Climate4you update September 2011

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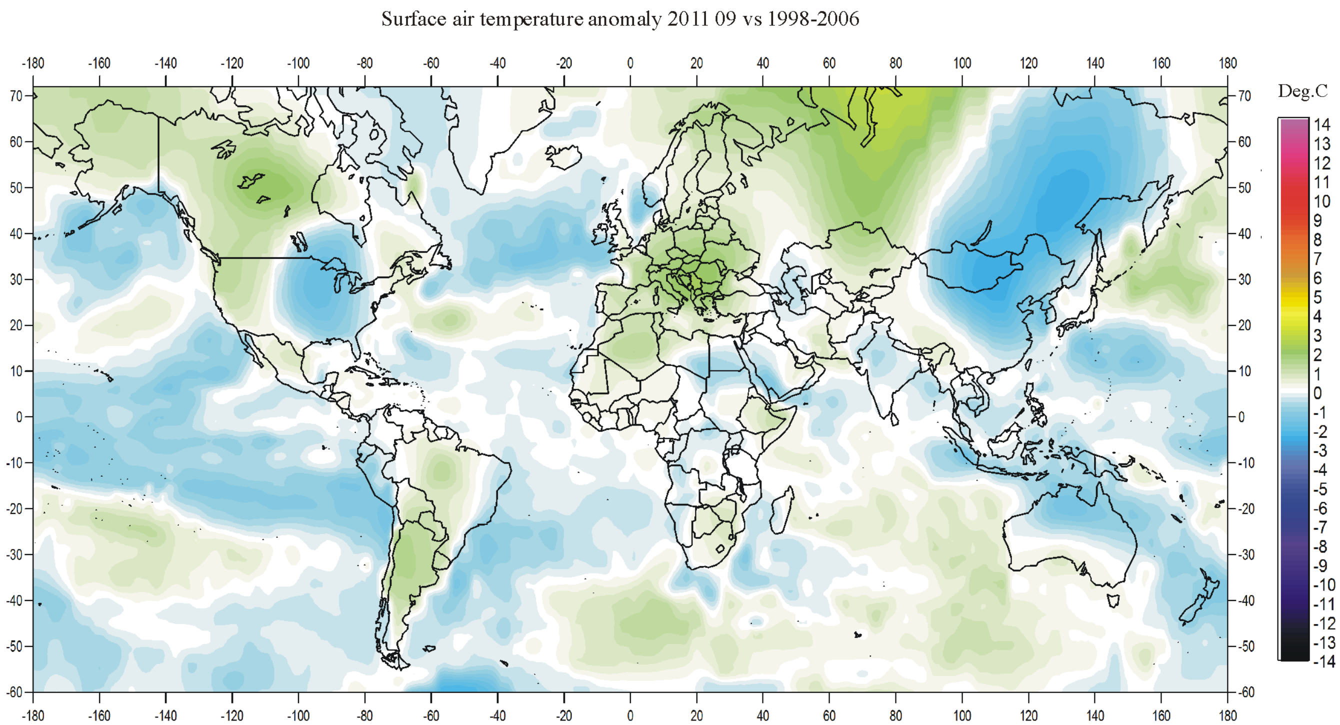
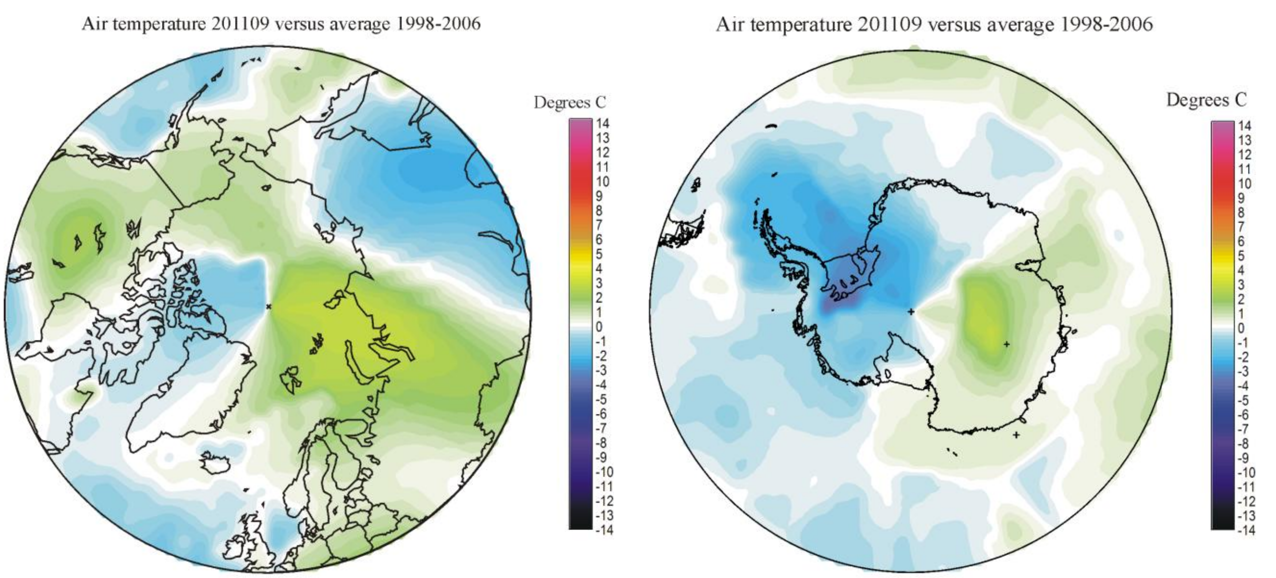
September 2011 global surface air temperature overview





September 2011 surface air temperature compared to the average 1998-2006. Green.yellow-red colours indicate areas with higher temperature than the 1998-2006 average, while blue colours indicate lower than average temperatures. Data source: [Goddard Institute for Space Studies](http://www.giss.nasa.gov/) (GISS)

Comments to the September 2011 global surface air temperature overview

General: This newsletter contains graphs showing a selection of key meteorological variables for August 2011. *All temperatures are given in degrees Celsius*.

In the above maps showing the geographical pattern of surface air temperatures, *the period 1998-2006 is used as reference period*. The reason for comparing with this recent period instead of the official WMO 'normal' period 1961-1990, is that the latter period is affected by the relatively cold period 1945-1980. Almost any comparison with such a low average value will therefore appear as high or warm, and it will be difficult to decide if 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.

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

The average global surface air temperatures August 2011:

The Northern Hemisphere – as usual - was characterised by relatively high regional variability, compared to the southern hemisphere. Lower than 1998-2006 average temperatures extended across most of China, Mongolia and Siberia, northern Pacific, eastern USA, and most of the North Atlantic. Above average temperatures characterised Russia and most of Europe, NW Canada and Alaska. The prominent August 2011 hotspot in central northern Pacific has now nearly disappeared.

The Southern Hemisphere in general was close to or slightly below average 1998-2006 conditions. Australia in general was relatively cold, Africa close to average, and South America somewhat above 1998-2006 average temperatures. Extensive areas in the Southern Pacific and southern Atlantic experienced below average temperatures.

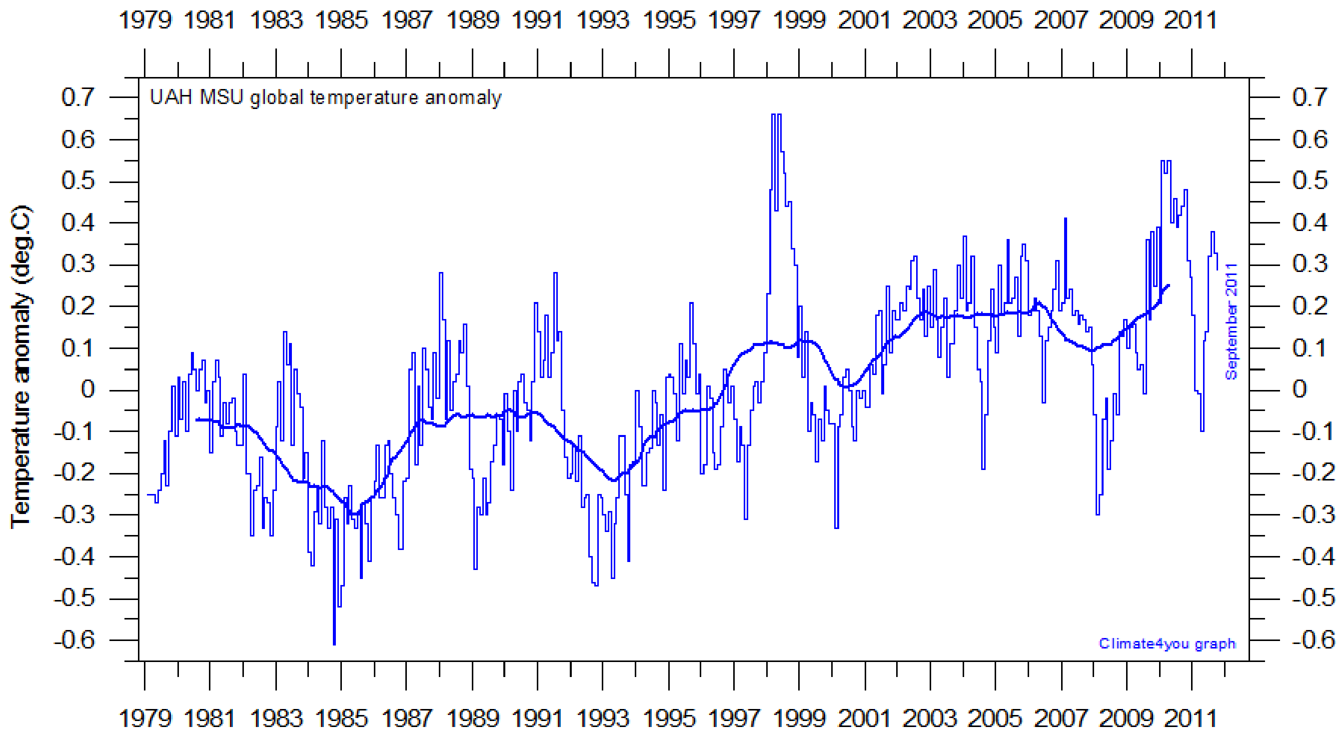
Near Equator temperatures conditions were close to average 1998-2006 conditions, although with a dominance of below average temperatures across most of the Pacific.

The Arctic was characterized by a high variability of average surface air temperatures. Most of Siberia had below average temperatures, while NW Siberia and the Russia-European sector of the Arctic experienced above average temperatures. Greenland and NE Canada had below temperatures, and Alaska was warmer than the 1998-2006 average. The apparent marked thermal contrast near the North Pole is a mathematical artefact, derived from the GISS interpolation procedure, and should be ignored.

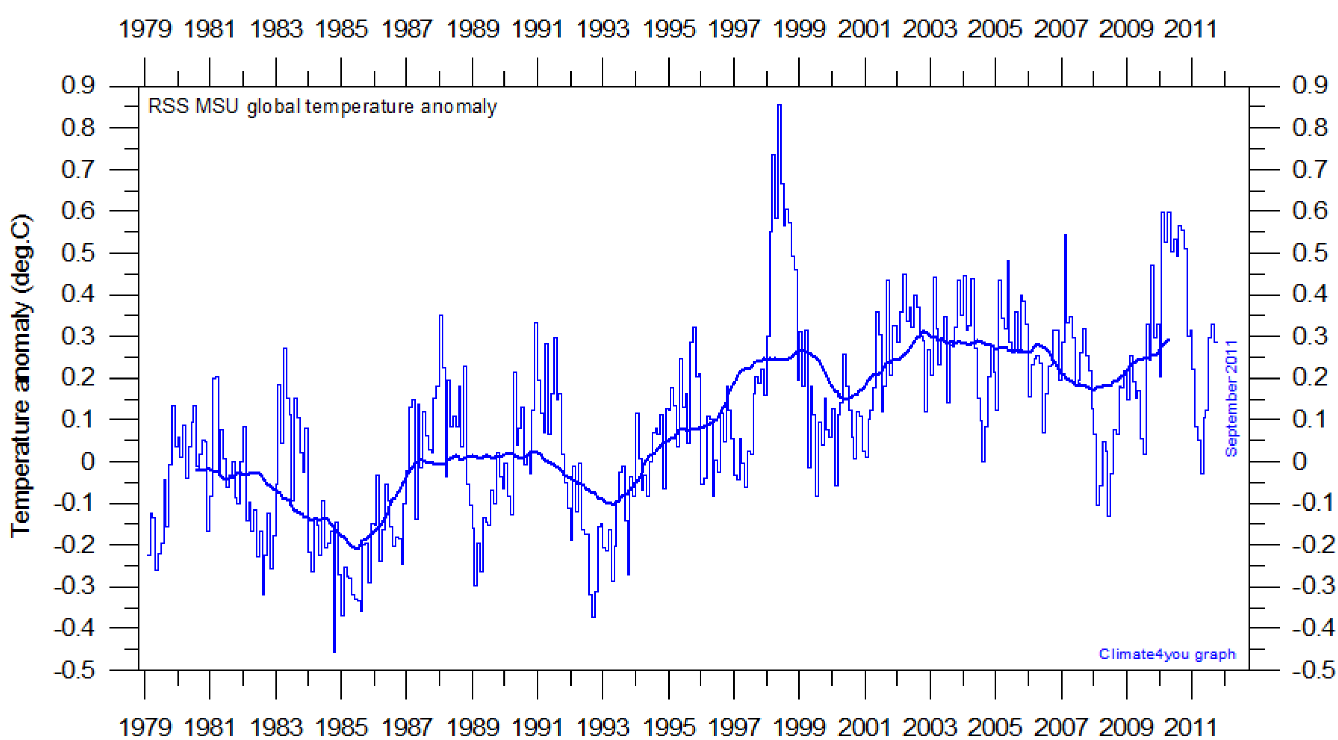
Most of the Antarctic continent experienced below average temperatures, a change compared to the previous two months. Only the central part of East Antarctica experienced above average temperatures.

The global oceanic heat content has now for several years been almost stable, as the diagrams on p.10 in this newsletter show, at least since 2003/2004 (data from the National Oceanographic Data Center).

Lower troposphere temperature from satellites, updated to September 2011

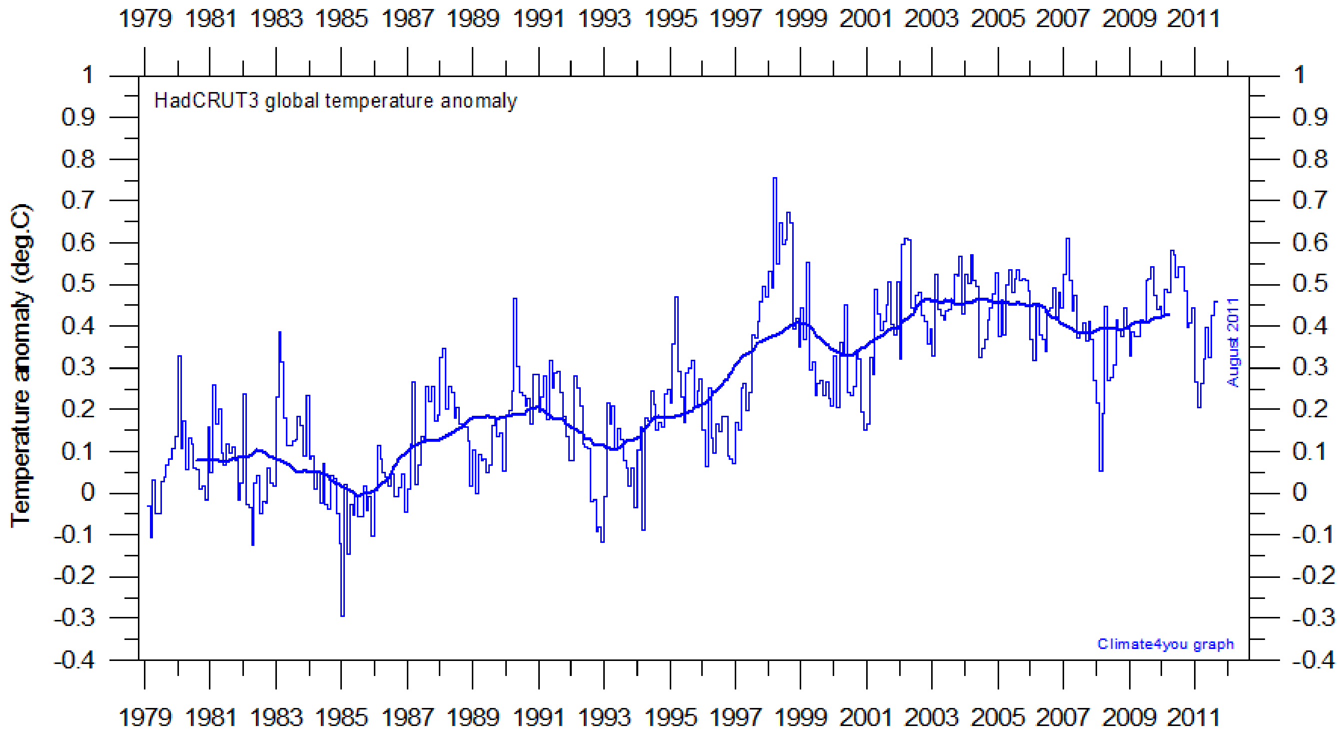


Global monthly average lower troposphere temperature (thin line) since 1979 according to University of Alabama at Huntsville, USA. The thick line is the simple running 37 month average.

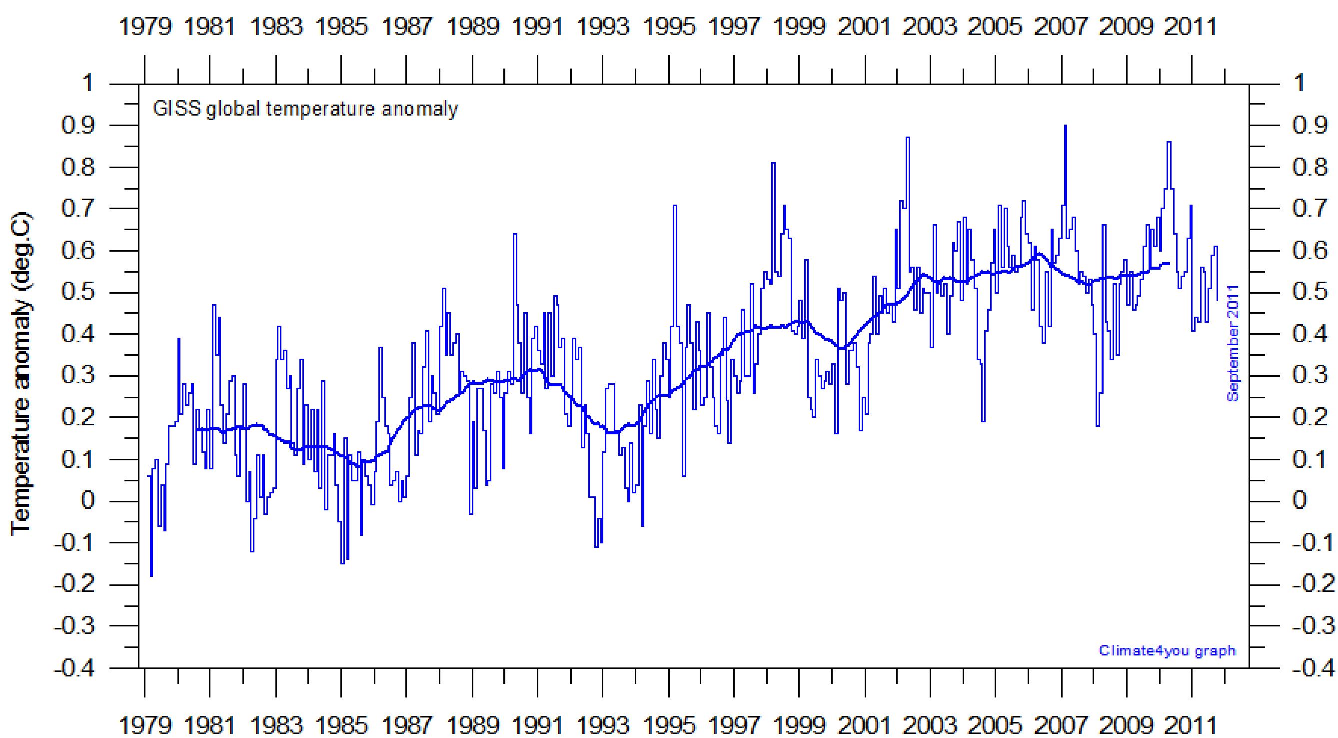


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to Remote Sensing Systems (RSS), USA. The thick line is the simple running 37 month average.

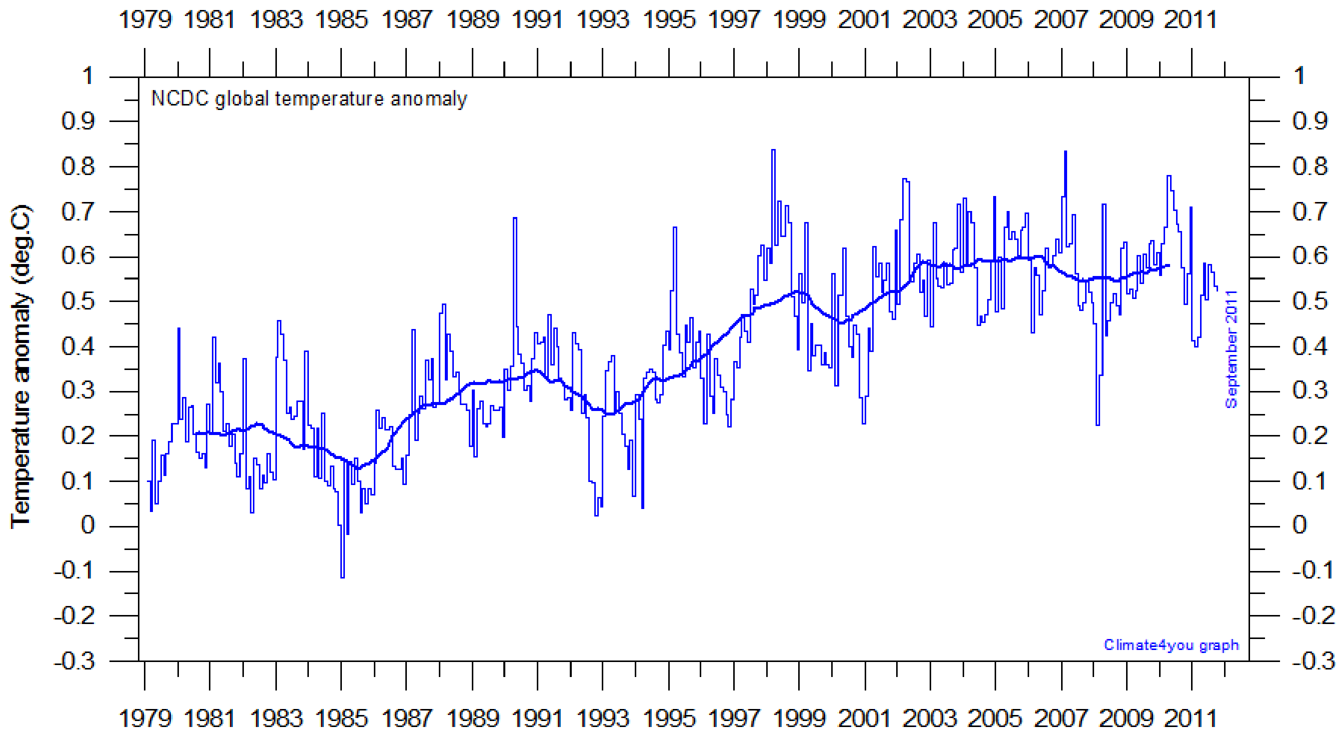
[Global surface air temperature, updated to September 2011]



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

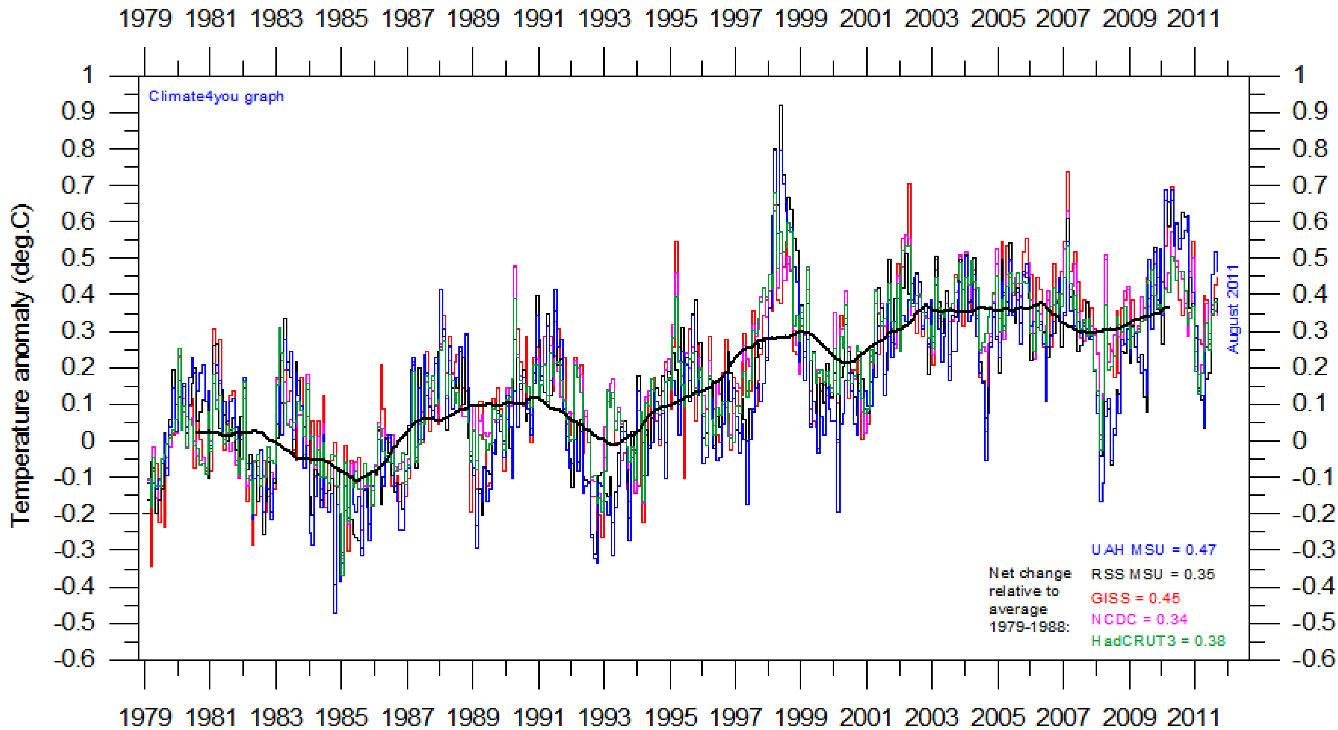
A note on data record stability:

All the above temperature estimates display changes when one compare with previous monthly data sets, not only for the most recent months as a result of 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.

The interested reader 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 August 2011]

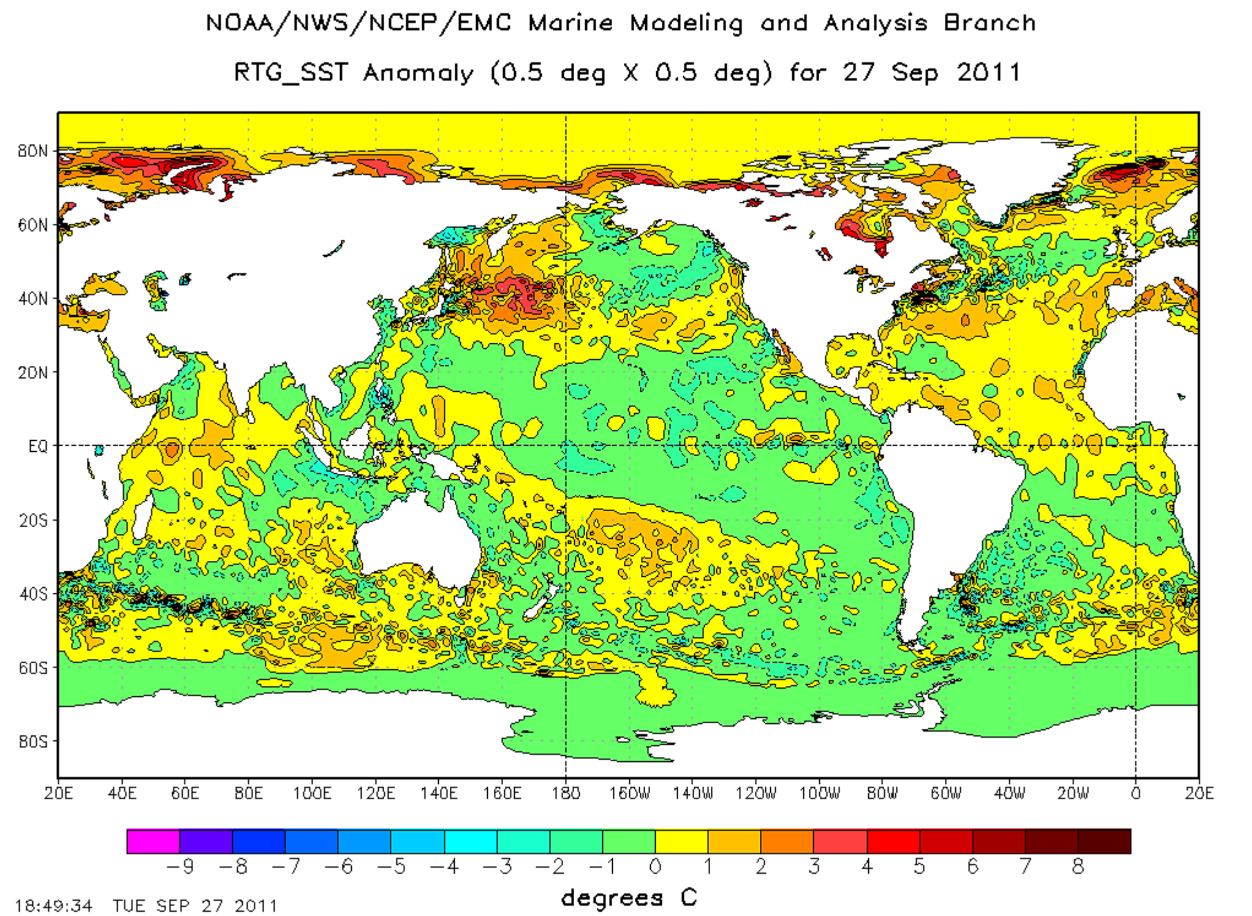


Superimposed plot of all five global monthly temperature estimates shown above. As the base period differs for the different temperature estimates, they have all been normalised by comparing to the average value of their initial 120 months (10 years) from January 1979 to December 1988. The heavy black 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 above mentioned 10 yr average.

It should be kept in mind that satellite- and surface-based temperature estimates are derived from different types of measurements, and that comparing them directly as done in the diagram above therefore in principle may be problematical. However, as both types of estimate often are discussed together, the above diagram may nevertheless be of some interest. In fact, the different types of temperature estimates appear to agree quite well as to the overall temperature variations on a 2-3 year scale, although on a shorter time scale there may be considerable differences between the individual records.

All five global temperature estimates presently show stagnation, at least since 2002. There has been no increase in global air temperature since 1998, which however was affected by the oceanographic El Niño event. This 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.

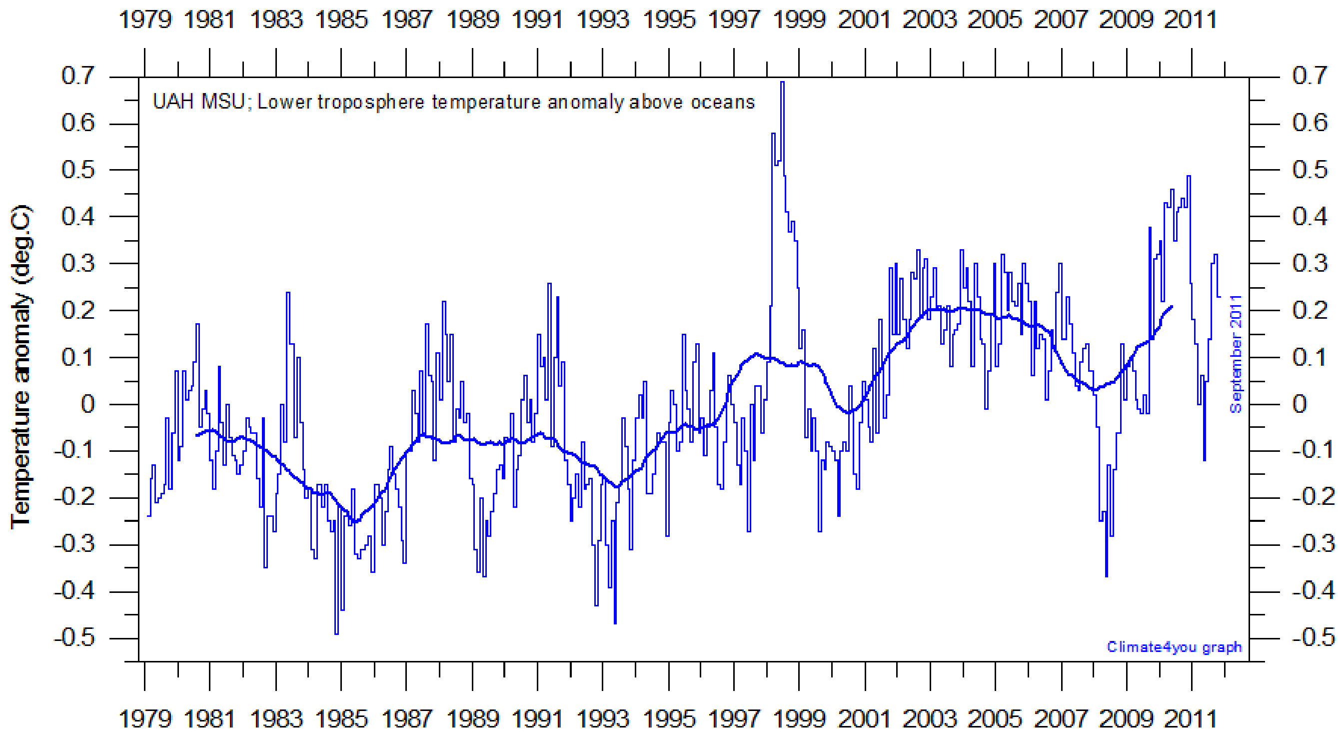
Global sea surface temperature, updated to the end of September 2011



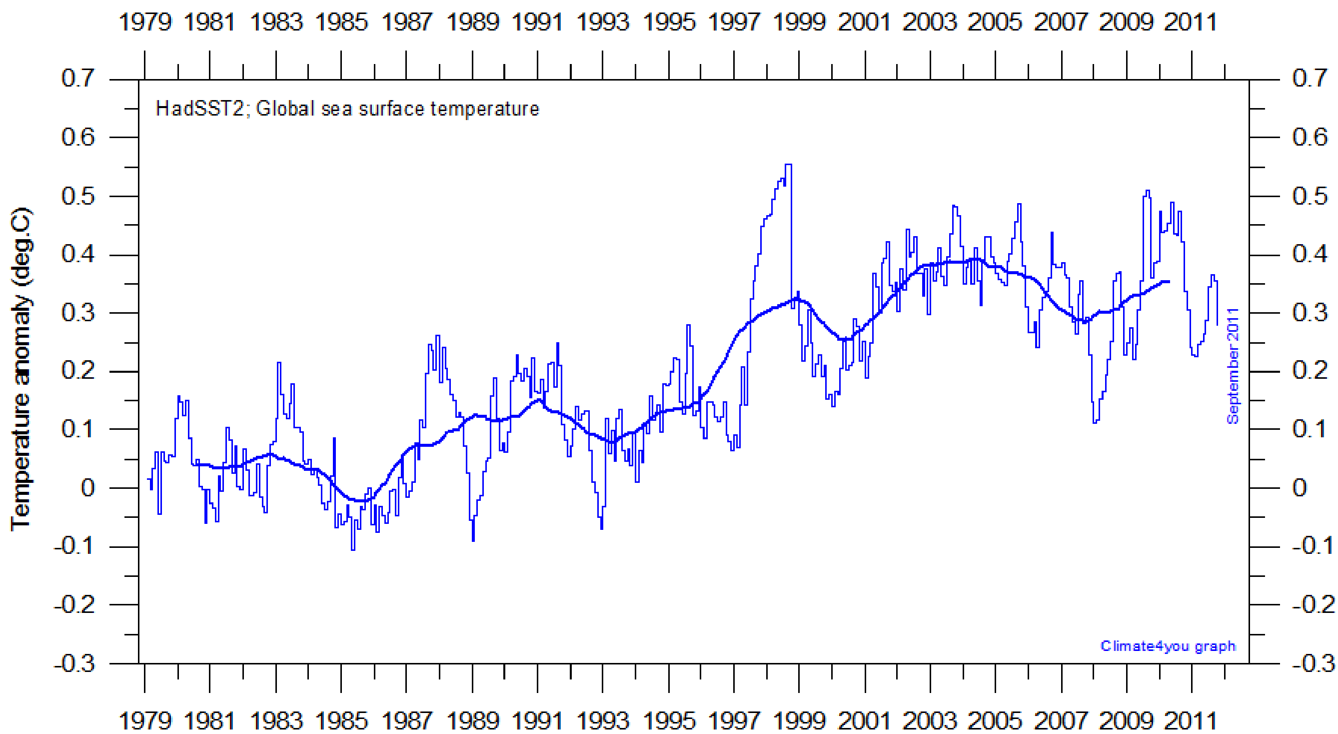
Sea surface temperature anomaly at 27 September 2011. Map source: National Centers for Environmental Prediction (NOAA).

Relative cold surface water dominates the regions near Equator, especially in the eastern Pacific Ocean, and represents remnants of the previous La Niña, which faded away in the spring 2011. At the moment it is not looking as if a new El Niño is going to materialise. Because of the large surface areas involved near Equator, the relatively cold surface water affects the global atmospheric temperature now and presumably also in the months to come.

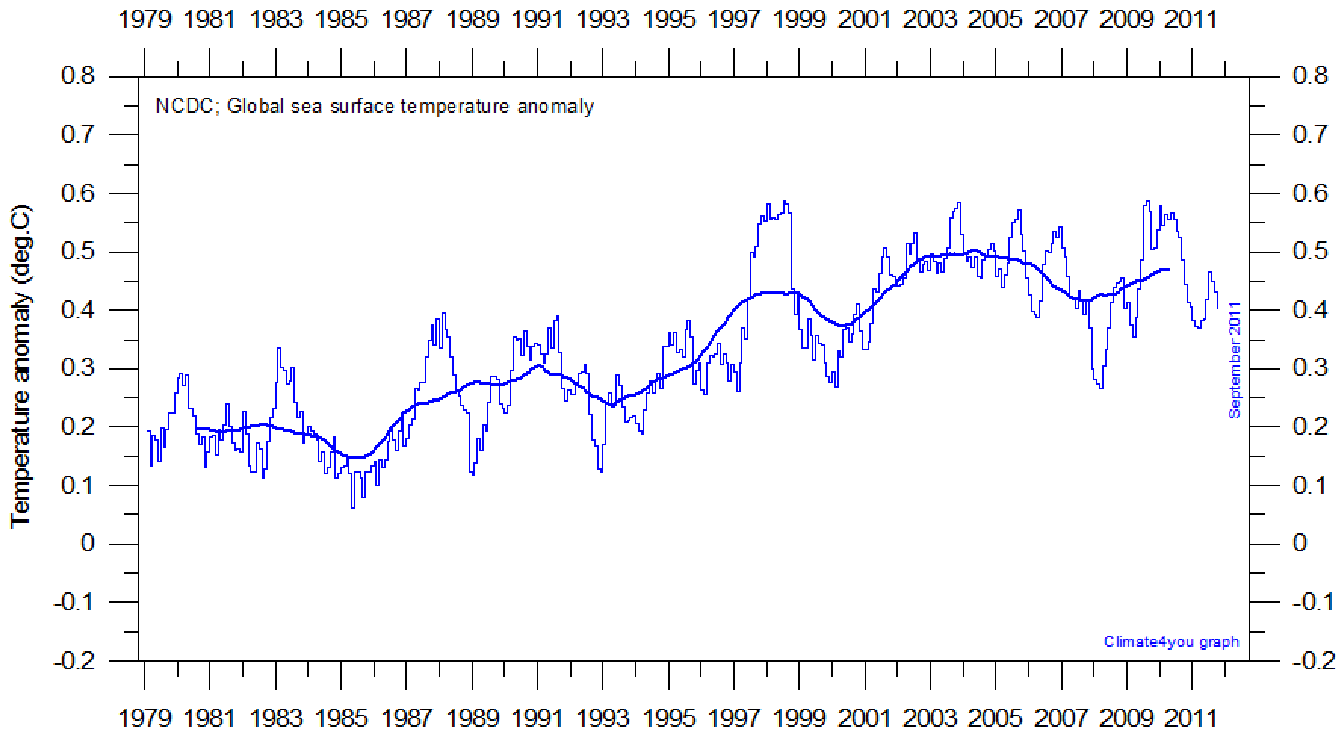
The significance of any warming or cooling seen in surface air temperatures should not be over stated. Whenever Earth experiences cold La Niña or warm El Niño episodes (Pacific Ocean) major heat exchanges takes place between the Pacific Ocean and the atmosphere above, eventually showing up in estimates 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 the above heat exchange mainly reflects a 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.

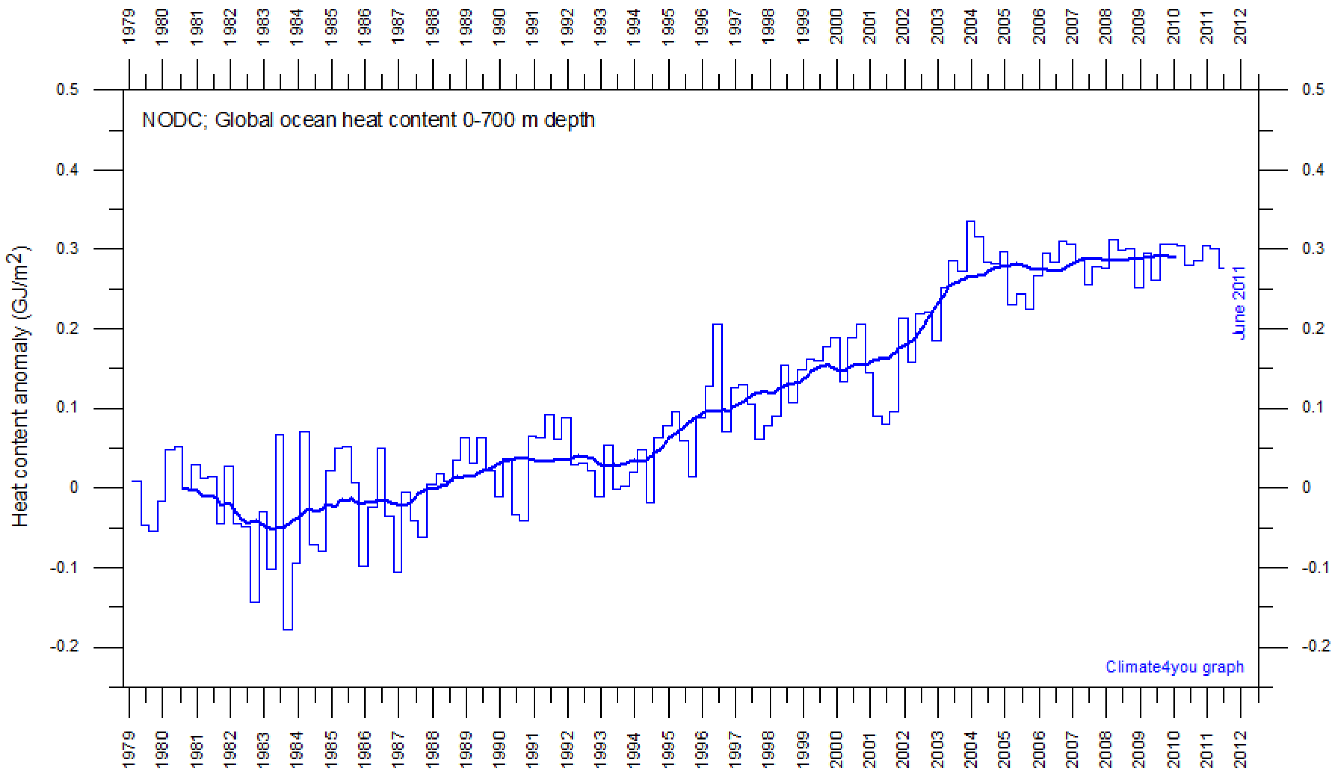


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit](#) ([CRU](#)), UK. Base period: 1961-1990. The thick line is the simple running 37 month average.

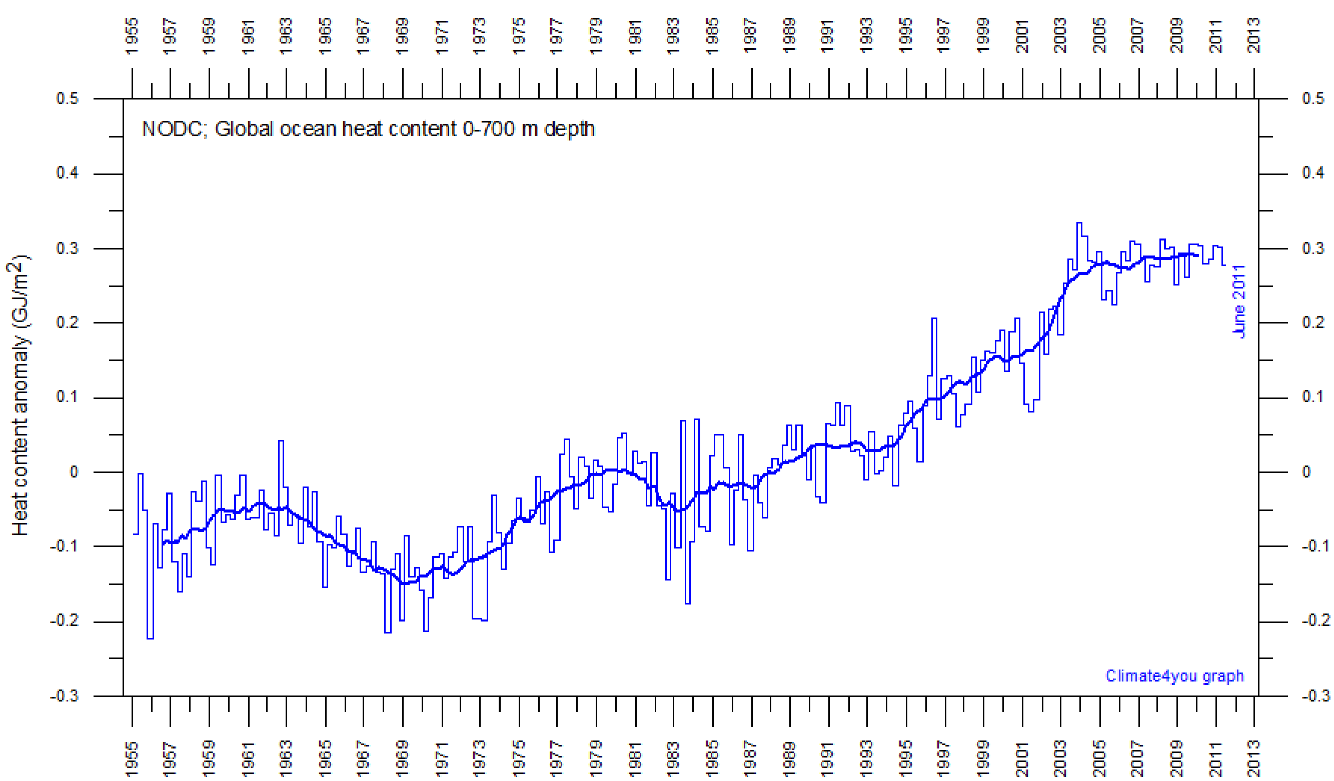


Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center](#) (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37 month average.

Global ocean heat content, updated to June 2011

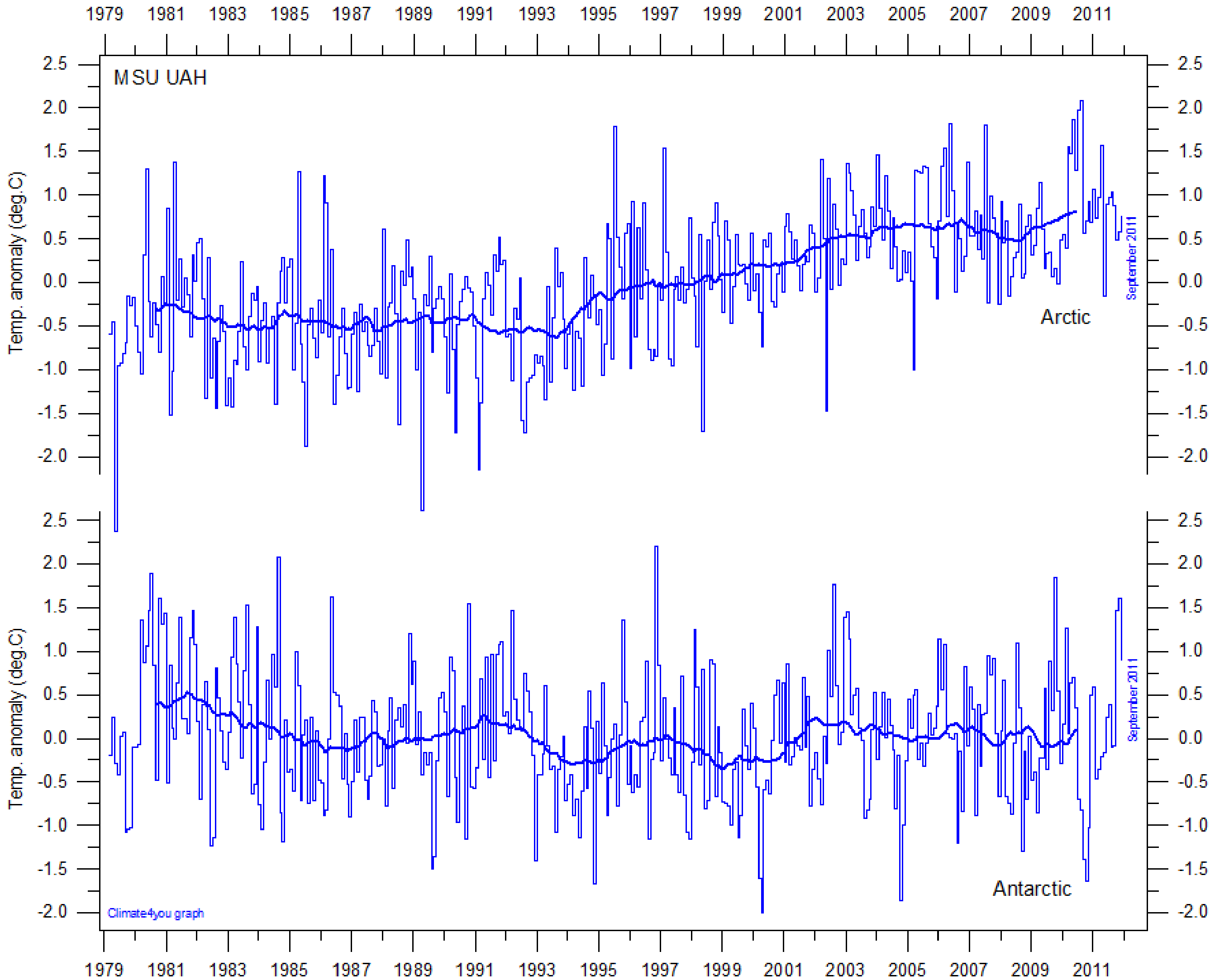


Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



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 September 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 August 2011](#)

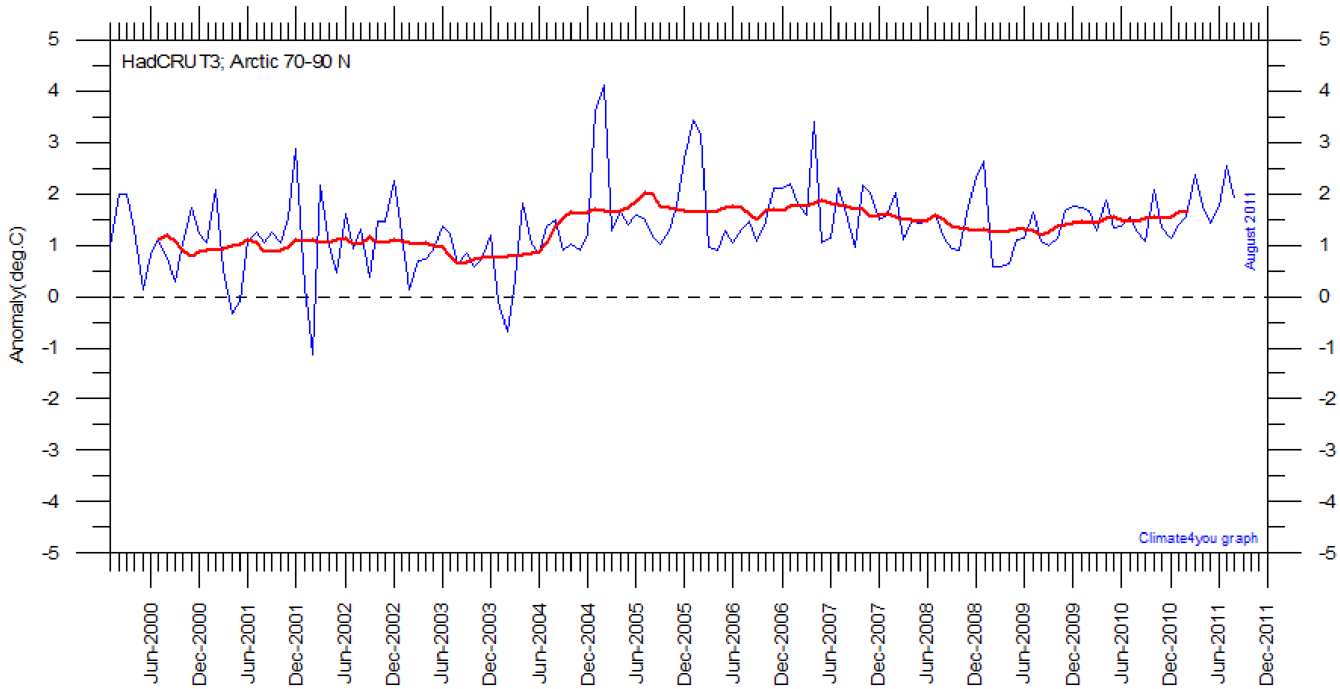


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre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

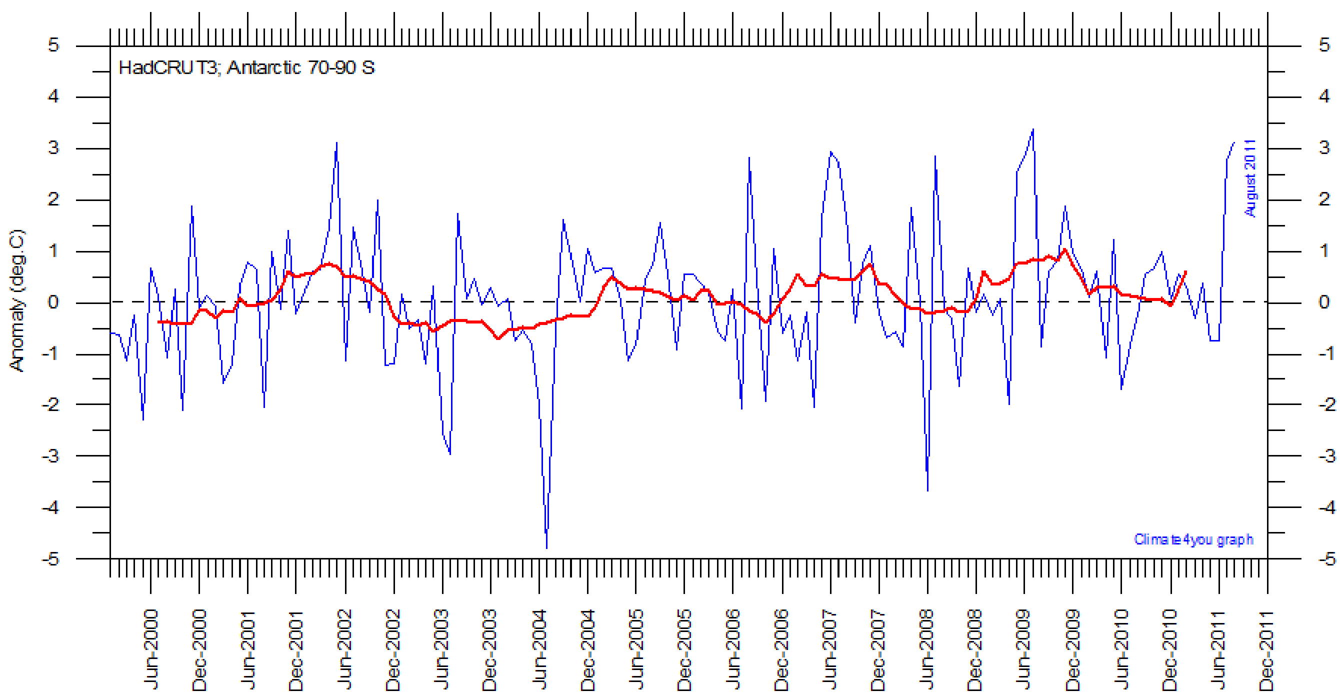


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley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

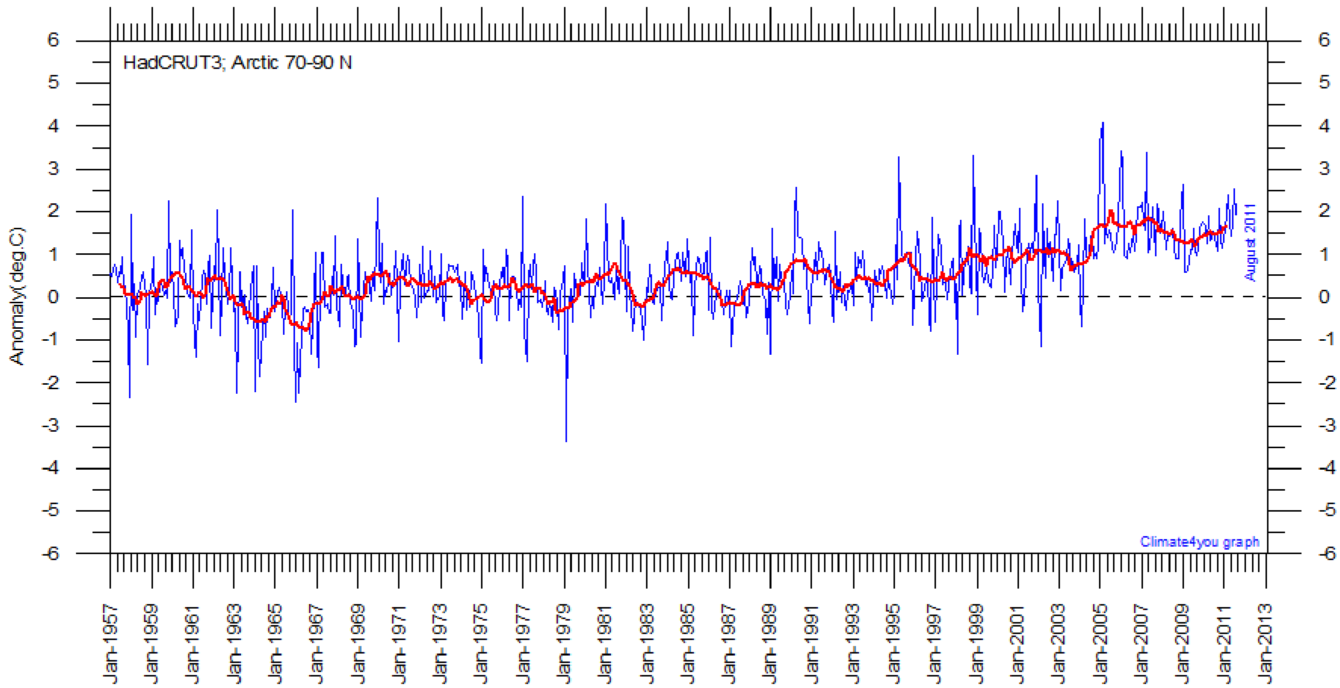


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 has been chosen as starting year, to ensure easy comparison with the maximum length of the realistic Antarctic temperature record shown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

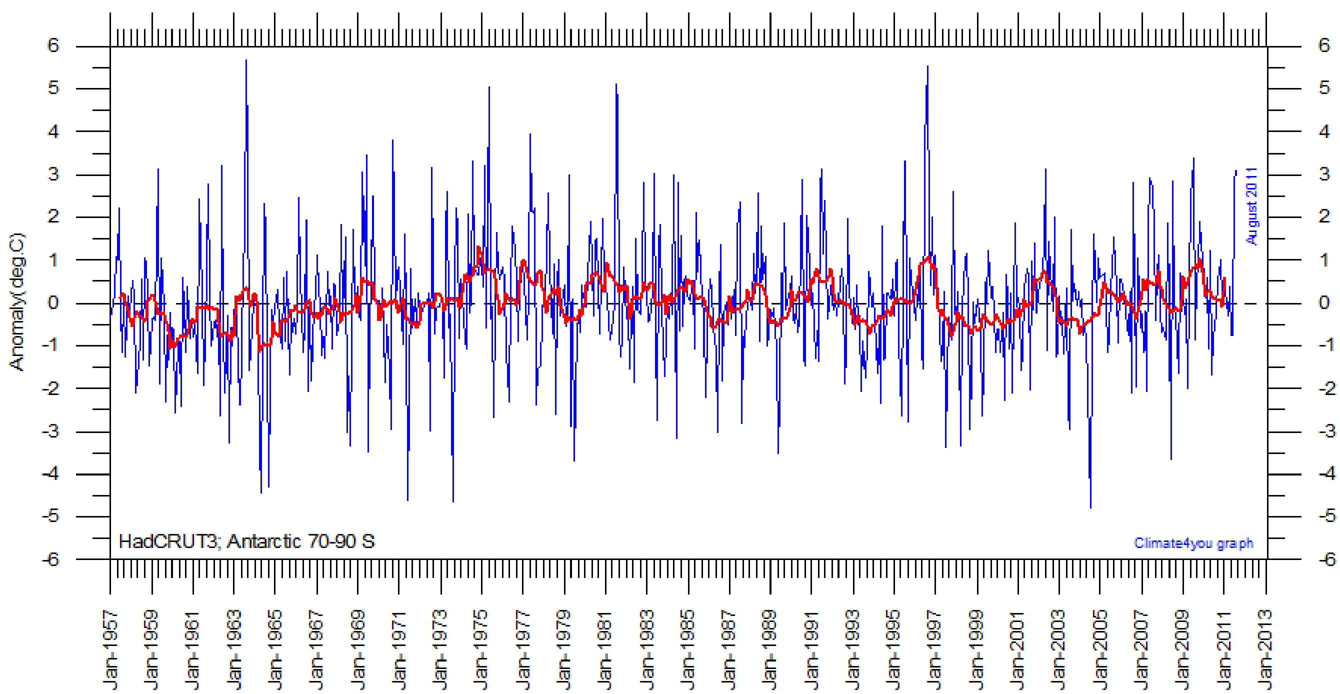


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 was an international geophysical year, and several meteorological stations were established in the Antarctic because of this. Before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

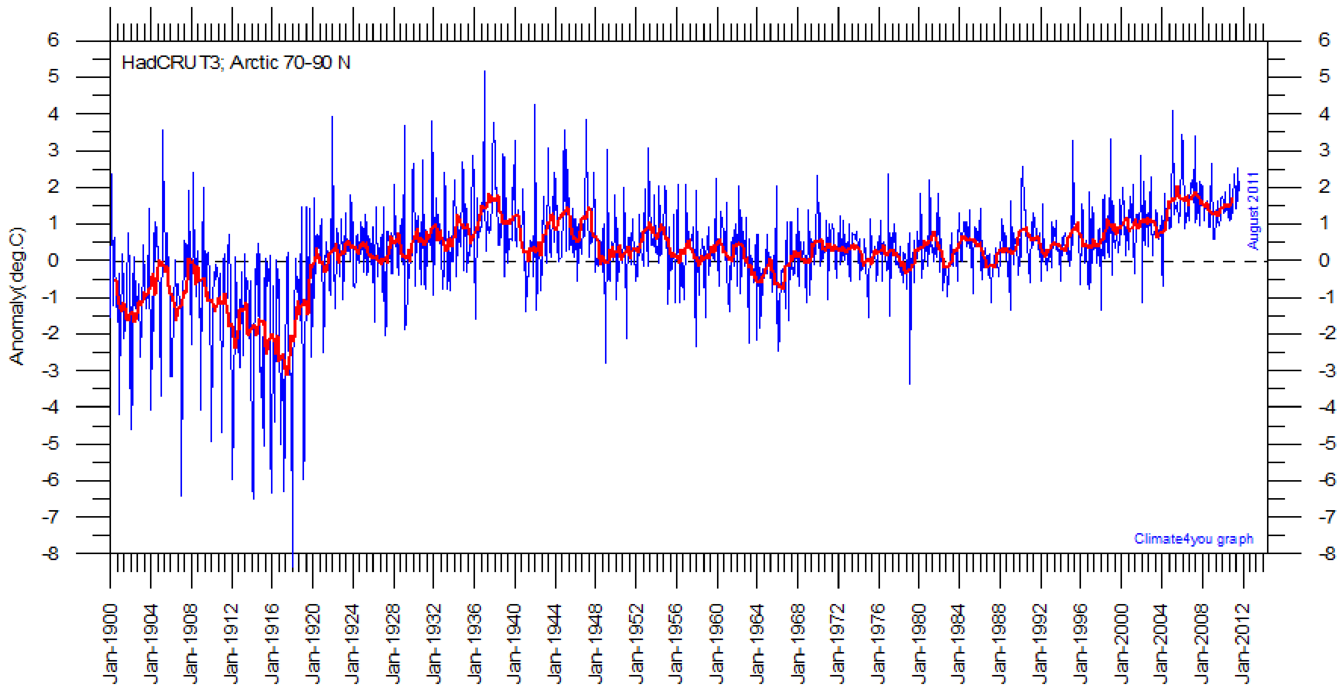


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1900, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. In general, the range of monthly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

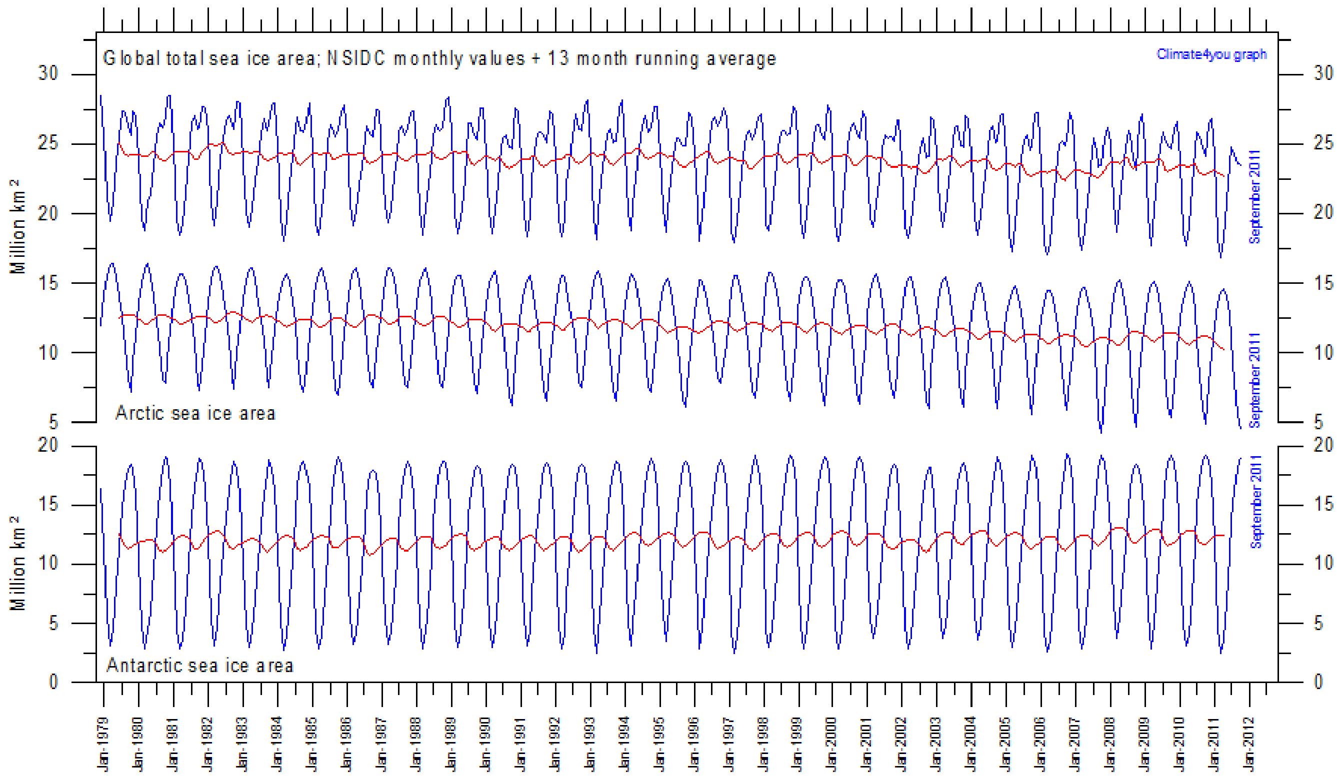
In general, the Arctic temperature record appears to be less variable than the Antarctic record, presumably at least partly due to the higher number of meteorological stations north of 70°N, compared to the number of stations south of 70°S.

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.

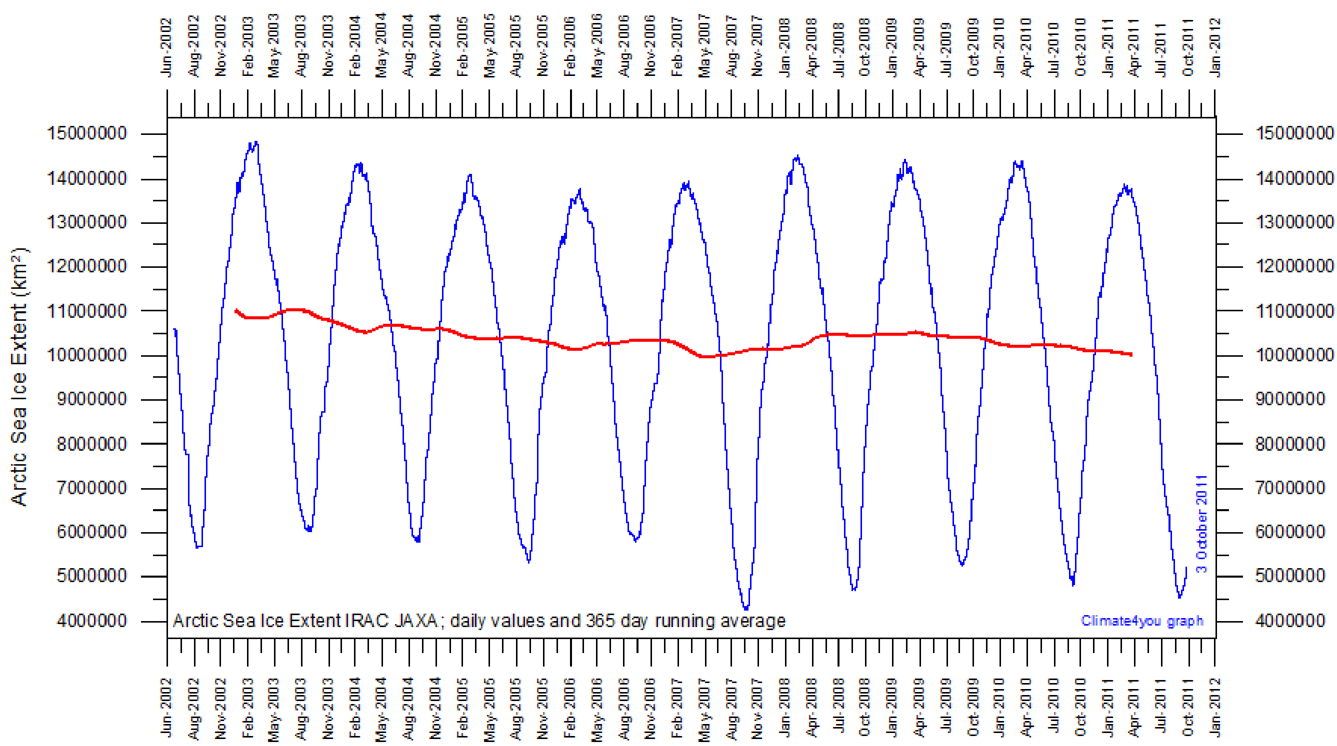
Literature:

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.

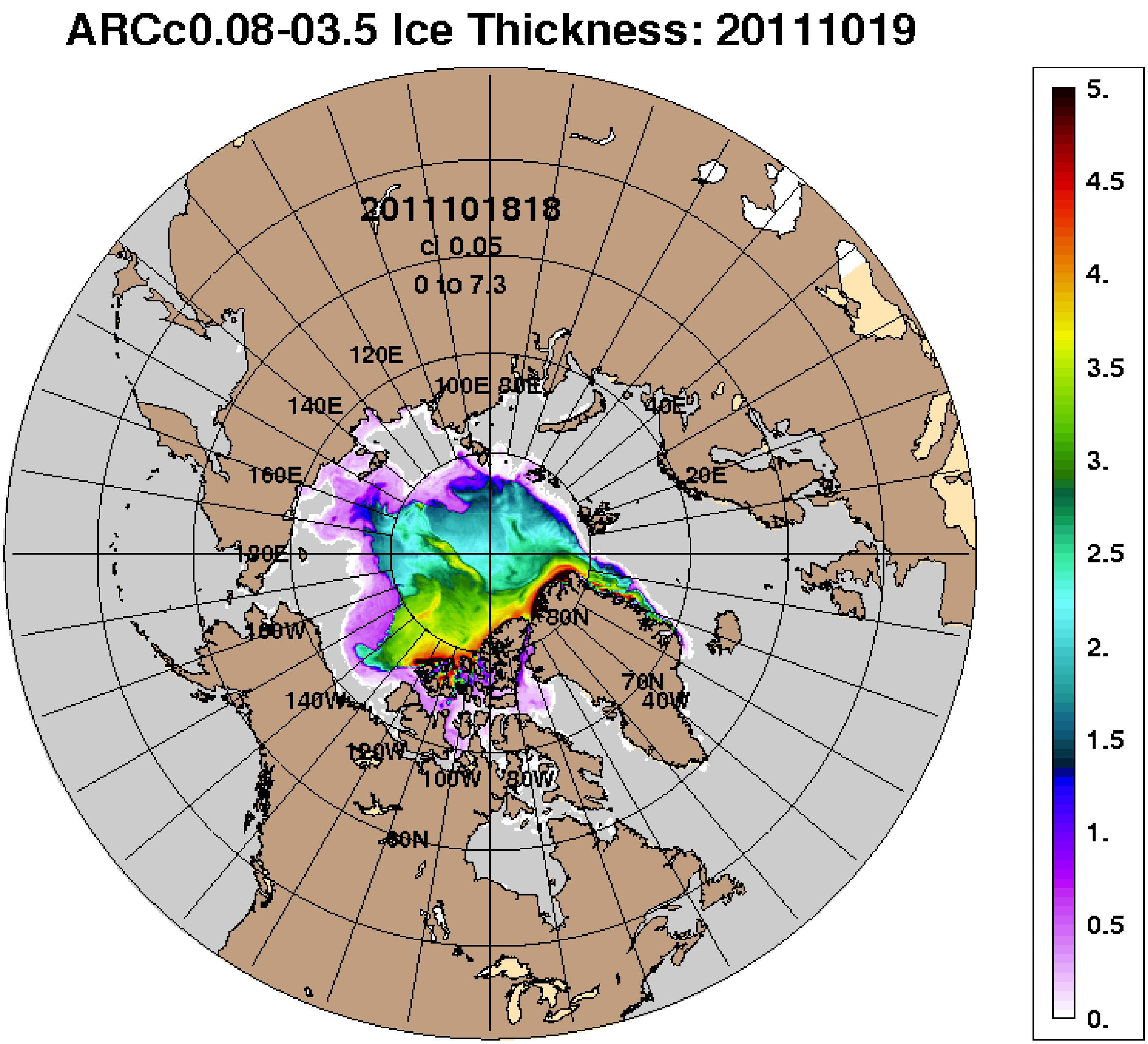
[Arctic and Antarctic sea ice, updated to September 2011](#)



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

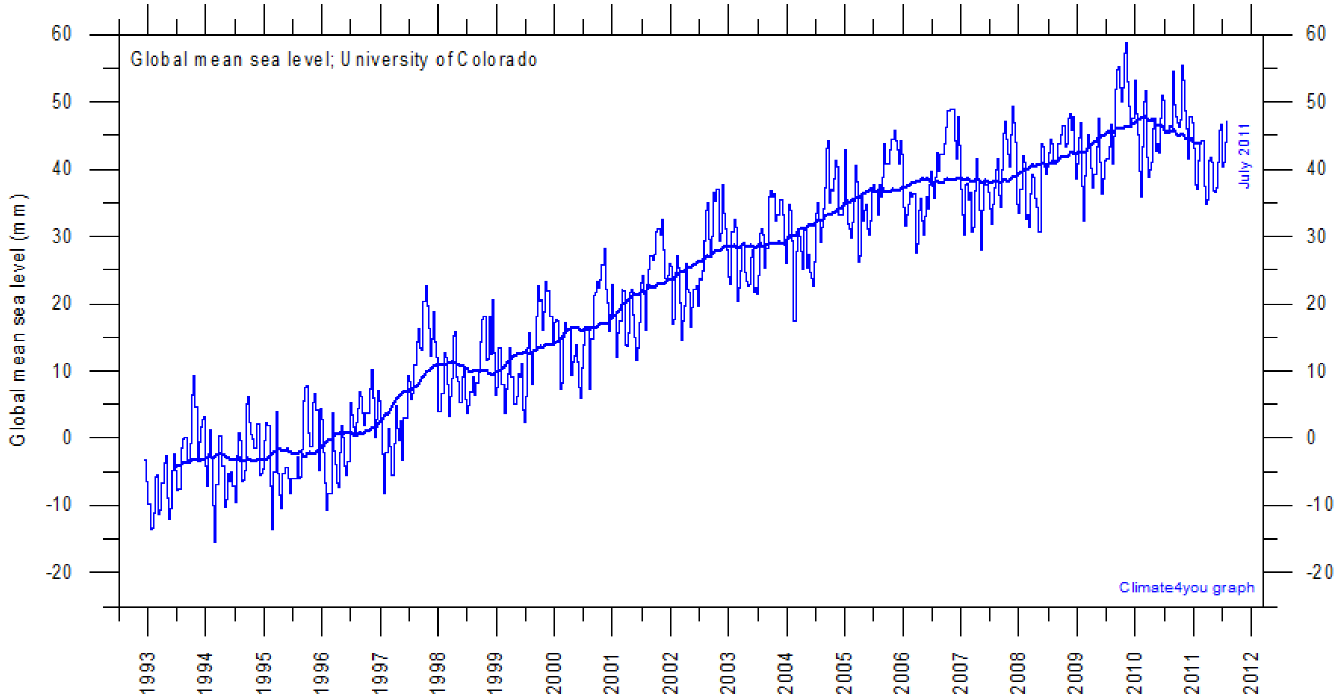


Graph showing daily Arctic sea ice extent since June 2002, to October 3, 2011, by courtesy of [Japan Aerospace Exploration Agency](#) (JAXA).

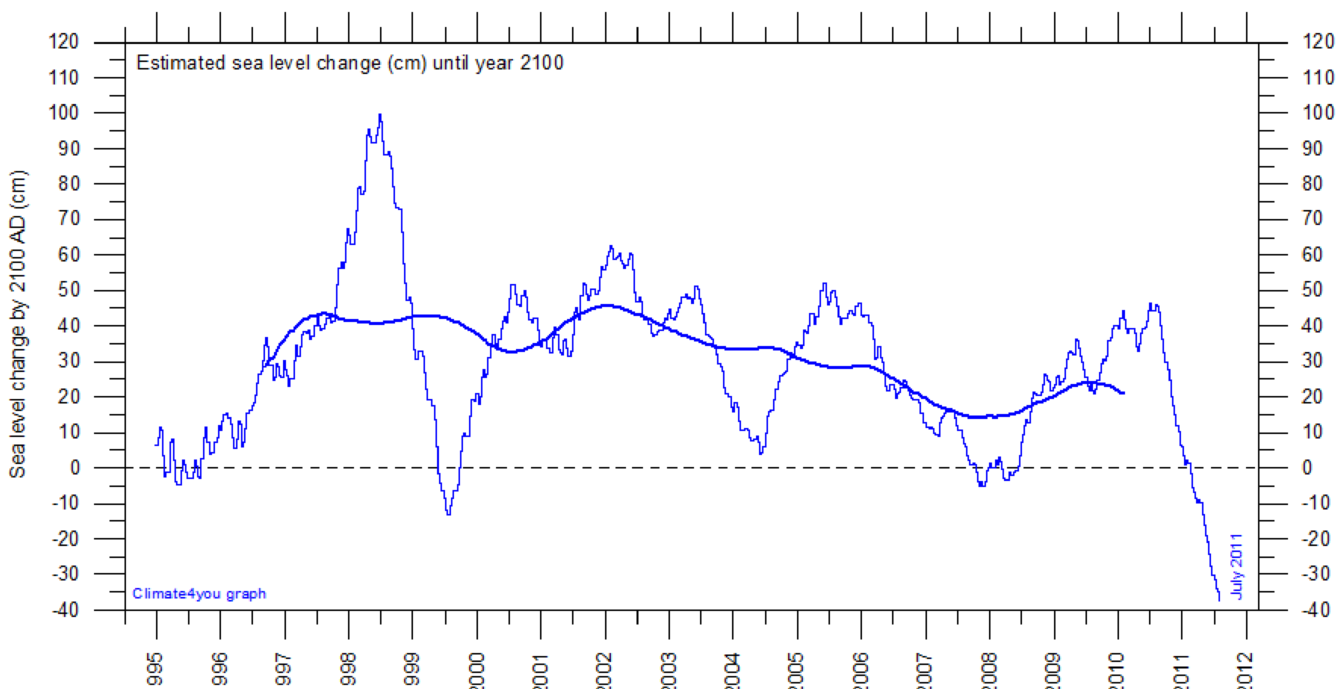


Northern hemisphere sea ice thickness on 19 October 2011 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) is shown to the right.

[Global sea level, updated to July 2011](#)

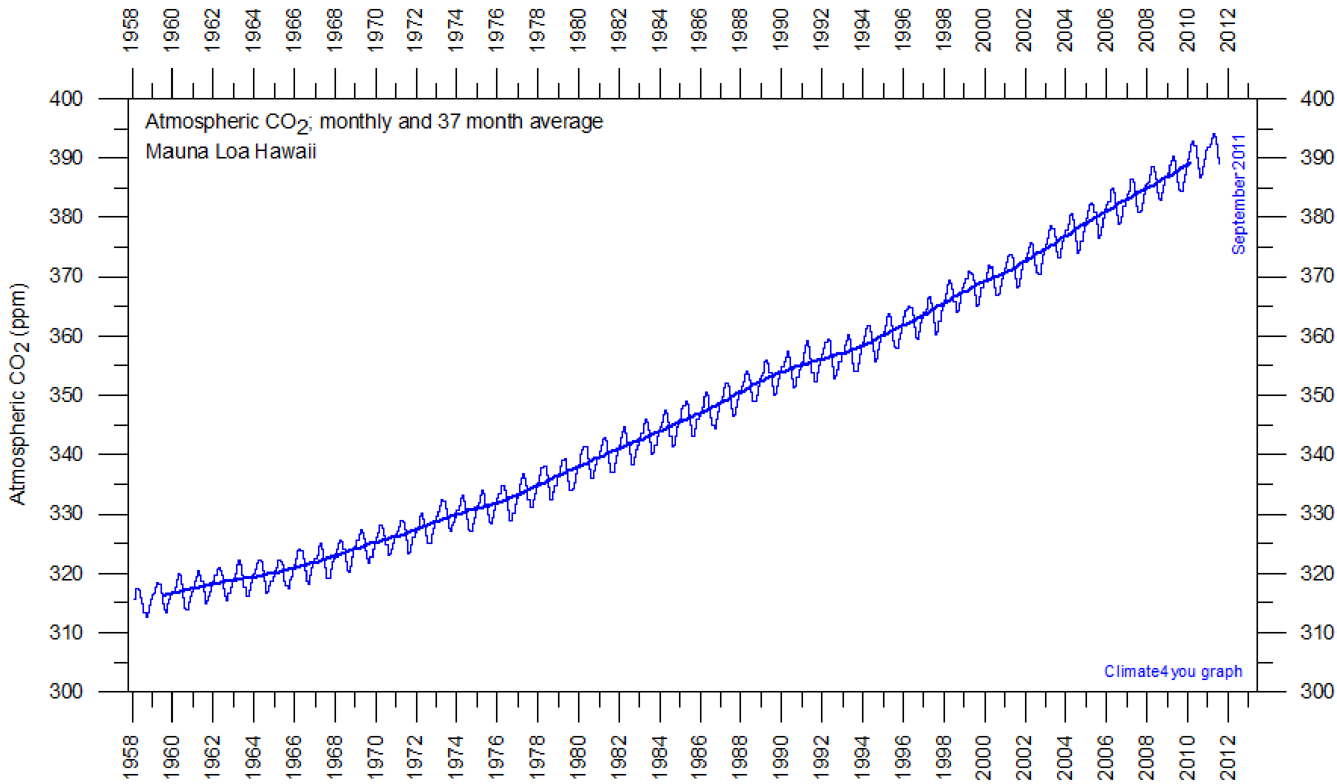


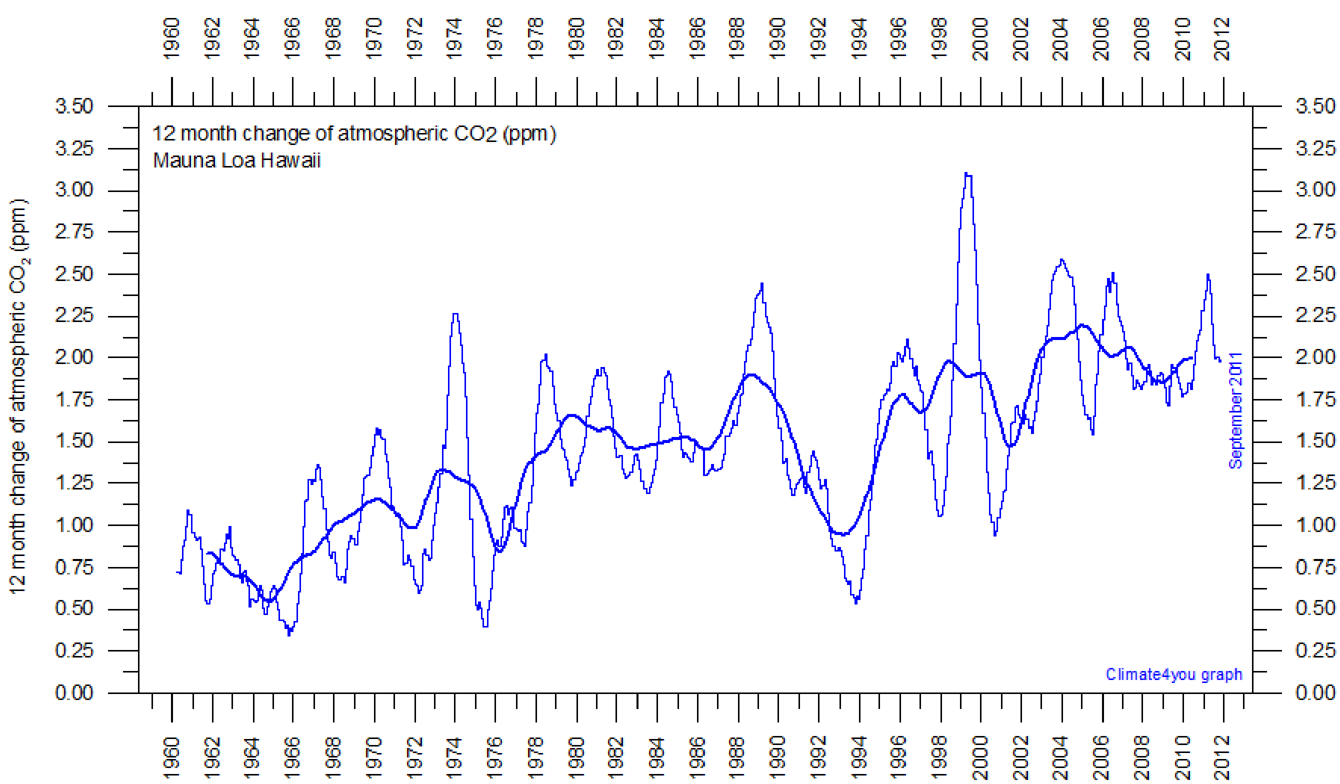
Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](#), USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.



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.

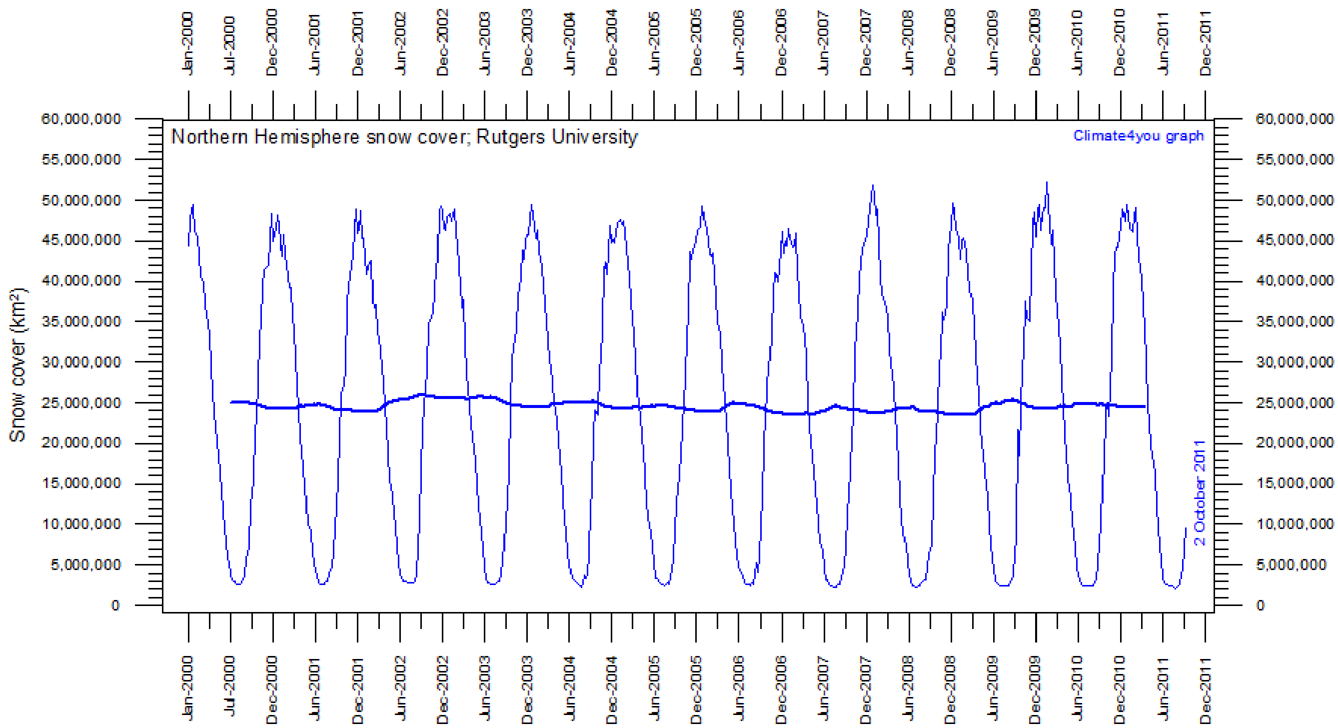
Atmospheric CO_2, updated to September 2011



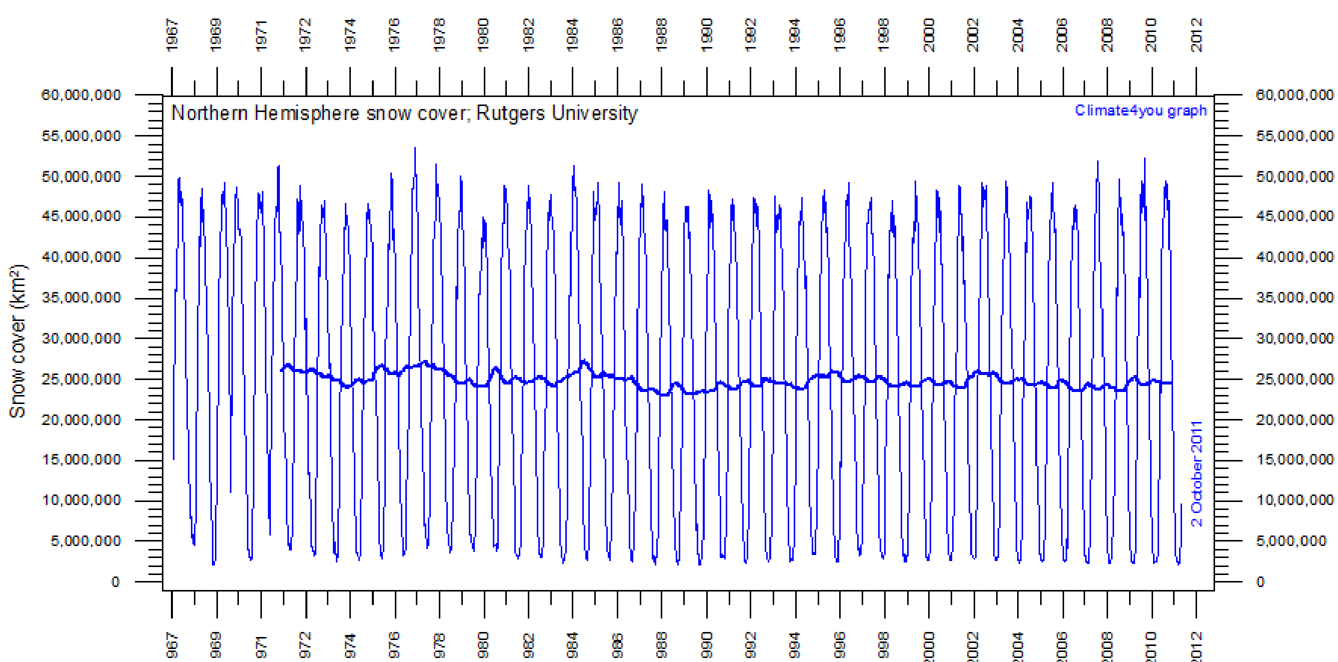


Monthly amount of atmospheric CO_2 (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO_2 since 1959, according to data provided by the Mauna Loa Observatory, Hawaii, USA. The thick line is the simple running 37 observation average, nearly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

Northern Hemisphere weekly snow cover, updated to early October 2011

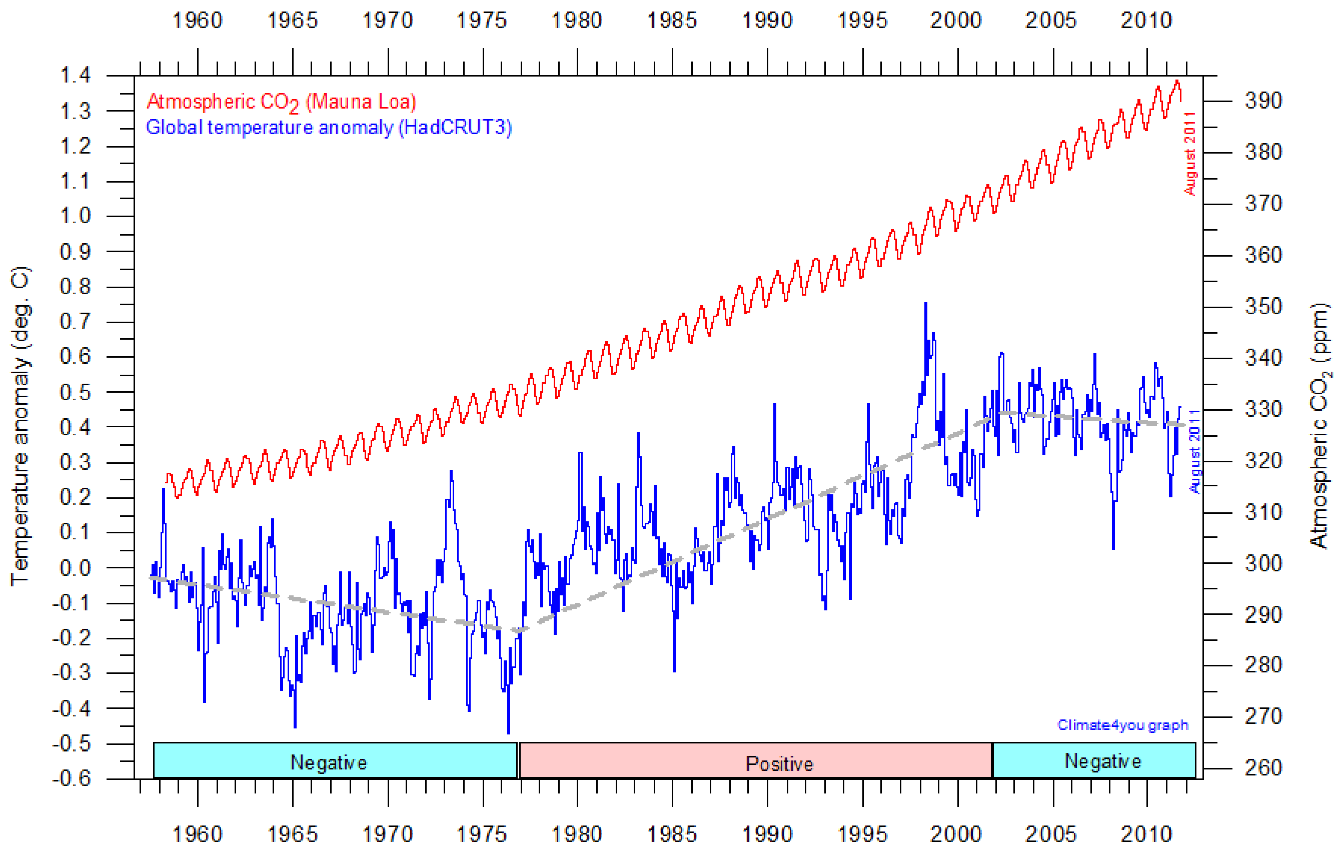


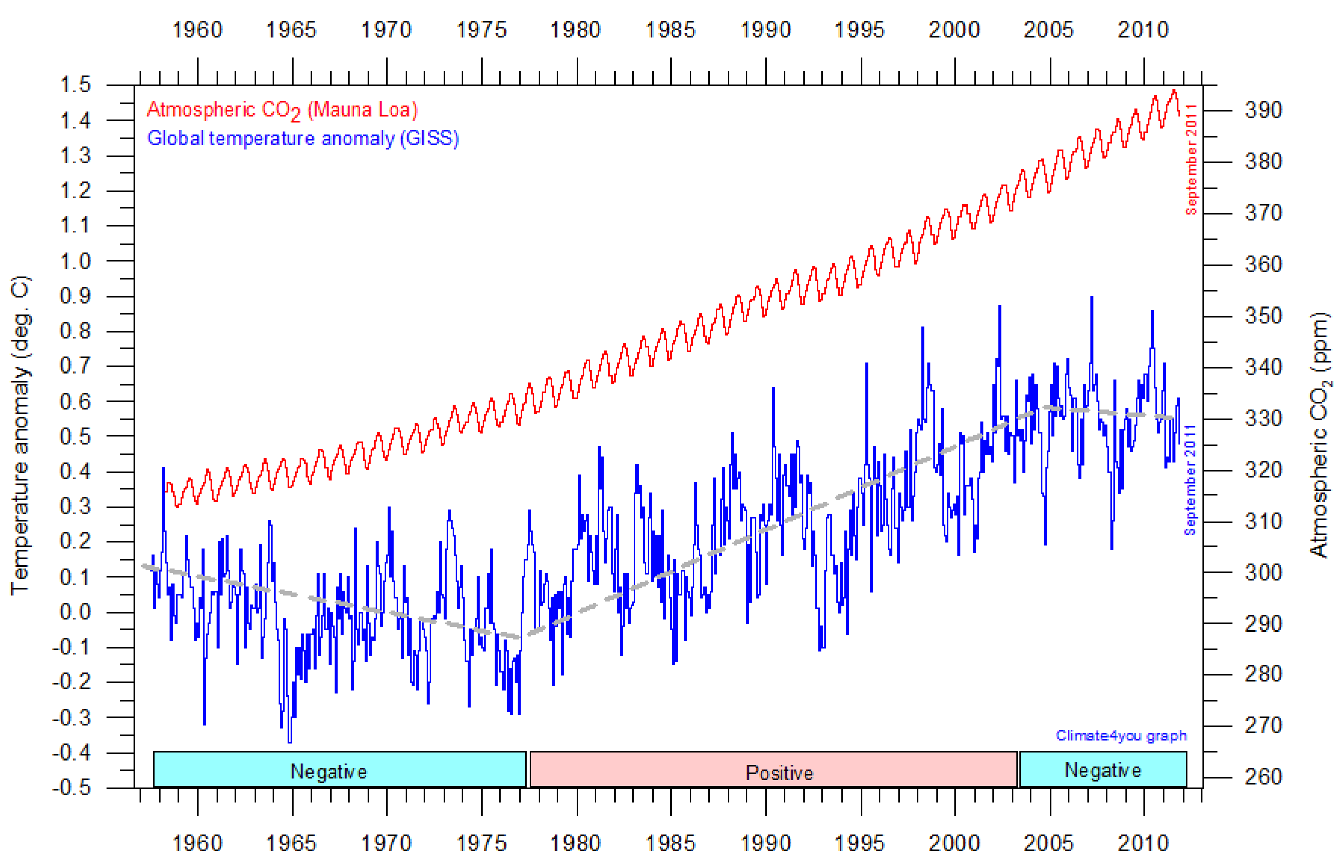
Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin line is the weekly data, and the thick line is the running 53 week average (approximately 1 year).

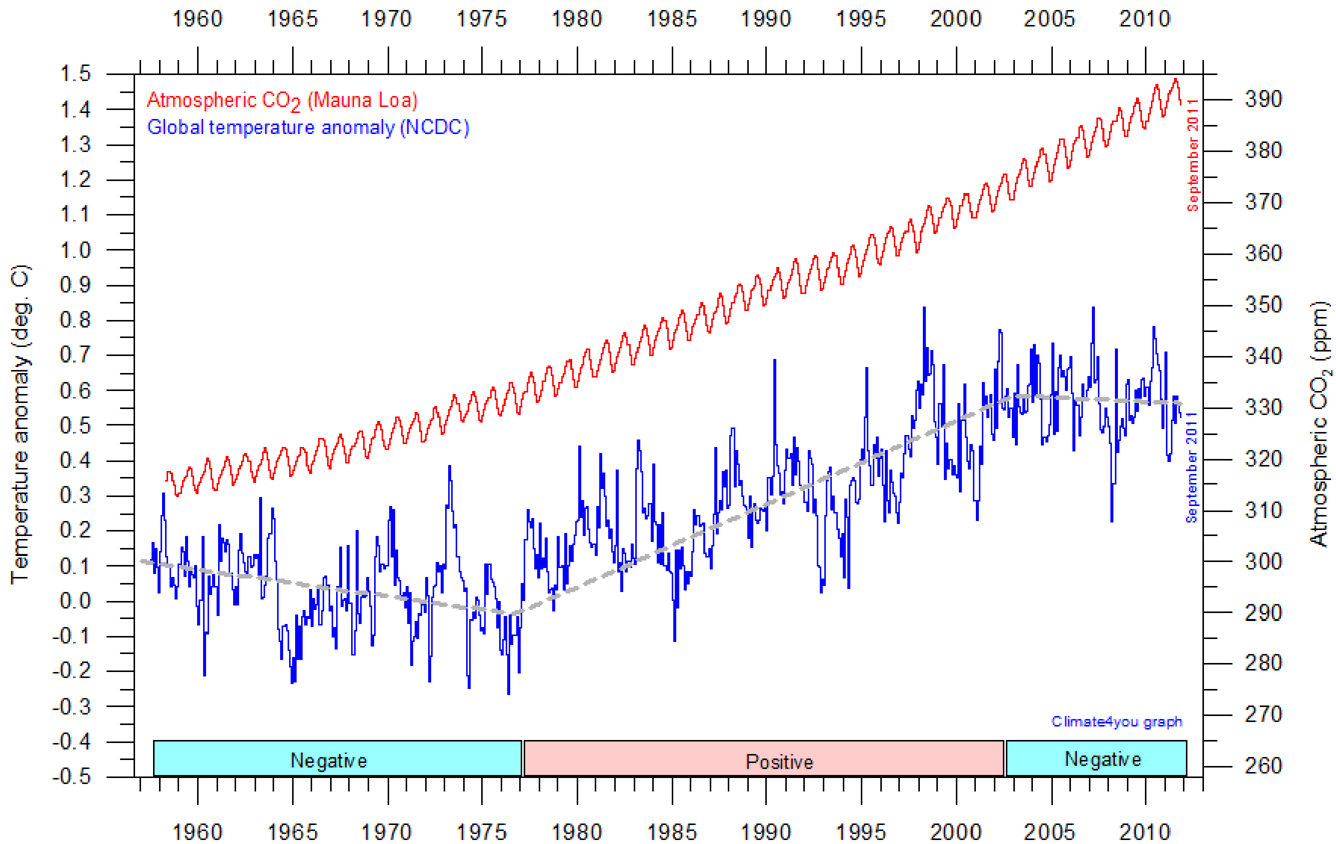


Northern hemisphere weekly snow cover since October 1966 according to Rutgers University Global Snow Laboratory. The thin line is the weekly data, and the thick line is the running 53 week average (approximately 1 year). The running average is not calculated before 1971 because of some data irregularities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

Global surface air temperature and atmospheric CO_2, updated to September 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 record is only updated to August 2011.

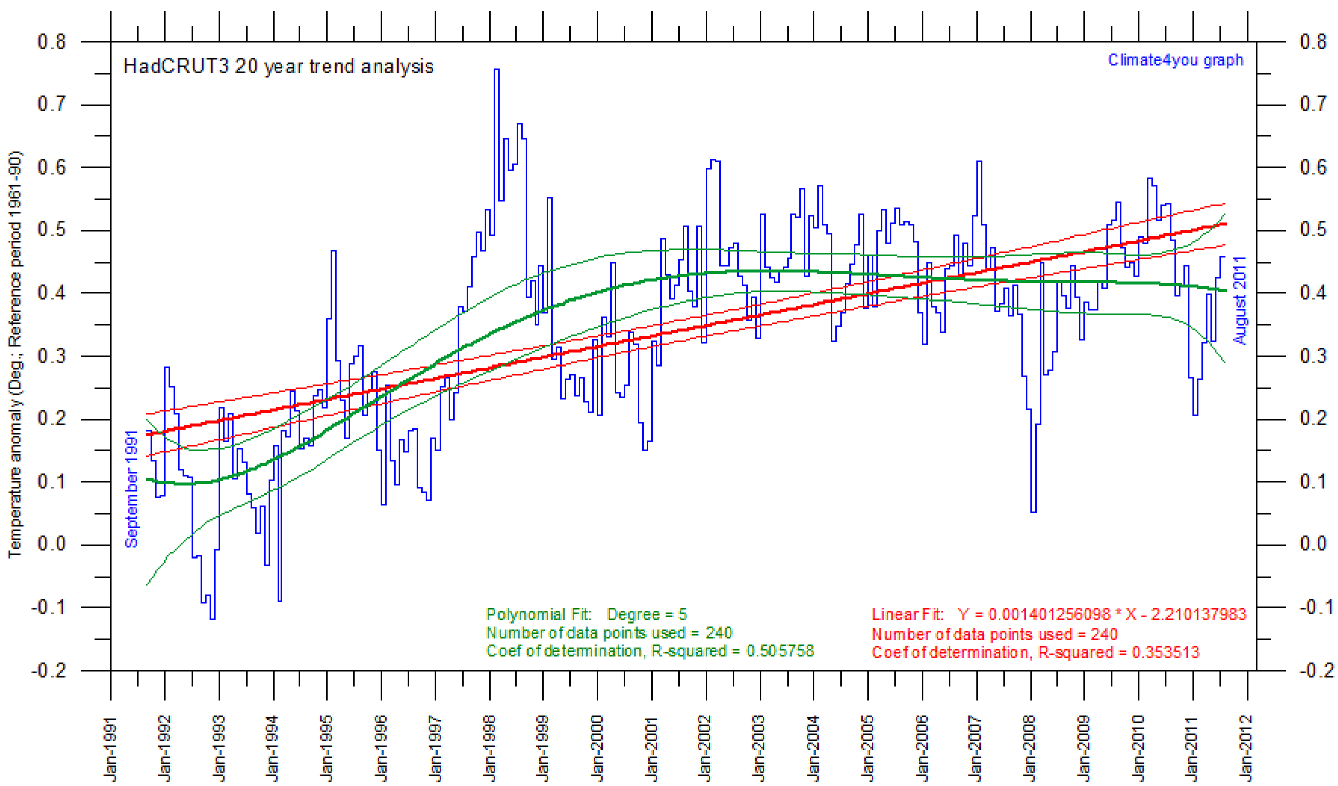
Most climate models assume the greenhouse gas carbon dioxide CO_2 to influence significantly upon global temperature. Thus, it is relevant to compare the different global temperature records with measurements of atmospheric CO_2, as shown in the diagrams above. Any comparison, however, should not be 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 August 2011

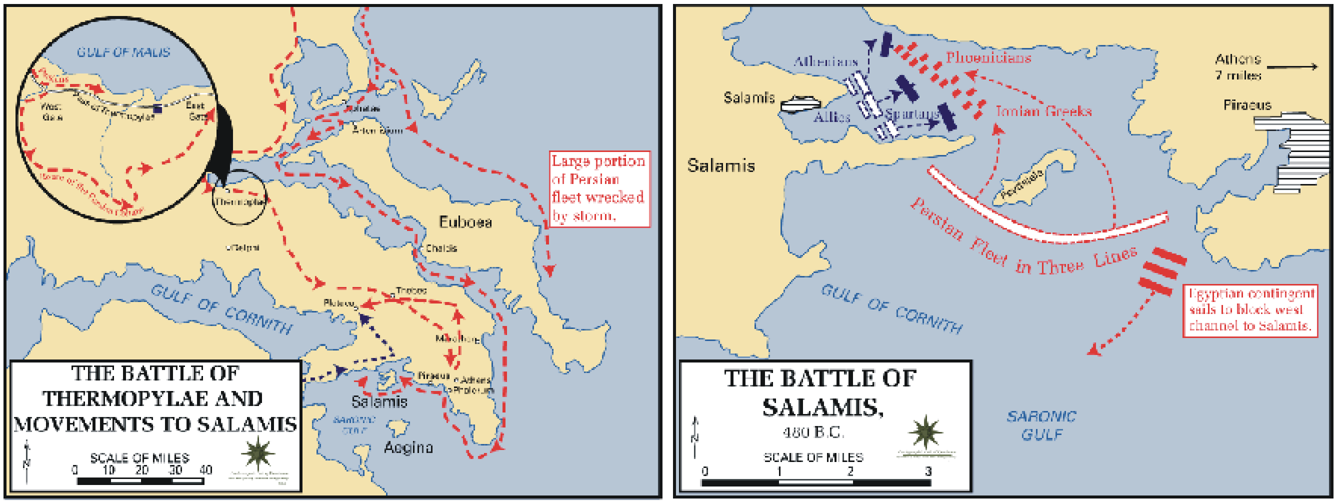


Last 20 years global monthly average surface air temperature according to Hadley CRUT, a cooperative effort between the [Hadley Centre for Climate Prediction and Research] and the [University of East Anglia]'s [Climatic Research Unit] ([CRU]), UK. The thin blue line represents the monthly values. The 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: August 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]()

480 BC: Battle of Salamis



Maps showing movement of the Persian army and navy (red) during the second Persian invasion of Greece 480 BC.

The Battle of Salamis was fought between an Alliance of Greek city-states and the Persian Empire (lead by king Xerxes) in September 480 BC in the straits between the Greek mainland and Salamis, an island in the Saronic Gulf west of Athens. It marked the high-point of the second Persian invasion of Greece which had begun in 480 BC. The main historical source for the Greco-Persian Wars is the Greek historian Herodotus. Much of the summary below is adopted from different sources in Wikepedia, Ancient Mesopotamia and from Rasmussen 2010, from where additional information is available.

To block the Persian advance, a small force of Greeks blocked the now famous pass of Thermopylae, while an Athenian-dominated Allied navy engaged the Persian fleet in the nearby straits of Artemisium. In the resulting Battle of Thermopylae, the rearguard of the Greek force was annihilated, whilst in the Battle of Artemisium the Greeks had heavy losses and retreated after the loss at Thermopylae. This allowed the Persians to conquer much of present-day Greece, although a large part of their navy was destroyed by a strong storm.

After the Battle of Thermopylae, the Allied Greek forces were in a very difficult position. The Athenians knew that their city would surely be destroyed by the Persians when they arrived. There was simply no place between the Persian forces and Athens where the Allied Greeks dared to risk battle. Most of the Greek fleet was withdrawn to the island of Salamis west of Athens, where they watched their city burn.

Notwithstanding the grave military situation, it was considered important by the Athenian statesman Themistocles to bring the Persian fleet to battle, in the hope that a victory would prevent naval operations against the remaining part of Greece. On his side, the Persian king Xerxes was equally anxious for a decisive battle, knowing that winter would soon be arriving, and making military operations difficult.

King Xerxes therefore decided on a naval assault on the remaining Athenians and their naval forces stationed on and at Salamis. The Persian fleet was weakened somewhat because of losses during the previous storm, but it was still a vastly larger force than the Greeks was able to muster. In total, the Persians had around seven hundred ships, while the

Greeks only had around three hundred operational ships. The Spartans and other Greek allied ground forces were encamped in the Isthmus of Corinth, awaiting the outcome of the sea battle.

King Xerxes was confident of victory. He had his throne placed on a hill overlooking the sea, in part to enjoy his victory and in part also so his commanders would know that their king was watching them closely. The Allied Greek naval forces were led by Themistocles, who was responsible for devising the tactics used during the battle. However, he was not the admiral who carried out the tactical plan; this was done by Eurybiades, a Spartan commander.

At this stage many of the captains of ships of Athen's allies were threatening to sail away to protect their own city states. Not surprisingly, they feared that the much larger Persian fleet would defeat and destroy them. In addition, Eurybiades wanted to move the fleet to the Isthmus of Corinth, where the Allied Greek army were building fortifications.

However, Themistocles used a ruse to prevent the Allied Greek navy from fleeing. First Themistocles tricked Xerxes into separating his fleet by sending part around the island to blockade the Greek fleet in the sound between Salamis and the mainland so the Greek fleet could not escape. The Persians took the bait and sailed into the strait. Now there was nothing to do for Eurybiades and the Allied Greek navy but to accept Salamis as the battlefield and to fight!

King Xerxes overlooking the naval battle at Salamis 480 BC (left). Greek vessels ramming Persian ships (centre and right).

An essential element of Themistocles offensive strategy was based on a local weather forecast. He was well aware of the daily land-sea breeze, a daily shift between onshore and offshore wind.

- A sea-breeze (or onshore breeze) is a wind from the sea that develops over land near coasts. It is formed by increasing temperature differences between the land and water which create a pressure minimum over the land due to its relative warmth and forces higher pressure, cooler air from the sea to move inland.
- The land-breeze (or offshore breeze) develops during the night, when the land cools off quicker than the ocean due to differences in their specific heat values, which forces the dying of the daytime sea breeze. If the land cools below that of the adjacent sea surface temperature, the pressure over the water will be lower than that of the land, setting up a land breeze.
- Usually the strength of the land breeze is weaker than the sea breeze. The land breeze will die once the land warms up again the next morning.
- The land-sea breeze phenomenon will only develop when the regional surface wind pattern is not strong enough to oppose it.

Knowing local conditions, Themistocles expected a sea-breeze to develop shortly after initiating his plan, generating a surface wind towards the Greek mainland, exposing the Persian ships to strong headwinds and waves in the narrow sound between the mainland and the island Salamis and (see map above). The Greek ships were low in their construction, and for that reason stable. In contrast, the Persian ships were of higher construction, and therefore less stable and more difficult to manoeuvre in heavy seas.

The second element of Themistocles strategy was to order the lighter Greek ships rowed out in a circular fashion around the Persian vessels, after which they rammed the Persian vessels by their pointed stern. In the developing sea battle, the waves, the wind, the speed and manoeuvrability of the Greek ships and their knowledge of the local conditions enabled them to sink no less than two hundred of the Persian ships. Some of the Persian ships were captured and the rest fled back to their bases in Asia Minor. King Xerxes, upon seeing this great defeat at Salamis, headed back to Persia with what was left of his navy and part of his army. After the battle Eurybiades was opposed to chasing the Persian fleet, and also to sailing towards the Hellespont to destroy the bridge of ships that the Persian king Xerxes had built there. He wanted Xerxes to be able to escape, rather than have him remain in Greece where he would possibly renew the land war.

As a result Xerxes retreated to Asia with most of his army, leaving general Mardonius to complete the conquest of Greece. However, the following year, the remainder of the Persian army was decisively beaten at the Battle of Plataea and the Persian navy at the Battle of Mycale. Afterwards the Persian made no more attempts to conquer the Greek mainland.

The battle of Salamis thus mark a turning point in the course of the Greco-Persian wars as a whole; from then onward, the Greek city-states would take the offensive. A number of historians believe that a Persian victory would have restricted the development of Ancient Greece, and by extension western civilization. It has even been claimed that the sea battle at Salamis is one of the most significant military battles in European history.

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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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