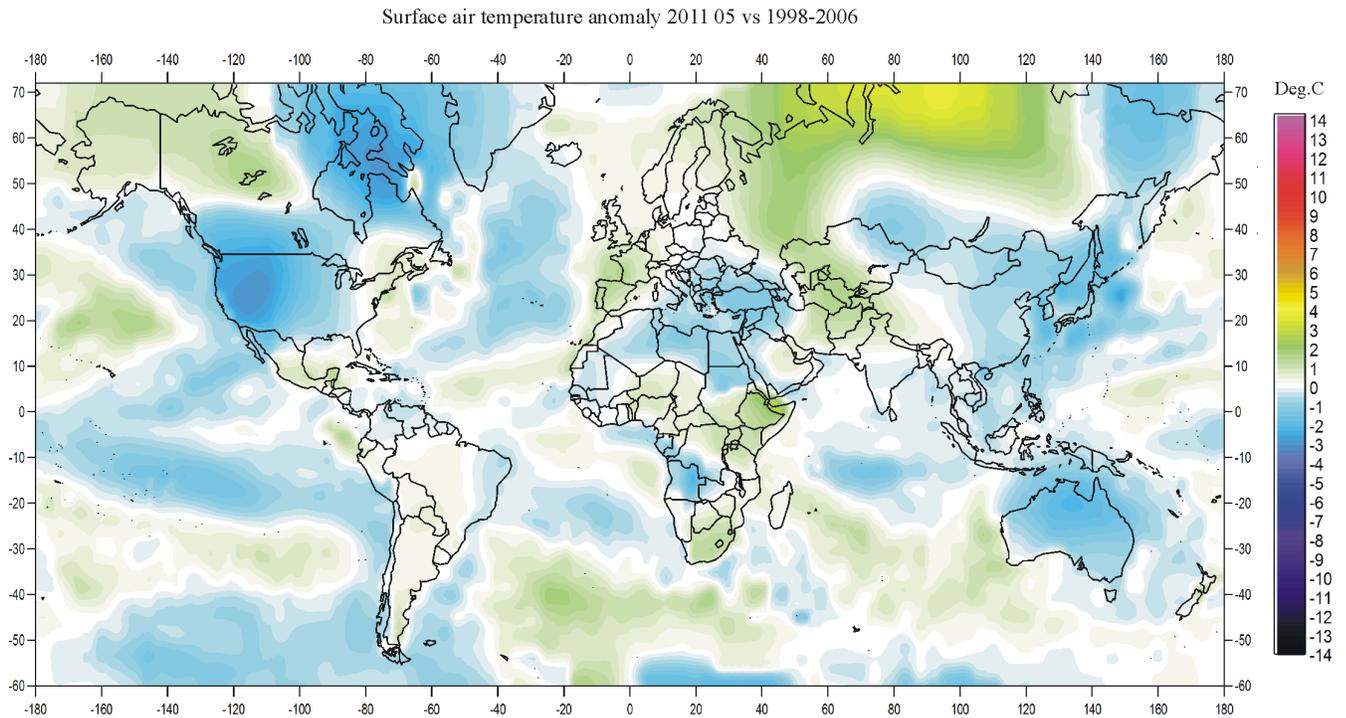


Climate4you update May 2011

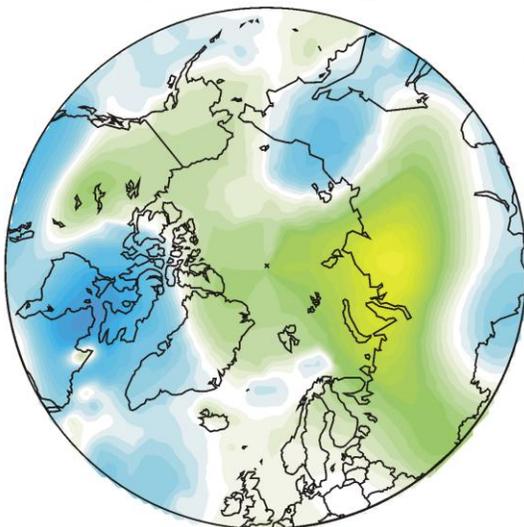
www.climate4you.com

May 2011 global surface air temperature overview

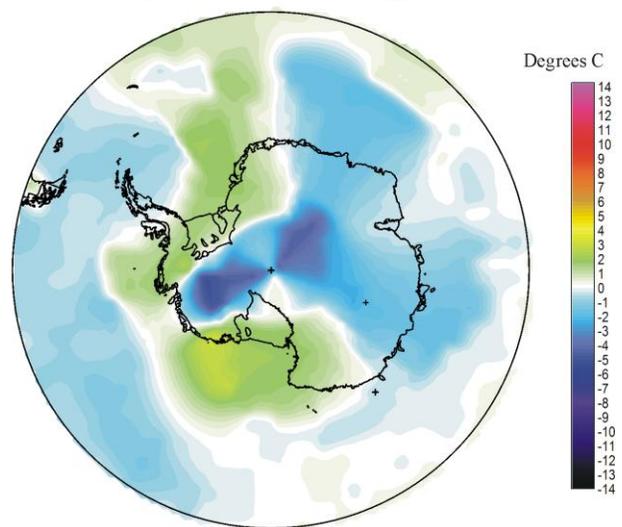


1

Air temperature 201105 versus average 1998-2006



Air temperature 201105 versus average 1998-2006



May 2011 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](http://www.giss.nasa.gov) (GISS)

Comments to the May 2011 global surface air temperature overview

General: This newsletter contains graphs showing a selection of key meteorological variables for May 2011. 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 modern surface air temperatures are increasing or decreasing. 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 several of the 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 on www.Climate4you.com.

Most diagrams shown in this newsletter are also available for download on www.climate4you.com

Global surface air temperatures May 2011 in general were somewhat below the 1998-2006 global average.

As usual, the Northern Hemisphere was characterised by rather high regional variability. A zone of below average temperatures extended across most of North America, except NW Canada and Alaska. Also the central North Atlantic, eastern Siberia, Mongolia, Japan, and most of China experienced below average temperatures. Above average temperatures characterised northern Russia and Siberia, Alaska and NW Canada.

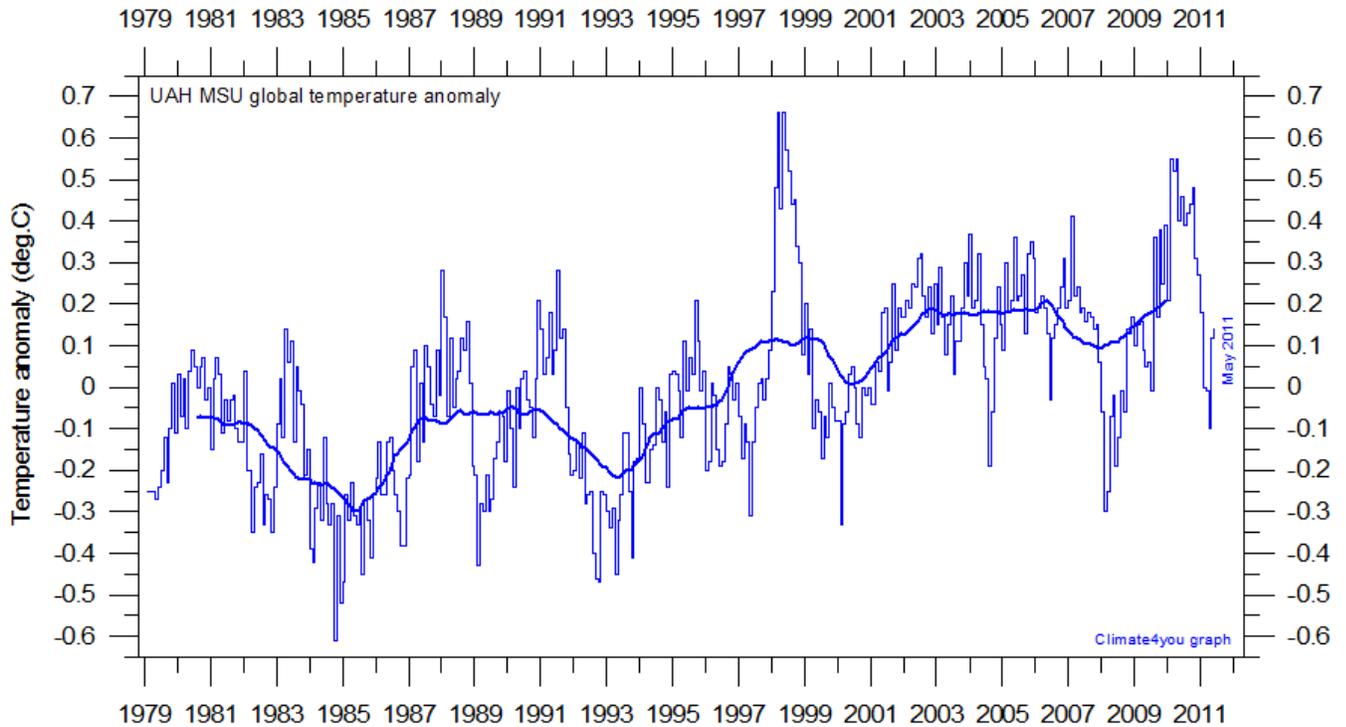
The Southern Hemisphere in general was close to average 1998-2006 conditions. Australia had below average temperatures, while conditions in Africa were more mixed. South America in general was close to average temperature conditions.

Near Equator temperatures conditions were still influenced by the previous cold La Nina situation. Relatively low temperatures characterised most of the Equatorial regions in the Pacific and Indian Ocean. The Equatorial Atlantic region was close to average temperature conditions. North Africa and the eastern Mediterranean was relatively cold.

The Arctic was once again characterized by marked contrasts as to the surface air temperature, although somewhat less compared to the previous month. The central Arctic in general had above average temperatures, while the conditions at lower latitudes were more mixed. Especially northern Siberia was relatively warm, while the region around Hudson Bay and Baffin Island was cold.

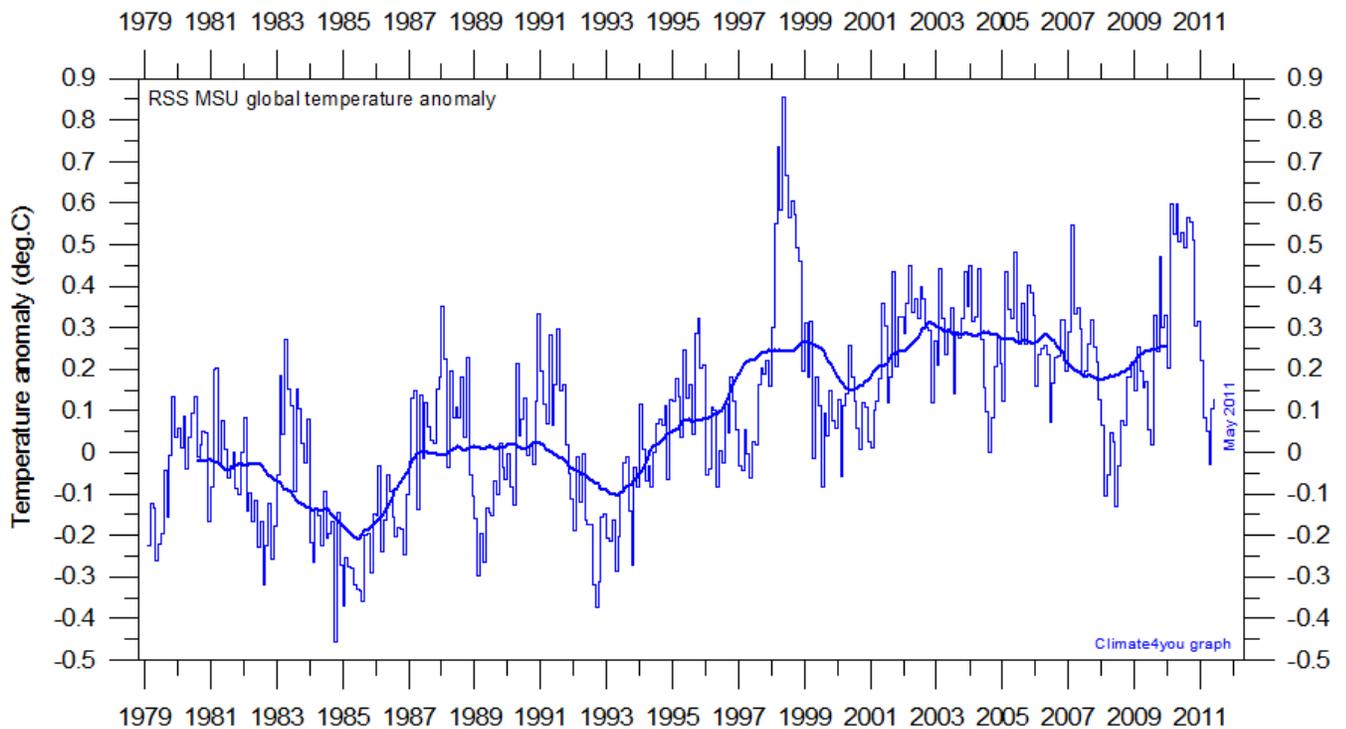
Most of East Antarctic and central West Antarctic had below average temperatures, but coastal parts of West Antarctic experienced above average temperatures.

Lower troposphere temperature from satellites, updated to May 2011



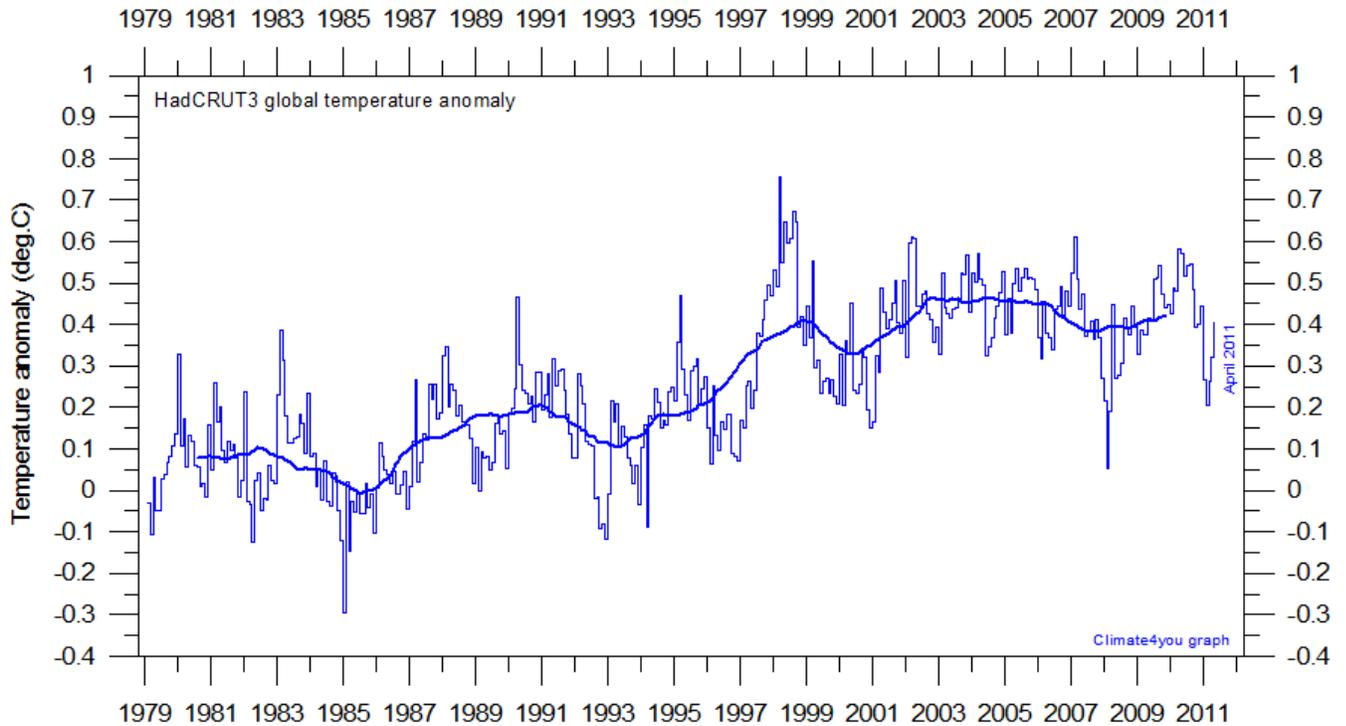
Global monthly average lower troposphere temperature (thin line) since 1979 according to [University of Alabama](#) at Huntsville, USA. The thick line is the simple running 37 month average.

3



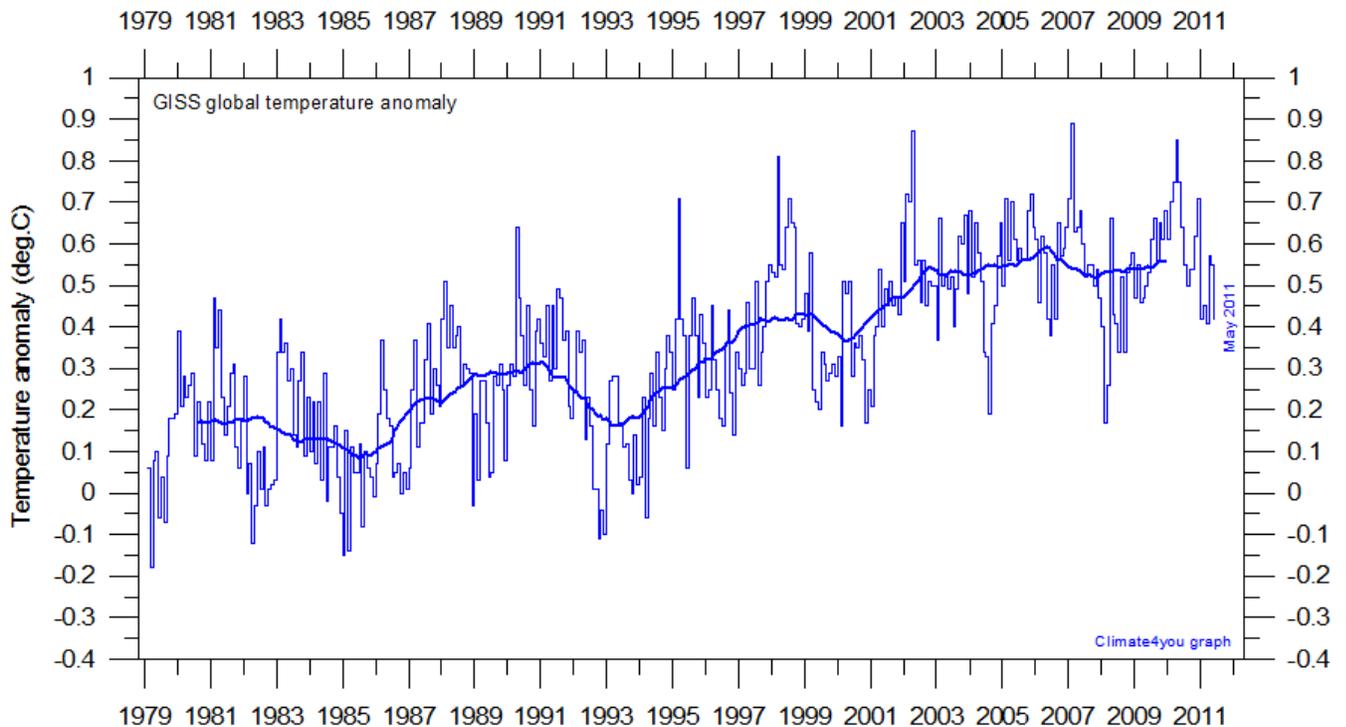
Global monthly average lower troposphere temperature (thin line) since 1979 according to according to [Remote Sensing Systems](#) (RSS), USA. The thick line is the simple running 37 month average.

Global surface air temperature, updated to May 2011

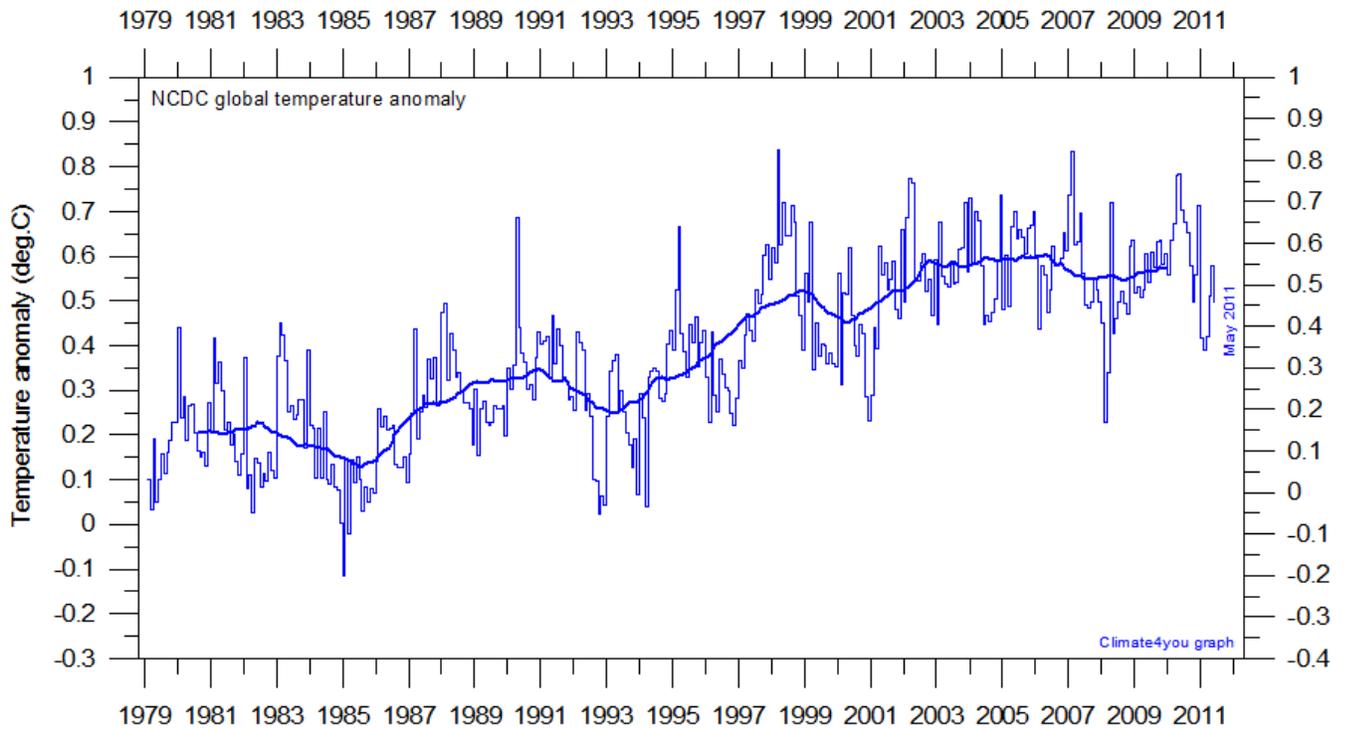


Global monthly average surface air temperature (thin line) since 1979 according to according to the Hadley Centre for Climate Prediction and Research and the University of East Anglia's [Climatic Research Unit \(CRU\)](#), UK. The thick line is the simple running 37 month average. Please note that the HadCRUT3 record is only updated to April 2011.

4

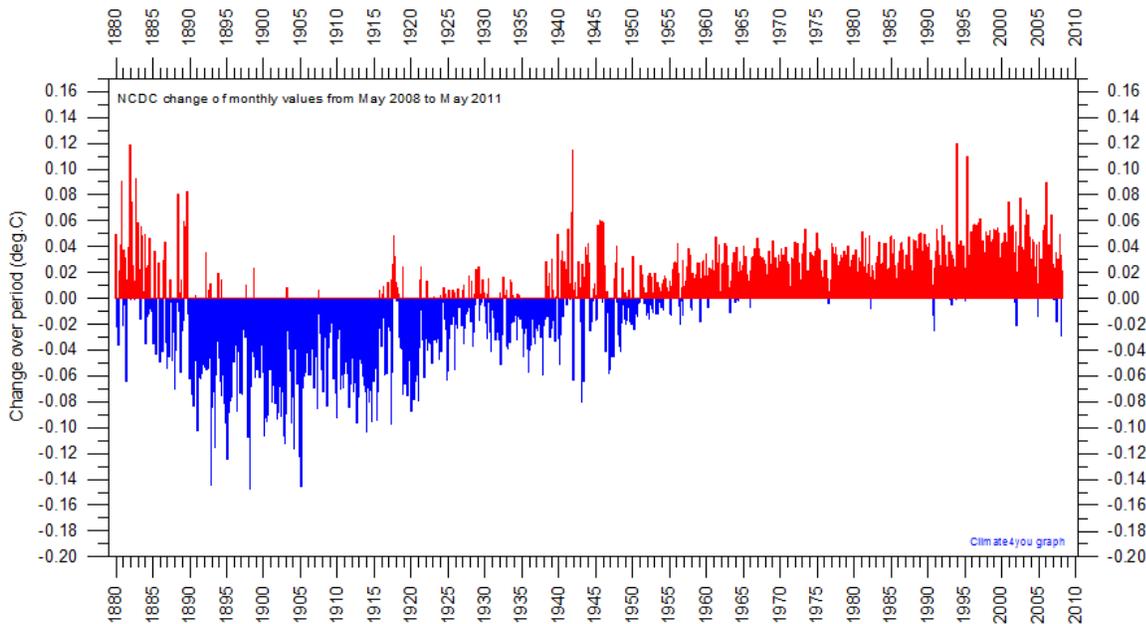


Global monthly average surface air temperature (thin line) since 1979 according to according to the [Goddard Institute for Space Studies \(GISS\)](#), at Columbia University, New York City, USA. The thick line is the simple running 37 month average.

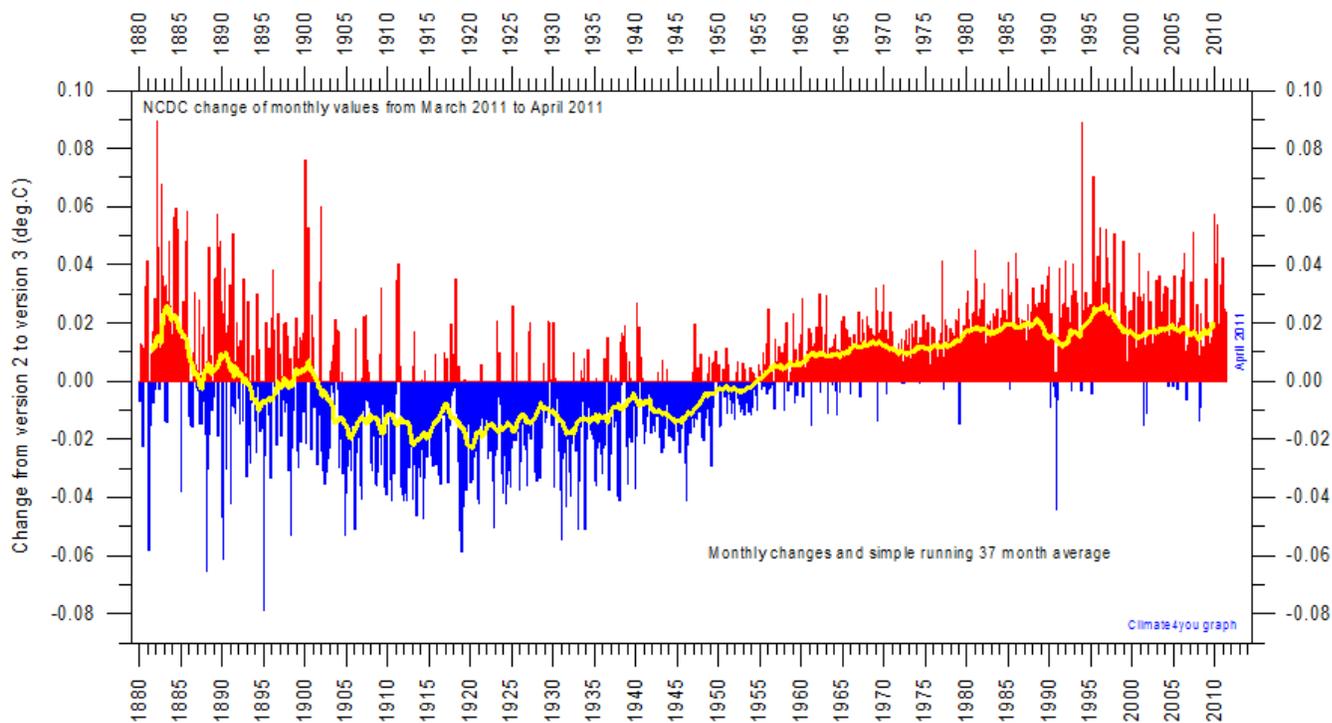


Global monthly average surface air temperature since 1979 according to according to the [National Climatic Data Center \(NCDC\)](#), USA. The thick line is the simple running 37 month average.

Some readers have noted that the above temperature estimates display changes when one compare with previous issues of this newsletter, not only for the most recent months, but actually for all months back to the beginning of the record. As an example, the net change of the NCDC record since 17 May 2008 is shown below. By this administrative effort the apparent global temperature increase since 1900 has been enhanced about 0.1°C, or about 14% of the total increase recorded since 1900 by NCDC. The interested reader may find more on this lack of temporal stability on www.climate4you (go to: Global Temperature and then Temporal Stability).



It should be noted that on May 2, 2011, NCDC transitioned to GHCN-M version 3 as the official land component of its global temperature monitoring efforts. GHCN-M version 2 mean temperature dataset will continue to be updated through May 30, 2011, but no support for this version of the dataset will be provided. The net effect of the change from version 2 to 3 can be seen in the diagram below.

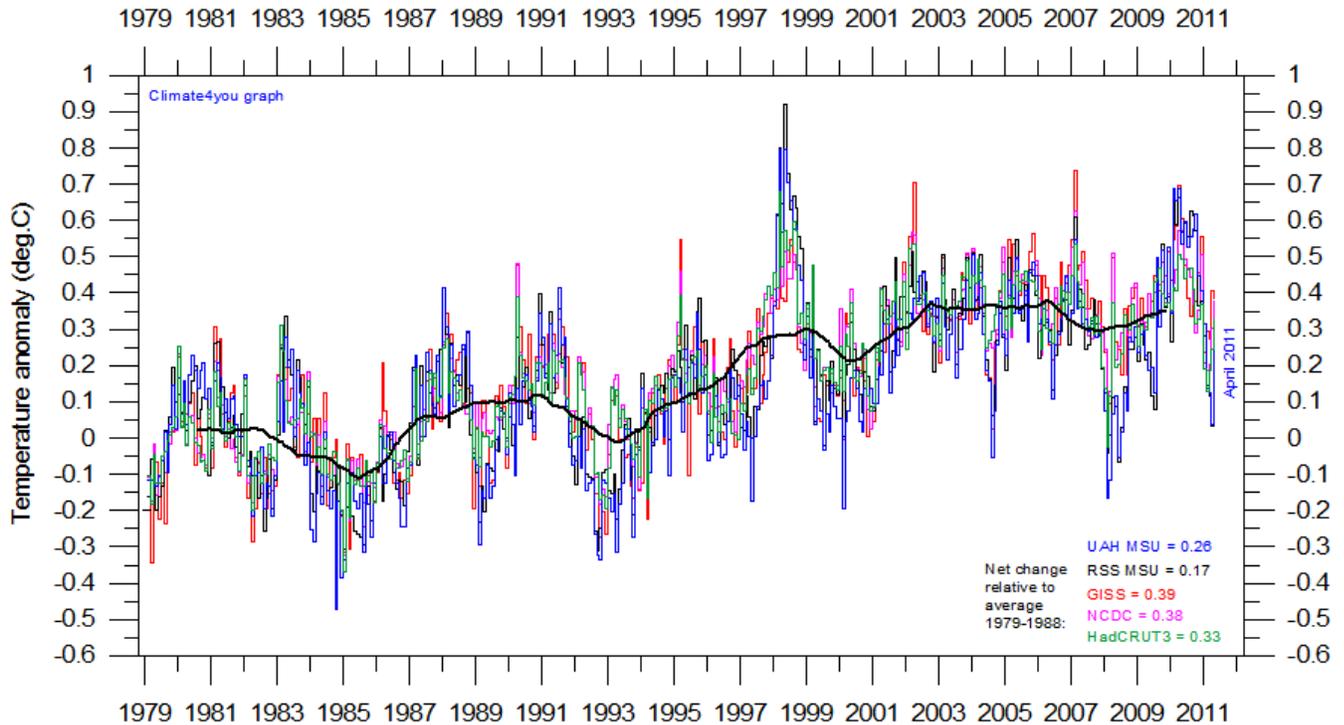


6

Net temperature effect of the 2 May 2011 transition from GHCN-M version 2 to version 3 as the official land component of its global temperature monitoring efforts. The vertical lines indicate the net effect of the version change on monthly temperature values, and the yellow line shows the effect on the simple running 37 month average, nearly corresponding to 3 years.

The overall net effect of the NCDC transition from GHCN-M version 2 to version 3 is to increase global temperatures before 1900, to decrease them between 1900 and 1950, and to increase temperatures after 1950. By this the 20th century temperature rise is about 0.04°C larger in the new version 3 compared to the previous version 2.

All in one, updated to April 2011



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Superimposed plot of all five global monthly temperature estimates shown above. As the base period differs for the different temperature estimates, they have all been normalised by comparing to the average value of their 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 above mentioned 10 yr average.

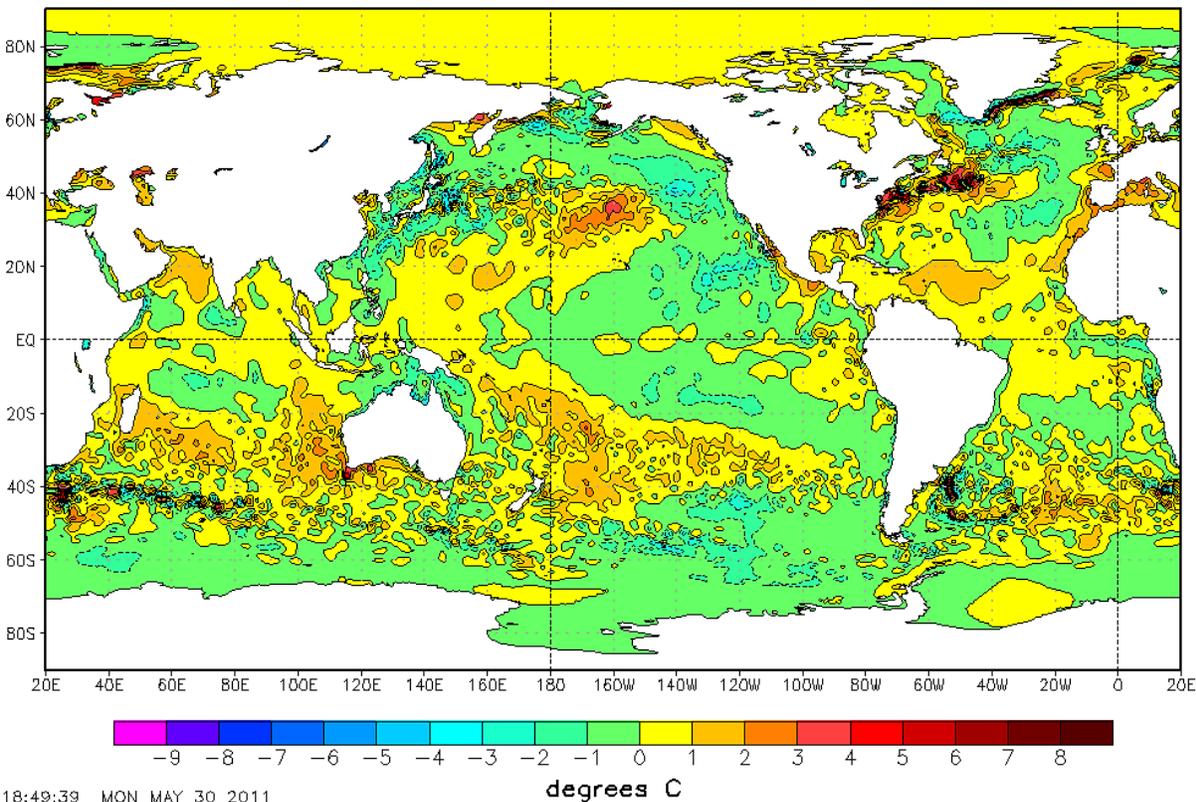
It should be kept in mind that satellite- and surface-based temperature estimates are derived from different types of measurements, and that comparing them directly as done in the diagram above therefore in principle may be problematical. However, as both types of estimate often are discussed together, 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 may be considerable differences between the individual records.

All five global temperature estimates presently show 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 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 end of May 2011

NOAA/NWS/NCEP/EMC Marine Modeling and Analysis Branch

RTG_SST Anomaly (0.5 deg X 0.5 deg) for 30 May 2011

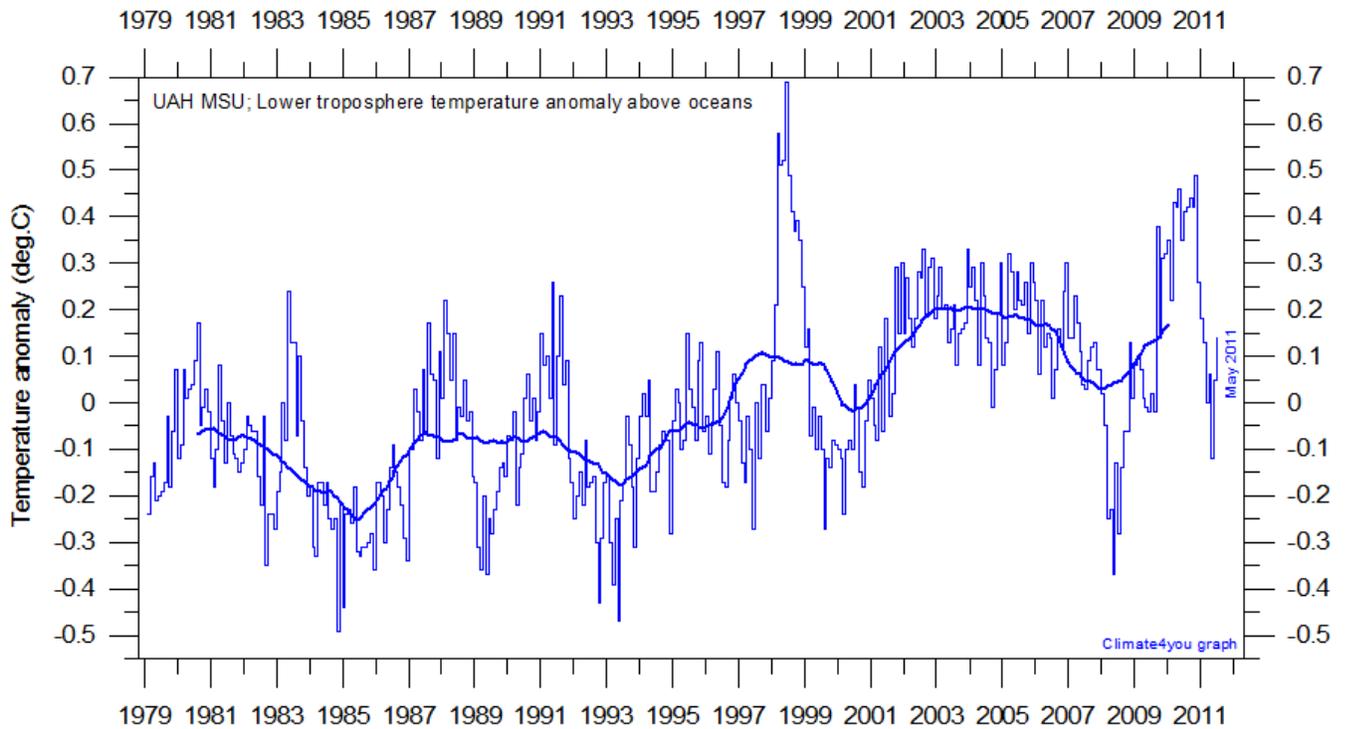


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Sea surface temperature anomaly at 30 May 2011. Map source: National Centers for Environmental Prediction (NOAA).

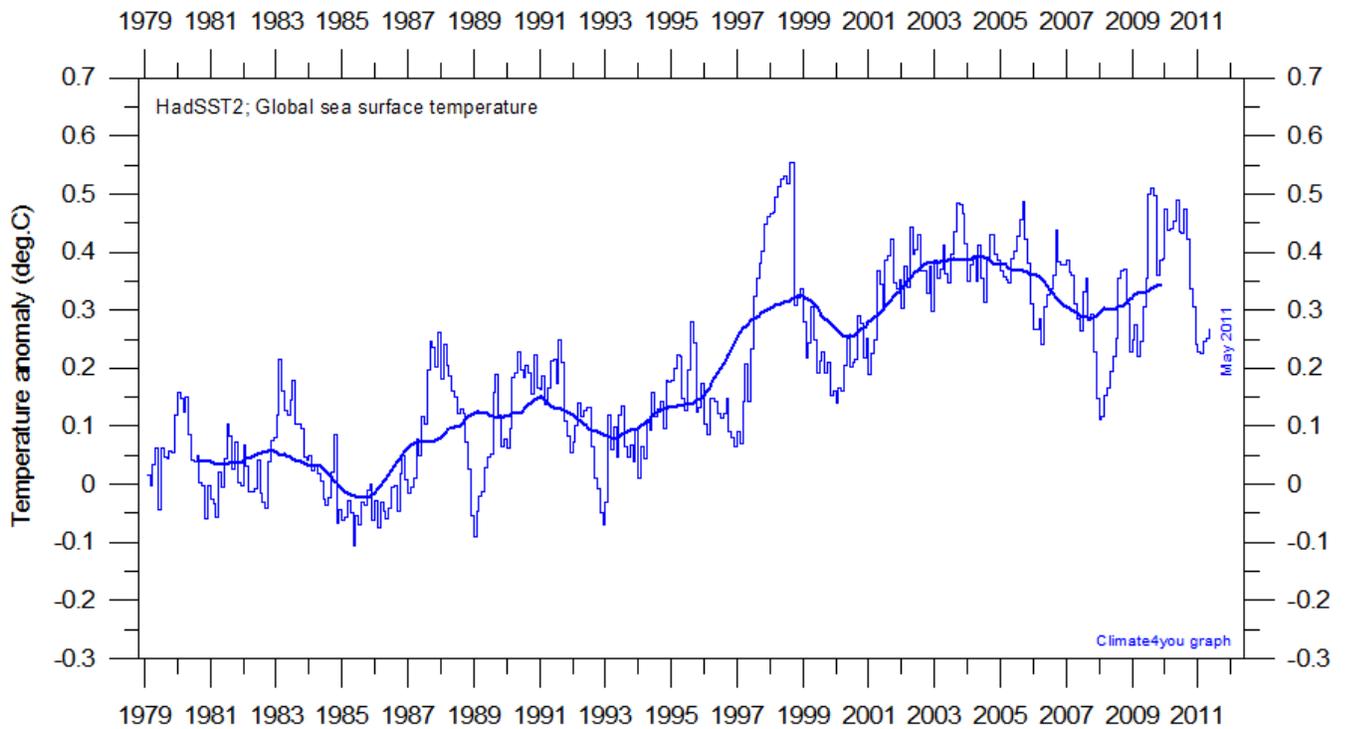
The relative cold surface water dominating the regions near Equator in the eastern Pacific Ocean represents the remnants of the previous La Niña situation, but warmer water is now beginning to spread west from the Peruvian coast. Because of the large surface areas involved (being near Equator) this natural cyclic oceanographic development will be affecting the global atmospheric temperature in the months to come.

However, the significance of any such cooling or warming seen in surface air temperatures should not be overstated. Whenever Earth experiences cold La Niña or warm El Niño episodes 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 the above heat exchange mainly reflects a redistribution of energy. What matters is the overall temperature development when seen over some years.

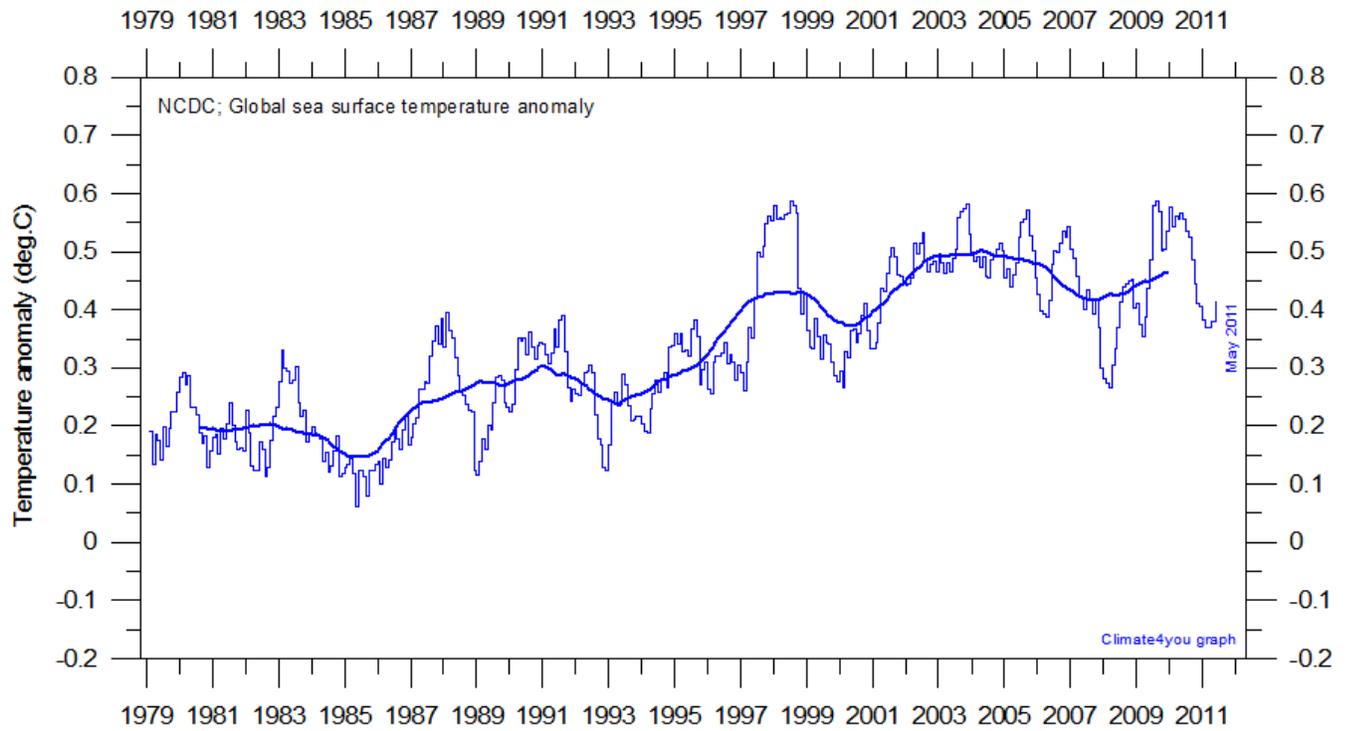


Global monthly average lower troposphere temperature over oceans (thin line) since 1979 according to [University of Alabama](#) at Huntsville, USA. The thick line is the simple running 37 month average.

9

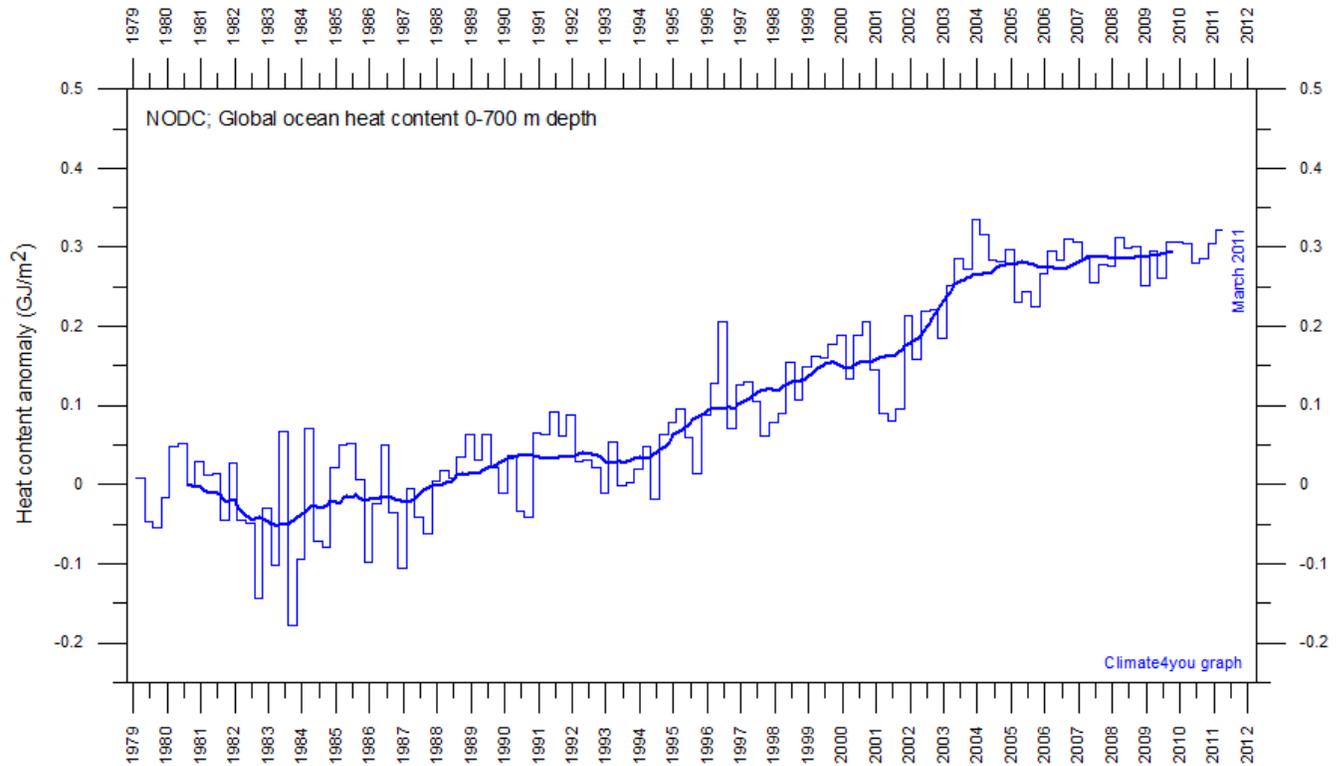


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit \(CRU\)](#), UK. Base period: 1961-1990. The thick line is the simple running 37 month average



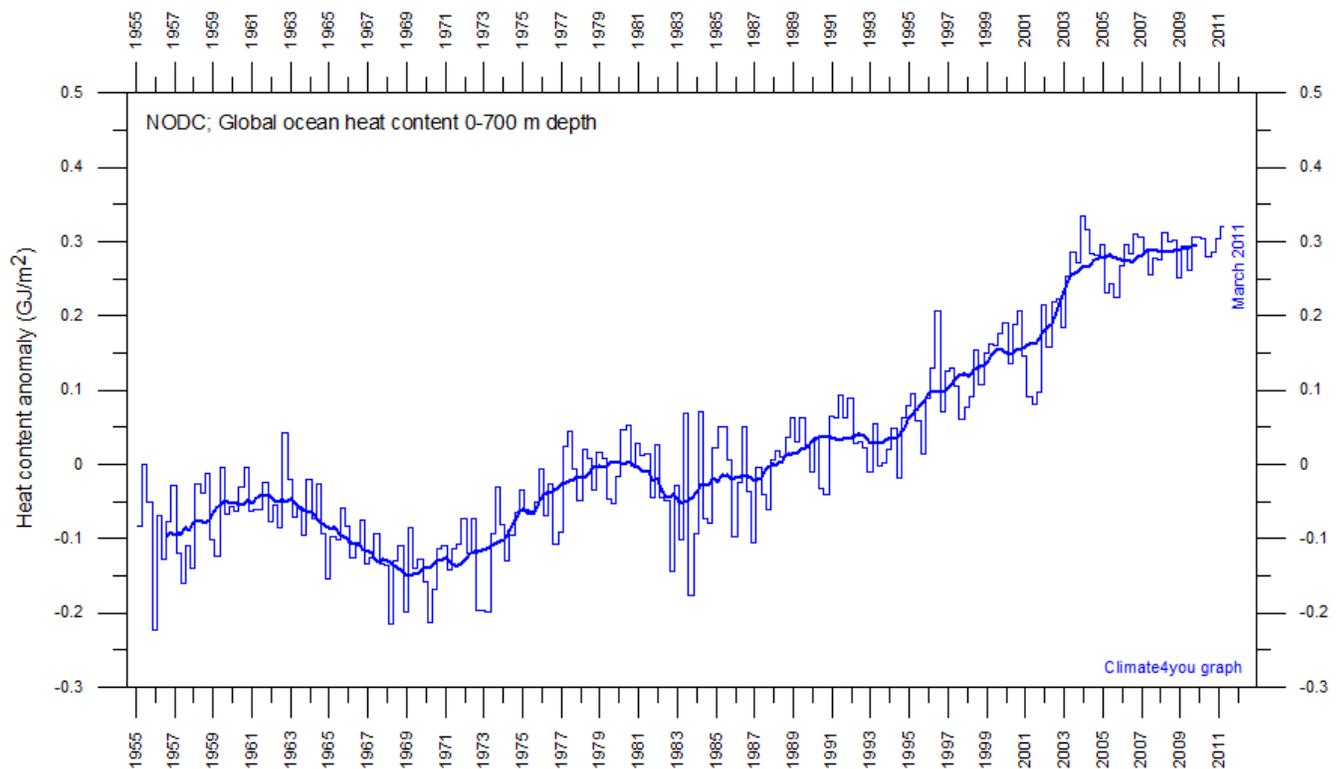
Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center \(NCDC\)](#), USA. Base period: 1901-2000. The thick line is the simple running 37 month average.

Global ocean heat content, updated to March 2011



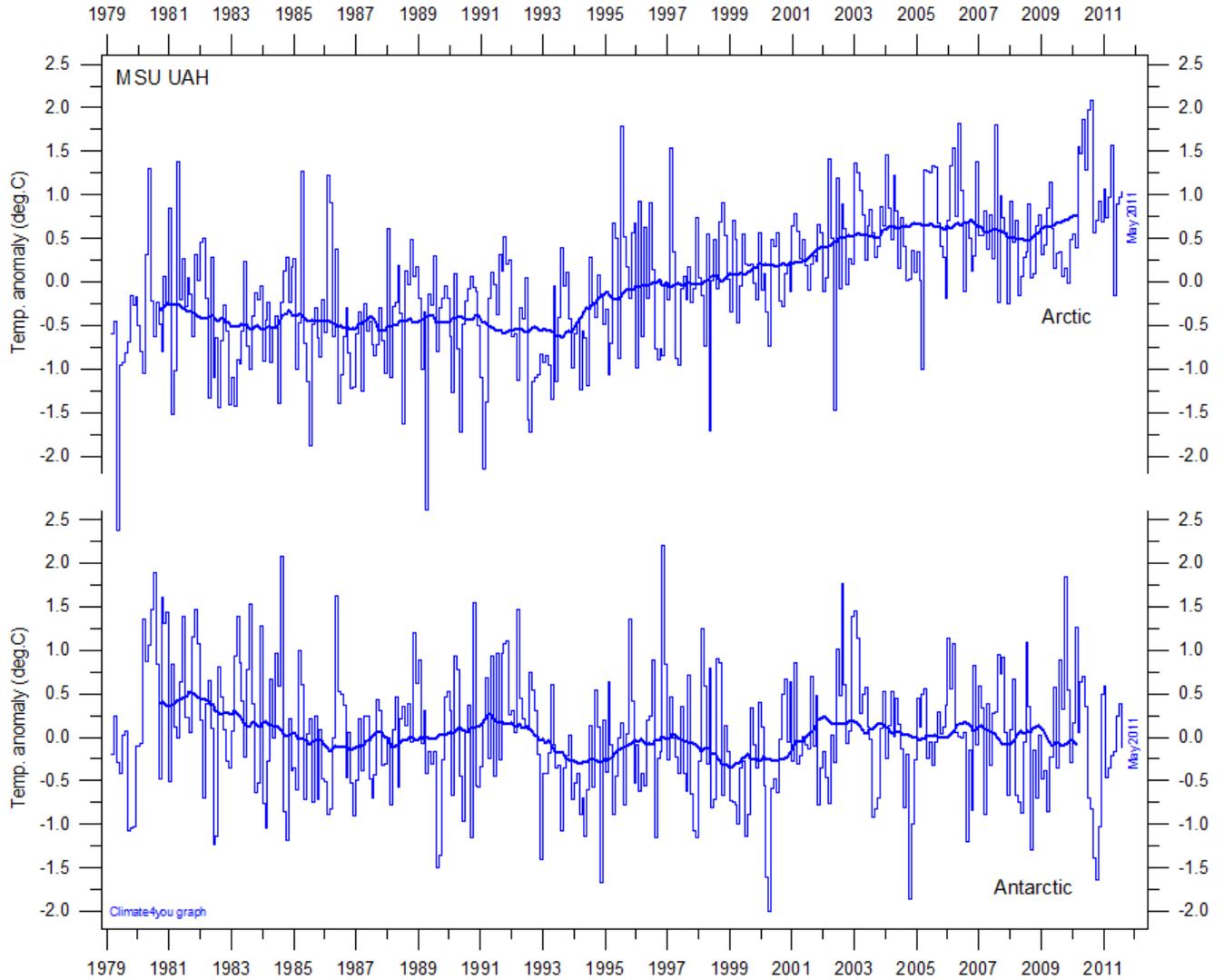
Global monthly heat content anomaly (GJ/m^2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).

11



Global monthly heat content anomaly (GJ/m^2) in the uppermost 700 m of the oceans since January 1955. Data source: National Oceanographic Data Center(NODC).

Arctic and Antarctic lower troposphere temperature, updated to May 2011



Global monthly average lower troposphere temperature since 1979 for the North Pole and South Pole regions, based on satellite observations ([University of Alabama](http://www.cgd.cba.uah.edu) at Huntsville, USA). 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 2011

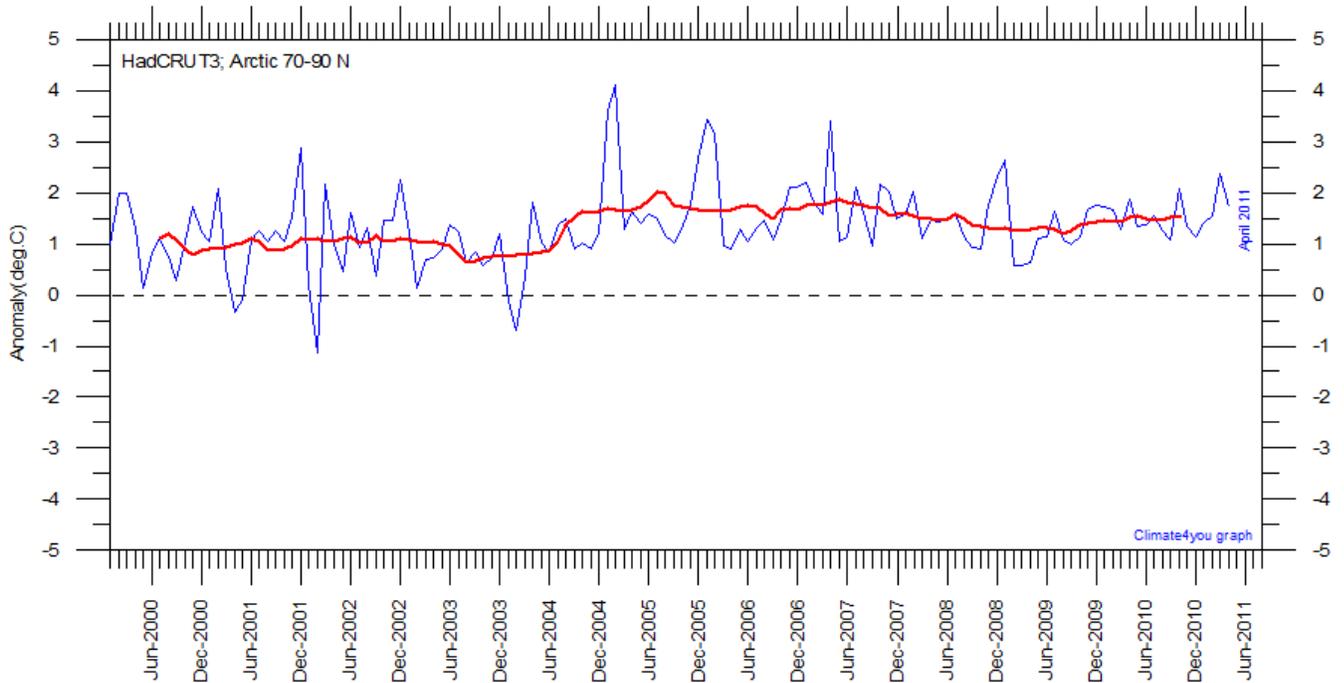


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 2000, in relation to the WMO reference “normal” period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre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

13

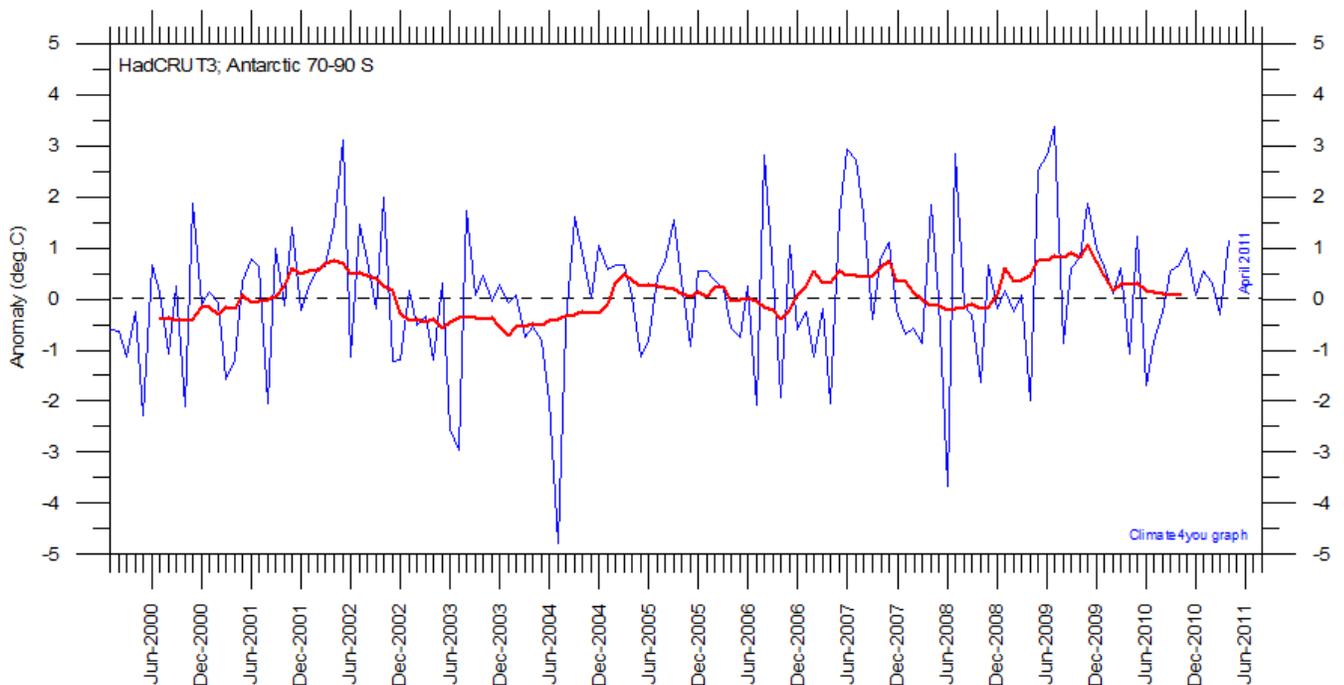


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 2000, in relation to the WMO reference “normal” period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley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

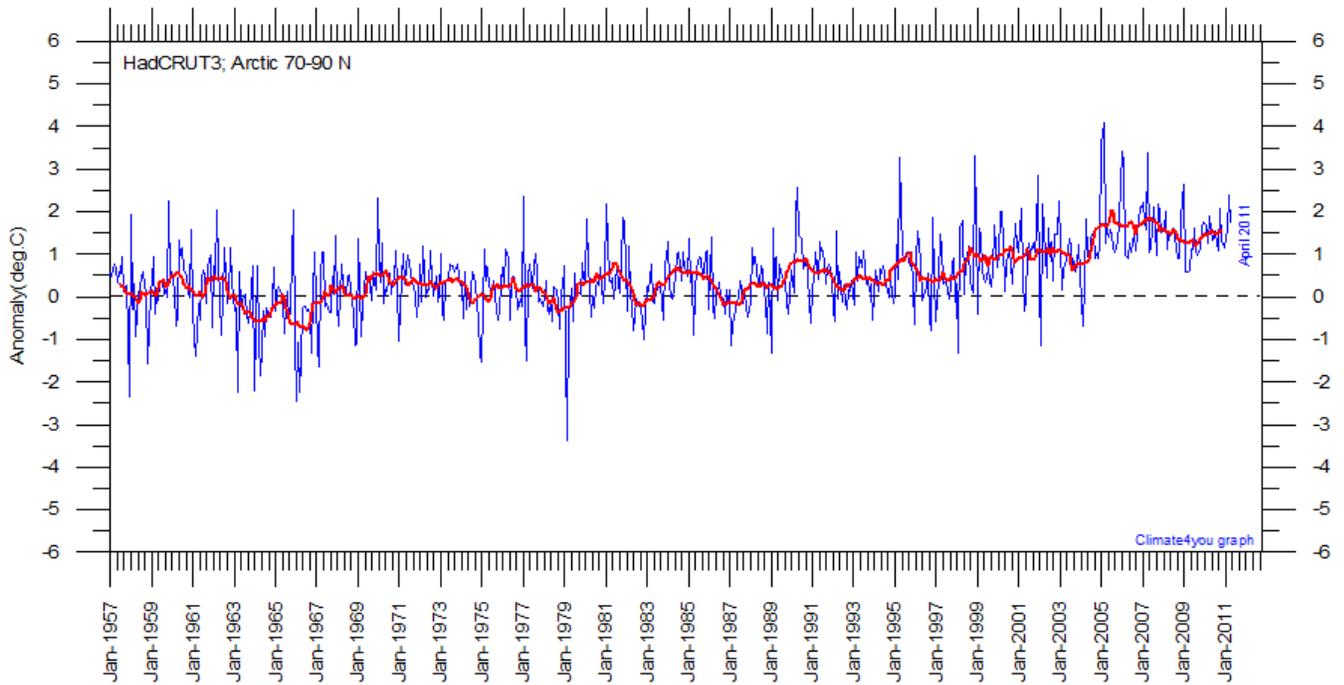


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1957, in relation to the WMO reference “normal” period 1961-1990. The year 1957 has been chosen as starting year, to ensure easy comparison with the maximum length of the realistic Antarctic temperature record shown 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.

14

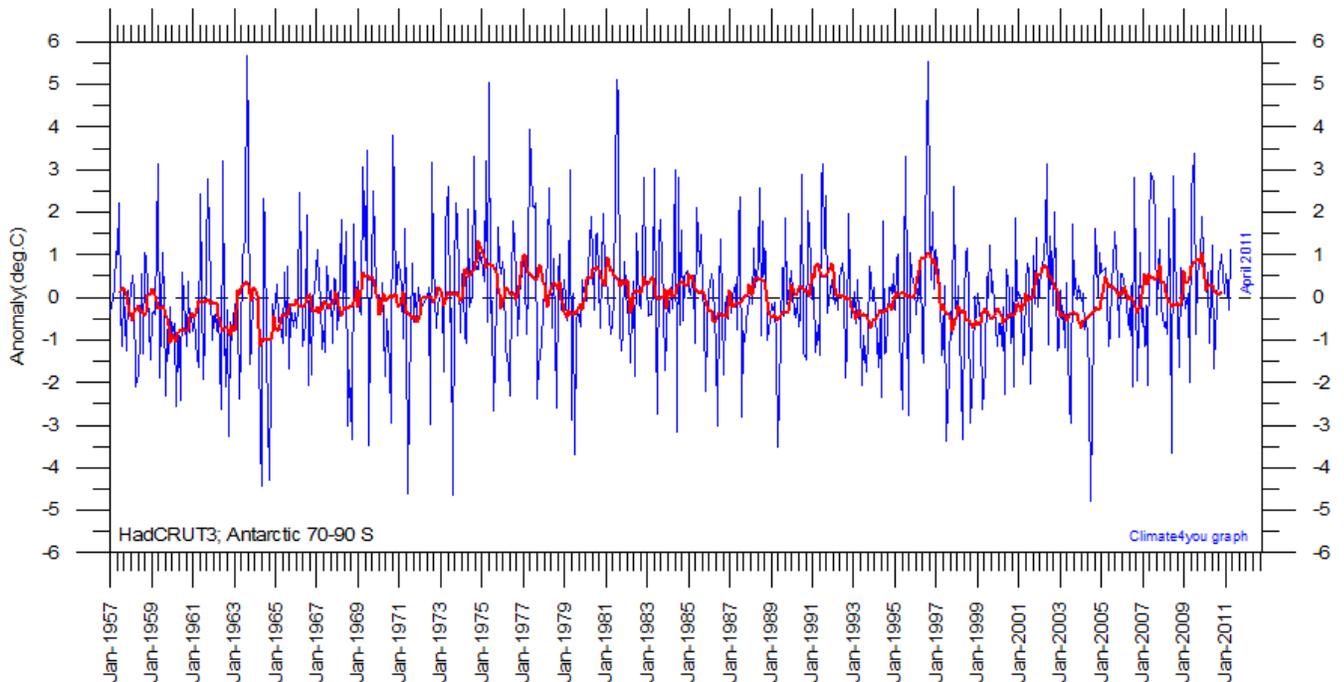


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 1957, in relation to the WMO reference “normal” period 1961-1990. The year 1957 was an international geophysical year, and several meteorological stations were established in the Antarctic because of this. Before 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.

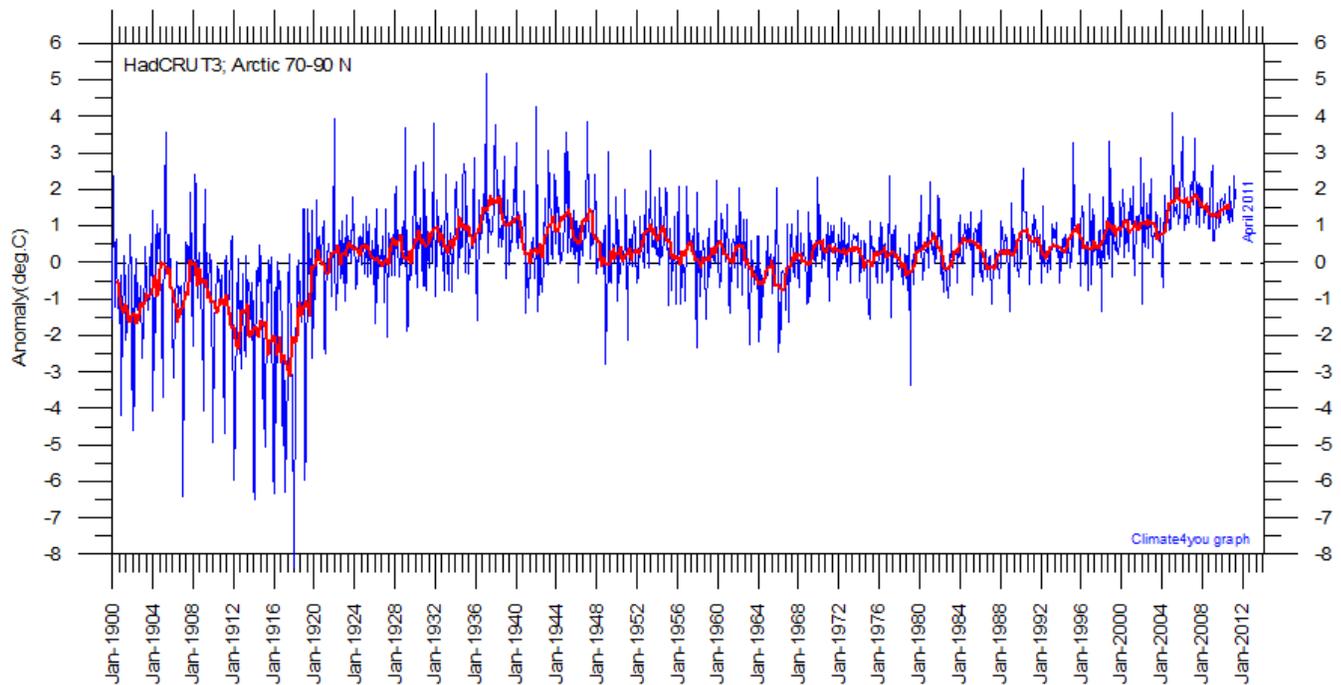


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1900, in relation to the WMO reference “normal” period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. In general, the range of monthly 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

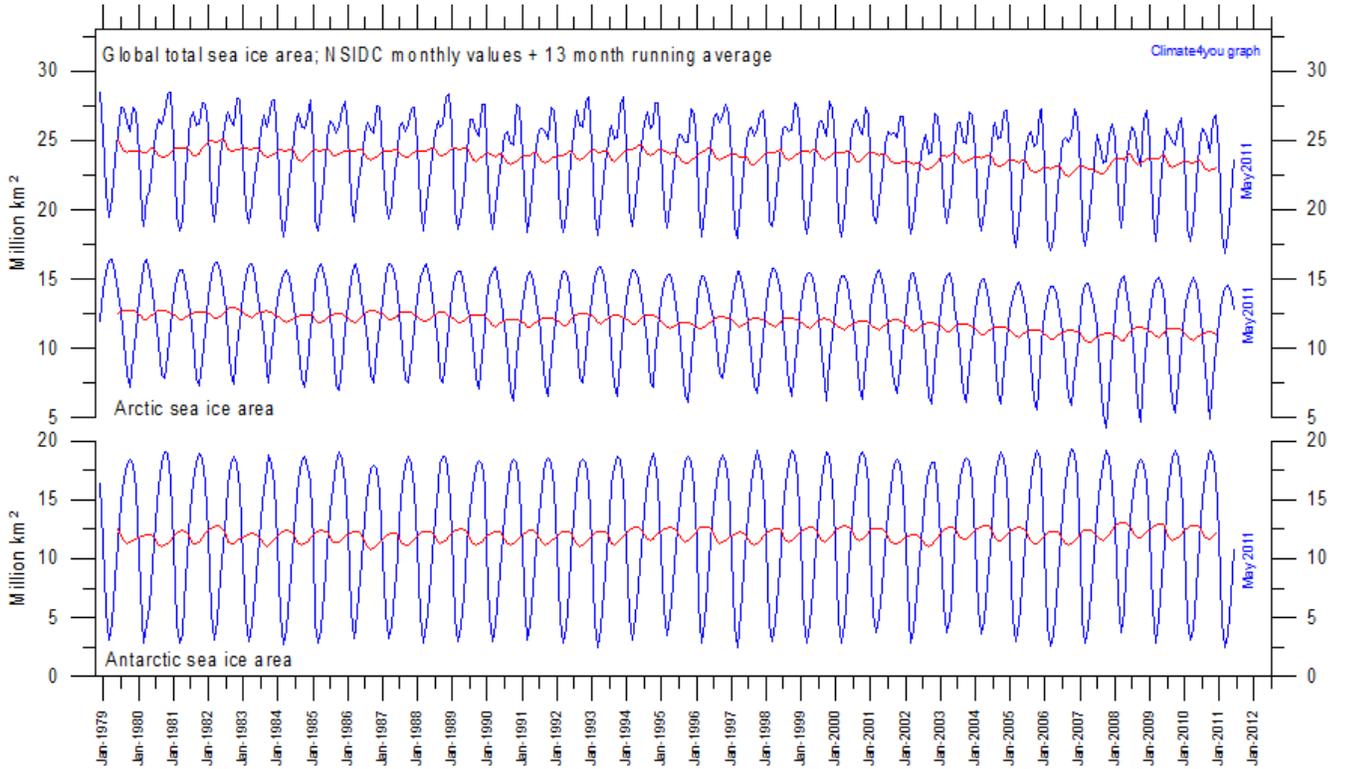
In general, the Arctic temperature record appears to be less variable than the Antarctic record, presumably at least partly due to the higher number of meteorological stations north of 70°N, compared to the number of stations south of 70°S.

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 cells.

Literature:

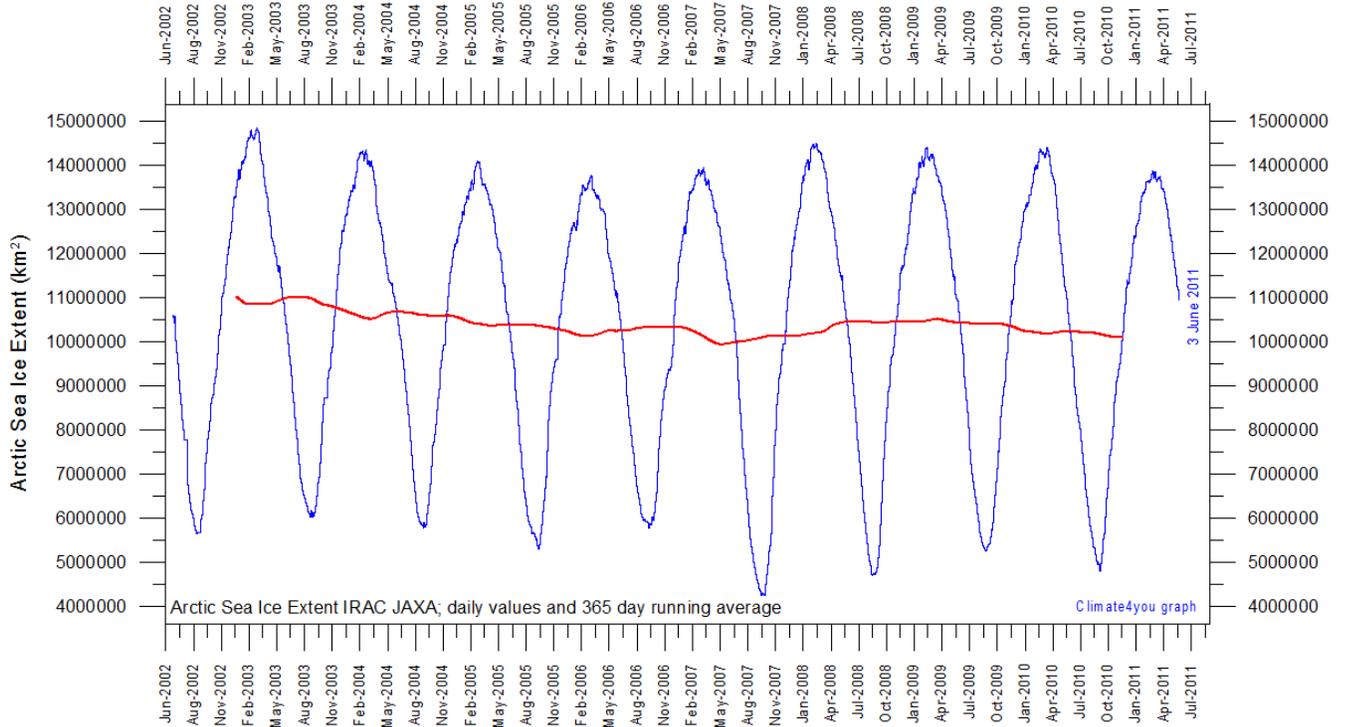
Gillet, N.P., Stone, D.A., Stott, P.A., Nozawa, T., Karpechko, A.Y.U., Hegerl, G.C., Wehner, M.F. and Jones, P.D. 2008. Attribution of polar warming to human influence. *Nature Geoscience* 1, 750-754.

Arctic and Antarctic sea ice, updated to May 2011



16

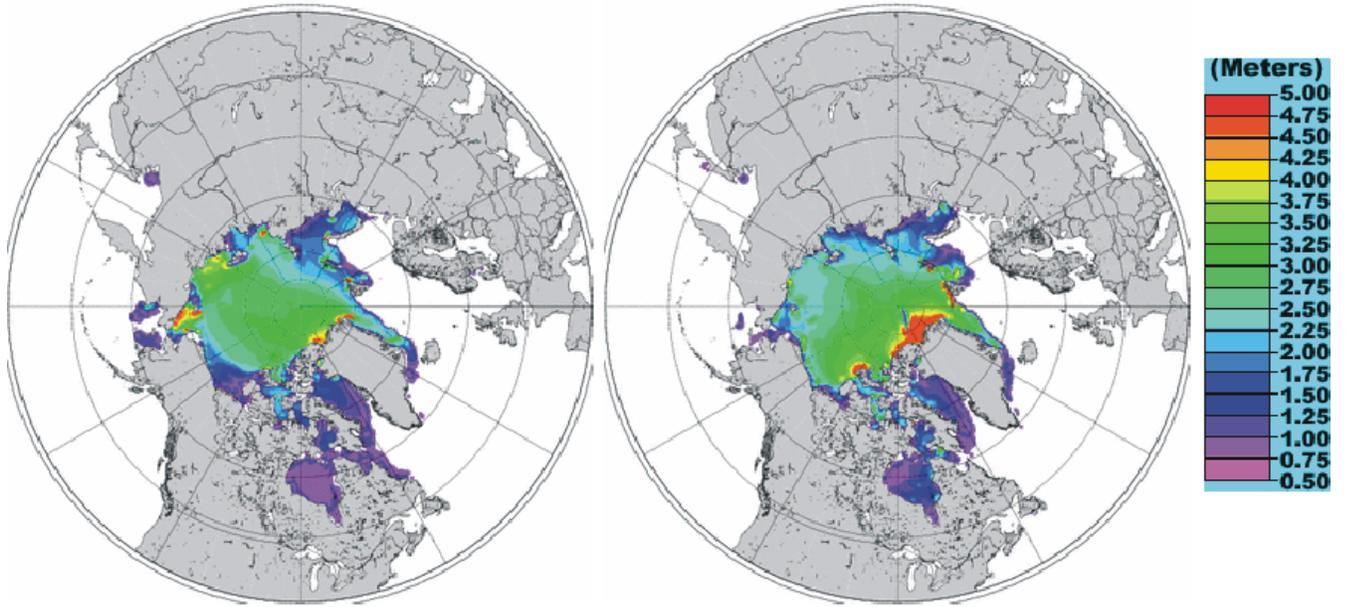
Graphs showing monthly Antarctic, Arctic and global sea ice extent since November 1978, according to the [National Snow and Ice data Center \(NSIDC\)](#).



Graph showing daily Arctic sea ice extent since June 2002, to June 3, 2011, by courtesy of [Japan Aerospace Exploration Agency \(JAXA\)](#).

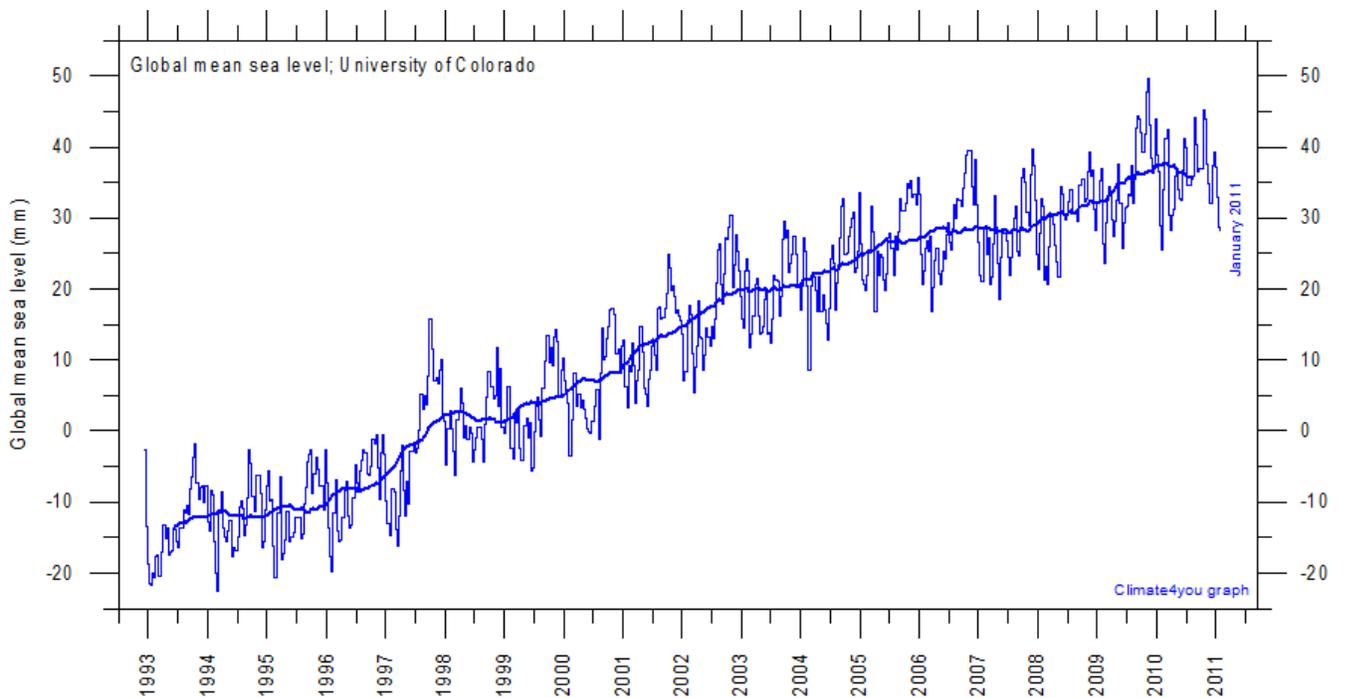
PIPS2.0 24hr forecast from 2010052200_024.dat
valid for 2010052300

PIPS2.0 24hr forecast from 2011052200_024.dat
valid for 2011052300

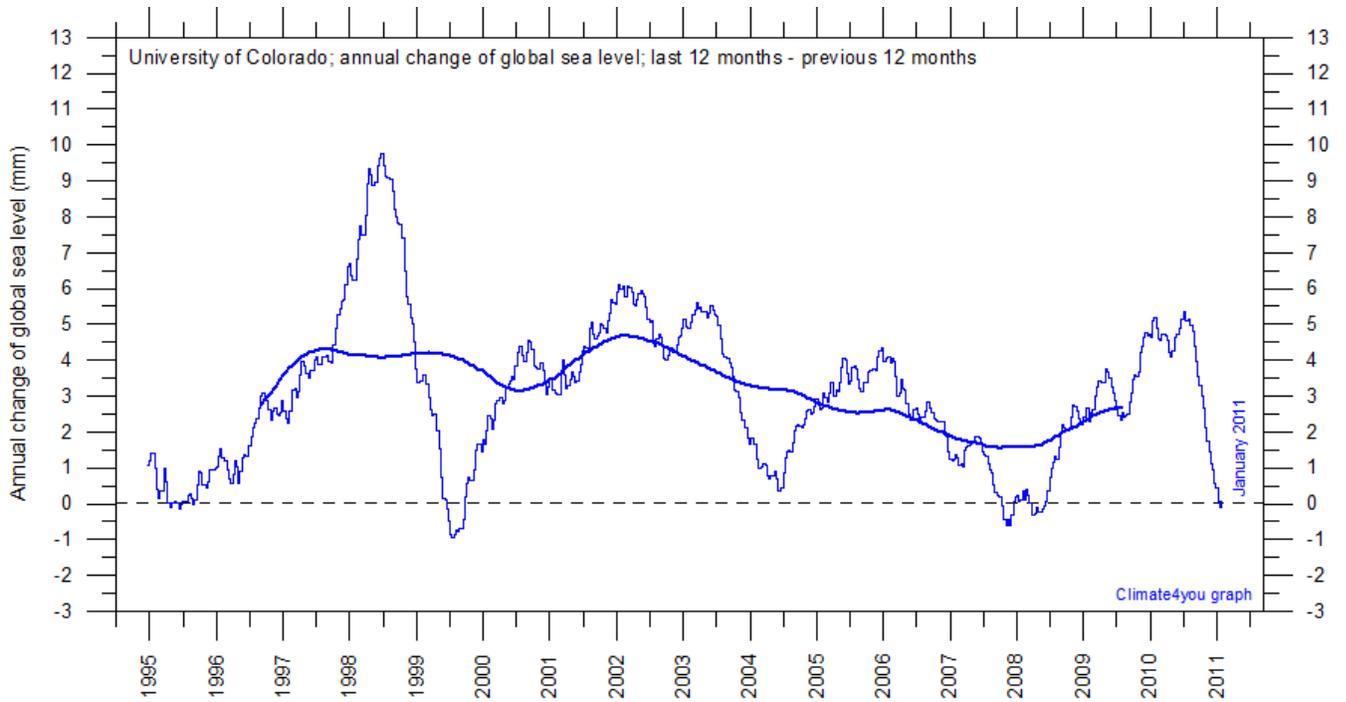


Northern hemisphere sea ice thickness on 23 May 2010 (left) and 2011 (right), according to the Naval Oceanographic Office (NAVO). Thickness values are calculated by the Polar Ice Prediction System (PIPS 2.0), based on the Special Sensor Microwave Image (SSM/I) to initialize the calculation. Thickness scale (m) is shown to the right.

Global sea level, updated to January 2011

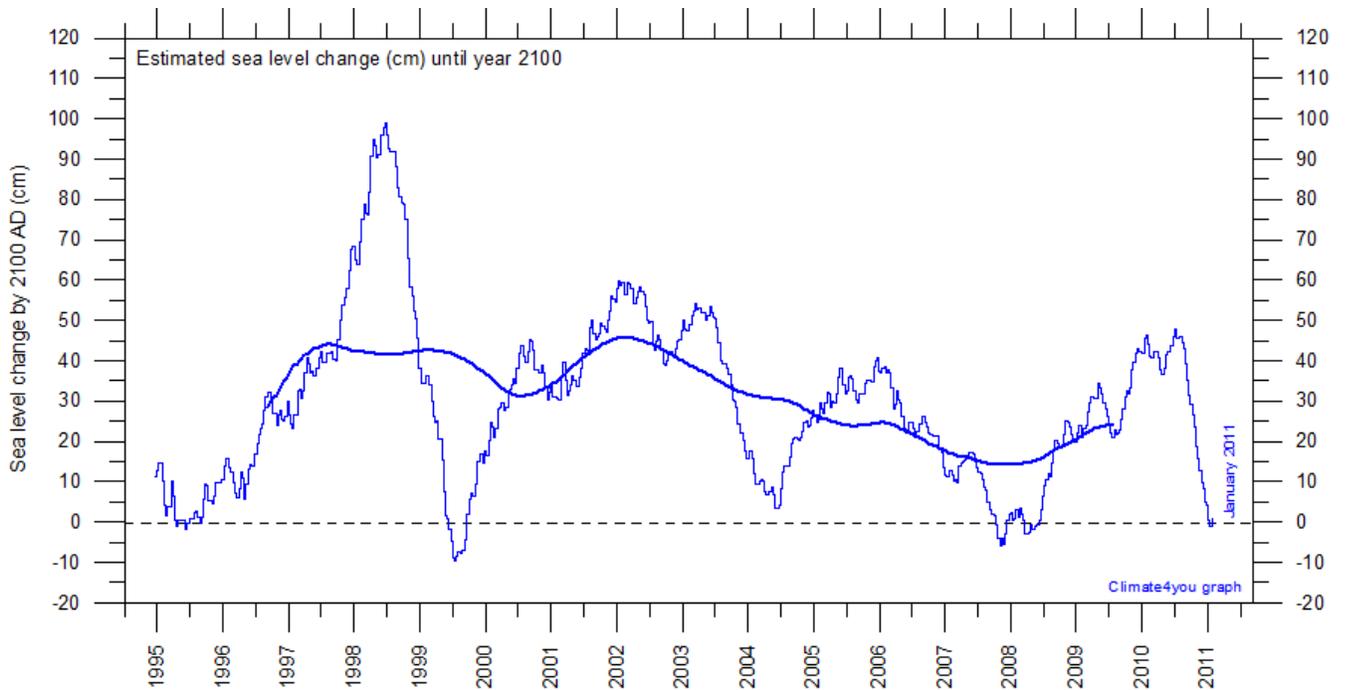


Globa lmonthly sea level since late 1992 according to the Colorado Center for Astro dynamics Research at [University of Colorado at Boulder](#), USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.



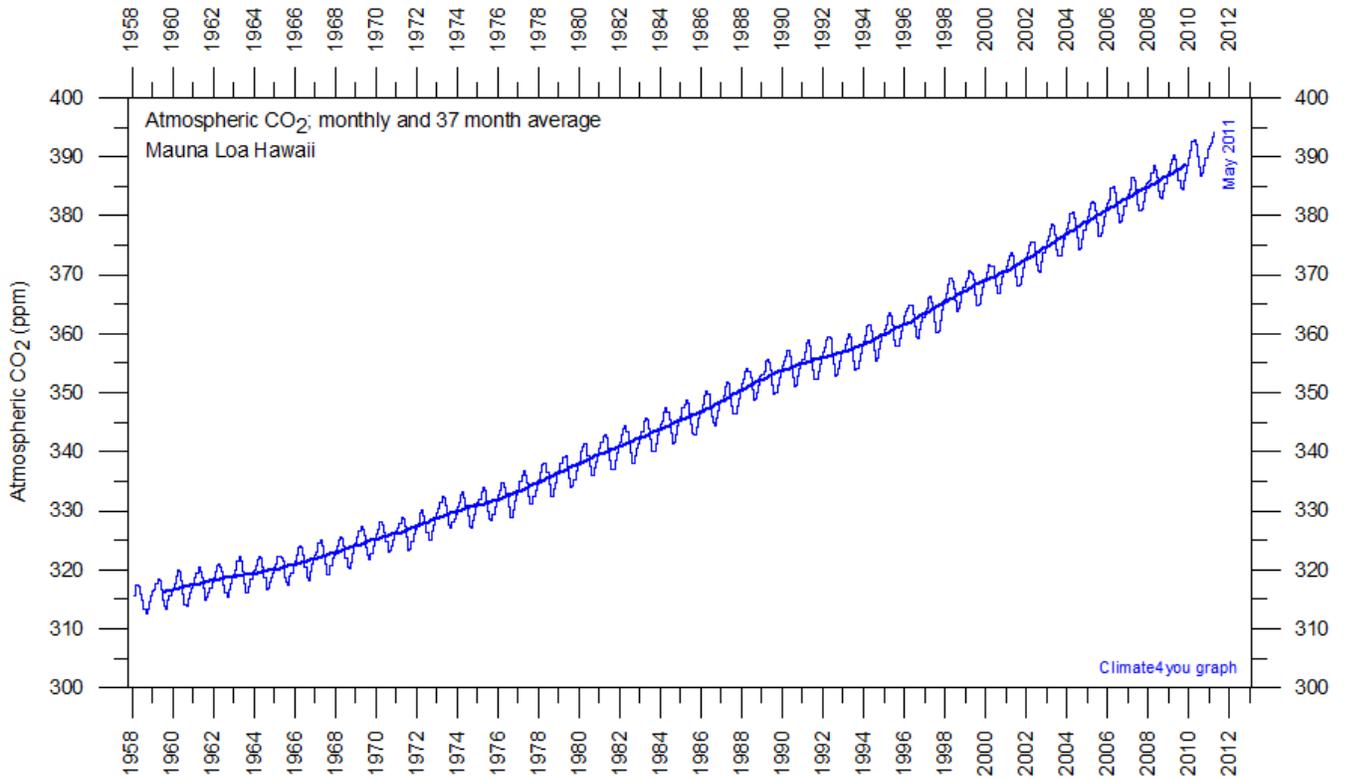
Annual change of global sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](http://www.ccar.colorado.edu), USA. The thick line is the simple running 3 yr average.

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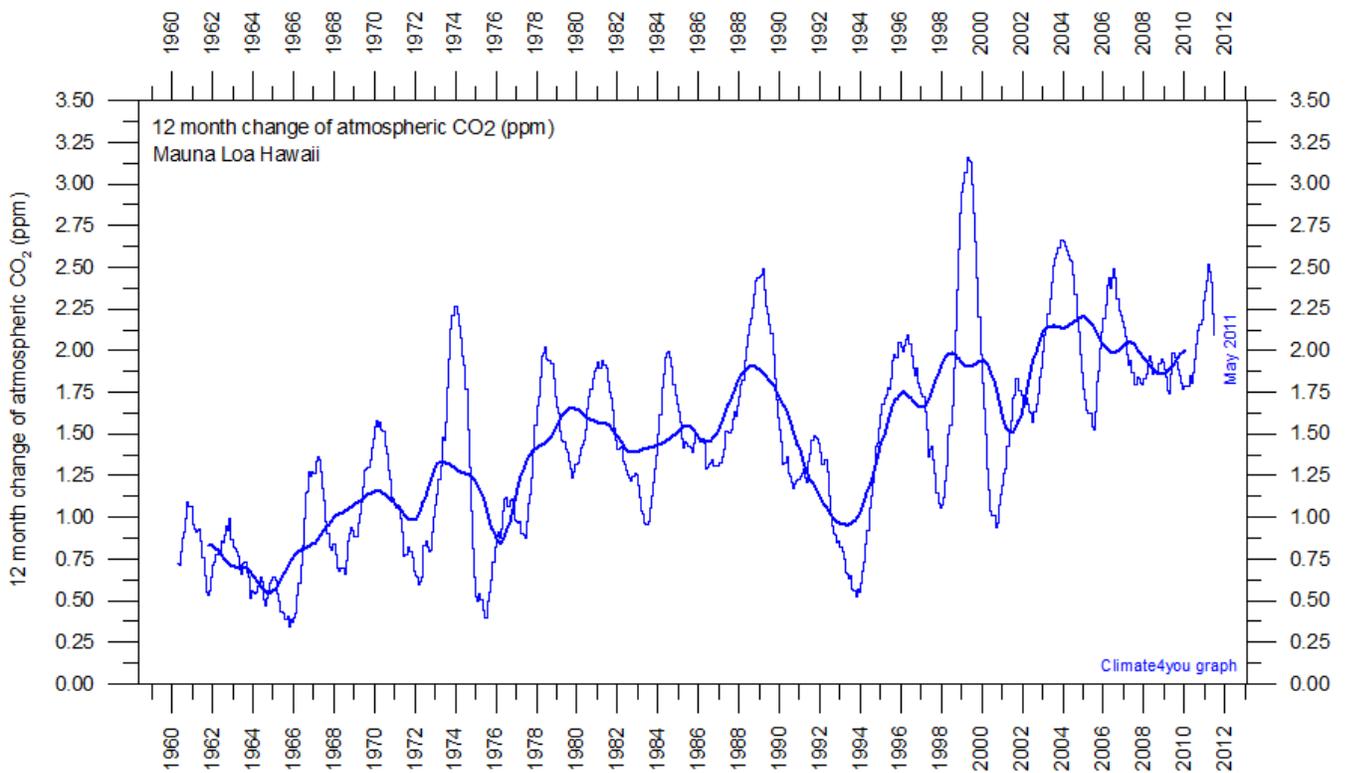


Forecasted change of global sea level until year 2100, based on measurements by the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](http://www.ccar.colorado.edu), USA. The thick line is the simple running 3 yr average forecast. The present forecast of sea level change until 2100 is 20-25 cm.

Atmospheric CO₂, updated to May 2011

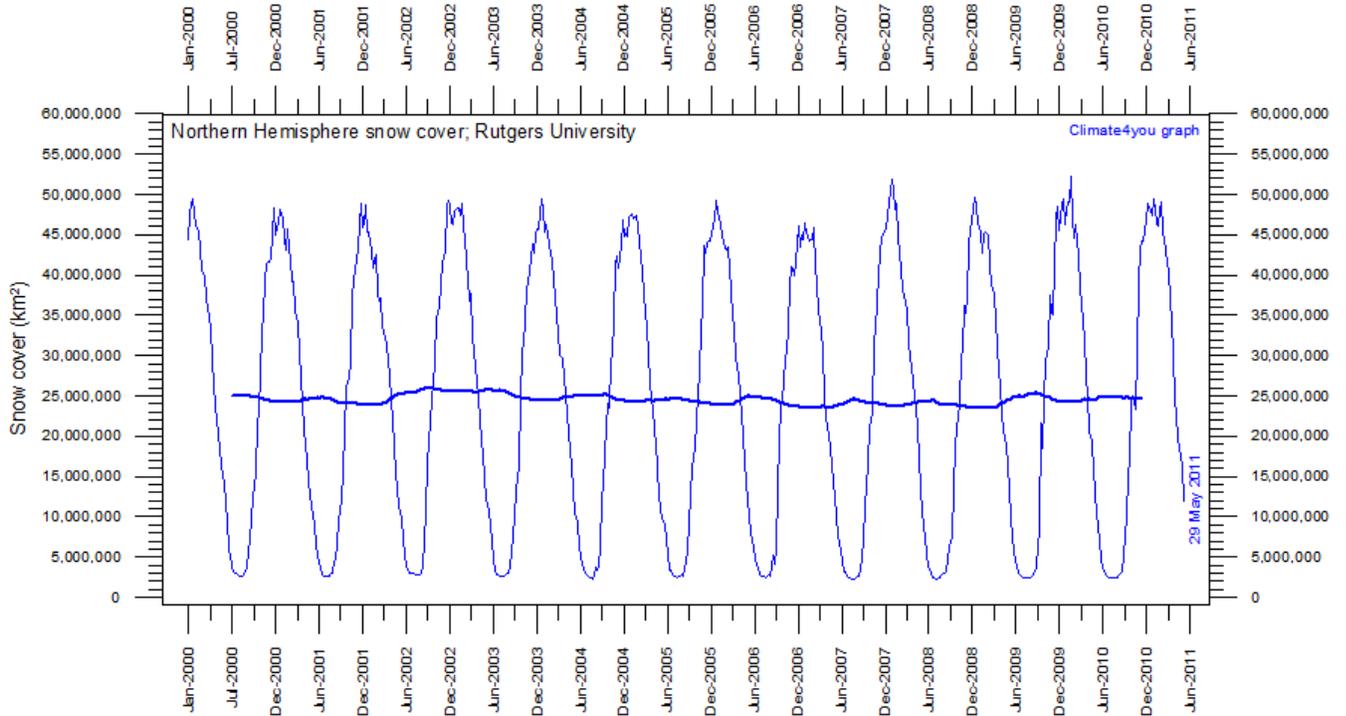


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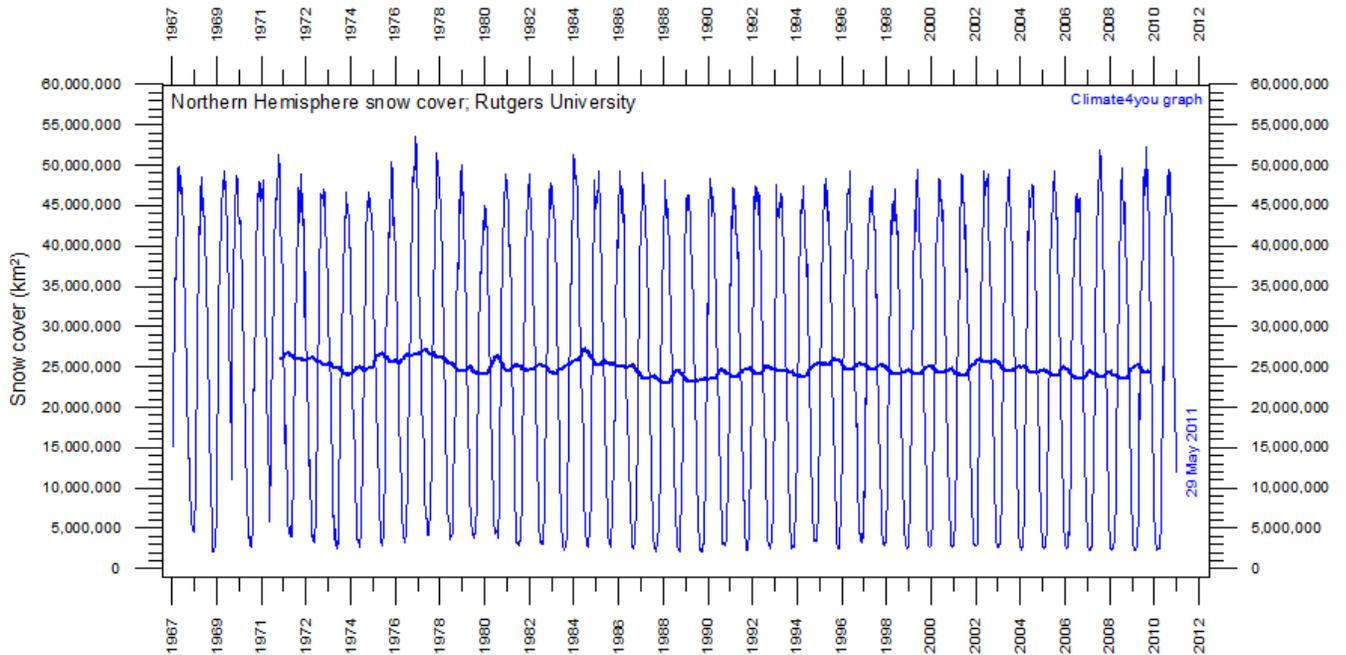


Monthly amount of atmospheric CO₂ (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO₂ since 1959, according to data provided by the [Mauna Loa Observatory](#), Hawaii, USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

Northern Hemisphere weekly snow cover, updated to late May 2011

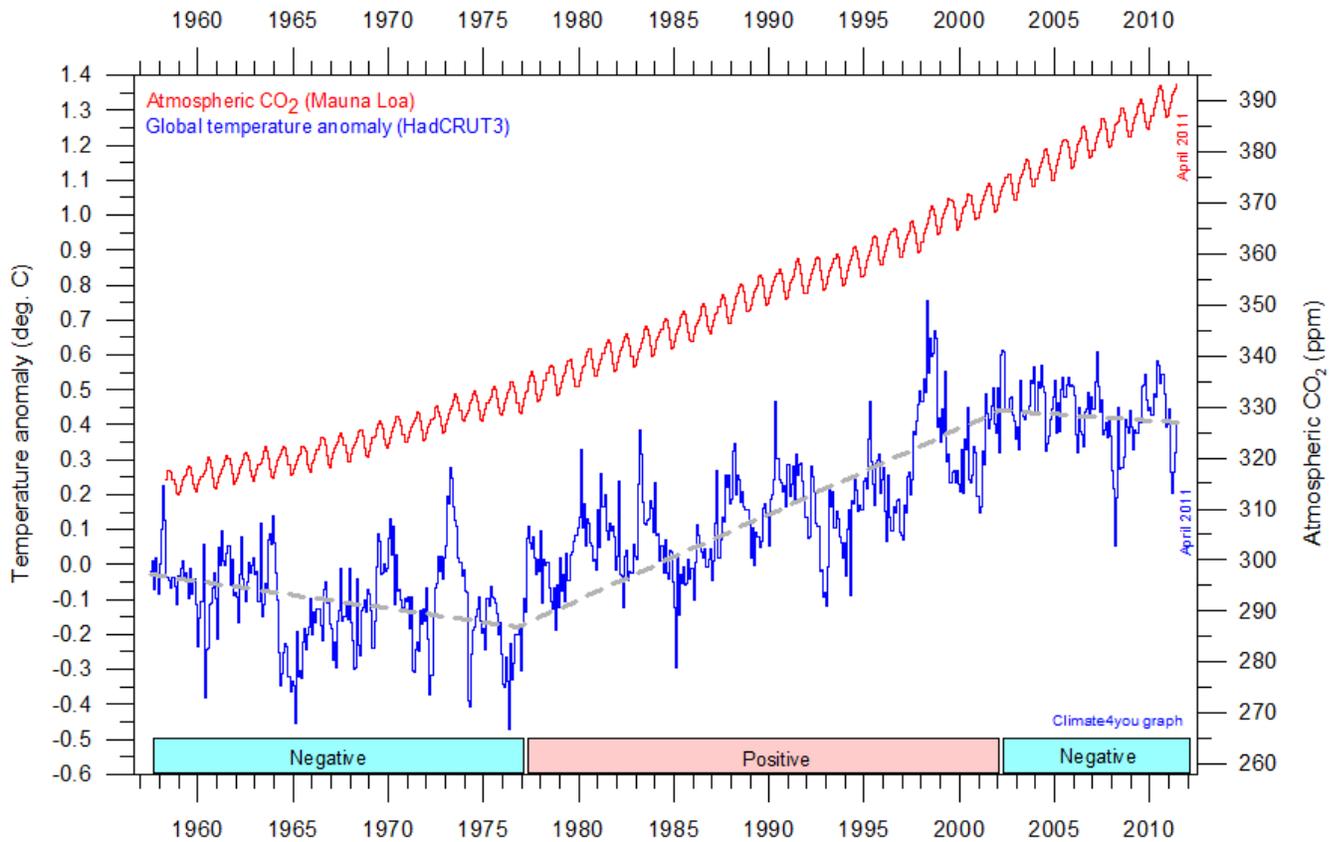


Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin line is the weekly data, and the thick line is the running 53 week average (approximately 1 year).

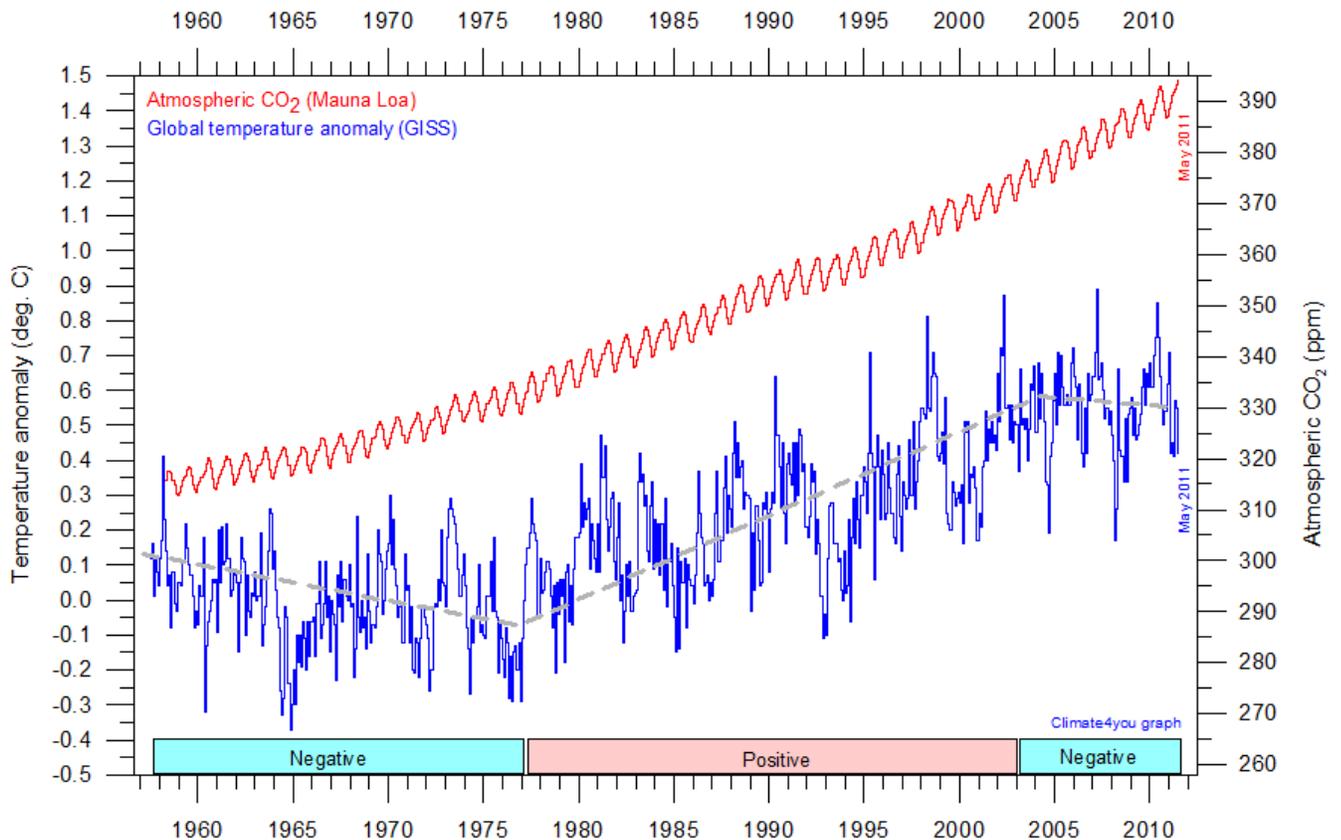


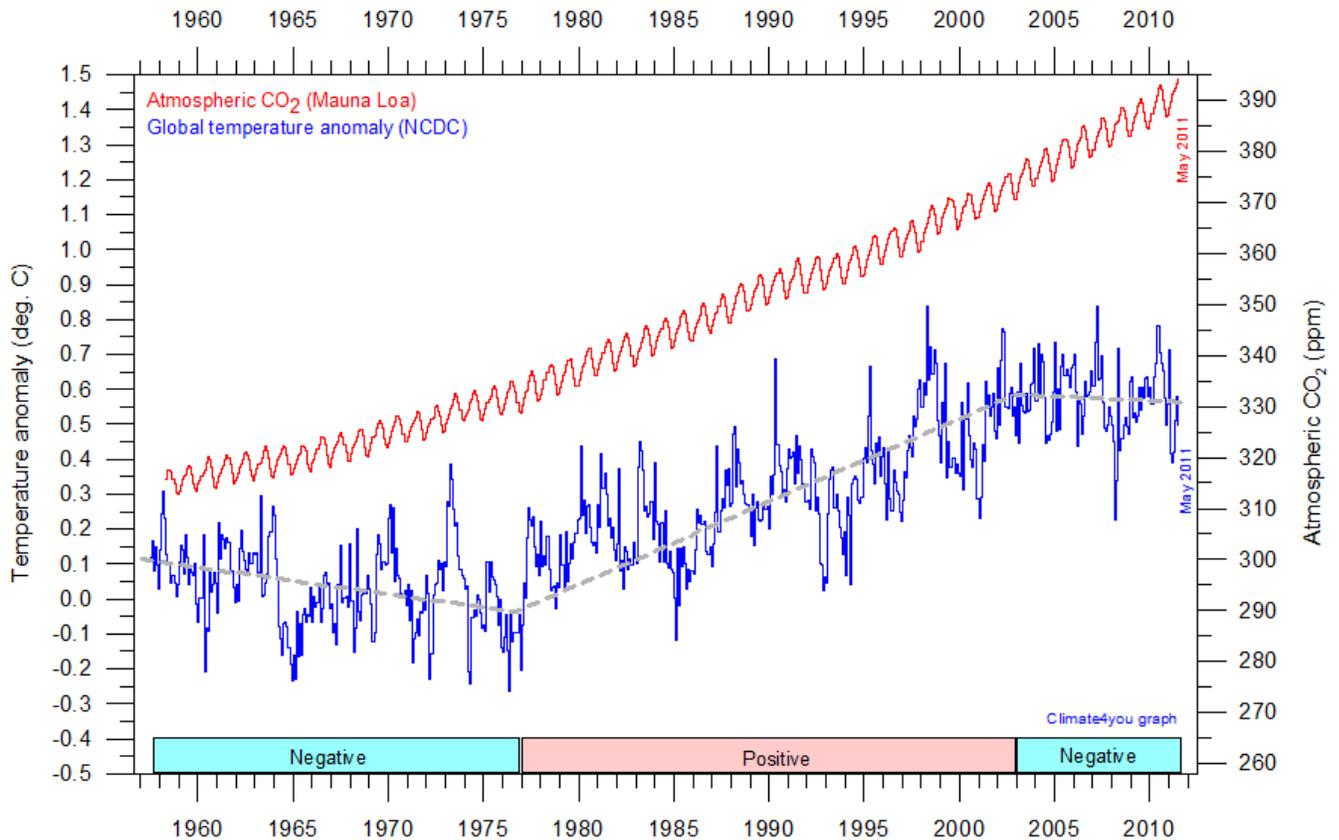
Northern hemisphere weekly snow cover since October 1966 according to Rutgers University Global Snow Laboratory. The thin line is the weekly data, and the thick line is the running 53 week average (approximately 1 year). The running average is not calculated before 1971 because of some data irregularities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

Global surface air temperature and atmospheric CO₂, updated to May 2011



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Diagrams showing HadCRUT3, GISS, and NCDC monthly global surface air temperature estimates (blue) and the monthly atmospheric CO₂ 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 CO₂ concentrations (before 1958) are not incorporated in this diagram, as such past CO₂ values are derived by other means (ice cores, stomata, or older measurements using different methodology, and therefore are not directly comparable with modern 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 CO₂ and global surface air temperature, negative or positive. Please note that the HadCRUT3 record is only updated to April 2011.

Most climate models assume the greenhouse gas carbon dioxide CO₂ to influence significantly upon global temperature. Thus, it is relevant to compare the different global temperature records with measurements of atmospheric CO₂, 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 CO₂ 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 CO₂ for global temperatures. Any such short-period meteorological record value may well be the result of other phenomena than atmospheric CO₂.

What exactly defines the critical length of a relevant time period to consider for evaluating the alleged high importance of CO₂ remains elusive, and is still a topic for debate. The critical period length must, however, be inversely proportional to the importance of CO₂ on the global temperature, including feedback effects, such as

assumed by most climate models. So if the net effect of CO₂ is strong, the length of the critical period is short, and vice versa.

After about 10 years of global temperature increase following global cooling 1940-1978, IPCC was established in 1988. Presumably, several scientists interested in climate then felt intuitively that their empirical and theoretical understanding of climate dynamics was sufficient to conclude about the high importance of CO₂ for global temperature. However, for obtaining public and political support for the CO₂-hypothesis the 10 year warming period leading up to 1988 in all likelihood was important. Had the global temperature instead been decreasing, public support for the hypothesis would have been difficult to obtain. Adopting this approach as to critical time length, the varying relation (positive or negative) between global temperature and atmospheric CO₂ has been indicated in the lower panels of the three diagrams above.

Climate and history; one example among many

1600-600 BC: Enuma Anu Enlil - The knowledge basis for the first astrometeorological forecasts



Examples of Enuma Anu Enlil tablets (see text below).

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In present Iraq, from about 4500 BC there were settlements on the edges of the marshes where the Tigris and the Euphrates reach the Persian Gulf. The region between these two rivers became known as Mesopotamia, and represents the area of the world's first major civilization.

In the Sumer region, close to the mouths of the Tigris and the Euphrates, the first Mesopotamian towns develop. Each grows up round a local temple, which acted as the centre of the region's economic activity. Unlike the other early river civilization within this region, that of Egypt (where a stable society was established along hundreds of miles of the Nile), Mesopotamia was characterized by constant warfare and a succession of shifting empires. Unlike in Egypt, towns in Mesopotamia therefore were sheltered by thick protective walls.

By the middle of the 4th millennium BC the Sumerians were firmly established in Mesopotamia, although it is still disputed when they arrived. By the third millennium BC, however, these urban centres had developed into increasingly complex societies. Irrigation and other means of exploiting food sources were being used to amass large surpluses. Huge building projects were being undertaken by rulers, and political organization was becoming ever more sophisticated. Throughout the millennium, the

various city-states Kish, Uruk, Ur and Lagash vied for power and gained hegemony at various times.

Between 3500 and 3000 BC, for reasons still not well understood, the civilization of Southern Mesopotamia underwent a sudden growth and change, centred in the cities of Ur and Uruk. This development was perhaps driven by climatic change which rendered the old ways of agriculture less productive. People clustered into fewer, but larger, locations and the plough, potter's wheel and the introduction of bronze can be seen as responses to the demands of a more intensive economic life, and also as causes of increased complexity in that life. In this same period came the beginnings of writing, metrological systems and arithmetic.

The Sumerian temple priests, needing to keep accurate accounts and to pass on all their findings, are presumably the first people to develop a system of writing. The general opinion at that time was that the different celestial objects influenced on the environment on Earth. The study of this was known as 'astrology', and the people specializing in this were known as 'astrologist'. Presumably the wish of passing on such knowledge in an efficient way to future generations was a driving force behind the early development of writing.

Extraordinary famous among such early written accounts are *Enuma Anu Enlil* (translation: In the days of the gods Anu and Enlil). *Enuma Anu Enlil* is a series of about 70 tablets dealing with [Babylonian astrology](#). These accounts were found in the early 19th century by excavation in Ninive, near present day Bagdad. The bulk of the work is a substantial collection of [omens](#), estimated to number between 6500 and 7000, which interpret a wide variety of celestial and atmospheric phenomena in terms relevant to the king and state. The tablets presumably date back to about 650 BC, but several of the omens may be as old as 1646 BC. Many of the reports found on the tablets represents 'astrometeorological' forecasts ([Rasmussen 2010](#)).

A majority of these reports simply list the relevant omens that best describe recent celestial events and many add brief explanatory comments concerning the interpretation of the omens for the benefit of the king, among other things addressing meteorological phenomena.

A typical report dealing with the first appearance of the moon on the first day of the month is [exemplified](#) below:

- If the moon becomes visible on the first day: reliable speech; the land will be happy.
- If the day reaches its normal length: a reign of long days.
- If the moon at its appearance wears a crown: the king will reach the highest rank.

The subject matter of the *Enuma Anu Enlil* tablets unfold in a pattern that reveals the behaviour of the moon first, then solar phenomena, followed by other weather activities, and finally the behaviour of various stars and planets.

The first 13 tablets deal with the first appearances of the moon on various days of the month, its relation to planets and stars, and such phenomena as lunar haloes and crowns. The omens from this

section, like those quoted above, are the most frequently used in the whole series of reports. This section is framed by tablet 14, which details a basic mathematical scheme for predicting the visibility of the moon.

Tablets 15 to 22 are dedicated to lunar eclipses. It uses many forms of encoding, such as the date, watches of the night and quadrants of the moon, to predict which regions and cities the eclipse was believed to affect.

Tablets 23 to 29 deal with the appearances of the sun, its colour, markings and its relation to cloudbanks and storm clouds when it rises. Solar eclipses are explored in tablets 30 to 39.

Tablets 40 to 49 concern weather phenomena and earthquakes, special attention being devoted to the occurrence of thunder.

The final 20 tablets are dedicated to the stars and planets. These tablets in particular use a form of encoding in which the names of the planets are replaced by the names of fixed stars and constellations.

Based on the omens in *Enuma Anu Enlil* the priests made forecasts for the kings. An example of this may be cited ([Rasmussen 2010](#)): "*In the month Ajjaru, day 2, Venus disappeared to the west. It remained hidden on the sky in 18 days, and in the month Ajjaru, day 20, Venus reappeared to the east. There will come rain and floods to the benefit for the country.*"

Very often especially the Moon had high importance for these early meteorological or environmental forecasts as exemplified here ([Rasmussen 2010](#)): "*When a dark halo surrounds the Moon, it will gather clouds and the month will bring rain. When the 'horns' of the Moon become blurred, floods will follow*".

References:

Rasmussen, E.A. 2010. *Vejret gennem 5000 år (Weather through 5000 years). Meteorologiens historie*. Aarhus Universitetsforlag, Århus, Denmark, 367 pp, ISBN 978 87 7934 300 9.

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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