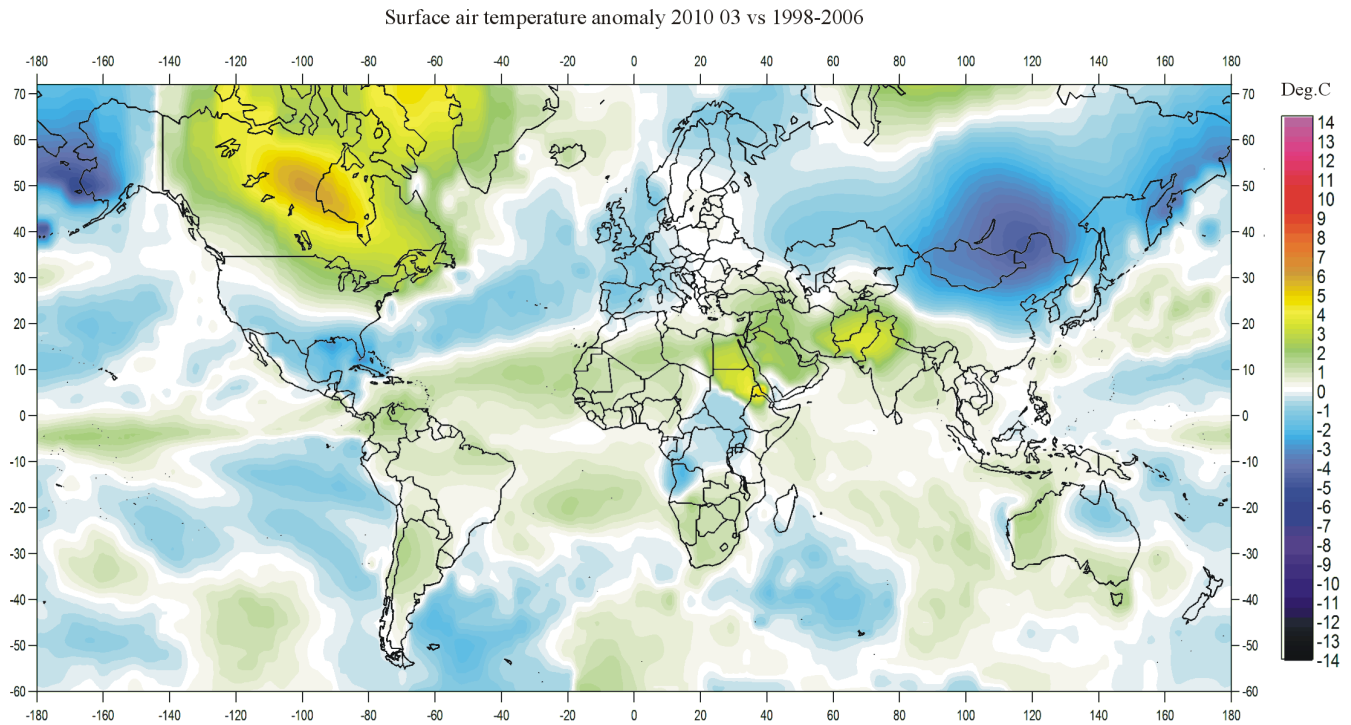


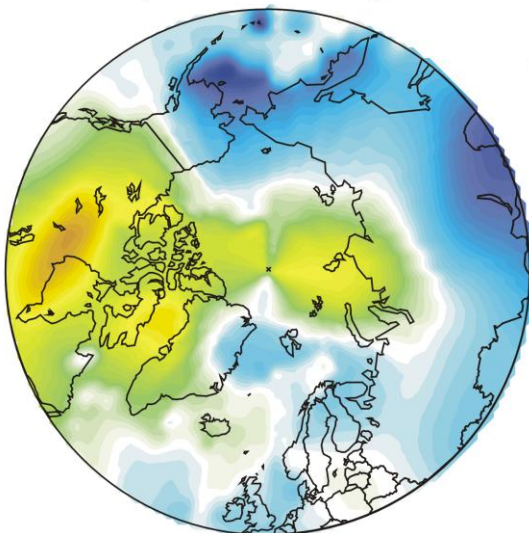
Climate4you update March 2010

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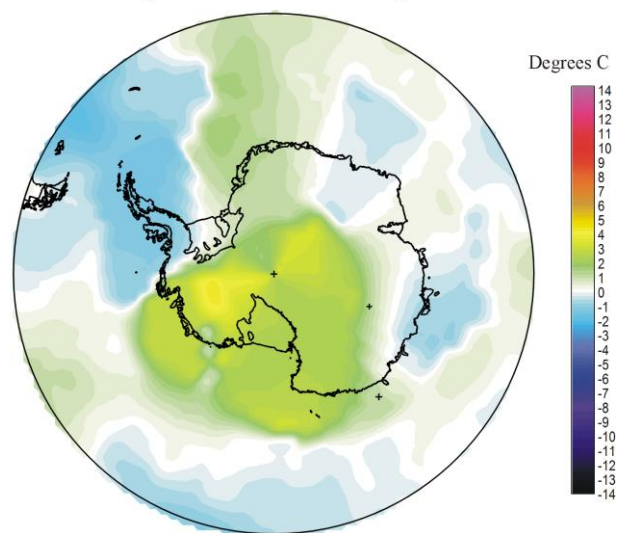
March 2010 global surface air temperature overview



Air temperature 201003 versus average 1998-2006



Air temperature 201003 versus average 1998-2006



March 2010 surface air temperature compared to the average for March 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 \(GISS\)](http://www.giss.nasa.gov)

Comments to the March 2010 global surface air temperature overview

This newsletter contains graphs showing a selection of key meteorological variables for March 2010. 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 37-month average, almost corresponding to three years.

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.

Global surface air temperatures March 2010 was characterised by varied conditions in the Northern Hemisphere, ranging from cold to warm conditions, although somewhat less pronounced than during the previous months. The Southern Hemisphere generally experienced smaller regional temperature variations than the Northern Hemisphere.

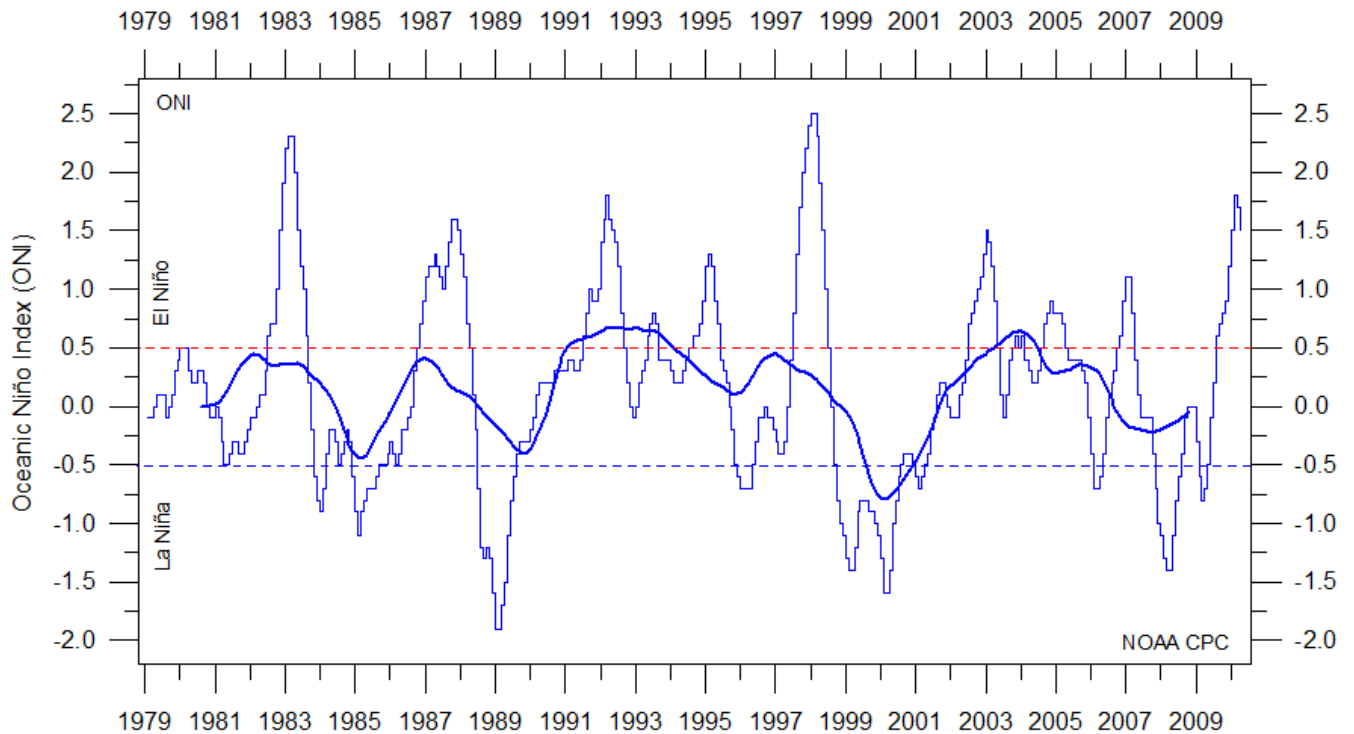
2

In the Northern Hemisphere extensive, relative cold areas extended across central Europe, Russia, Siberia, Mongolia, China, Alaska, USA and Mexico. Canada and most of Greenland experienced relatively high temperatures, according to the values published by GISS. The previous (17/4) issue of incorrect GISS temperatures for Finland has now been resolved. By this the global average GISS surface temperature estimate was reduced by 0.01°C compared to the previous published value, and the warm spot over Finland and adjoining regions disappeared.

Conditions near Equator were influenced by the still ongoing El Niño in the Pacific Ocean. This El Niño ended up as being relatively strong (see diagram on page 3), and influenced atmospheric temperatures correspondingly. At the same time relatively warm conditions extended from the Equatorial Atlantic across northern Africa into eastern Mediterranean. As all these regions are located near the Equator, their surface area is considerable, and the effect on the global average surface temperature therefore significant.

In this context the following note might be useful:

Quite often global meteorological temperature conditions are communicated by using map projections of the Mercator type. This is a useful cylindrical map projection that preserves angles at all locations, but scale varies from place to place, distorting the size of land areas. In particular, areas closer to the poles are more affected, making land areas of similar size looking increasingly oversized towards the poles, and underestimating the areal importance of areas located nearer to the Equator. To exemplify this effect, the areas of Mexico (1,972,550 km²) and Greenland (2,166,086 km²) are comparable in size. Greenland, however, in a map of Mercator type of map looks very much bigger than Mexico, even though only the southern half of Greenland is shown in the uppermost diagram on page 1 (see above). In other words, the visual effect of the Mercator type map is to visually overstate the importance of temperature variations near the poles, compared to equatorial regions. To avoid the worst effects of this cartographic distortion of areas, the two Polar Regions are therefore shown in separate, polar projections in this newsletter (the two lowermost diagrams on the first page).



Warm ($>+0.5^{\circ}\text{C}$; red stippled line) and cold ($<0.5^{\circ}\text{C}$; blue stippled line) episodes for the Oceanic Niño Index (ONI), defined as 3 month running mean of ERSST.v3b SST anomalies in the Niño 3.4 region (5°N - 5°S , 120° - 170°W). Reference period: 1971-2000. For historical purposes cold and warm episodes are defined when the threshold is met for a minimum of 5 consecutive over-lapping seasons. The thin line indicates 3 month average values, and the thick line is the simple running 7 year average of these. Last 3 month running mean shown: January-February-March 2009-2010.

3

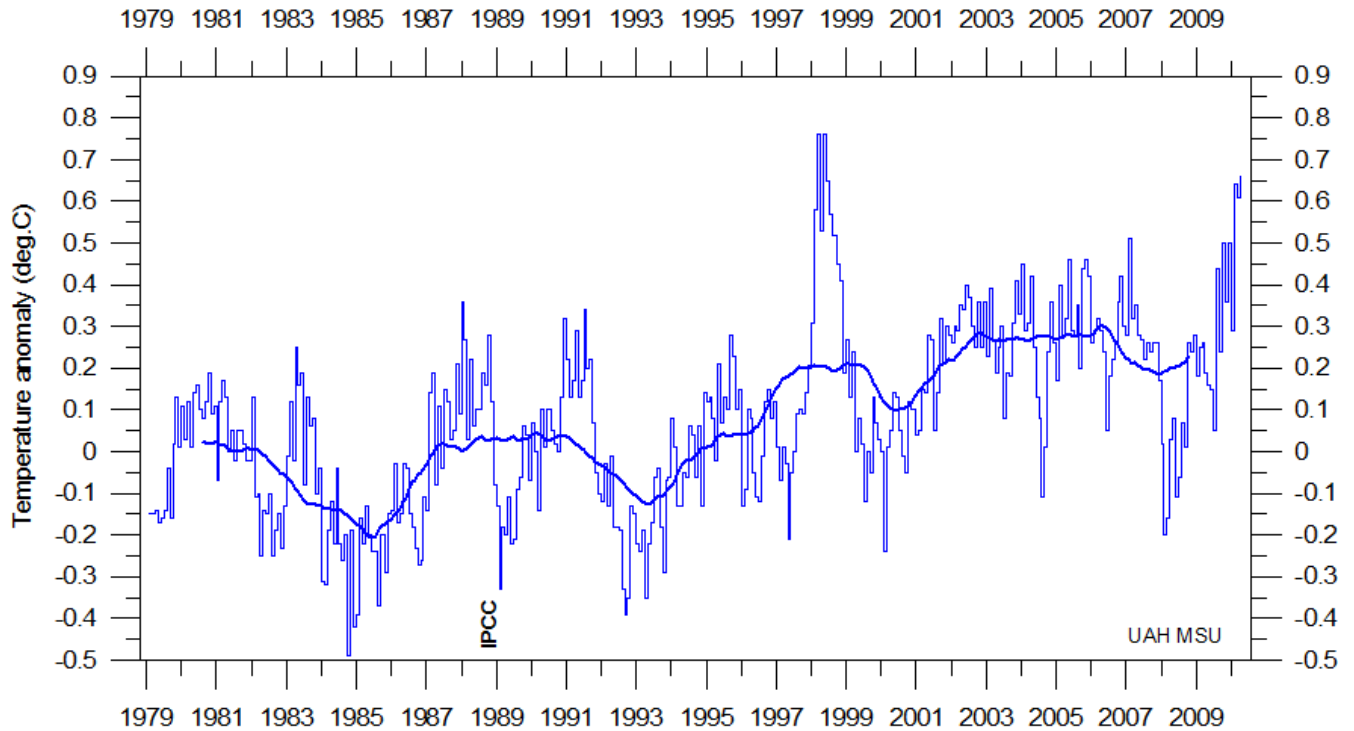
In the Southern Hemisphere most areas experienced temperature conditions near the 1998-2006 average. Most of South America, however, experienced temperatures slightly above average.

In the Arctic, Canada and most of Greenland experienced relatively high temperatures. In contrast, Alaska, Siberia, Russia, Svalbard and NE Greenland all had temperatures below the 1998-2006 average.

In the Antarctic, the air temperature was generally somewhat above the 1998-2006 average, however, with the peninsula and parts of eastern Antarctica experiencing relatively low temperatures.

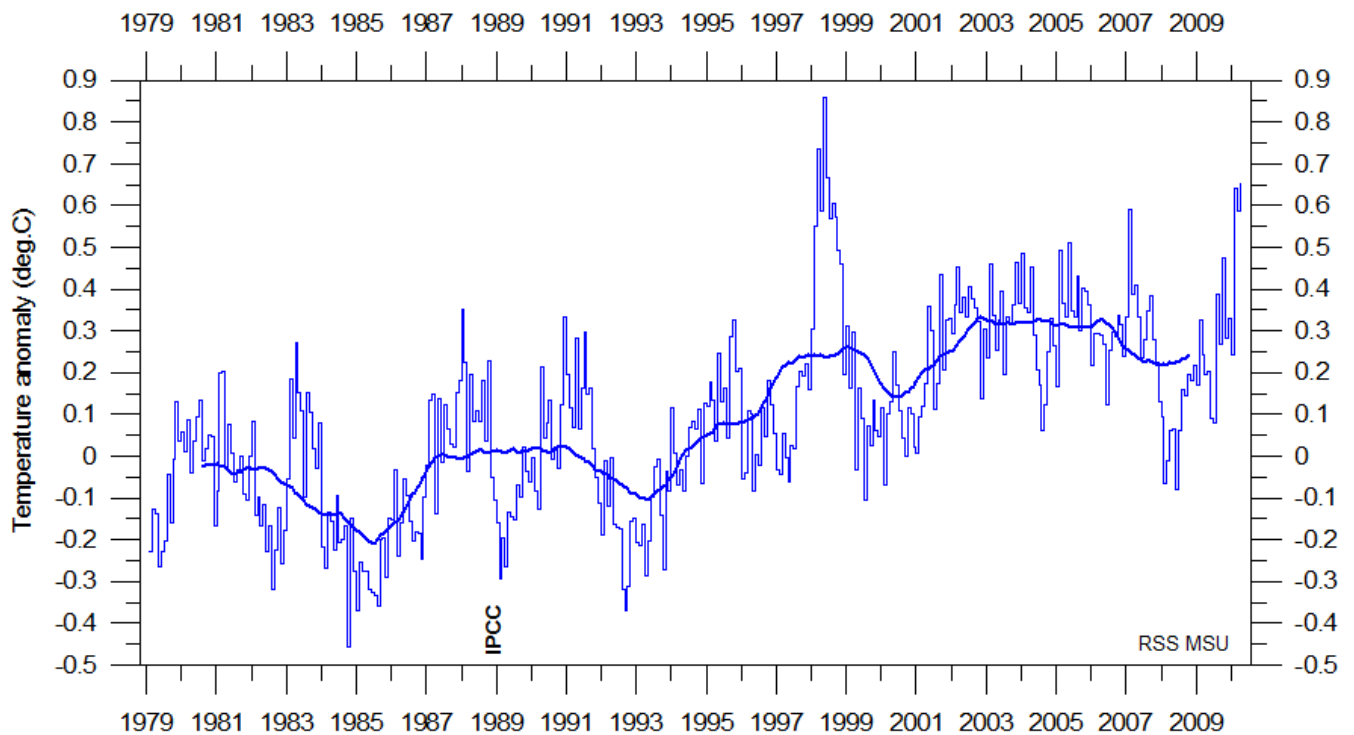
All diagrams shown in this newsletter are available for download on www.climate4you.com

Lower troposphere temperature from satellites, updated to March 2010



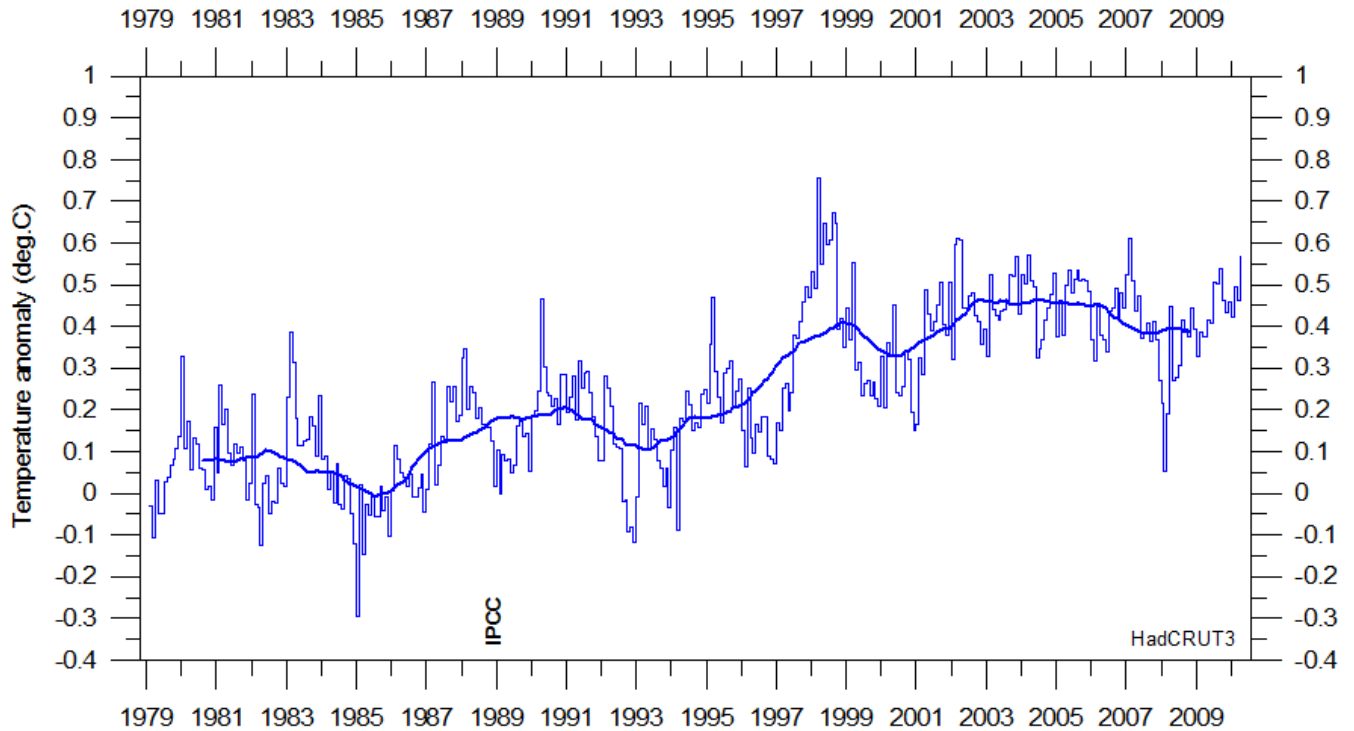
Global monthly average lower troposphere temperature (thin line) since 1979 according to [University of Alabama](#) at Huntsville, USA. The thick line is the simple running 37 month average.

4



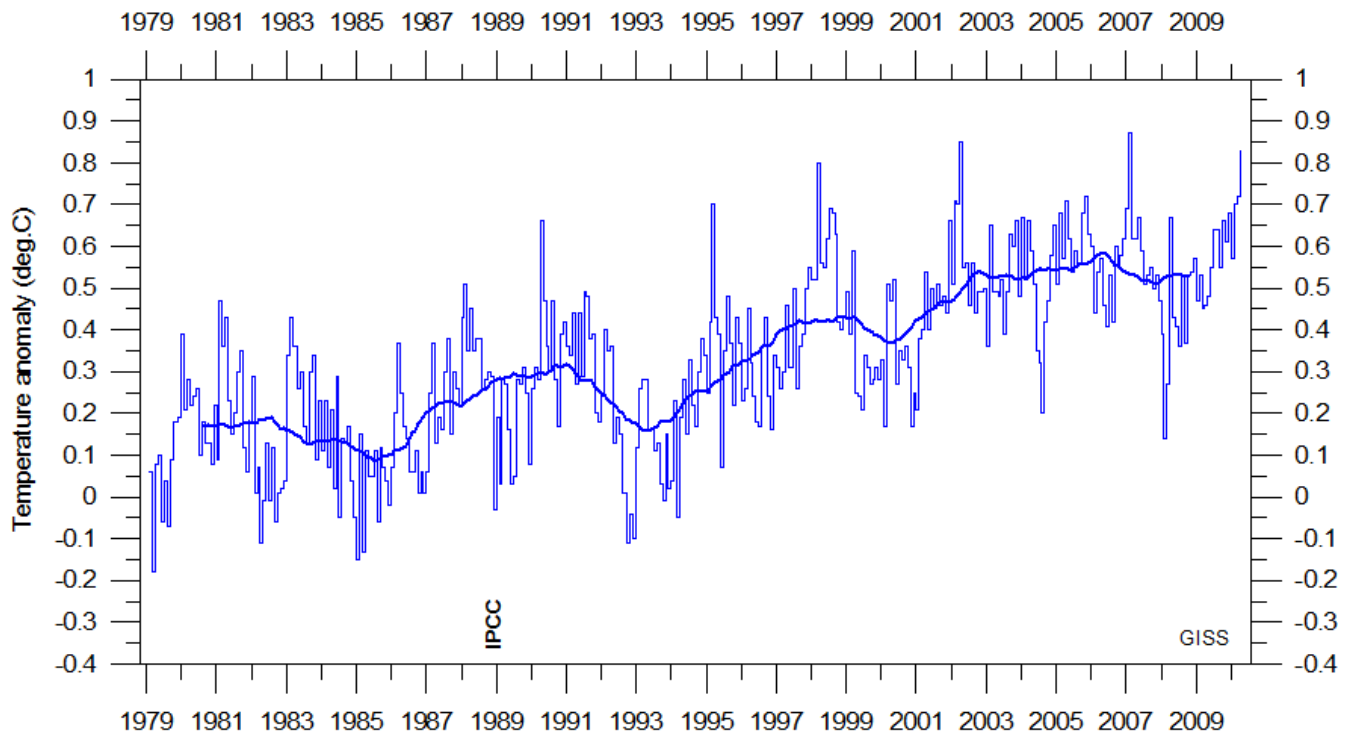
Global monthly average lower troposphere temperature (thin line) since 1979 according to according to [Remote Sensing Systems](#) (RSS), USA. The thick line is the simple running 37 month average.

Global surface air temperature, updated to March 2010

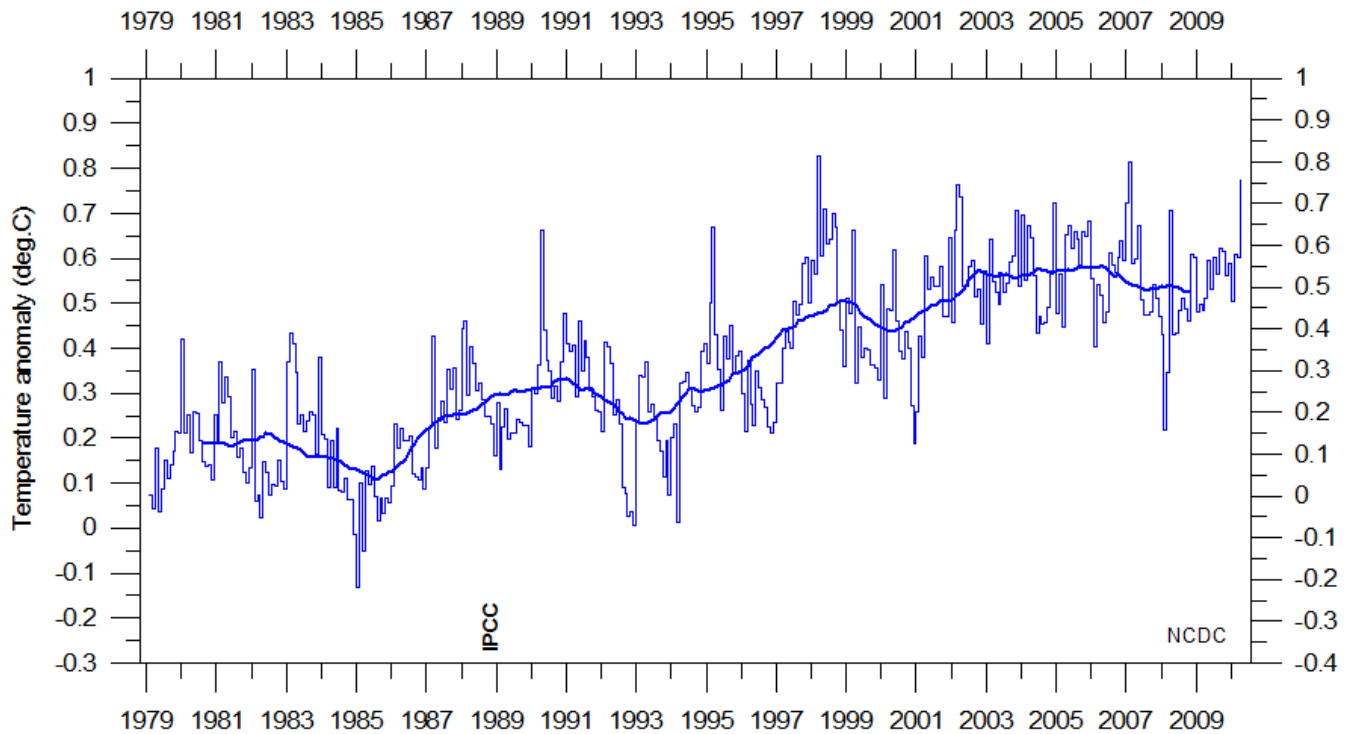


Global monthly average surface air temperature (thin line) since 1979 according to according to the Hadley Centre for Climate Prediction and Research and the University of East Anglia's [Climatic Research Unit \(CRU\)](#), UK. The thick line is the simple running 37 month average.

5



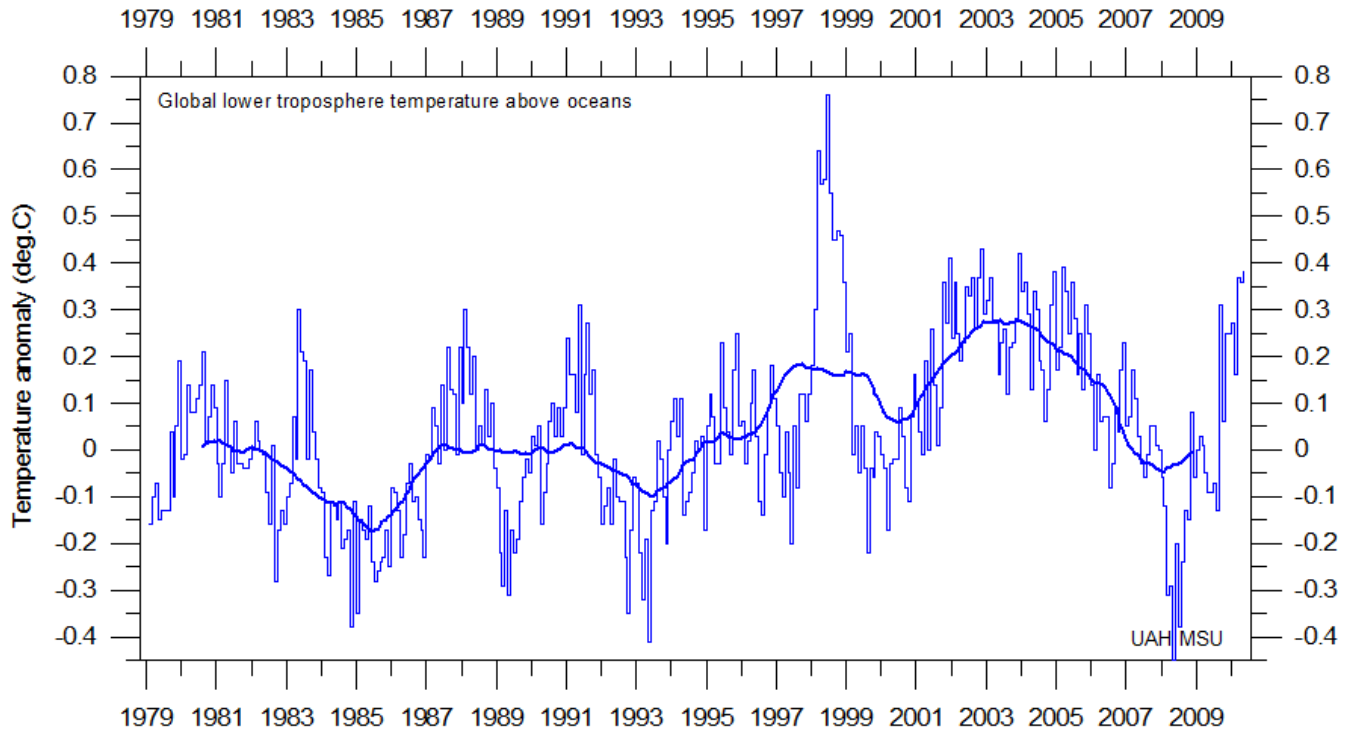
Global monthly average surface air temperature (thin line) since 1979 according to according to the [Goddard Institute for Space Studies \(GISS\)](#), at Columbia University, New York City, USA. The thick line is the simple running 37 month average.



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.

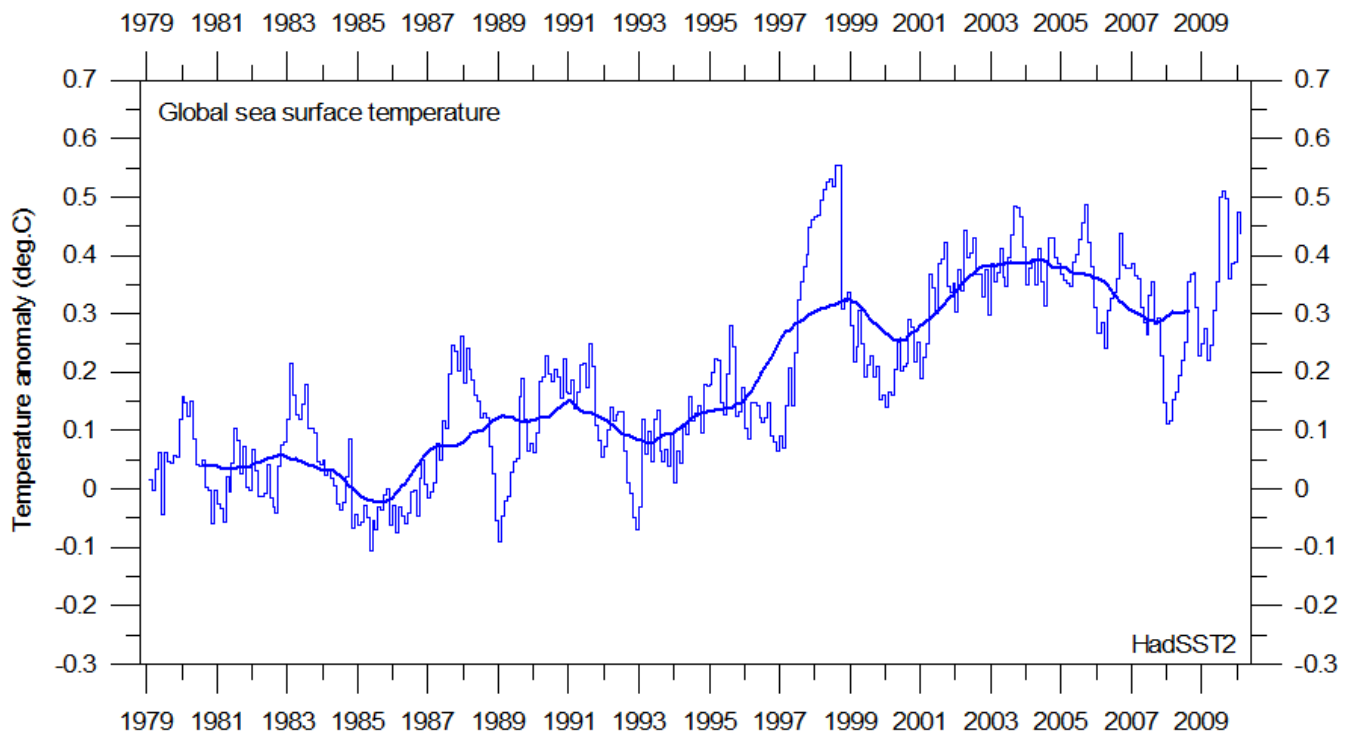
Some readers have noted that several of the above data series display changes when one compare with previous issues of this newsletter, not only for the most recent months, but actually for most of months included in the data series. The interested reader may find more on this lack of temporal stability on www.climate4you (go to: Global Temperature and then Temporal Stability).

Global sea surface temperature, updated to March 2010

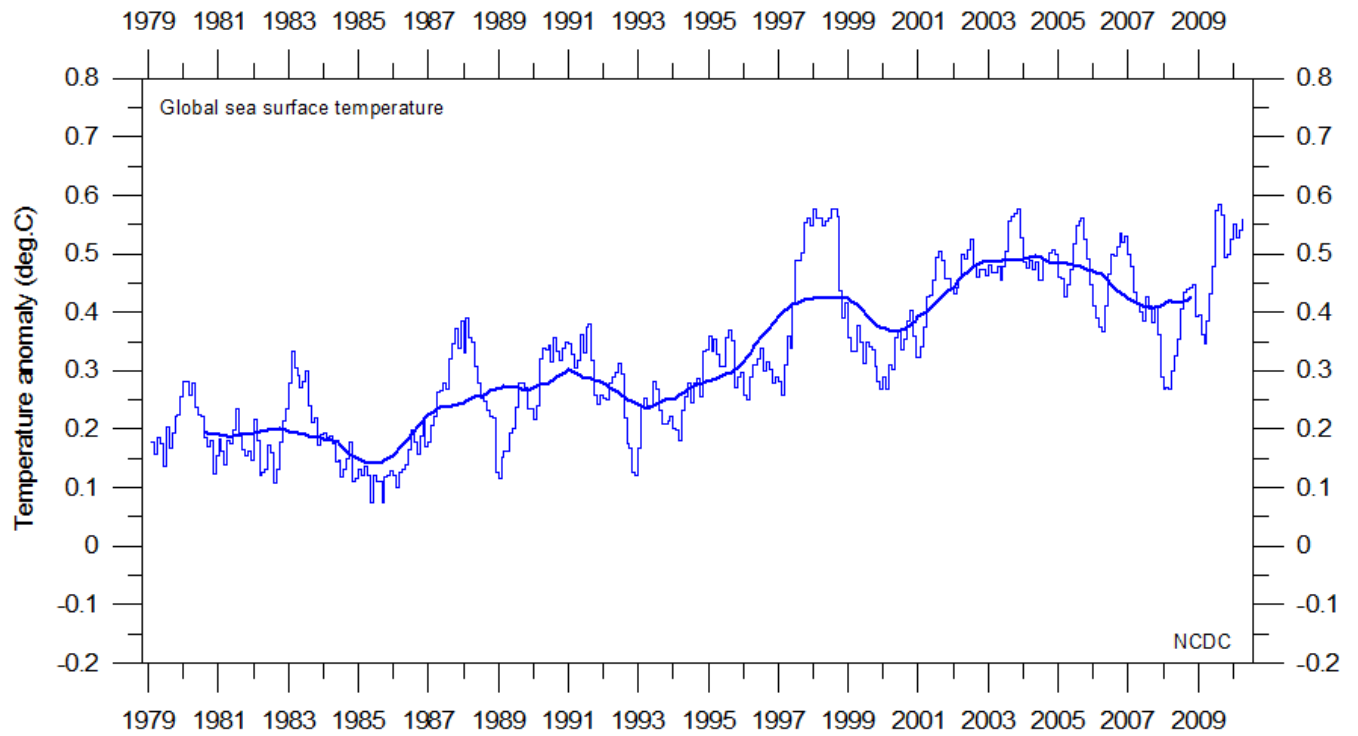


Global monthly average lower troposphere temperature over oceans (thin line) since 1979 according to [University of Alabama](#) at Huntsville, USA. The thick line is the simple running 37 month average.

7

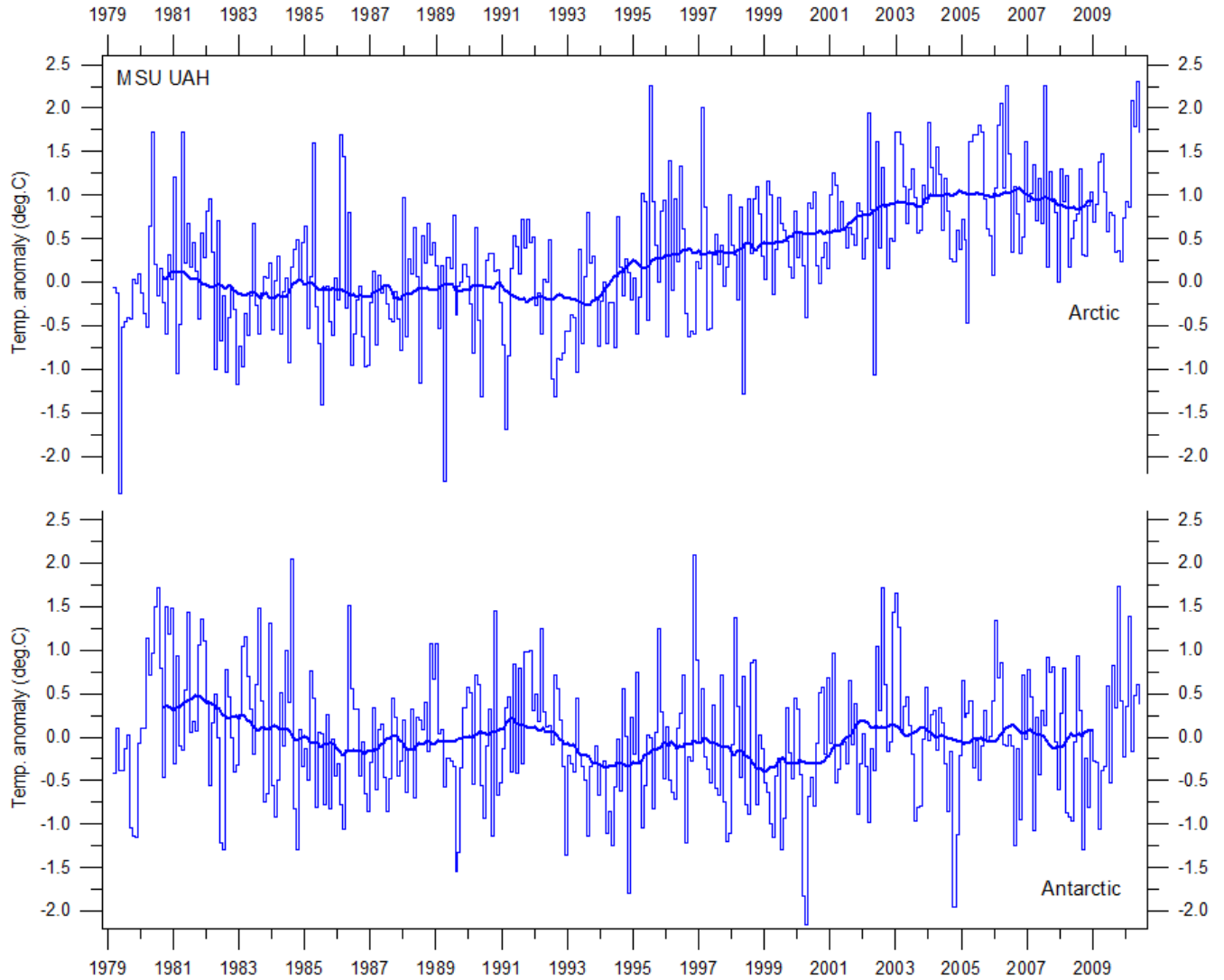


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit \(CRU\)](#), UK. Base period: 1961-1990. The thick line is the simple running 37 month average. Please note that this data series has not yet been updated beyond February 2010.



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.

Arctic and Antarctic lower troposphere temperature, updated to March 2010



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.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 February 2010

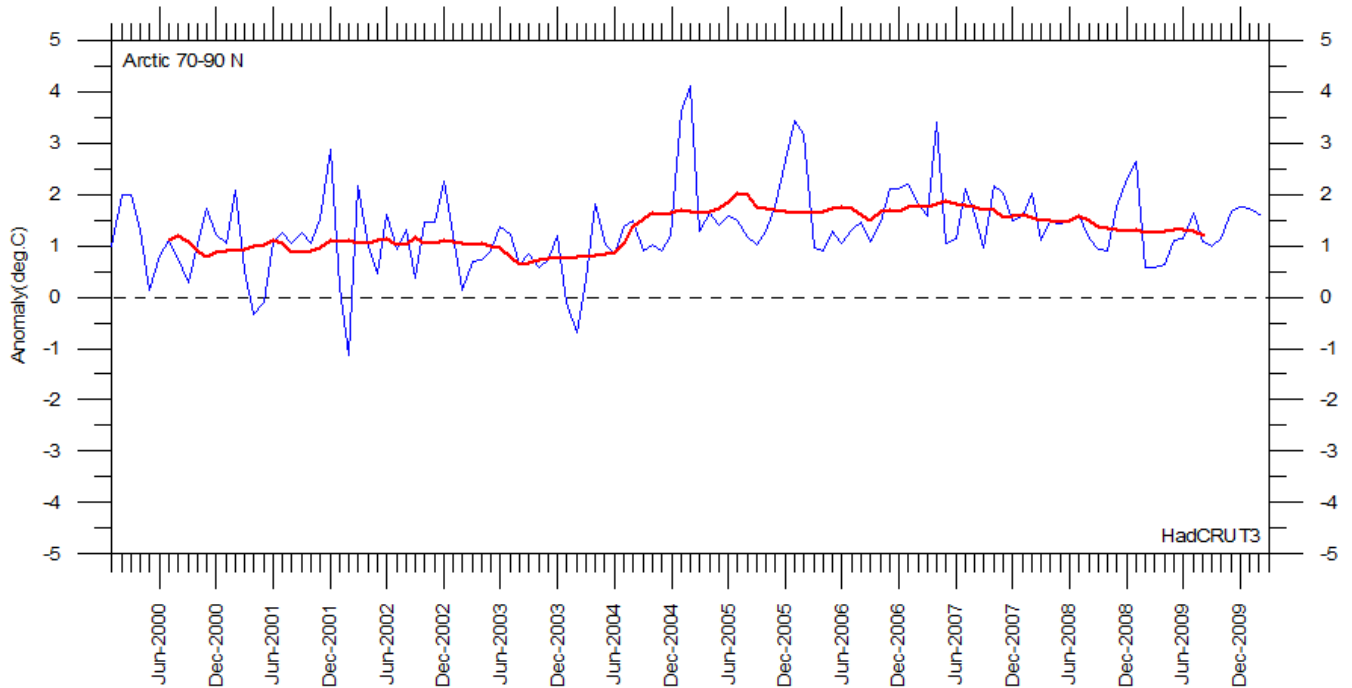


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 2000, in relation to the WMO reference “normal” period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's [Climatic Research Unit \(CRU\)](#), UK. Please note that this data series has not yet been updated beyond February 2010.

10

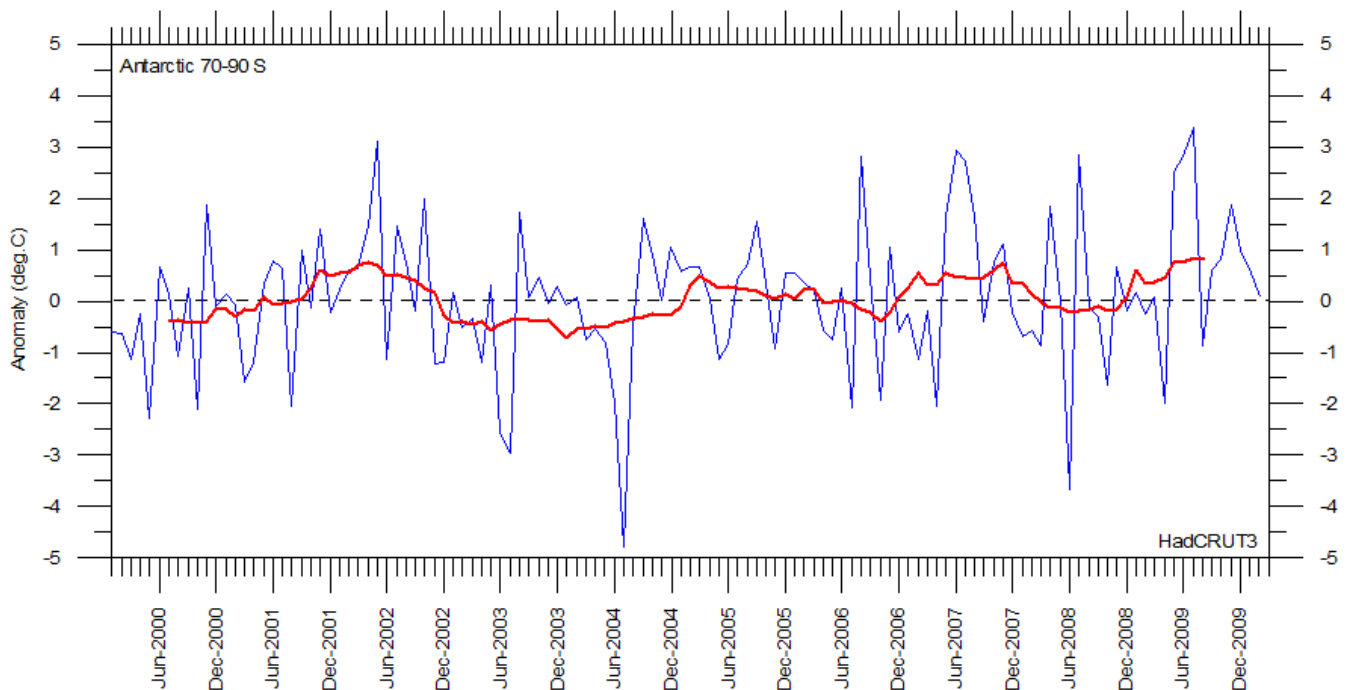


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 2000, in relation to the WMO reference “normal” period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's [Climatic Research Unit \(CRU\)](#), UK. Please note that this data series has not yet been updated beyond February 2010.

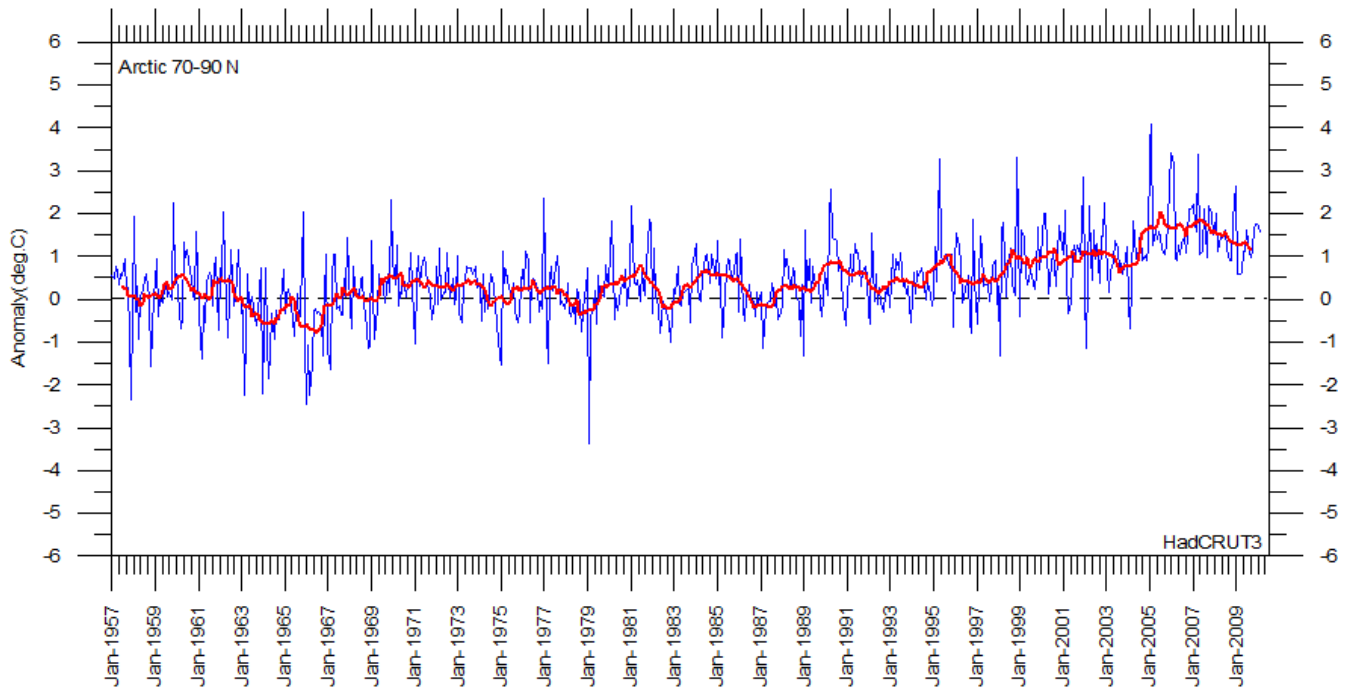


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1957, in relation to the WMO reference “normal” period 1961-1990. The year 1957 has been chosen as starting year, to ensure easy comparison with the maximum length of the realistic Antarctic temperature record shown 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. Please note that this data series has not yet been updated beyond February 2010.

11

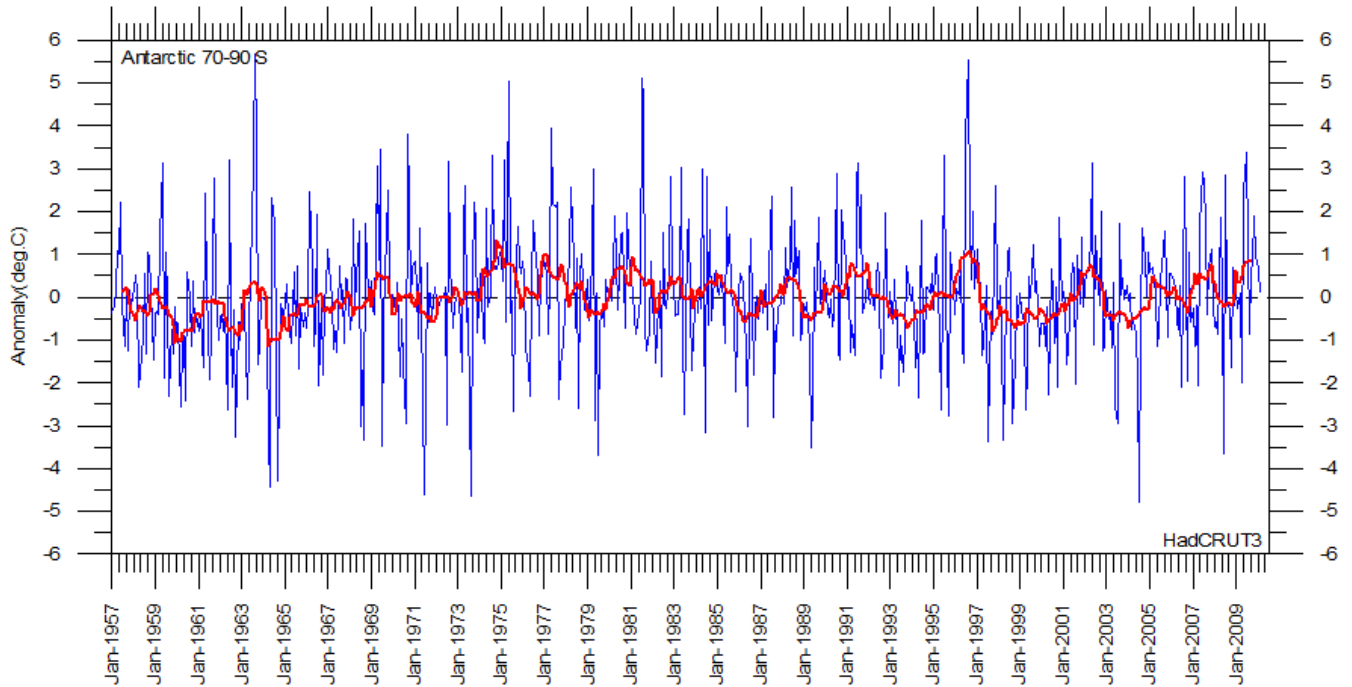


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 1957, in relation to the WMO reference “normal” period 1961-1990. The year 1957 was an international geophysical year, and several meteorological stations were established in the Antarctic because of this. Before 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. Please note that this data series has not yet been updated beyond February 2010.

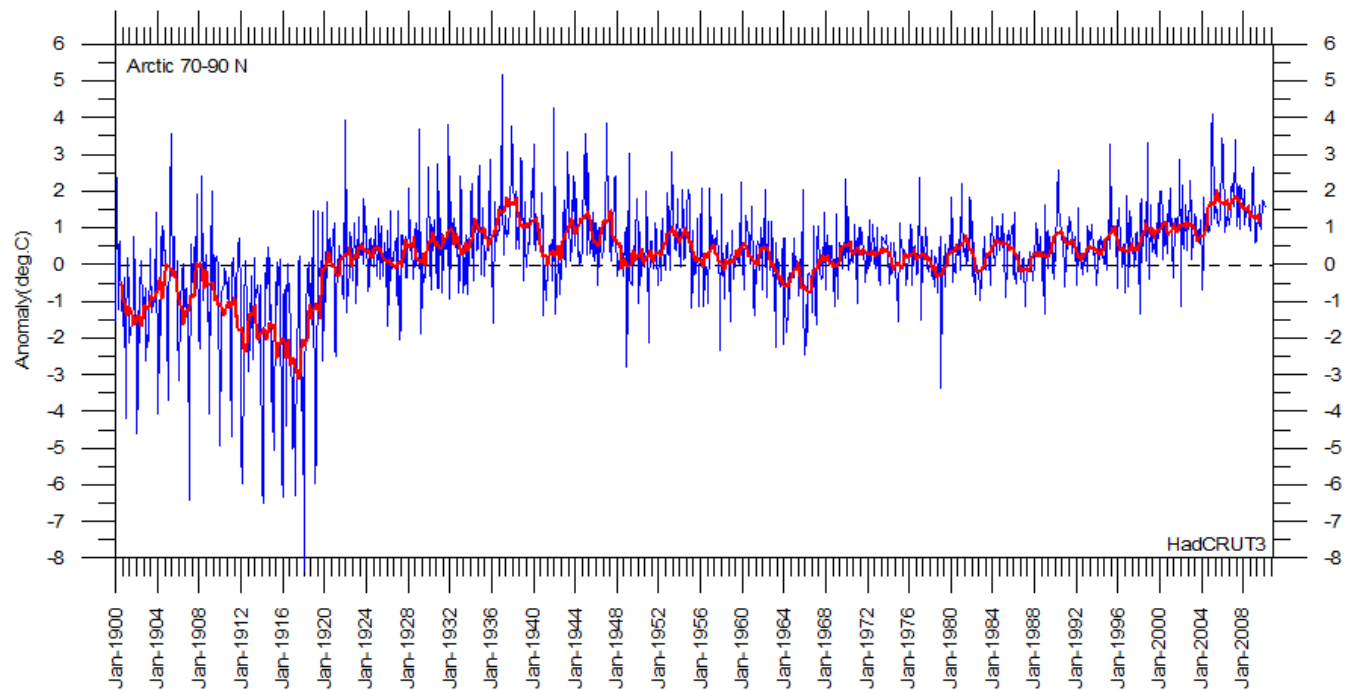


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1900, in relation to the WMO reference “normal” period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. In general, the range of monthly 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. Please note that this data series has not yet been updated beyond February 2010.

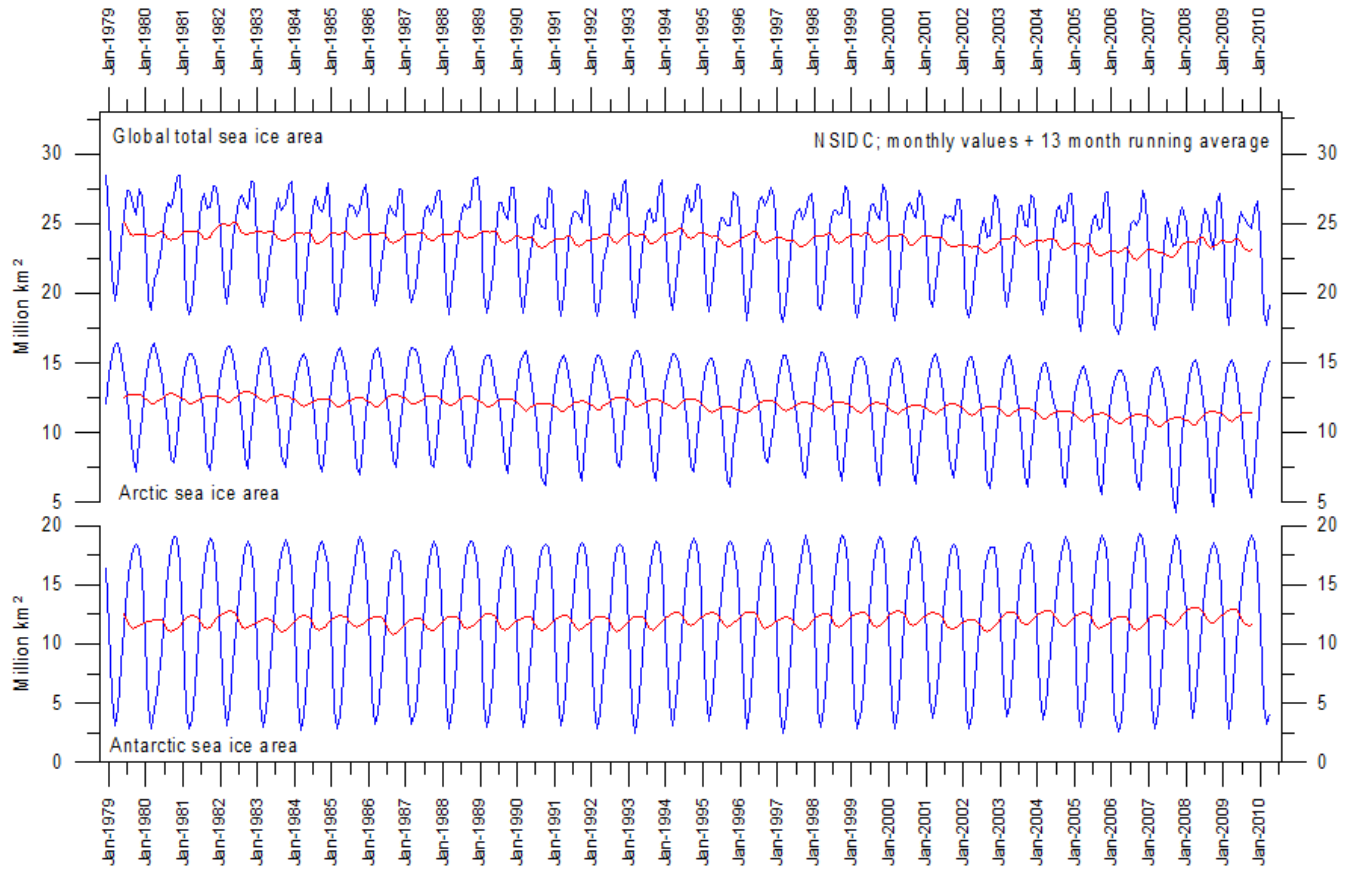
In general, the Arctic temperature record appears to be less variable than the contemporary Antarctic record, presumably at least partly due to the higher number of meteorological stations north of 70°N, compared to the number of stations south of 70°S.

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 areas of the grid cells.

Litterature:

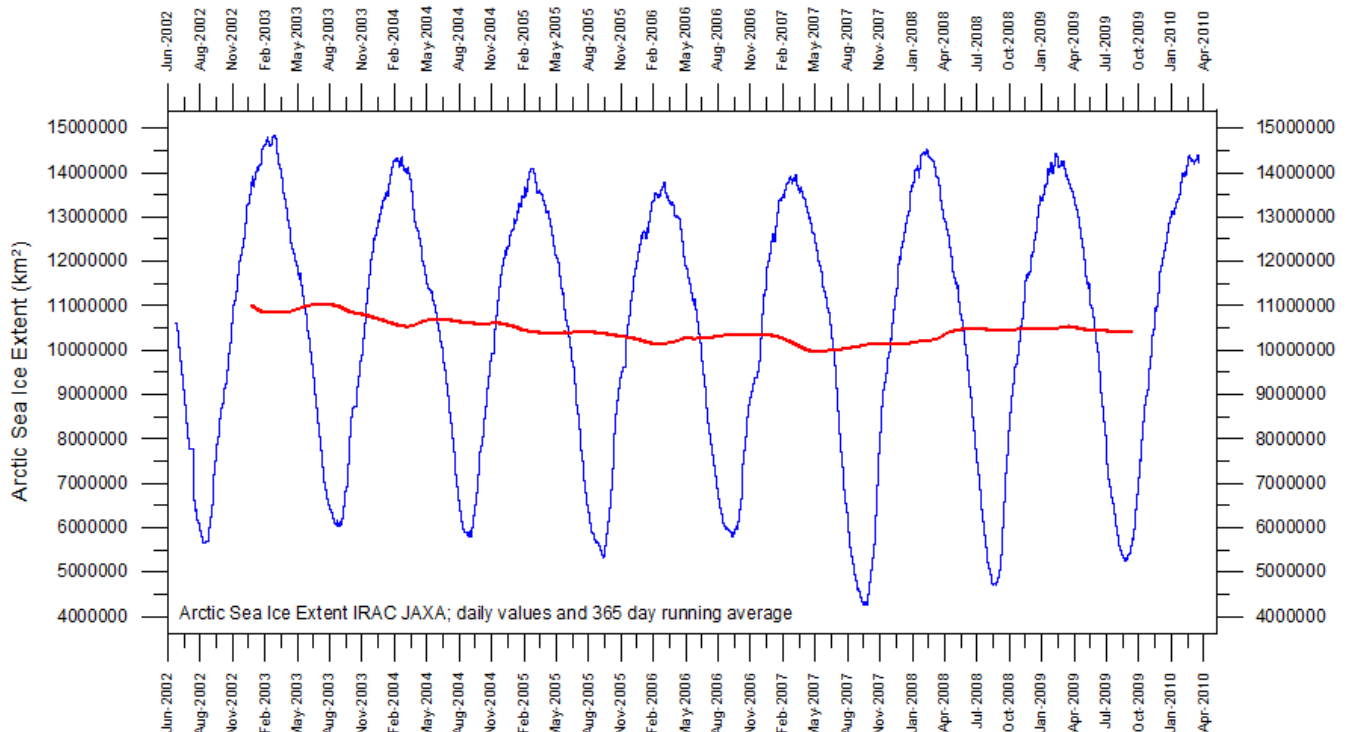
Gillett, N.P., Stone, D.A., Stott, P.A., Nozawa, T., Karpechko, A.Y.U., Hegerl, G.C., Wehner, M.F. and Jones, P.D. 2008. Attribution of polar warming to human influence. *Nature Geoscience* 1, 750-754.

Arctic and Antarctic sea ice, updated to March 2010



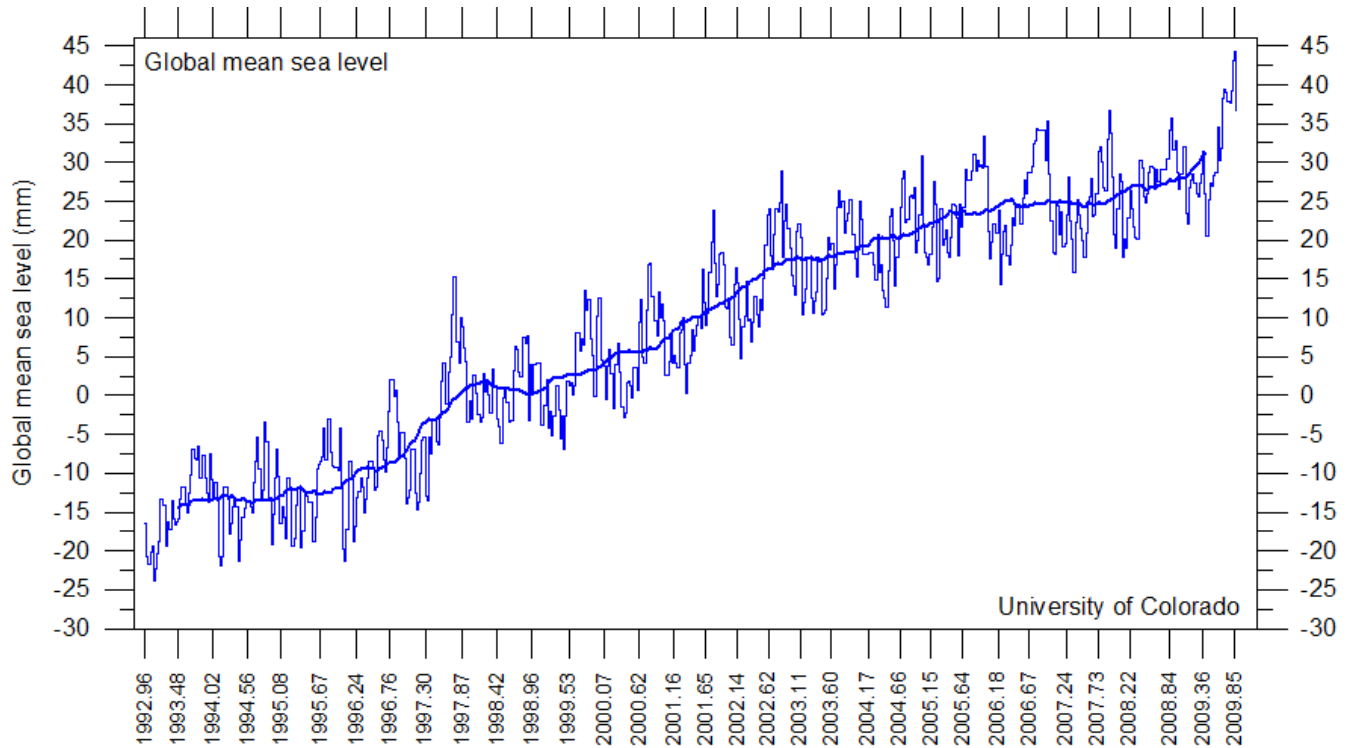
13

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



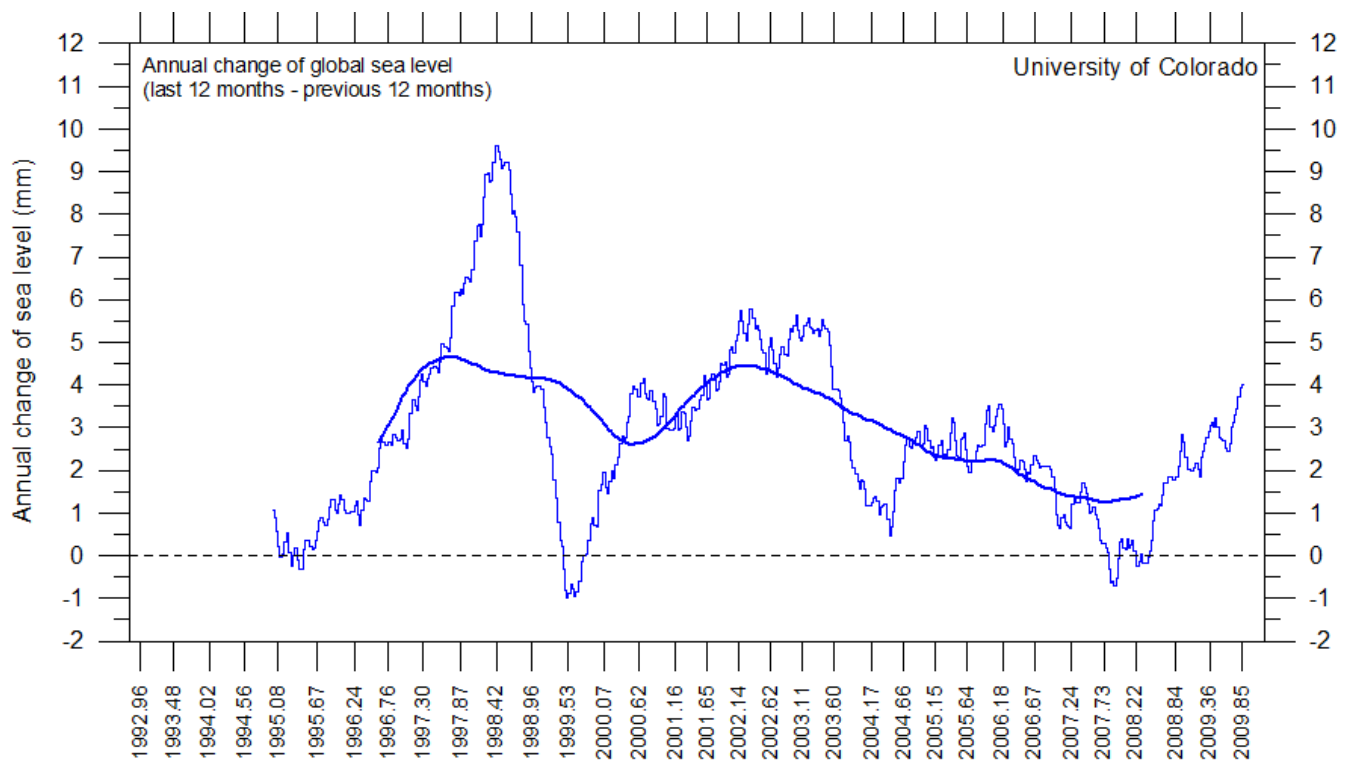
Graph showing daily Arctic sea ice extent since June 2002, to 06/04 2010, by courtesy of [Japan Aerospace Exploration Agency \(JAXA\)](#).

Global sea level, updated January 2010



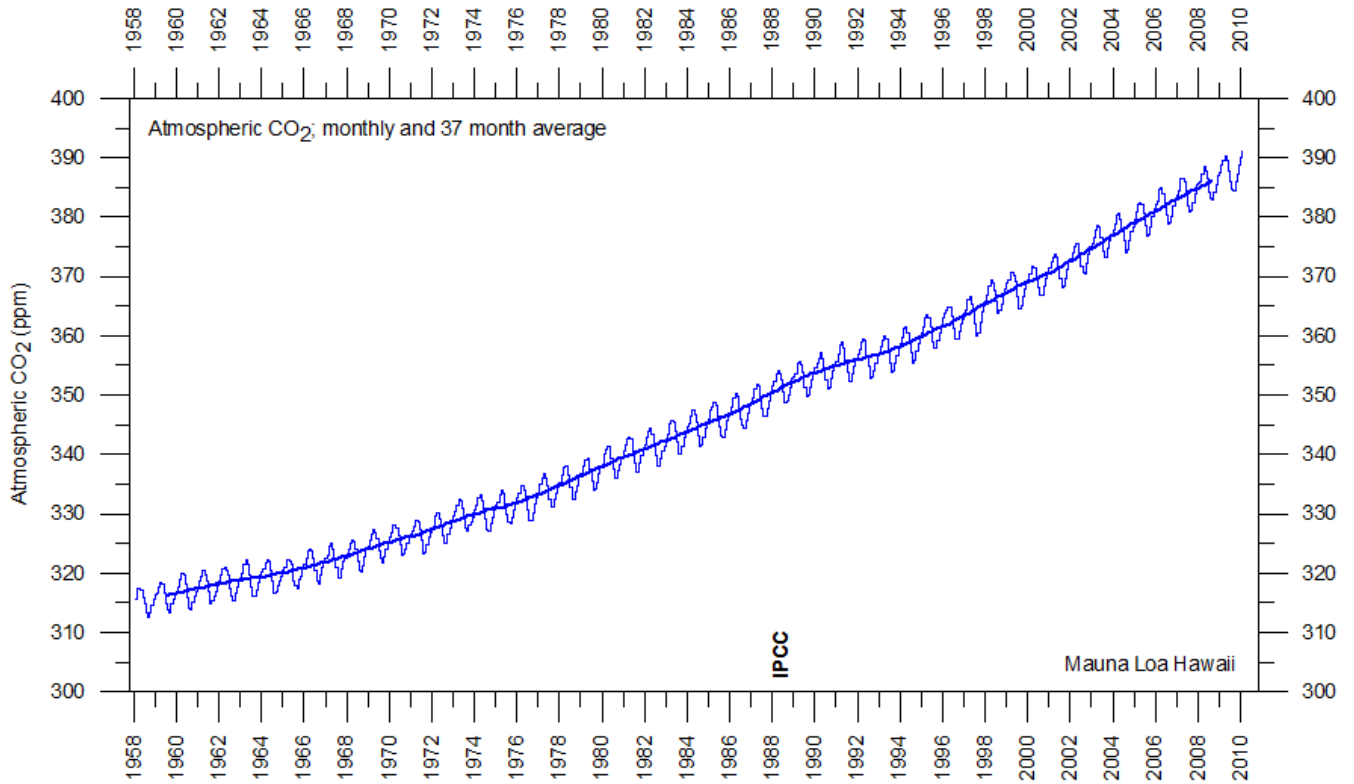
Global monthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](#), USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

14

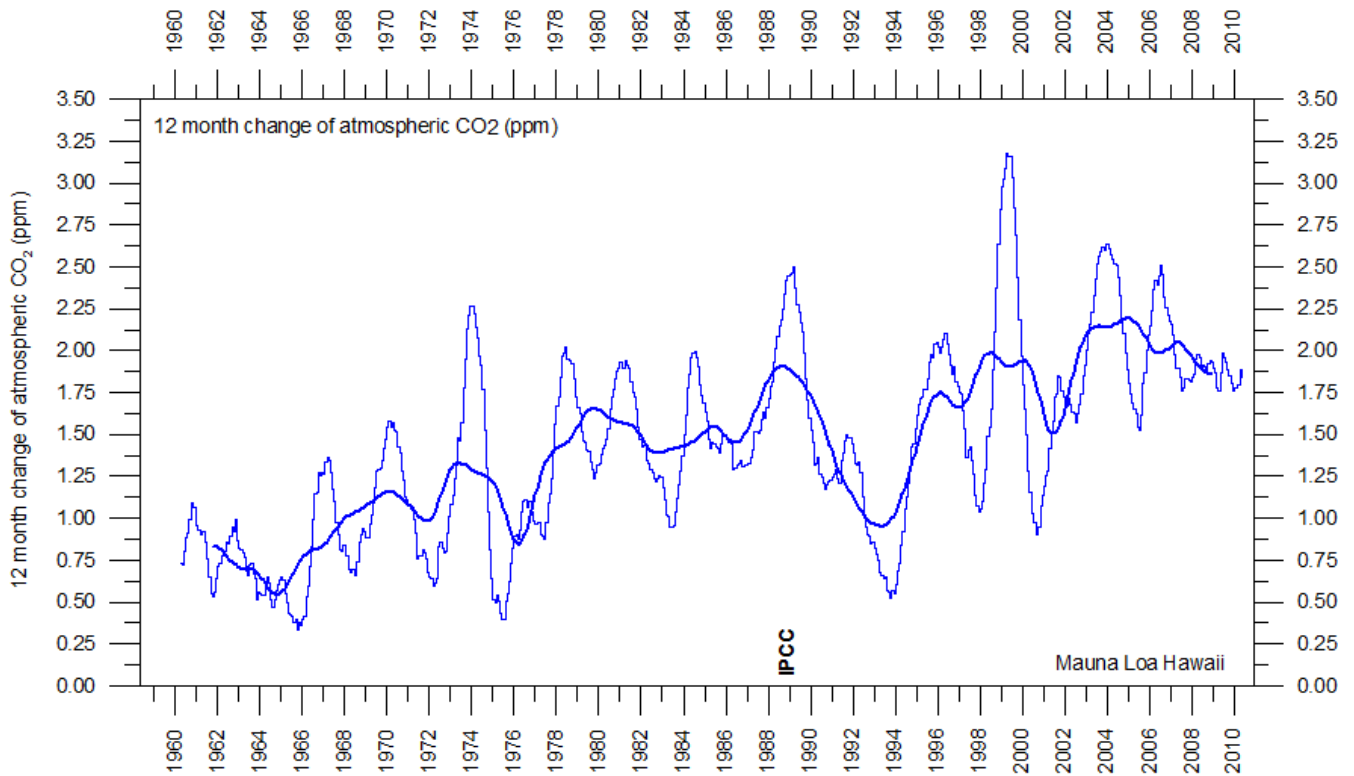


Annual change of global sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](#), USA. The thick line is the simple running 3 yr average.

Atmospheric CO₂, updated to March 2010

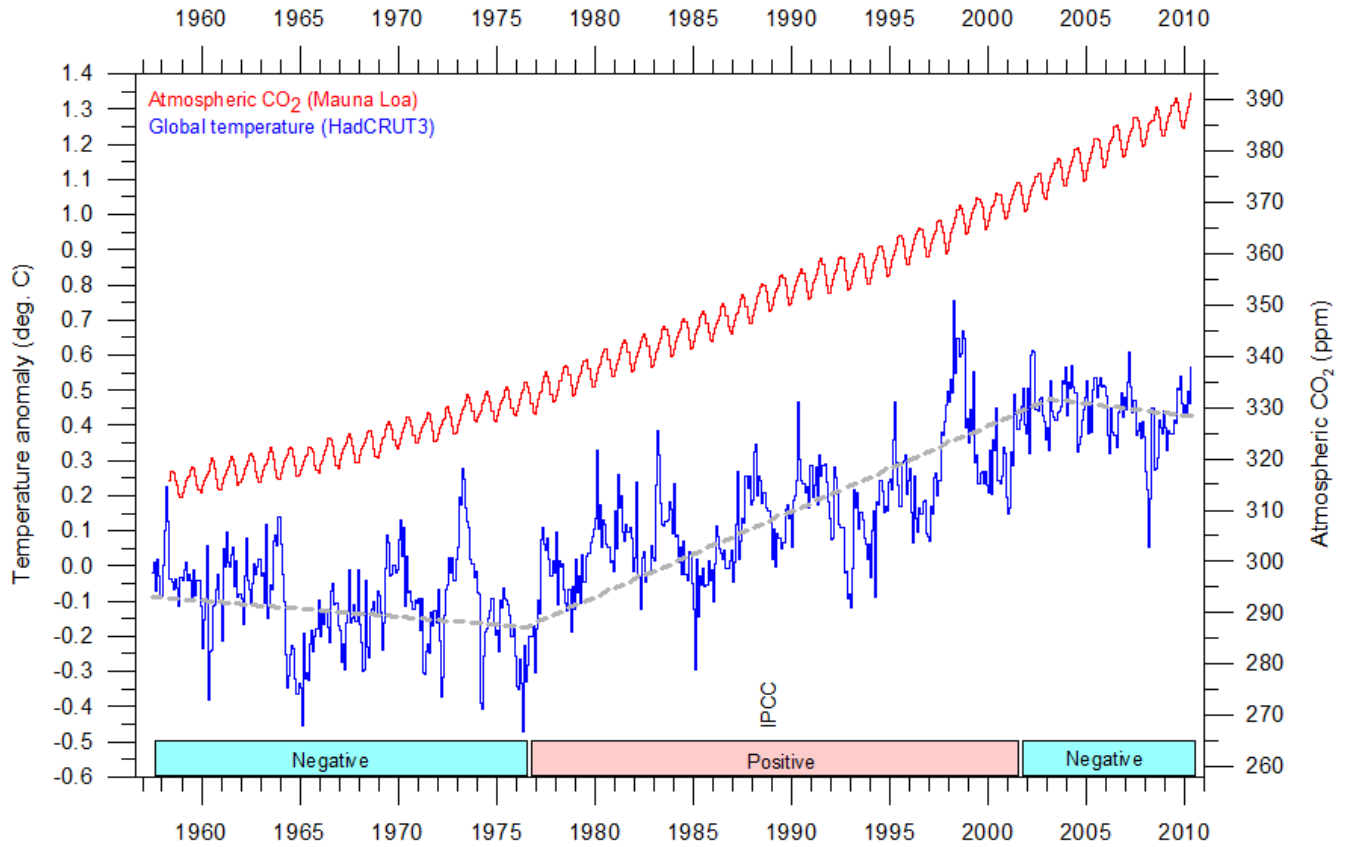


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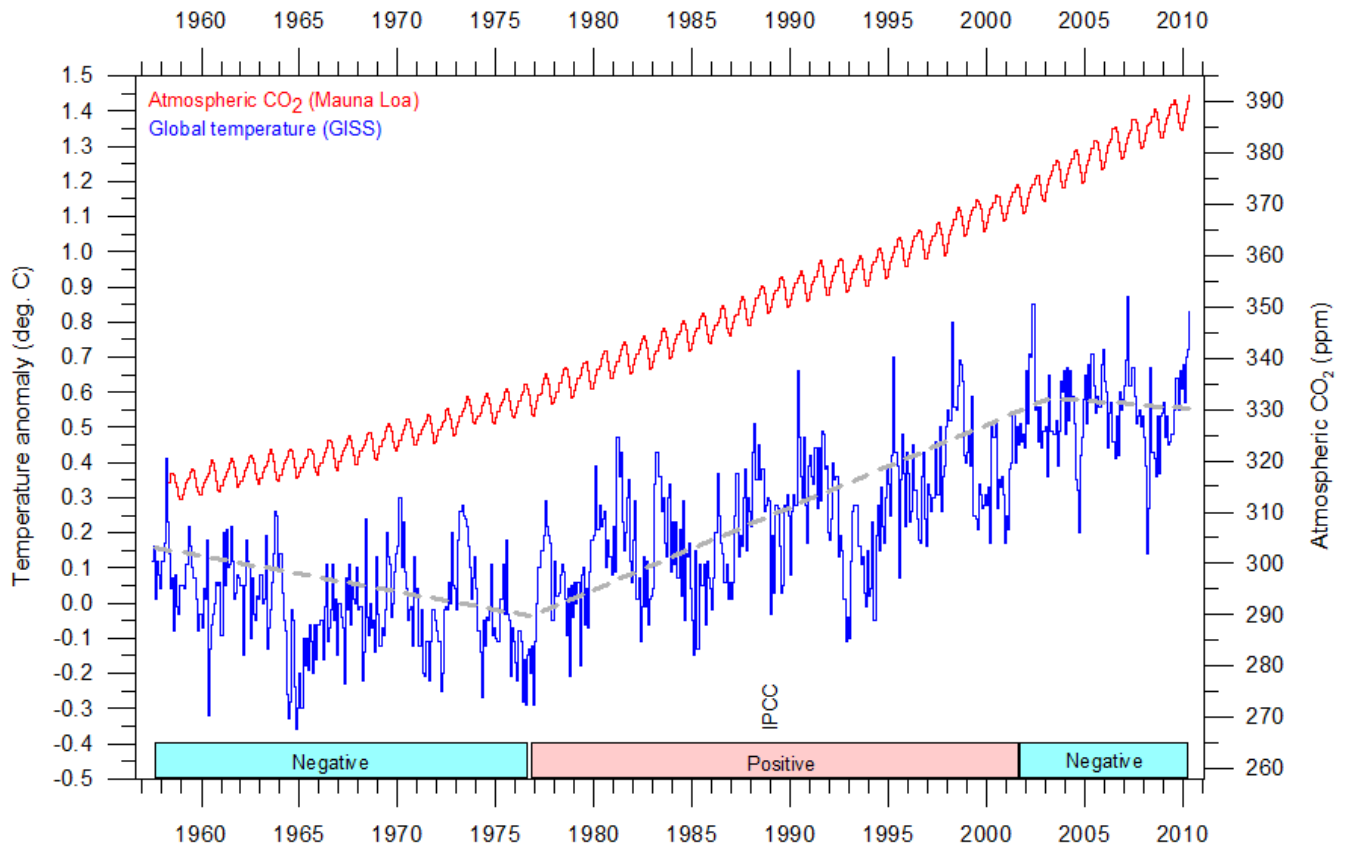


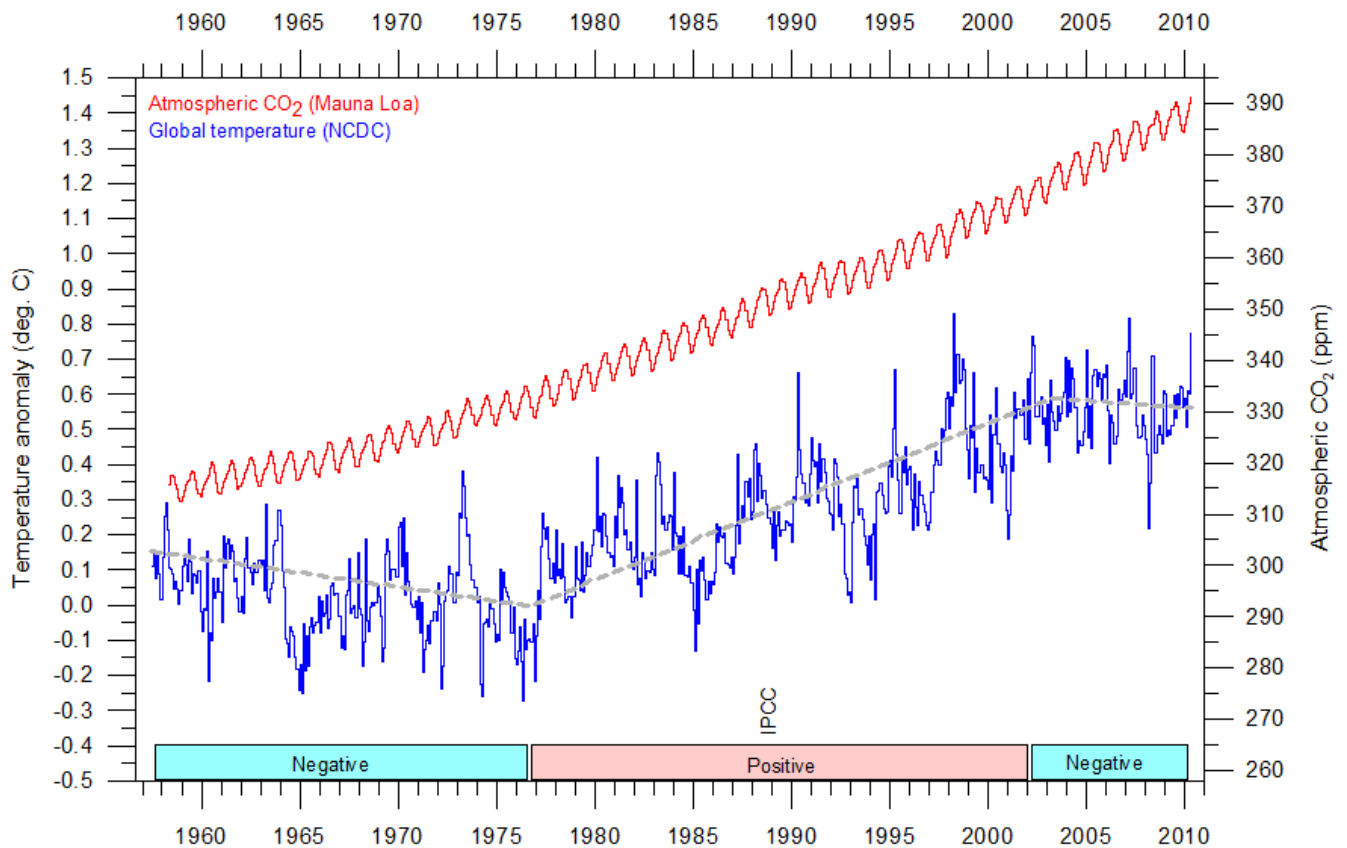
Monthly amount of atmospheric CO₂ (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO₂ since 1959, according to data provided by the [Mauna Loa Observatory](#), Hawaii, USA. The thick line is the simple running 37 observation average, nearly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

Global surface air temperature and atmospheric CO₂, updated to March 2010



16





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.

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, etc.) may well override the potential influence of CO₂ on short time scales such as just a few years.

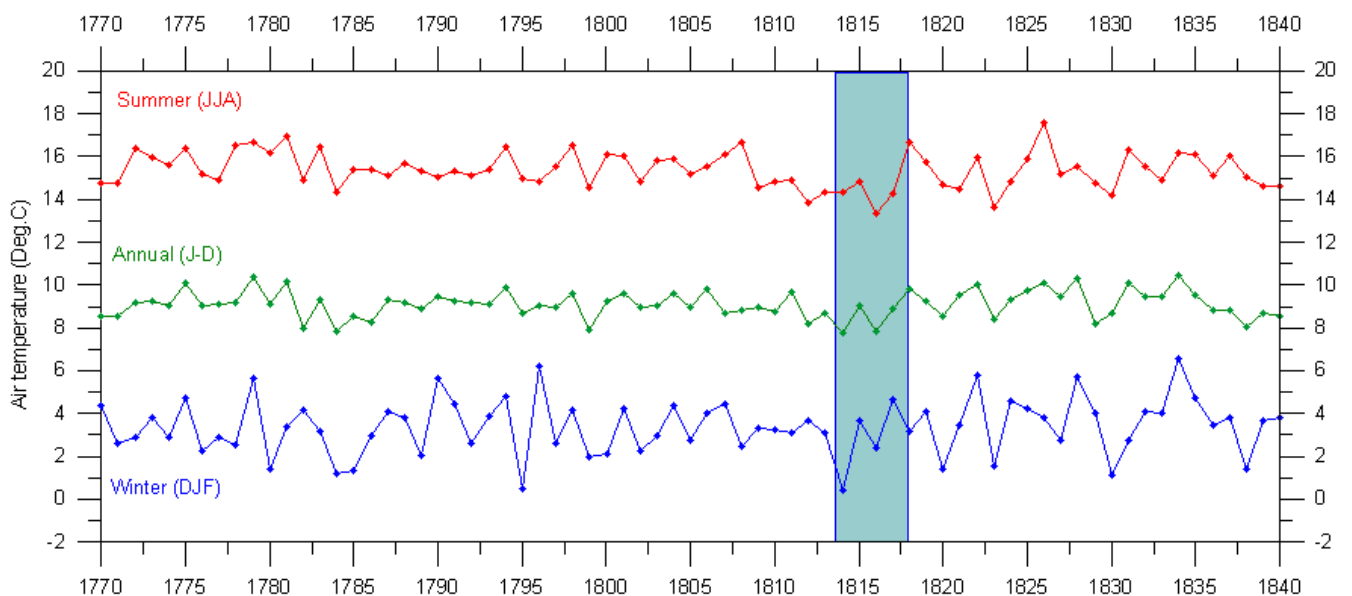
It is of cause equally inappropriate to present new meteorological record values, whether daily, monthly or annual, as support for the hypothesis ascribing high importance of atmospheric CO₂ for global temperatures. Any such short-period meteorological record value may well be the result of other phenomena 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 effect of CO₂ is strong, the length of the critical period is short.

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.

1815: The Tambora volcanic eruption and the cold summer in New England 1816

The April 1815 eruption of Tambora was probably the largest eruption in historic time. About 150 cubic kilometres of ash were erupted. This is about 150 times more than the 1980 eruption of Mount St. Helens in USA. Ash fell as far as 1,300 km from the volcano. In central Java and Kalimantan, 900 km from the eruption, one centimetre of ash fell. The eruption column is estimated to have reached a height of about 45 km.



The Central England temperature series 1770-1840. The length of the cooling effect of the Tambora 1815 eruption is indicated by the blue bar. These graphs has been prepared using the composite monthly meteorological series since 1659, originally painstakingly homogenized and published by the late professor Gordon Manley (1974). The data series is now updated by the Hadley Centre

An estimated 92,000 people were killed by the 1815 Tambora eruption eruption. About 10,000 direct deaths were caused by bomb impacts, tephra fall, and pyroclastic flows, the rest indirectly by starvation, disease, and hunger. The eruption apparently lowered average world temperature by about 0.5-0.7°C over a period of 2-3 years. The 1815 eruption of Tambora was followed in North America and Europe by what was called "the year without a summer". London experienced snow in August 1816.

In the years following the eruption air temperatures were low in many parts of the world, including New England in North America, where 1816 became known as the 'poverty year' (Perley 2001). Actually, the coldest summer known to have been experienced in New England was that of 1816. Many of the crops proved a failure and it seemed at the time as if nothing would be produced. In New Hampshire but little pork was fattened on account of the scarcity and consequent great cost of corn, and the people used mackerel as a substitute for it. There was frost and snow in all the summer months, and in the northwestern part of New England a severe drought prevailed, which added to the disastrous effects of the season.



Northeastern USA with New England as seen in Google Earth.

Perley (2001) states that 'Many people have endeavoured to ascertain some cause for the extraordinary nature of this summer, though no opinion has gained much ground. A large number of the people of that time believed that the large spots which appeared on the sun's disk that spring lessened the number of rays of light and consequently the earth was to that extent cooler than usual. The spots were so large that, for the first time in their history, they could be seen without the aid of telescope....They were seen by the naked eye for several days, beginning on the third of May, and, reappearing on June 11, they were again seen for a few days only'.

Clearly people also at that time (1816) were skilled observers of nature. However, the organized international communication of news was apparently not equally well developed. Clearly few people, if any, in New England had received information on the Tambora eruption the previous year.

May 1816 became both dry and unseasonably cold. At Chester, New Hampshire, newly ploughed land froze hard on 15 May, and snow fell in some of the northern parts of New England (Perley 2001). In the vicinity of Weare, New Hampshire, there were no blossoms on the fruit trees until about 20 May. Throughout the entire summer the weather was the subject of conversations. People asked themselves and each other, if a change had not come over the climate, especially when they heard that in Ohio it had snowed on May 22, and on 13 May there had been frost as far south as Virginia (c.f. Perley 2001).

June 1816 began with some excessively hot days, but soon it became cold again (Perley 2001). At Chester, New Hampshire ice formed on ponds of standing water in the morning of 6 June, while snow fell in Vermont, New Hampshire and Maine. The frost and cold chilled and killed the martins and other birds, and froze the ground, cutting down corn and potatoes. In Vermont, the snow melted as fast as it fell, but in Massachusetts it was blown about as in winter. At Waterbury, Vermont, new fallen snow lay 20-25 cm thick 8 June. The oldest inhabitants did not recollect such an extraordinary cold June as June 1816. Many sheep perished with the cold, birds flew into houses for shelter, and great numbers of them were found dead in the fields. Throughout Maine, vegetation seemed to have been suspended.

July 1816 was characterized by frost in northern New Hampshire, which did considerable injury to the crops, and in Amherst, New Hampshire, snow fell. On 8 July the frost was so severe at Franconia, New Hampshire, that it cut off all the beans (Perley 2001). Vegetables and fruits, however, was pleasantly free of blemish, as the cold weather had indeed annihilated the caterpillars and cranker-worms, but the king-bird and others, which usually feed on such insects, now resorted for sustenance to cherry trees and pea vines.

In early August 1816 there again was frost in New England, and at Amherst snow fell (Perley 2001). Then the weather improved, becoming warm and pleasant. At 20 August cold weather again returned. At Keene and Chester in New Hampshire frost killed a large part of the corn, potatoes, beans and wine, and also injured many crops in Maine. The mountains in Vermont were covered by snow.

In September 1816 3-5 cm snow fell at Springfield, Massachusetts, and the Vermont mountains had then been covered with snow for several days (Perley 2001). At Hartford, Connecticut, it was as cold as it usually is in November. At Hallowell, Maine, frost killed the corn and injured potatoes in low grounds on 20 September. Before the end of September, snow fell at Boston for several hours.

Perley (2001) states the following about the general situation in New England following the cold and adverse weather during the summer 1816: "There was great destitution among the people the next winter and spring. The farmers in some instances were reduced to the last extremity, and many cattle died. The poorer men could not buy corn at the exorbitant prices for which it was sold.In the autumn, stock was sold at extremely low prices on account of lack of hay and corn, a pair of four-year-old cattle being brought for thirty-nine dollars in Chester, New Hampshire.The next spring hay was sold in New Hampshire in a few instances as high as one hundred and eighty dollars per ton, its general price, however, being thirty dollars.

Small wonder that periods of cooling traditionally have been characterized as periods of 'climatic deterioration', while periods of warming have been described as periods of 'climatic improvement'.

References:

Perley, S. 2001. *Historic Storms of New England*. Commonwealth Editions, Beverly, Massachusetts, 302 pp. First published in 1891 by Salem Press Publishing and Printing Company, Salem, Massachusetts.

All above diagrams with supplementary information (including links to data sources) are available on www.climate4you.com

Yours sincerely, Ole Humlum (Ole.Humlum@geo.uio.no)

17 April 2010.

All GISS diagrams corrected on 18 April 2010.