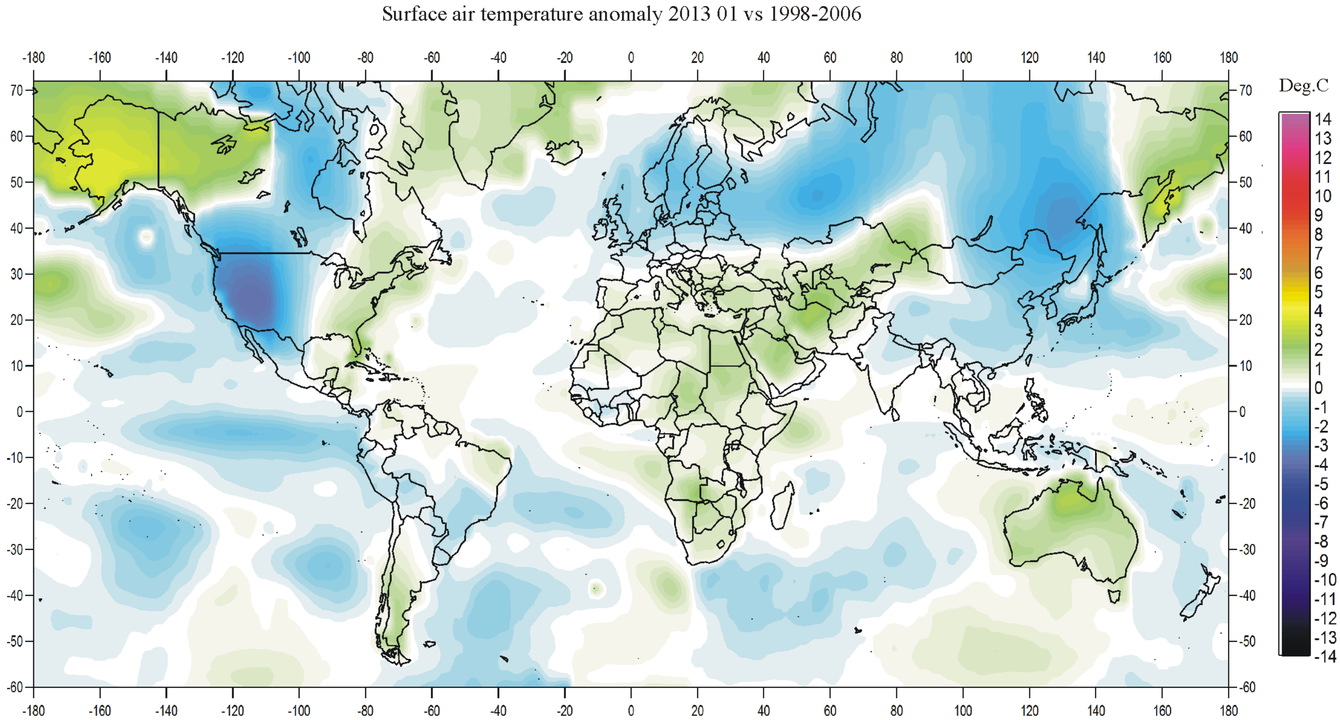
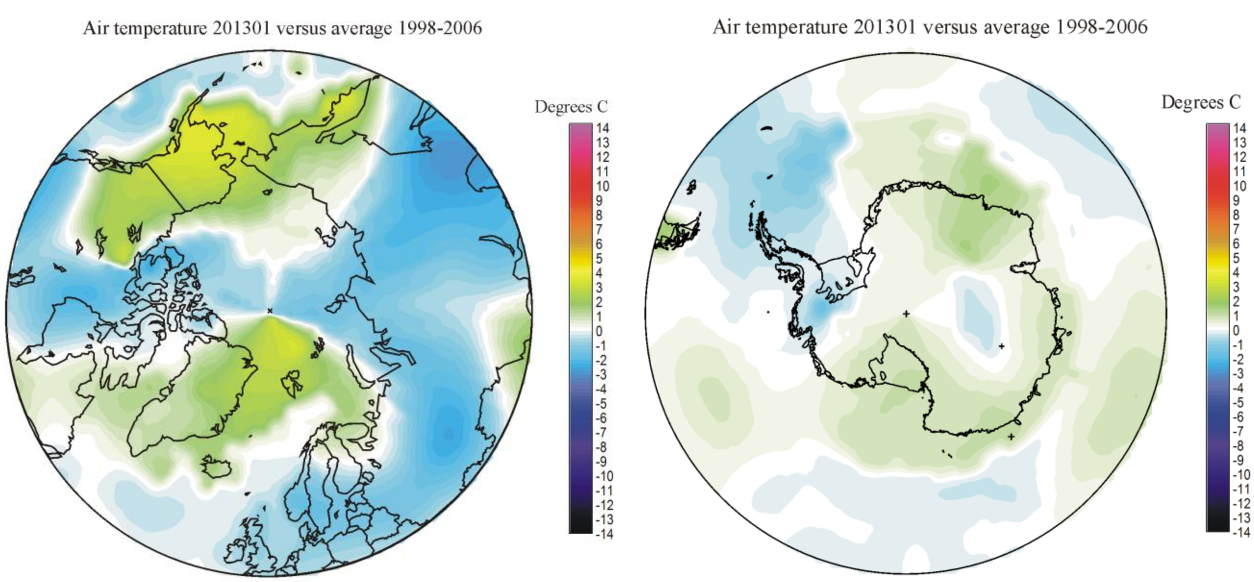
Climate4you update January 2013

Contents:

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

January 2013 global surface air temperature overview





January 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 January 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.

January 2013 global surface air temperatures

General: On average, global air temperatures were near the 1998-2006 average, although with big regional differences

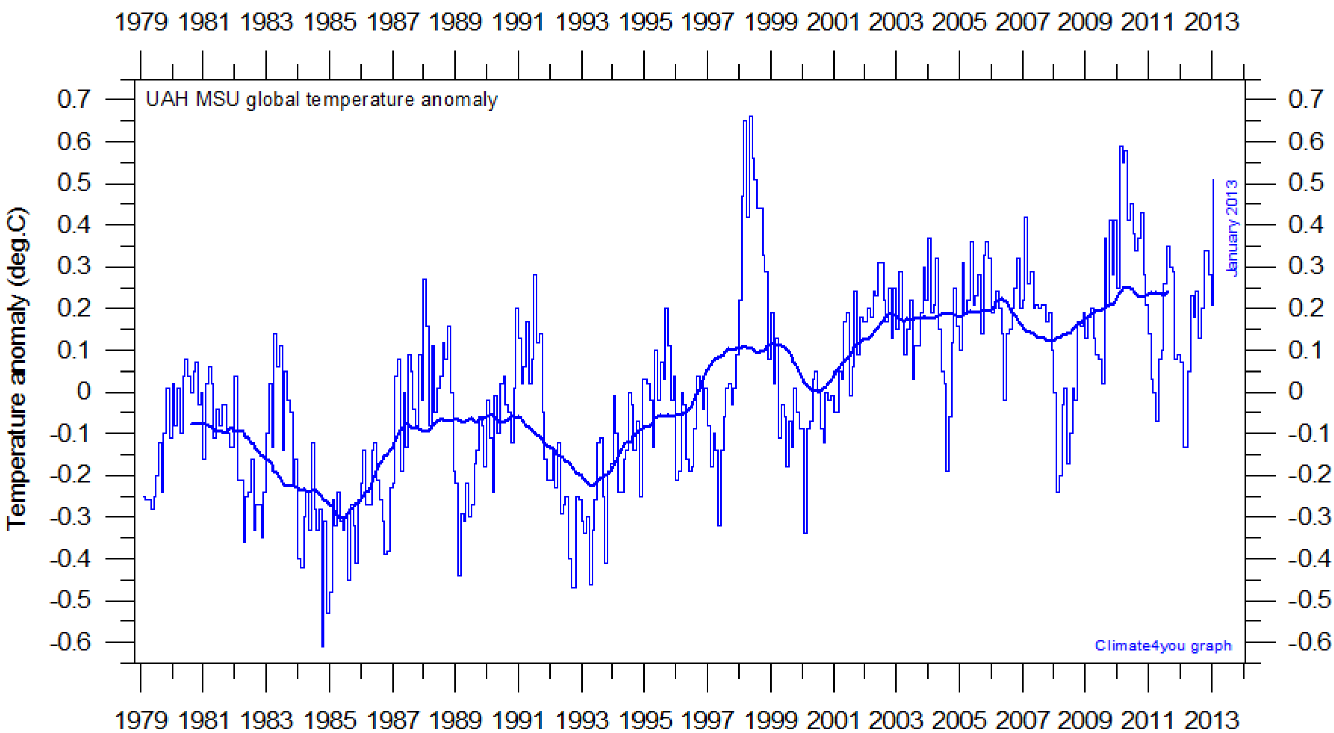
The Northern Hemisphere was characterised by big temperature contrast from one region to another. Most of Europe, Russia, western Siberia, mid Canada and western USA had temperatures below average. Easternmost Siberia, Alaska and NW Canada had relatively warm conditions. The marked limit between warm 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. However, central Africa had above average temperatures.

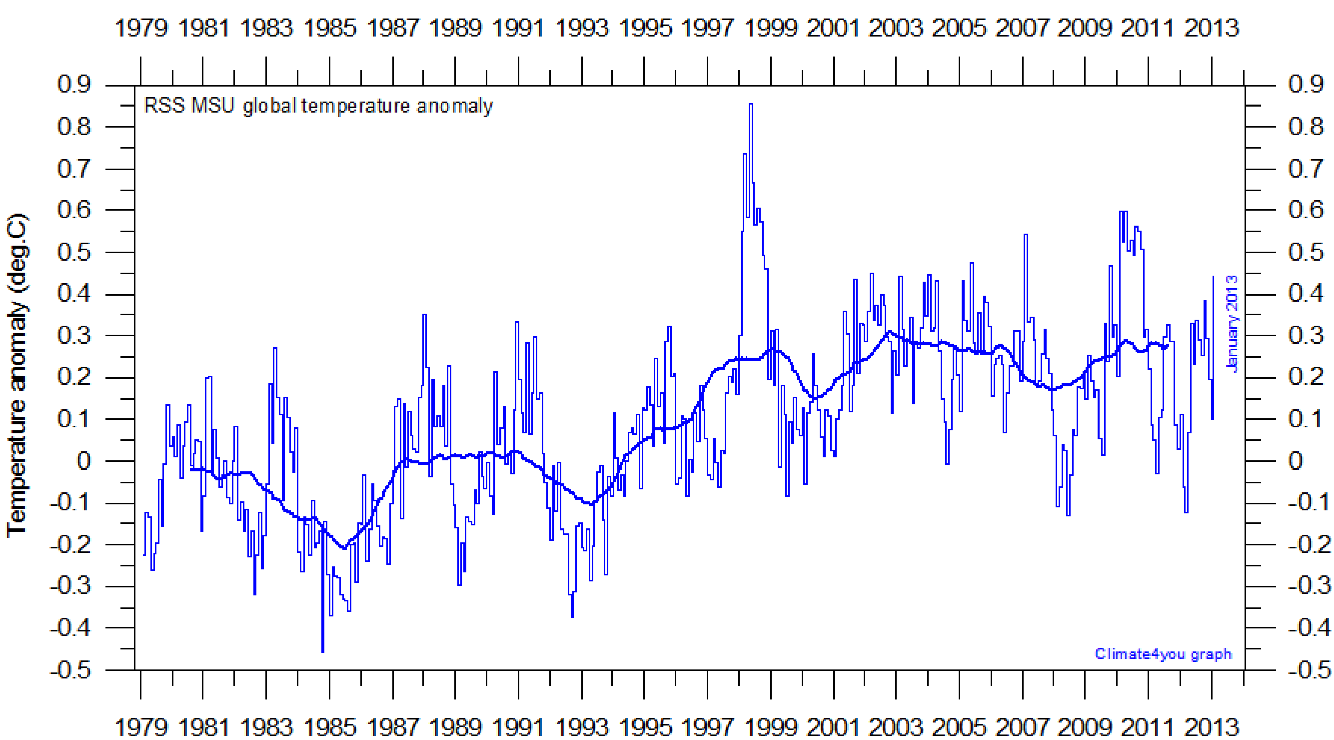
The Southern Hemisphere was mainly at or below average 1998-2006 conditions. The only important exceptions to this is represented by southern Africa and Australia, which experienced temperatures above the 1998-2006 average. The Antarctic continent was near or slightly above the temperature average.

The global oceanic heat content has been rather stable since 2003/2004 (page 12).

Lower troposphere temperature from satellites, updated to January 2013

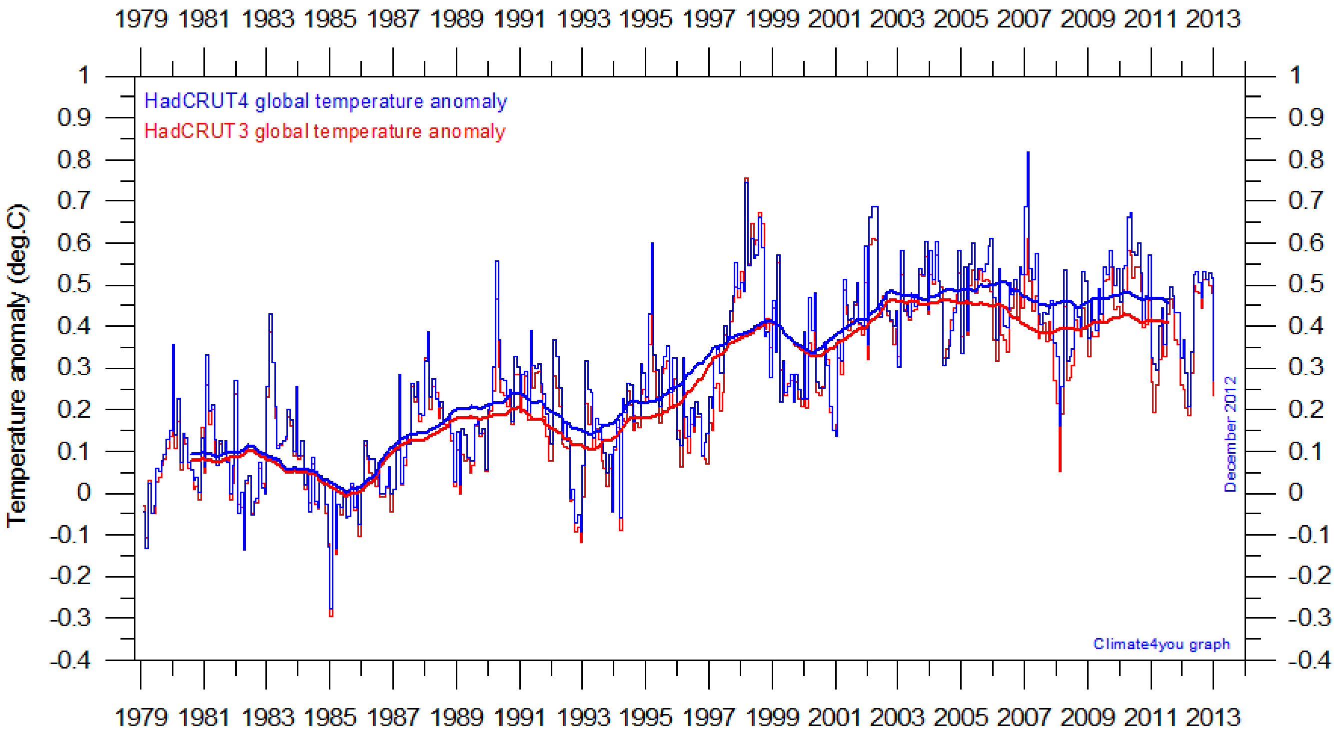


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37 month average.

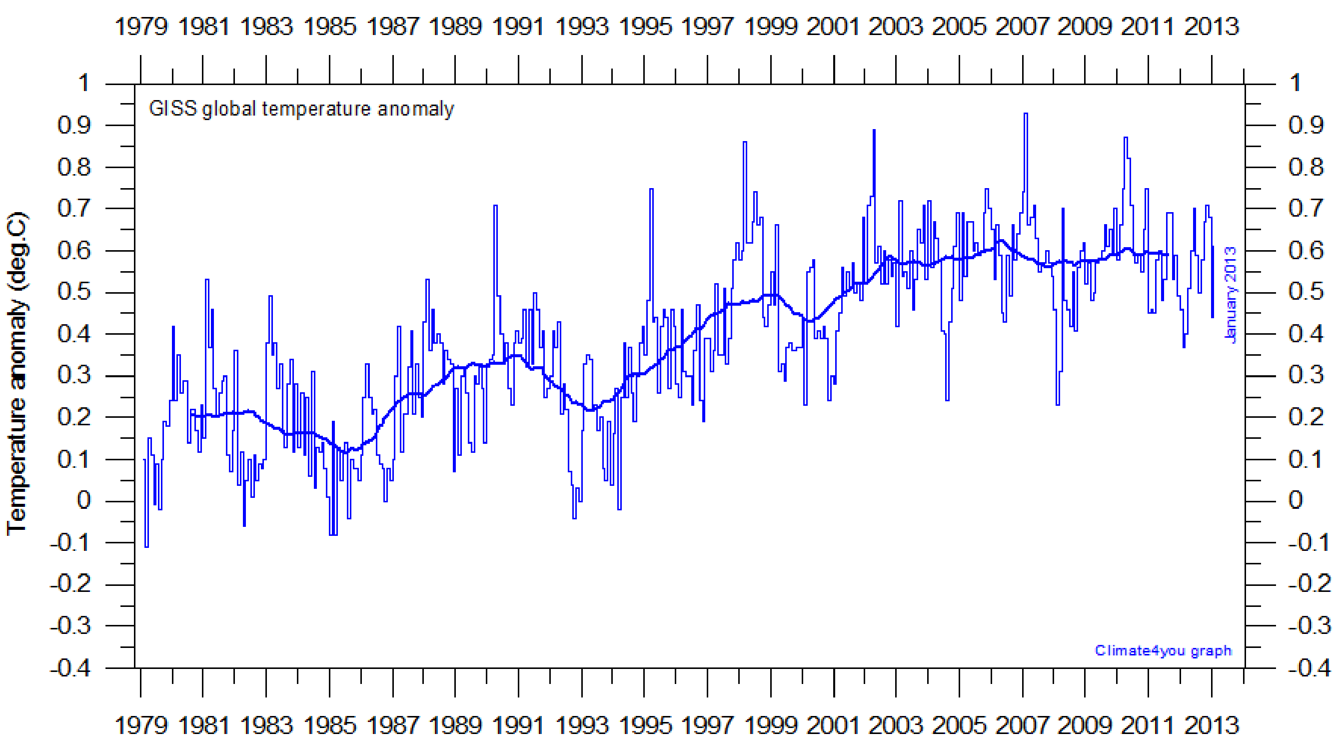


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37 month average.

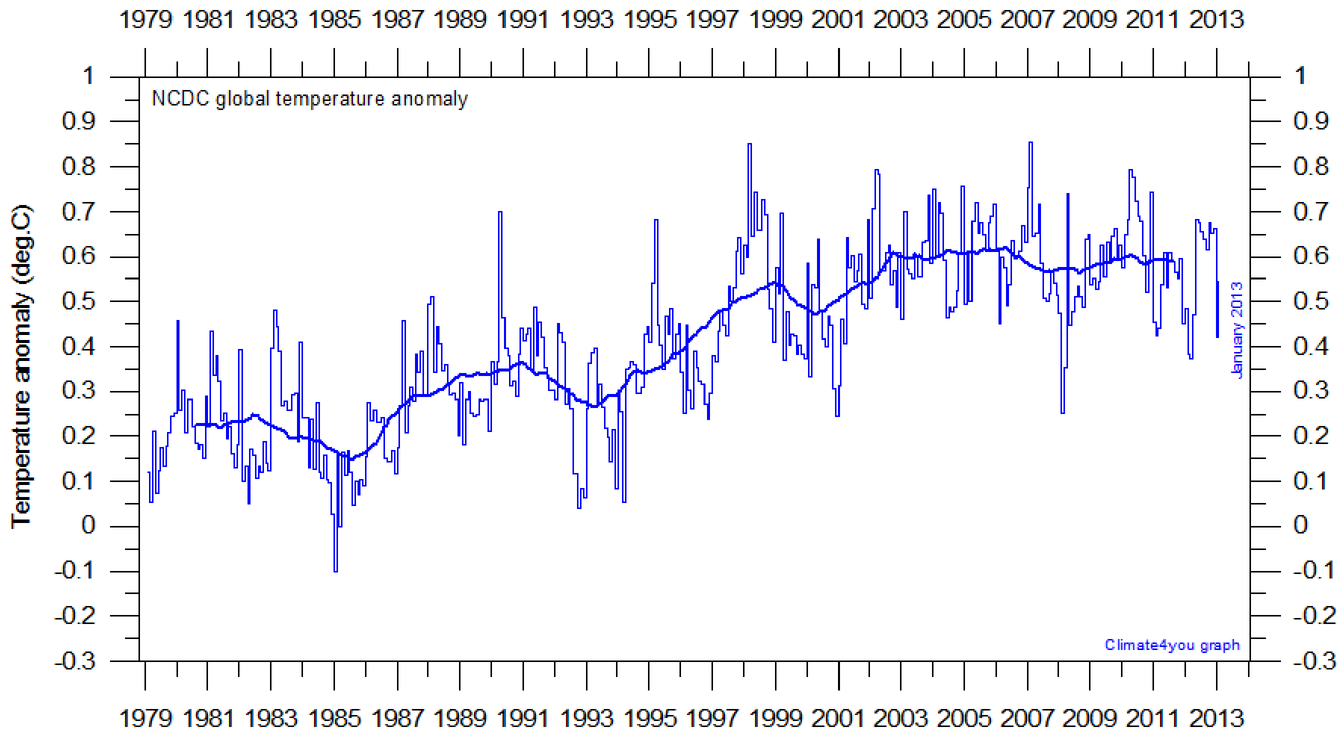
Global surface air temperature, updated to January 2013



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 is not updated beyond December 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.

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*).

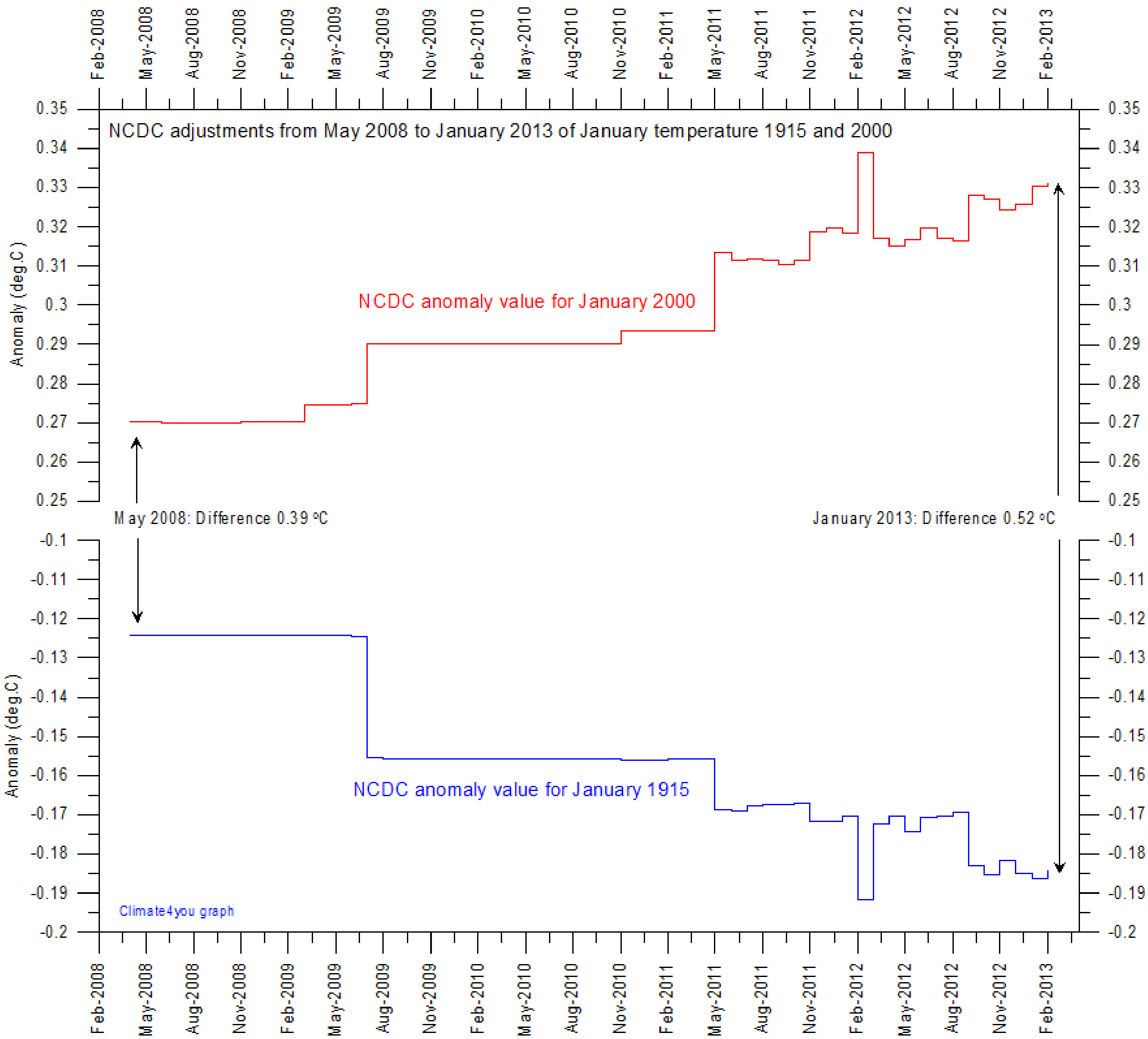
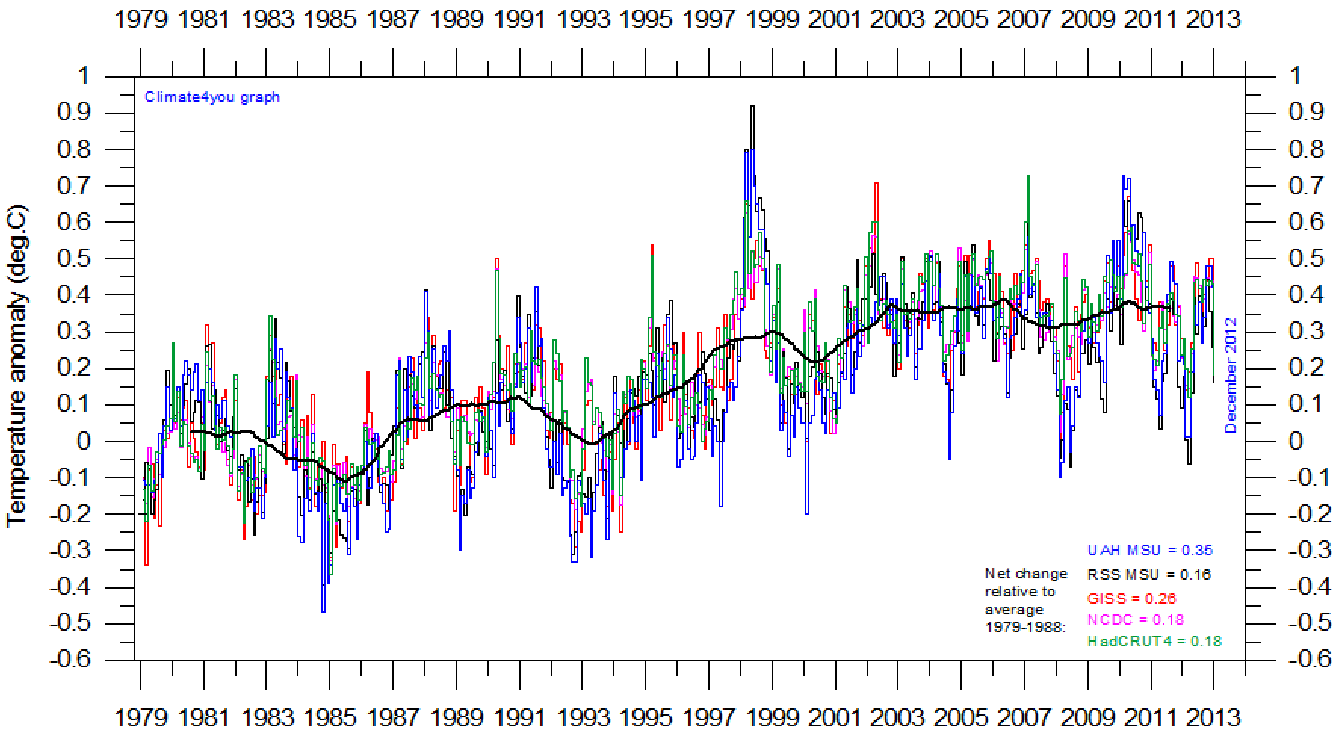


Diagram showing the adjustment made since May 2008 by the National Climatic Data Center (NCDC) in the anomaly values for the two months January 1915 and January 2000.

All in one, updated to December 2012

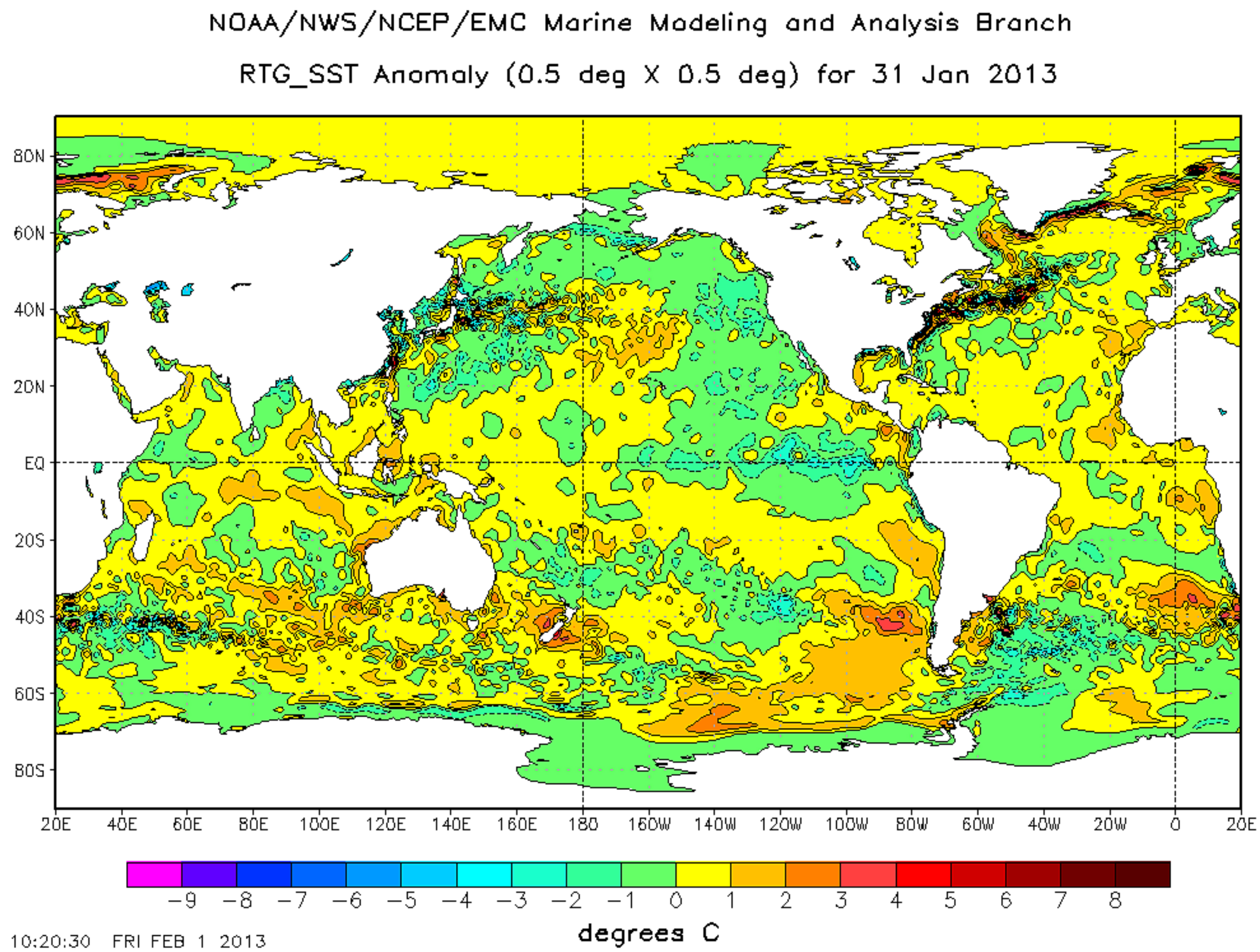


Superimposed plot of all five global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (10 years) from January 1979 to December 1988. The heavy black line represents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



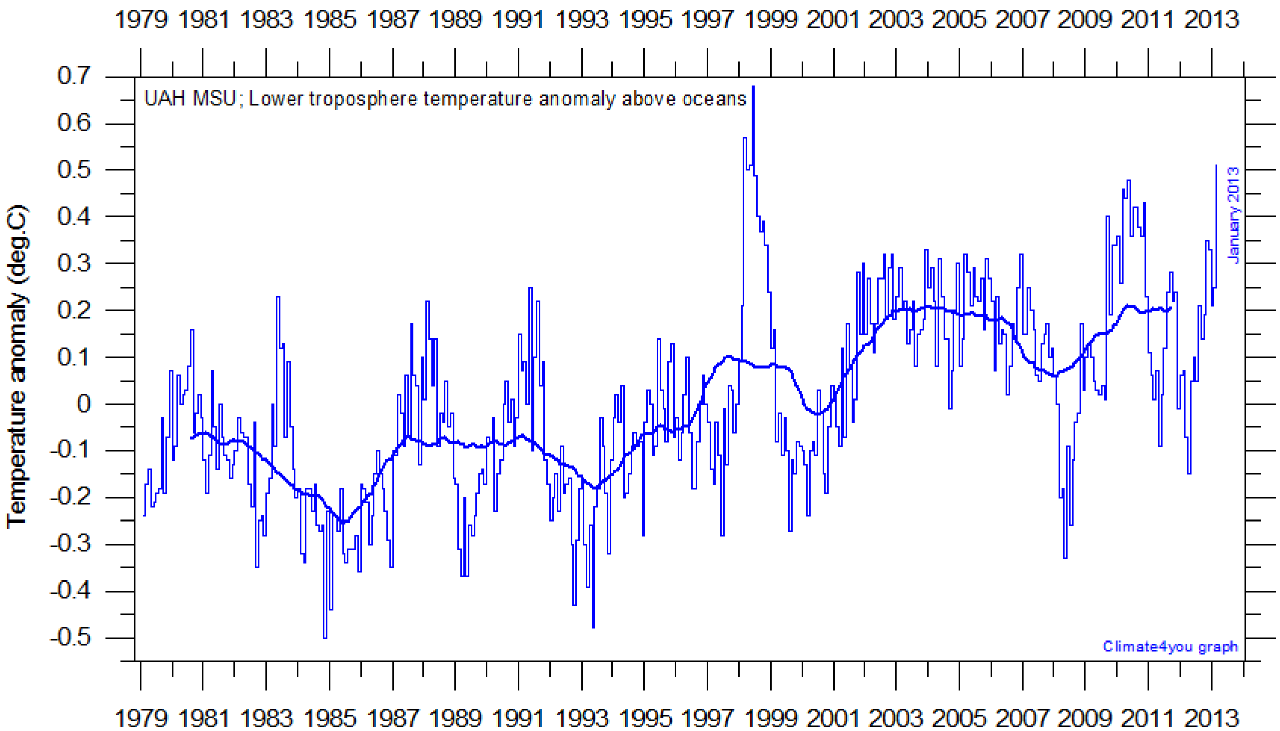
Sea surface temperature anomaly at 31 January 2013. Map source: National Centers for Environmental Prediction (NOAA).

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.

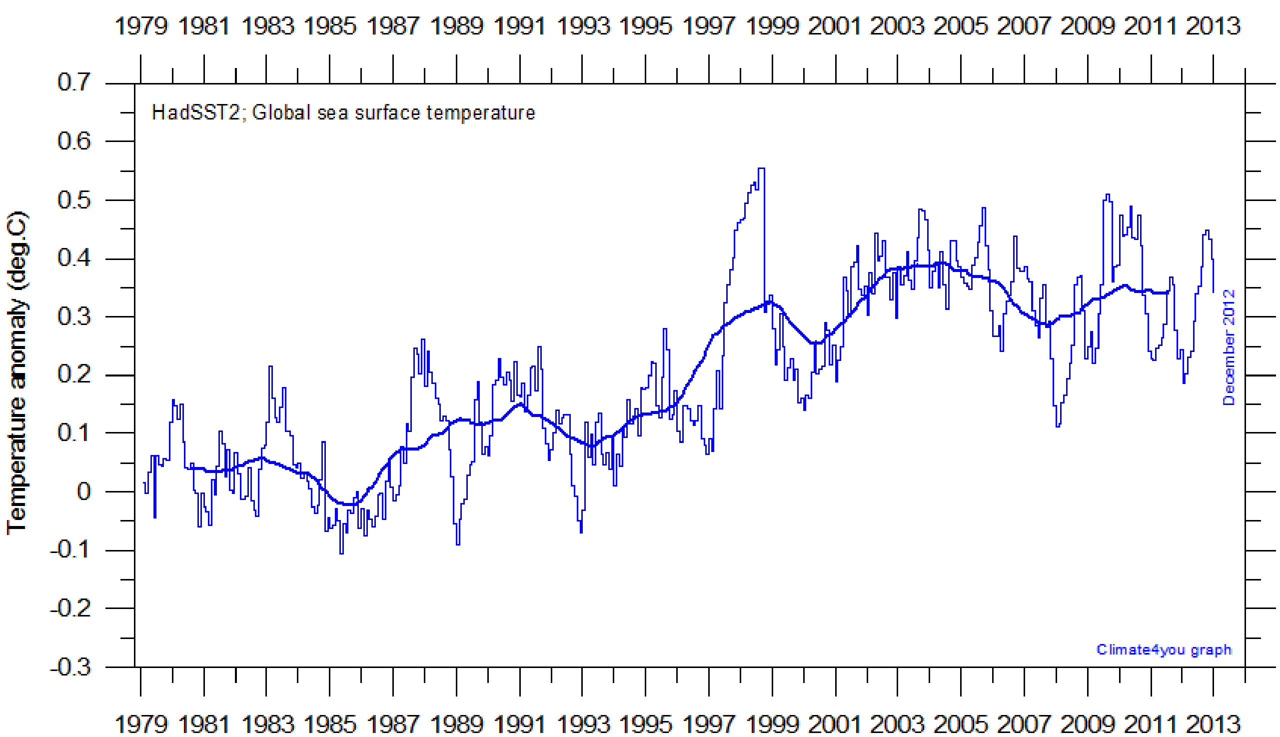
Because of the large surface areas involved especially near Equator, the temperature of the surface water in these regions clearly affects the global atmospheric temperature (p.3-5).

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.

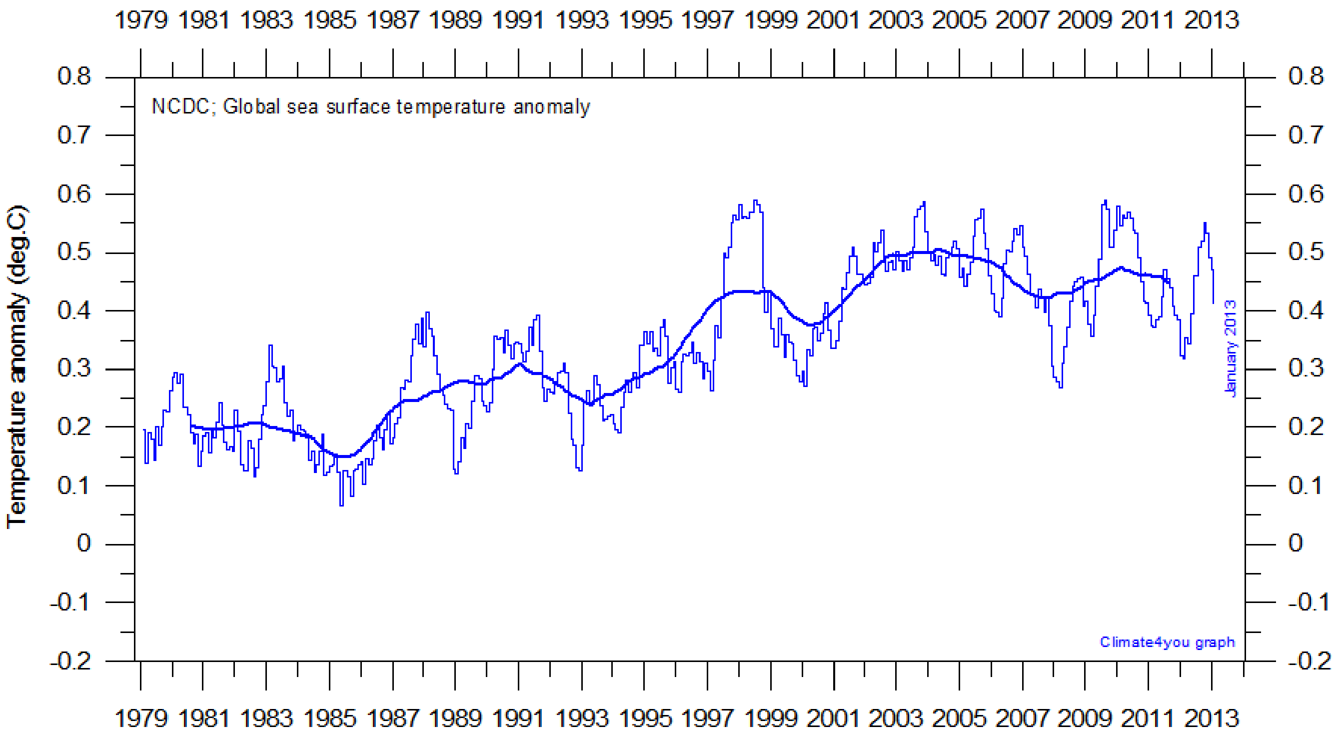
However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, net changes may be small, as heat exchanges as the above mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when seen 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 December 2012.



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:

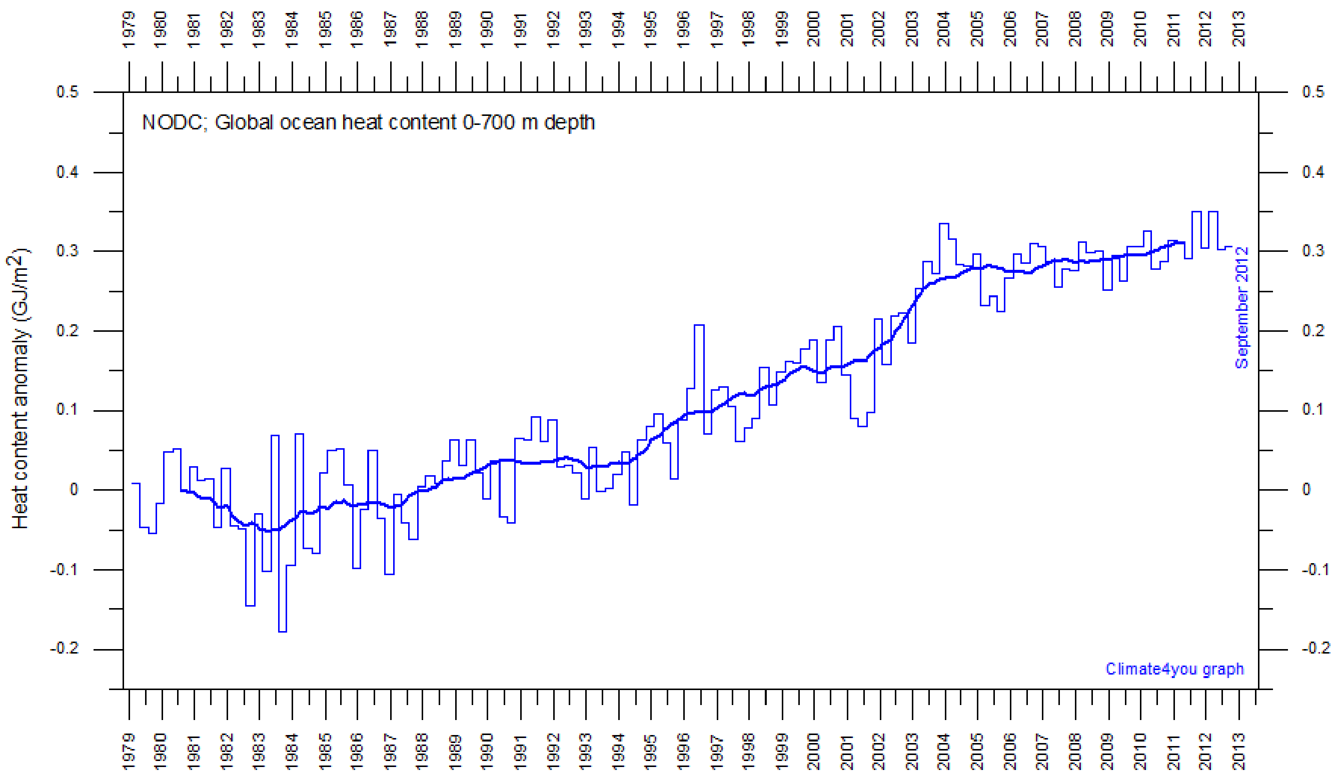
"These temperature swings are mostly the result of variations in rainfall activity. Precipitation systems, which are constantly occurring around the world, release the latent heat of condensation of water vapor which was absorbed during the process of evaporation from the Earth's surface.

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.

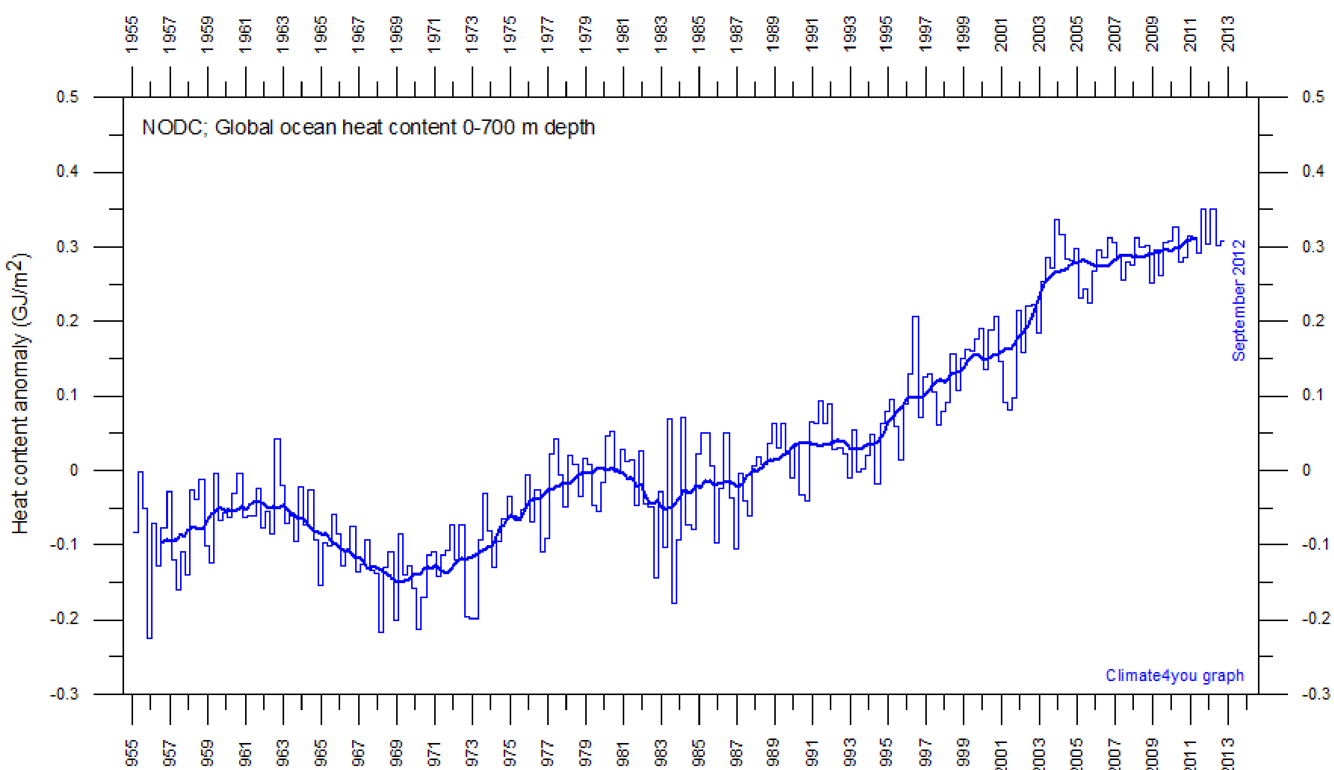
During the convectively active phase of the ISO, there are increased surface winds of up to 1 to 2 knots averaged over the tropical oceans, which causes faster surface evaporation, more water vapor in the troposphere, and more convective rainfall activity. This above-average release of latent heat exceeds 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 September 2012

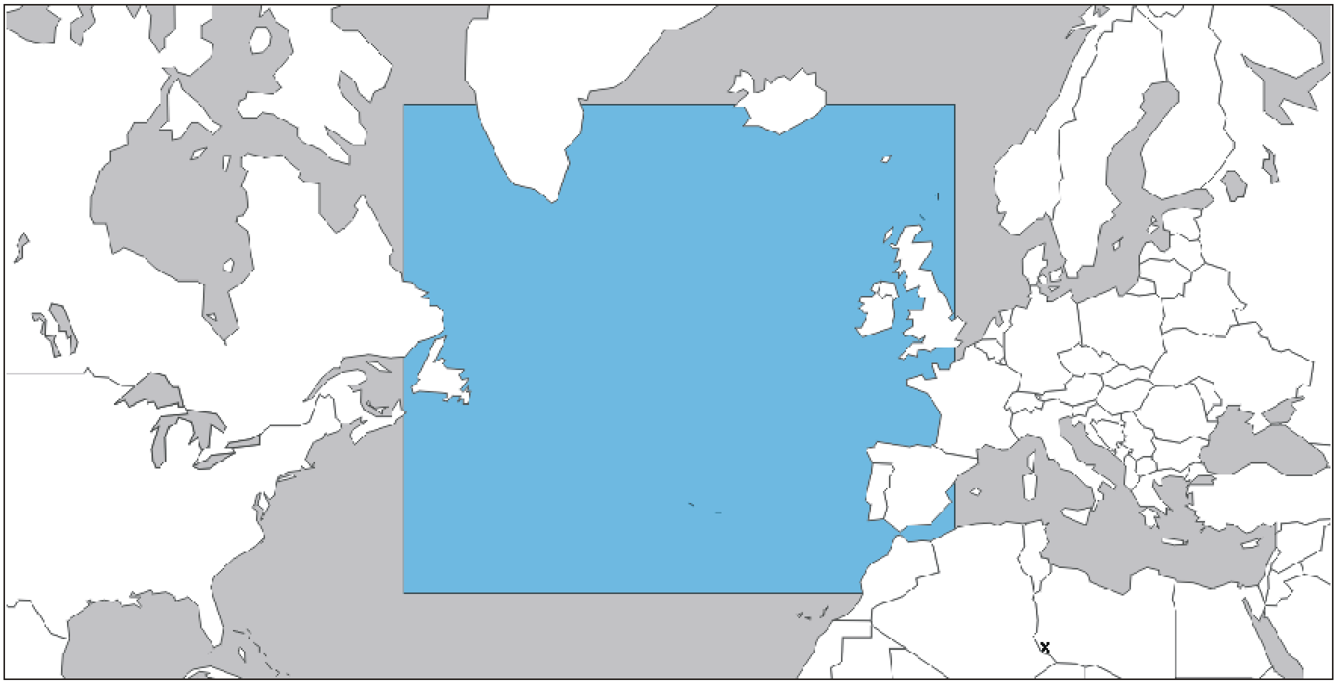


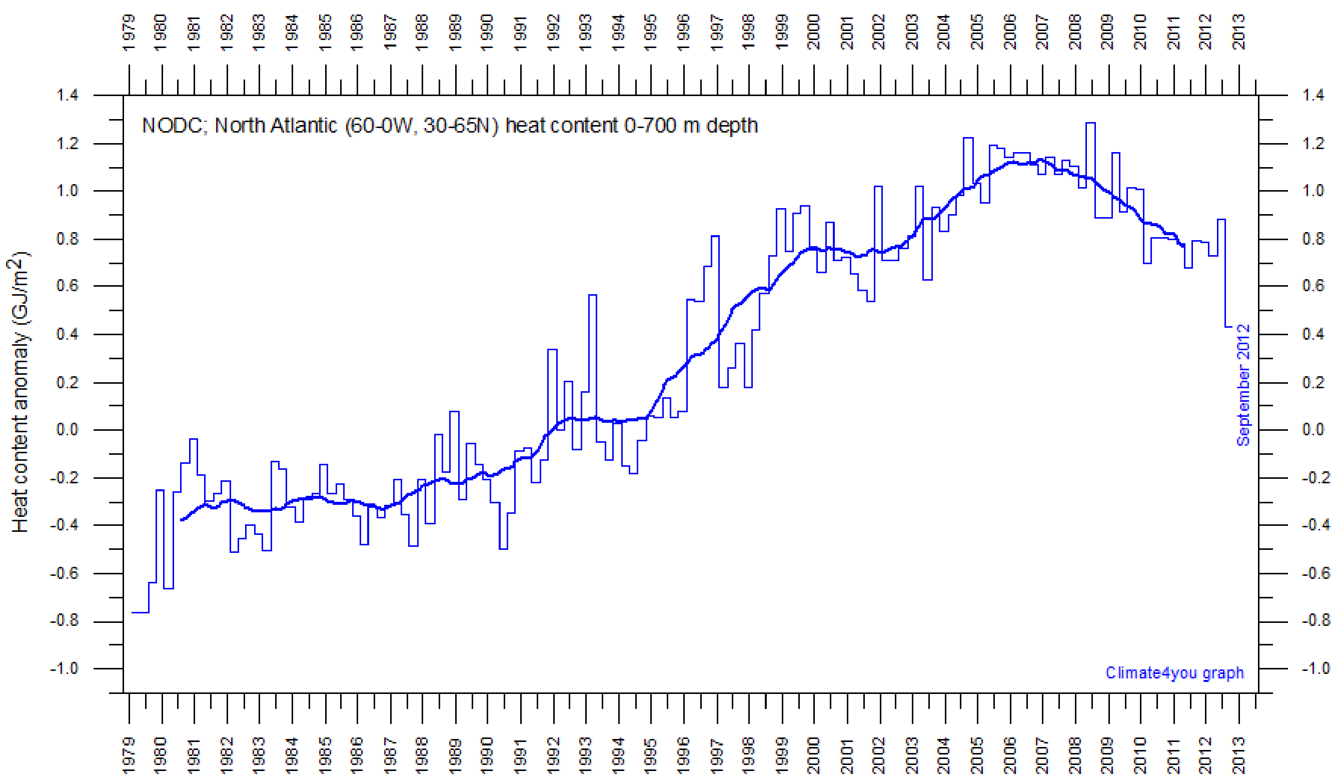
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



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).

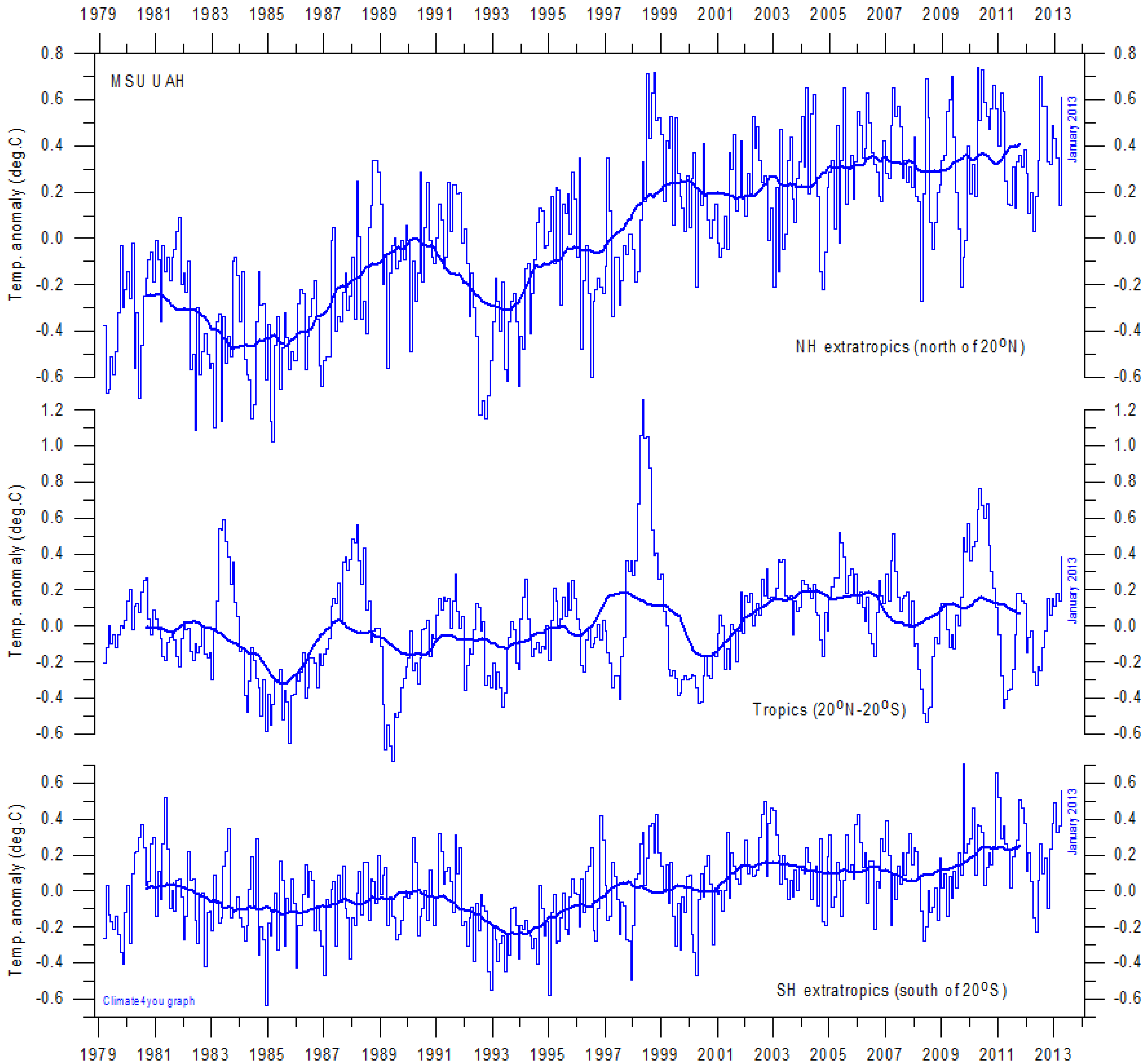
North Atlantic heat content uppermost 700 m, updated to September 2012





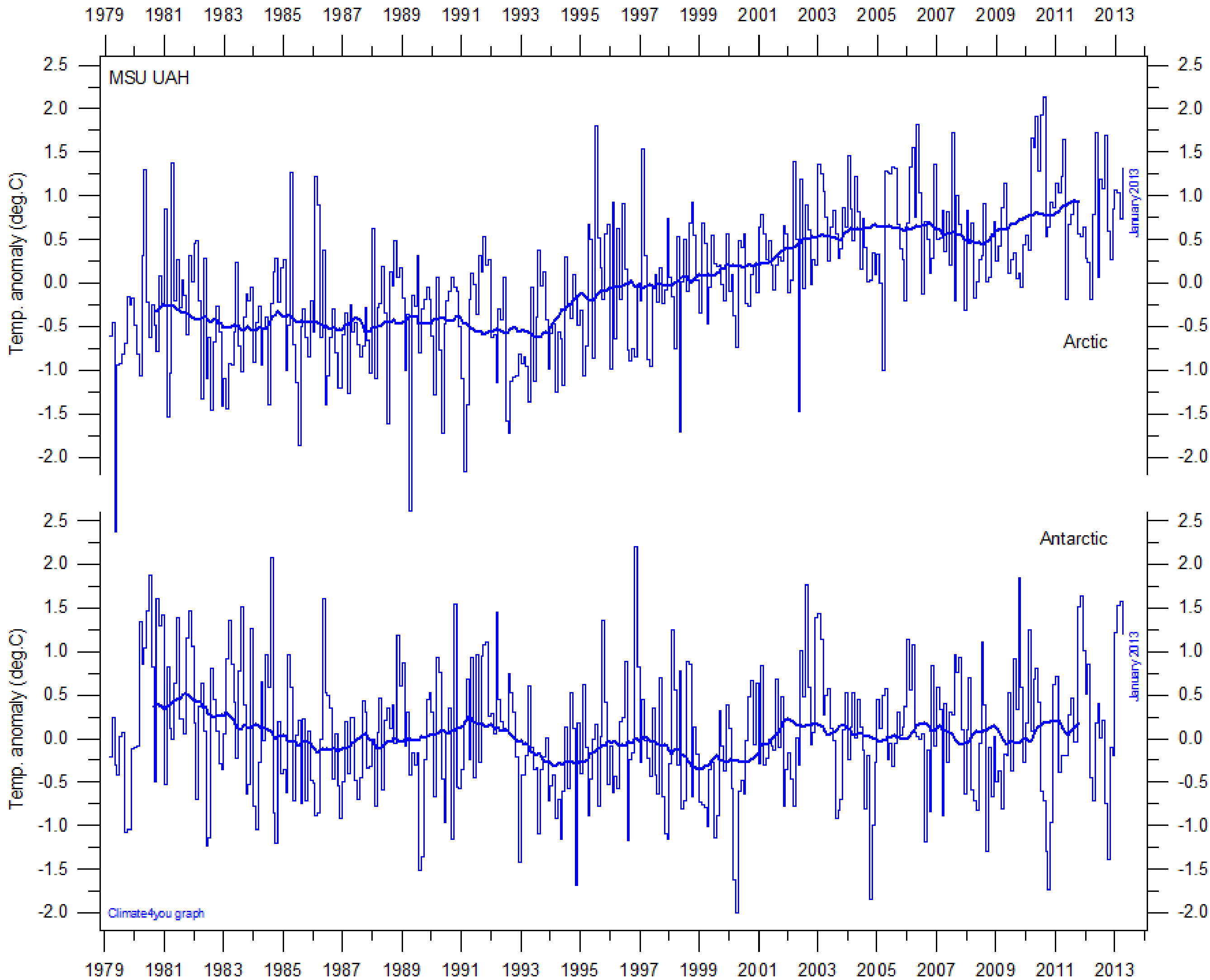
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the North Atlantic (60-0W, 30-65N; see map above) *ocean since January 1979. The thin line indicates monthly values, and the thick line represents the simple running 37 month (c. 3 year) average. Data source: National Oceanographic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

Zonal lower troposphere temperatures from satellites, updated to January 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 January 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 December 2012

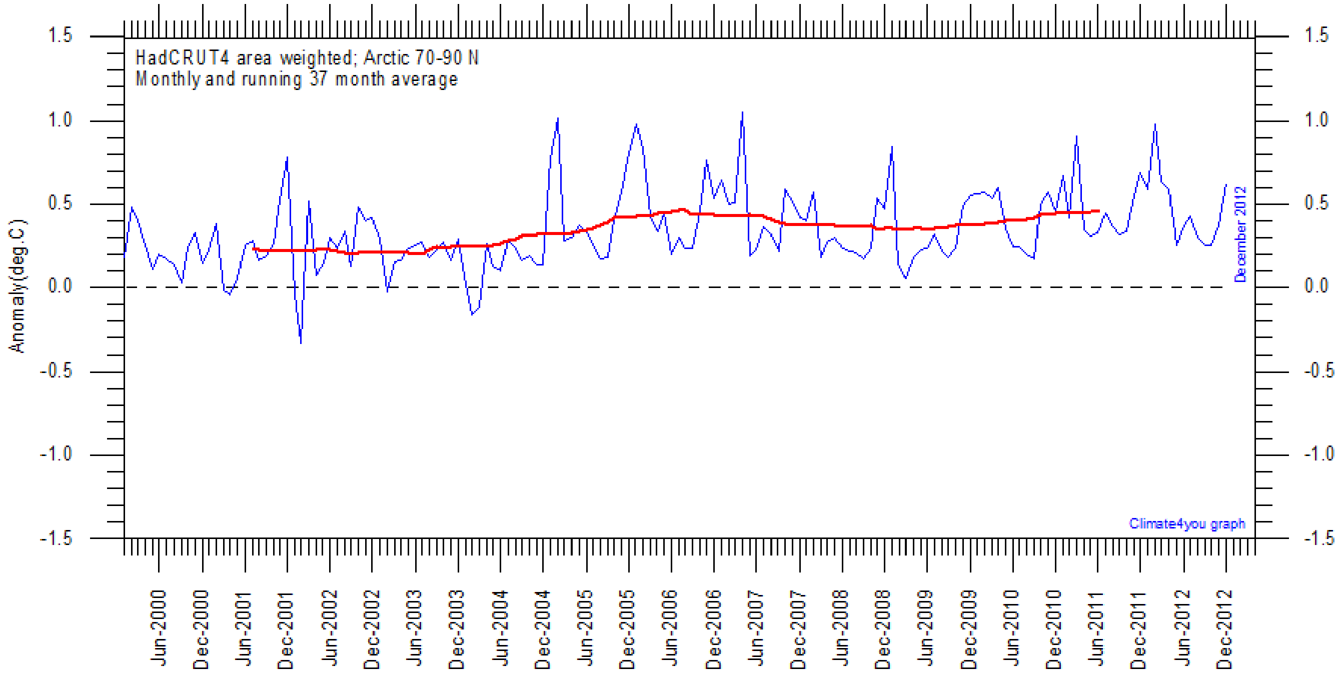


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

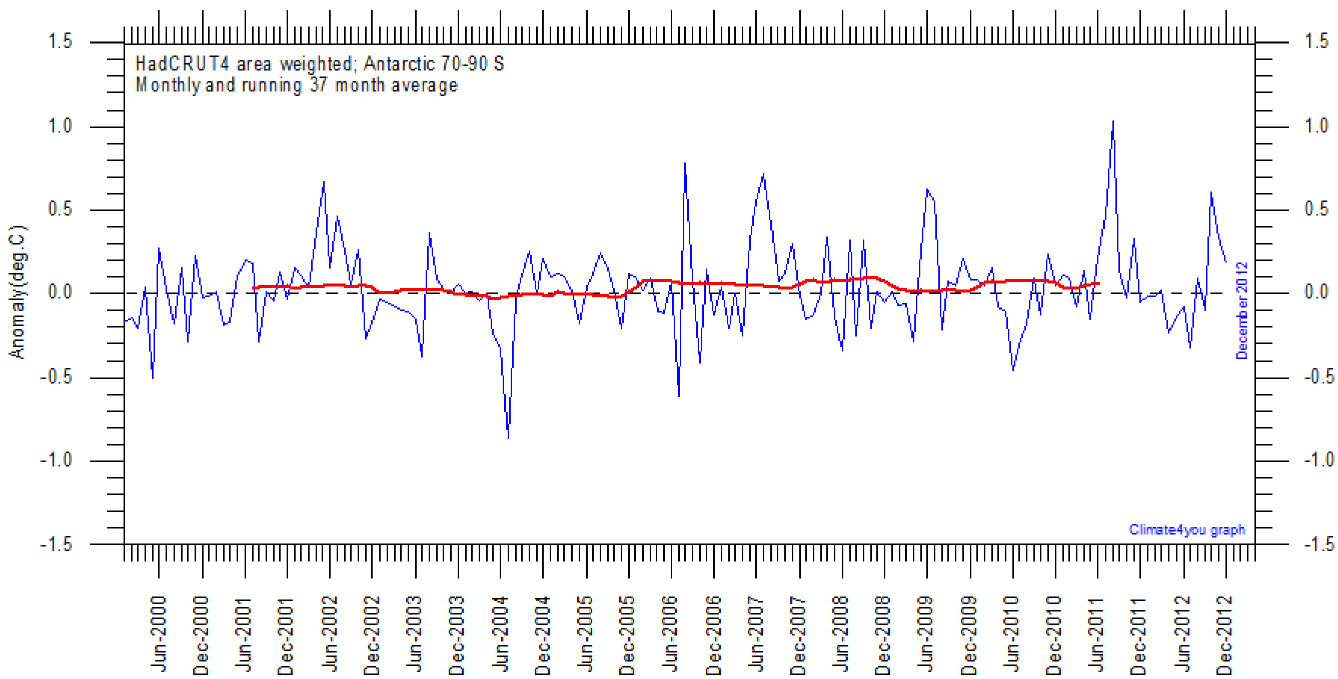


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

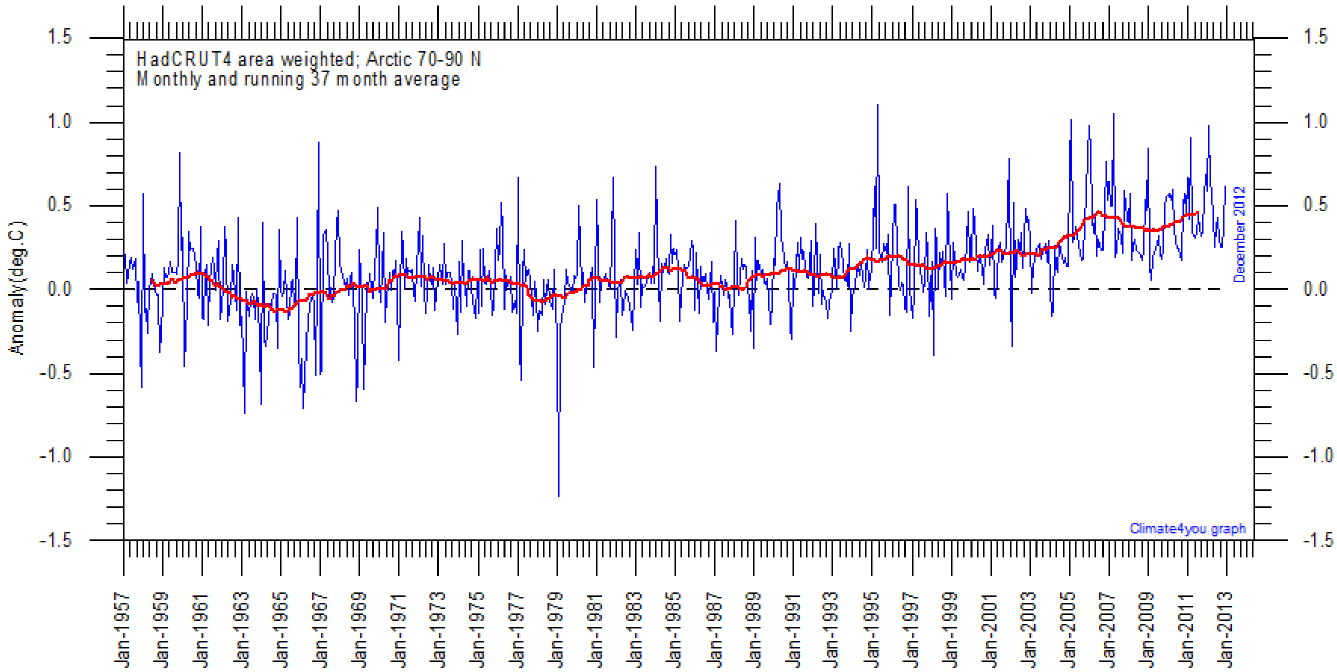


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 1957, in relation to the WMO normal period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

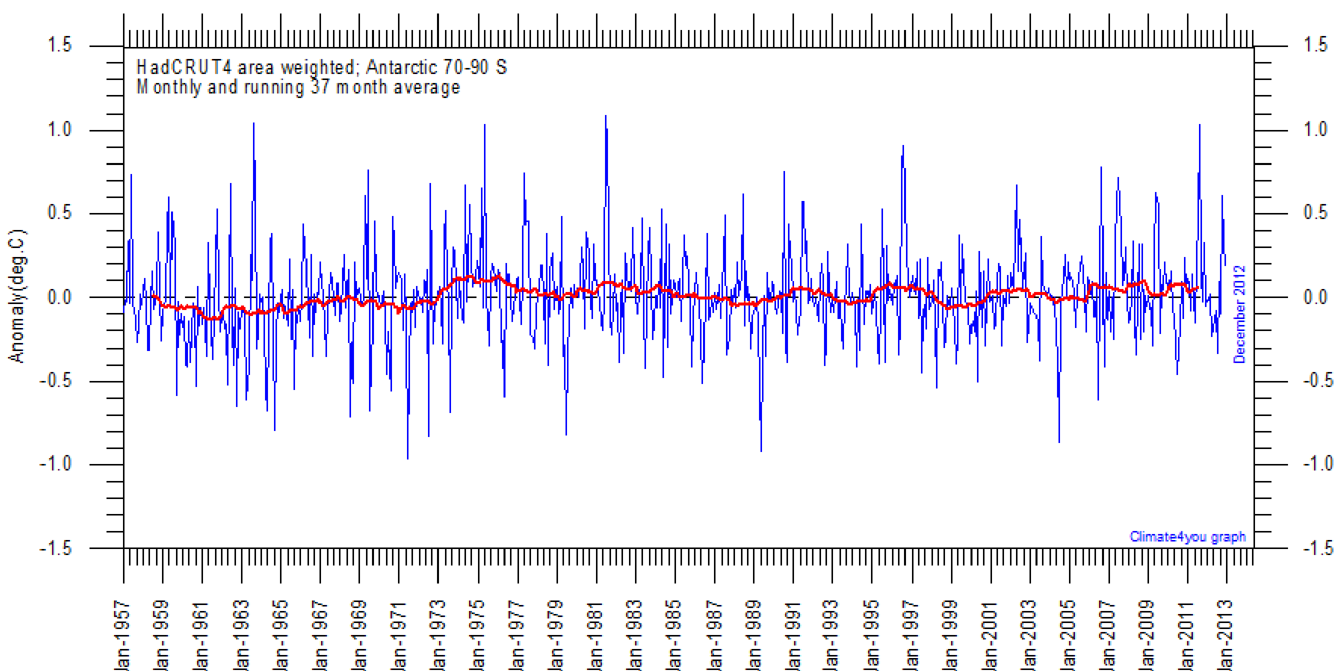


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 1957, in relation to the WMO normal period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

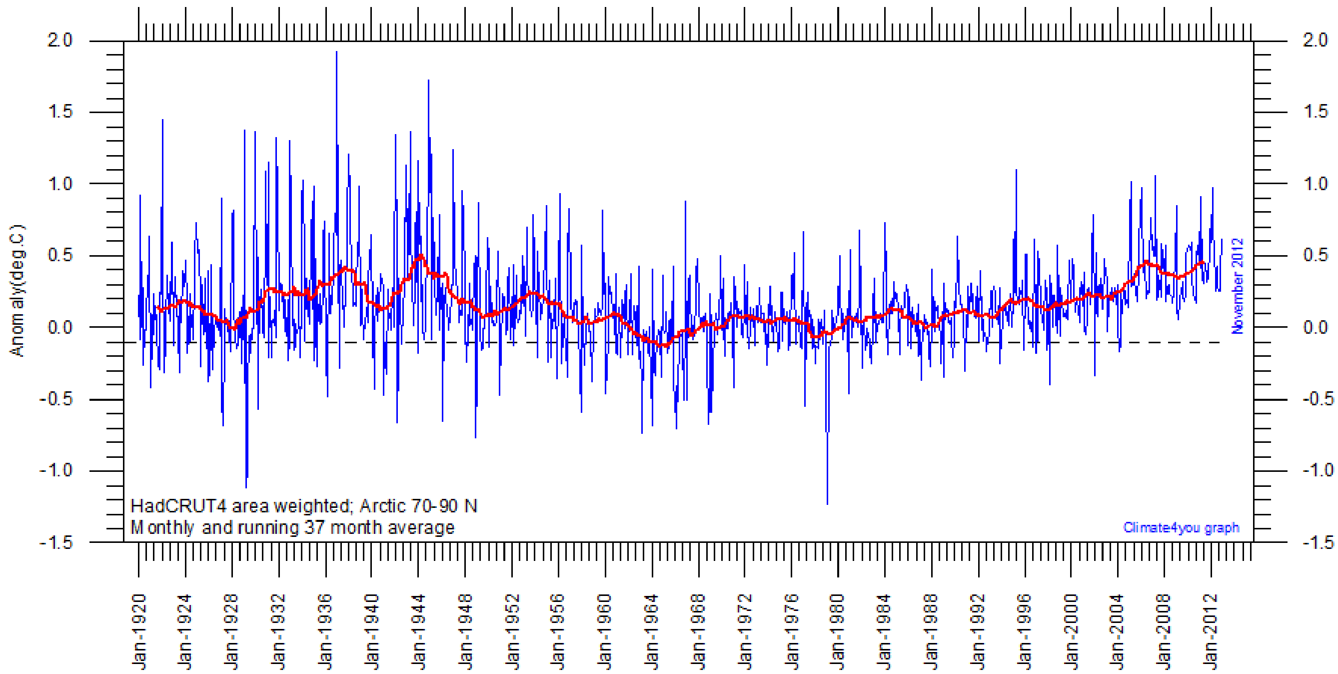


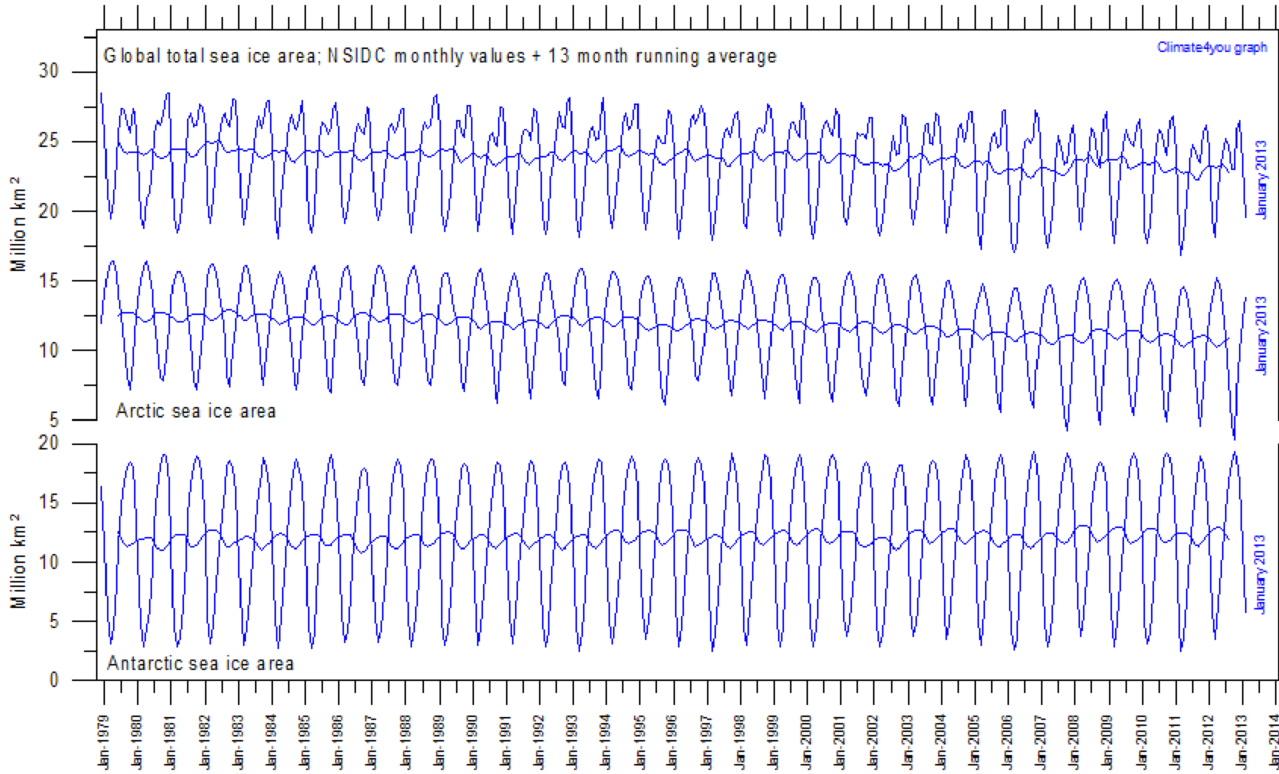
Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies (HadCRUT4) since January 1920, in relation to the WMO normal period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average. Because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

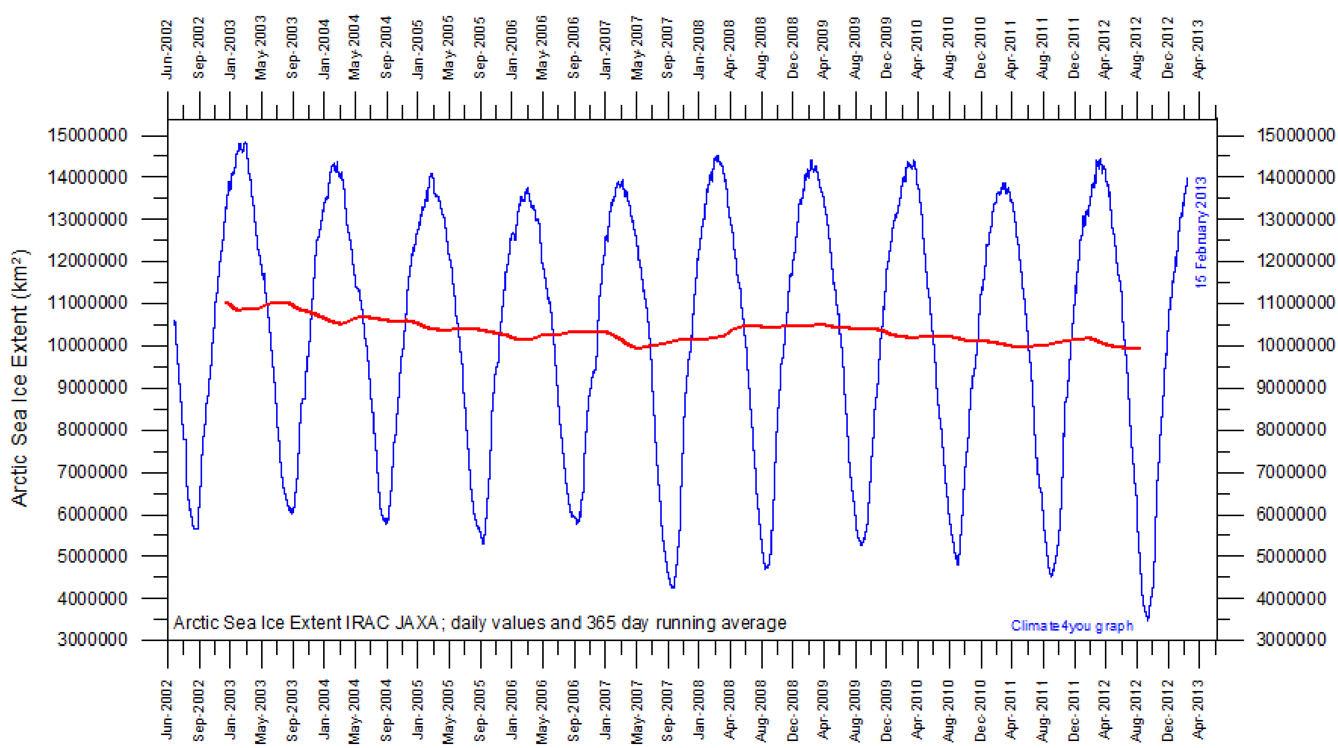
Literature:

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.

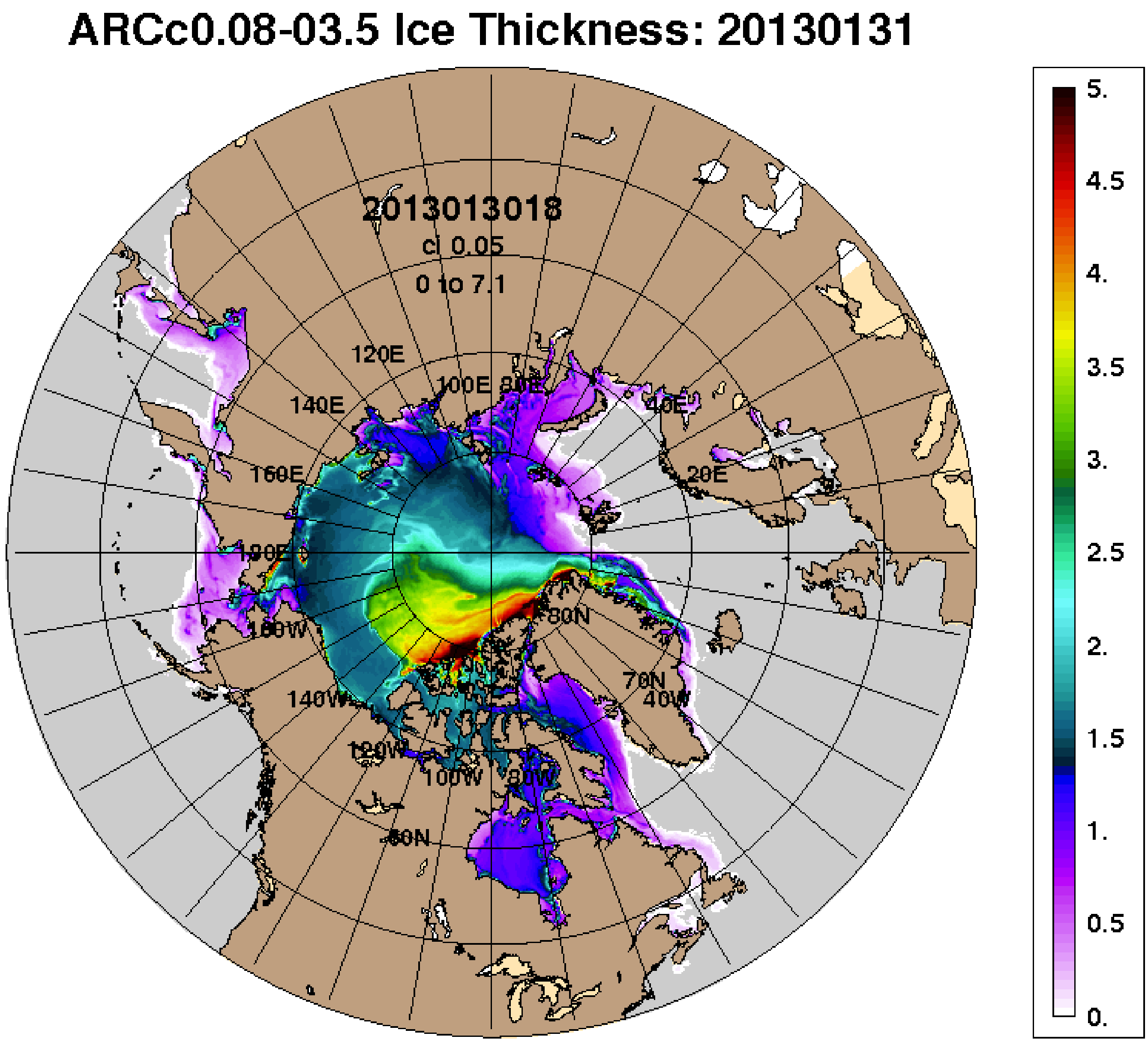
Arctic and Antarctic sea ice, updated to January 2013



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



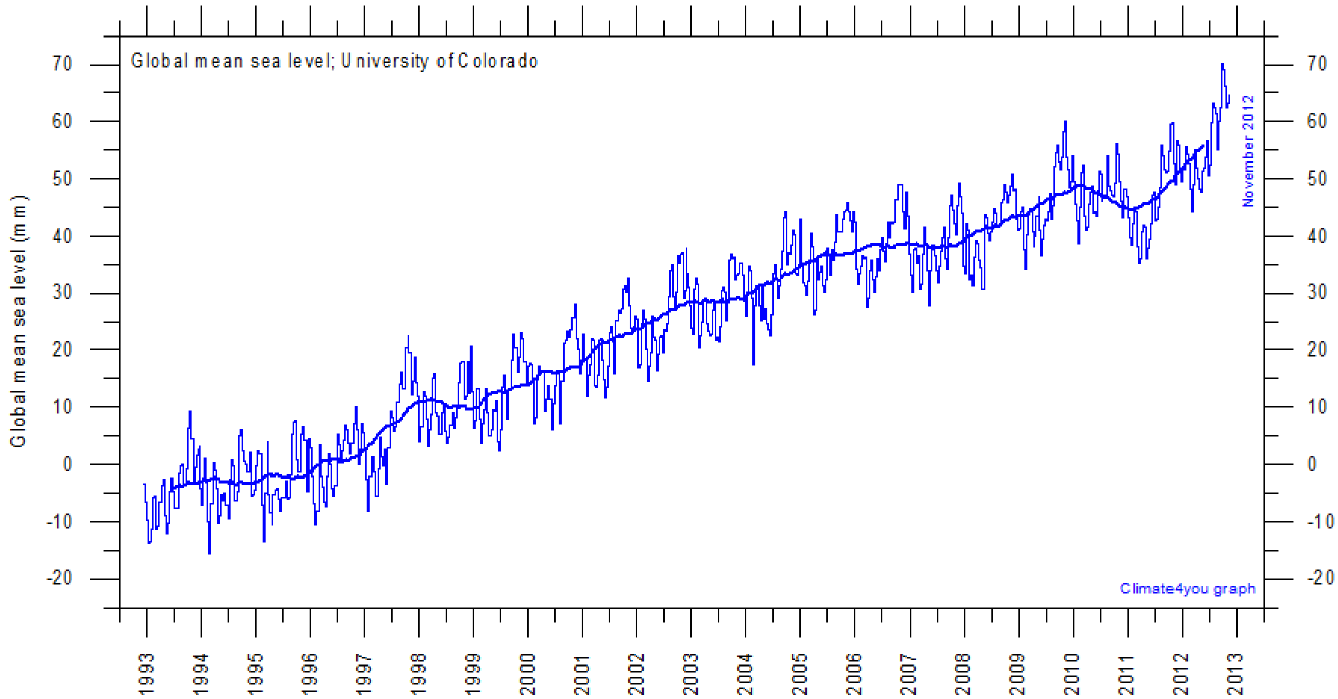
Graph showing daily Arctic sea ice extent since June 2002, to February 15, 2013, by courtesy of [Japan Aerospace Exploration Agency](#) (JAXA).



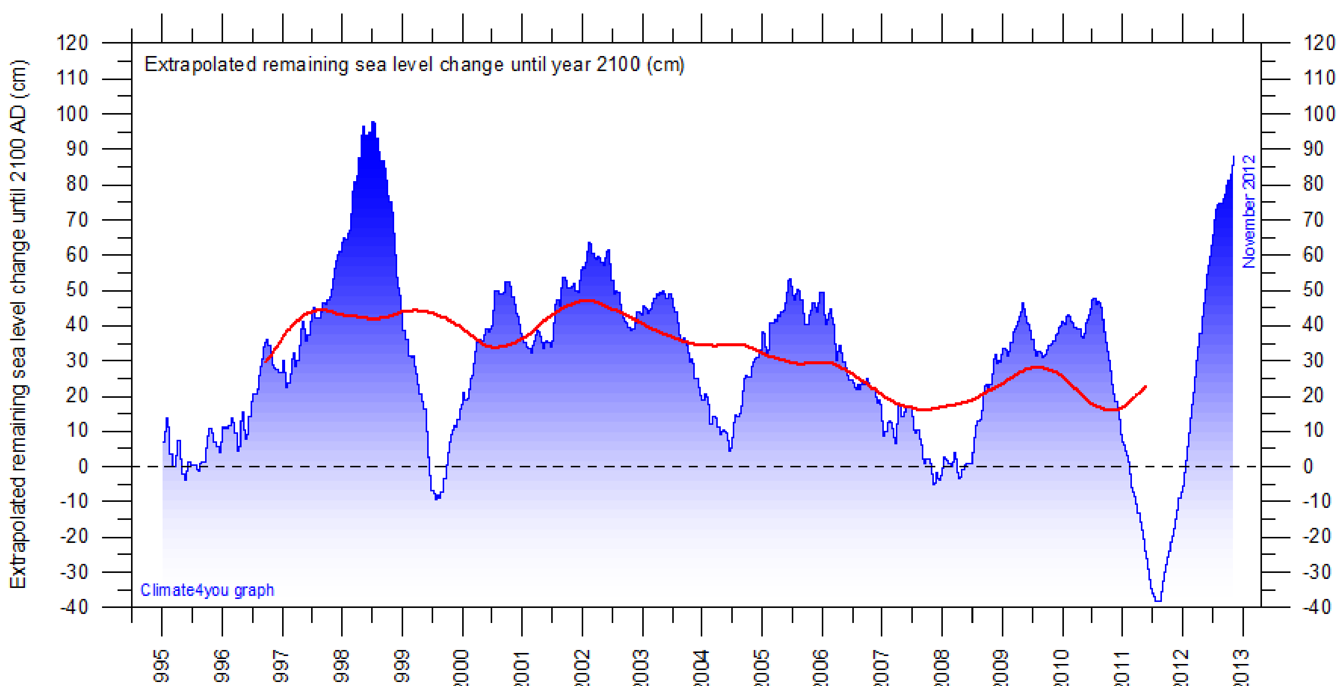
20

Northern hemisphere sea ice extension and thickness on 31 January 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 November 2012

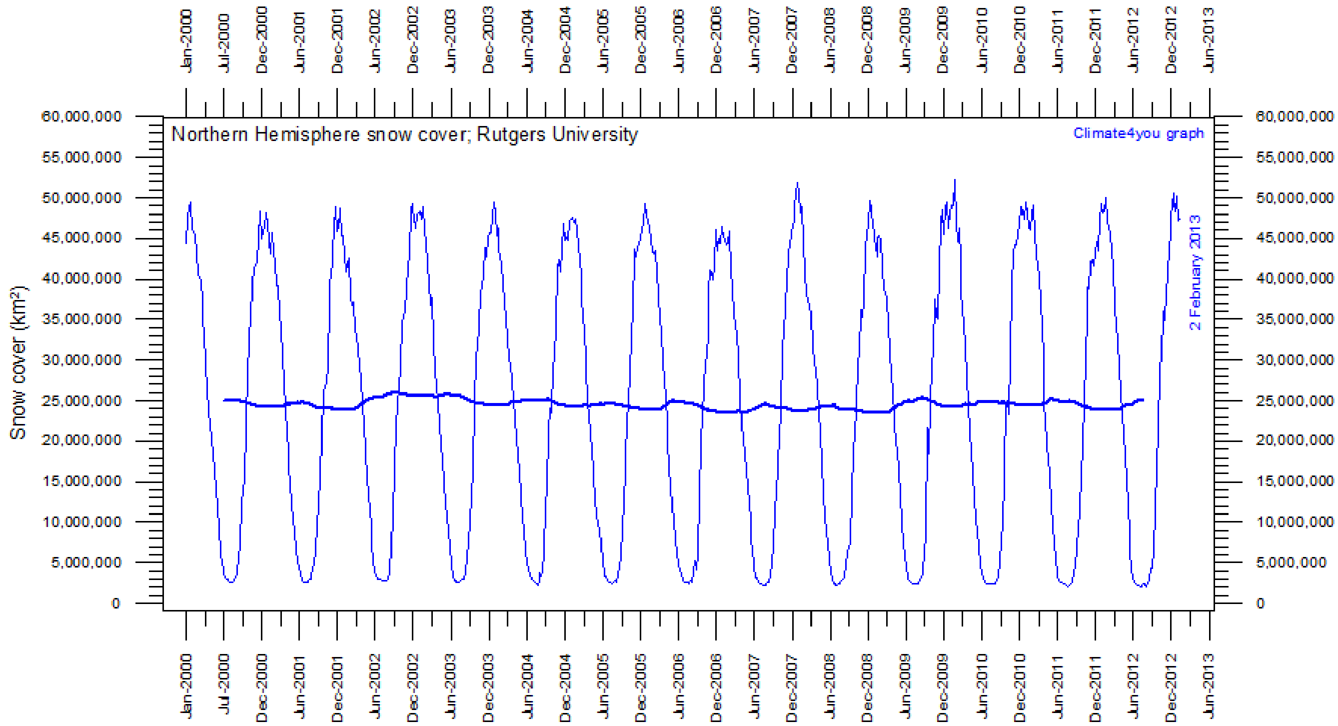


Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

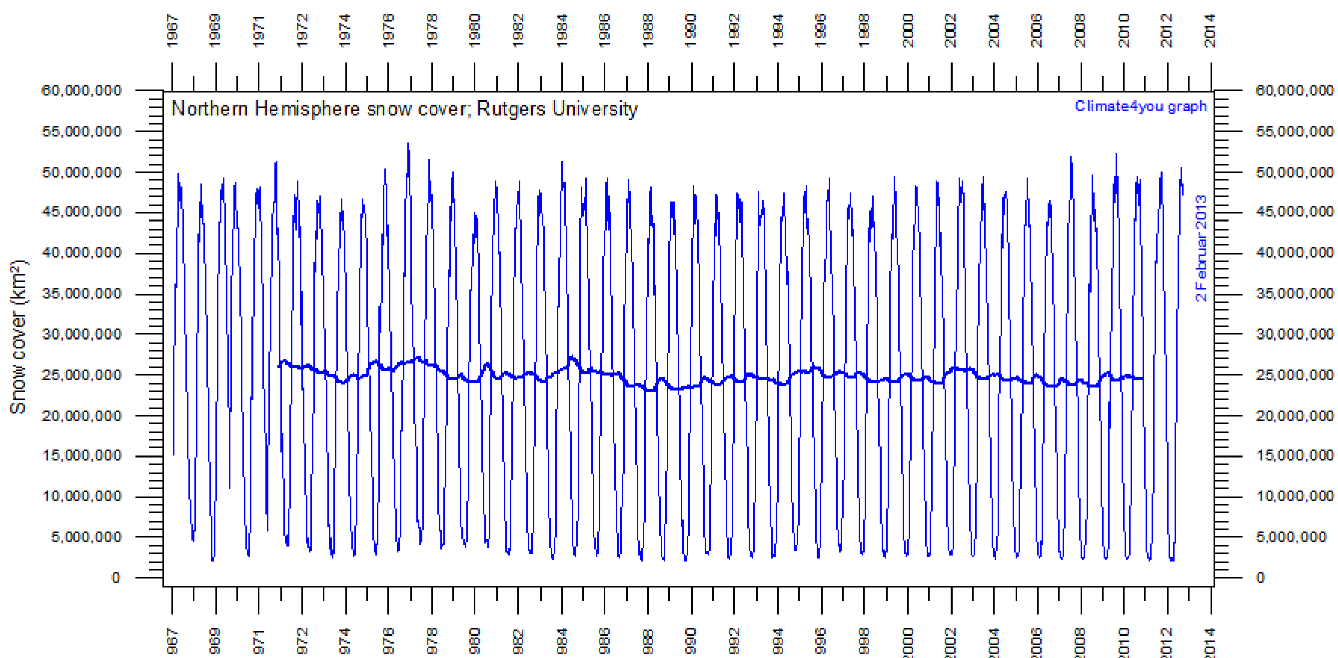


Forecasted change of global sea level until year 2100, based on simple extrapolation of measurements done by the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 3 yr average forecast for sea level change until year 2100. Based on this (thick line), the present simple empirical forecast of sea level change until 2100 is about +17 cm.

Northern Hemisphere weekly snow cover, updated to early February 2013

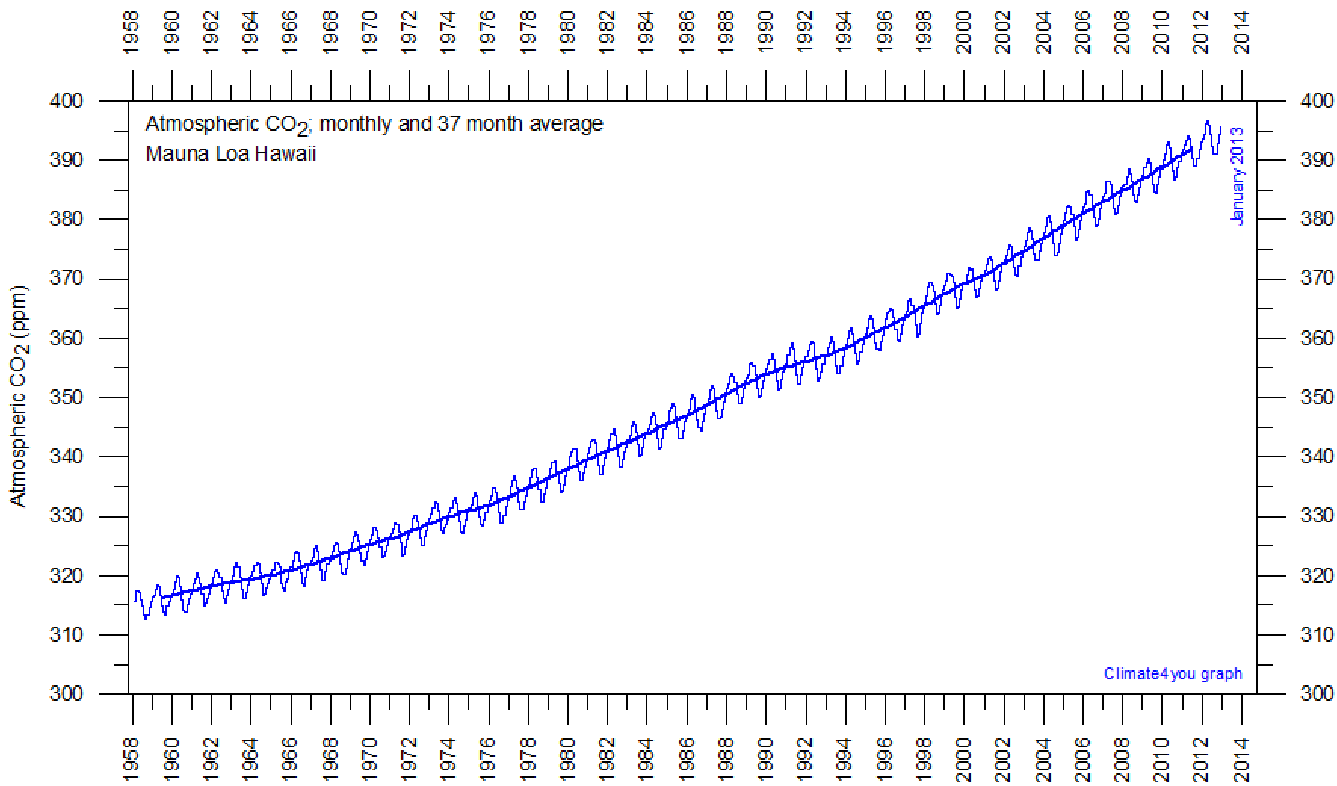


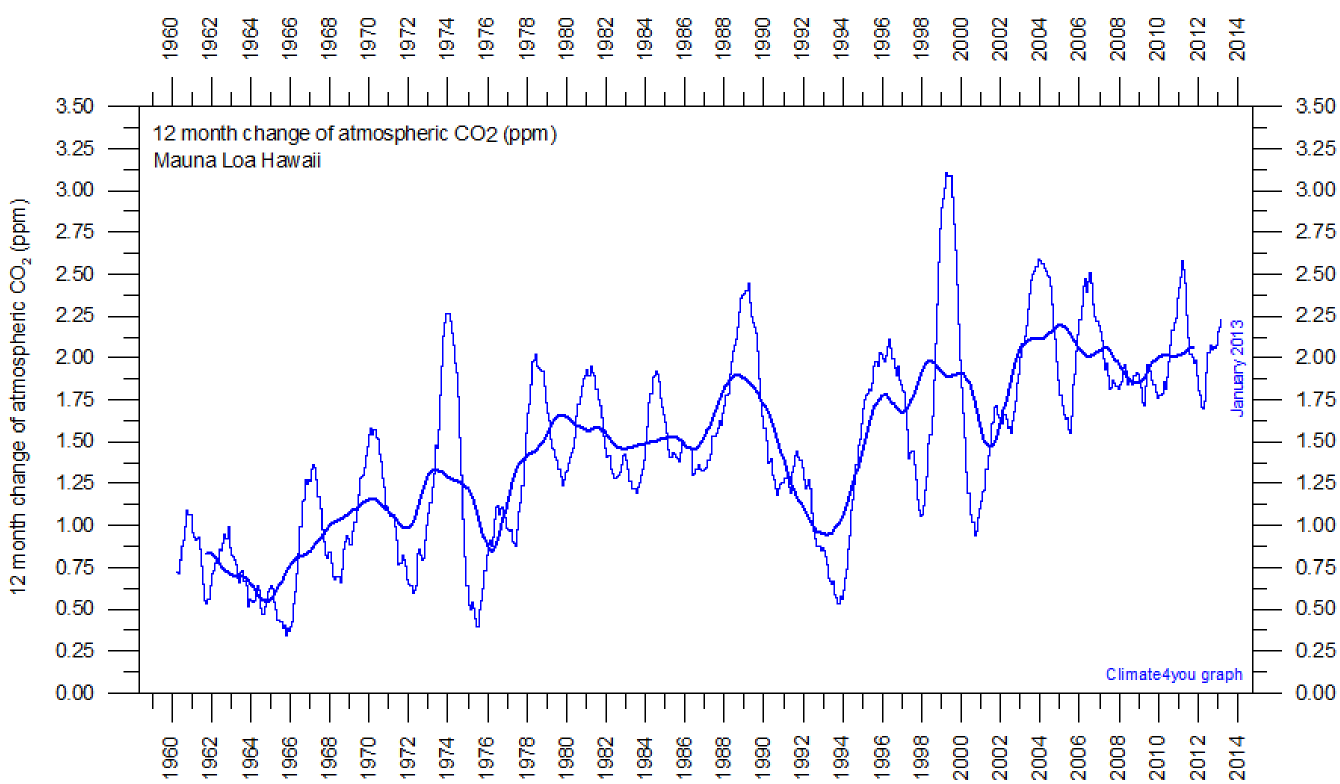
Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin line represents the weekly data, and the thick line is the running 53 week average (approximately 1 year).



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.

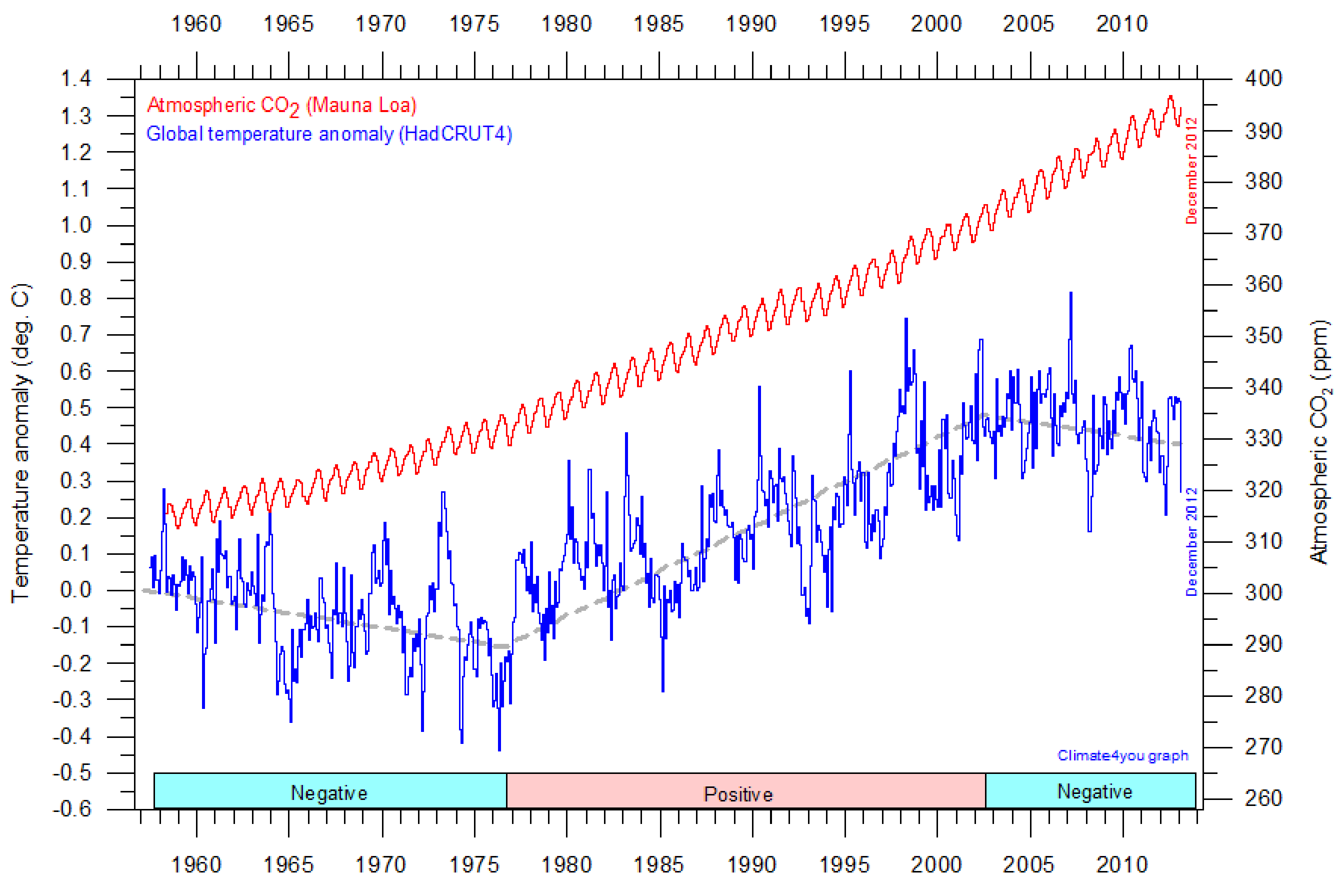
Atmospheric CO_2, updated to January 2013

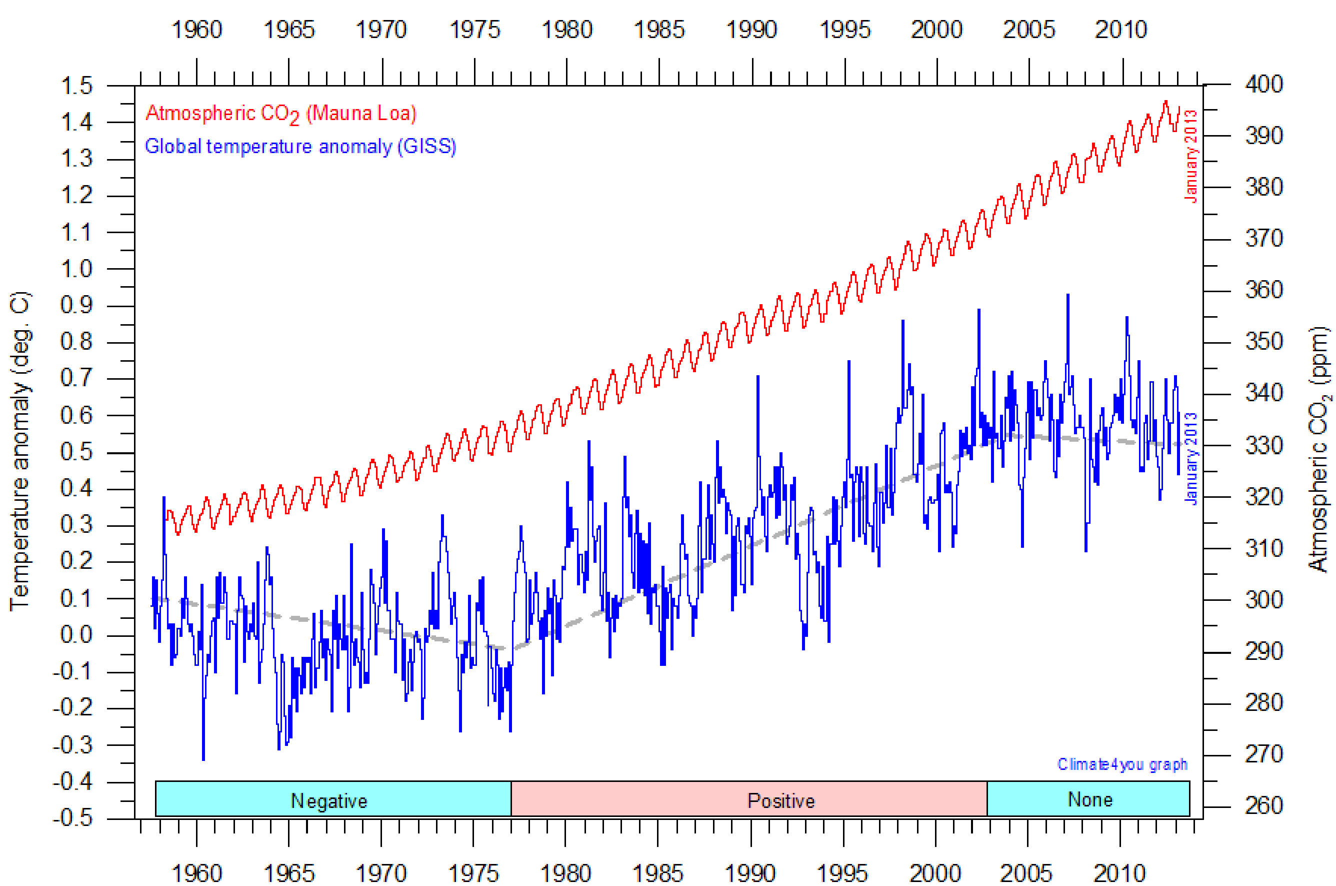


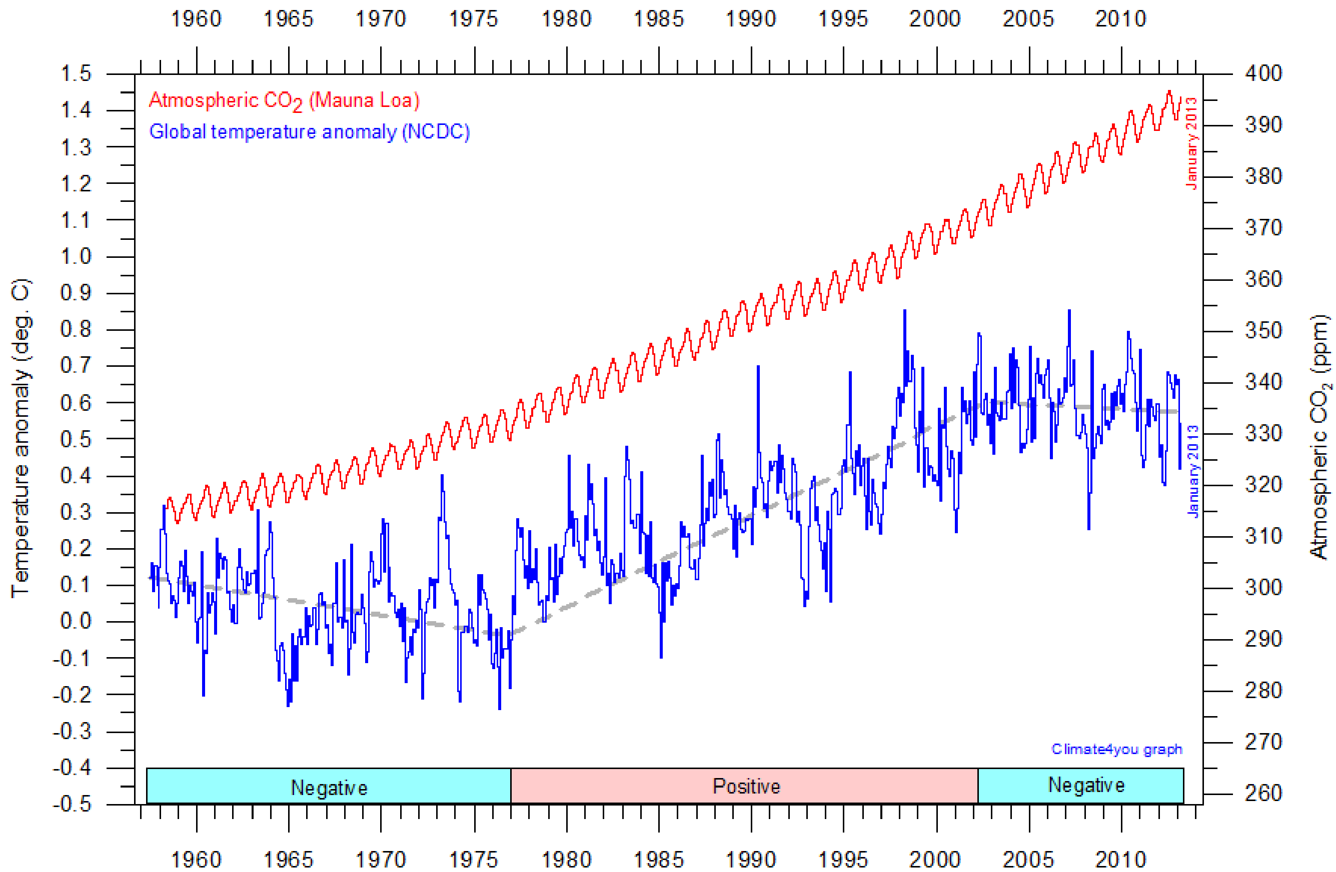


Monthly amount of atmospheric CO_2 (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO_2 since 1959, according to data provided by the [Mauna Loa Observatory](), Hawaii, USA. The thick line is the simple running 37 observation average, nearly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

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







25

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 are not updated beyond December 2012.

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.

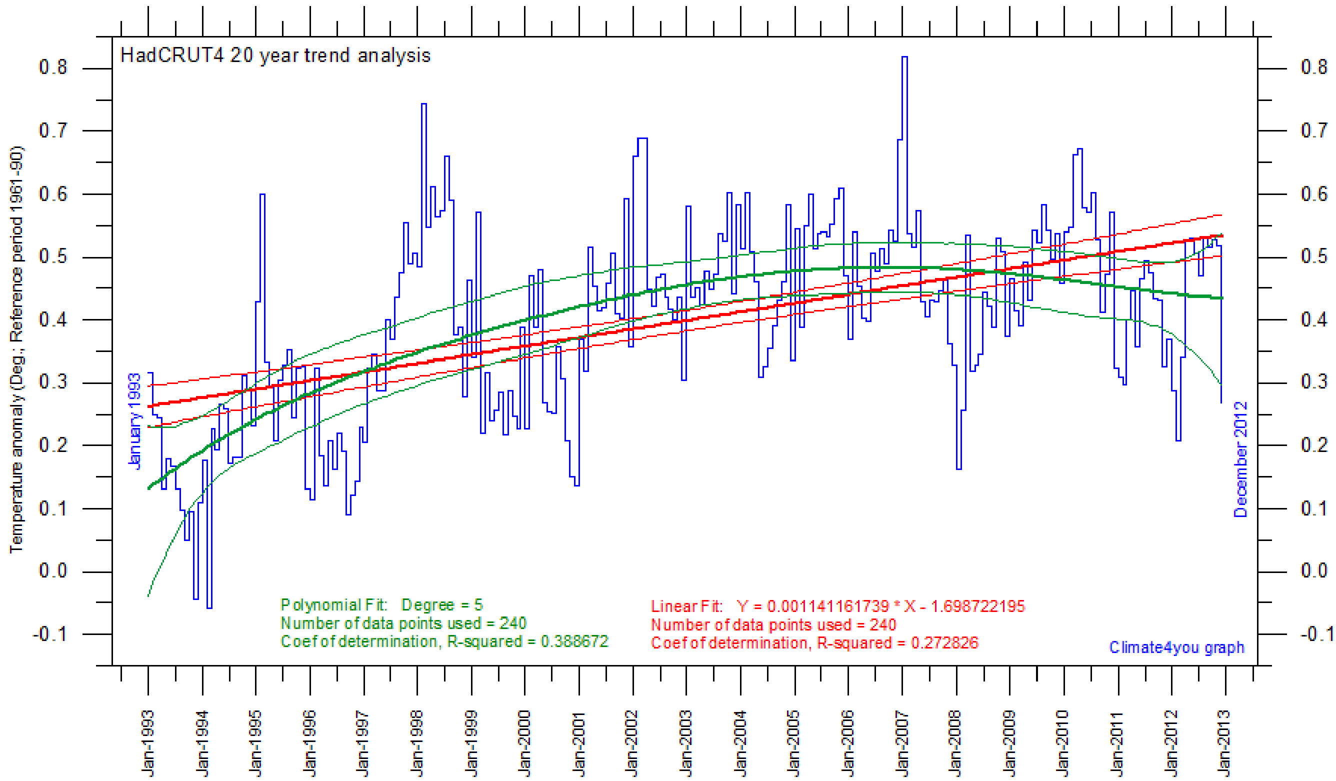
What exactly defines the critical length of a relevant time period to consider for evaluating the alleged importance of CO_2 remains elusive, and is still a topic for discussion. However, the critical period length must be inversely proportional to the temperature sensitivity of CO_2, including feedback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

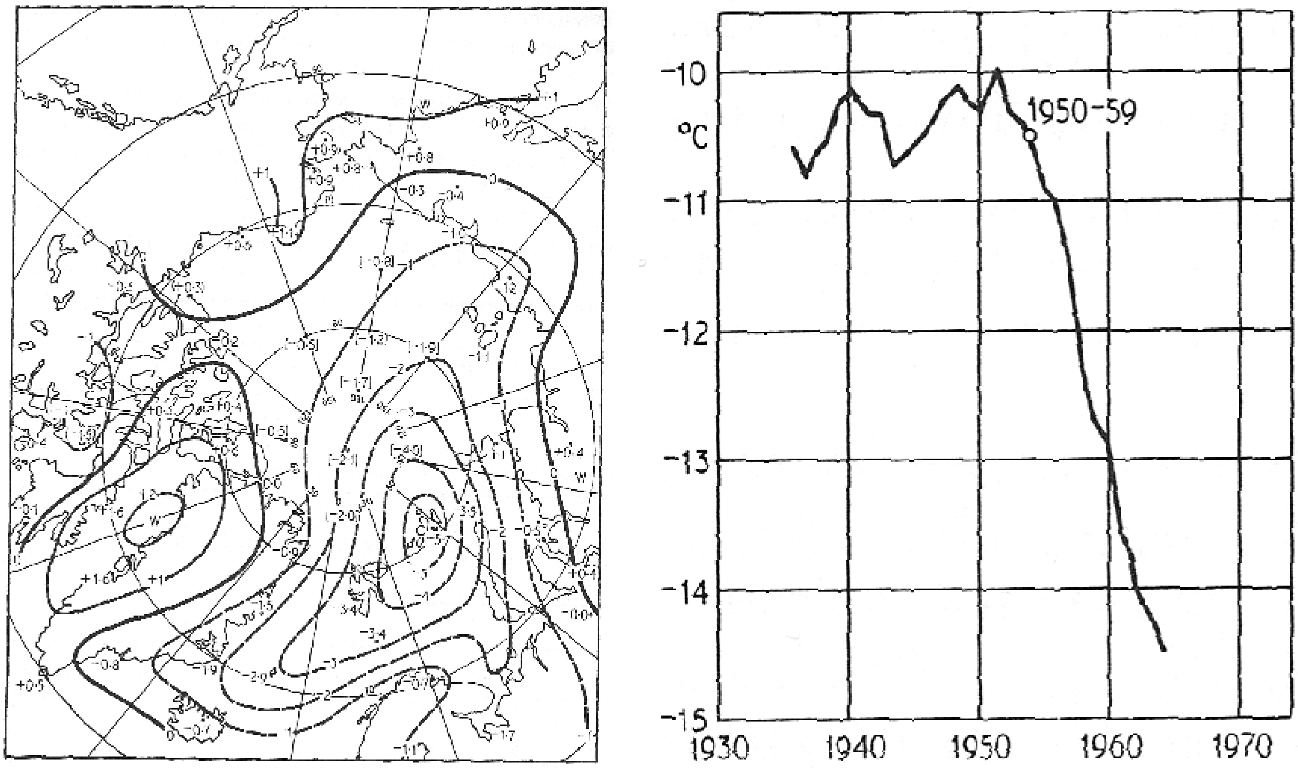
Last 20 year monthly surface air temperature changes, updated to December 2012



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.

1968-1971: Arctic cooling, The Rome Club and Limits to Growth



Left diagram: Change of Arctic air temperature for the four winter months December-March: average values 1961-70 minus 1951-60. Note the general cooling, greatest near the Norwegian Sea and the European sector, but warming near the Bering Strait and northernmost Pacific, also off Arctic Canada and west Greenland. Source: Lamb 1977. Right diagram: Average 10 yr mean annual air temperature at Franz Josefs Land. Source: Rodewald 1972.

Bach in the 1960s and early 1970s, the timeframe of most scientists interested in climate and environmental change was still retrospective, rather than prospective (Oldfield, 1993). However, the revived notion of the Milanković theory then suddenly offered the new possibility of actual climate prediction.

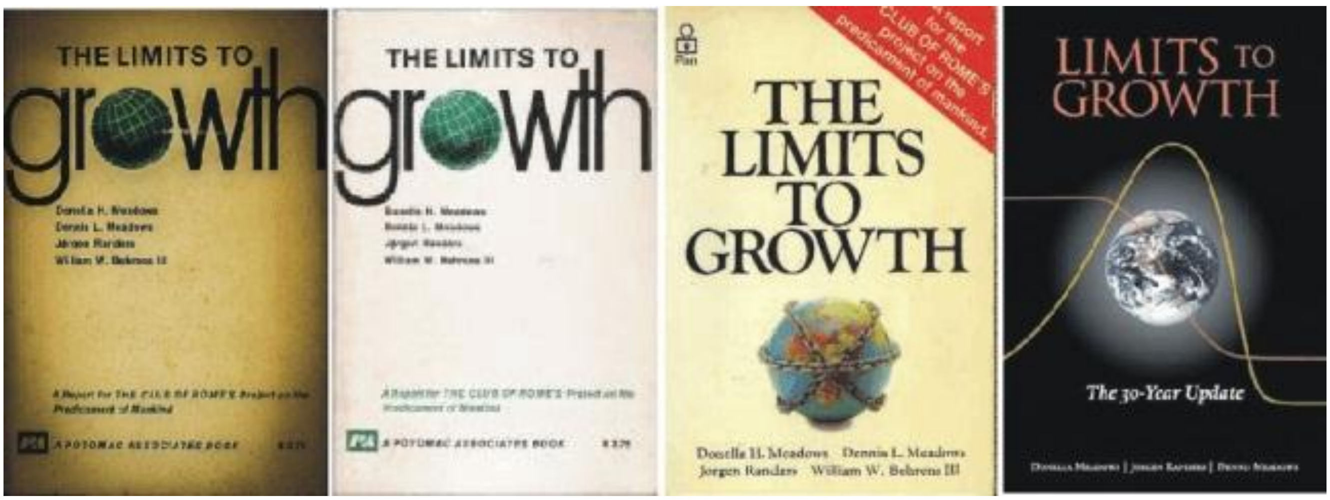
At that time there was relatively little emphasis on potential or actual 'global warming', and the idea was virtually unknown to popular consciousness. Indeed, a widespread belief at that time was that the planet was heading for a new ice age, fuelled by acceptance of the Milanković theory and new knowledge gained from isotope analysis of Greenland ice cores (Dansgaard et al., 1970, 1971). Hays et al. (1976) suggested that the observed orbital-climate relationships predict that the long-term trend over the next several thousand years would be toward extensive Northern Hemisphere glaciation.

This beginning period of global cooling, at that time very pronounced in the European sector of the Arctic (Rodewald 1971; Lamb 1976), was by some seen as the first indication of a coming new ice age, perhaps even accelerated by aerosols from industrial pollution blocking out sunlight.

Even among some of those scientists drawing attention to contemporary increases of atmospheric CO_2, a phase of significant global cooling was envisaged (e.g. Rasool and Schneider, 1971). Surface temperature changes as shown in the 1940-1965 panel of figure 9 was frequently taken as the empirical evidence for a coming ice age (e.g. Calder 1974; Ponte, 1976).

Such concerns in the mid-1970s brought together atmospheric scientists and the US Central Intelligence Agency (CIA) in an attempt to determine the geopolitical consequences of a sudden onset of global cooling.

Quite naturally, many people at that time were becoming increasingly worried about the future, especially if the ongoing cooling was to continue.



Front cover of various editions of 'The Limits to Growth'

This was the general environmental and socio-economical background on which the Club of Rome was founded in 1968 at [Accademia dei Lincei](#) in Rome, Italy. The Club of Rome describes itself as "a group of world citizens, sharing a common concern for the future of humanity." It consists of current and former Heads of State, UN bureaucrats, high-level politicians and government officials, diplomats, scientists, economists, and business leaders from around the globe. The club states that its mission is *"to act as a global catalyst for change through the identification and analysis of the crucial problems facing humanity and the communication of such problems to the most important public and private decision makers as well as to the general public."* In 1972 it raised considerable public attention with its report *The Limits to Growth* (Meadows et al. 1972).

The Limits to Growth describes the result of quantitative computer modeling of unchecked economic and population growth with finite resource supplies. Its authors were Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens III. The book used the World3 model to simulate the consequence of interactions between the Earth's and human systems. With much fanfare and alarm the book revived the concerns and predictions of Thomas Malthus in *An Essay on the Principle of Population* (1798).

In the spirit of Malthus, Limits to Growth predicted an end to the economic progress that the West has experienced since the Industrial Revolution. Today this particular modeling exercise stands as a celebrated example of failure of quantitative modeling (Pilkey and Pilkey-Jarvis 2007). Limits to Growth famously predicted that within the coming hundred years, there would be widespread natural resource shortages and economic collapses. The authors warned that unless immediate action was taken to control population and pollution, we would not be able to turn the situation around. This doomsday prediction was based on a mathematical model known as the pessimist model, called World III. Compared to modern conditions, the model was simple, but at that time still requiring relative extensive computer calculations. The report argued that population growth and pollution from industrial expansion were leading to total exhaustion of natural resources and massive environmental destruction. It predicted that catastrophes would begin by the year 2000.

However, there were many problems with the World III model. It treated the earth's mineral reserves as fixed and unchanging, and that food production per unit of land area would remain static. In addition, it ignored the possibility of additional major oil discoveries, advances in petroleum exploration and extraction technology, and the possible contributions of nuclear, solar, or wind energy resources, or any other new development instigated by man's creativity (Pilkey and Pilkey-Jarvis 2007).

University of Manitoba professor Vaclav Smil summed up his view by noting that the Limits to Growth report "*pretended to capture the intricate global interactions of population, economy, natural resources, industrial production and environmental pollution with less than 150 lines of simple equations using dubious assumptions to tie together sweeping categories of meaningless variables*" (Pilkey and Pilkey-Jarvis 2007).

Yale University professor Nordhaus (1973) went even further in his critique of the companion study ***World Dynamics*** (Forrester 1971) to Limits to Growth: "*The treatment of empirical relations can be summarised as measurement without data. The model contains 43 variables connected by 22 non-linear (and several linear) relationships. Not a single relationship or variable is drawn from actual data or empirical studies*". *"The main result of aggregation theory is that aggregation is generally possible only when the underlying micro relations are linear. In fact, few of Forrester's relations are linear…"*

However, the problems with the World III model clearly went beyond the technical weaknesses of the model. A Club of Rome official stated shortly after the predictions were released that the idea was "*to get a message across, and to make people aware of the impending crisis*". In other words, the model outcome had been determined before the model was run. Finding the truth according to a preconceived opinion or philosophy is a common flaw in applied mathematical modeling, and the World III model is today considered a fine example of a numerical advocacy model (Pilkey and Pilkey-Jarvis 2007).

References:

http://en.wikipedia.org/wiki/Club_of_Rome

http://en.wikipedia.org/wiki/The_Limits_to_Growth

Calder, N. 1974. *The Weather Machine and the Threat of Ice*. British Broadcasting Corporation (BBC), London, 143.

Dansgaard, W., Johnsen, S.J. and Clausen, H.B. 1970. Vi går mot bistra tider. *Forskning och Framsteg* 8(7), 11-15.

Dansgaard, W., Johnsen, S., Clausen, H.B. and Langway, C.C., Jr. 1971. *Climatic record revealed by the Camp Century ice core*. In: K.K. Turekian (ed.), *Late Cenozoic glacial ages.* Yale Univ. Press, New Haven and London, 37-56.

Forrester, J.W. 1971: *World Dynamics*. Cambridge, Massachusets, Wright-Allen Press, Inc.

Hays, J.D., Imbrie, J. and Shackleton, N.J. 1976. Variations in the Earth's orbit: pacemaker of the ice ages. *Science* 194, 1121-1132.

Lamb, H.H. 1977. *Climate: present, past and future*. Vol.2. Climatic history and the future. London, Methuen, 835 pp.

Meadows, D.H., Meadows, D.L., Randers, J. and Behrens III, W.W. 1972: *The Limits to Growth*. Universe Books, New York. ISBN 0-87663-165-0.

Nordhaus, W.D. 1973. World Dynamics: Measurement Without Data. *The Economic Journal* 83, No. 332, 1156-1183.

Oldfield, F. 1993. Forward to the past: changing approaches to Quaternary palaeoecology. In Chambers, F.M. (ed.), *Climate change and human impact on the landscape*. Chapman and Hall, London, 3-9.

Pilkey, O.H. and Pilkey-Jarvis, L. 2007. *Useless aritmetric. Why Environmental Scientists can't Predict the Future*. Columbia University Press, New York, 230 pp. ISBN 0-231-13212-3.

Ponte, L. 1976. *The Cooling*. Englewood Cliffs, N.J. Prentice Hall.

Rasool, S. and Schneider, S. 1971. Atmospheric carbon dioxide and aerosols – effects of large increases on global climate. *Science* 173, 138-141.

Rodewald, M. 1971. Das grosse Erlahmen der Eisberg-Drift bei Newfoundland. *Hansa (Nautic),* 108 (23), 2341-3244.

*****

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)

February 26, 2013.