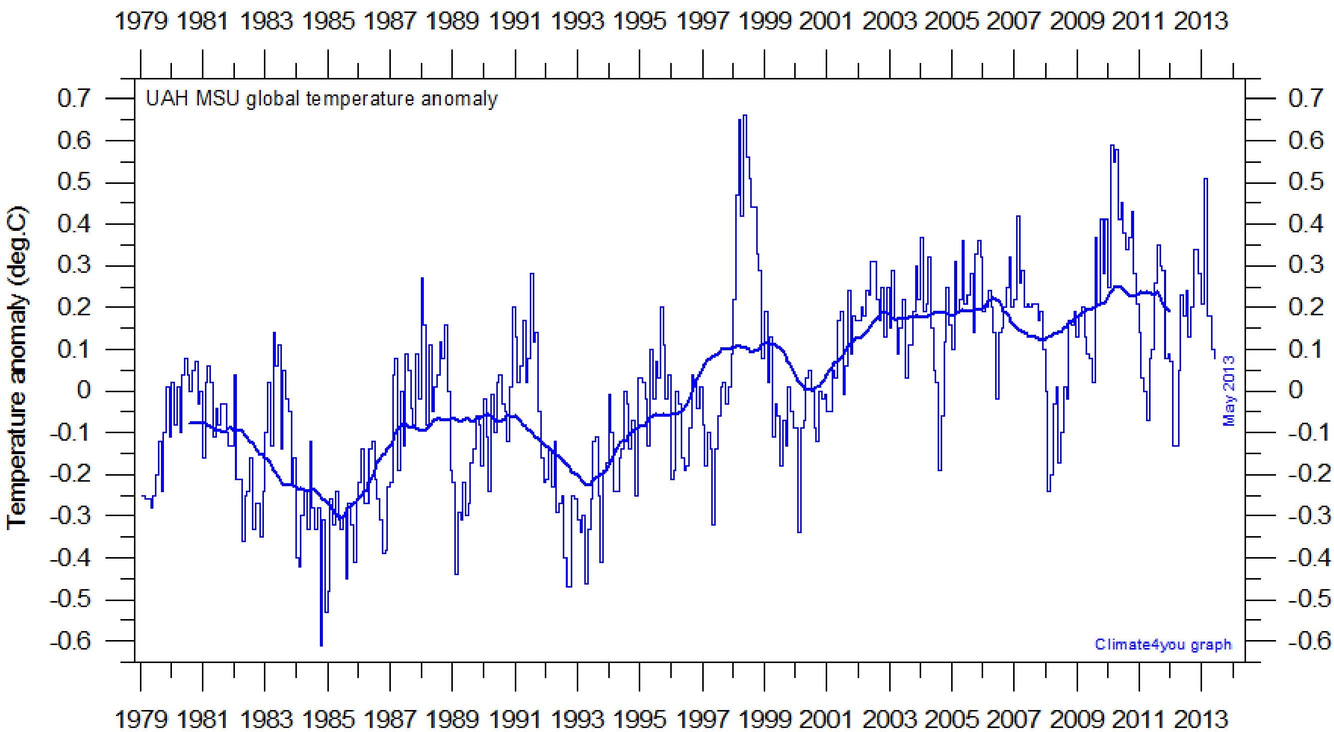
The Northern Hemisphere was characterised by large temperature contrast between individual regions. Most of North America, West Europe and western Siberia experienced below average temperatures, while major parts of Russia and eastern Siberia were relatively warm. Most of Asia experienced near average temperatures. The North American sector of the Arctic was relatively cold, while most of the European sector was relatively warm. The marked limit between warm and cold areas across the Arctic Ocean represents an artefact derived from the GISS interpolation technique and should not be over interpreted.

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

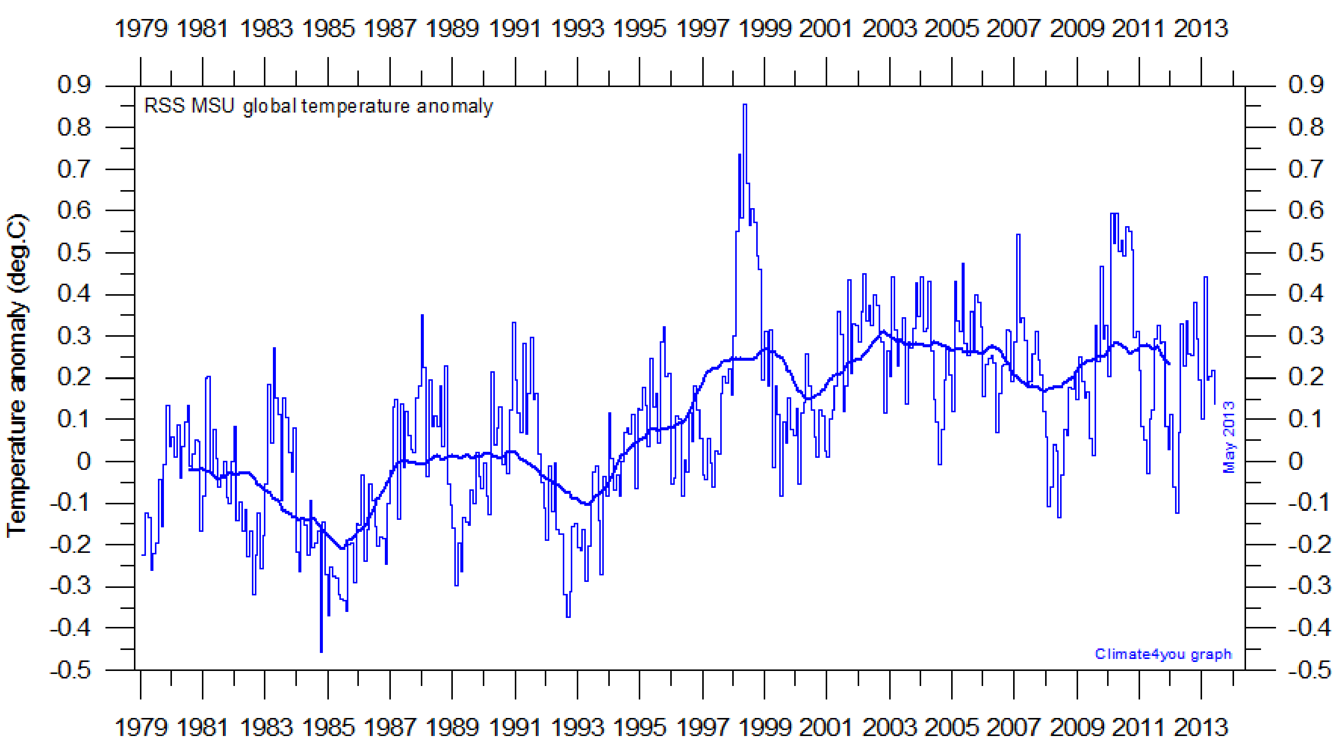
The Southern Hemisphere was mainly near or below average 1998-2006 conditions. Only parts of central Australia were somewhat warmer than the 1998-2006 average. The major part of the Antarctic continent had below average temperatures, and only some coastal parts of East Antarctica and the Ross Sea region experienced above average temperatures.

The global oceanic heat content has been rather stable since 2003/2004, although with a small upward trend (page 13).

Lower troposphere temperature from satellites, updated to May 2013

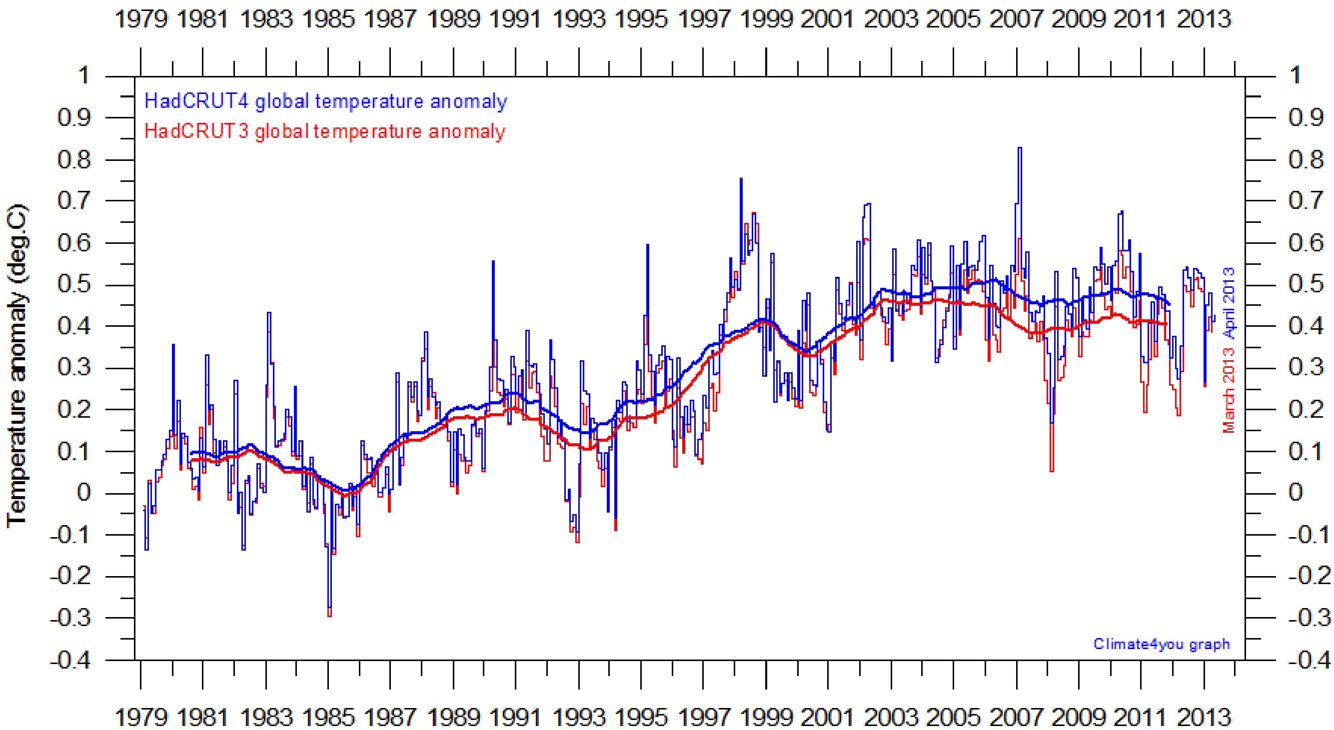


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37 month average.

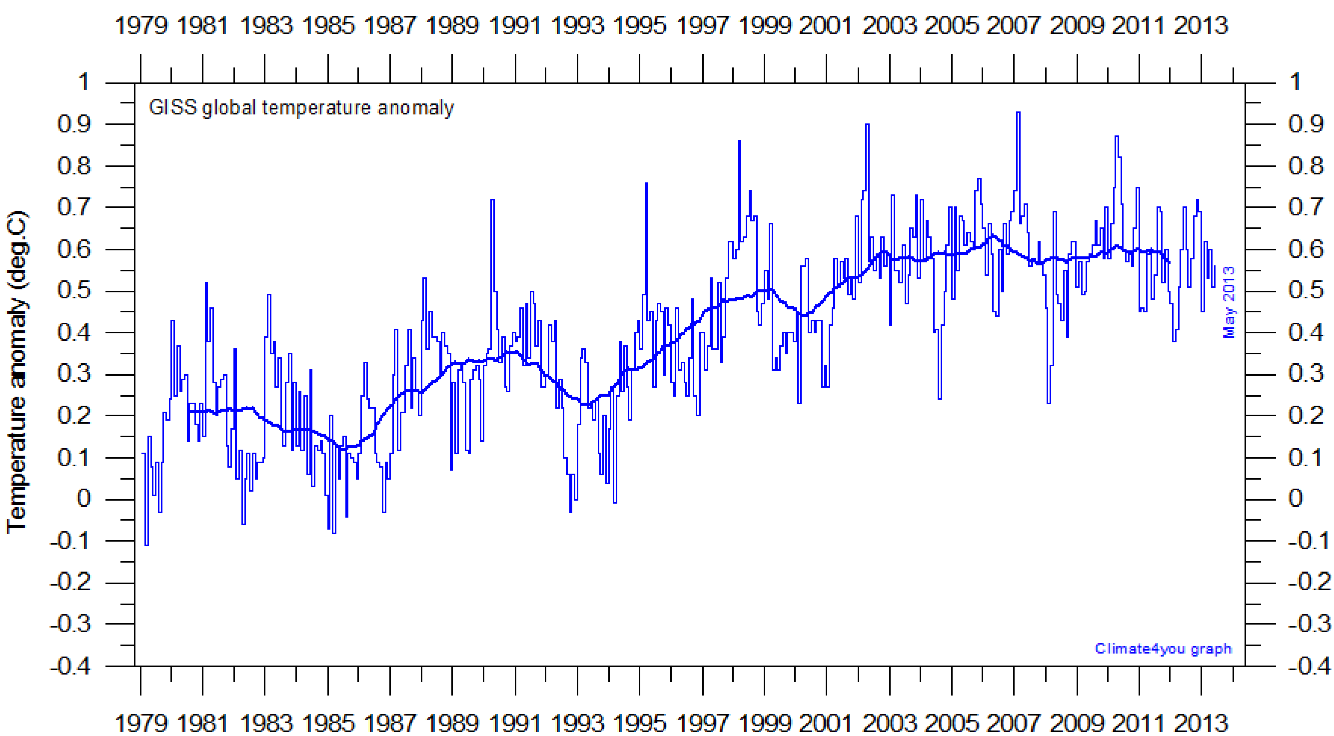


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37 month average.

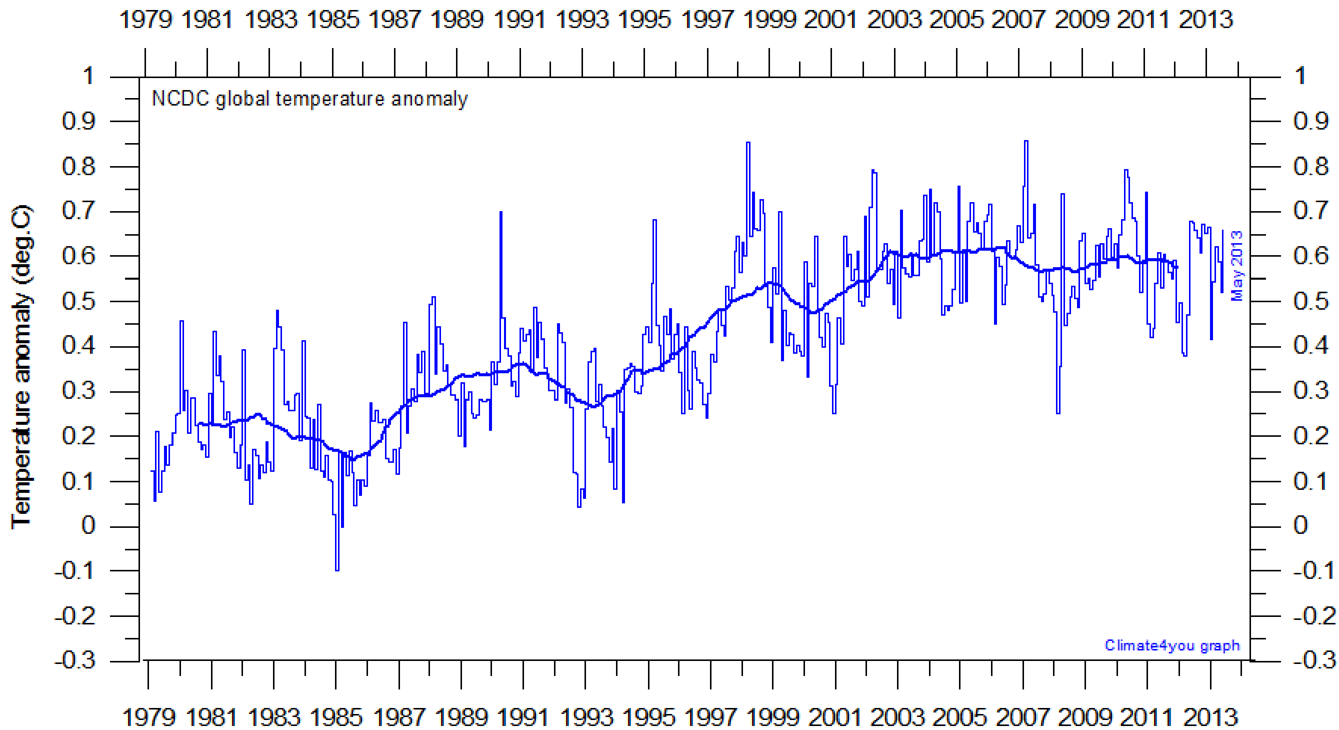
Global surface air temperature, updated to May 2013



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](#)), 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 April 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*).

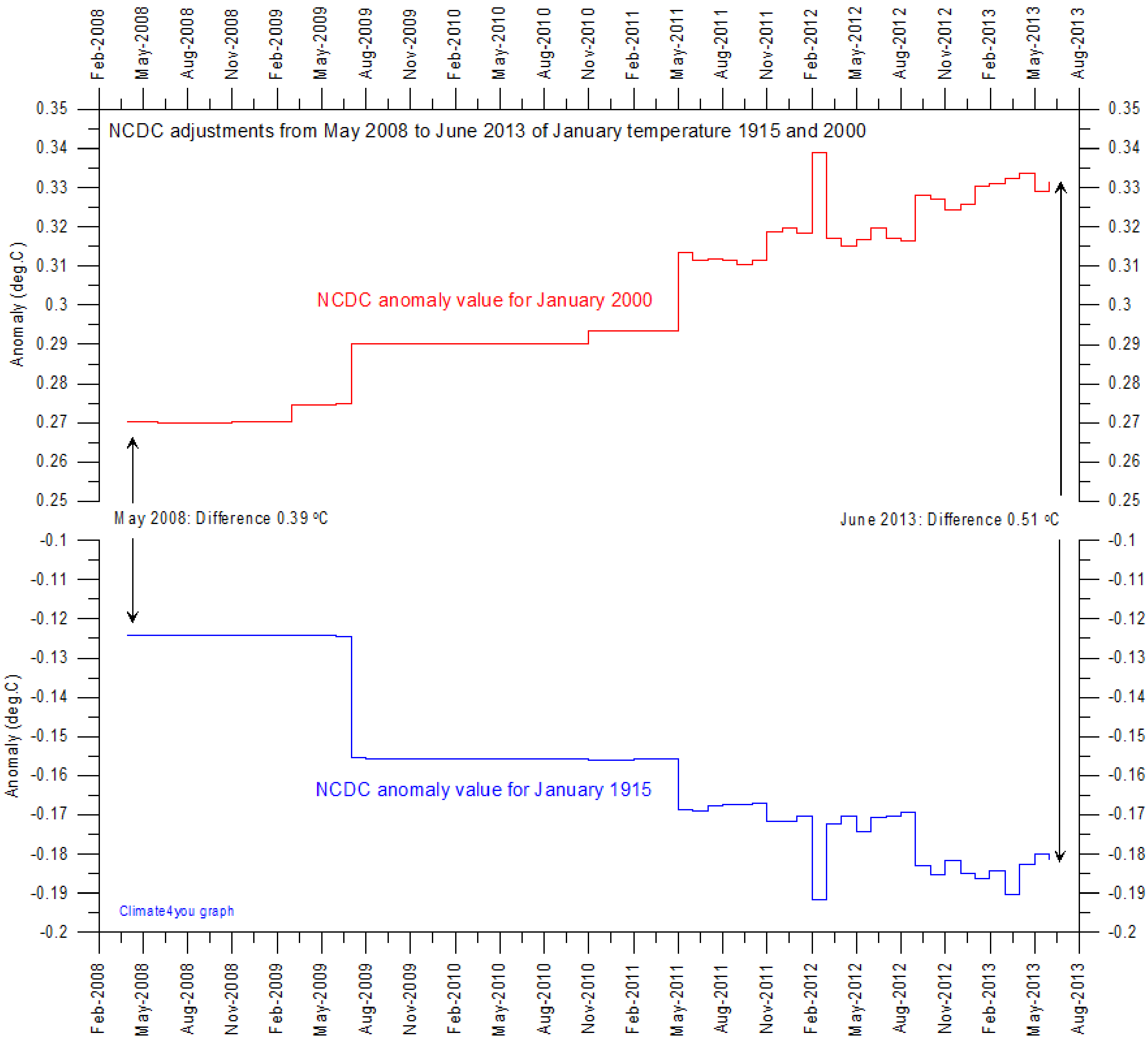


Diagram showing the adjustment made since May 2008 by the [National Climatic Data Center](#) (NCDC) in the anomaly values for the two months January 1915 and January 2000.

<u>June 2013:</u> By administrative means the May 2008 temperature difference between January 1915 and January 2000 has grown from 0.39 to 0.51 ^{o}C, representing an about 31% increase of the original May 2008 difference.

Global surface air temperature linear trends

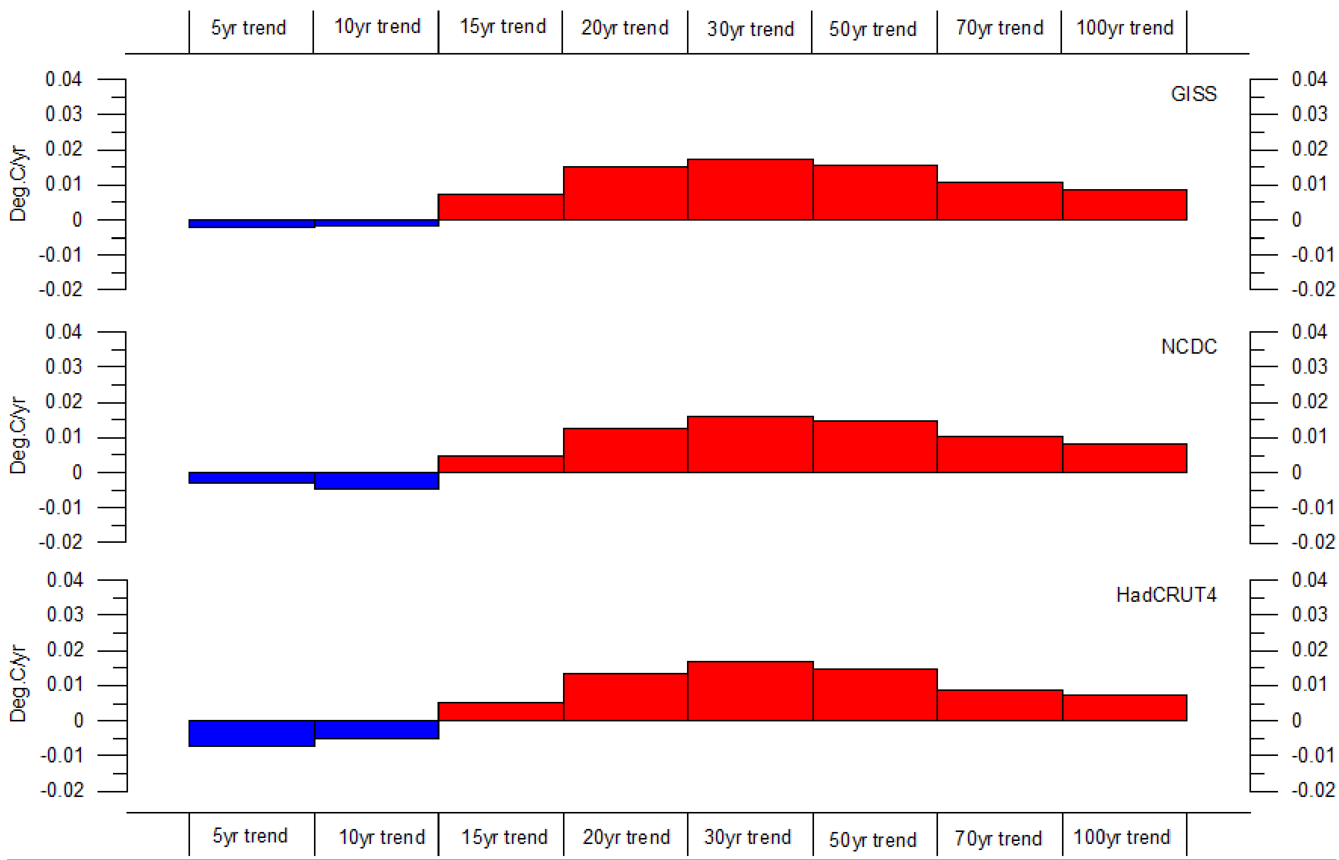
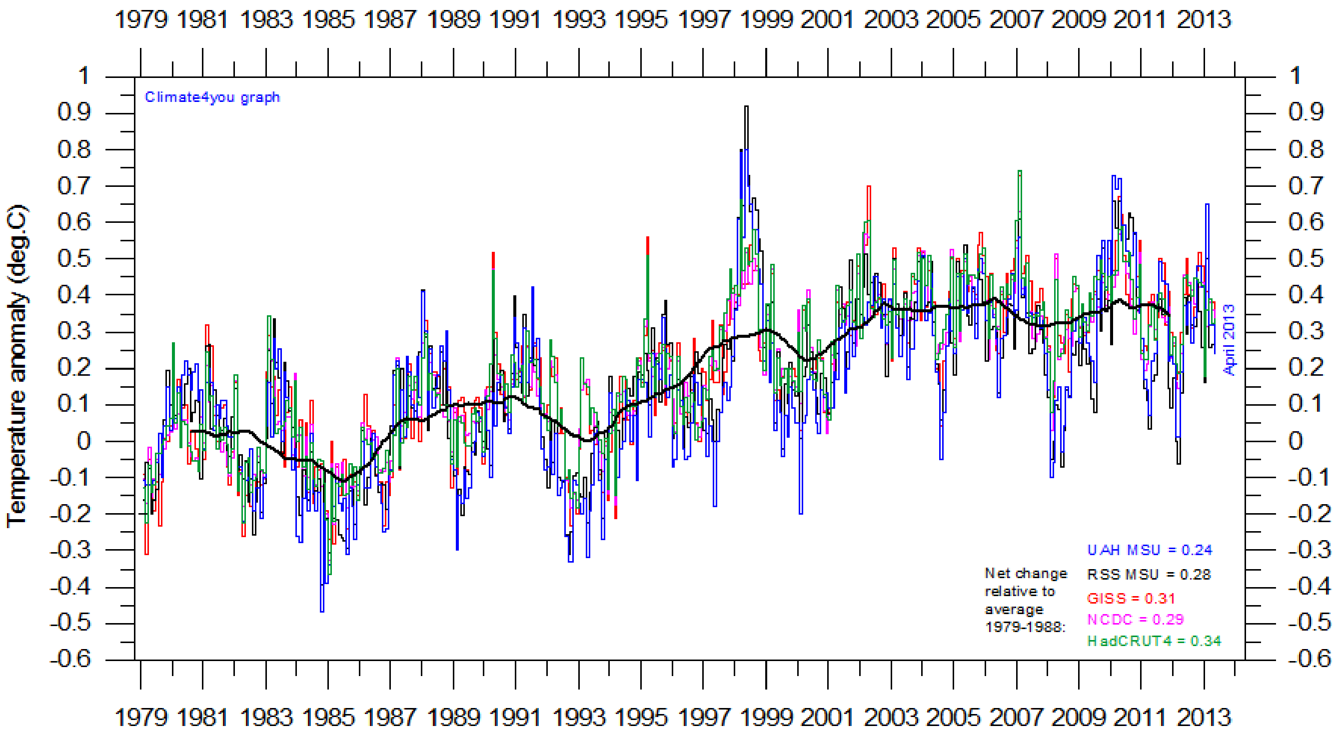


Diagram showing the latest 5, 10, 20, 30, 50, 70 and 100 year linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for three surface-based temperature estimates (GISS, NCDC and HadCRUT4). Last month included in all analyses: April 2013.

All in one, updated to April 2013

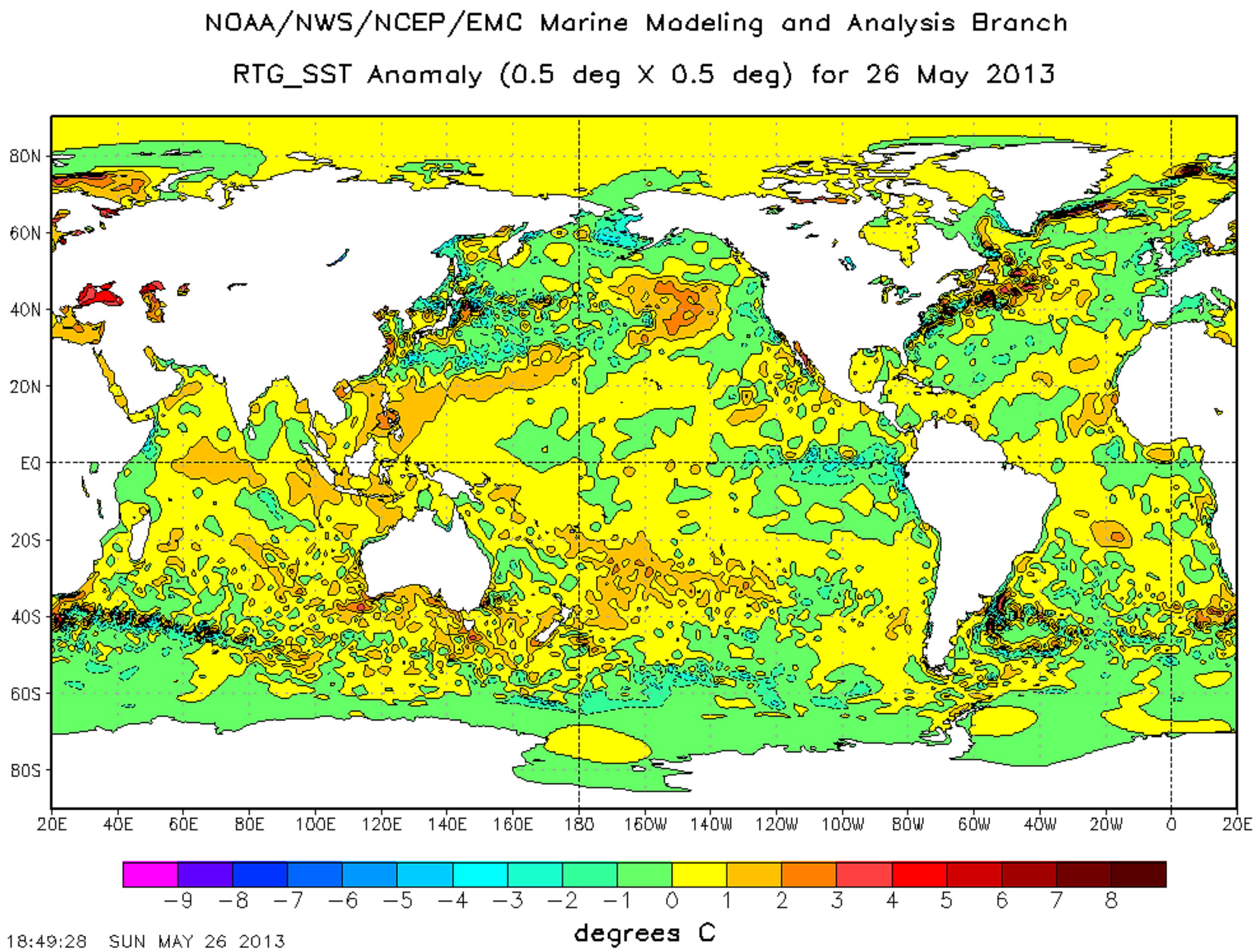


Superimposed plot of all five global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (10 years) from January 1979 to December 1988. The heavy black line represents 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 2013



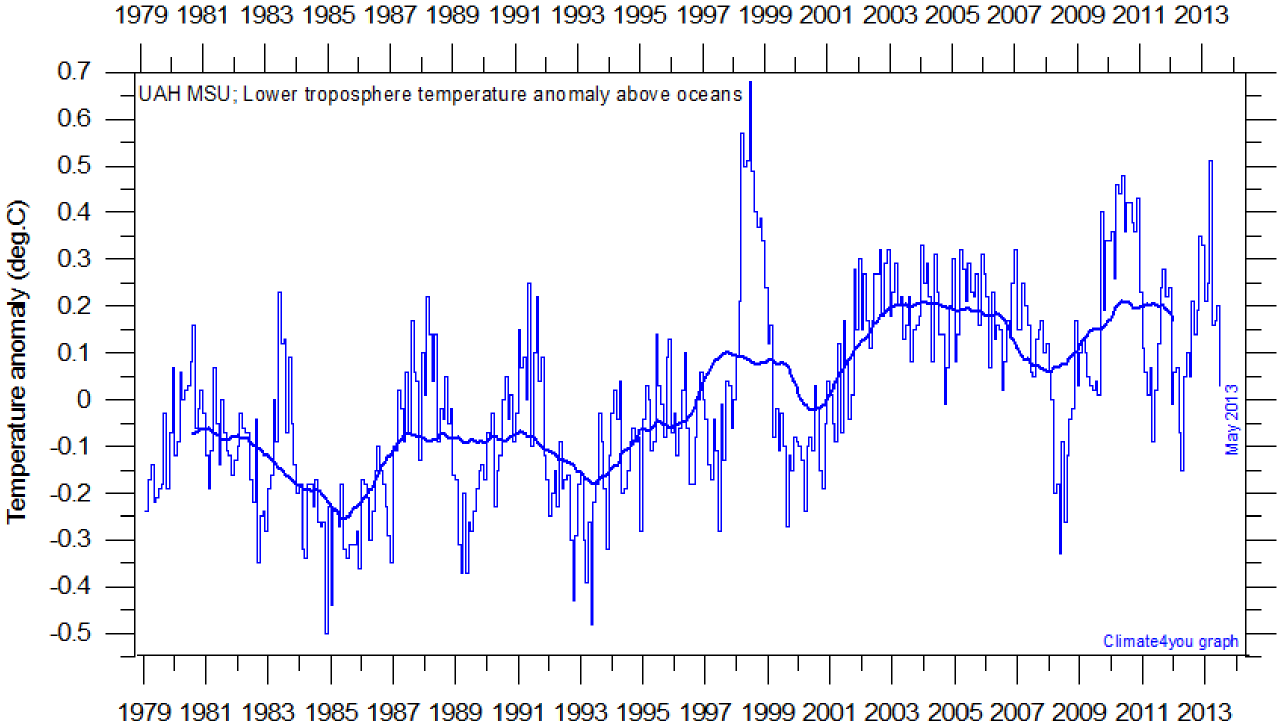
Sea surface temperature anomaly on 26 May 2013. Map source: National Centers for Environmental Prediction (NOAA).

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

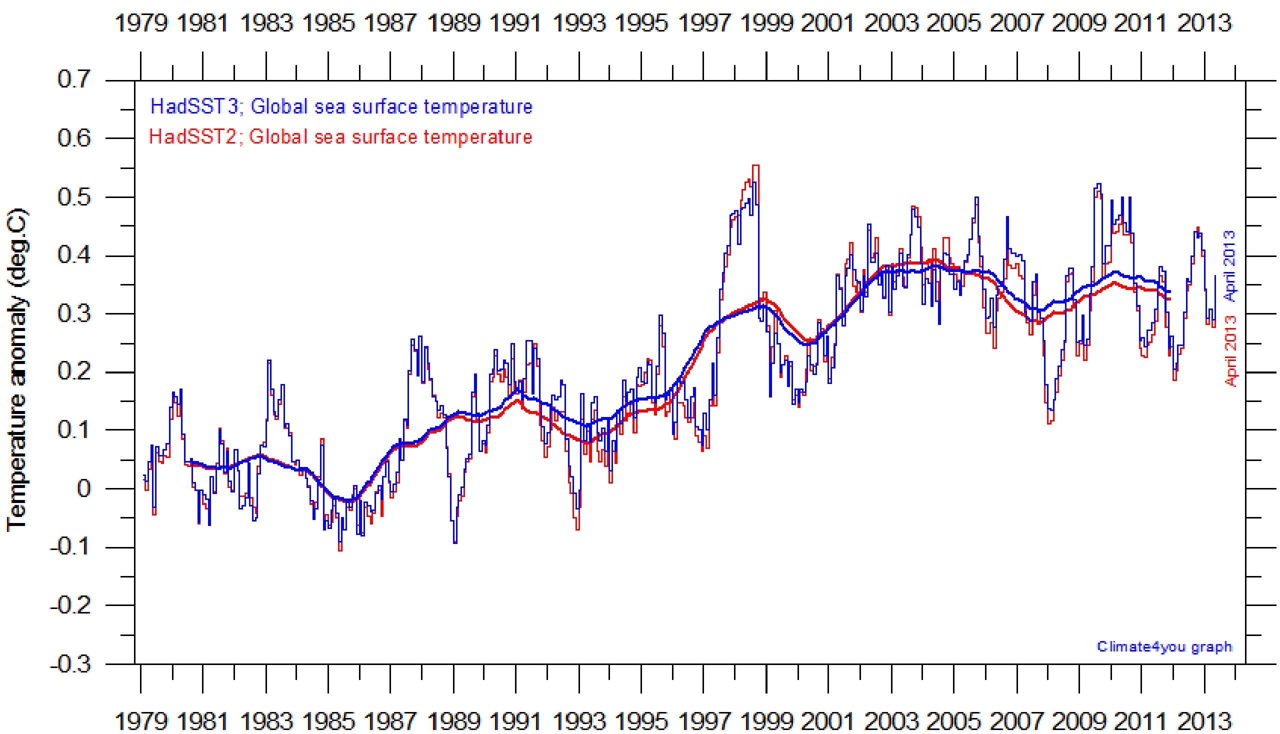
Relatively cold water is beginning to spread across the Pacific Ocean near the Equator, and may influence global air temperatures in the months to come.

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.

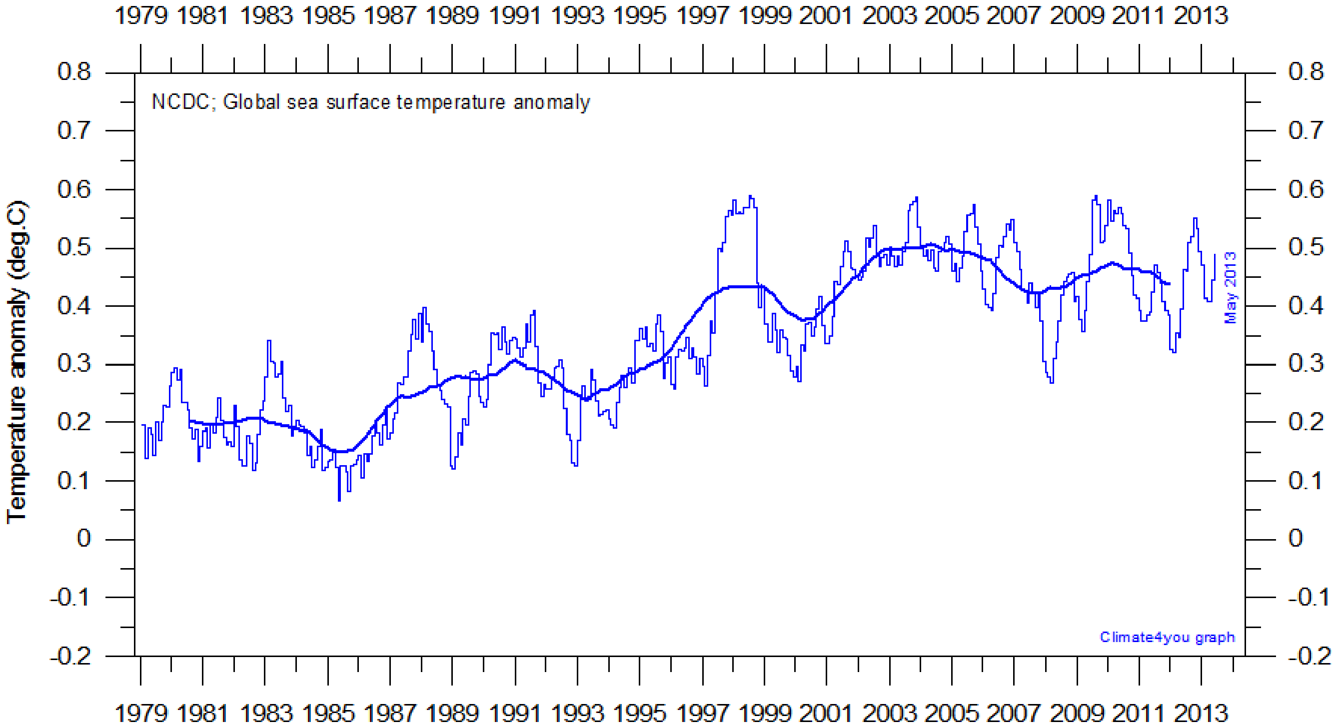
However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, net changes may be small, as such heat exchanges mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when seen over a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

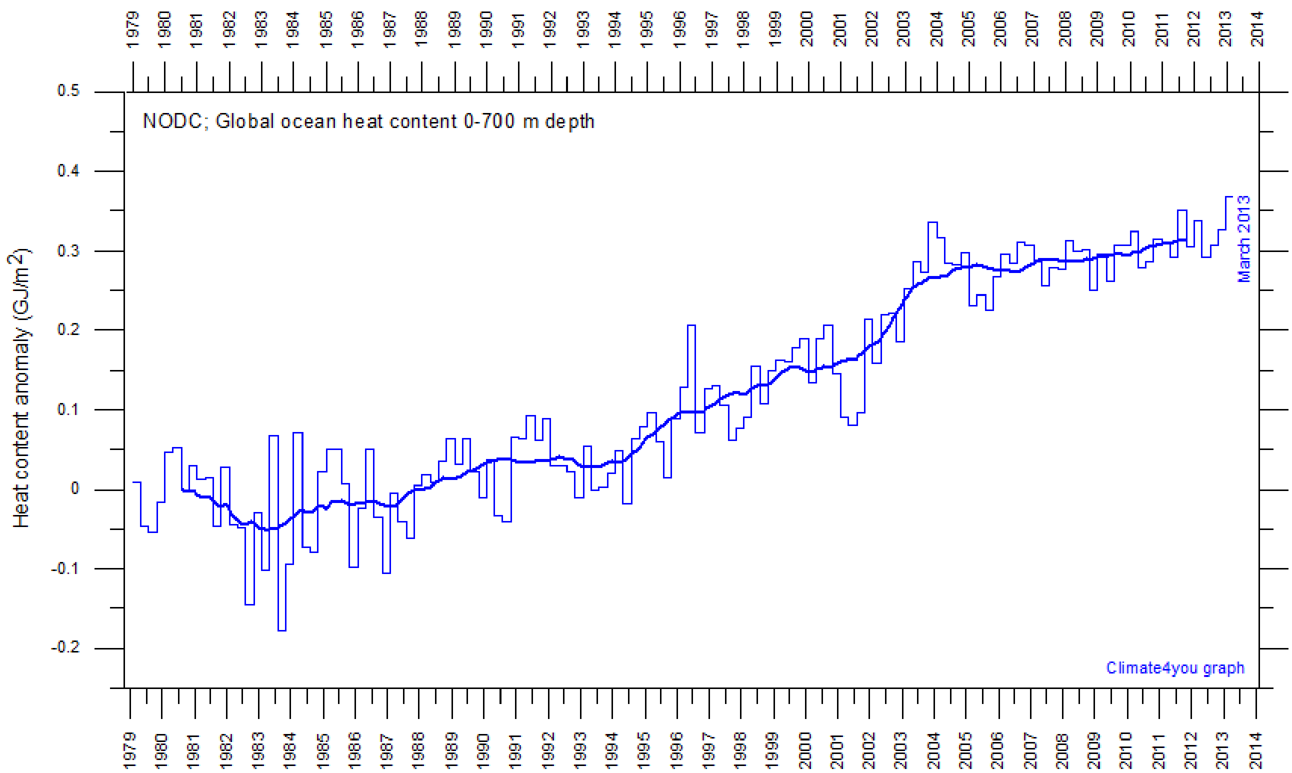


Global monthly average sea surface temperature since 1979 according to University of East Anglia's Climatic Research Unit (CRU), UK. Base period: 1961-1990. The thick line is the simple running 37 month average. Please note that this diagram is not updated beyond April 2013.

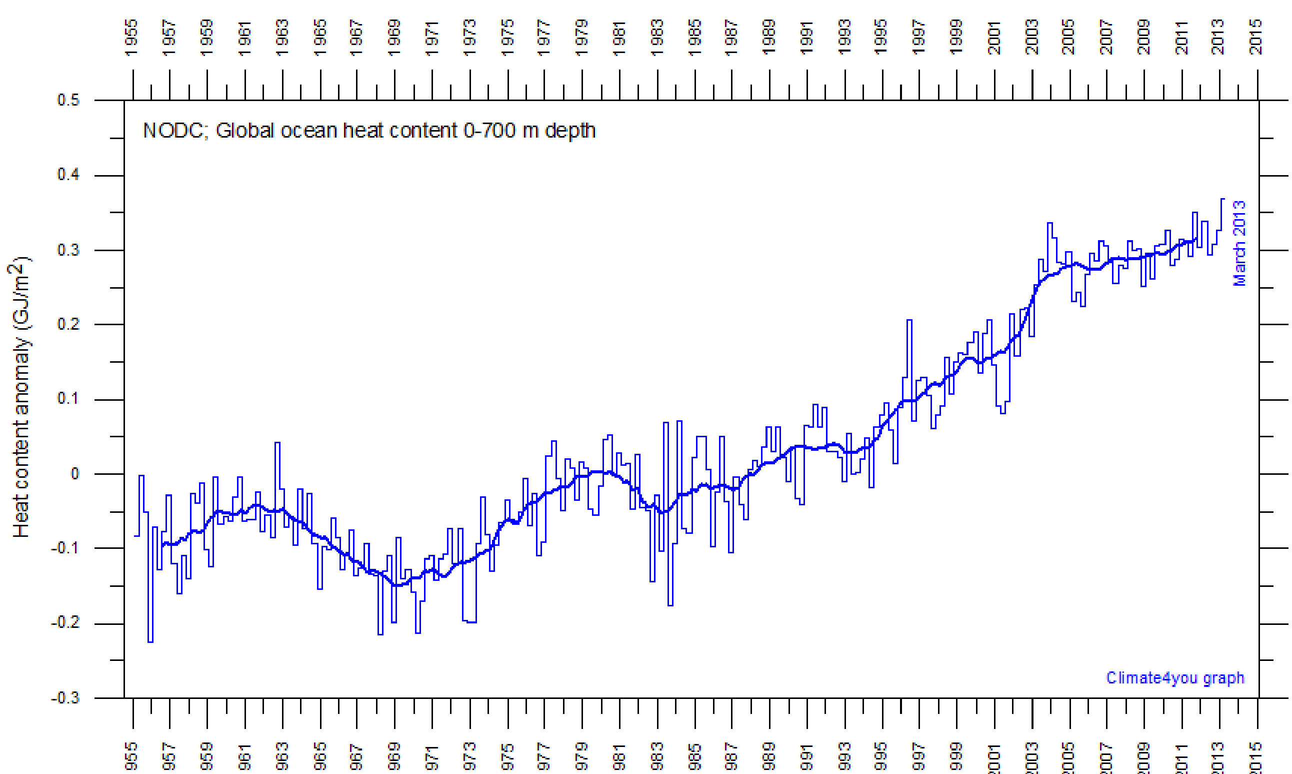


Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center](#) (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37 month average.

Global ocean heat content uppermost 700 m, updated to March 2013

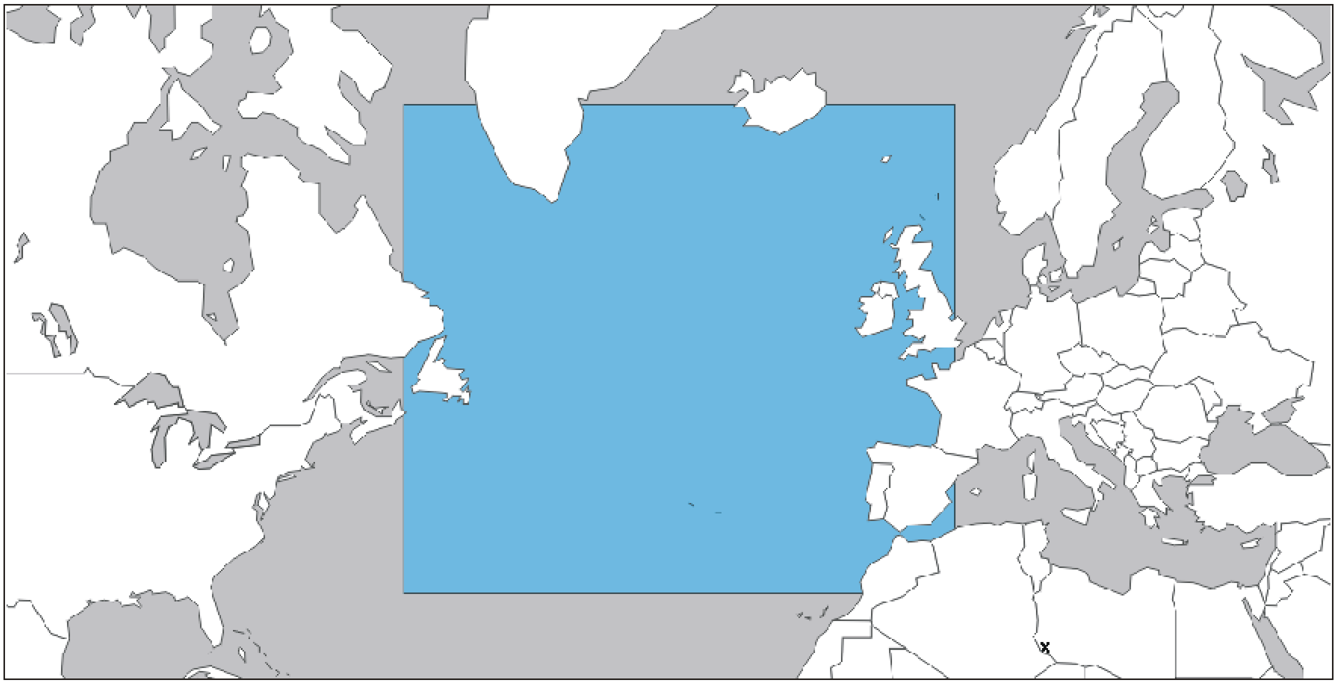


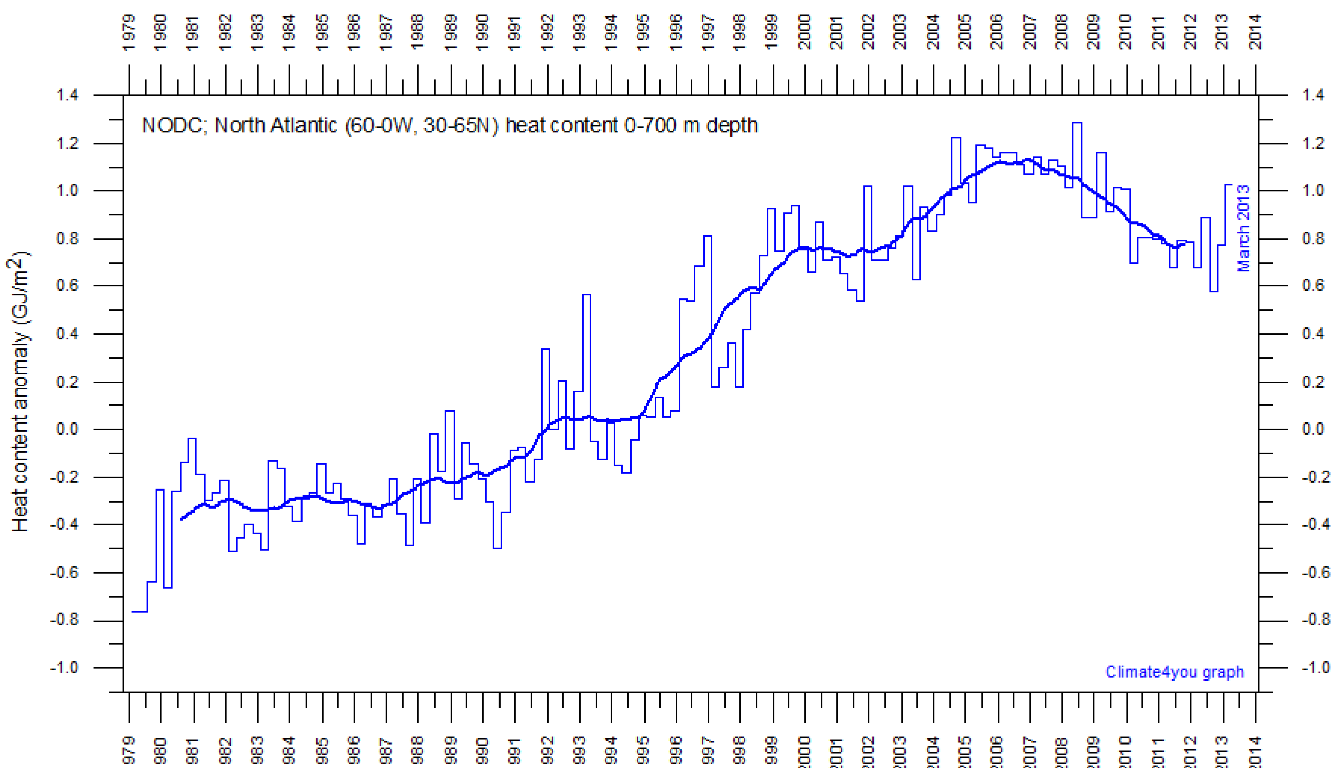
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



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).

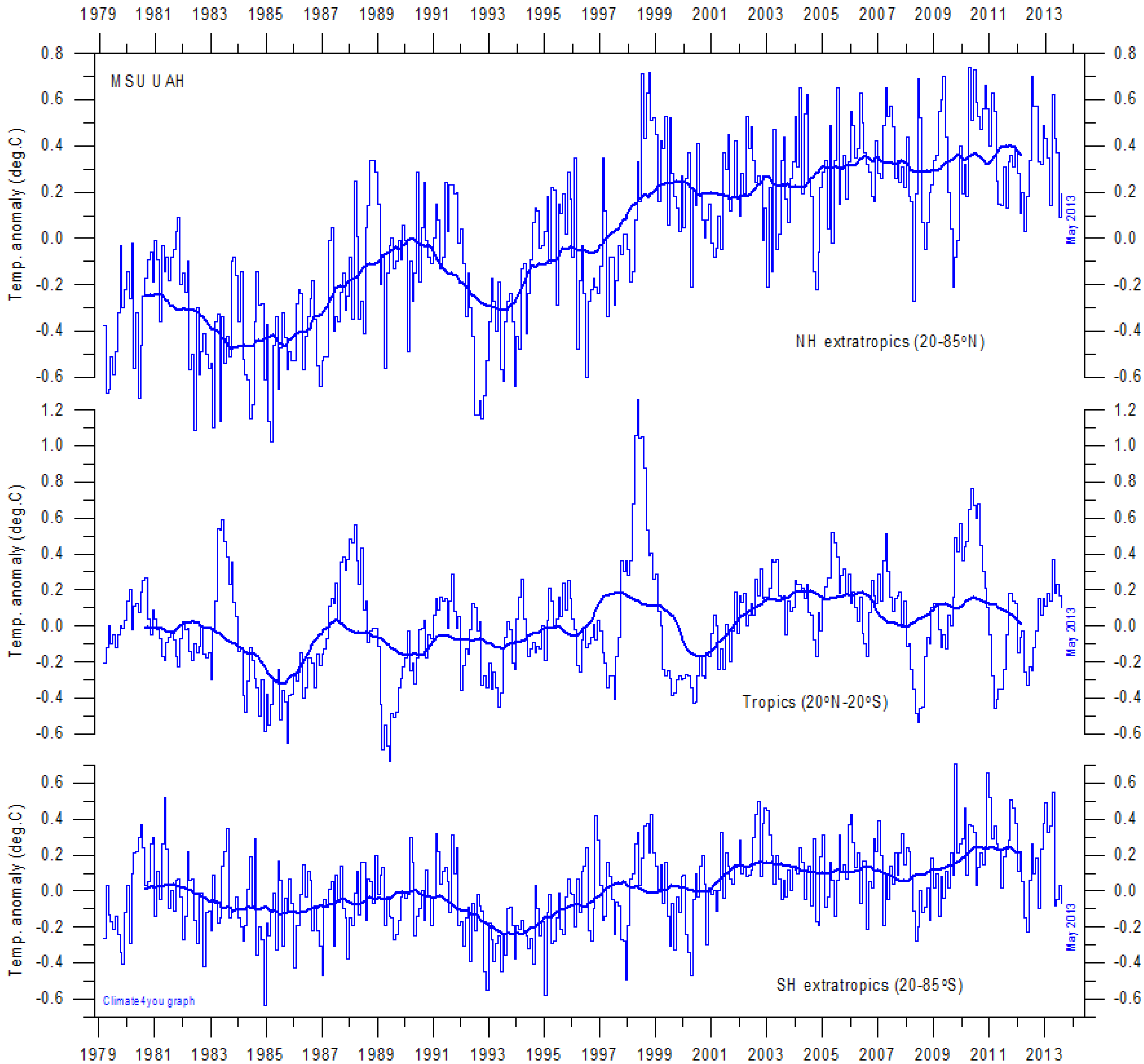
North Atlantic heat content uppermost 700 m, updated to March 2012





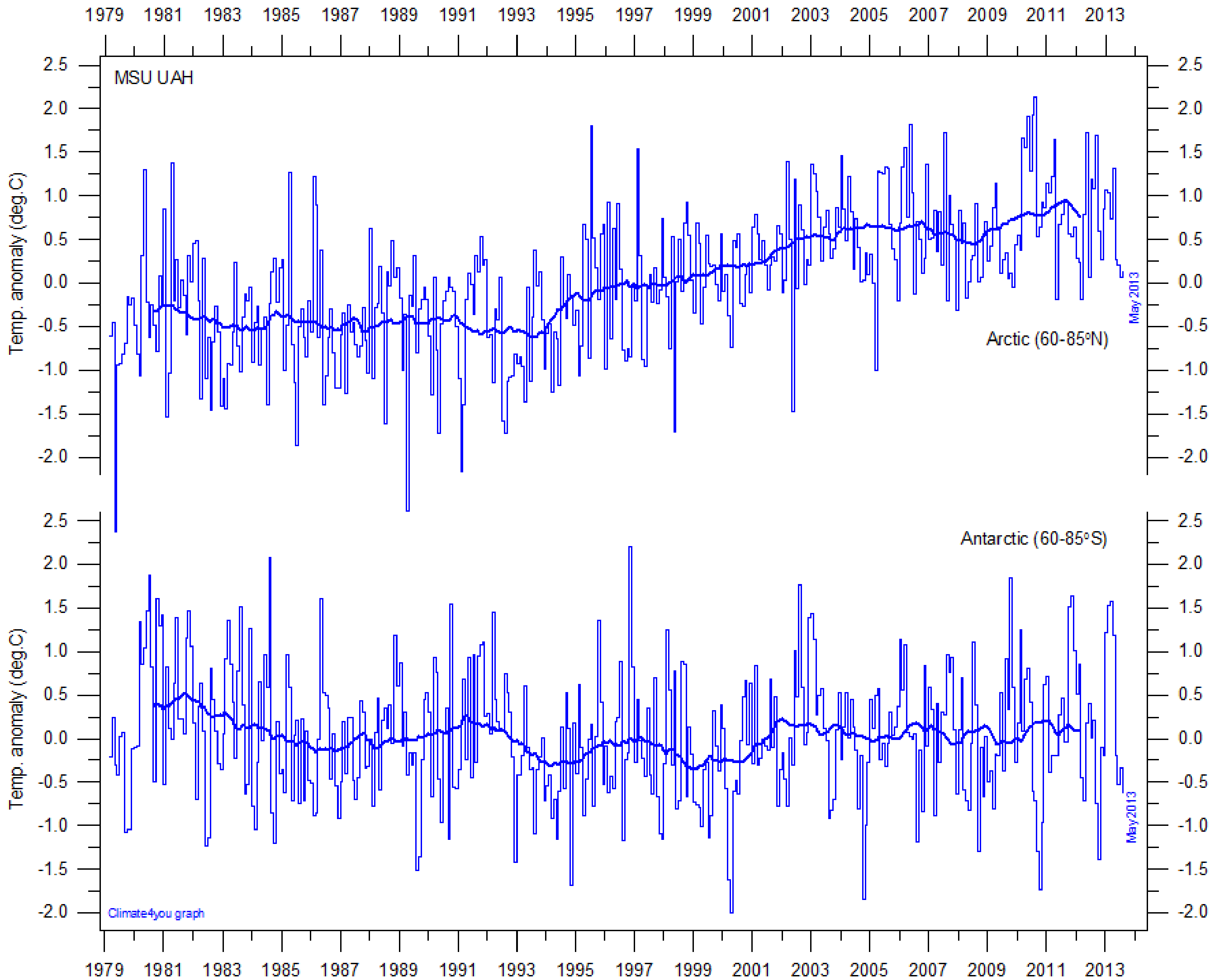
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the North Atlantic (60-0W, 30-65N; see map above) *ocean since January 1979. The thin line indicates monthly values, and the thick line represents the simple running 37 month (c. 3 year) average. Data source: National Oceanographic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

Zonal lower troposphere temperatures from satellites, updated to May 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 May 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 April 2013

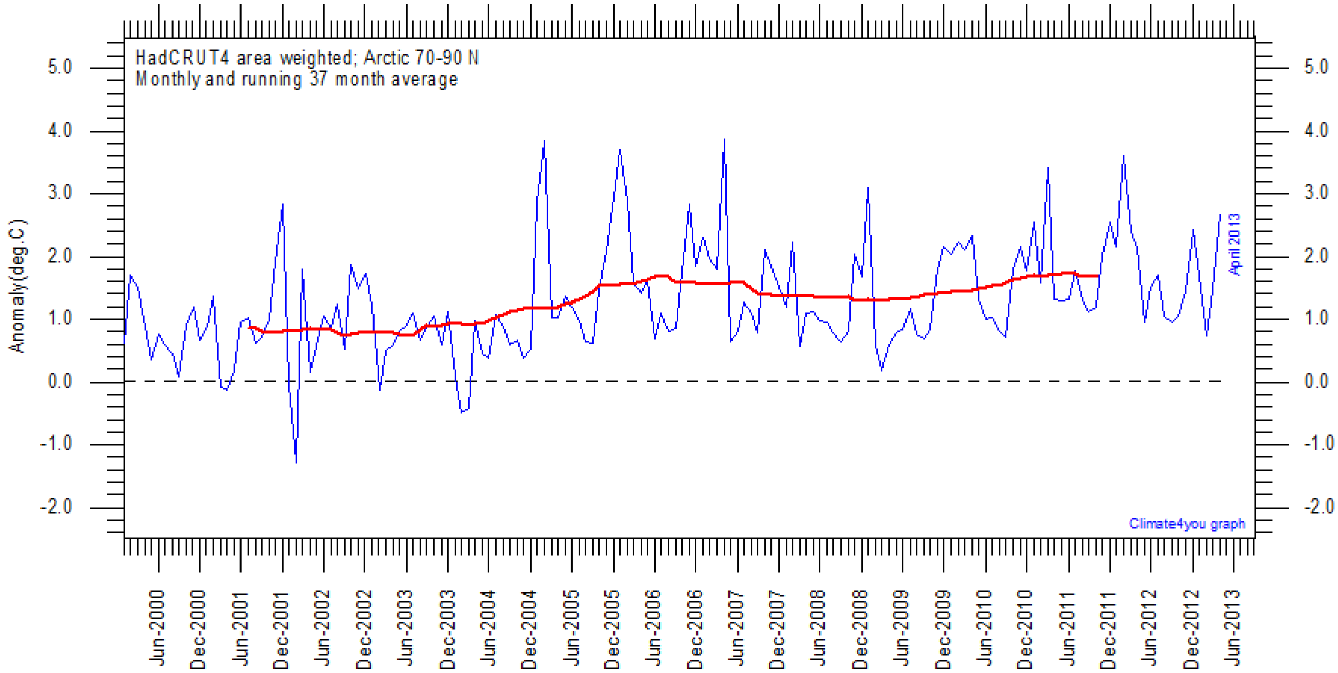


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]()) since January 2000, in relation to the WMO [normal period]() 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

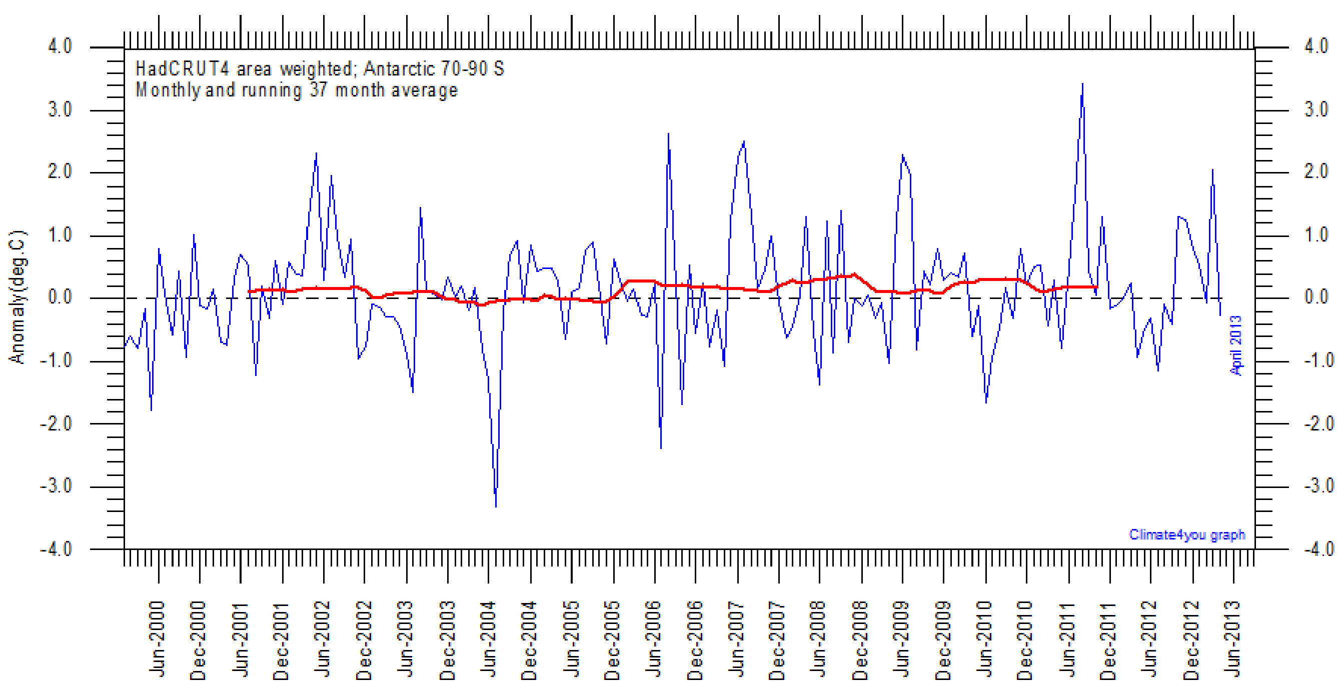


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]()) since January 2000, in relation to the WMO [normal period]() 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

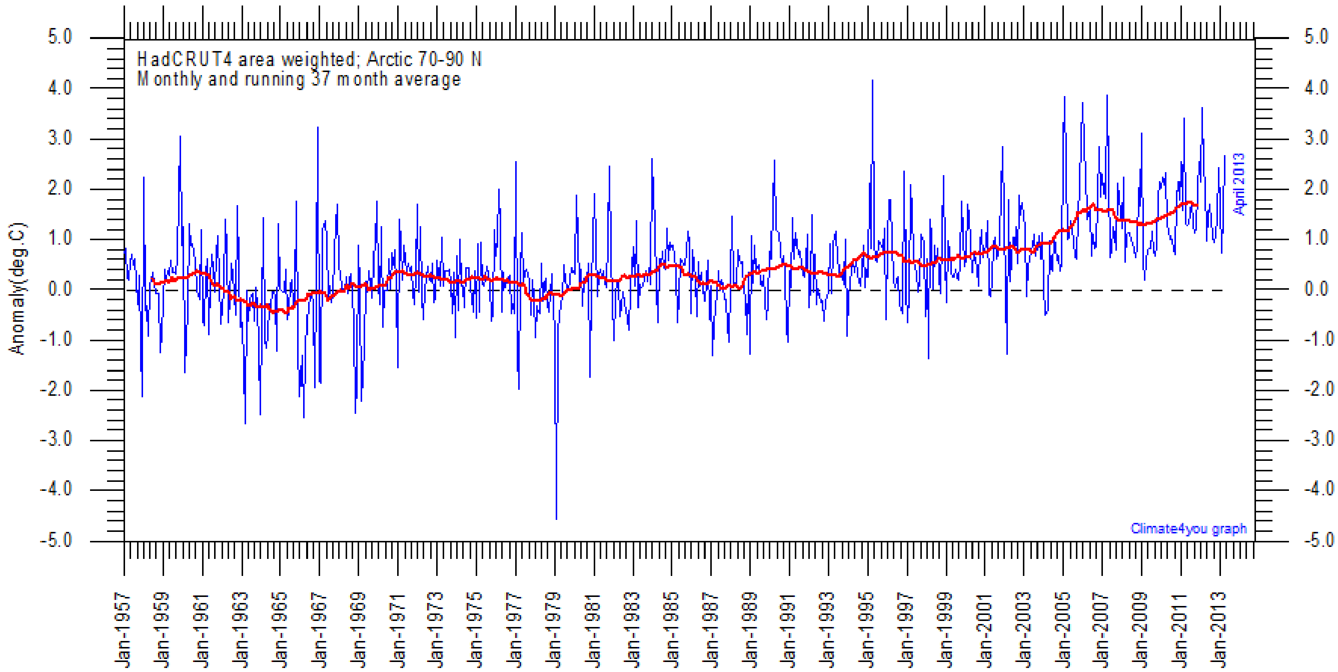


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

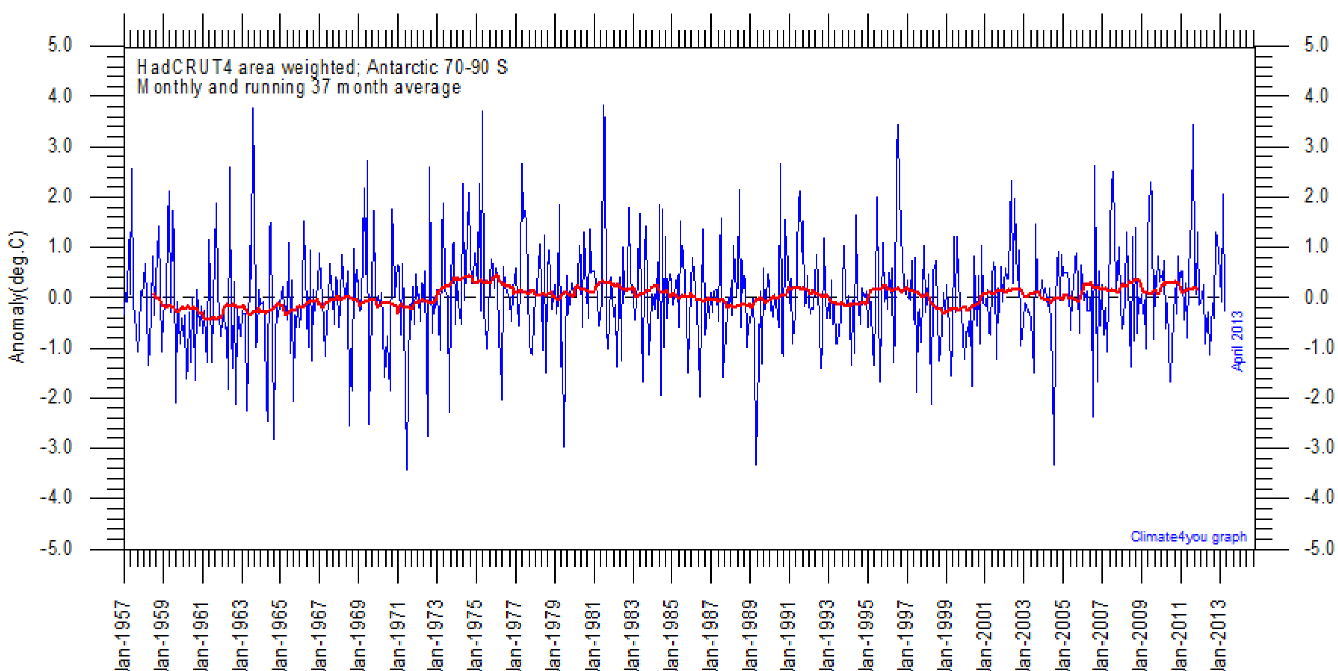


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

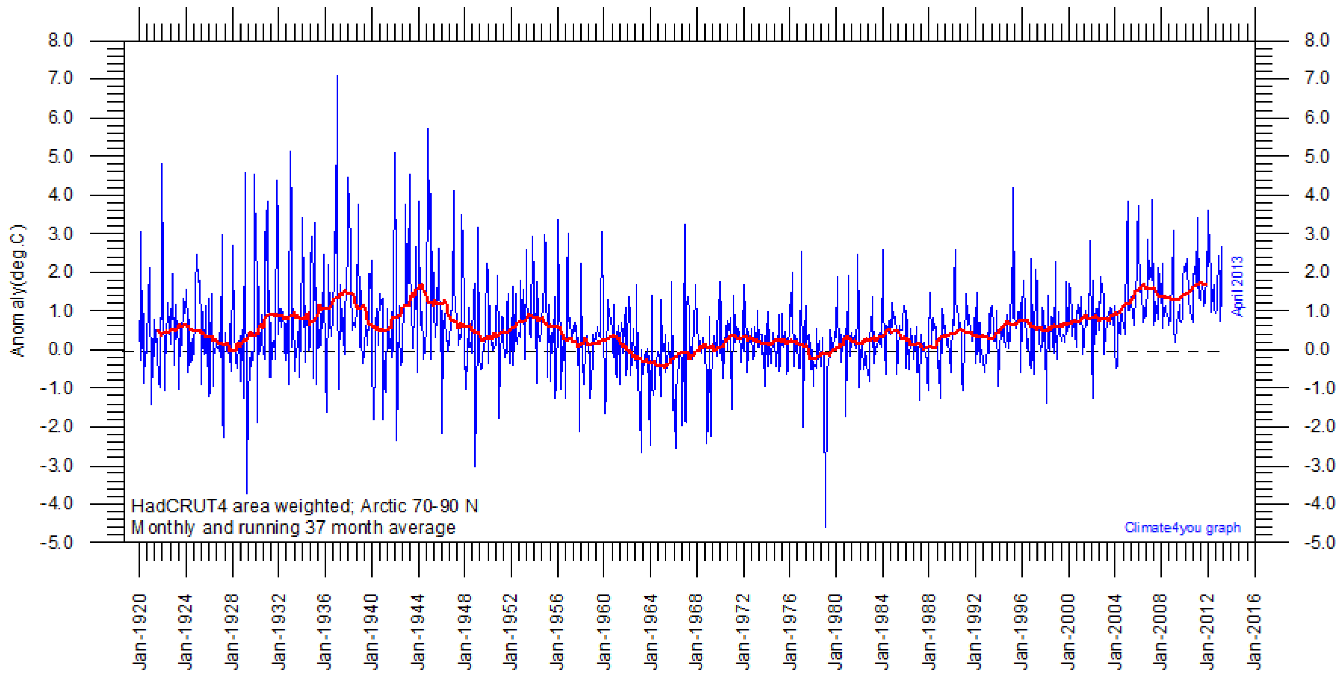


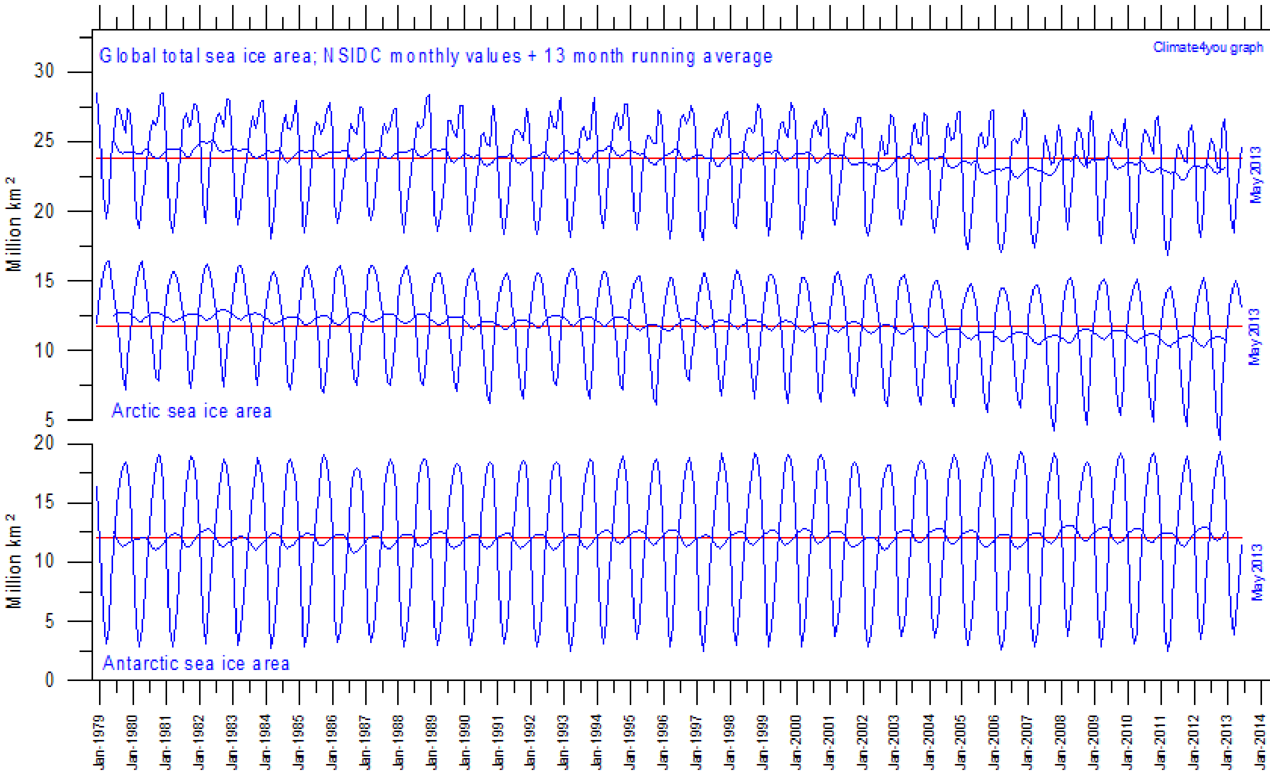
Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 1920, in relation to the WMO normal period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average. Because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

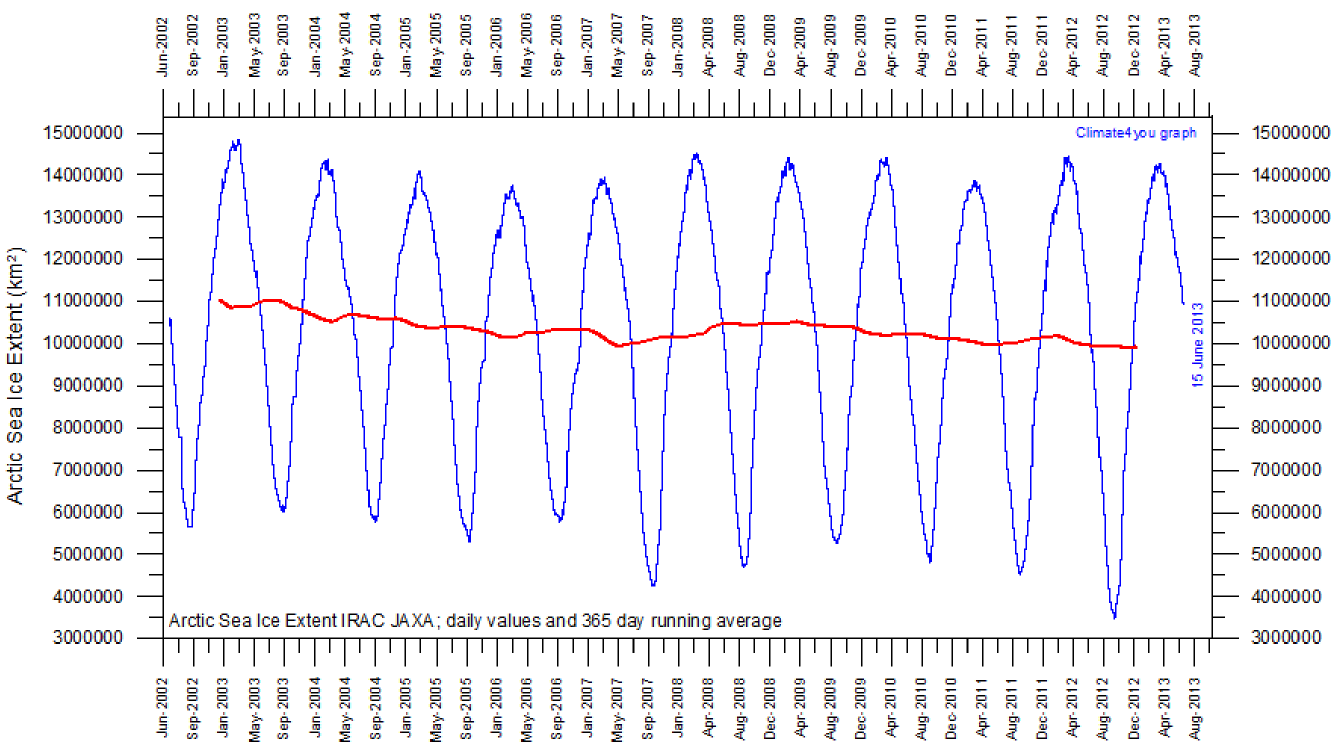
Literature:

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.

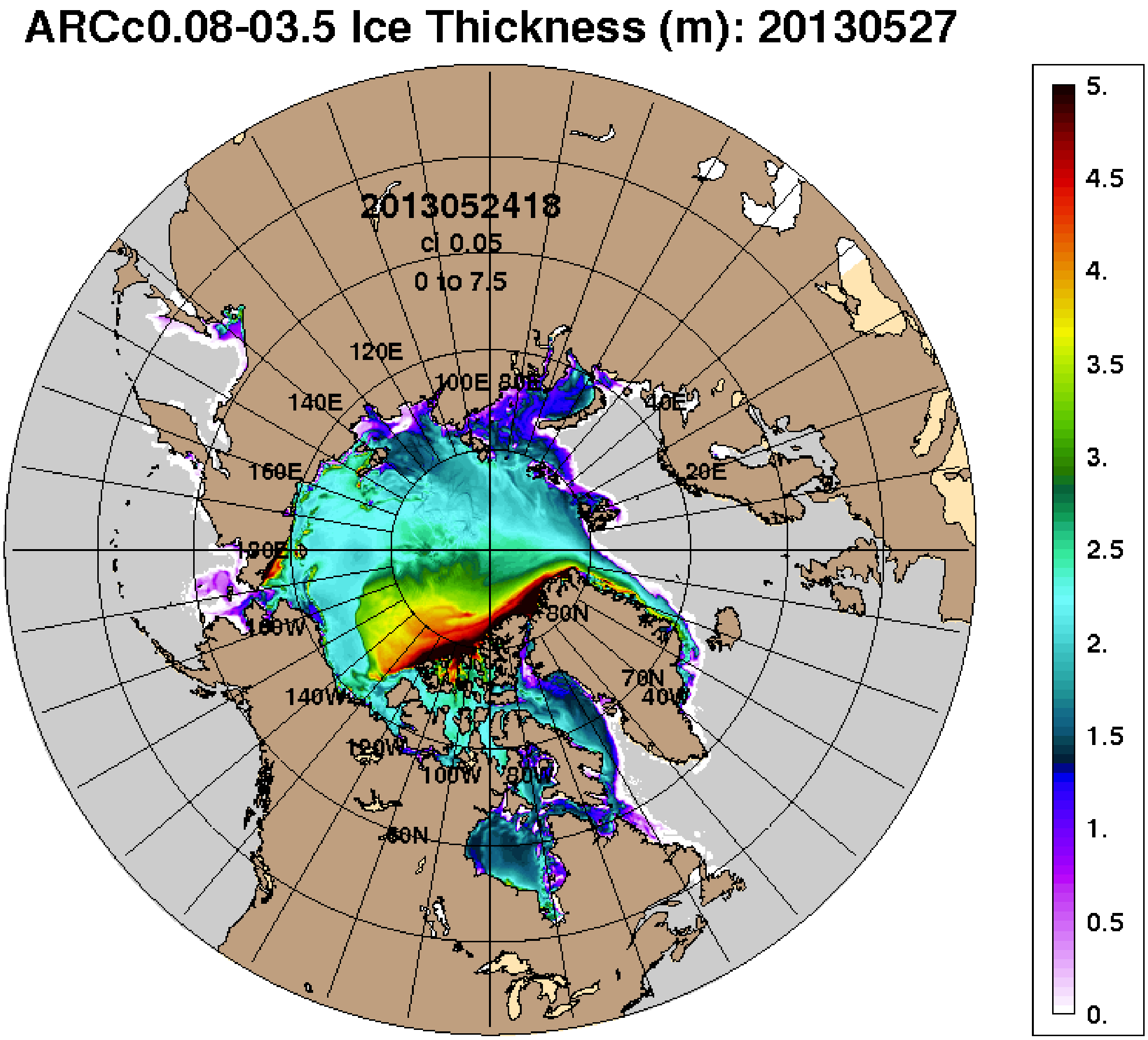
Arctic and Antarctic sea ice, updated to May 2013



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

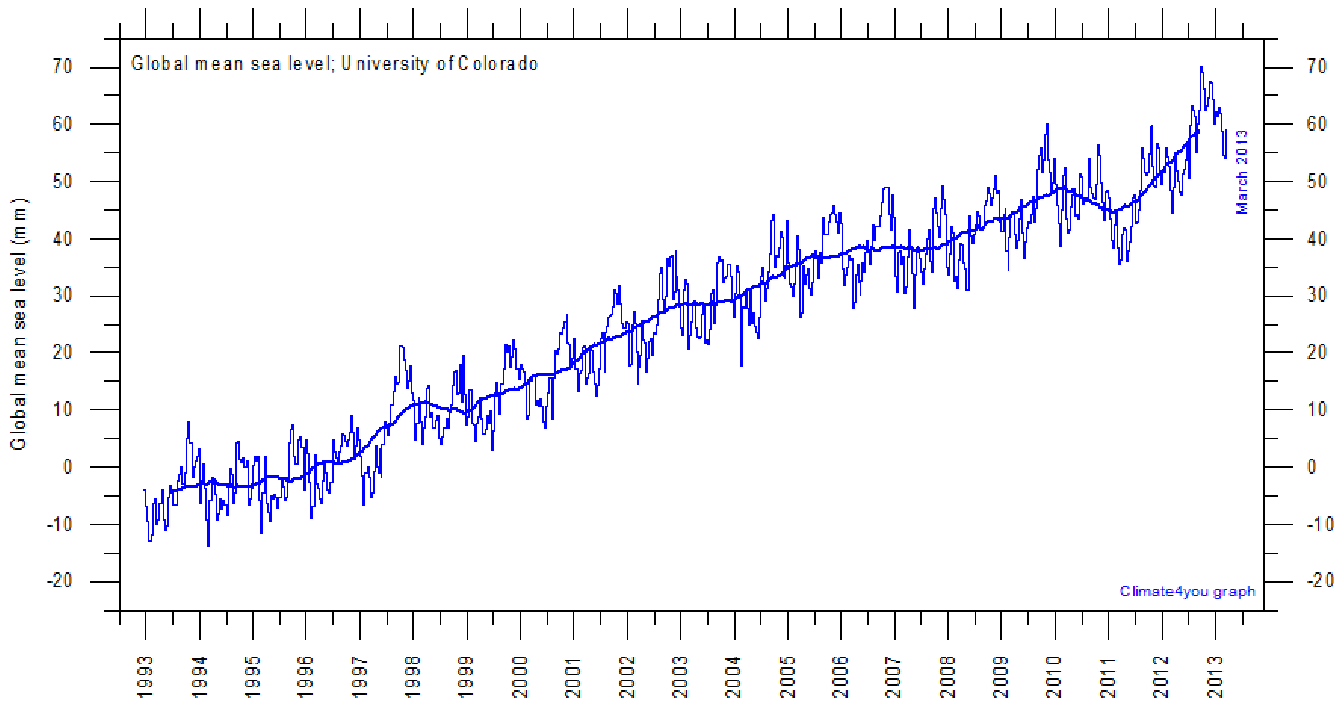


Graph showing daily Arctic sea ice extent since June 2002, to June 15, 2013, by courtesy of [Japan Aerospace Exploration Agency](#) (JAXA).

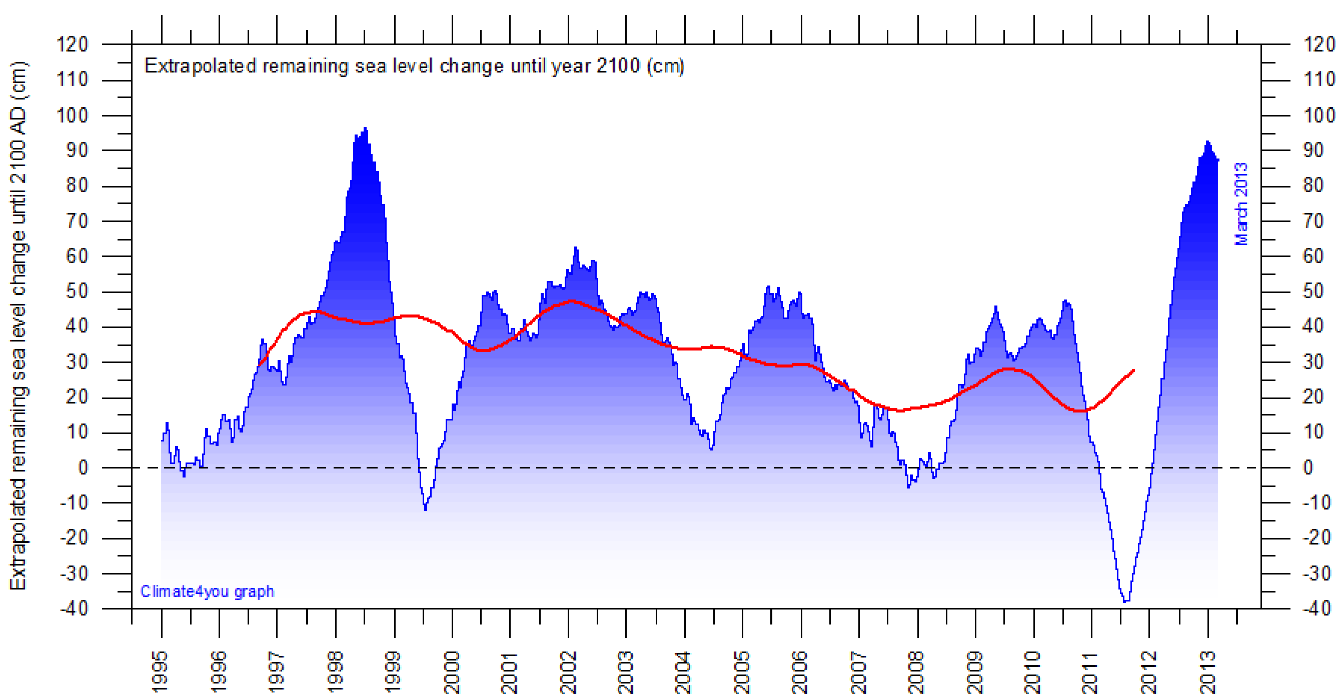


Northern hemisphere sea ice extension and thickness on 27 May 2013 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) is shown to the right.

Global sea level, updated to March 2013

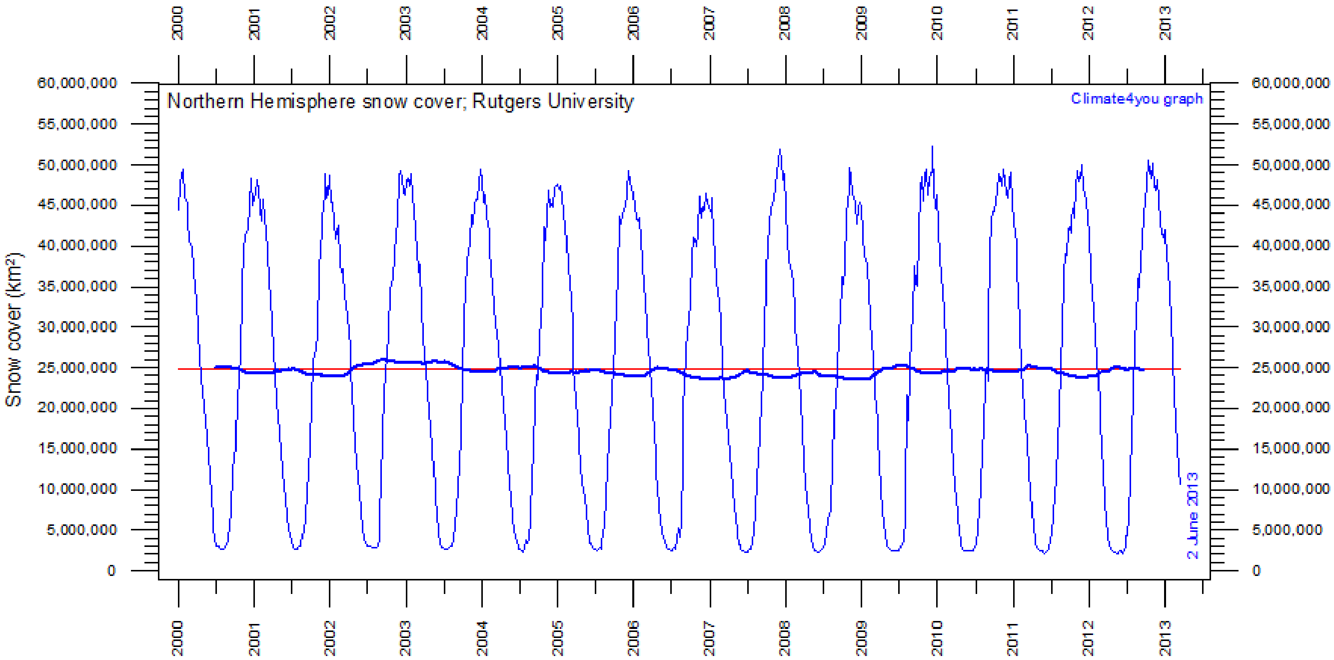


Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at University of Colorado at Boulder, USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

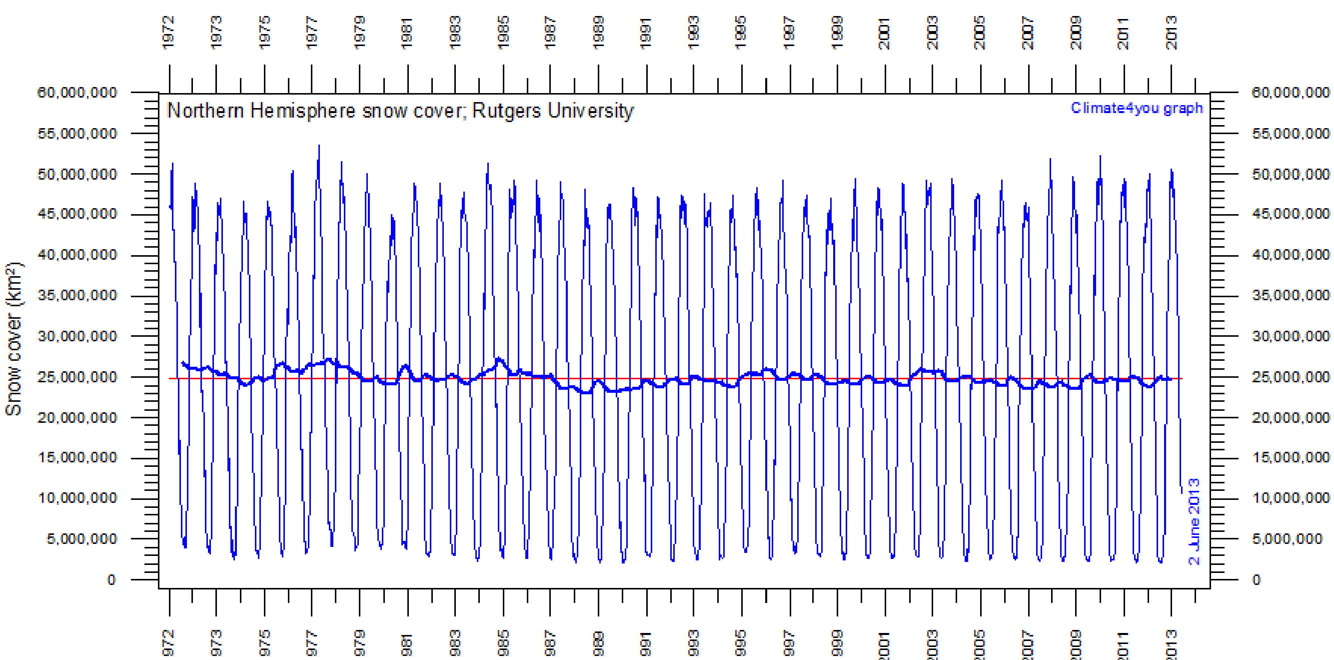


Forecasted change of global sea level until year 2100, based on simple extrapolation of measurements done by the Colorado Center for Astrodynamics Research at University of Colorado at Boulder, USA. The thick line is the simple running 3 yr average forecast for sea level change until year 2100. Based on this (thick line), the present simple empirical forecast of sea level change until 2100 is about +29 cm.

Northern Hemisphere weekly snow cover, updated to early June 2013

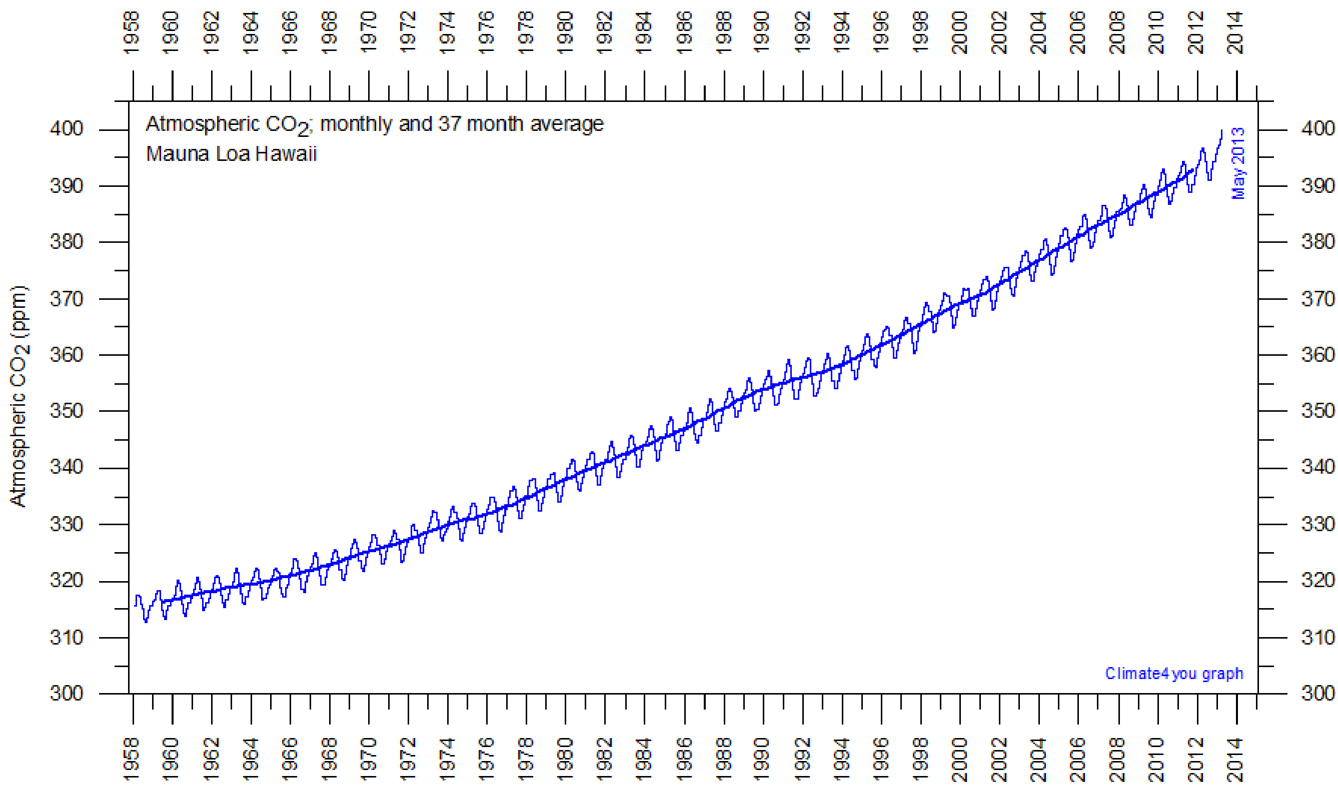


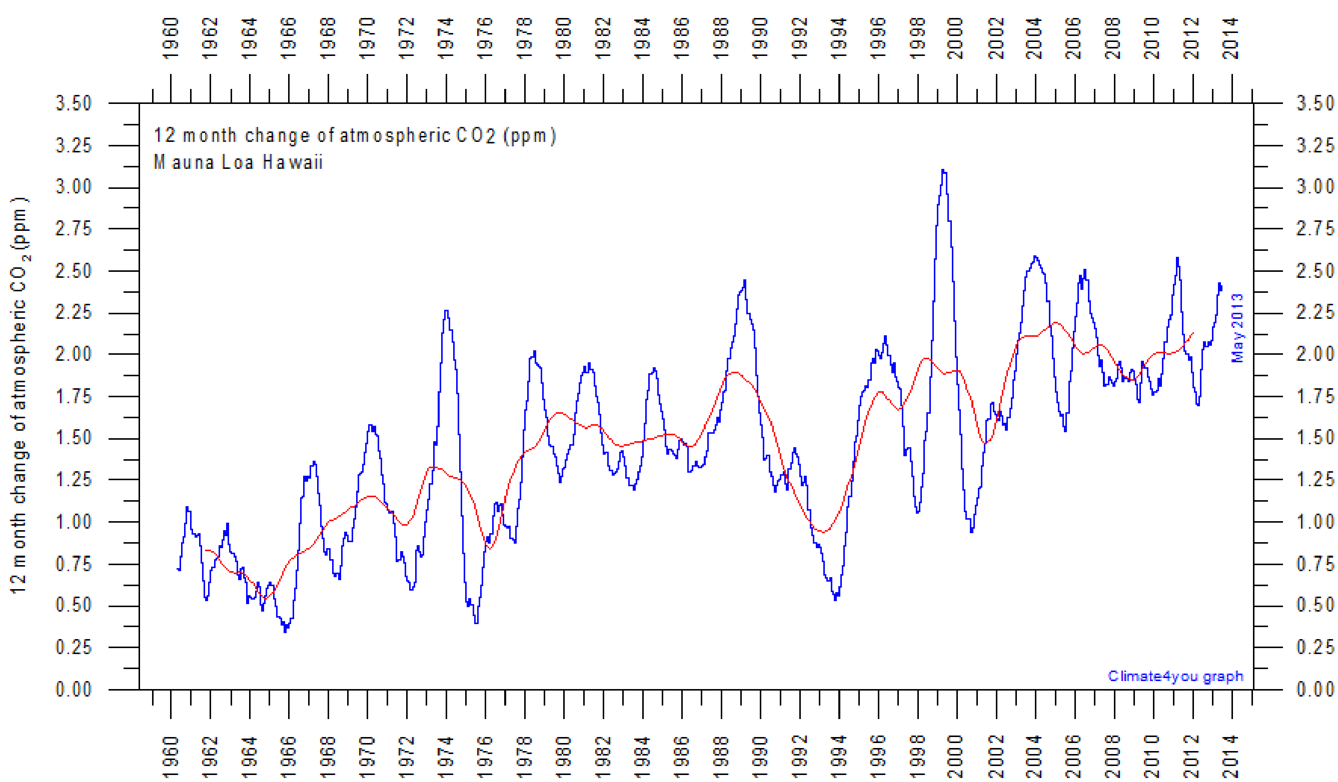
Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53 week average (approximately 1 year). The horizontal red line is the 1972-2012 average.



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.

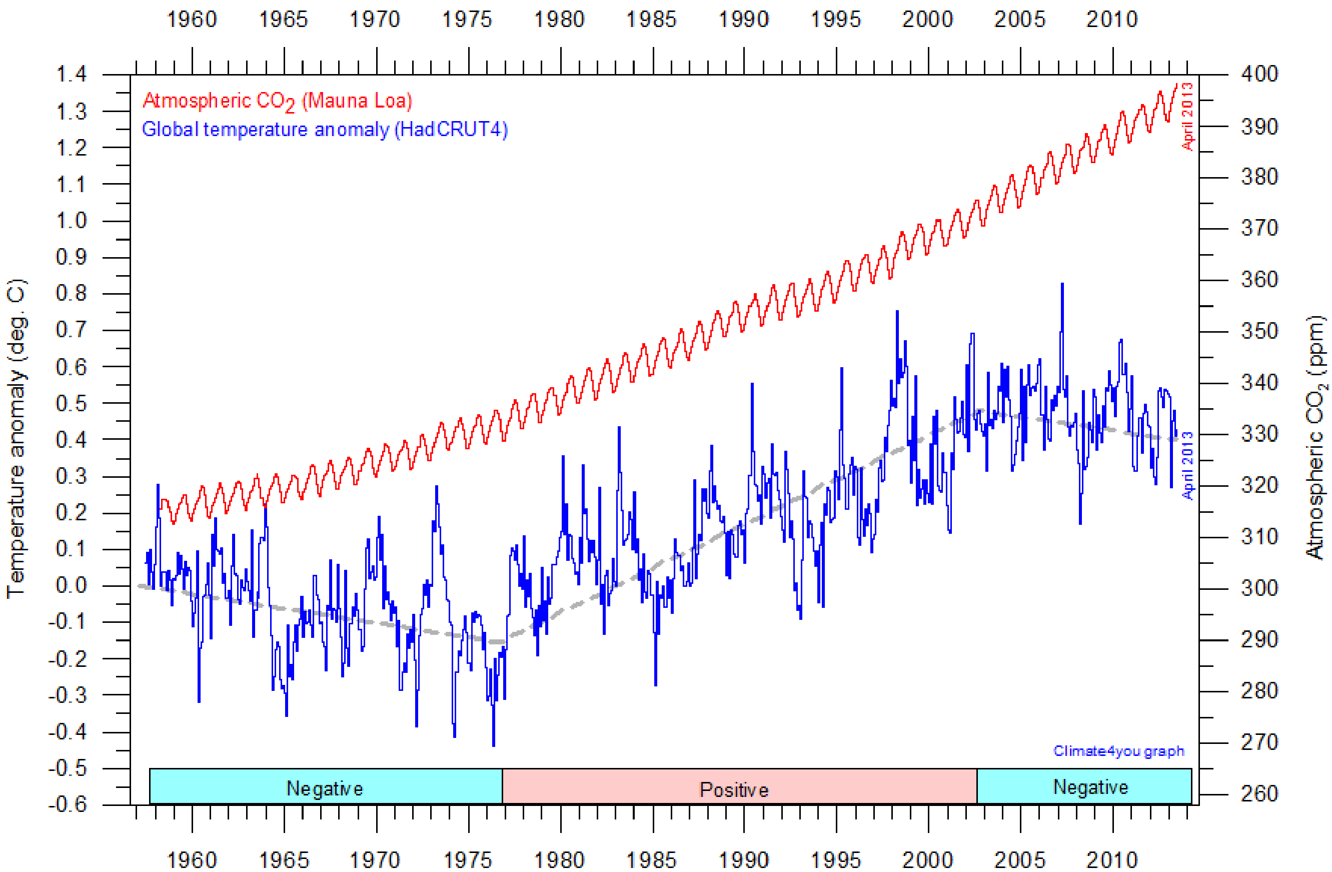
Atmospheric CO_2, updated to May 2013

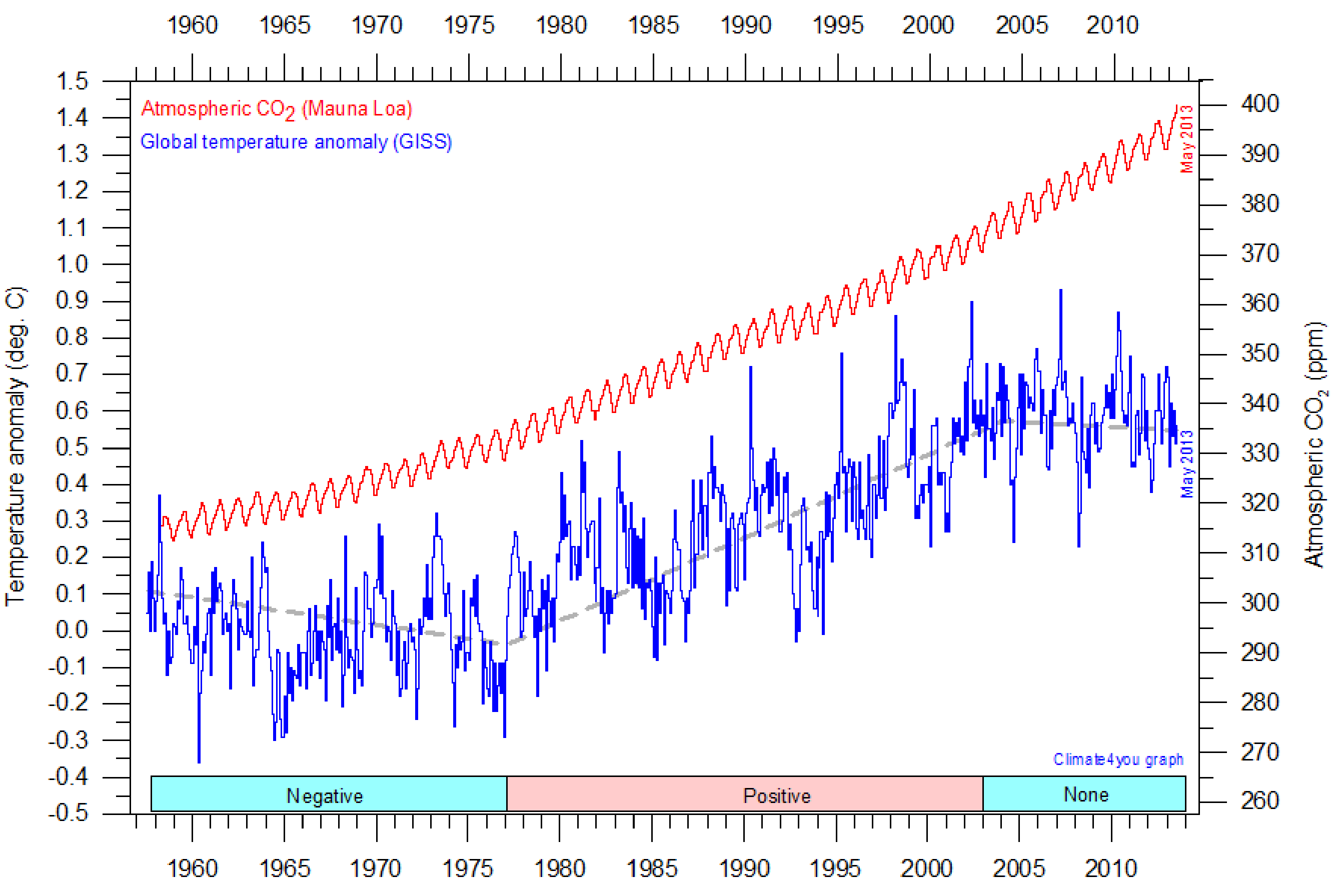


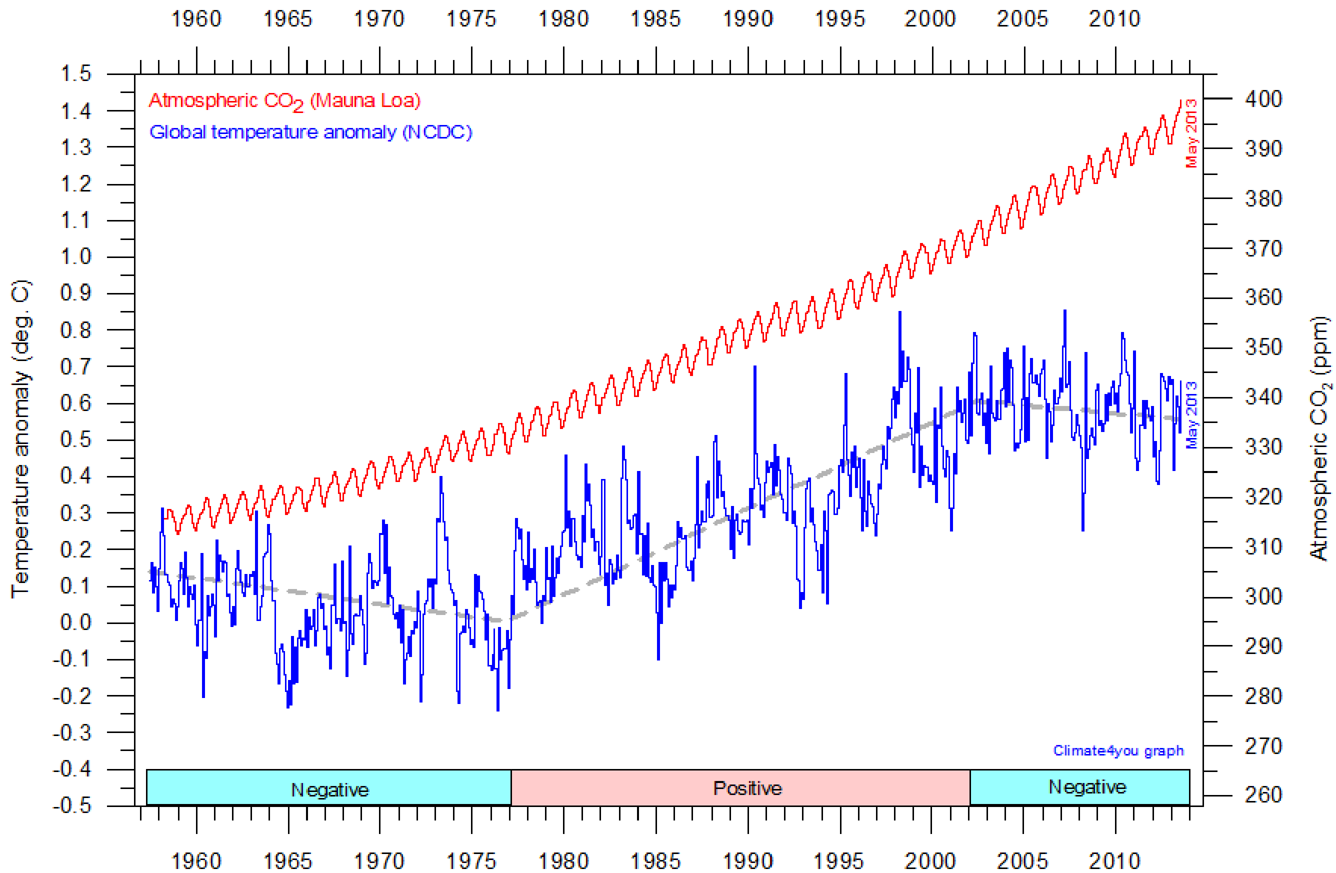


Monthly amount of atmospheric CO_2 (upper diagram) and annual growth rate (lower diagram); average last 12 months minus average preceding 12 months, blue line) of atmospheric CO_2 since 1959, according to data provided by the Mauna Loa Observatory, Hawaii, USA. The red line is the simple running 37 observation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

Global surface air temperature and atmospheric CO_2, updated to May 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 April 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.

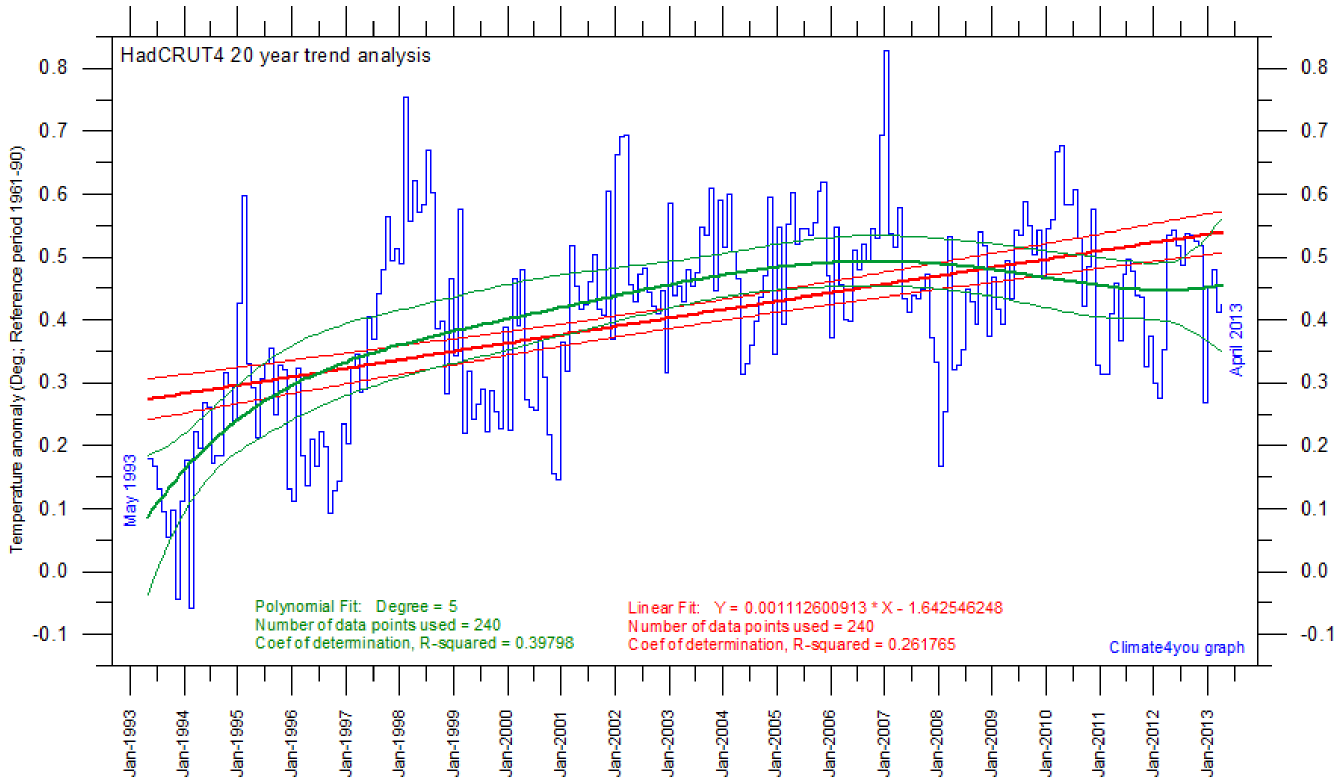
What exactly defines the critical length of a relevant time period to consider for evaluating the alleged importance of CO_2 remains elusive, and is still a topic for discussion. However, the critical period length must be inversely proportional to the temperature sensitivity of CO_2, including feedback 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 April 2012



28 *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.

Year 1600-1800: Land abandonment in southeast Scotland

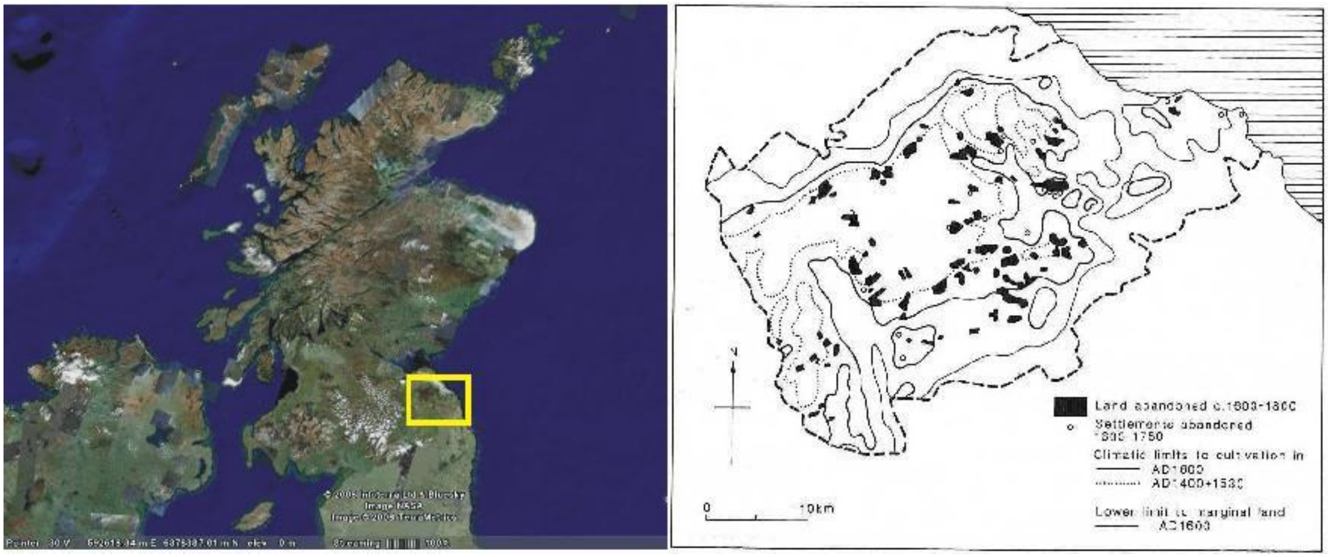
Moulzie farm (290 m asl.) in uppermost Glen Clova, Angus, Scotland, May 7, 2008. At this altitude only grass can be grown and harvested in the early 21st century. .

In southeast Scotland, as in much of northwestern Europe, higher-altitude arable land has commonly been used to grow oats, but there has been extensive abandonment of such land in the last millennium.

In Britain, oats grown above 250 m altitude are known to be sensitive to summer warmth, exposure and summer wetness, which may be measured in terms of accumulated temperature, average wind speed and end-of-summer potential water surplus (Parry 1975).

In the Lammermuir Hills in southeastern Scotland (see figure next page), minimum levels of summer warmth for the ripening of oats have been established to be 1050 degree-days above a base of 4.4^{o}C, and maximum tolerable levels of the other two limiting factors 6.2 m/s average wind speed and 60 mm potential water surplus (Parry 1975, 1976). It is estimated that if, over the period 1250-1450, the mean annual air temperature fell a little less than 1^{o}C, then summer warmth at 300 m altitude in northern England would have been reduced by 15 per cent. The frequency of crop failure would increase sevenfold from 1 year in 20 to 1 year in 3, and the frequency of two consecutive crop failures increased 70 times.

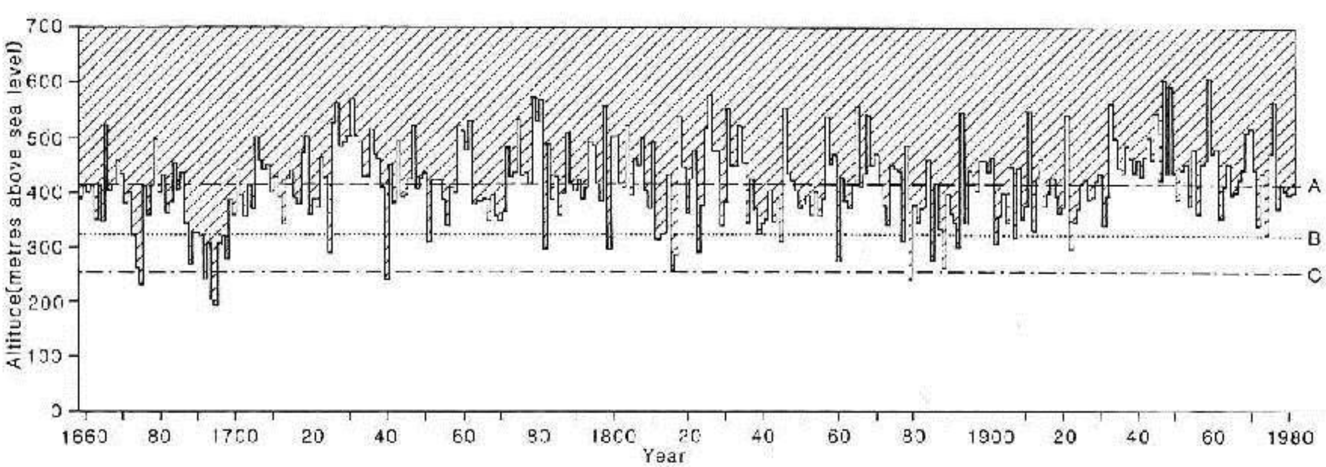
The processes involved in land abandonment can be better understood if changes in climate are considered in terms of changes in frequency of short-term anomalous events (Grove 1988). Such events affect the level of risk faced by the farmer. The viability of farmland essentially depends on its ability to sustain the household from one harvest to the next. The extent to which yield exceeds this essential minimum is less important than the likelihood of achieving the minimum in a given year, and the probability of harvest failure is more important than average yield over a number of years. Harvest failure in two successive years, leading to the consumption of the seed grain or the exhaustion of cash reserves, is likely to be disastrous.



Satellite picture showing Scotland with Lammermuir Hills indicated (left). Map over Lammermuir Hills showing farmland abandoned and lowered climatic limits to cultivation 1600-1800. Small circles show settlements abandoned 1600-1750 (Parry 1975; right).

In maritime upland areas, quite small increases in altitude commonly result in marked shortening of the growing season and a great reduction in the accumulated warmth as measured in degree-days above a certain temperature (Manley 1945). Parry and Carter (1985) evaluated the risk of crop failure resulting from low levels of accumulated temperature in the Lammermuir Hills, southeastern Scotland, using data for the period 1659-1981 from central England (Manley 1974) compared with meteorological observations at Edinburgh and a network of 27 stations covering the Southern Uplands.

As the regionally averaged lapse rate of air temperature with elevation is known to be 0.68°C per 100 m, the height at which the minimum accumulated temperature for ripening of oats of 970 degree-days is achieved each year could be calculated (see diagram below). It is seen that while the critical altitude for ripening of oats was about 450 m above sea level during the warm period around 1940, this critical altitude was depressed to about 250-300 m during the cold period between 1685 and 1700.



Hypothetical shift of oat crop failure with altitude in southern Scotland 1650-1981. A = mean altitude of crop failure. B = 1:10 failure frequency. C = 1:50 failure frequency (from Parry and Carter 1985).

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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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