Climate4you update December 2010

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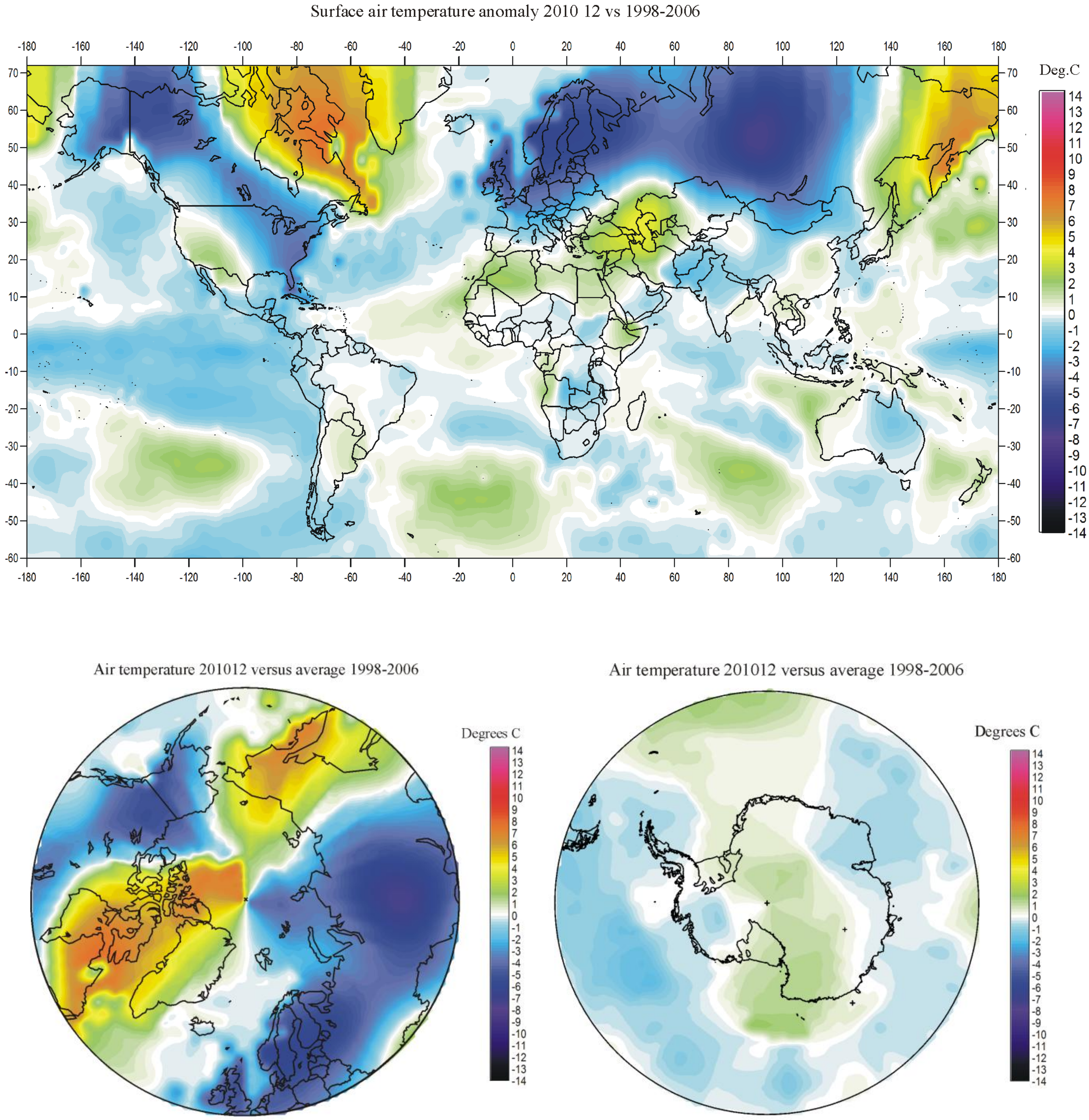
[December 2010 global surface air temperature overview]



December 2010 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 December 2010 global surface air temperature overview

General: This newsletter contains graphs showing a selection of key meteorological variables for December 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 December 2010 in general was below what has characterised most of 2010, as is detailed by several of the temperature diagrams shown below.

In the Northern Hemisphere was characterised by generally low temperatures, but also high regional variability. A zone of low temperature extended from central Siberia across Europe, the North Atlantic, eastern USA, western Canada to Alaska. Above average temperatures characterised northeast Canada, western Greenland and eastern Siberia.

The Southern Hemisphere in general was close to average conditions. Northeast Australia experienced below average temperature, presumably due to extensive cloud cover and heavy precipitation in connection with the December floods in north-easten Australia. Presumably, the zone with above temperatures extending from the southern Pacific across northern Australia into the eastern part of the Indian Ocean, should bee seen in connection with these floods (see also sea surface temperature map on page 7). There were, however, no major warm regions in the Southern Hemisphere in December 2010.

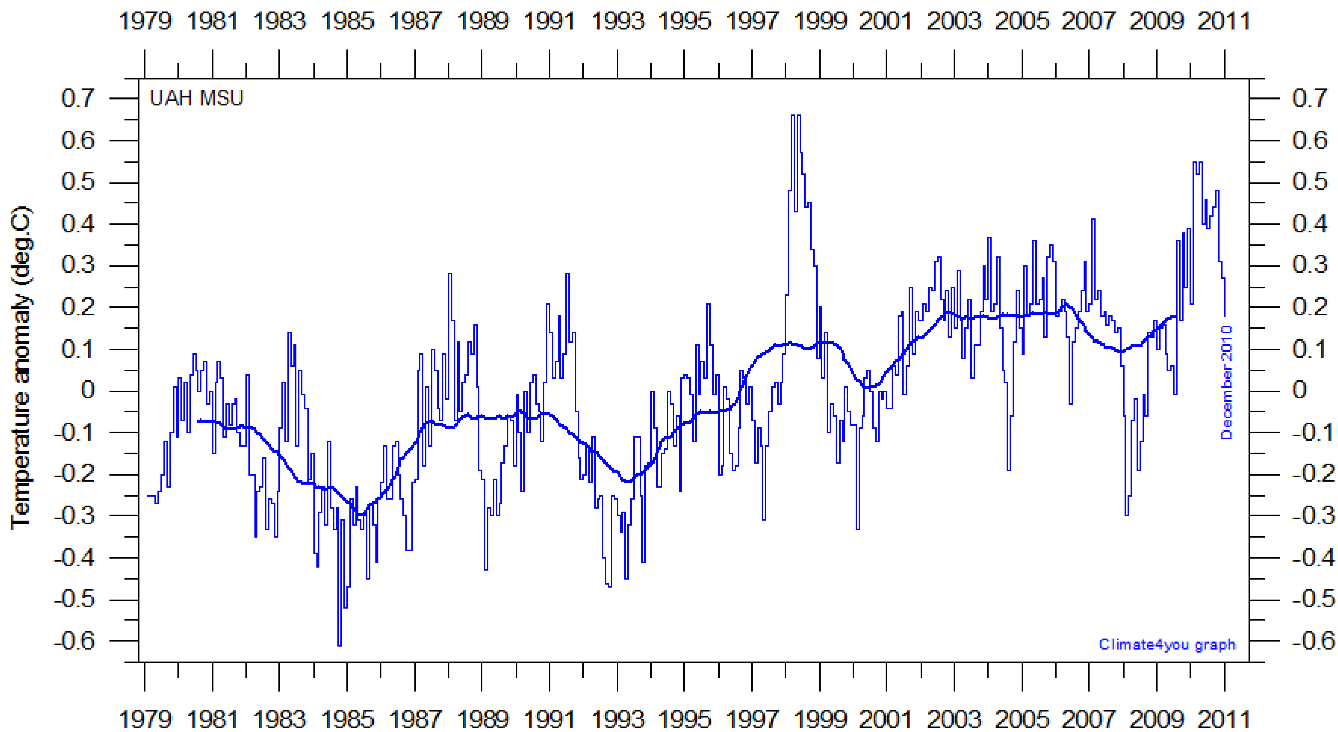
Near Equator conditions were influenced by the La Nina situation. Relatively low temperatures therefore characterised most of the Equatorial regions in the Pacific Ocean. The Equatorial Atlantic was close to average conditions, but the Indian Ocean now appears to be developing below average temperatures at the surface.

The Arctic was characterized by huge contrasts as to the temperatures. Most areas experienced below temperatures, but northeast Canada, western Greenland and eastern Siberia had above average temperatures.

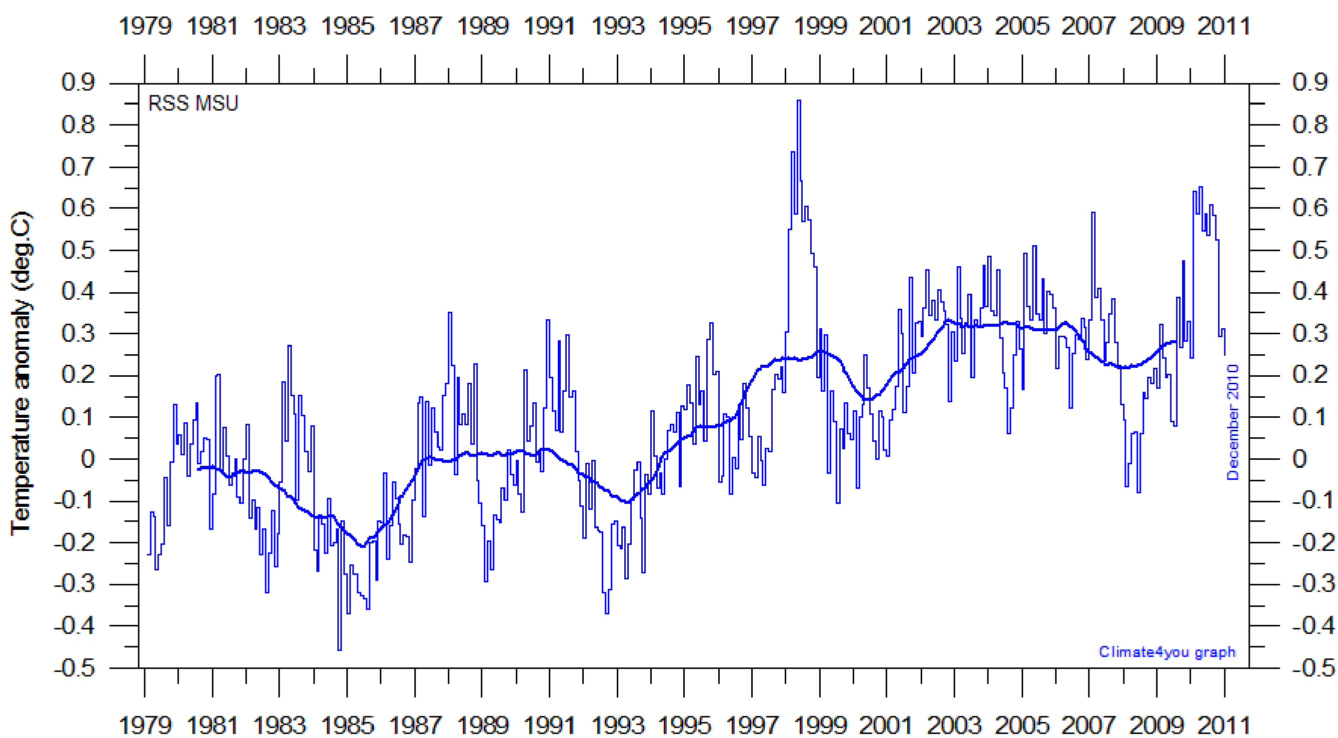
In the Antarctic temperature conditions were close to the average for 1998-2006.

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

[Lower troposphere temperature from satellites, updated to December 2010]

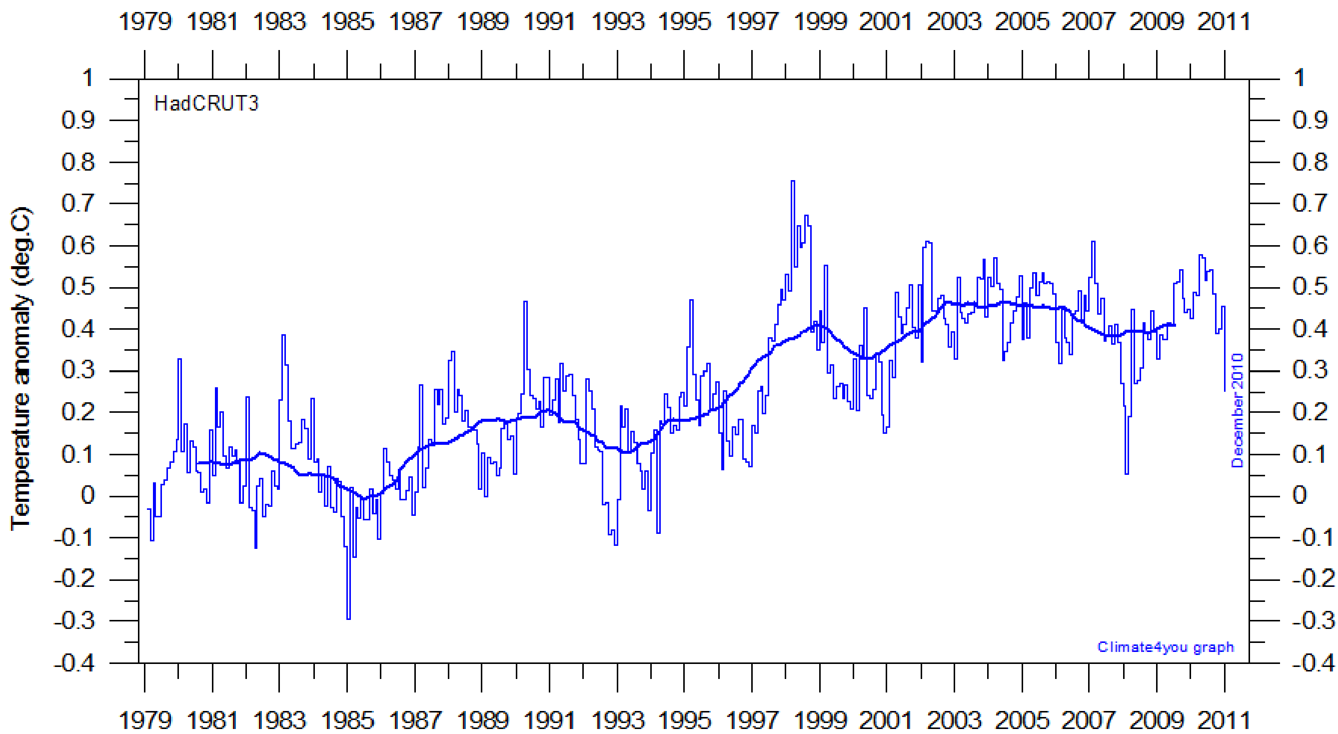


Global monthly average lower troposphere temperature (thin line) since 1979 according to [University of Alabama] at Huntsville, USA. The thick line is the simple running 37 month average.

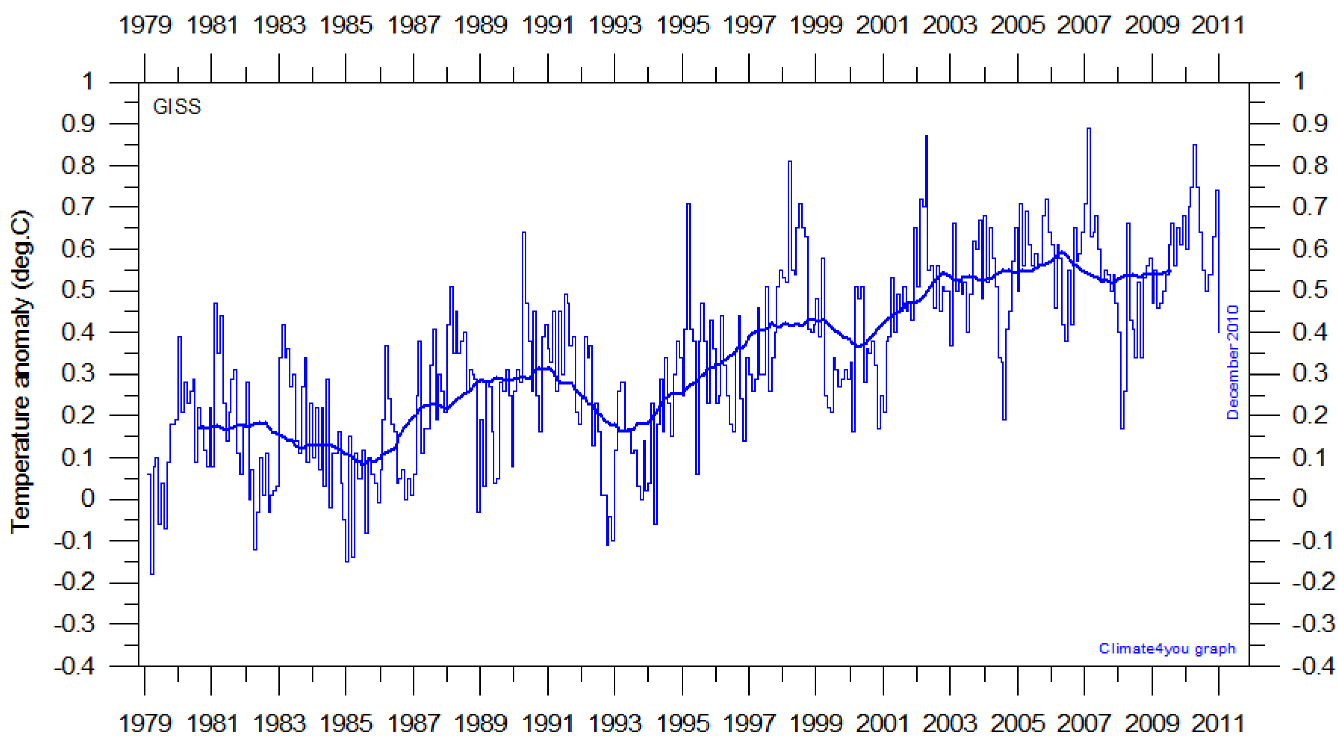


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to [Remote Sensing Systems] (RSS), USA. The thick line is the simple running 37 month average.

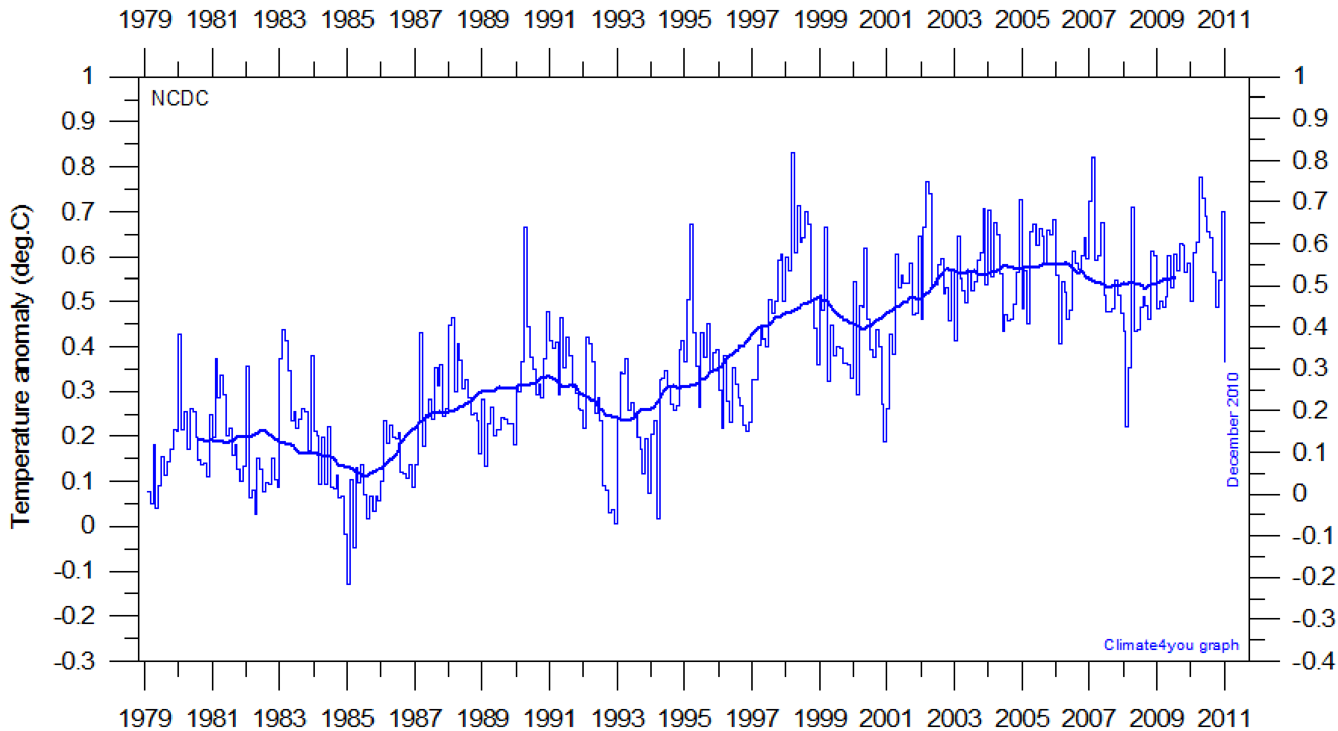
Global surface air temperature, updated to December 2010



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. Please note that this record has not been updated beyond October 2010.

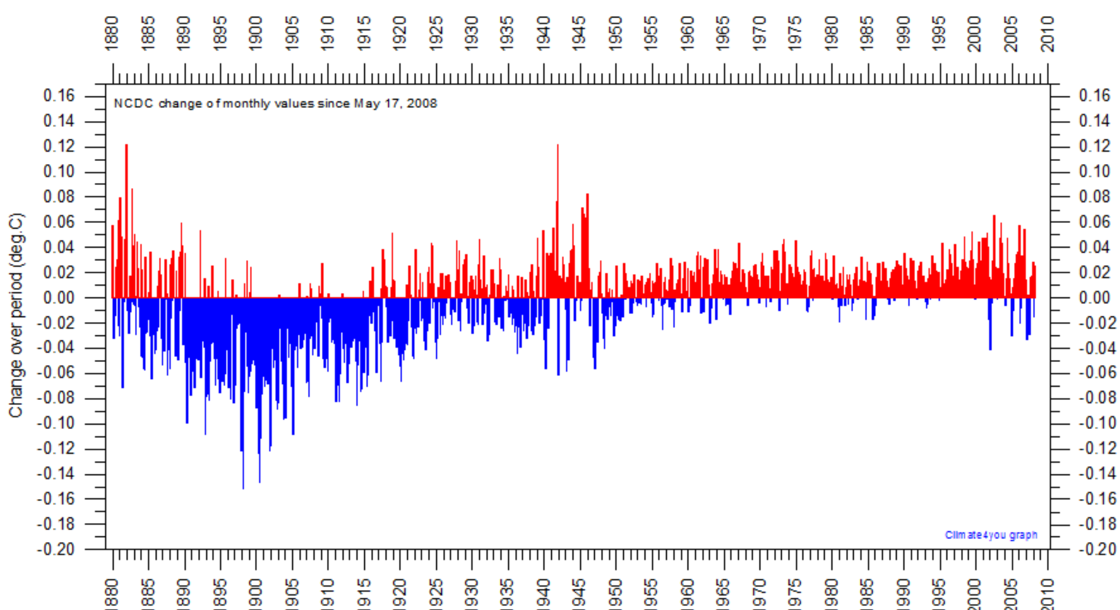


Global monthly average surface air temperature (thin line) since 1979 according to according to the [Goddard Institute for Space Studies](#) (GISS), at Columbia University, New York City, USA. The thick line is the simple running 37 month average.

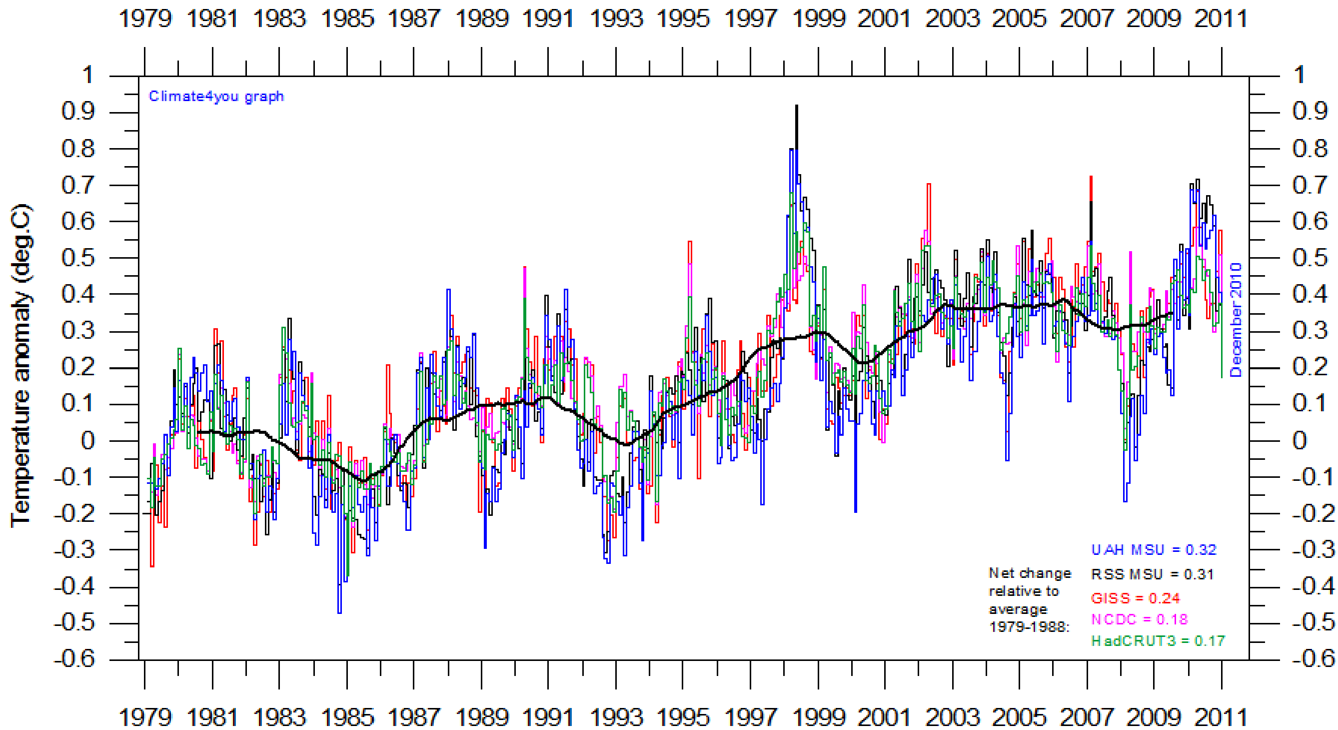


Global monthly average surface air temperature since 1979 according to according to the [National Climatic Data Center](#) (NCDC), USA. The thick line is the simple running 37 month average.

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^{o}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).



All in one, updated to December 2010

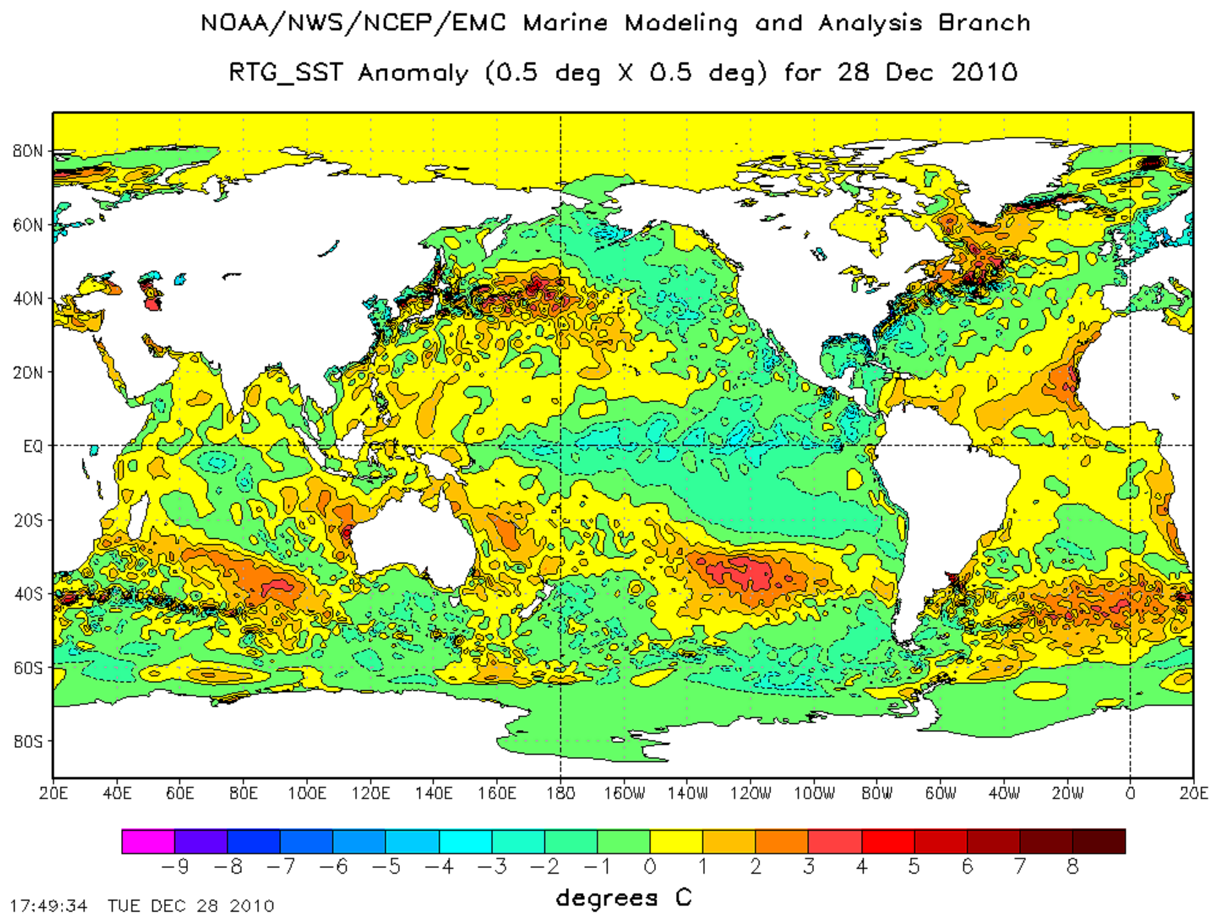


Superimposed plot of all five global monthly temperature estimates shown above. As the base period differs for the different temperature estimates, they have all been normalised by comparing to the average value of their initial 120 months (10 years) from January 1979 to December 1988. The heavy black 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 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 is problematical. However, as both types of estimate often are discussed together, the above diagram may nevertheless be of 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 short term scale there may be considerable differences.

All five global temperature estimates presently show stagnation, at least since 2002. There has been no increase in global air temperature since 1998, which 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 5-10 years. Only time will show which of these possibilities is correct.

Global sea surface temperature, updated to end of December 2010

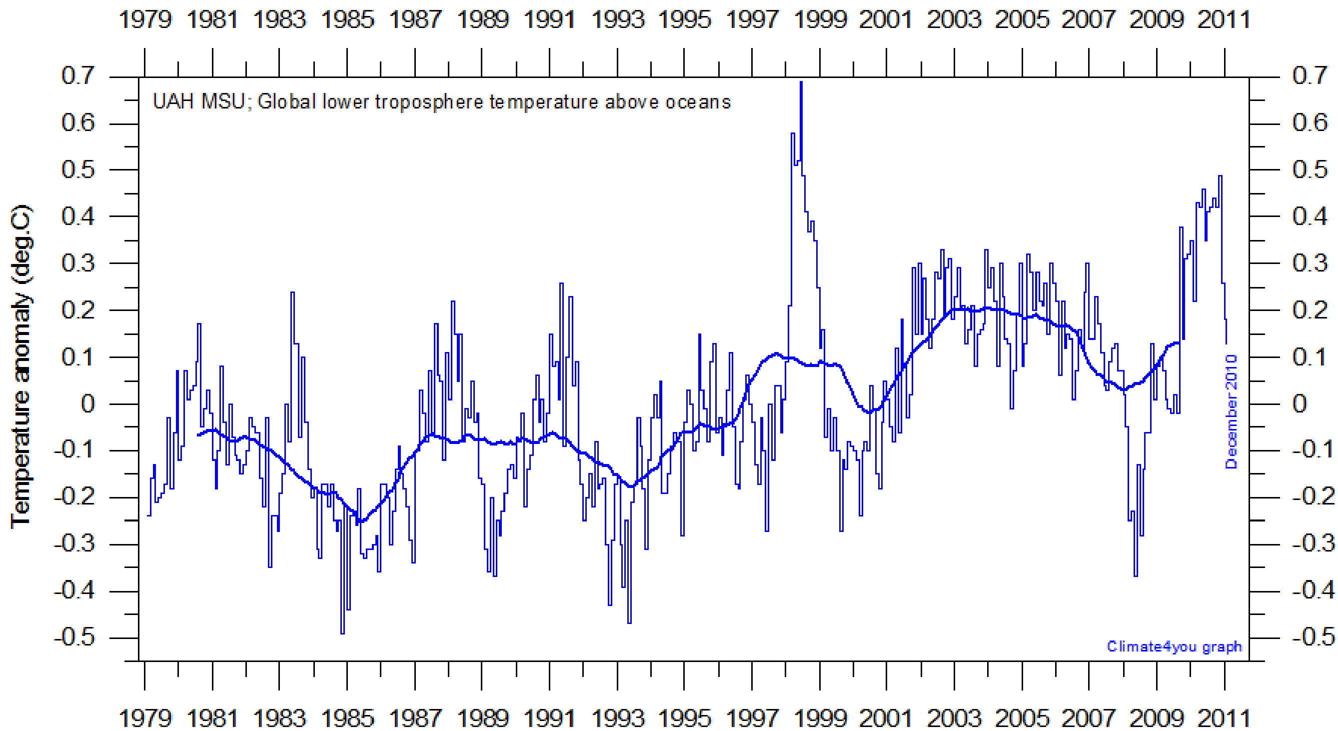


Sea surface temperature anomaly at 28 December 2010. Map source: National Centers for Environmental Prediction (NOAA).

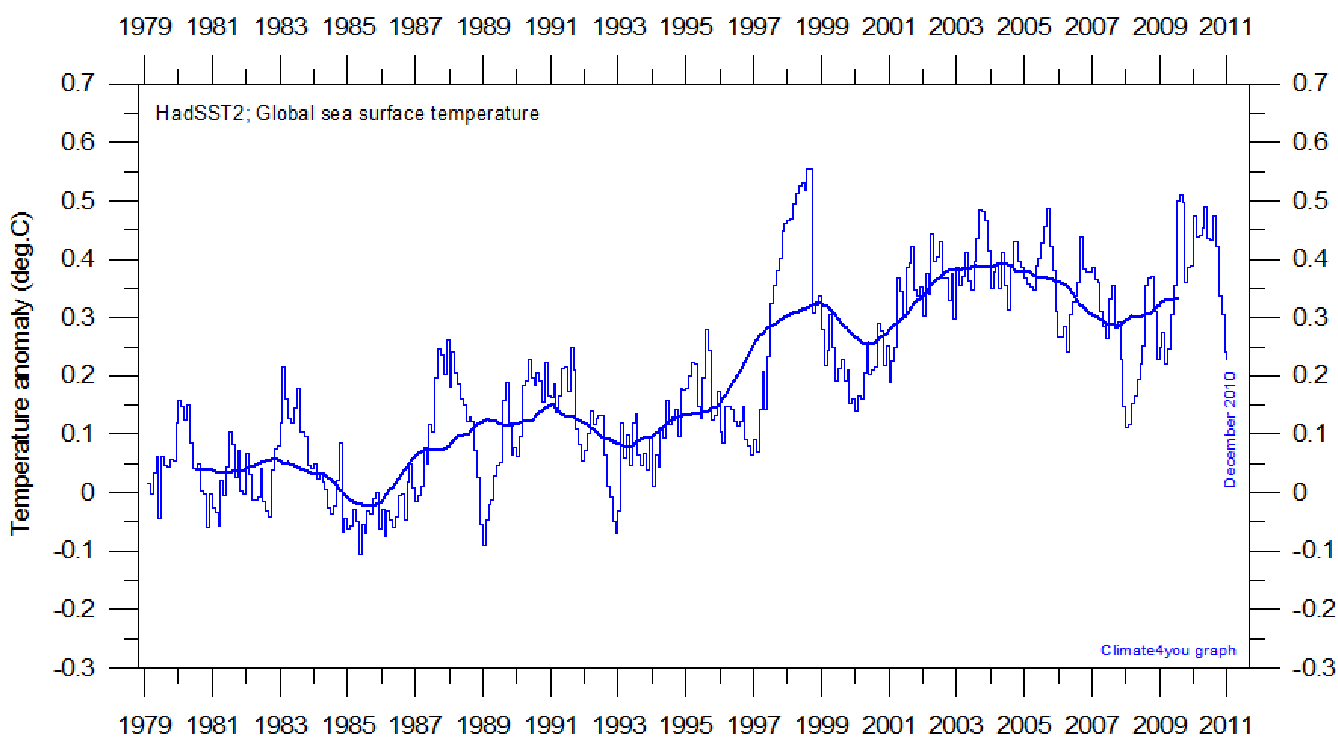
The relative cold water now spreading west along the Equator in the Pacific Ocean represents the early part of a La Niña situation and affects the temperature of the atmosphere above. Because of the large surface areas involved (near Equator) this natural cyclic development is beginning to affect the global atmospheric temperature towards lower temperatures.

However, the significance of any such global cooling should not be over interpreted. 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. This does not, however, reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, net changes may be small, as it mainly reflects a redistribution of energy. What matters is the overall development when seen over some years.

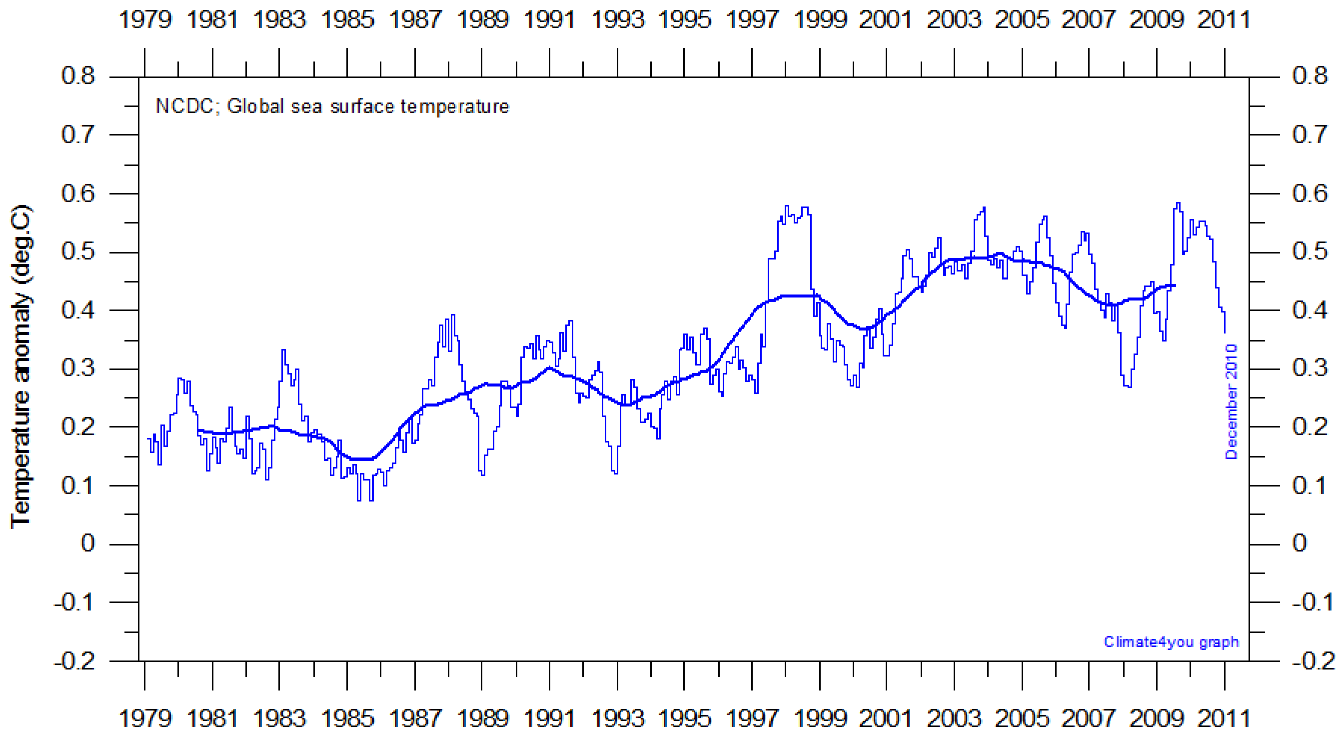
On this background it has been disappointing lately to witness several announcements in news media describing the first part of the year 2010 as being extraordinary warm, without at the same time mentioning the warm El Niño situation. Of cause global air temperatures then was affected upwards by these important oceanographic developments, without this corresponding to a similar change of the global heat content.



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.

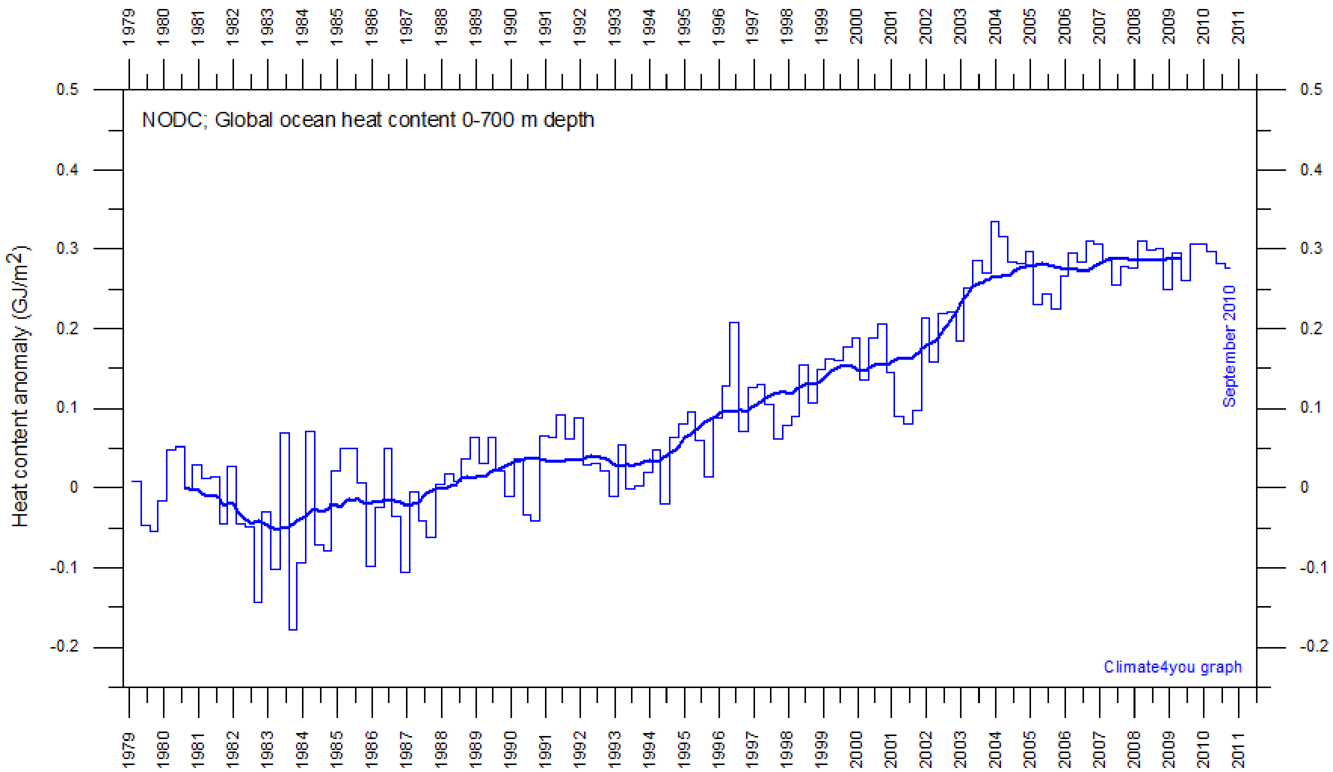


Global monthly average sea surface temperature since 1979 according to University of East Anglia's Climatic Research Unit (CRU), UK. Base period: 1961-1990. The thick line is the simple running 37 month average.

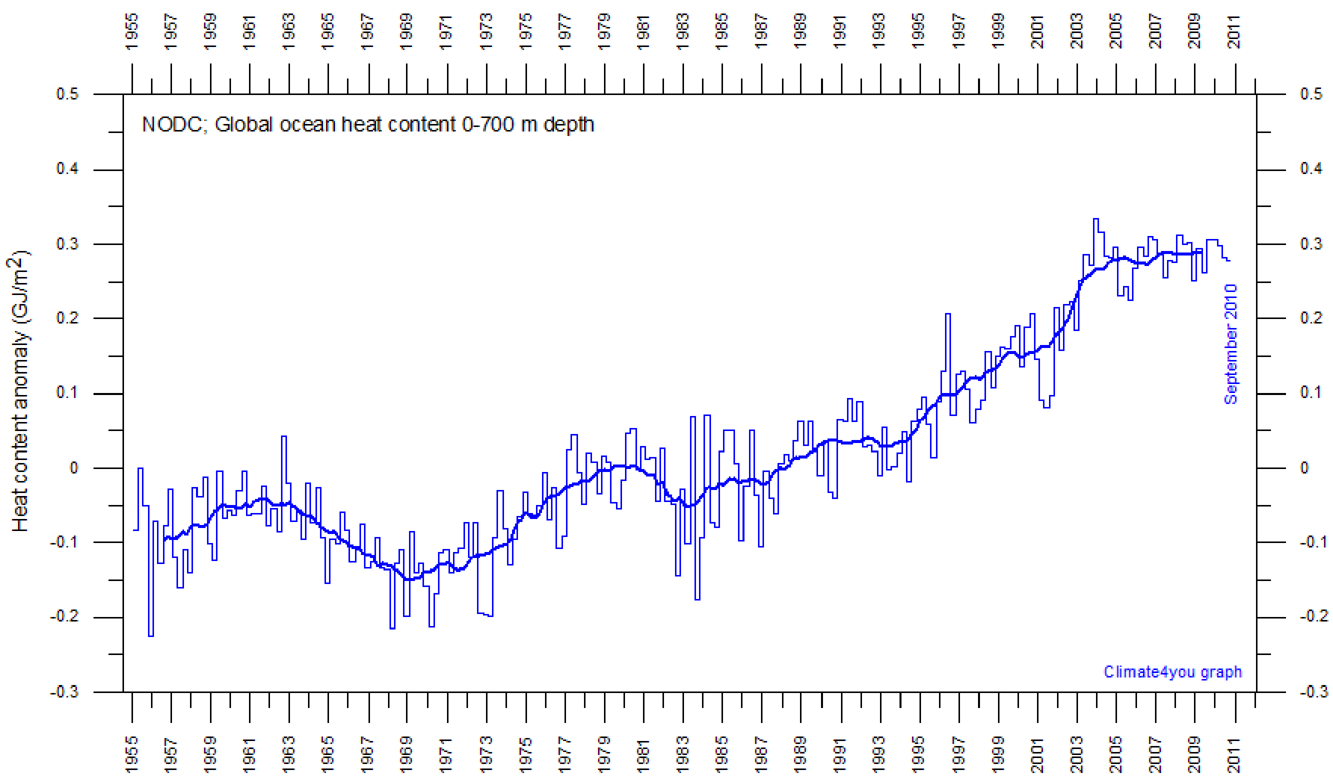


Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center](#) (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37 month average.

Global ocean heat content, updated to September 2010

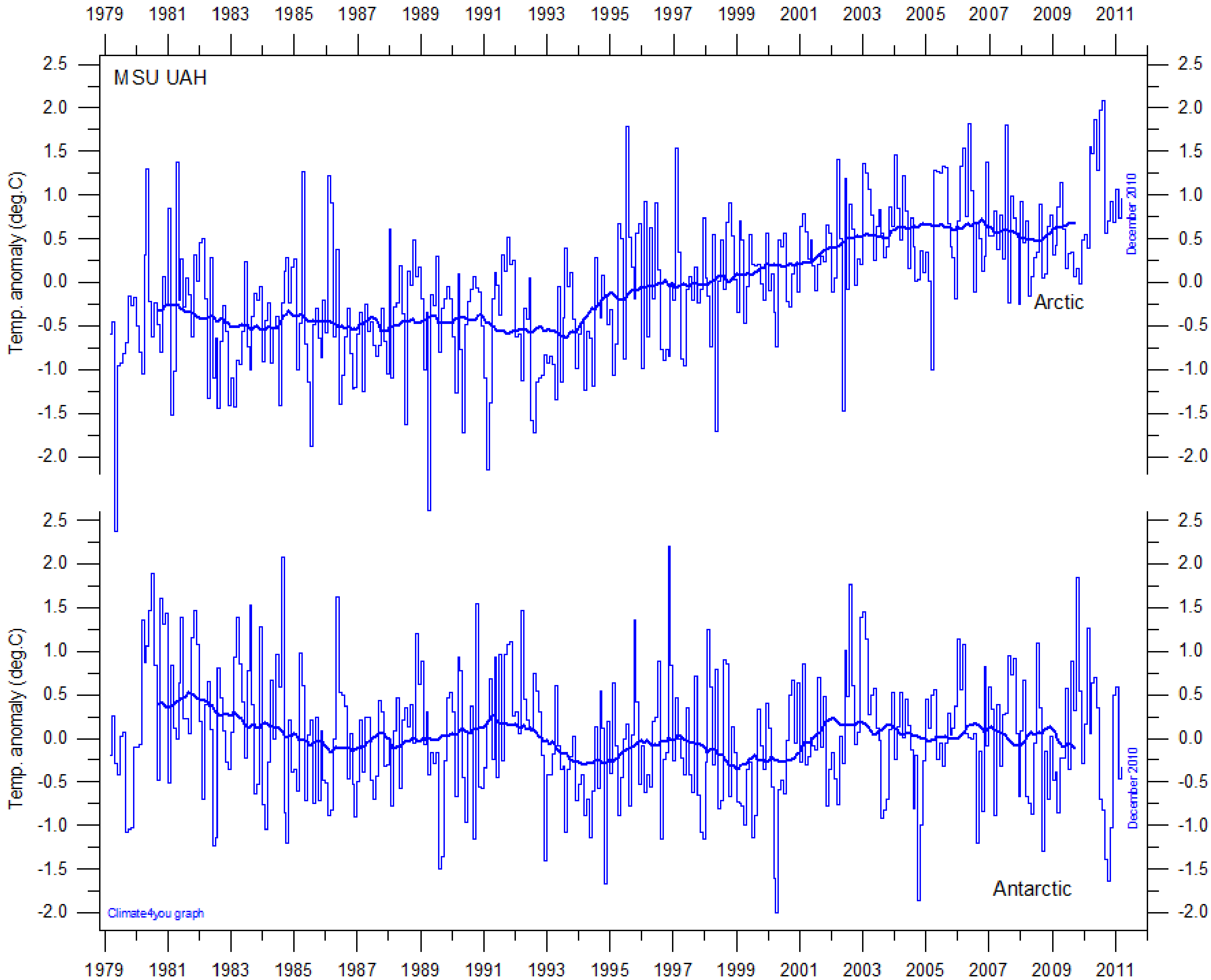


Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



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).

Arctic and Antarctic lower troposphere temperature, updated to December 2010



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). 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 November 2010

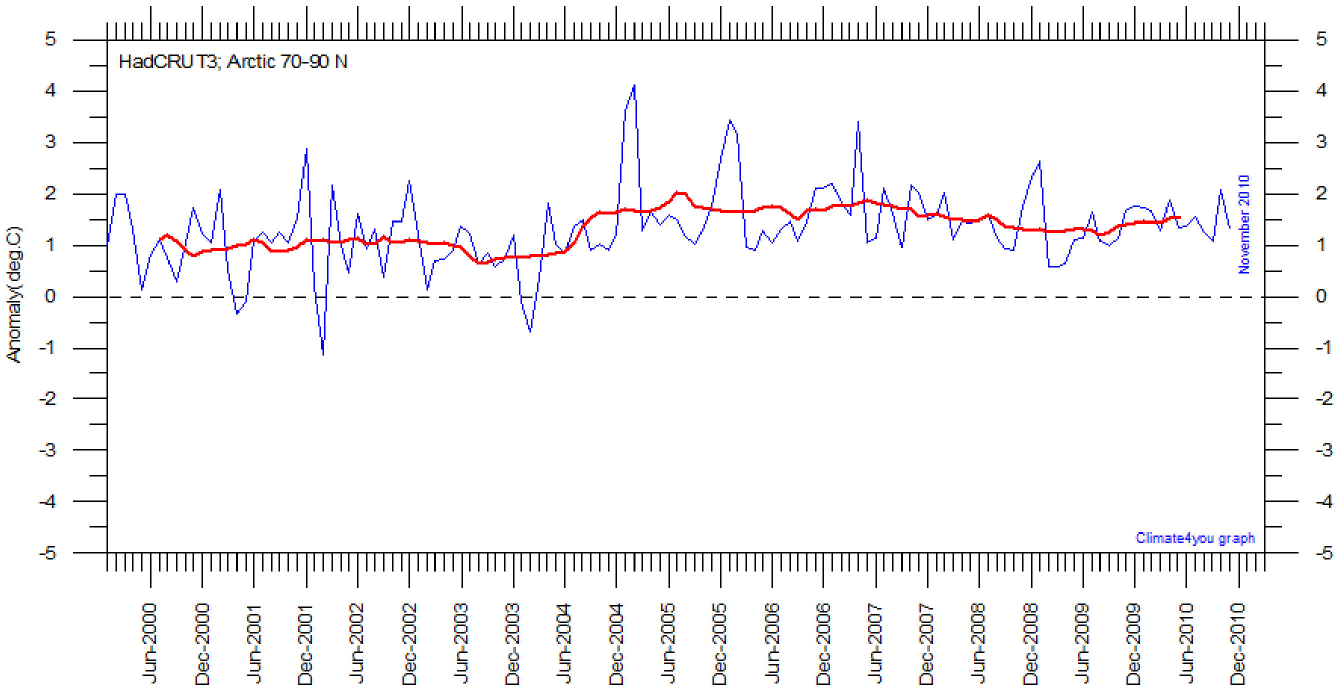


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre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

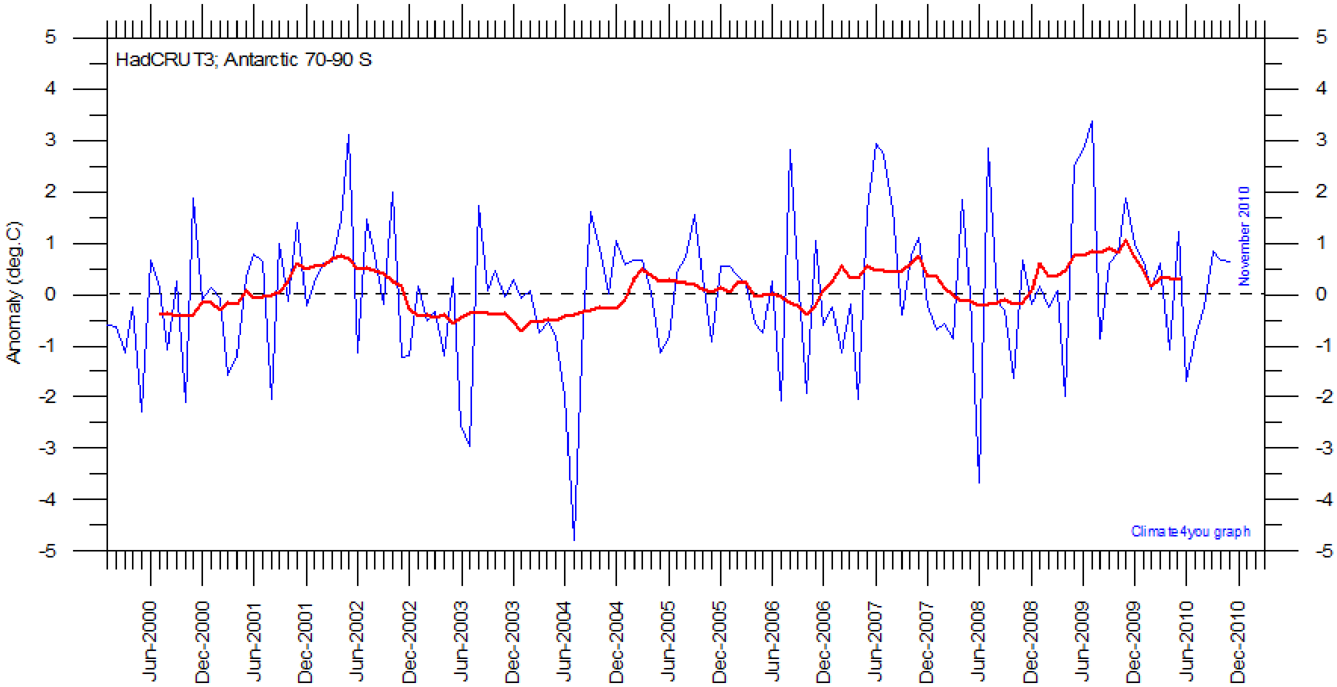


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley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

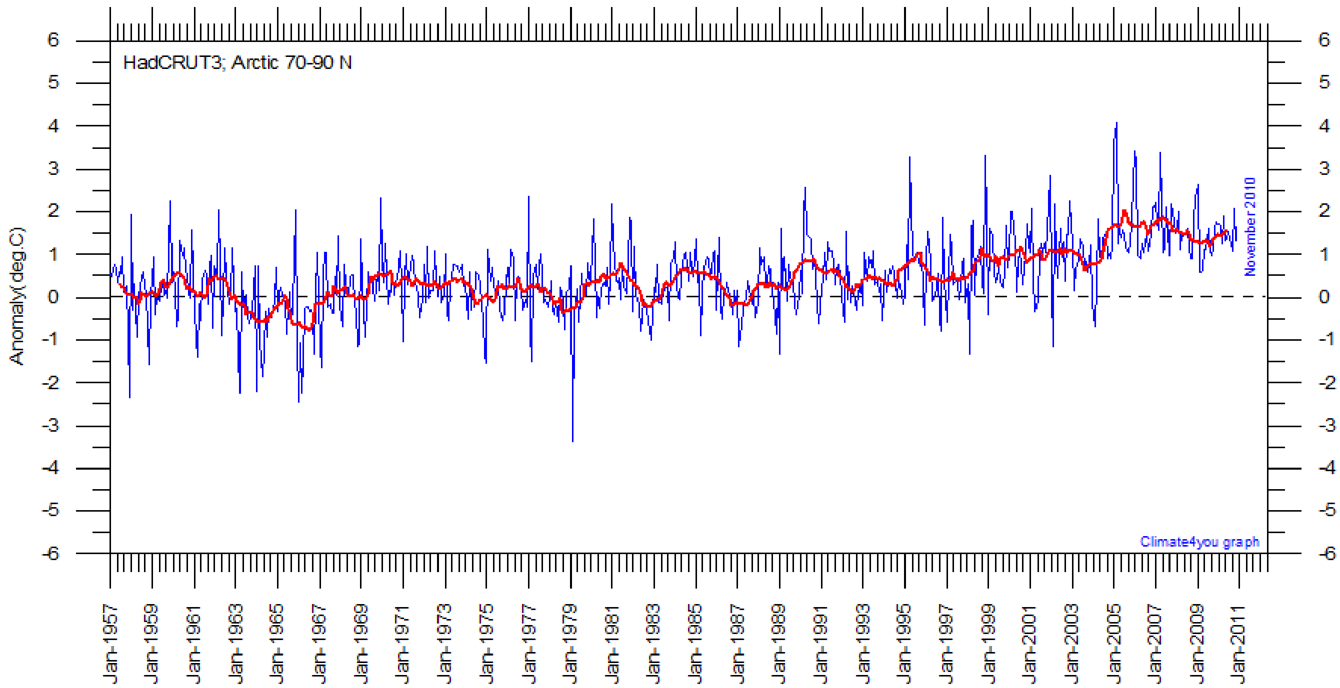


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 has been chosen as starting year, to ensure easy comparison with the maximum length of the realistic Antarctic temperature record shown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

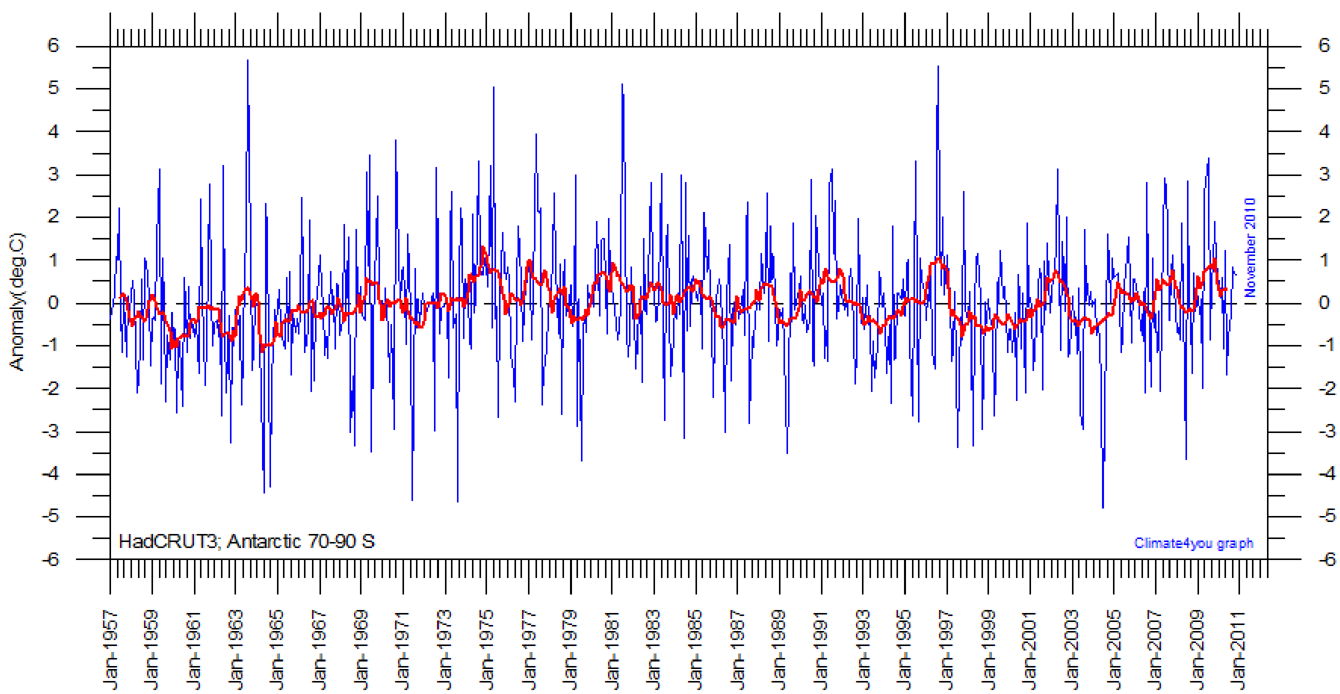


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 was an international geophysical year, and several meteorological stations were established in the Antarctic because of this. Before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

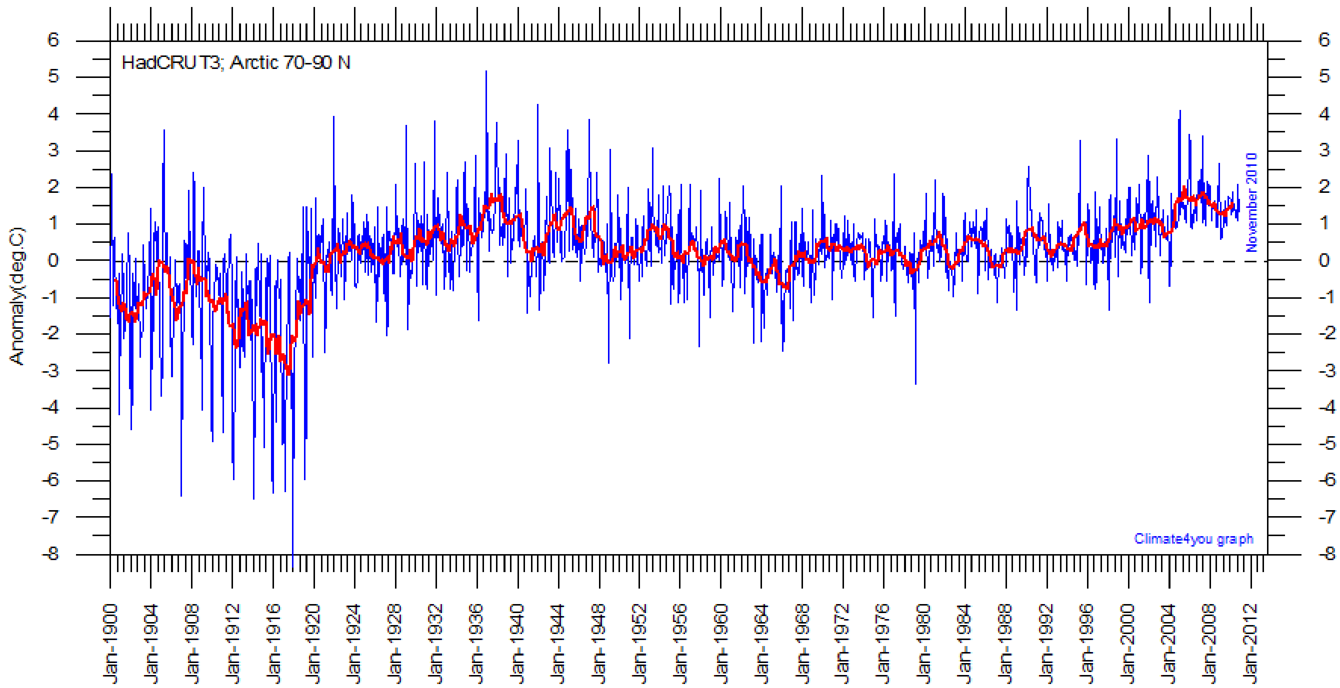


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1900, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. In general, the range of monthly temperature variations decreases throughout the first 30-50 years of the record, reflecting the increasing number of meteorological stations north of 70°N over time. Especially the period from about 1930 saw the establishment of many new Arctic meteorological stations, first in Russia and Siberia, and following the 2nd World War, also in North America. Because of the relatively small number of stations before 1930, details in the early part of the Arctic temperature record should not be over interpreted. The rapid Arctic warming around 1920 is, however, clearly visible, and is also documented by other sources of information. The period since 2000 is warm, about as warm as the period 1930-1940. Data provided by the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK

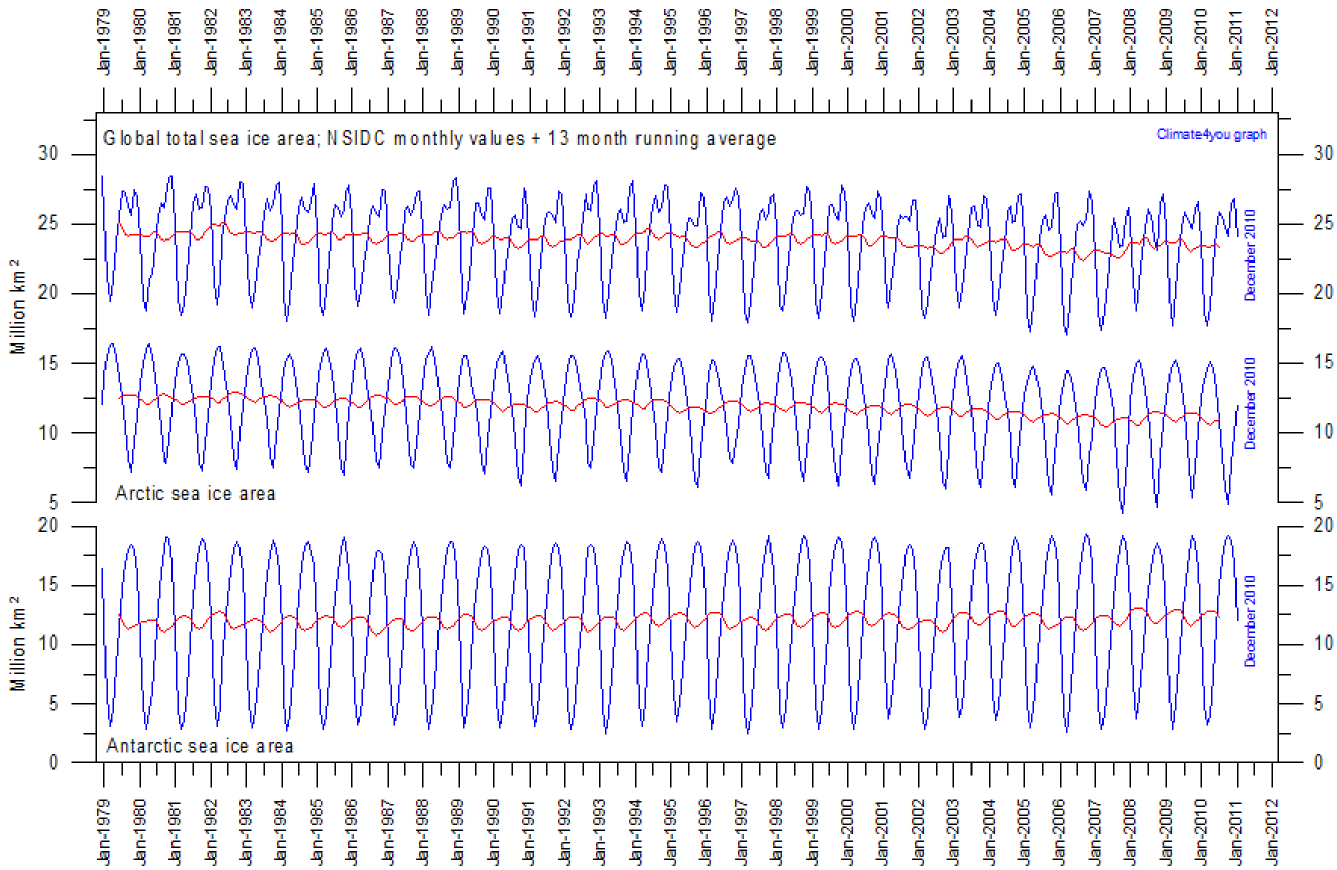
In general, the Arctic temperature record appears to be less variable than the contemporary Antarctic record, presumably at least partly due to the higher number of meteorological stations north of 70°N, compared to the number of stations south of 70°S.

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 dells.

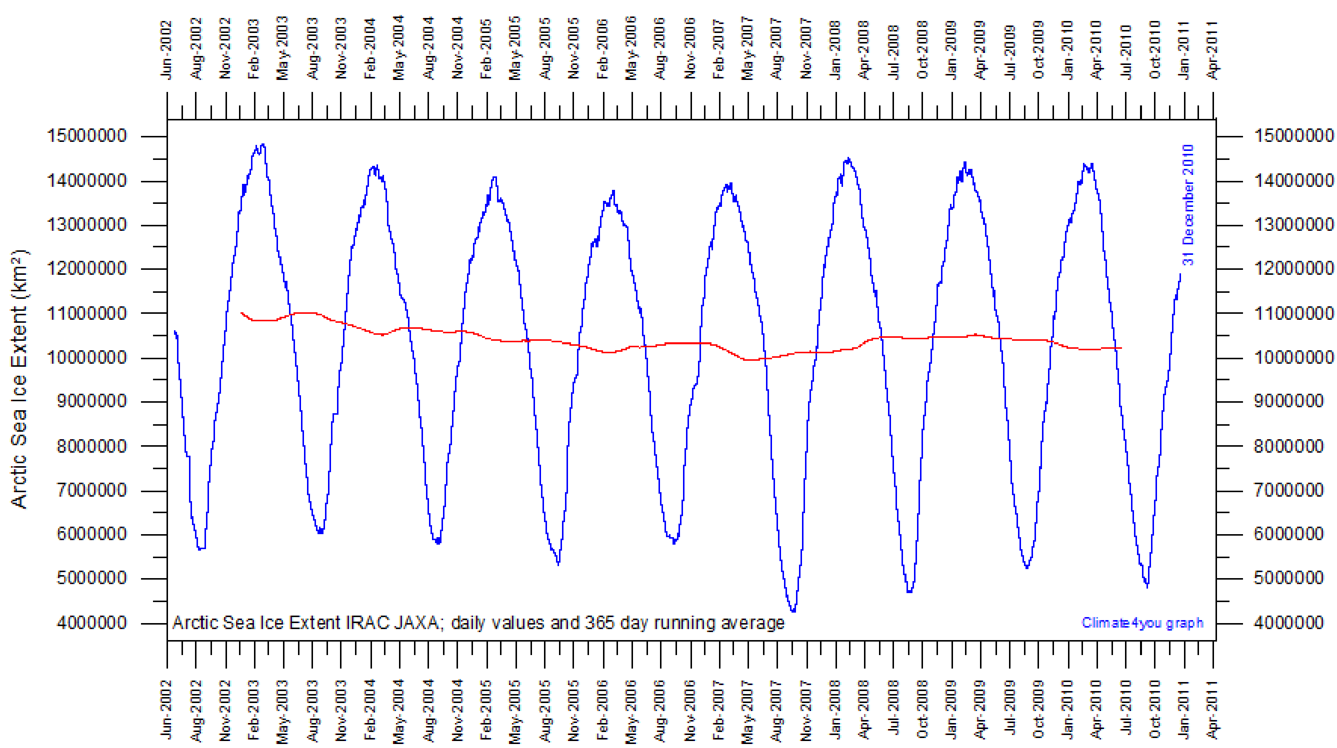
Literature:

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

Arctic and Antarctic sea ice, updated to December 2010

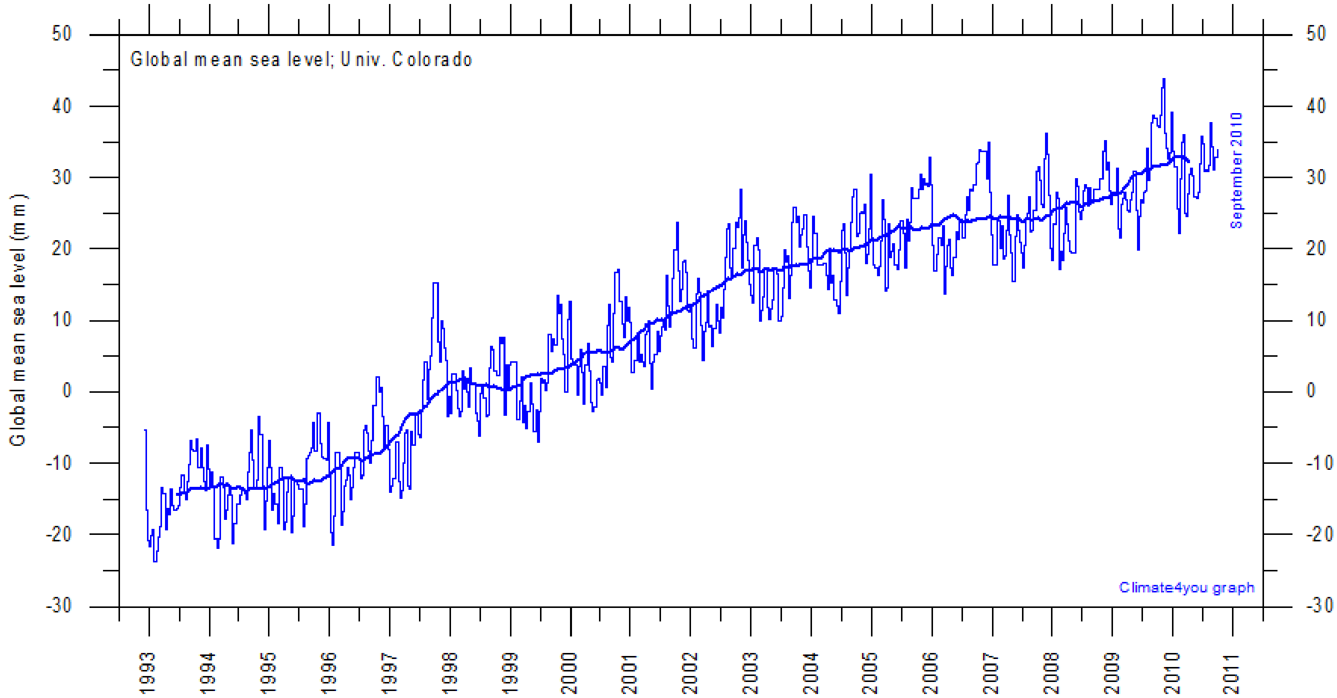


Graphs showing monthly Antarctic, Arctic and global sea ice extent since November 1978, according to the [National Snow and Ice data Center](#) (NSIDC).

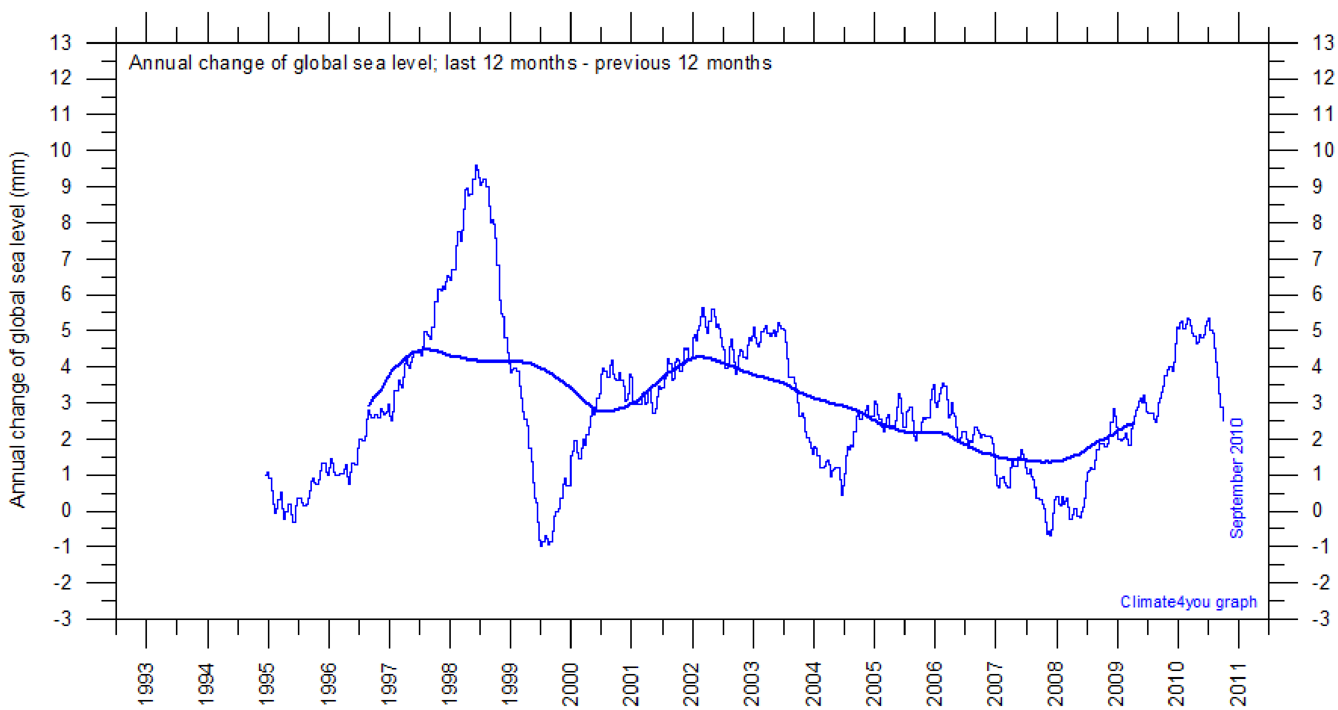


Graph showing daily Arctic sea ice extent since June 2002, to 31/12 2010, by courtesy of [Japan Aerospace Exploration Agency](#) (JAXA).

[Global sea level, updated to September 2010]

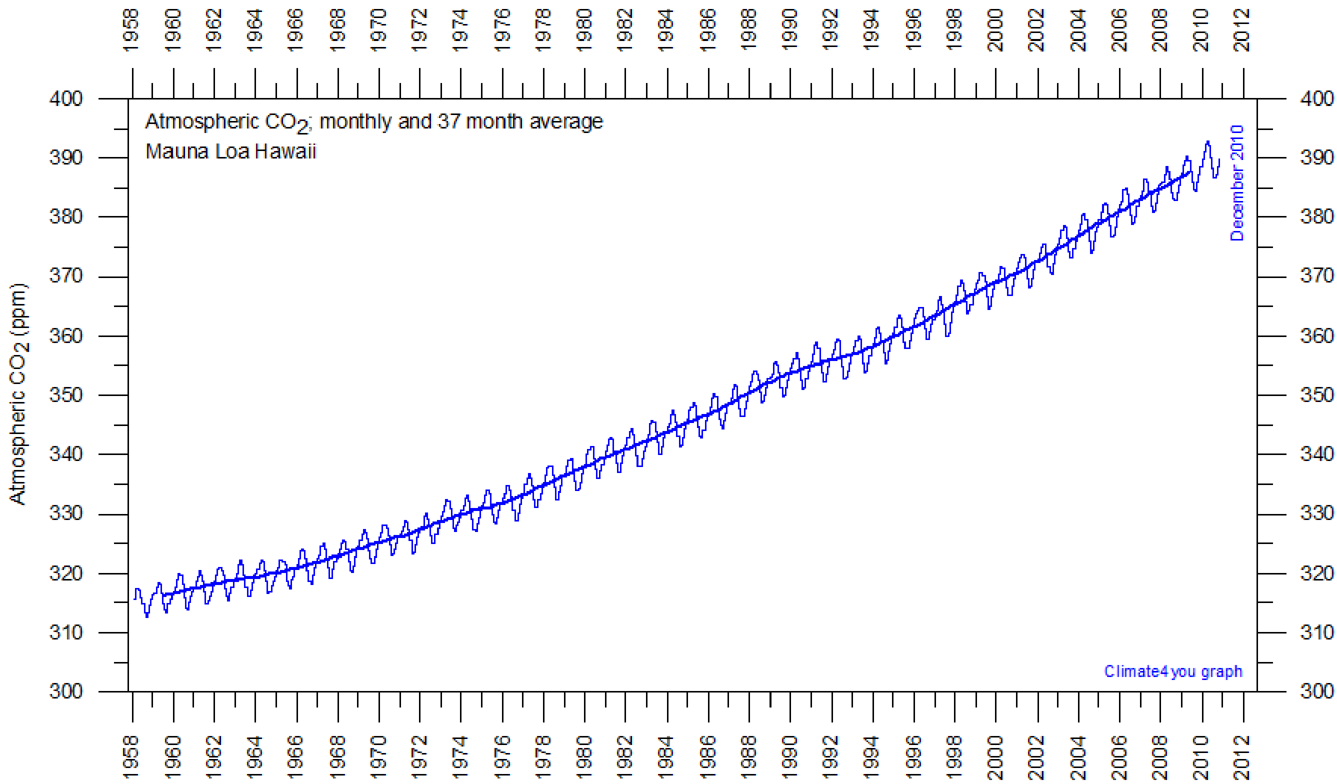


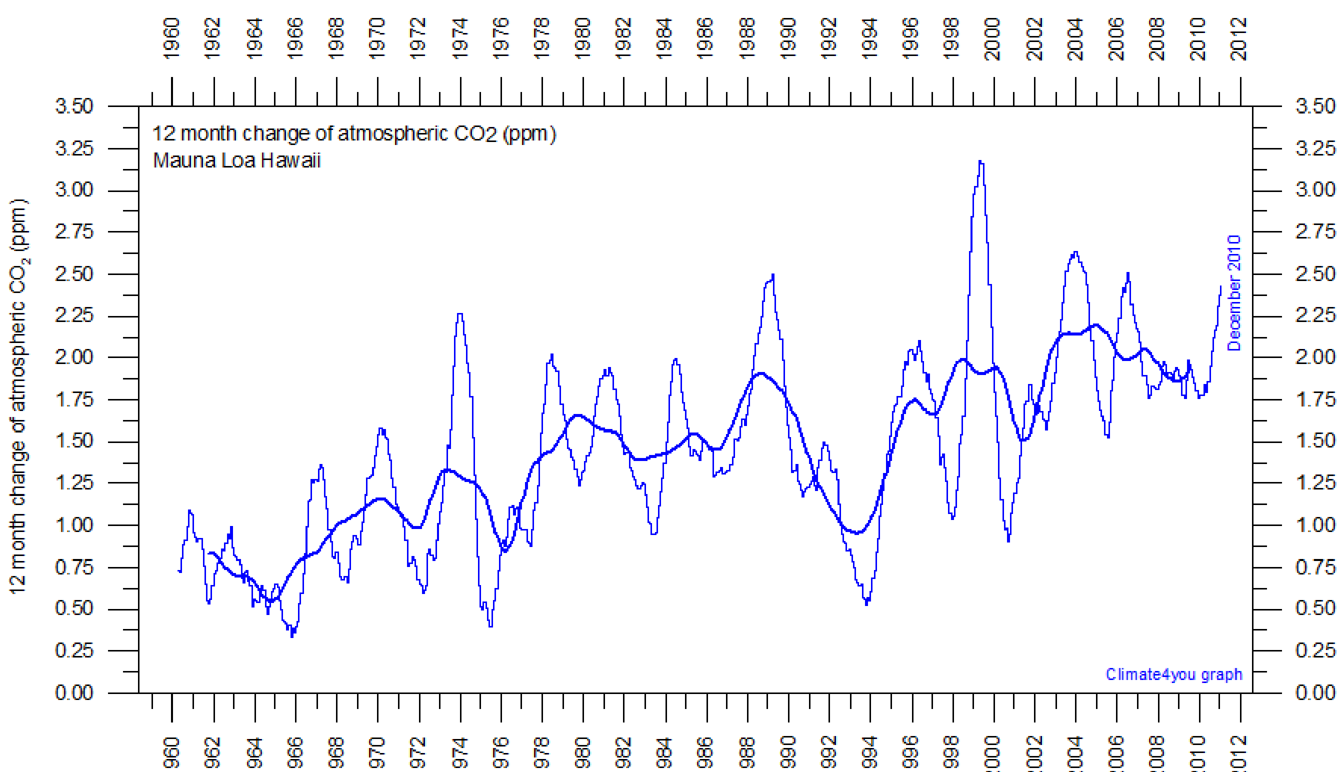
Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder], USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.



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.

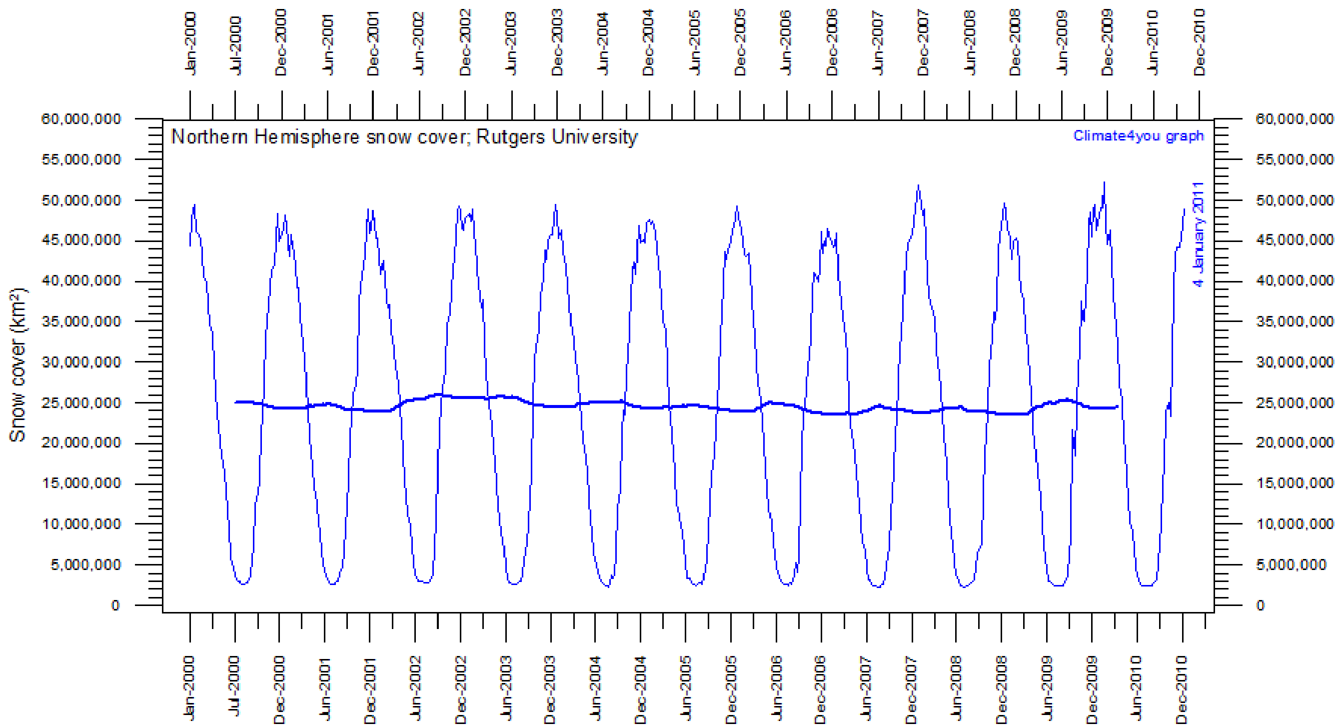
Atmospheric CO_2, updated to December 2010



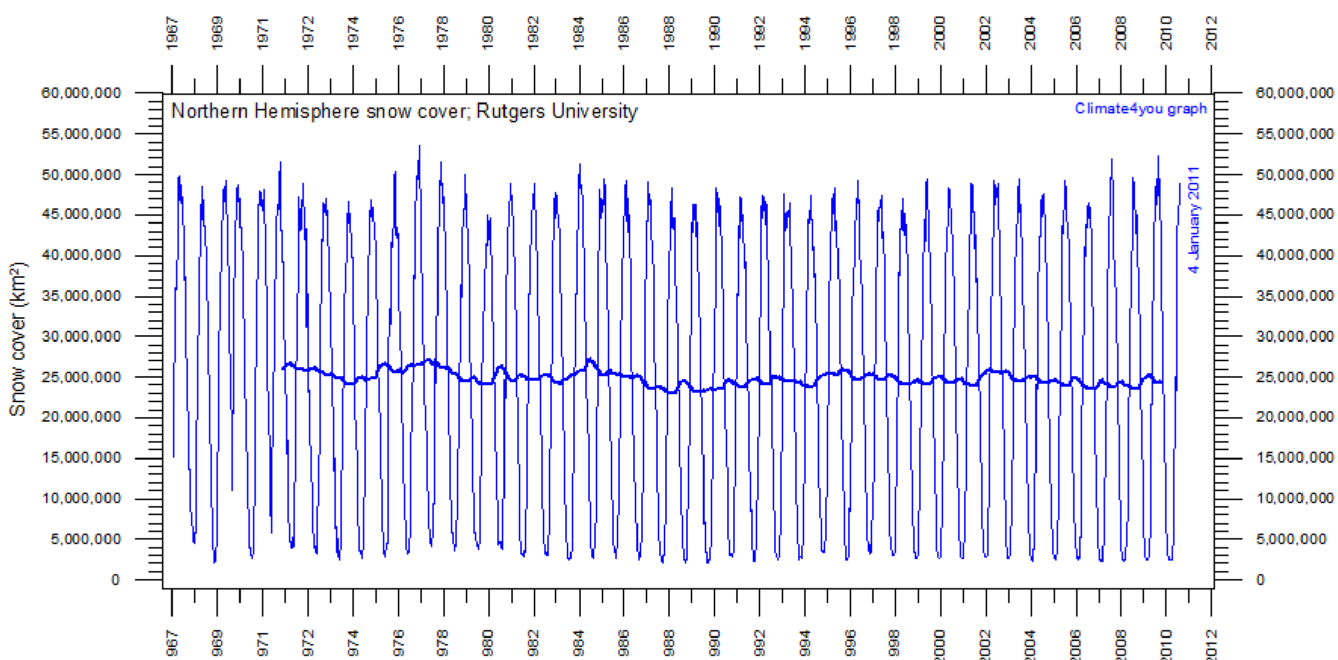


Monthly amount of atmospheric CO_2 (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO_2 since 1959, according to data provided by the [Mauna Loa Observatory](), Hawaii, USA. The thick line is the simple running 37 observation average, nearly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

Northern Hemisphere weekly snow cover, updated to early January 2011

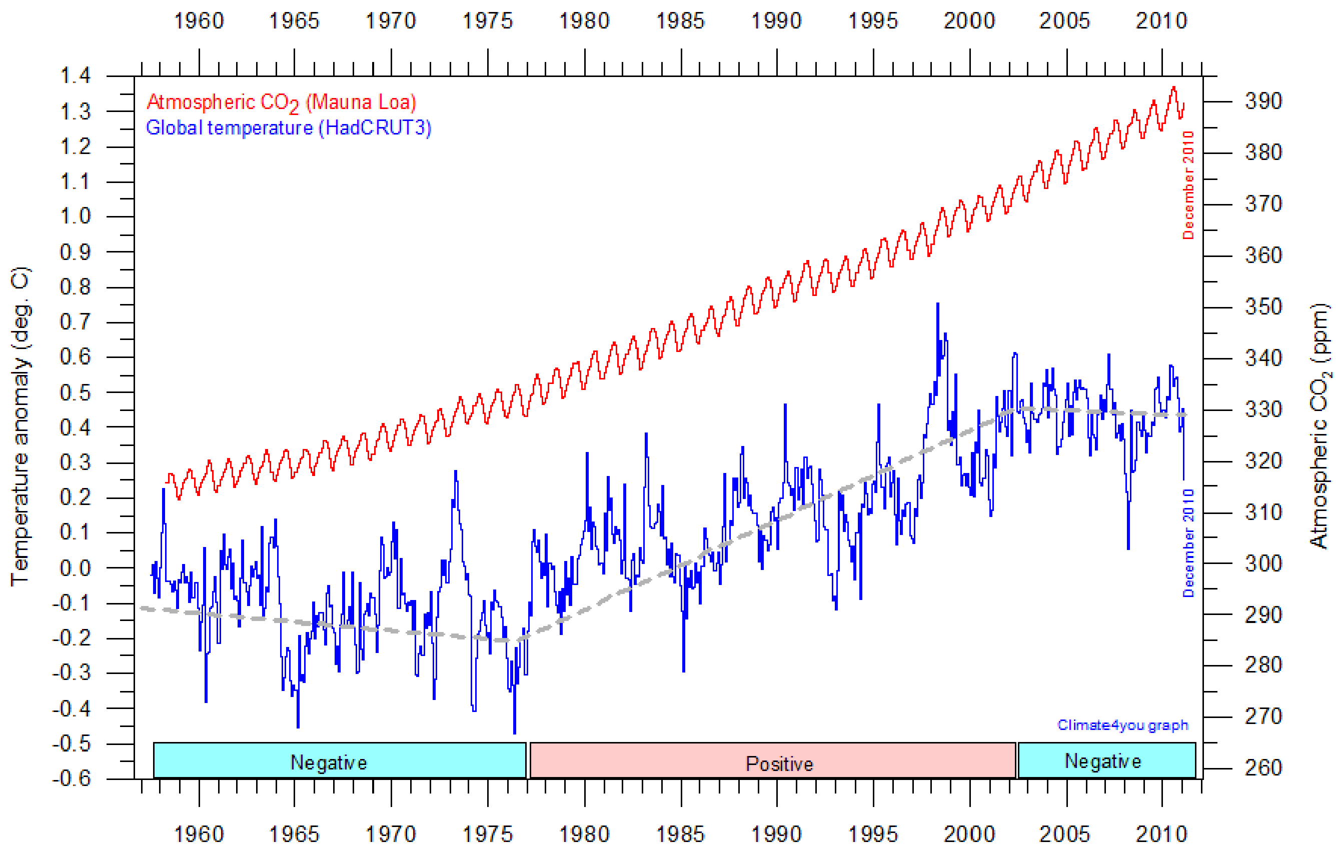


Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin line is the weekly data, and the thick line is the running 53 week average (approximately 1 year).



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 CO_2, updated to December 2010



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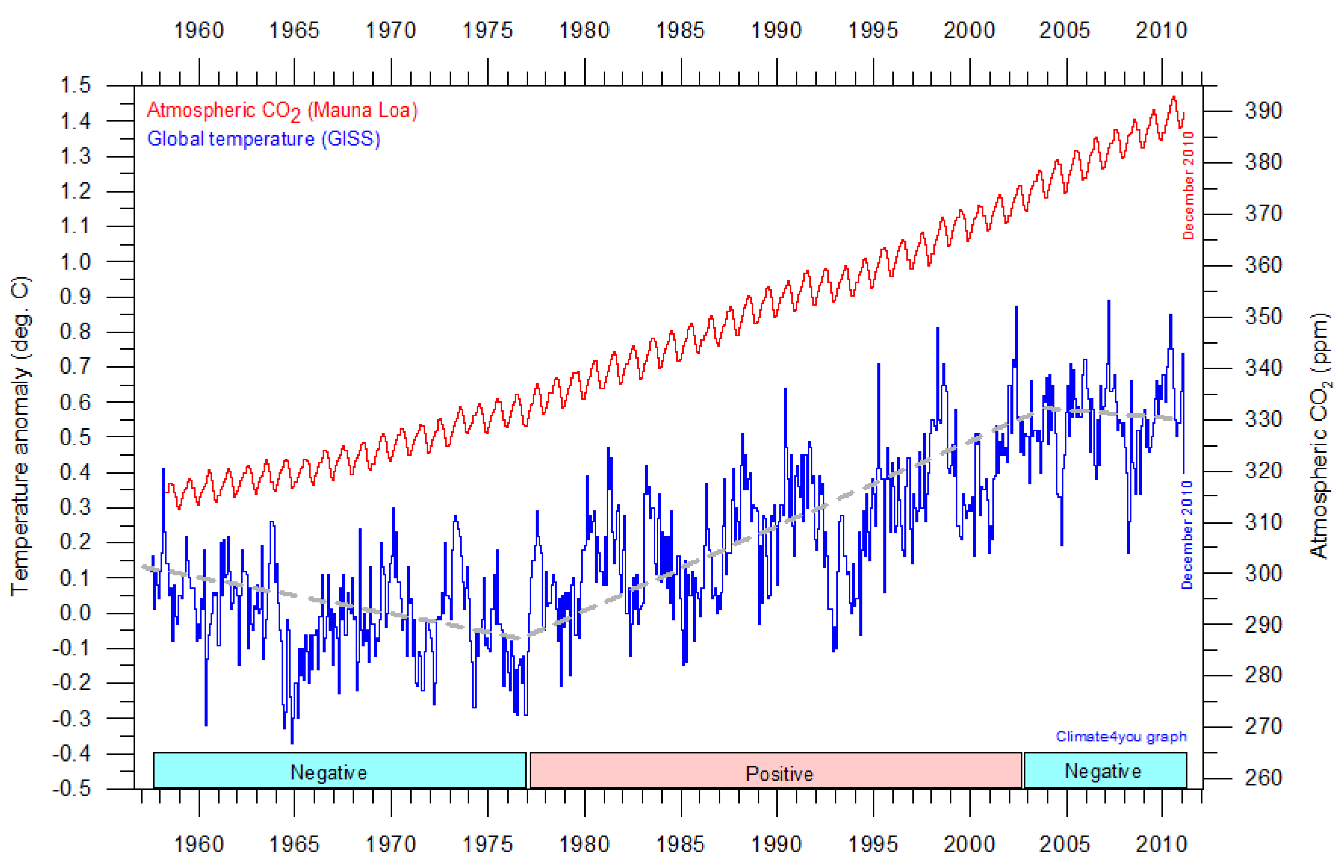
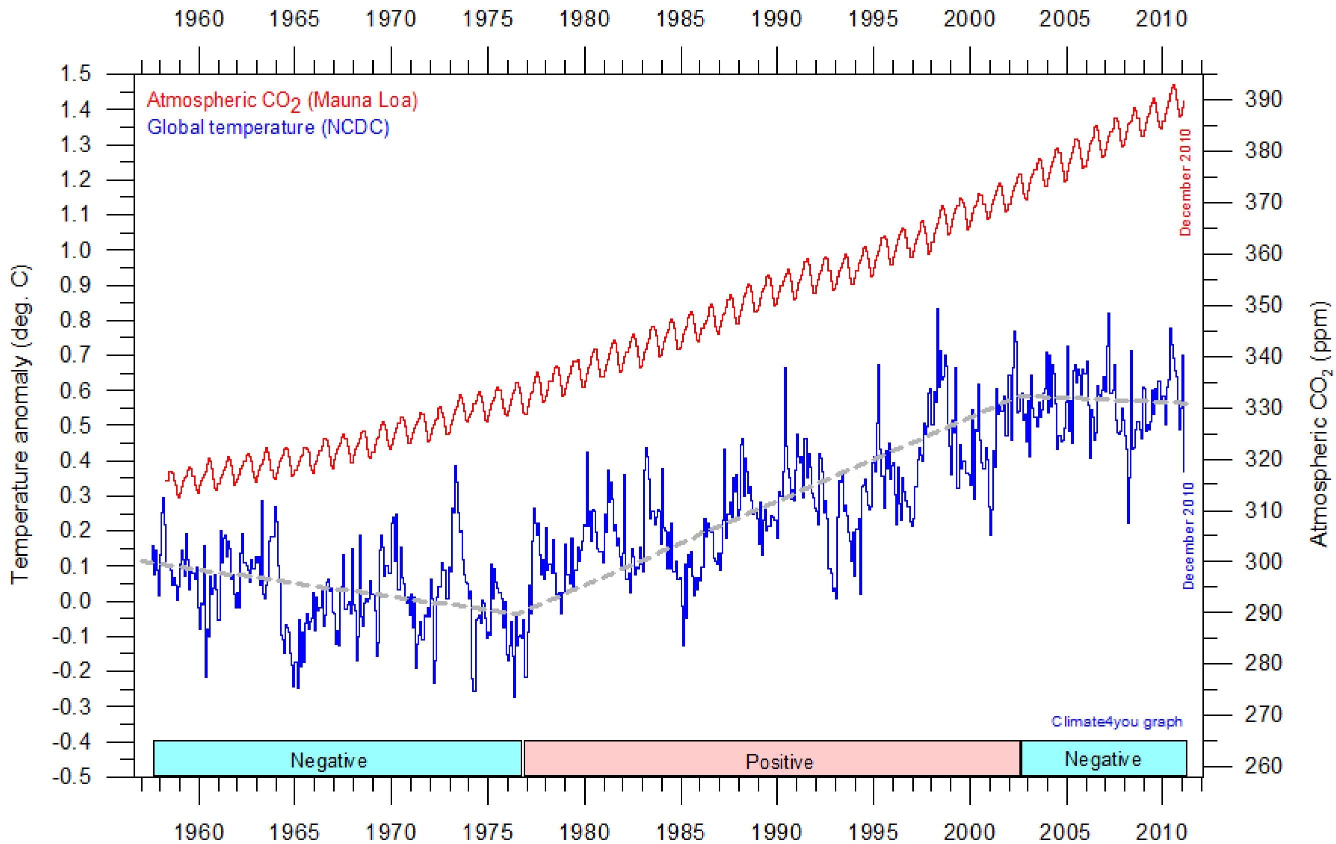




Diagrams showing HadCRUT3, GISS, and NCDC monthly global surface air temperature estimates (blue) and the monthly atmospheric CO_2 content (red) according to the [Mauna Loa Observatory](), Hawaii. The Mauna Loa data series begins in March 1958, and 1958 has therefore been chosen as starting year for 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 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 CO_2 and global surface air temperature, negative or positive.

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

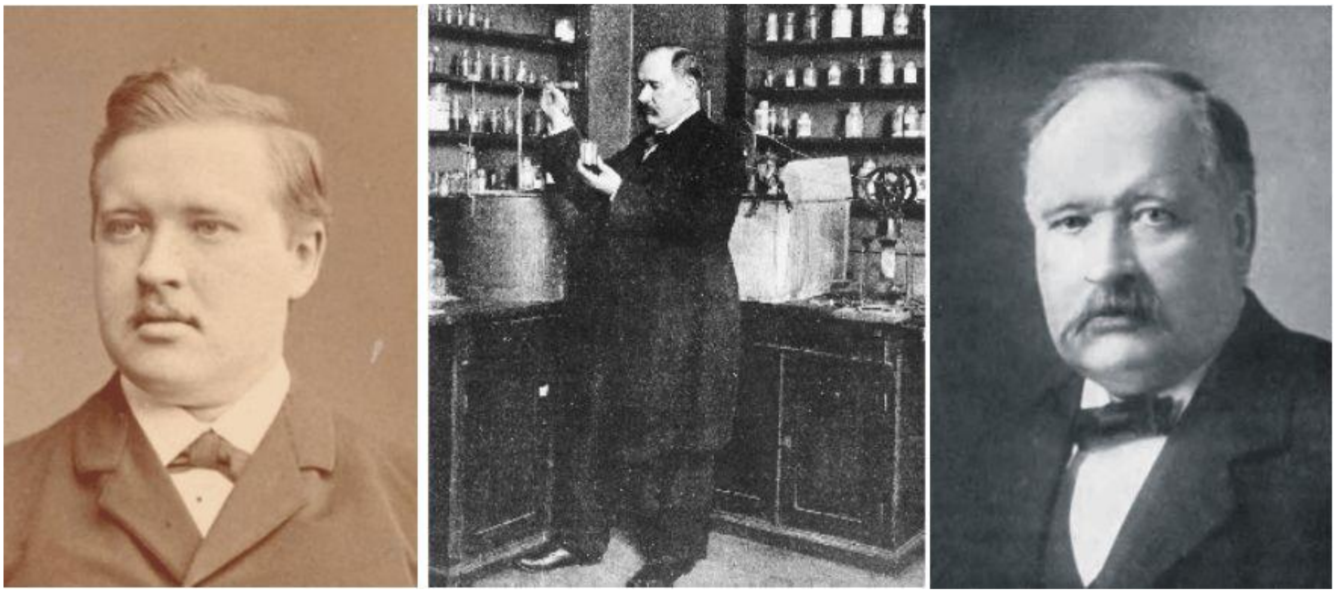
It is of cause equally inappropriate to present new meteorological record values, whether daily, monthly or annual, as support for the hypothesis ascribing high importance of atmospheric CO_2 for global temperatures. Any such short-period meteorological record value may well be the result of other phenomena than atmospheric CO_2.

What exactly defines the critical length of a relevant time period to consider for evaluating the alleged high importance of CO_2 remains elusive, and is still a topic for debate. The critical period length must, however, be inversely proportional to the importance of CO_2 on the global temperature, including feedback effects, such as assumed by most climate models. So if the effect of CO_2 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 CO_2 for global temperature. However, for obtaining public and political support for the CO_2-hyphotesis the 10 year warming period leading up to 1988 in all likelihood was 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 CO_2 has been indicated in the lower panels of the three diagrams above.

[Climate and history; one example among many]

1895: Arrhenius suggests that CO_2 may trigger glacial advances and retreats



Svante August Arrhenius around 1884 (left). Svante Arrhenius in his laboratory in Stockholm (centre), and Professor Arrhenius around 1920 (right).

Svante August Arrhenius (1859-1927) is best known as an electrochemist who, along with Wilhelm Ostwald and Jacobus Henricus van't Hoff, pioneered the theory of electrolytic dissociation (Fleming 1998).

He was born in 1859 near Uppsala in Sweden. In 1876 he entered Uppsala University, where he followed a broad curriculum, including mathematics, physics, chemistry, Latin, history, geology and botany. In 1881, Arrhenius left Uppsala because of problems in the Physics Department, and instead went to Stockholm. There he came to work at the Institute of Physics of the Swedish Academy of Sciences with Erik Edlund, a professor of physics who was interested in meteorology and who had ties to the Central Meteorological Office. Following the Crimean War (1853–1856) meteorology was becoming an issue of widespread scientific interest. In 1884 Arrhenius submitted his doctoral thesis on the chemical theory of electrolytes. The examination committee ignored certain theoretical aspects of this work, and did not award him the highest distinction. This was a severe blow to Arrhenius psyche and academic career, and he spends the next two years at home with his parents (Fleming 1998).

After a long postdoctoral period of six years and several unsuccessful candidacies, Arrhenius in 1891 obtained a lectureship in physics at the Stockholm Högskola (Stockholm College). In 1895 he became professor of physics at the same place. He was elected to the Swedish Academy in 1901, and his work on the electrolytic theory of dissociation earned him the Nobel Price for Chemistry in 1903. In late 1925 he suffered a stroke, and died in Stockholm after a brief illness on 2 October 1927.

Arrhenius was interested in general geophysics, although he did little experimental or observational work in geophysics. His basic approach was to apply physical and chemical principles to make sense of existing empirical observations. But as his grandson and biographer, Gustav O. S. Arrhenius, pointed out, "*theoretical explanations of poorly known natural systems display a high mortality rate when confronted with accumulating evidence*." Such was the general fate of Arrhenius's geophysical work, which served mainly as a catalyst for the more empirically based investigations of other scientists (Fleming 1998).

In 1895, while he was living home with his parents, he prepared a paper in which he suggested that a reduction or increase of about 40% in atmospheric CO_2 might trigger feedback phenomena that could account for glacial advances and retreats during ice ages. As a result of Louis Agassiz's visit in Scotland, the glacial hypothesis had gradually gained support and general acceptance since 1850, which was the background for Arrhenius's interest in ice ages. The paper was presented to the Stockholm Physical Society, and published the following year (1896) under the title "*On the Influence of Carbonic Acid in the Air upon the temperature of the Ground*." In this paper he developed an energy budget for planet Earth, relying, among others, on the work of Josef Stefan's new law that radiant emission was proportional to the fourth power of temperature, and Samuel P. Langley's measurements of the transmission of heat radiation through the atmosphere.

Arrhenius in the 1895 paper made a number of very rough estimates of surface and cloud albedo and included simple radiative feedback effects in the presence of snow on the ground. At the same time, for simplicity, he ignored the effects of variations in horizontal heat transport and in the global cloud cover. Also the spectroscopic information available to Arrhenius was quite primitive. Arrhenius himself stated that for wavelengths greater than 9.5 microns, "*we possess no direct observations on the emission or absorption of the two gasses (water vapour and CO_2)*".

Arrhenius argued that variations in trace components (including CO_2) of the atmosphere could have a significant effect on the overall planetary heat budget. Using the best data available at that time, and making a number of simplifying assumptions (see above), he calculated the theoretical effect on the global temperature for a number of theoretical situations with reduction or increase in atmospheric CO_2. Being primarily interested in the background for the onset of glaciations, he concluded that the temperature of the Arctic regions would rise about 8-9^{o}C, if atmospheric CO_2 increases to between 2.5 and 3 times its present value (Fleming 1998). Arrhenius understandably had a special interest in the modern Arctic regions, as he along with many contemporary scientists assumed that this was where future glaciations would initiate.

It is important to remember that Arrhenius was addressing the likely cause of the - at that time - newly accepted concept of "Ice Ages". From the onset, he showed little interest in the potential influence of human activity on the future chemical composition of the atmosphere. Instead, he wanted to evaluate the likelihood of great variations in atmospheric CO_2 in relatively short geological times. For that reason he extensively referred to the research findings of his good friend and colleague, the Swedish geologist Arvid Gustav Högbom, who had worked on the geochemistry of carbon for several years. From Högbom's perspective, neither the combustion of fossil fuels nor the removal of organic carbon (deforestation) influenced atmospheric CO_2 nearly as much as the different geological processes (Fleming 1998). Later, Arrhenius speculated about the potential warming effect of CO_2 emitted by industry. On the time scale of hundreds to thousands of years, he thought that burning fossil fuels could help prevent a rapid return to the conditions of an ice age (Fleming 1998).

References:

Fleming, J.R. 1998. *Historical Perspectives on Climate Change*. Oxford University Press, 194 pp.

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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