Climate4you update December 2011

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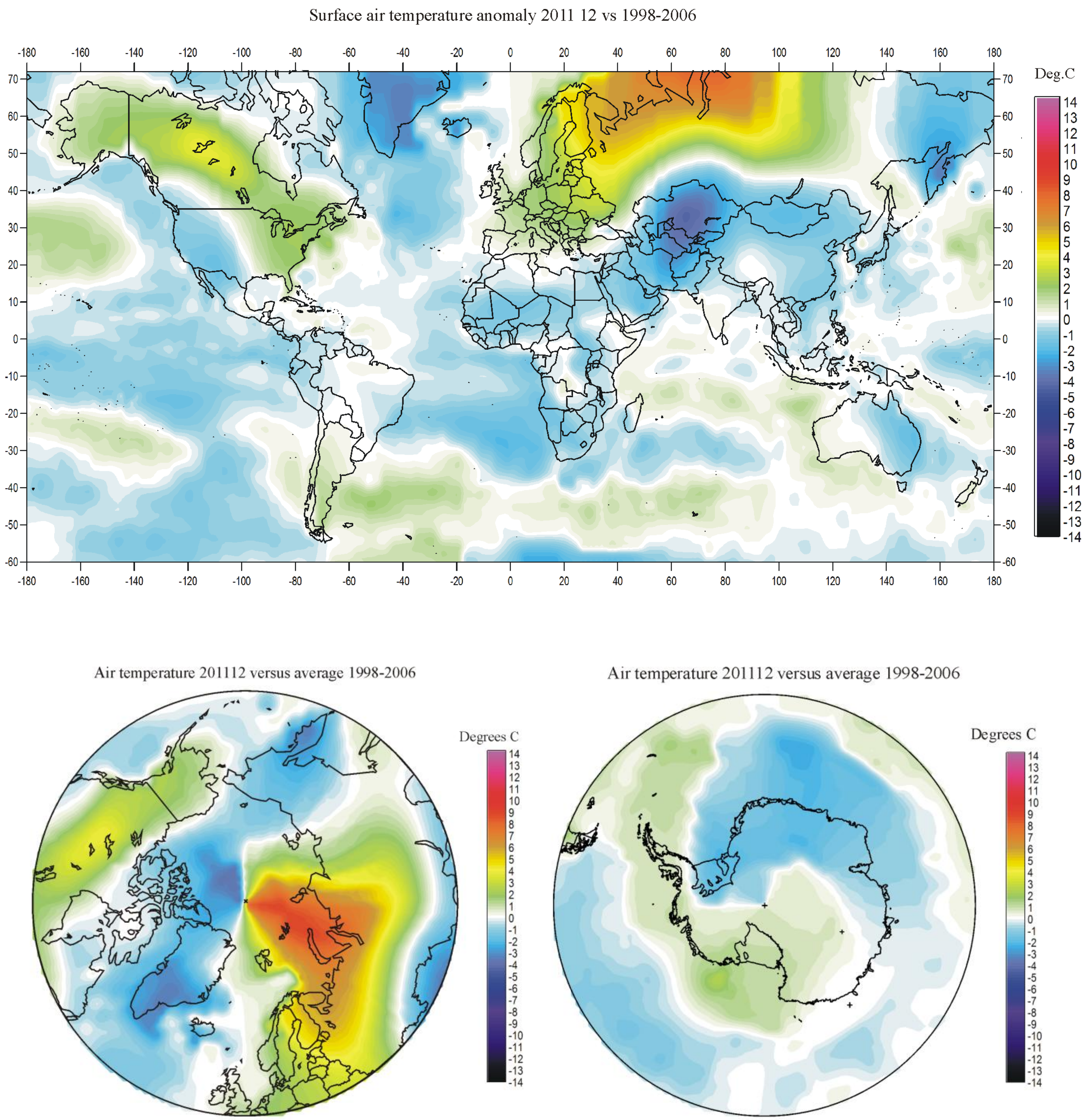
December 2011 global surface air temperature overview



December 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://data.giss.nasa.gov/gistemp/) (GISS)

Comments to the December 2011 global surface air temperature overview

General: This newsletter contains graphs showing a selection of key meteorological variables for the past month. *All temperatures are given in degrees Celsius*.

In the above maps showing the geographical pattern of surface air temperatures, *the period 1998-2006 is used as reference period*. The reason for comparing with this recent period instead of the official WMO 'normal' period 1961-1990, is that the latter period is affected by the relatively cold period 1945-1980. Almost any comparison with such a low average value will therefore appear as high or warm, and it will be difficult to decide if and where modern surface air temperatures are increasing or decreasing at the moment. Comparing with a more recent period overcomes this problem. In addition to this consideration, the recent temperature development suggests that the time window 1998-2006 may roughly represent a global temperature peak. If so, negative temperature anomalies will gradually become more and more widespread as time goes on. However, if positive anomalies instead gradually become more widespread, this reference period only represented a temperature plateau.

In the other diagrams in this newsletter *the thin line represents the monthly global average value*, and *the thick line indicate a simple running average*, in most cases a simple moving 37-month average, nearly corresponding to a three year average. The 37-month average is calculated from values covering a range from 18 month before to 18 months after, with equal weight for every month.

The year 1979 has been chosen as starting point in many diagrams, as this roughly corresponds to both the beginning of satellite observations and the onset of the late 20th century warming period. However, several of the records have a much longer record length, which may be inspected in grater detail on www.Climate4you.com.

The average global surface air temperatures December 2011:

General: Surface air temperatures were relatively low in most regions.

The Northern Hemisphere was characterised by high regional variability. Eastern Europe and northern Russia had above average temperatures, while especially the northwestern part of the North Atlantic region (incl. Greenland) experienced below average temperatures. Arctic temperature changes in a longer perspective can be studied on page 12-14.

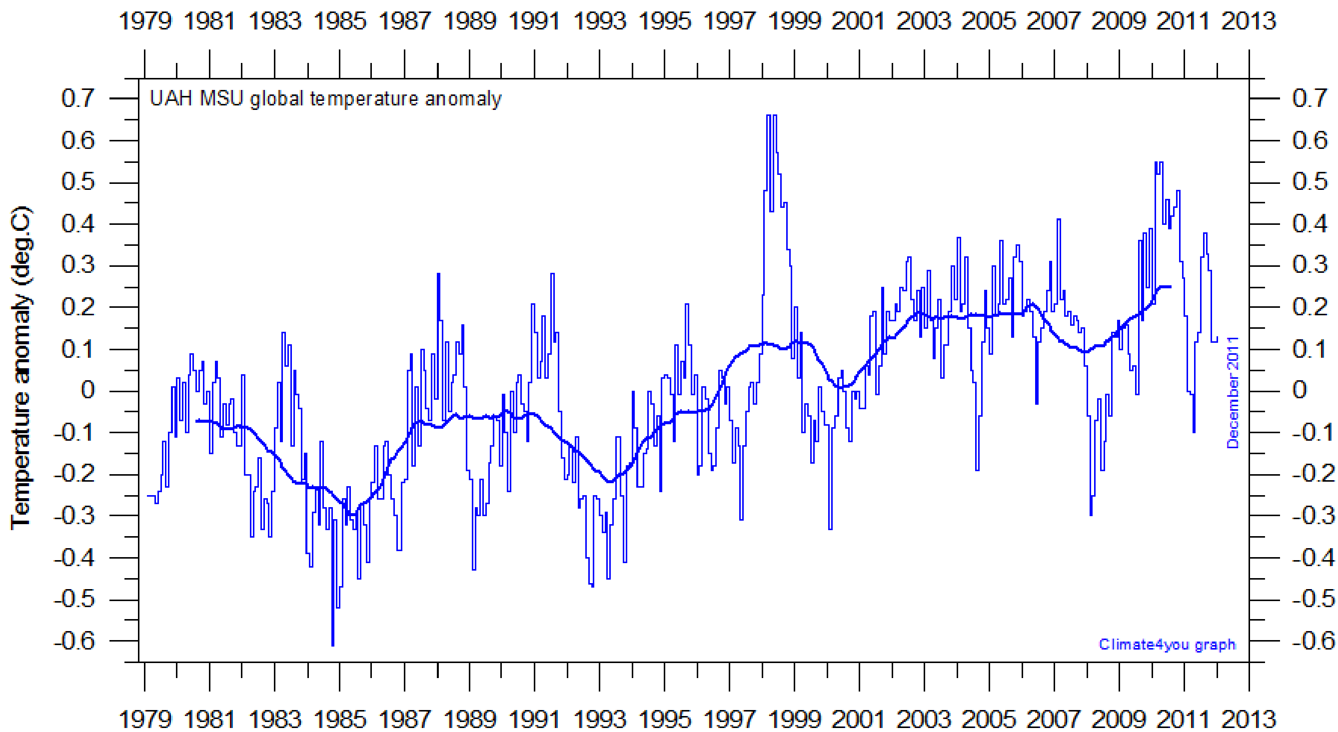
Near Equator temperatures conditions in general were below average 1998-2006 temperature conditions.

The Southern Hemisphere was below or near average 1998-2006 conditions. Only the southern part of South America experienced average temperatures somewhat above the 1998-2006 average. With the exception of the Antarctic Peninsula, the Atlantic part of the Antarctic continent experienced below average temperatures, while the Pacific part had above average temperatures. Antarctic temperature changes in a longer perspective can be studied on page 12-13.

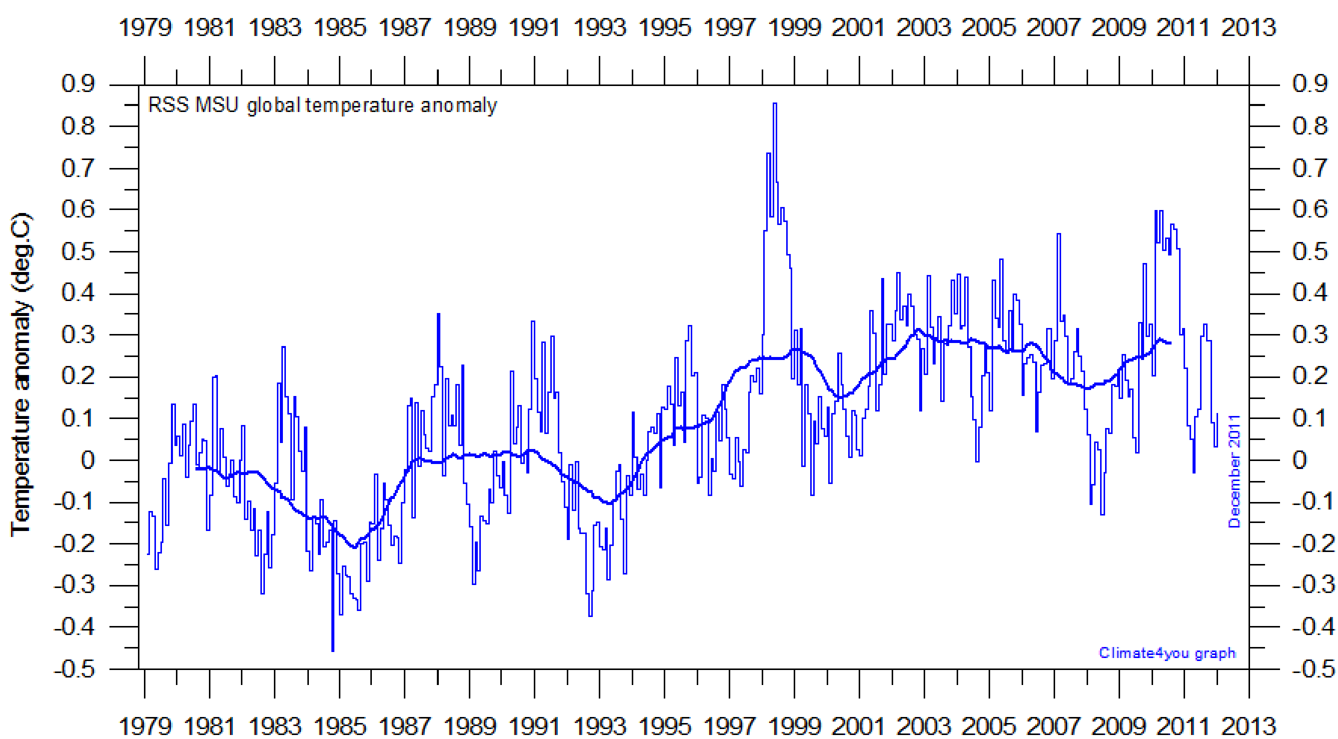
The global oceanic heat content has been almost stable since 2003/2004, although the latest update July-September 2011 suggests a possible new temperature increase (page 10).

The global sea level has not been changing very much since 2009 (page 17; updated to September 2012).

Lower troposphere temperature from satellites, updated to December 2011

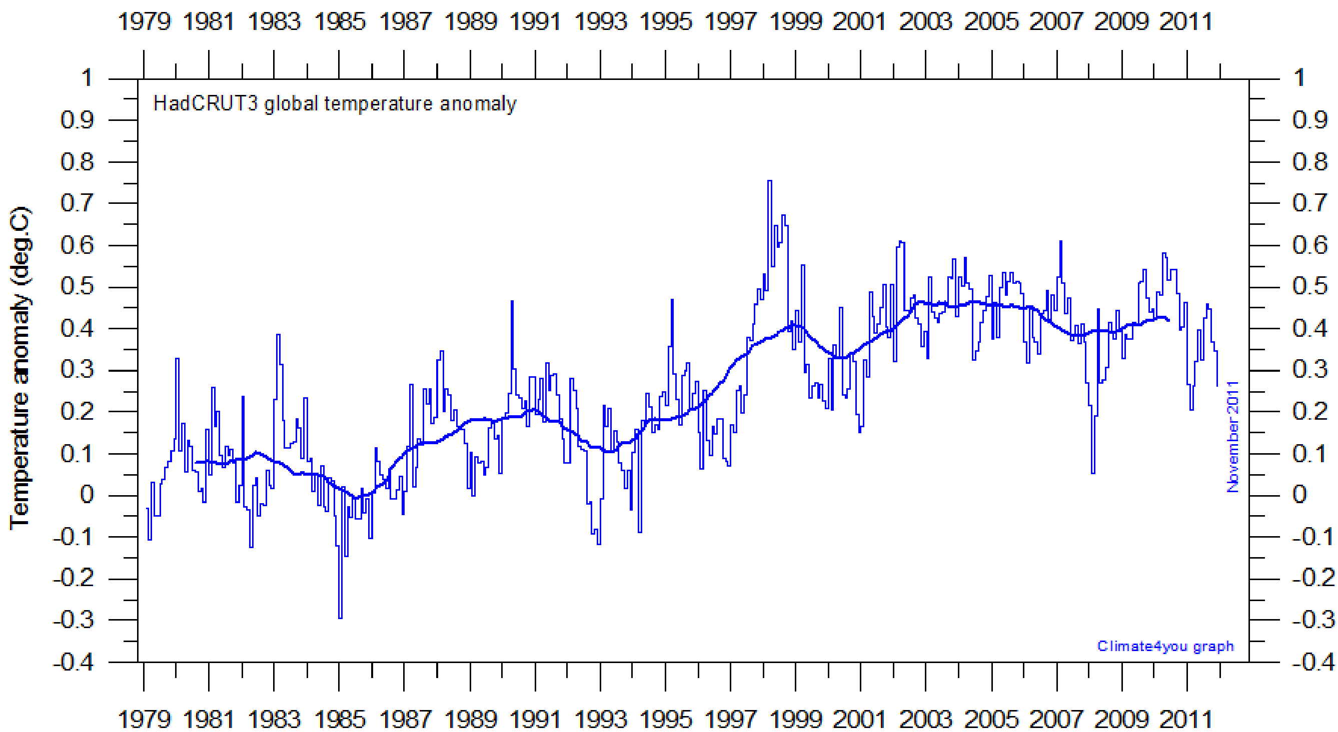


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37 month average.

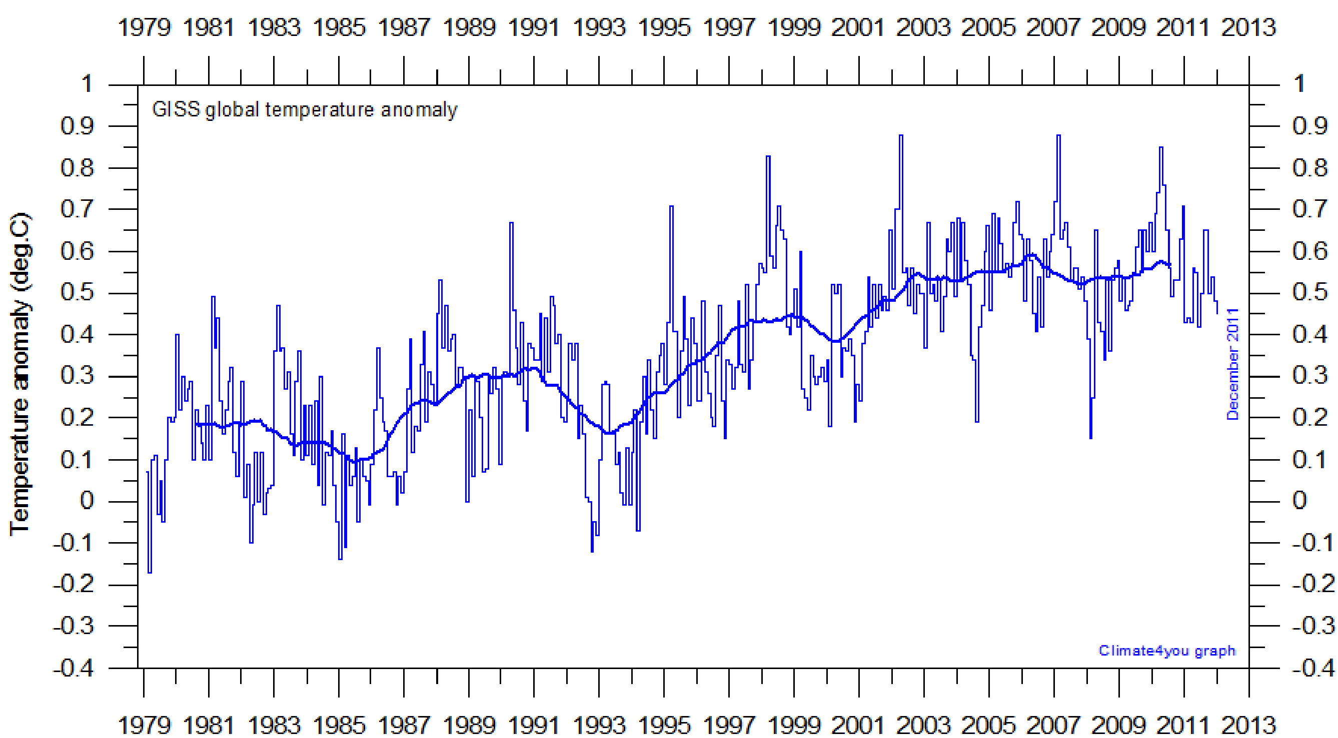


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37 month average.

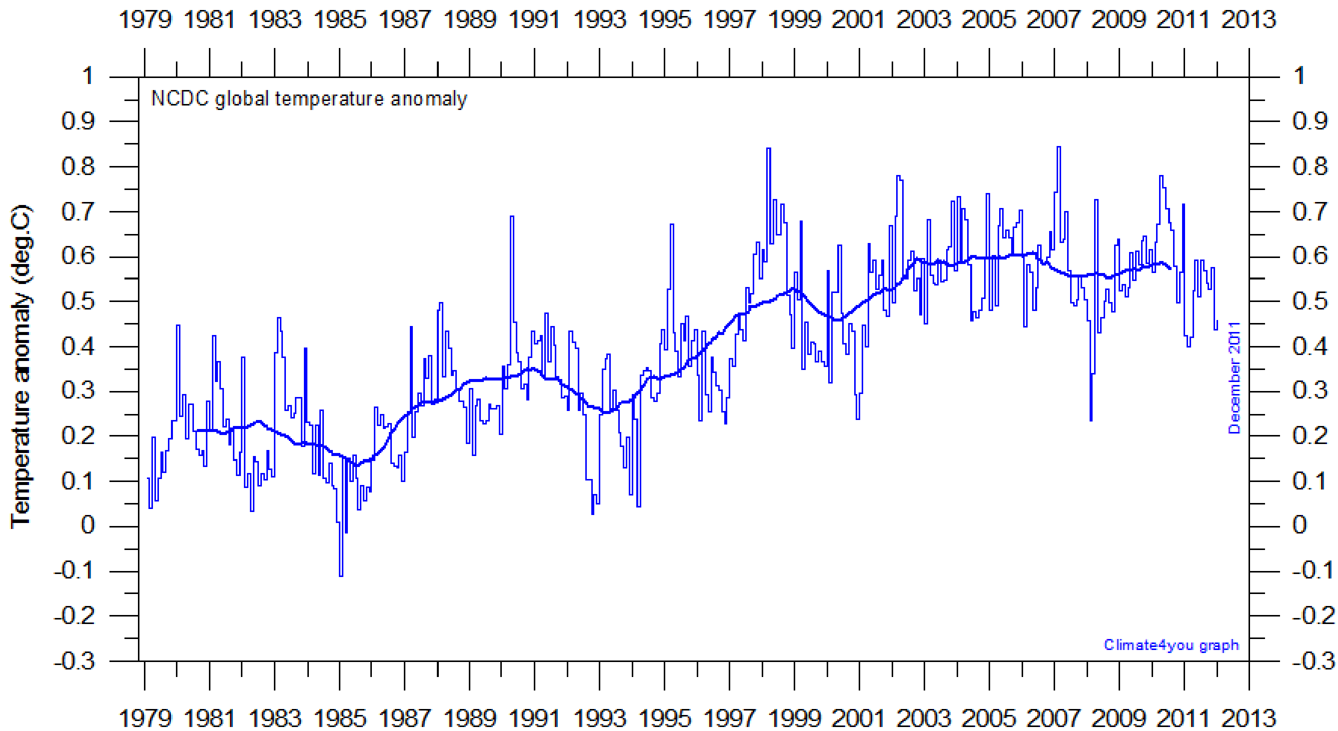
Global surface air temperature, updated to December 2011



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 this diagram has not been updated beyond November 2011.



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



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

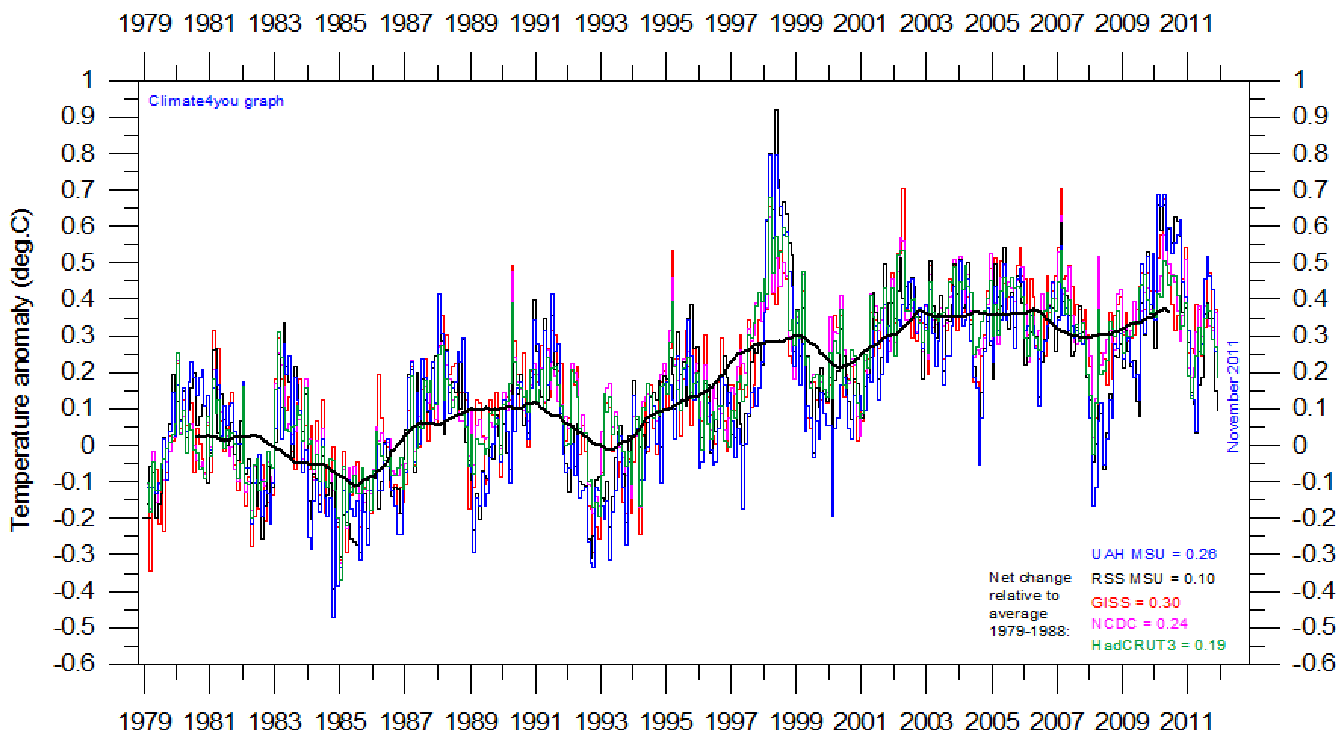
<u>A note on data record stability:</u>

All the above temperature estimates display changes when one compare with previous monthly data sets, not only for the most recent months as a result of additional data being added, but actually for all months back to the very beginning of the records. Presumably this reflects recognition of errors and changes in the averaging procedure followed.

The most stable temperature record over time of the five global records shown above is the HadCRUT3 series.

You may find more on the issue of temporal stability (or lack of this) on [www.climate4you](#) (go to: *Global Temperature*, followed by *Temporal Stability*).

[All in one, updated to November 2011]

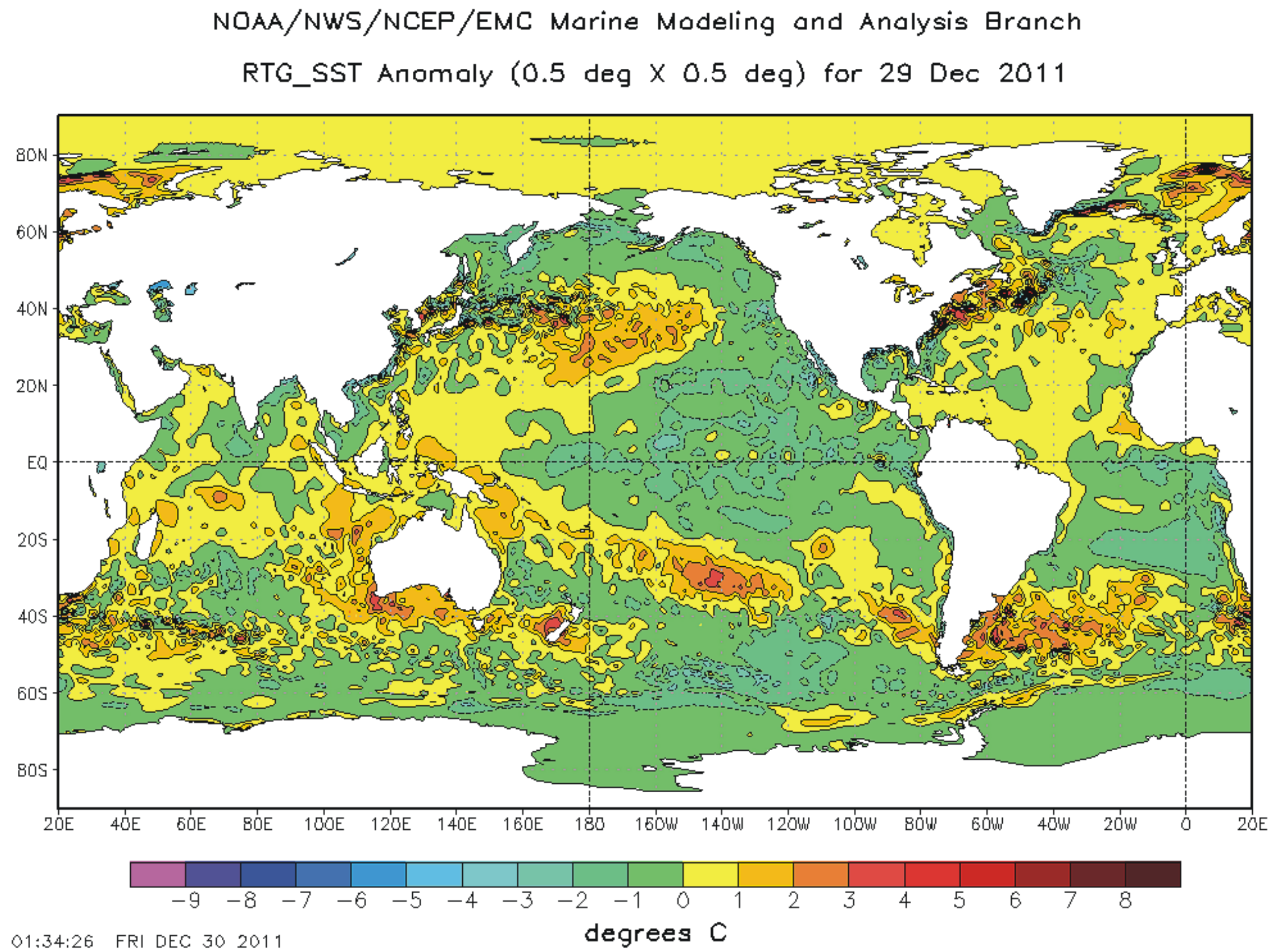


Superimposed plot of all five global monthly temperature estimates shown above. As the base period differs for the different temperature estimates, they have all been normalised by comparing to the average value of their initial 120 months (10 years) from January 1979 to December 1988. The heavy black 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 1979-1988 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 stagnation does not exclude the possibility that global temperatures will begin to increase again later. On the other hand, it also remain a possibility that Earth just now is passing a temperature peak, and that global temperatures will begin to decrease within the coming years. Time will show which of these two possibilities is correct.

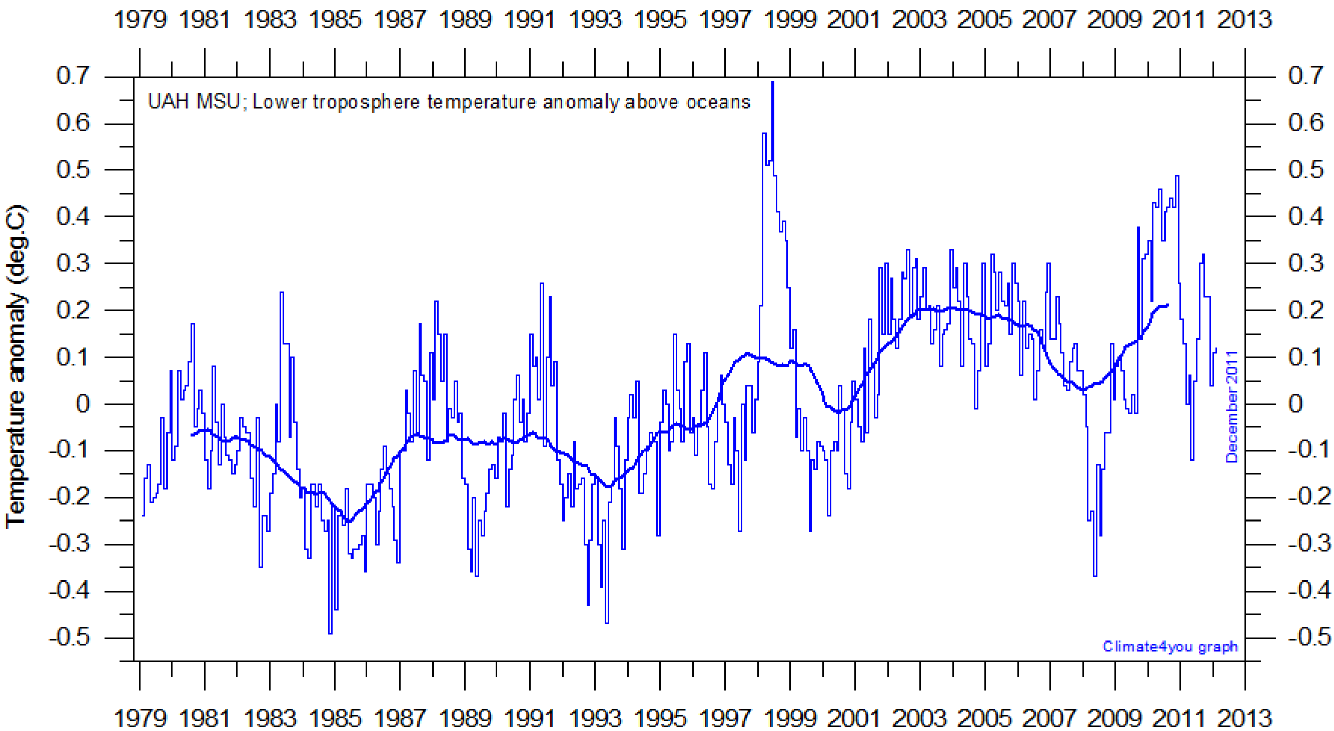
Global sea surface temperature, updated to the end of December 2011



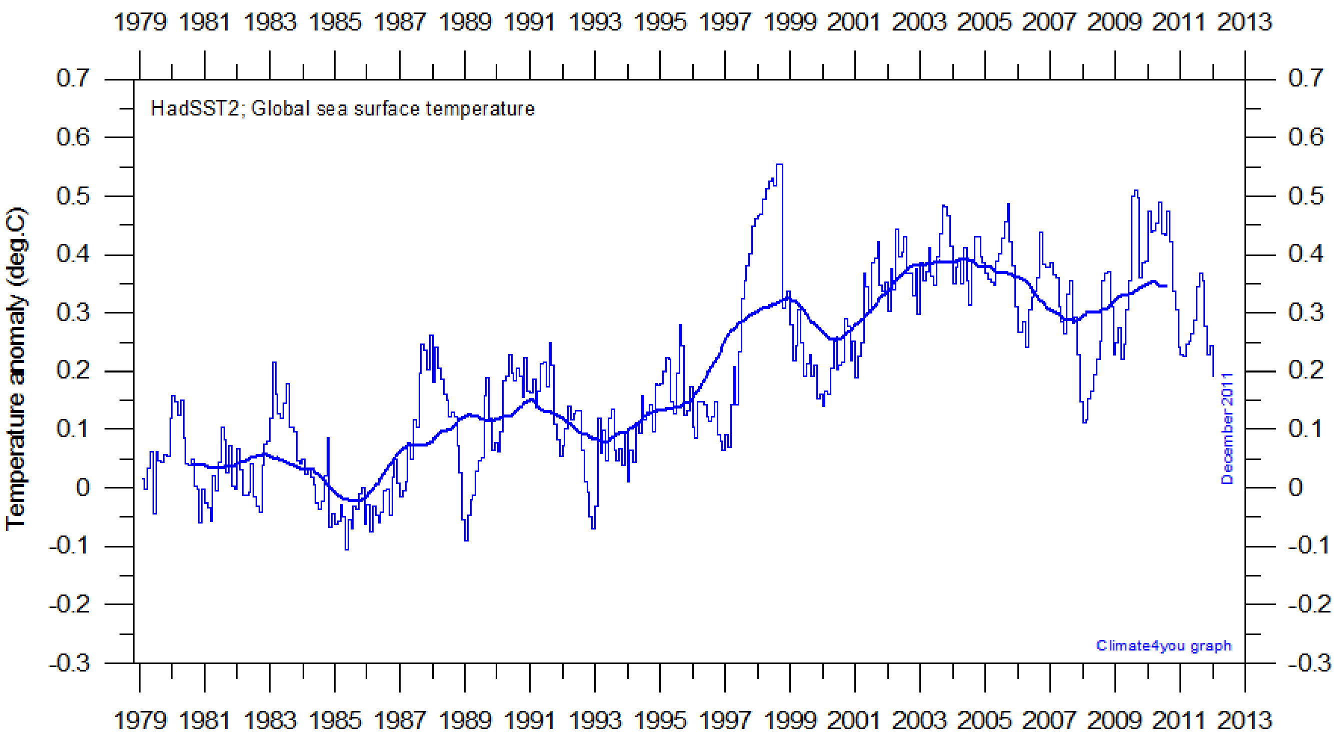
Sea surface temperature anomaly at 29 December 2011. Map source: National Centers for Environmental Prediction (NOAA).

Relative cold sea surface water dominates the southern hemisphere and the regions near Equator. Because of the large surface areas involved especially near Equator, the temperature of the surface water in these regions affects the global atmospheric temperature.

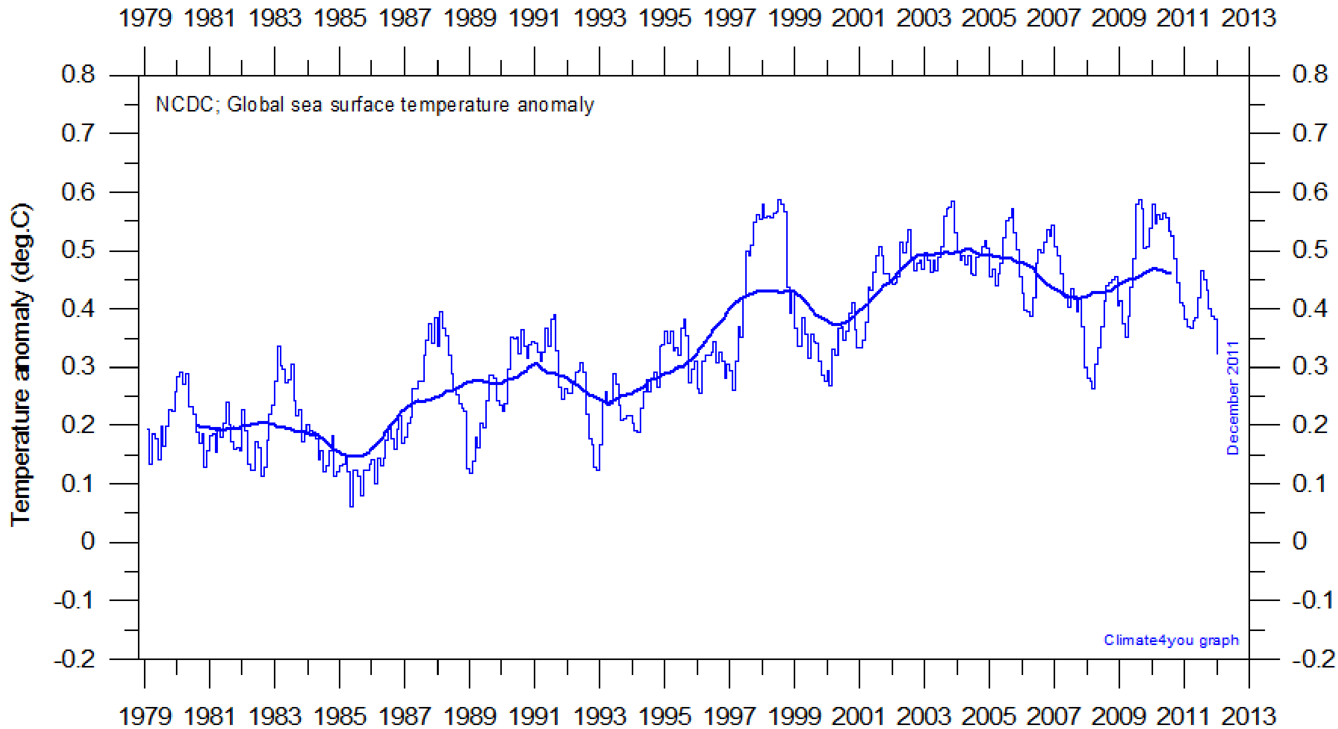
The significance of any short-term warming or cooling seen in surface air temperatures should not be over stated. Whenever Earth experiences cold La Niña or warm El Niño episodes (Pacific Ocean) major heat exchanges takes place between the Pacific Ocean and the atmosphere above, eventually showing up in estimates of the global air temperature. However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, net changes may be small, as heat exchanges as the above mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when seen over a number of years.



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

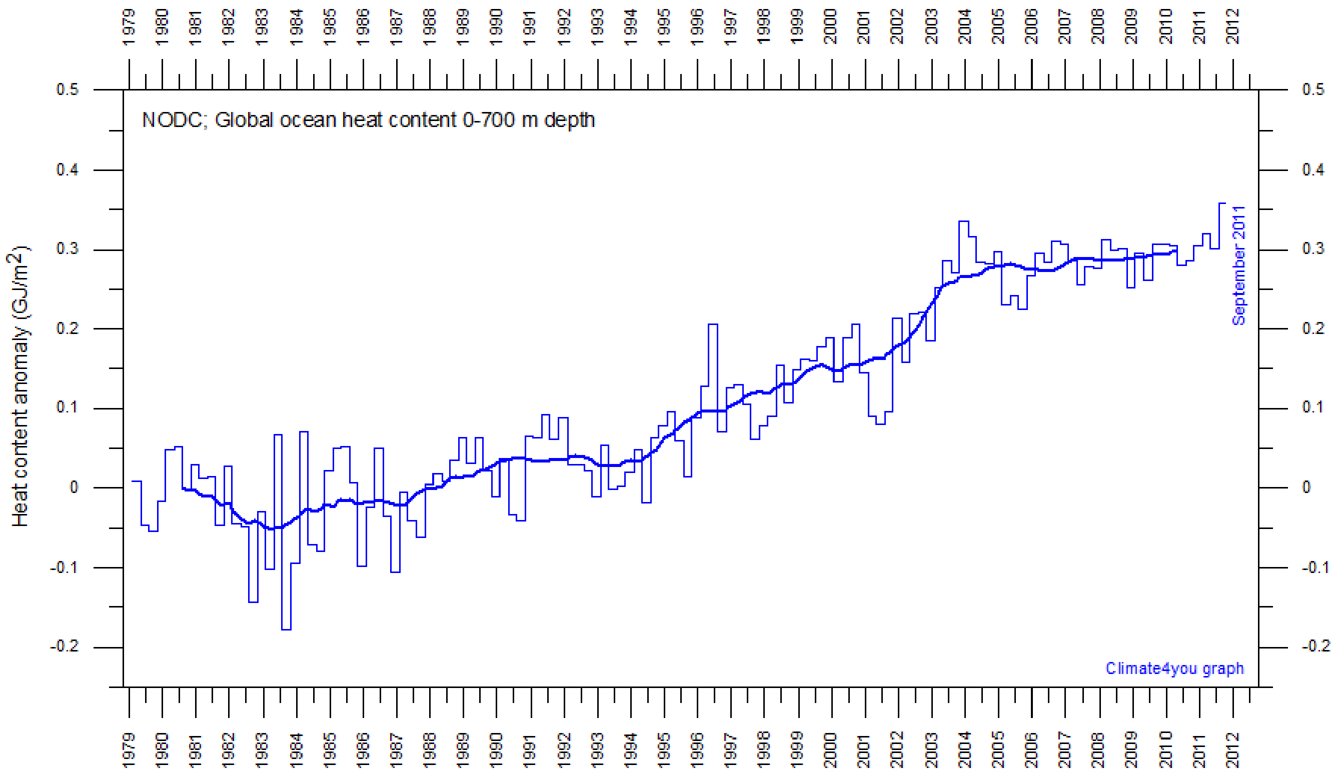


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit](#) ([CRU](#)), UK. Base period: 1961-1990. The thick line is the simple running 37 month average.

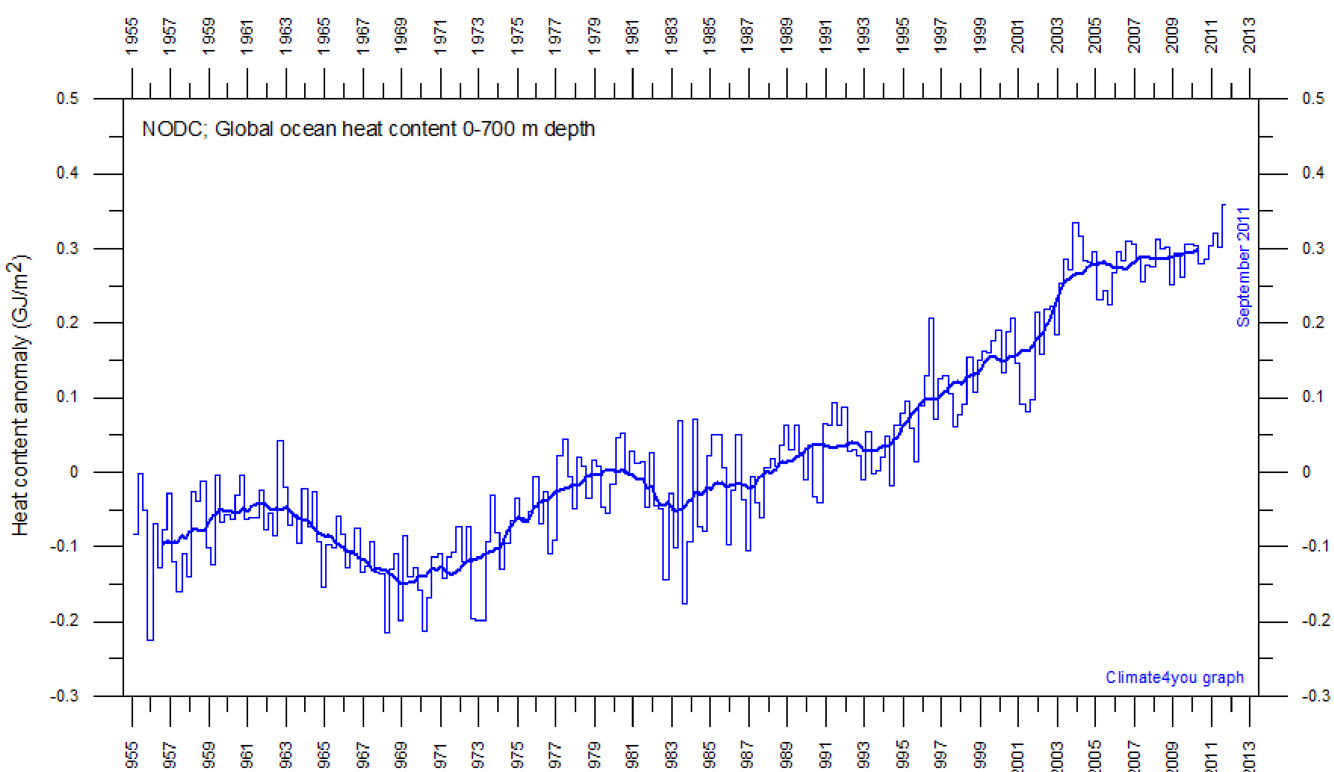


Global monthly average sea surface temperature since 1979 according to the National Climatic Data Center (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37 month average.

Global ocean heat content, updated to September 2011

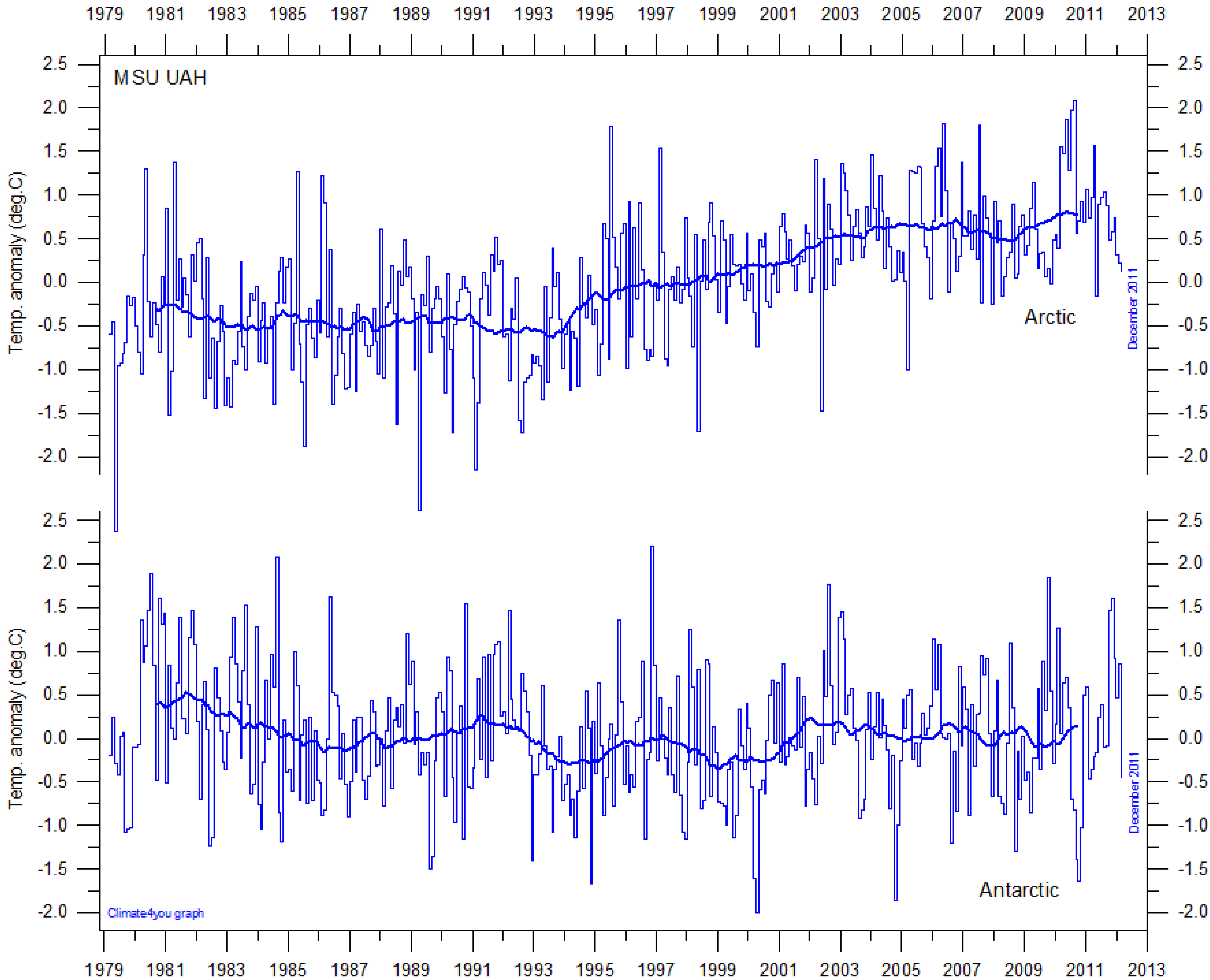


Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



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 2011



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 2011]

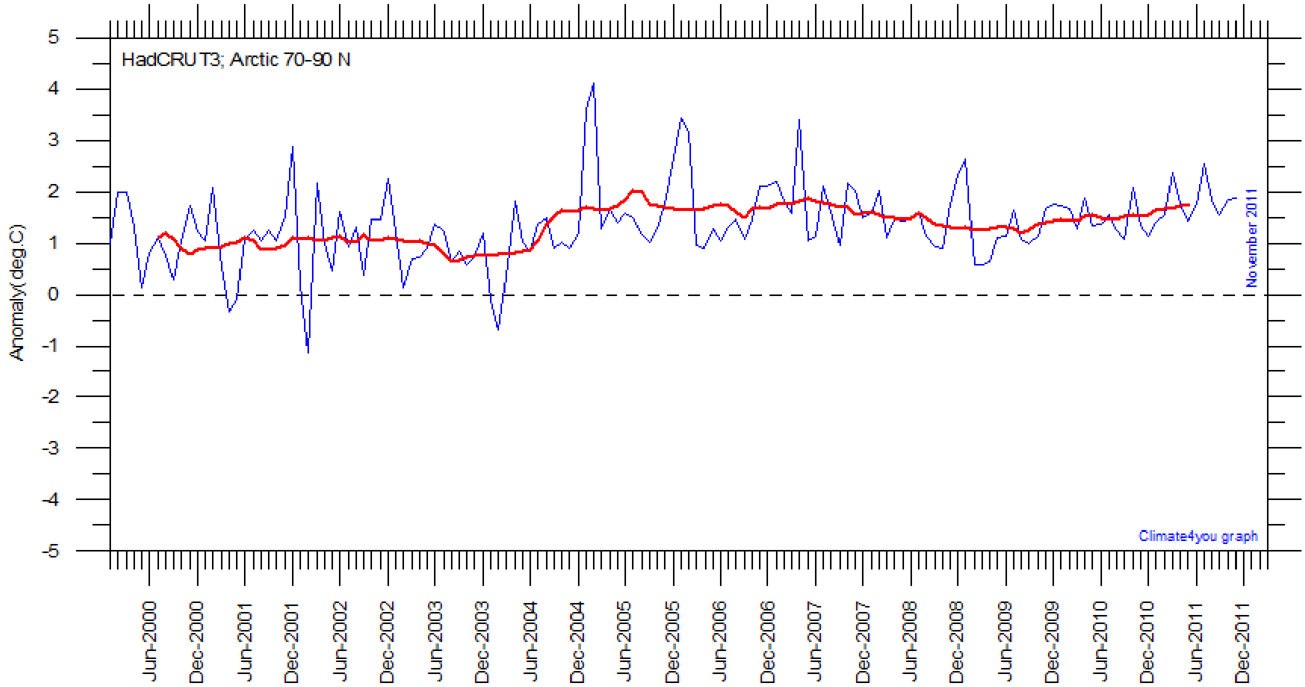


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre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

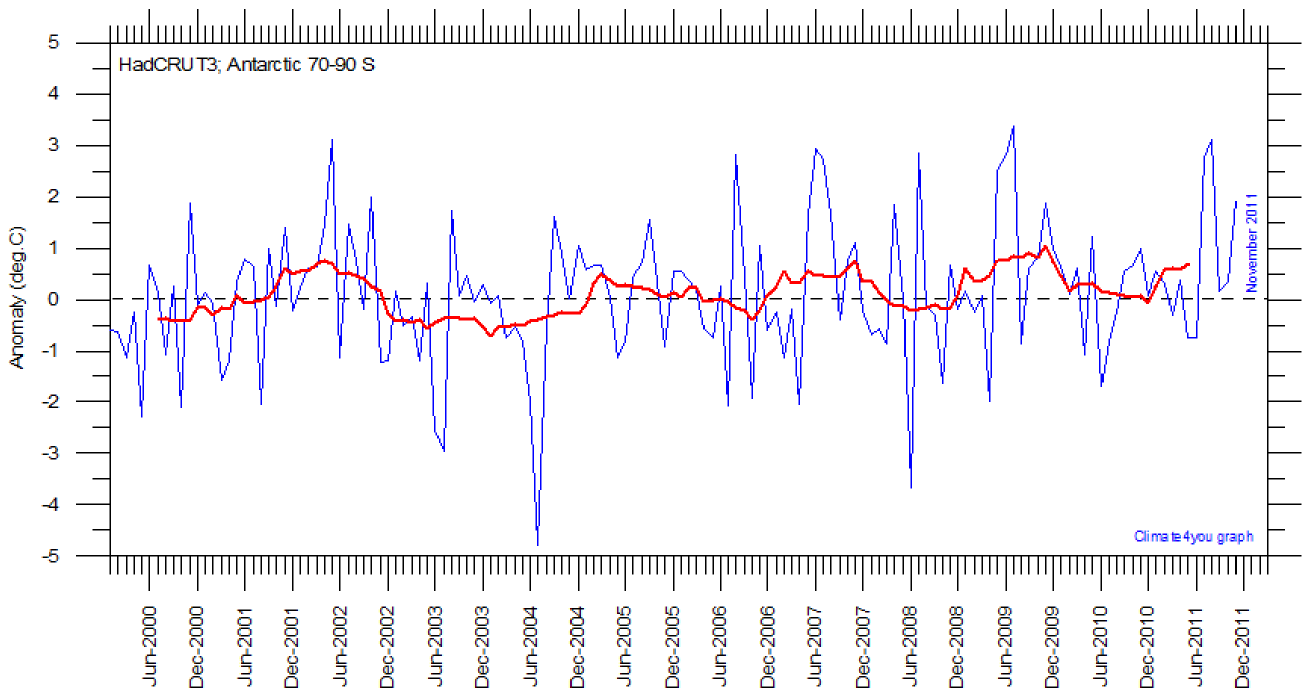


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley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

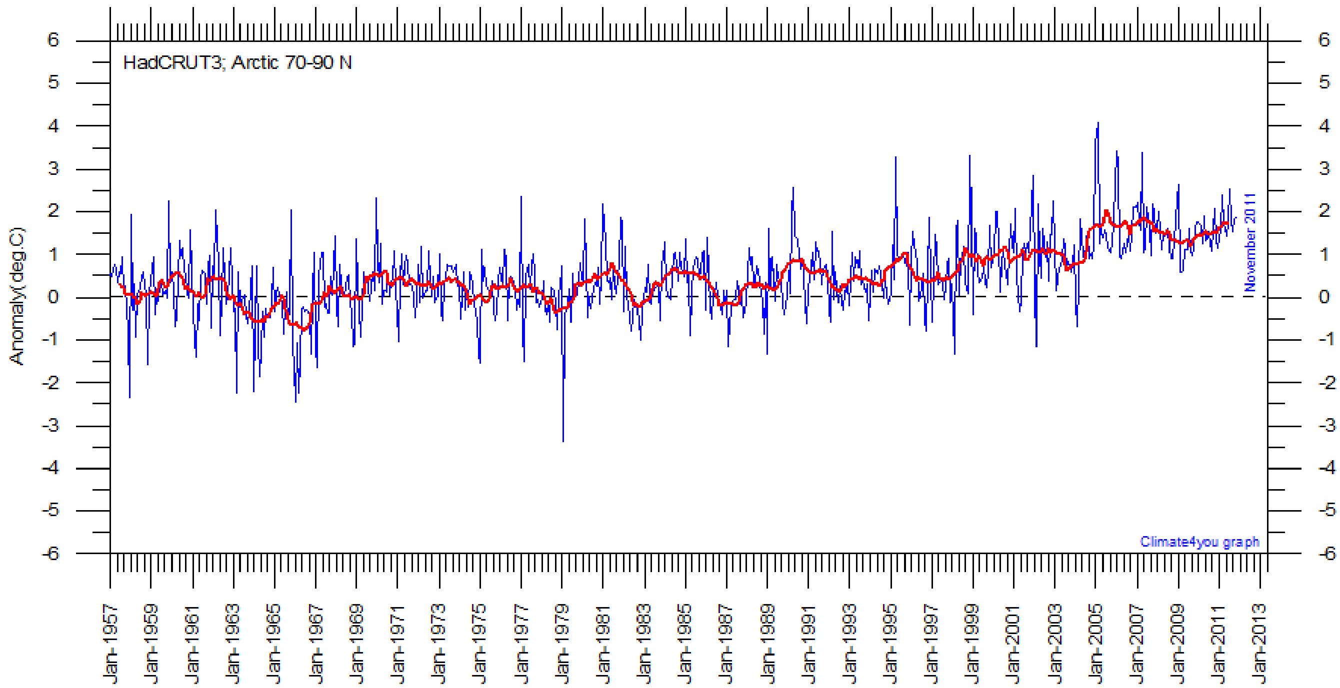


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 has been chosen as starting year, to ensure easy comparison with the maximum length of the realistic Antarctic temperature record shown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

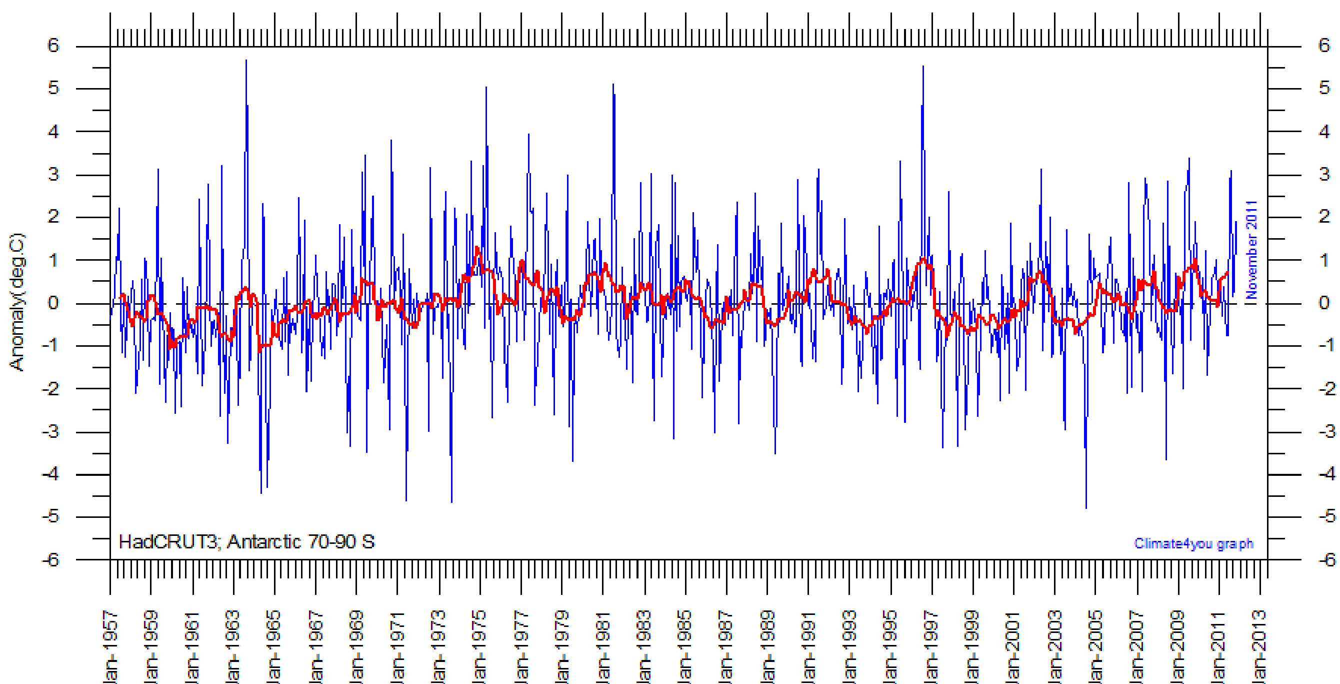


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 was an international geophysical year, and several meteorological stations were established in the Antarctic because of this. Before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

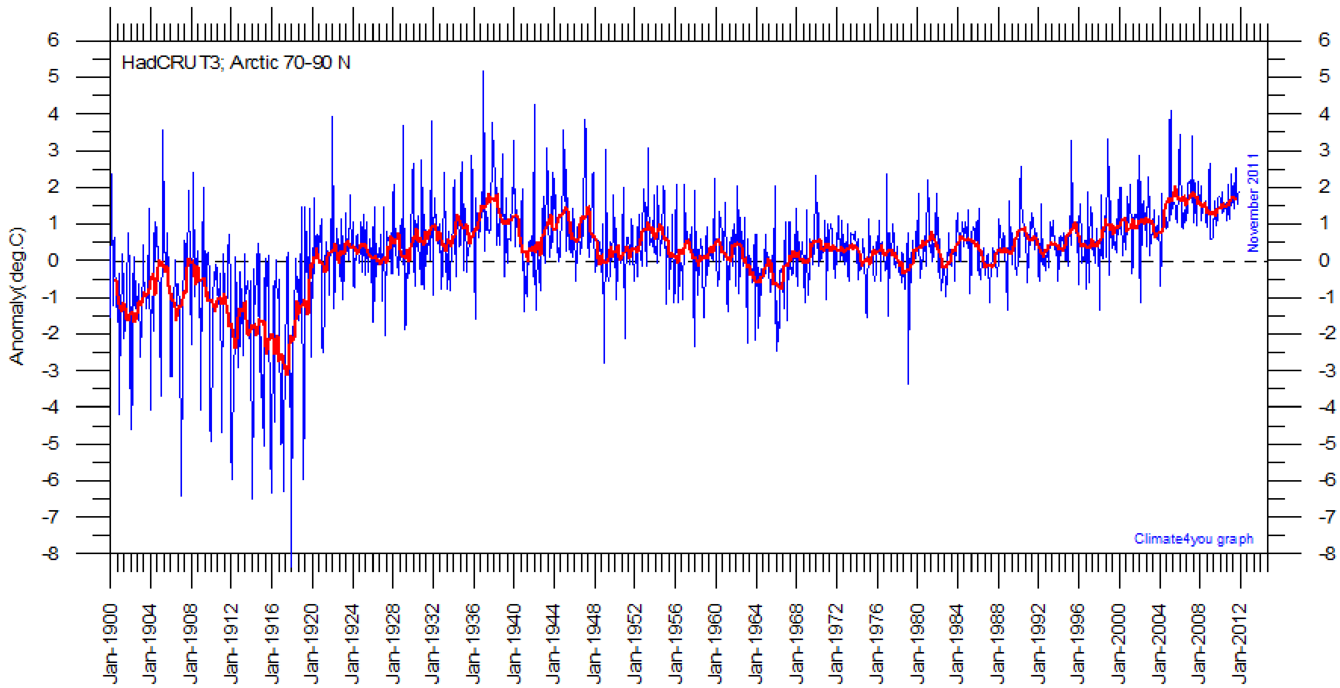


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1900, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. In general, the range of monthly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

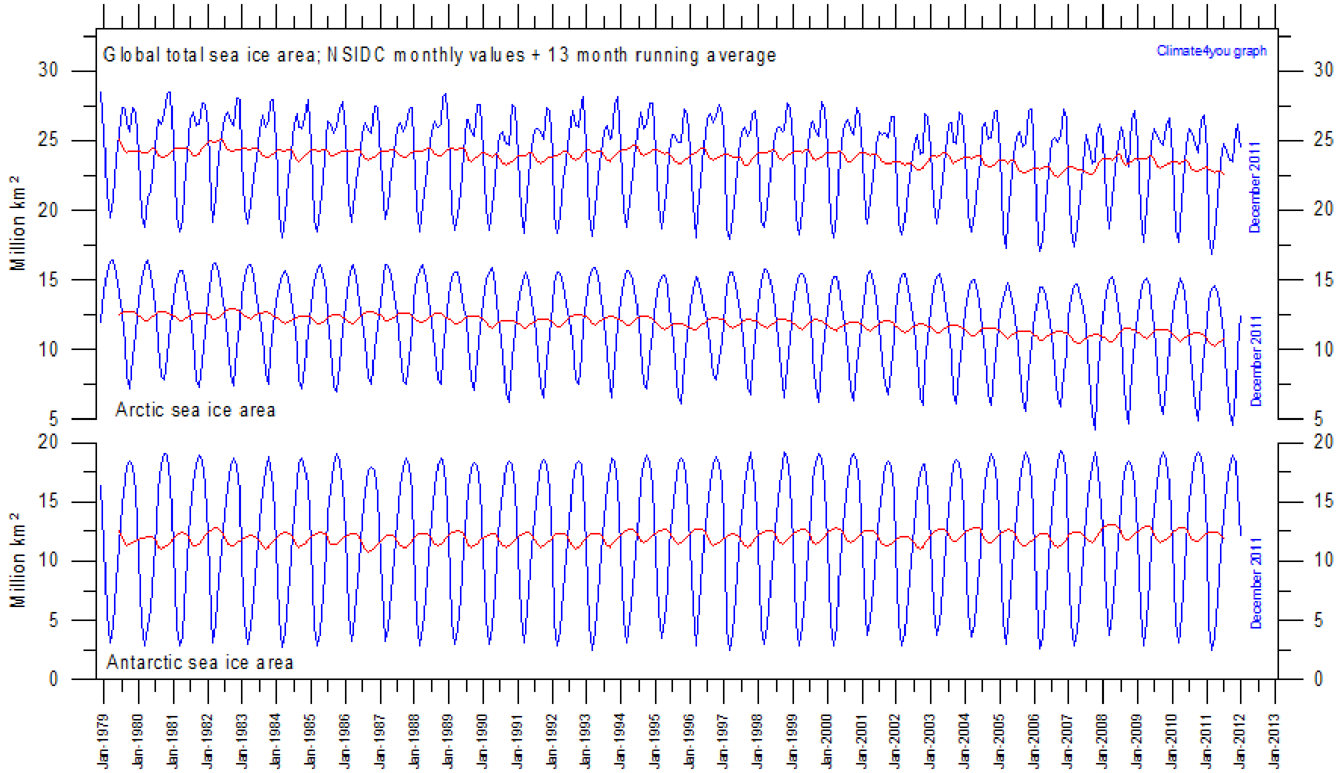
In general, the Arctic temperature record appears to be less variable than the Antarctic record, presumably at least partly due to the higher number of meteorological stations north of 70°N, compared to the number of stations south of 70°S.

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 dells.

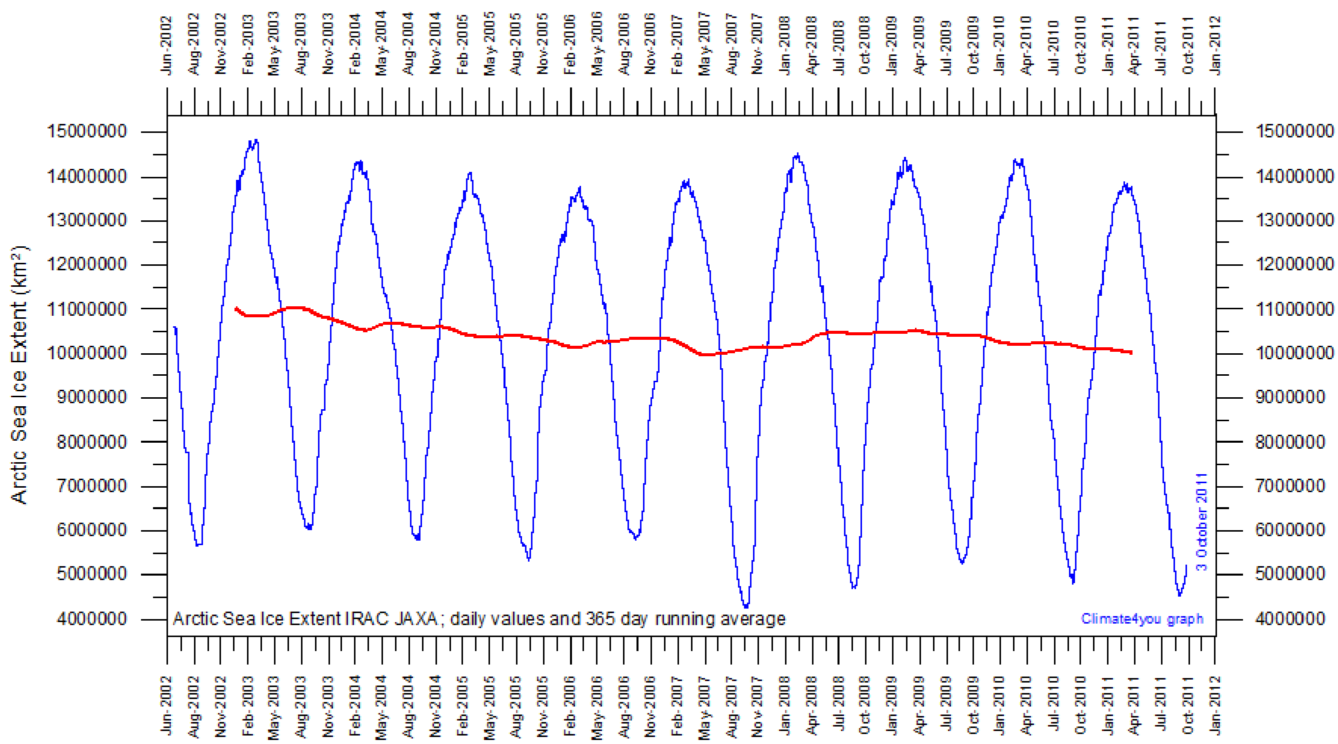
Literature:

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.

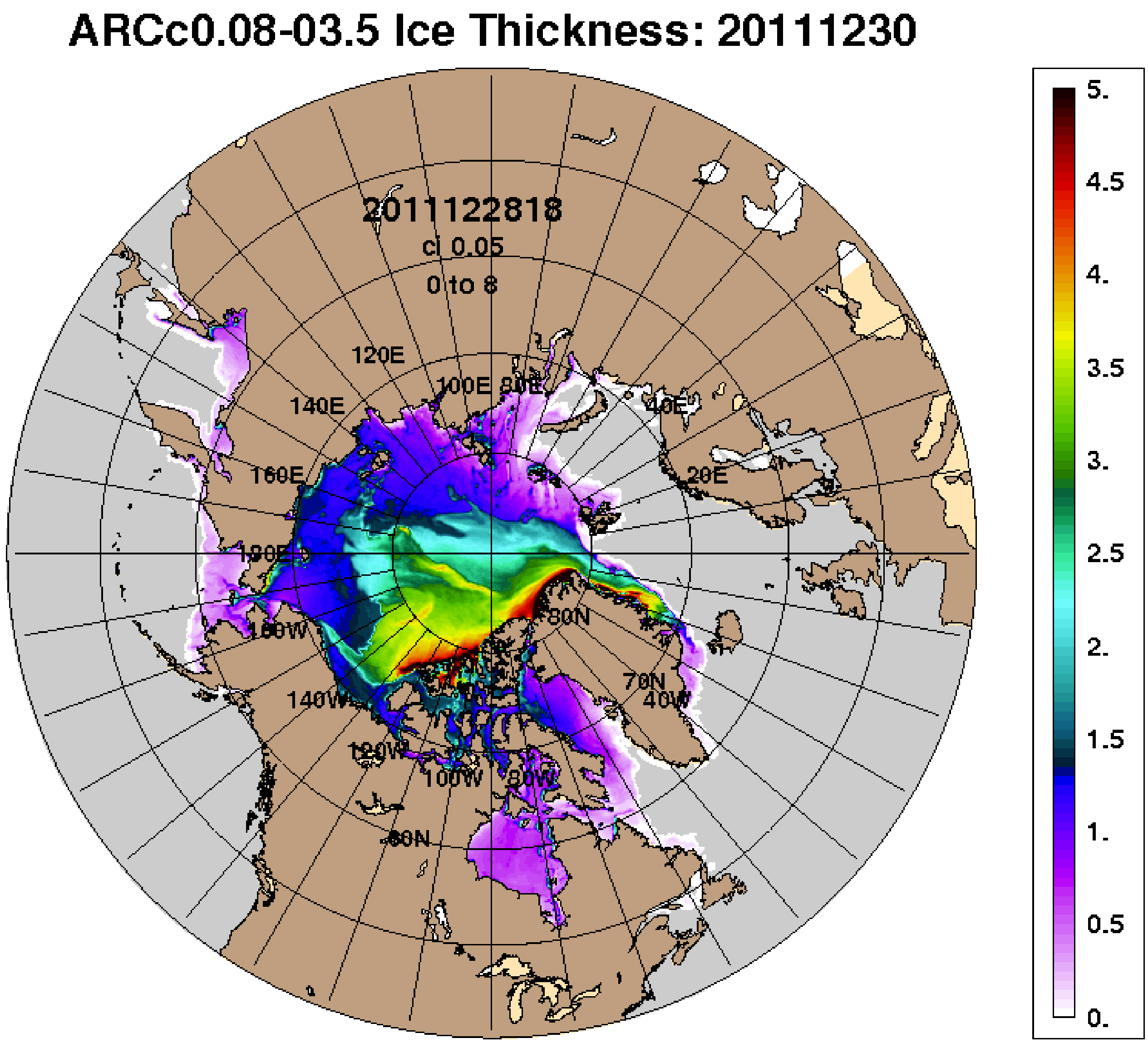
Arctic and Antarctic sea ice, updated to December 2011



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 October 3, 2011, by courtesy of Japan Aerospace Exploration Agency (JAXA). Please note that this diagram is not updated beyond 3 October 2011 due to the suspension of AMSR-E observation.



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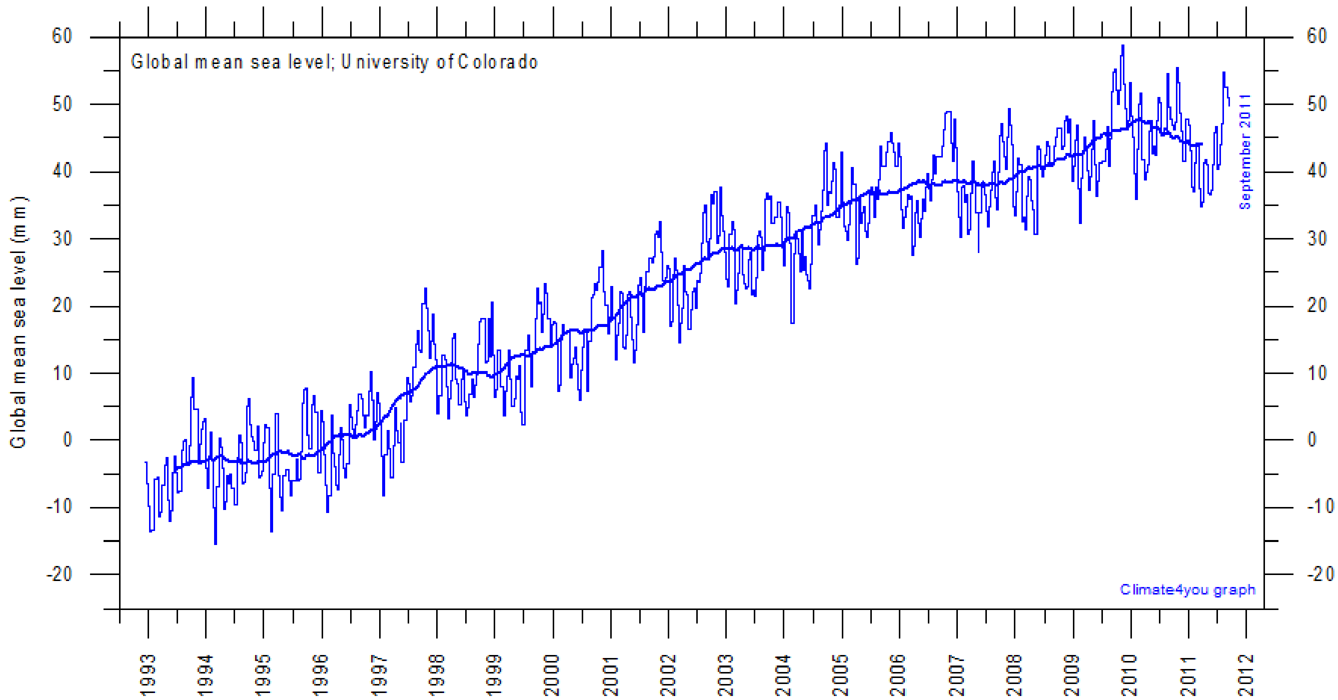
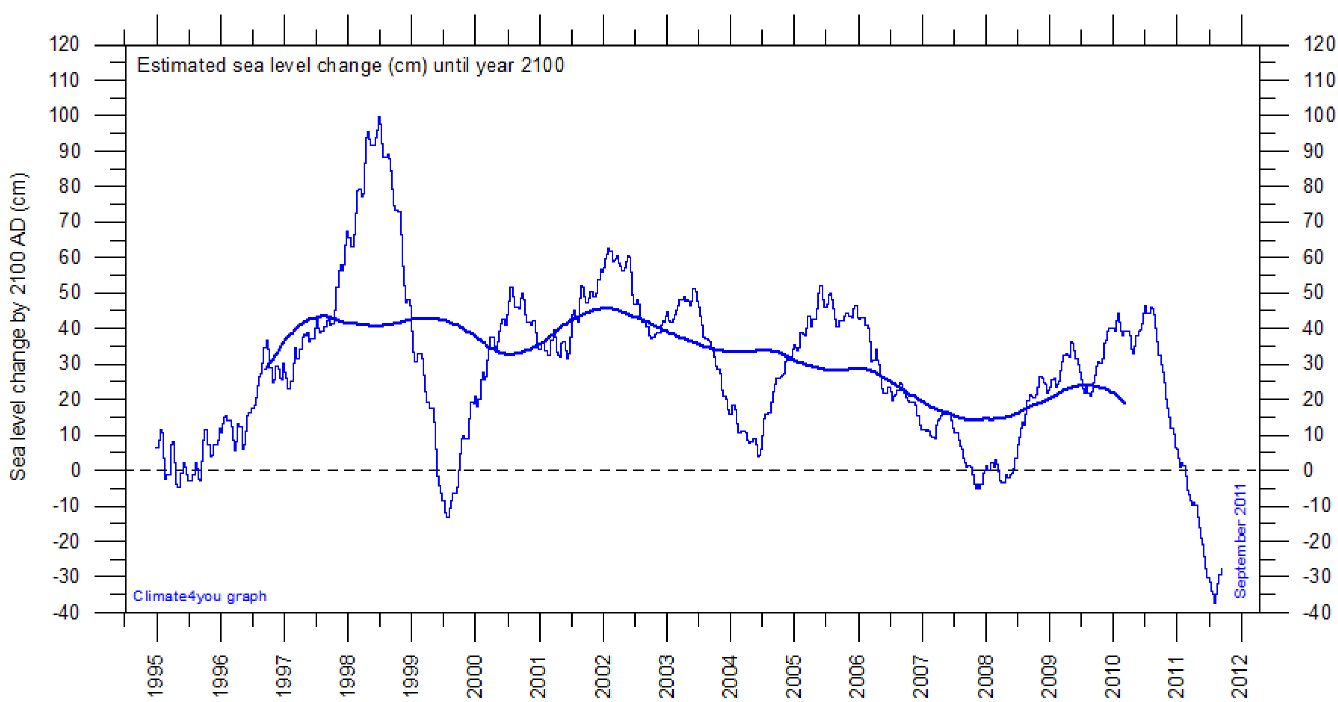
Northern hemisphere sea ice extension and thickness on 30 December 2011 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) is shown to the right.

Global sea level, updated to September 2011

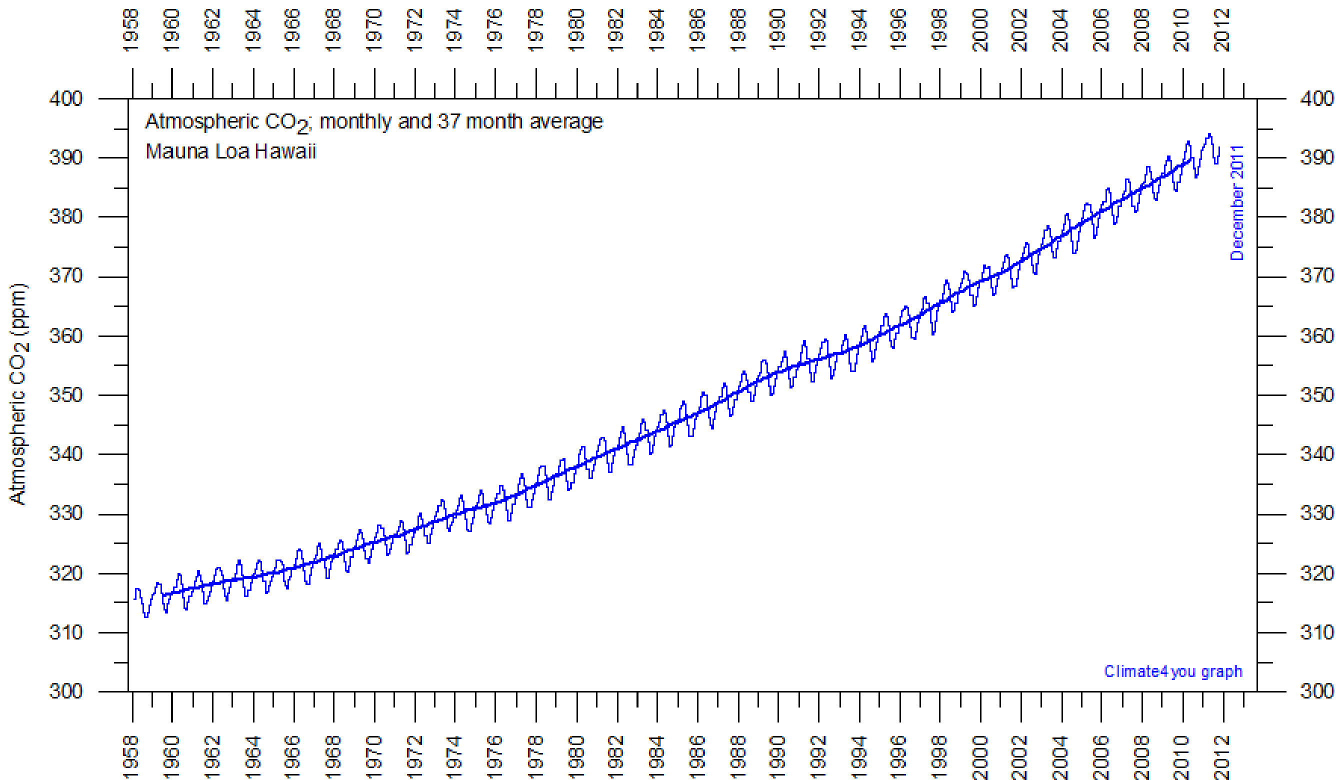


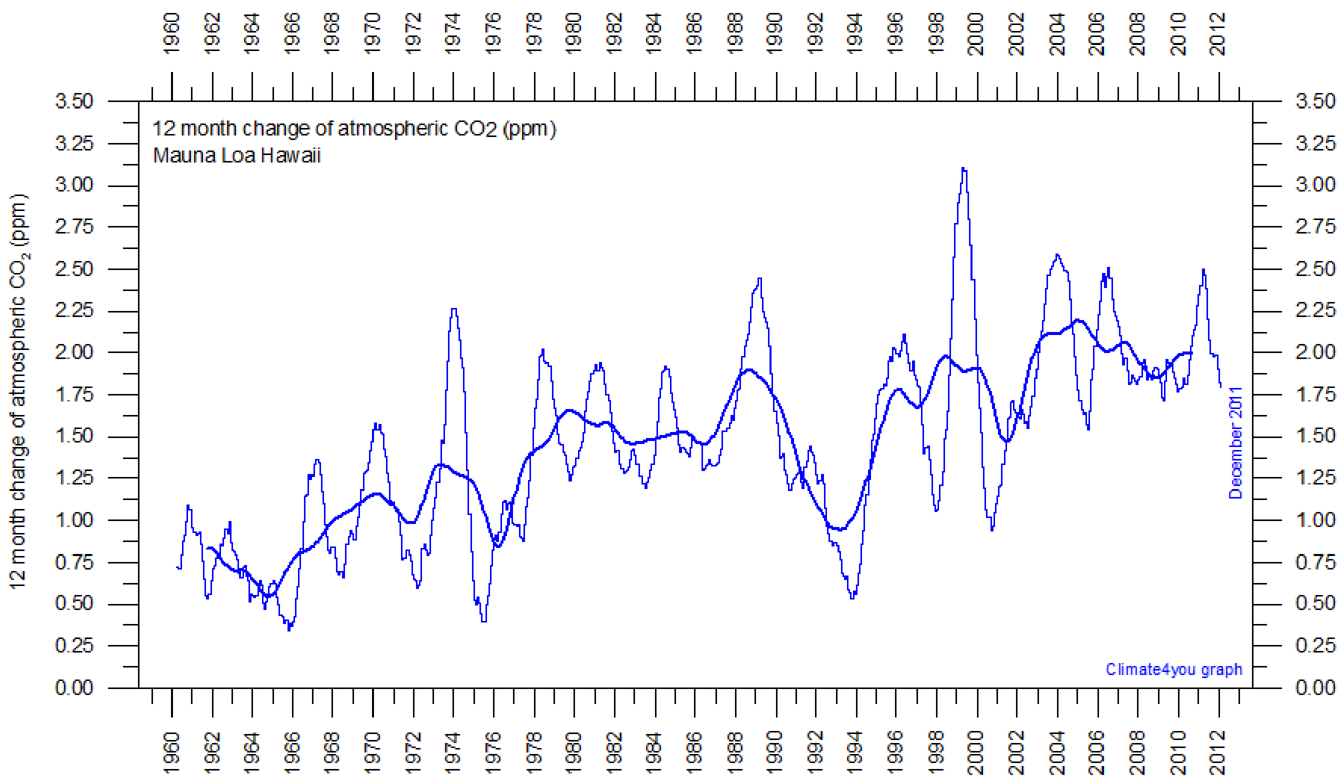
Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.



Forecasted change of global sea level until year 2100, based on simple extrapolation of measurements done by the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 3 yr average forecast for sea level change until year 2100. Based on this (thick line), the present empirical forecast of sea level change until 2100 is about +20 cm.

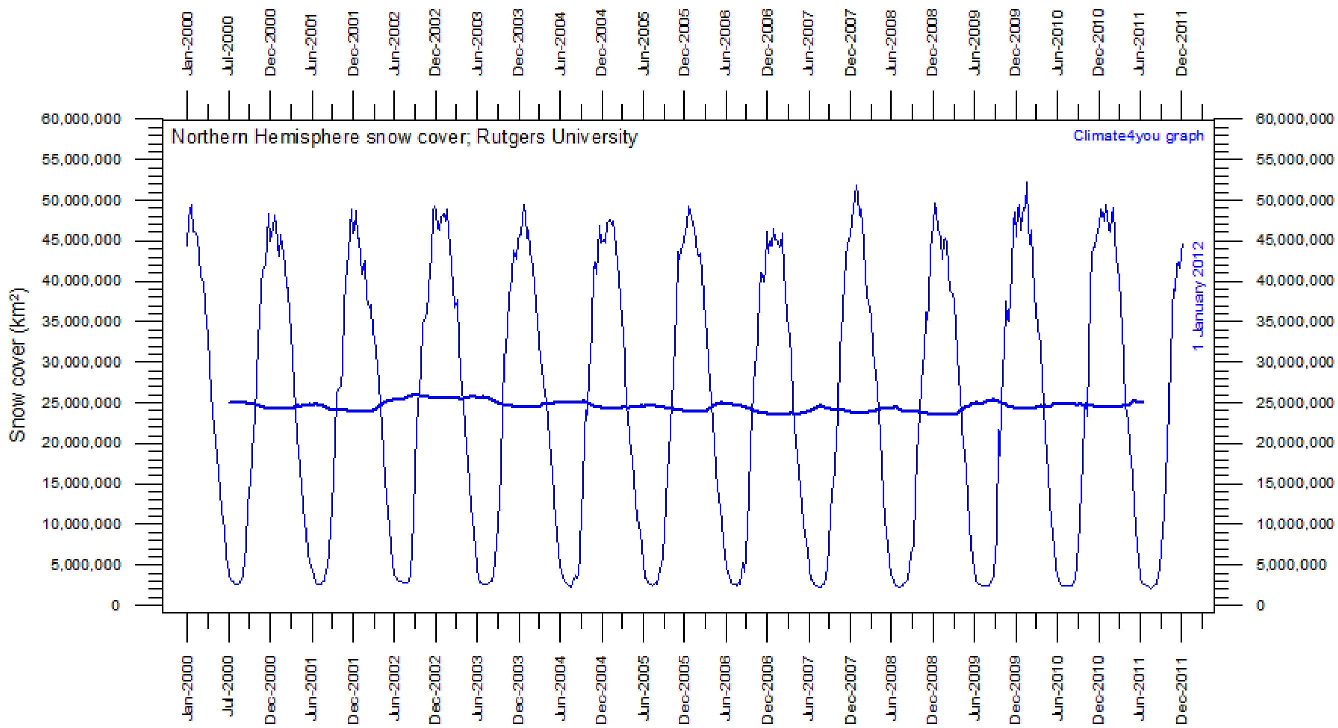
Atmospheric CO_2, updated to December 2011



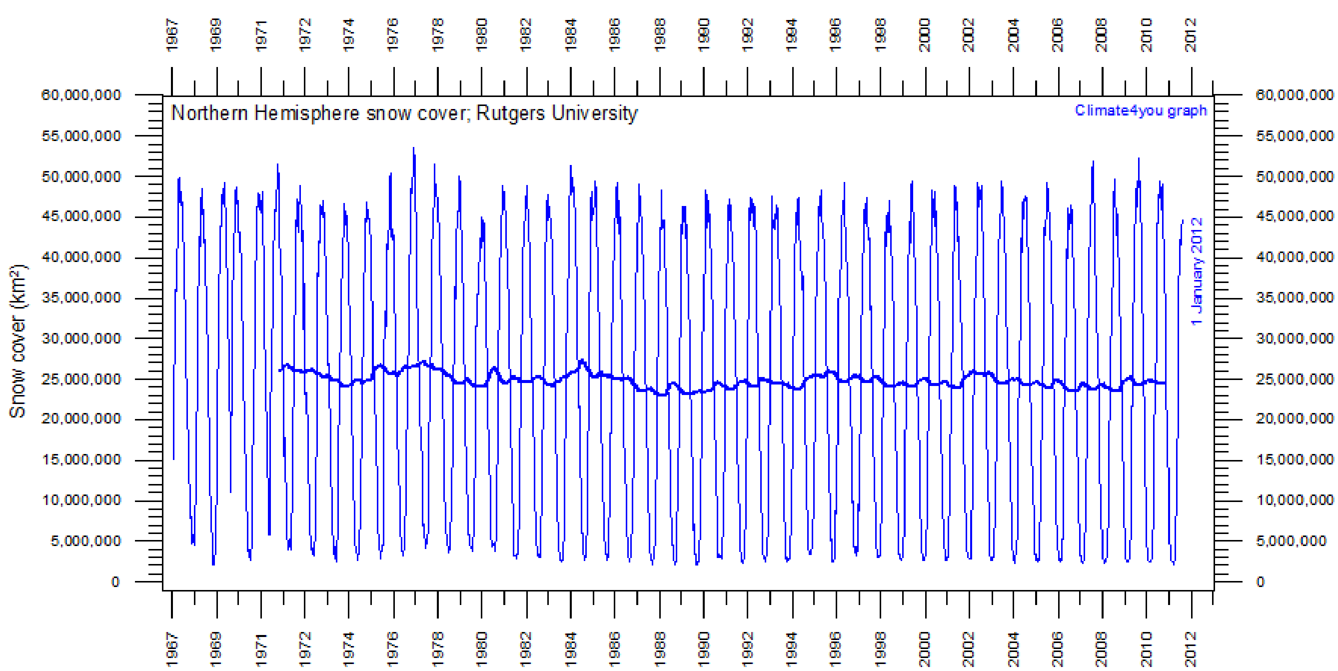


Monthly amount of atmospheric CO_2 (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO_2 since 1959, according to data provided by the Mauna Loa Observatory, Hawaii, USA. The thick line is the simple running 37 observation average, nearly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

Northern Hemisphere weekly snow cover, updated to early January 2012

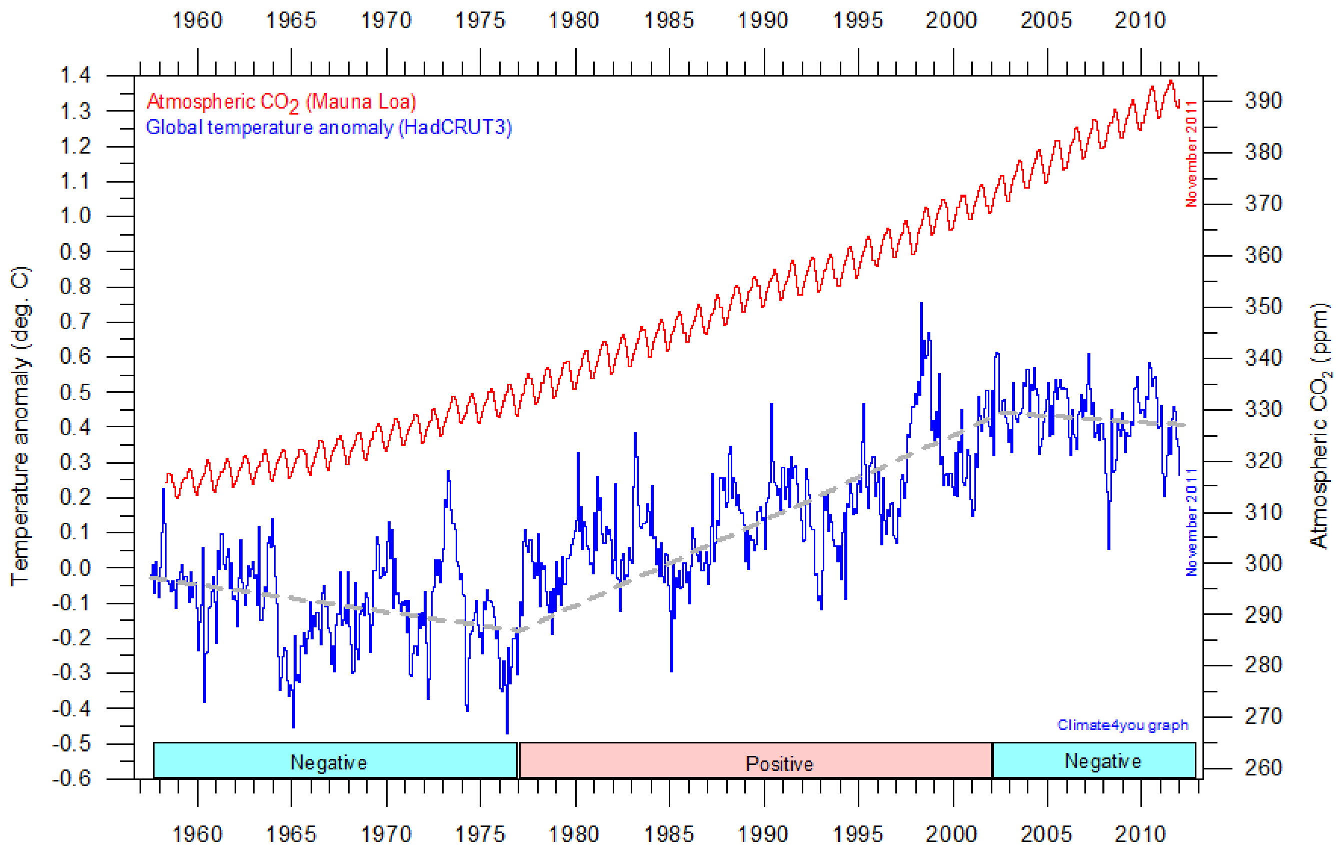


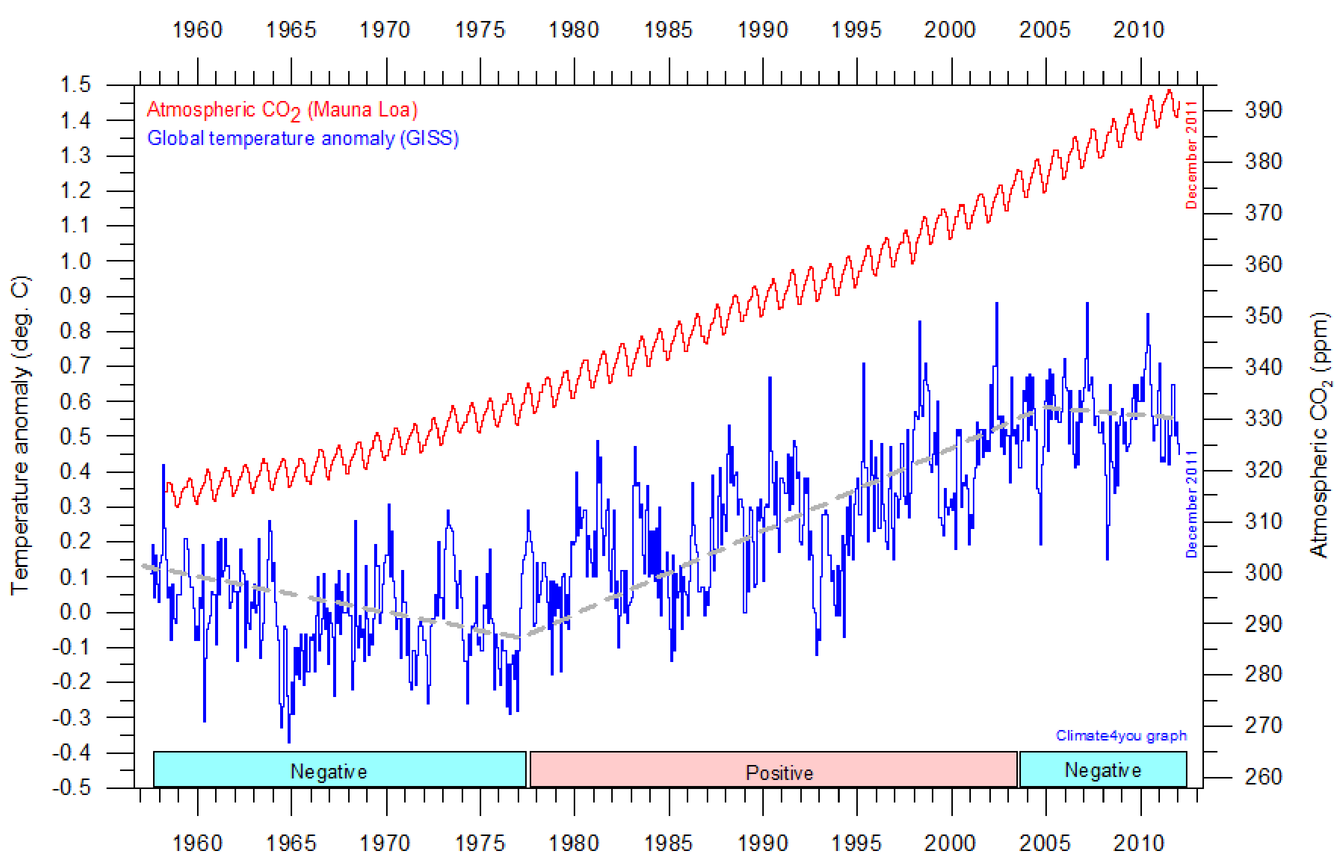
Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin line is the weekly data, and the thick line is the running 53 week average (approximately 1 year).

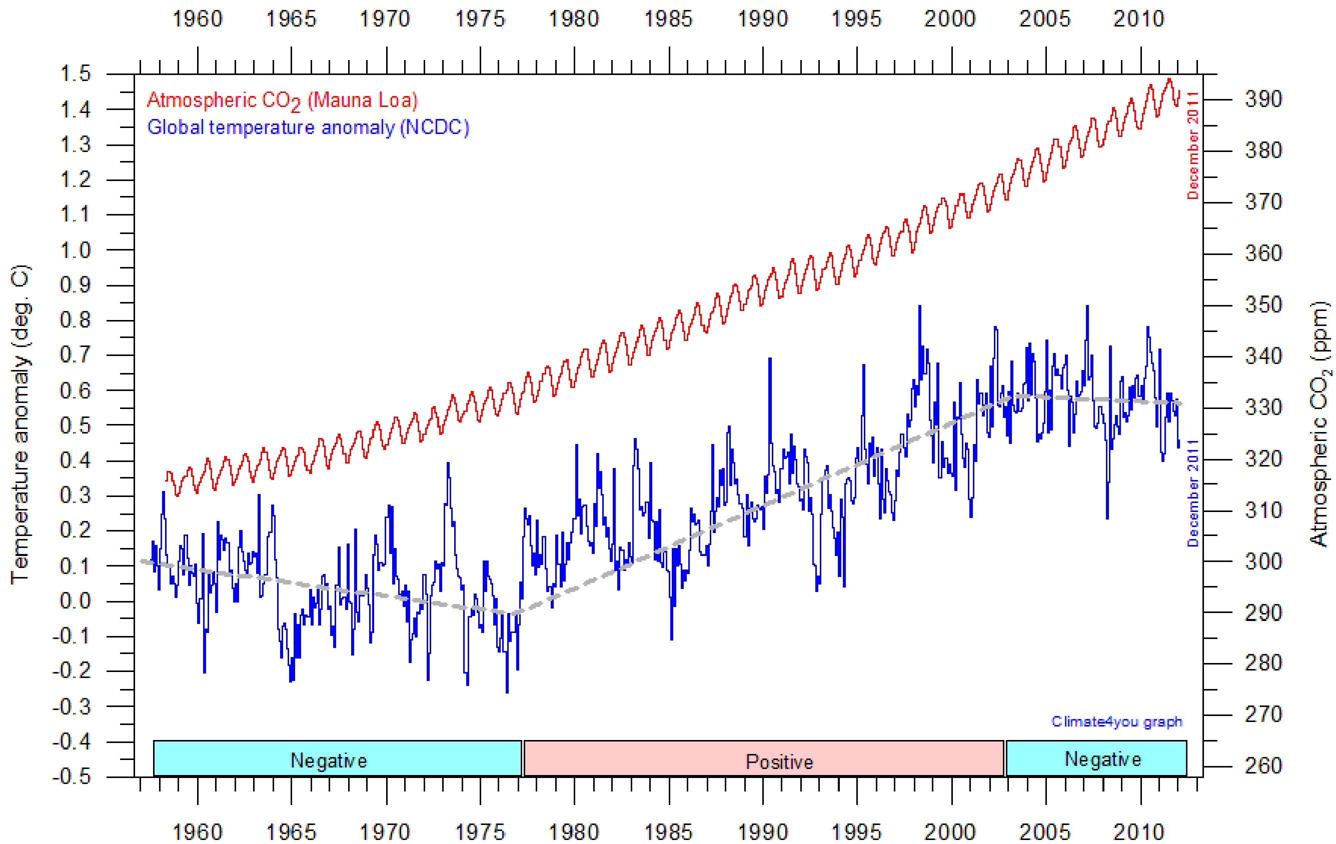


Northern hemisphere weekly snow cover since October 1966 according to Rutgers University Global Snow Laboratory. The thin line is the weekly data, and the thick line is the running 53 week average (approximately 1 year). The running average is not calculated before 1971 because of some data irregularities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

Global surface air temperature and atmospheric CO_2, updated to December 2011







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. Please note that the HadCRUT3 diagram has not been updated beyond November 2011.

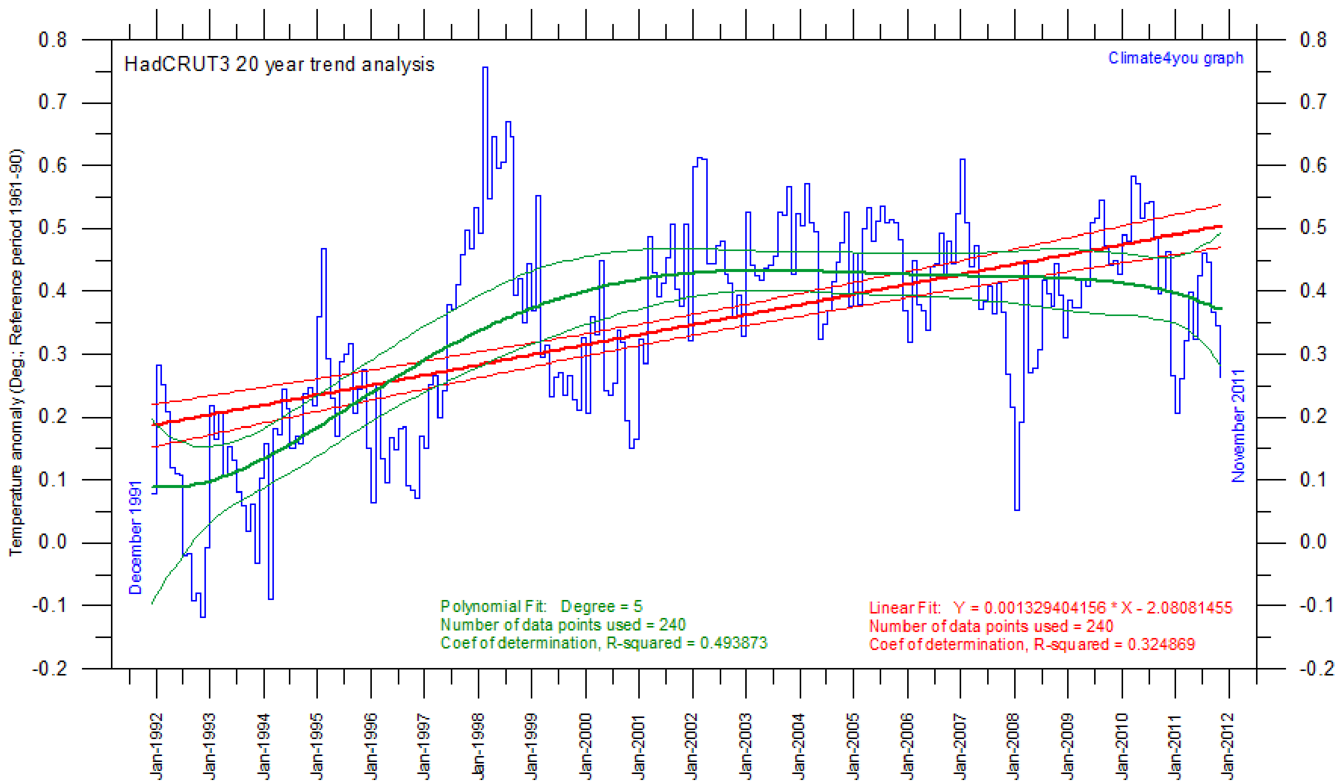
Most climate models assume the greenhouse gas carbon dioxide CO_2 to influence significantly upon global temperature. Thus, it is relevant to compare the different global temperature records with measurements of atmospheric CO_2, as shown in the diagrams above. Any comparison, however, should not be made on a monthly or annual basis, but for a longer time period, as other effects (oceanographic, clouds, volcanic, 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. However, the length of the critical period must be inversely proportional to the importance of CO_2 on the global temperature, including possible feedback effects. So if the net effect of CO_2 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 in 1988 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, political and public support for the CO_2-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.

Last 20 year surface temperature changes, updated to November 2011

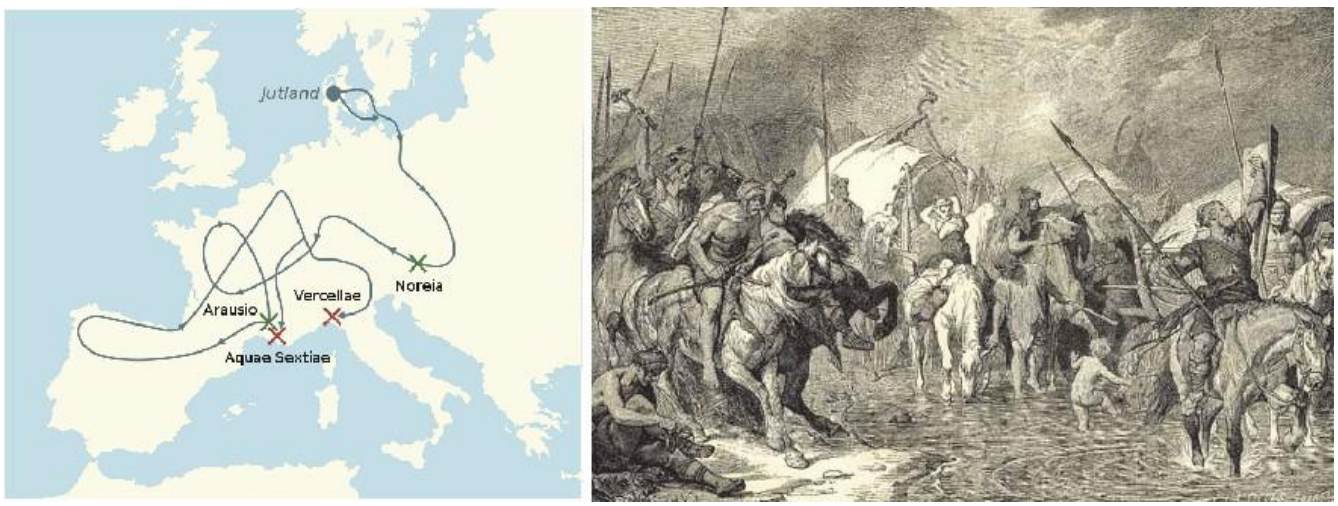


Last 20 years global monthly average surface air temperature according to Hadley CRUT, a cooperative effort between the Hadley Centre for Climate Prediction and Research and the University of East Anglia's Climatic Research Unit (CRU), UK. The thin blue line represents the monthly values. The thick red line is the linear fit, with 95% confidence intervals indicated by the two thin red lines. The thick green line represents a 5-degree polynomial fit, with 95% confidence intervals indicated by the two thin green lines. A few key statistics is given in the lower part of the diagram. Last month included in analysis: November 2011.

From time to time it is debated if the global surface temperature is increasing, or if the temperature has leveled out during the last 10-15 years. The above diagram may be useful in this context. If nothing else, it demonstrates the differences between two different statistical approaches to determine recent temperature trends.

Climate and history; one example among many

120-114 BC: The Cimbrian flood and the following Cimbrian war 113-101 BC



The migrations of the Cimbri and the Teutons between 113 and 101 BC (left diagram), with places of major battles with Roman forces indicated. Drawing showing Cimbrian people during their European journey (right).

The Cimbrian flood (or Cymbrian flood) was a large-scale incursion of the North Sea in the region of the Jutland peninsula (Denmark) in the period 120 to 114 BC, resulting in a permanent change of coastline with much land lost. The flood was caused by one or several very strong storm(s). A high number of people living in the affected area of Jutland drowned, and the flooding apparently set off a migration of the Cimbri tribes previously settled there (Lamb 1991). Most likely the Cimbrian flood was the result of the gradual flooding of the present North sea since the end of the last (Weichselian) glaciation, in combination with a stormy period, presumably influenced by a period of global cooling (see below).

The Cimbri were a tribe from Northern Europe, who, together with the Proto-Germanic Teutones and the Ambrones threatened the Roman Republic in the late 2nd century BC. Most ancient sources categorize the Cimbri as a Germanic tribe, but some authors include the Cimbri among the Celts (http://en.wikipedia.org/wiki/Celts). Old sources located their original home in Jutland, which was referred to as the Cimbrian peninsula throughout early historical times. For example, on the map of Ptolemy, the "Kimbroi" are placed in the northernmost part of the Jutland peninsula, in the modern Danish region Himmerland, shortly south of the sound Limfjorden. The moden Vendsyssel-Thy region of Denmark north of Limfjorden was at that time still mainly a group of islands. *Himmerland* (Old Danish *Himbersysel*) is generally thought to refer to the name Cimbri. However, the precise origin of the name *Cimbri* is unknown.

Some time before 100 BC many of the Cimbri, as well as the Teutons and Ambrones migrated south-east. After several unsuccessful battles with the Boii and other Celtic tribes, they appeared ca 113 BC on the Danube, in Noricum, where they invaded the lands of one of Rome's allies, the Taurisci. On the request of the Roman consul Gnaeus Papirius

Carbo, sent to defend the Taurisci, they retreated, but only to find themselves deceived and attacked by Roman forces at the Battle of Noreia. Here they nevertheless defeated the Roman army seriously. Only a storm, which separated the armies, saved the Roman forces from complete annihilation.

However, Rome was however finally victorious in the Cimbrian war, and the Cimbri-Teutonic forces - who had inflicted on the Roman armies the heaviest losses that they had suffered since the Second Punic War with victories at the battles of Arsusio and Noreia – were almost completely annihilated, during the battles at Aquae Sextiae and Vercellae.

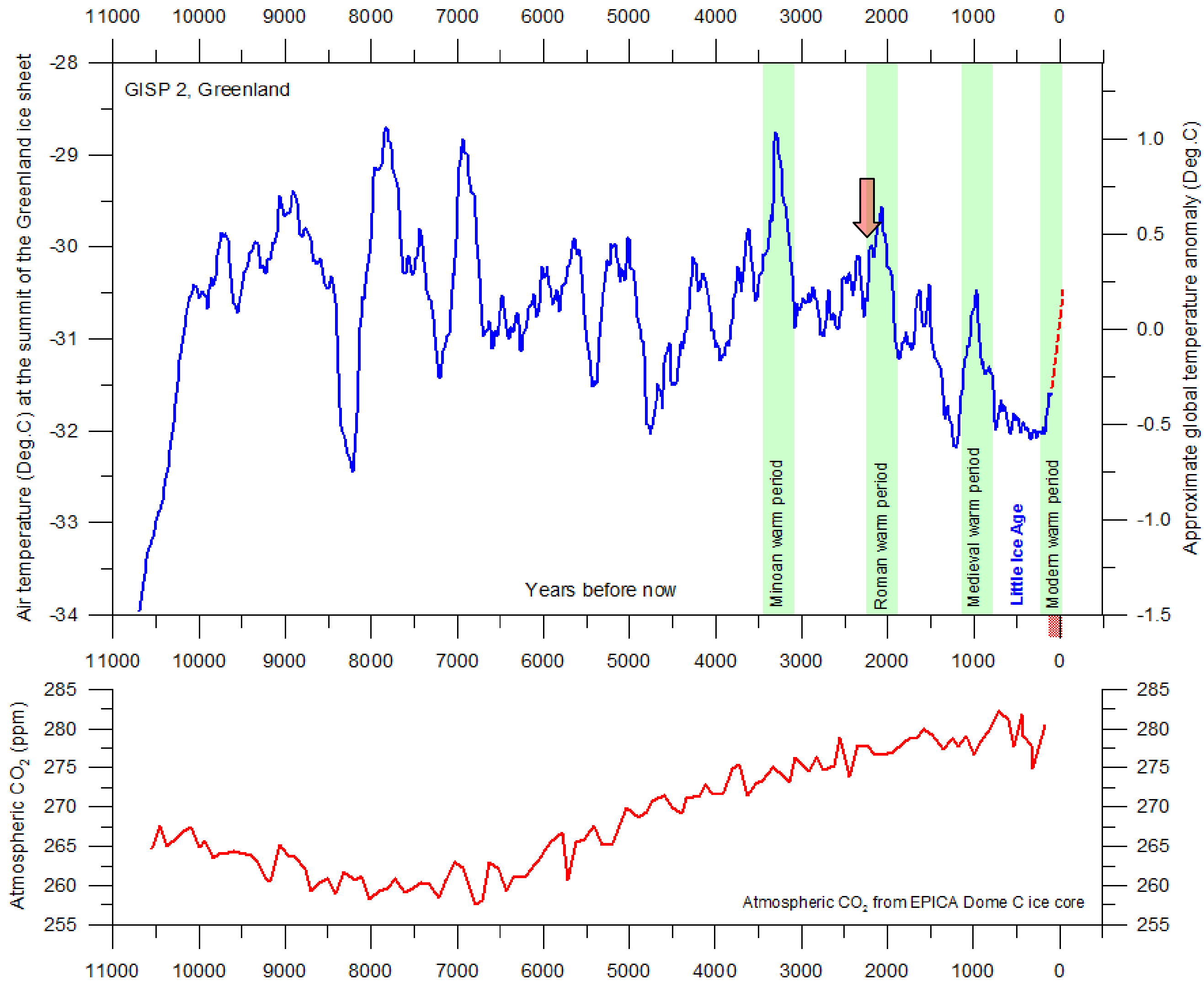
The timing of the war had a great effect on the internal politics of Rome, and the organization of its military. The war contributed greatly to the political career of Gaius Marius, whose consulships and political conflicts challenged many of the Roman republic's political institutions and customs of the time. The Cimbrian threat, along with the Jugurthine War, inspired the landmark Marian reforms of the Roman legions.

Gundestrup cauldron (left). Plate E from the Gundestrup Cauldron (right), apparently showing Roman warriors.

The Gundestrup Cauldron is the largest known example of European Iron Age silverwork. It is 69 cm in diameter and 42 cm in height, and weighs almost 9 kg. It has been dated to the period between 130 BC and 1 BC. The cauldron is made up from 13 separate plates - 5 long rectangular plates that form the interior; 7 short rectangular plates that form the exterior; and one round base plate, together with the shallow, curved, undecorated base. The cauldron was found in Himmerland on May 28, 1891, by peat cutters working in a small peat bog called Rævemose, near Gundestrup.

This unique piece of artwork suggests that there was contact between Jutland and southeastern Europe, but it is uncertain if this contact can be directly associated with the Cimbrian migration. Neither has archaeologists found any clear indications of a mass migration from Jutland around this time, and presumably it was only the tribes living in the areas directly affected by the flood and subsequent sand drifting which decided to move south, out of Jutland.

Part of the explanation for the Cimbrian Flood might perhaps be sought in the diagram below, showing the Cimbrian flood to occur in the latter part of a relatively cold period shortly before the Roman Warm Period.



The upper panel shows the air temperature at the summit of the Greenland Ice Sheet, reconstructed by Alley (2000) from GISP2 ice core data. The approximate timing of the Cimbrian Flood (arrow) is in the latter part of the cold period before the Roman Warm Period. The time scale shows years before modern time, which is shown at the right hand side of the diagram. The rapid temperature rise to the left indicate the final part of the even more pronounced temperature increase following the last ice age. The temperature scale at the right hand side of the upper panel suggests a very approximate comparison with the global average temperature (see comment below). The GISP2 record ends around 1855, and the red dotted line indicate the approximate temperature increase since then. The lower panel shows the past atmospheric CO_2 content, as found from the EPICA Dome C Ice Core in the Antarctic (Monnin et al. 2004). The Dome C atmospheric CO_2 record ends in the year 1777.

Whenever the planet cools, the cooling is especially pronounced near the poles and smaller near the Equator. The planetary cooling thereby produces an enhanced thermal contrast between equatorial regions and the poles. In the northern hemisphere, this thermal contrast tends to develop especially in latitudes between about 50 and 65°N, in the so-called zone of westerlies. Global cooling and the strengthened north-south thermal gradient is typically the basis for development of stronger cyclonic storms over oceans in the zone of westerlies, leading to increasing flood frequency and damage for adjoining coasts and land areas, especially around the North Sea.

References:

Lamb, H. 1991. *Historical Storms of the North Sea, British Isles and Northwest Europe*. Cambridge University press, Cambridge, 204 pp.

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All the above diagrams with supplementary information, including links to data sources and previous issues of this newsletter, are available on www.climate4you.com

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