Climate4you update December 2013

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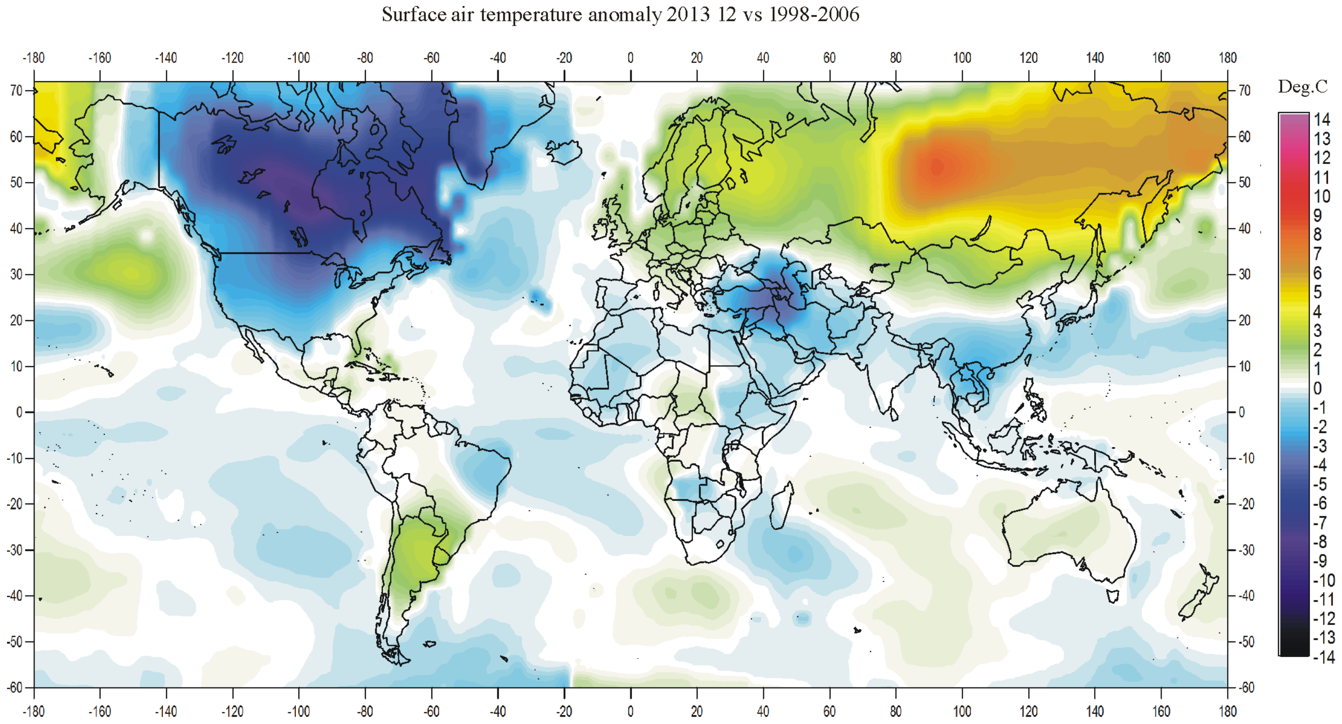
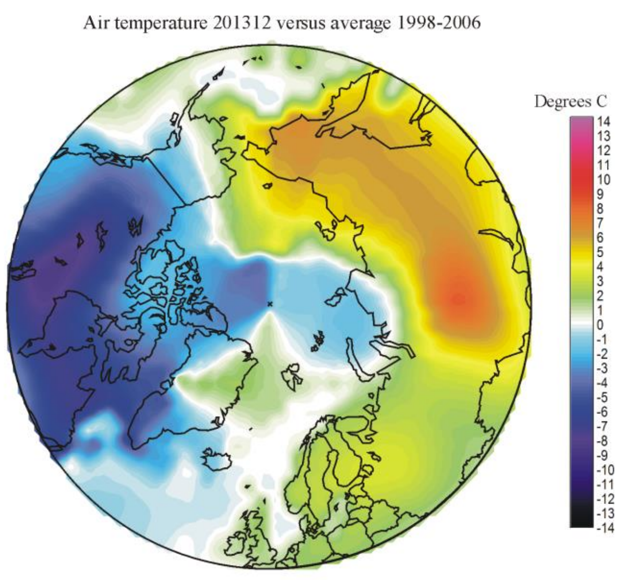
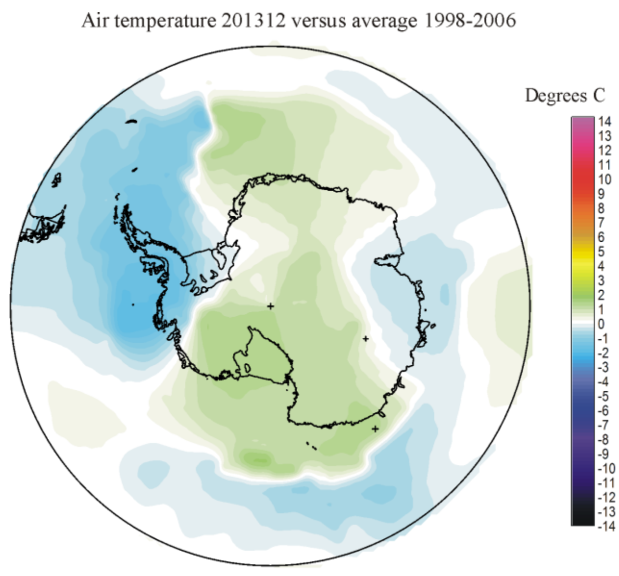
All diagrams in this newsletter as well as links to the original data are available on www.climate4you.com

December 2013 global surface air temperature overview







December 2013 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 2013 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, the GISS temperature data used for preparing the above diagrams show a rather pronounced temporal instability for data before 2000 (see p. 6). Any comparison with the WMO 'normal' period 1961-1990 is therefore influenced by monthly changing values for the so-called 'normal' period, and therefore not suitable as reference using GISS data.

In addition to the above 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 greater detail on www.Climate4you.com.

December 2013 global surface air temperatures

General: In general, global air temperatures were near the 1998-2006 average, and the temperature anomaly pattern to some degree resembles that of November, although with somewhat lower anomaly values.

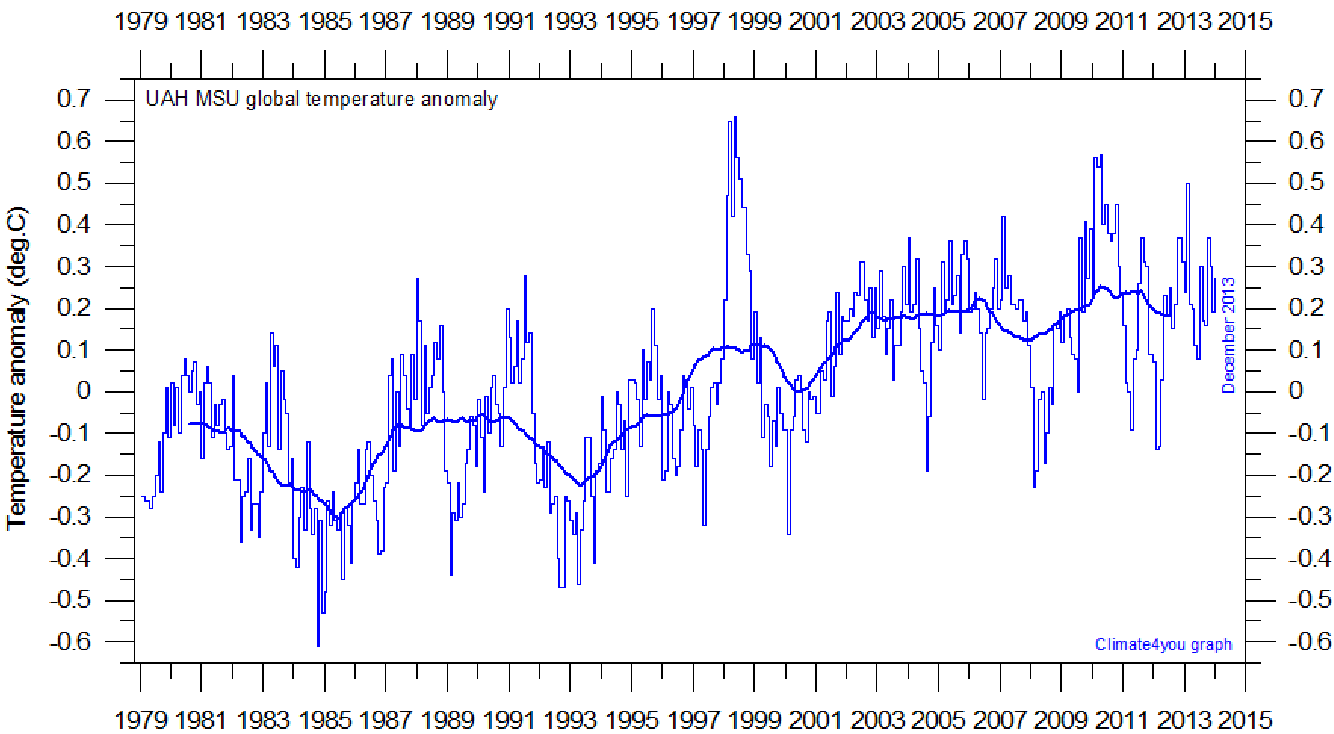
The Northern Hemisphere was characterised by pronounced regional contrasts. Most of North America had below average temperatures, while much of Europe, Russia (including Siberia) enjoyed above average temperatures. The North Atlantic generally had temperatures near or below average. Most of the Arctic has below average temperatures, with the exception of the NE-Greenland-Svalbard sector and most of the Russian-Siberian coastal regions.

Near Equator temperatures conditions were generally below the 1998-2006 average.

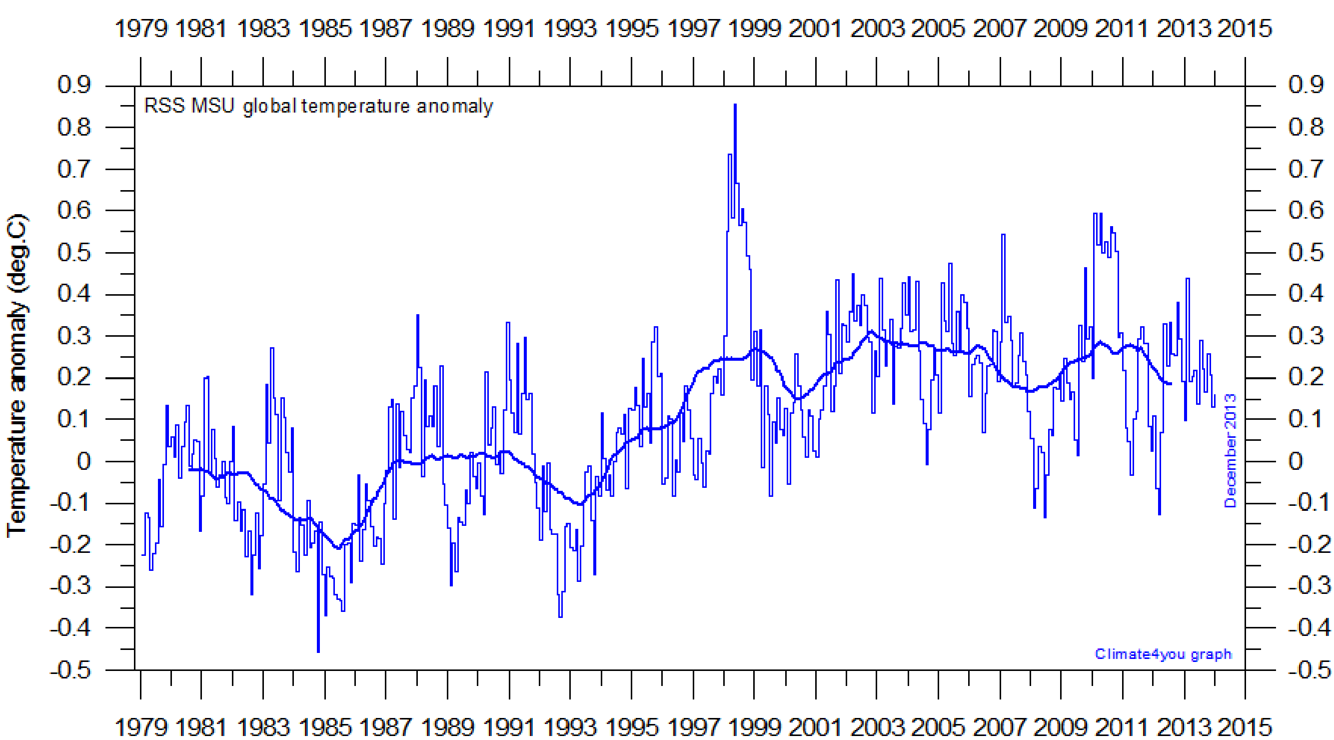
The Southern Hemisphere temperatures was mainly below or near average 1998-2006 conditions. The only major exception from this was the major part of Argentina. Also extensive regions in the Antarctic continent had temperatures slightly above the 1998-2006 average.

The global oceanic heat content has been rather stable since 2003/2004. North Atlantic temperatures are steadily decreasing (page 14).

Lower troposphere temperature from satellites, updated to December 2013

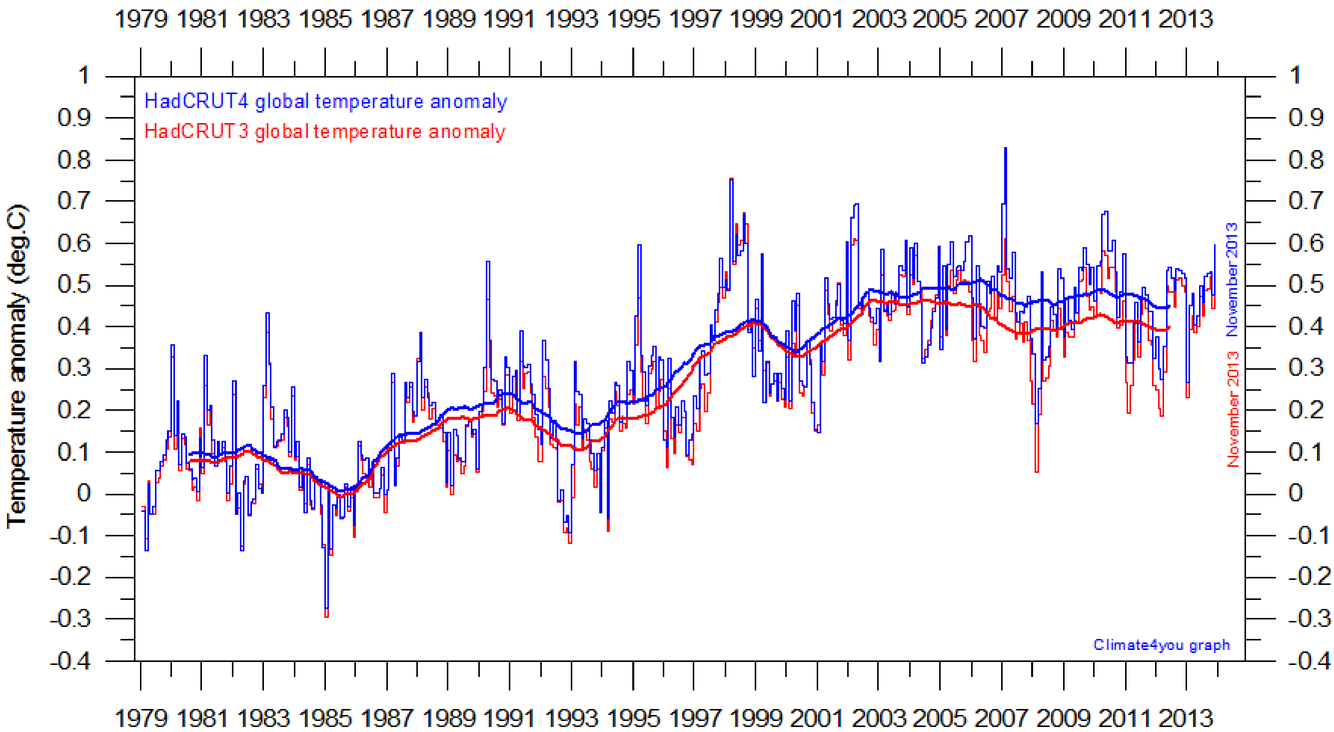


Global monthly average lower troposphere temperature (thin line) since 1979 according to [University of Alabama](#) at Huntsville, USA. The thick line is the simple running 37 month average.

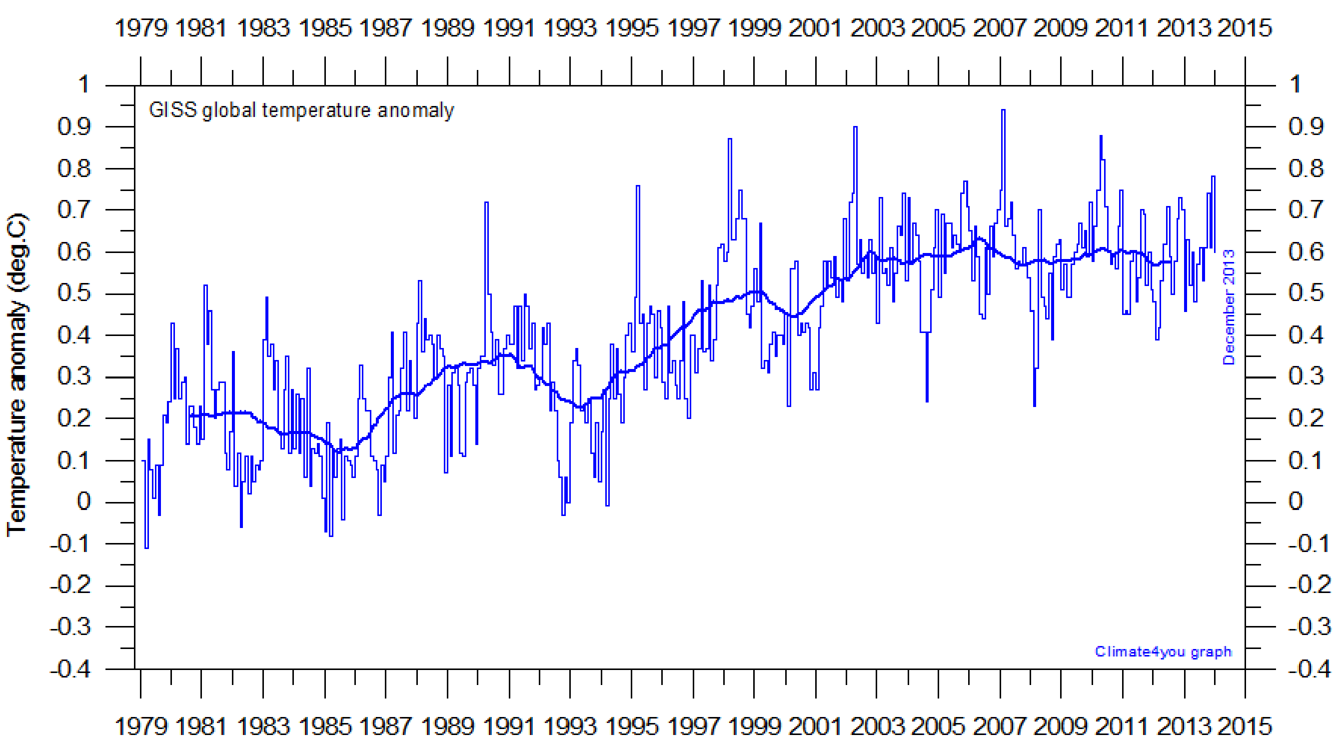


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to [Remote Sensing Systems](#) (RSS), USA. The thick line is the simple running 37 month average.

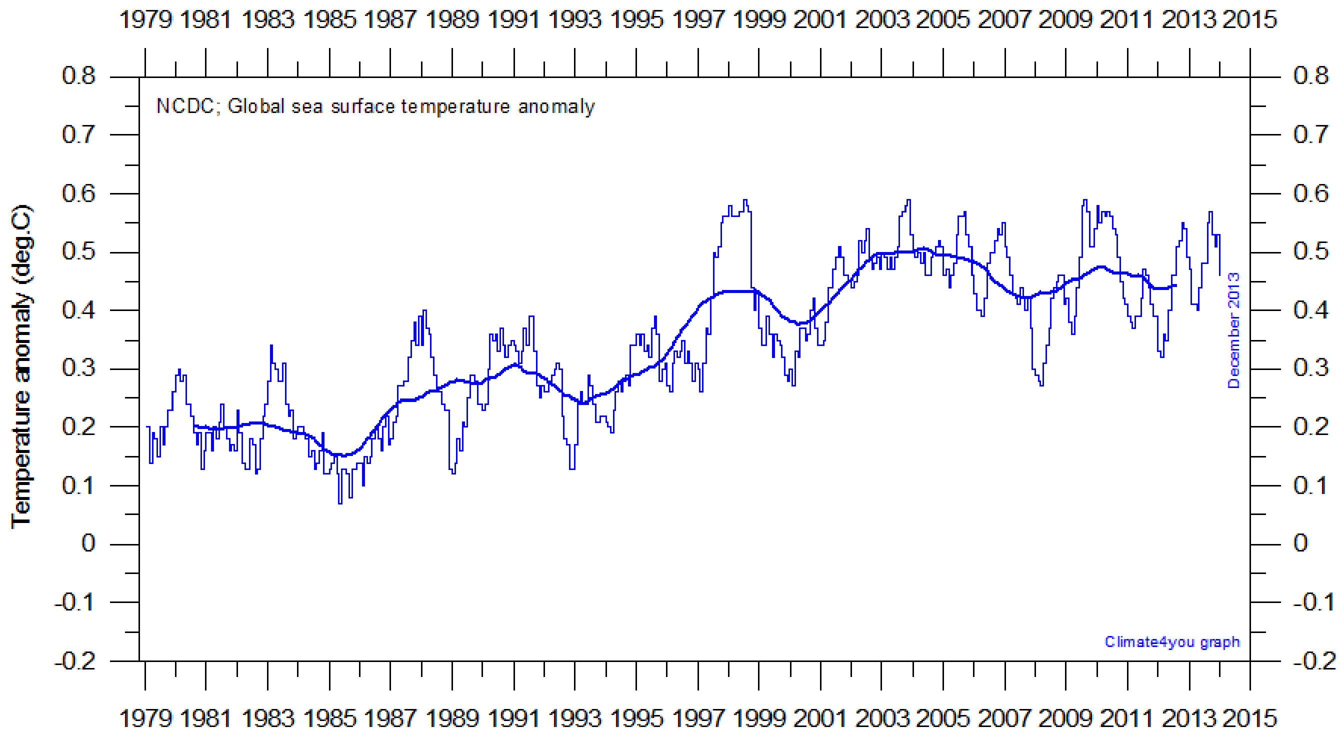
Global surface air temperature, updated to December 2013



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. Version HadCRUT4 (blue) is now replacing HadCRUT3 (red). Please note that this diagram is not yet updated beyond November 2013.



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 supplementary data being added, but actually for all months back to the very beginning of the records. Presumably this reflects recognition of errors, changes in the averaging procedure, and the influence of other phenomena.

None of the temperature records are stable over time (since 2008). The two surface air temperature records, NCDC and GISS, show apparent systematic changes over time. This is exemplified the diagram on the following page showing the changes since May 2008 in the NCDC global surface temperature record for January 1915 and January 2000, illustrating how the difference between the early and late part of the temperature records gradually is growing by administrative means.

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

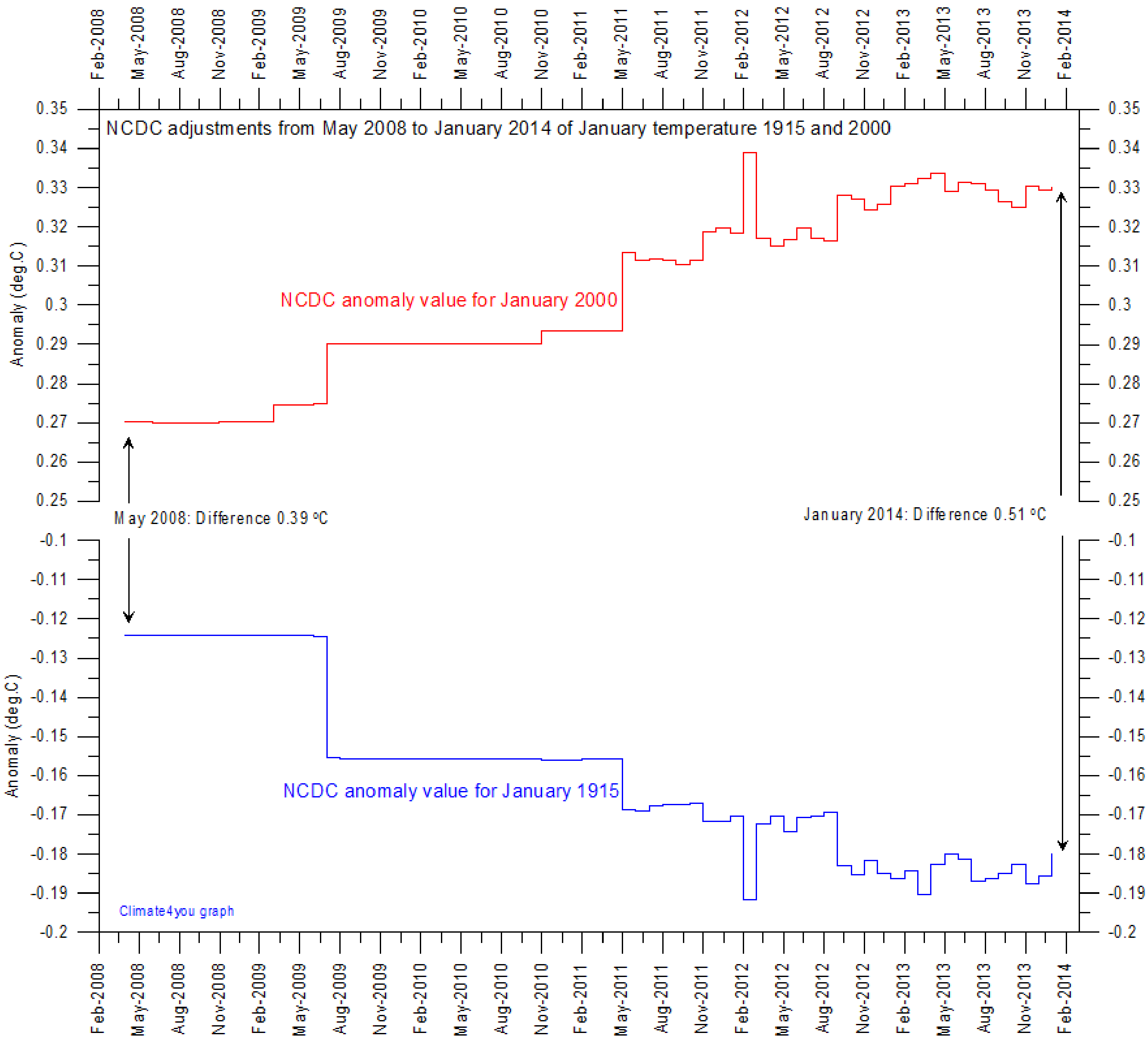


Diagram showing the adjustment made since May 2008 by the [*National Climatic Data Center*]() *(NCDC) in the anomaly values for the two months January 1915 and January 2000.*

<u>September 2013:</u> By administrative means the July 2013 temperature increase from January 1915 to January 2000 has increased from 0.39 to 0.51 ^{o}C, representing an about 31% increase of the original temperature increase reported in May 2008.

Global surface air temperature linear trends

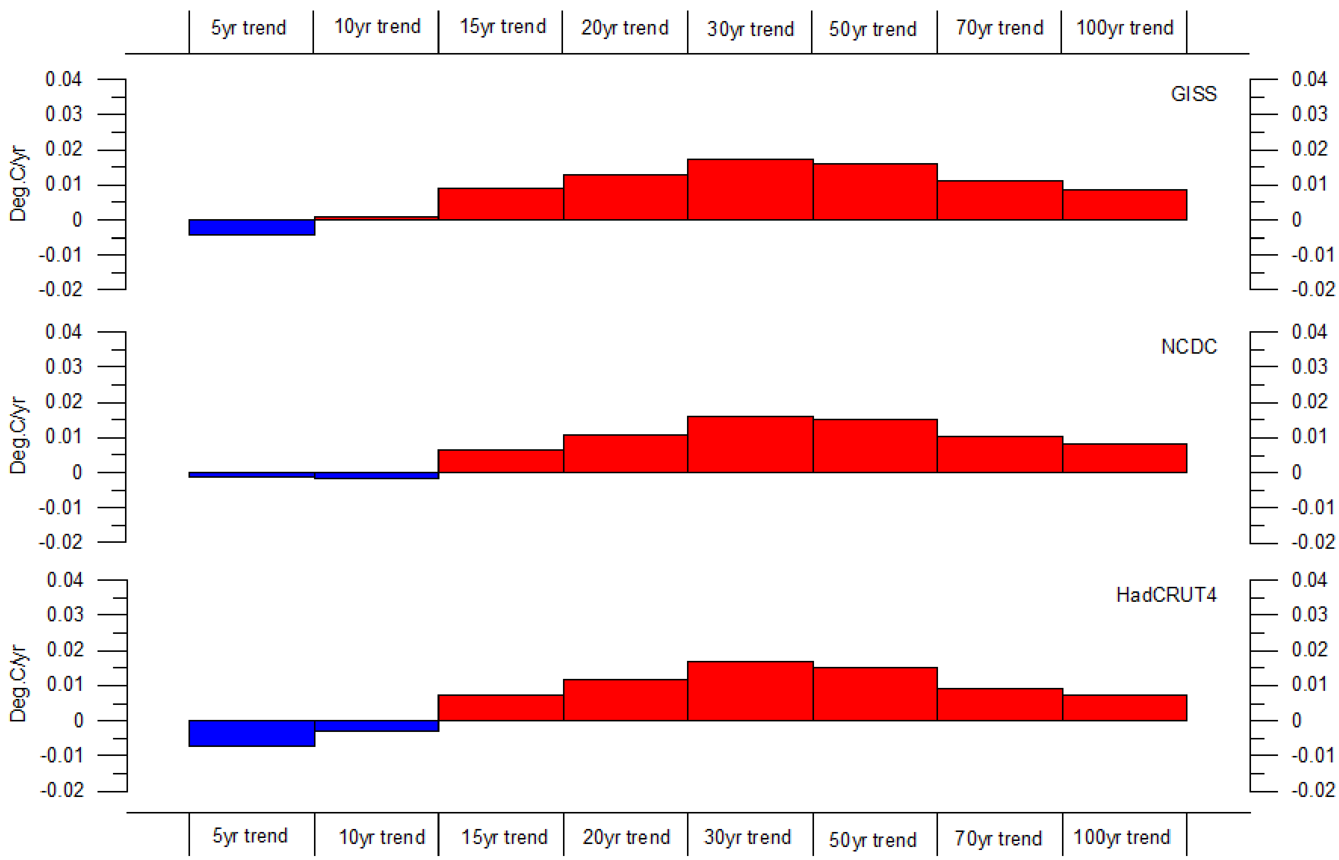
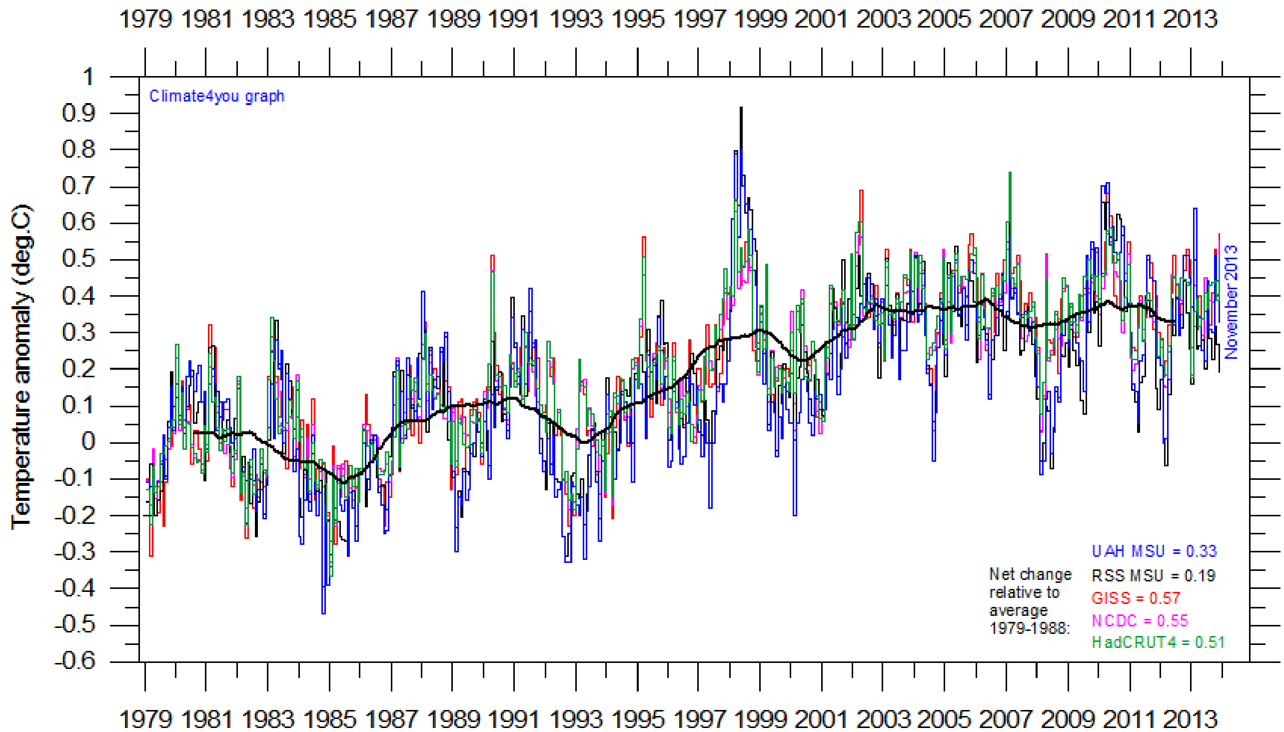


Diagram showing the latest 5, 10, 20, 30, 50, 70 and 100 year linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for three surface-based temperature estimates (GISS, NCDC and HadCRUT4). Last month included in all analyses: November 2013.

All in one, updated to November 2013

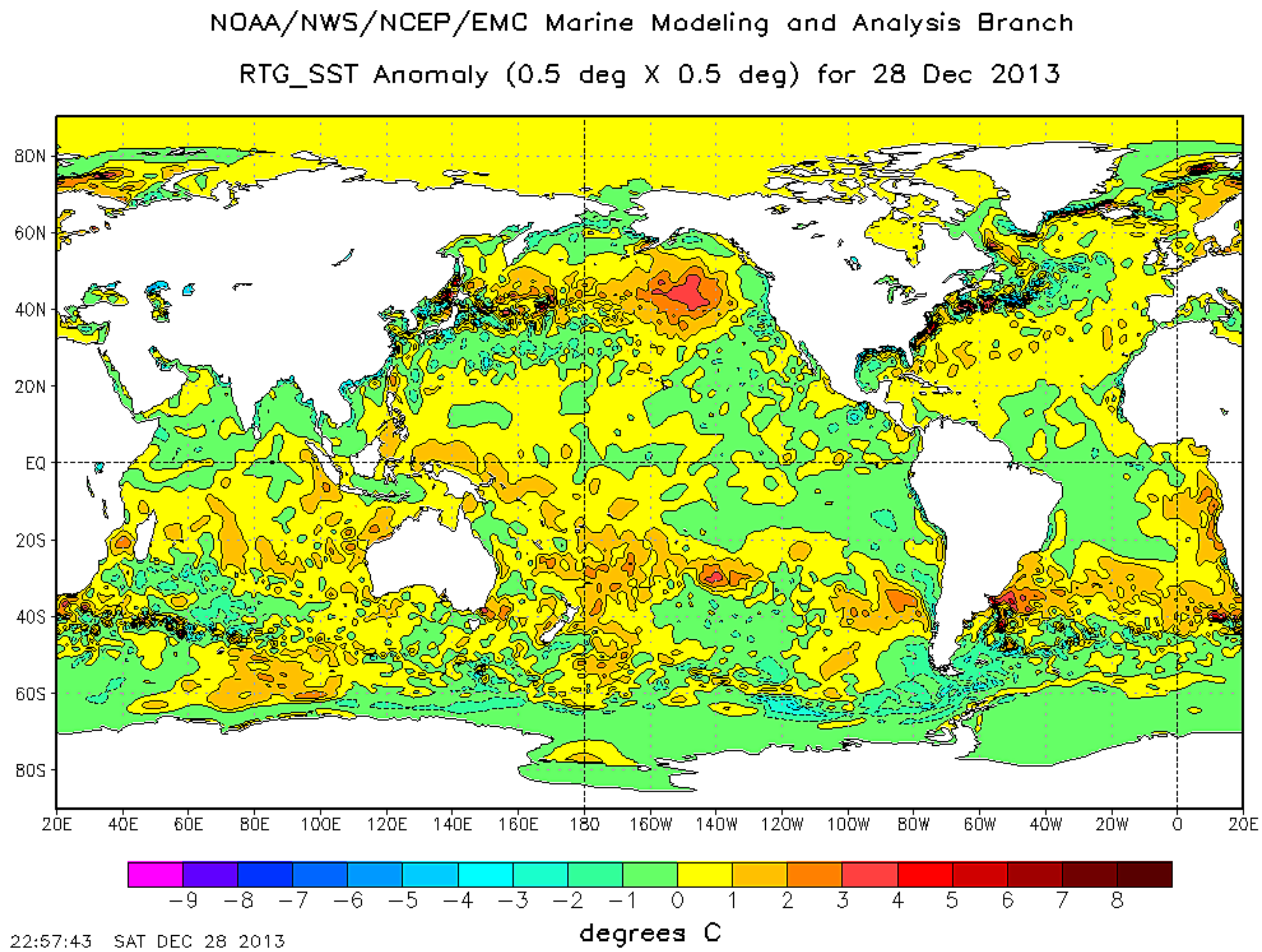


Superimposed plot of all five global monthly temperature estimates. As the base period differs for the individual temperature estimates, they have all been normalised by comparing with the average value of the initial 120 months (10 years) from January 1979 to December 1988. The heavy black line represents 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 individual 1979-1988 averages.

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 are often considerable differences between the individual records.

All five global temperature estimates presently show an overall 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 December 2013



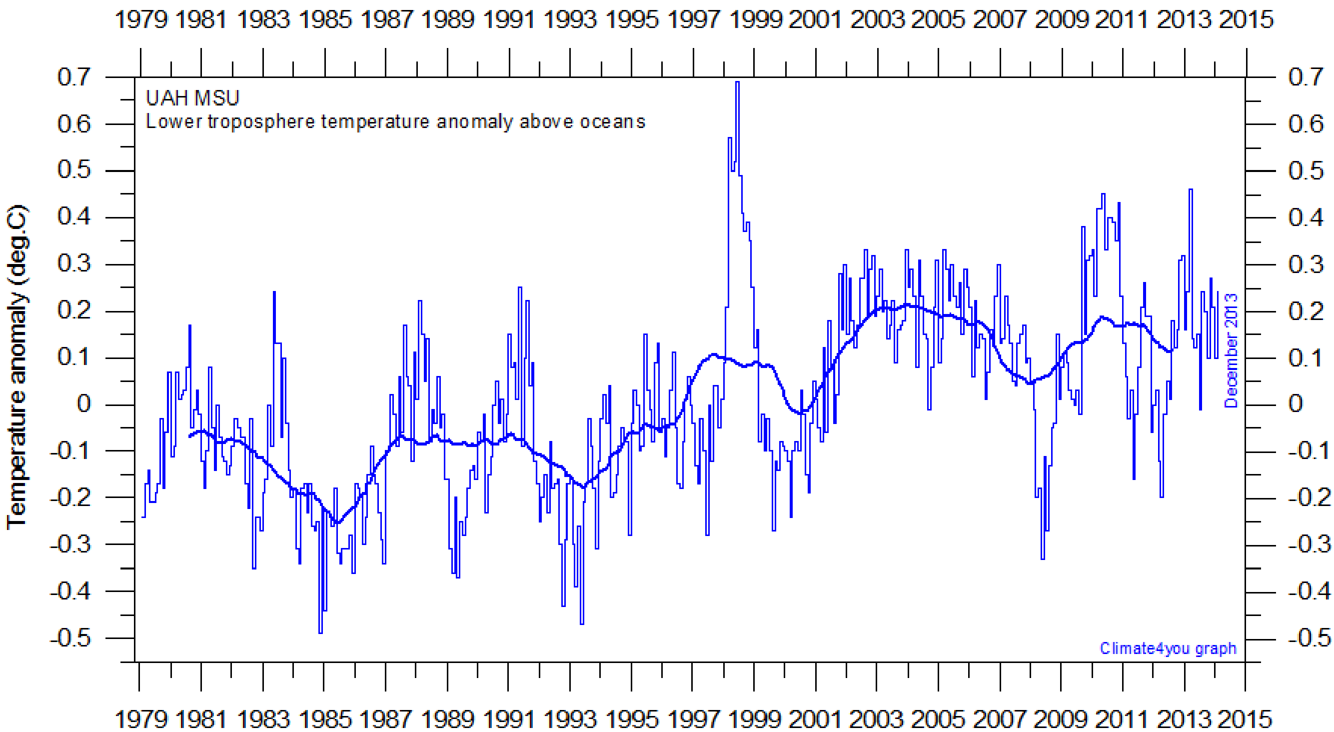
Sea surface temperature anomaly on 28 December 2013. Map source: National Centers for Environmental Prediction (NOAA).

Because of the large surface areas near Equator, the temperature of the surface water in these regions is especially important for the global atmospheric temperature (p.3-5).

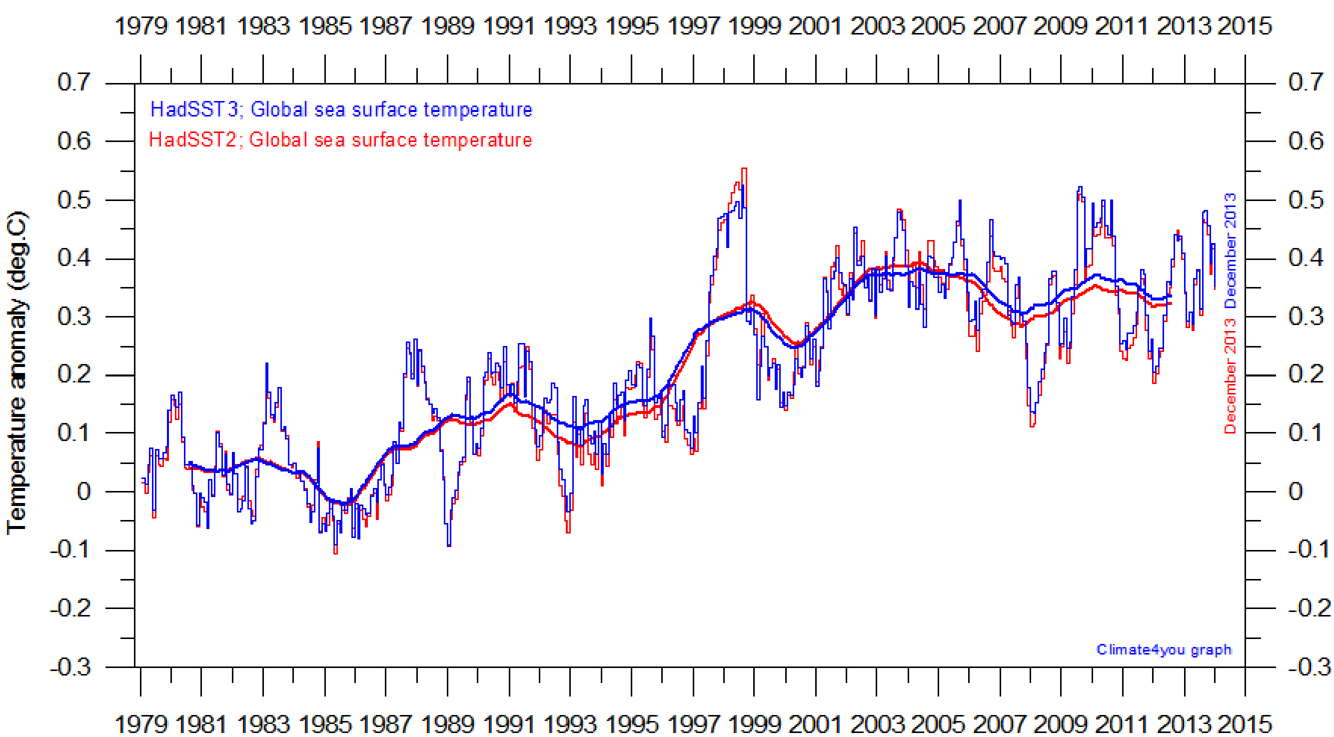
Relatively cold water is slowly spreading across the Pacific Ocean near the Equator, and may influence global air temperatures in the months to come.

The significance of any such short-term cooling or warming reflected in 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.

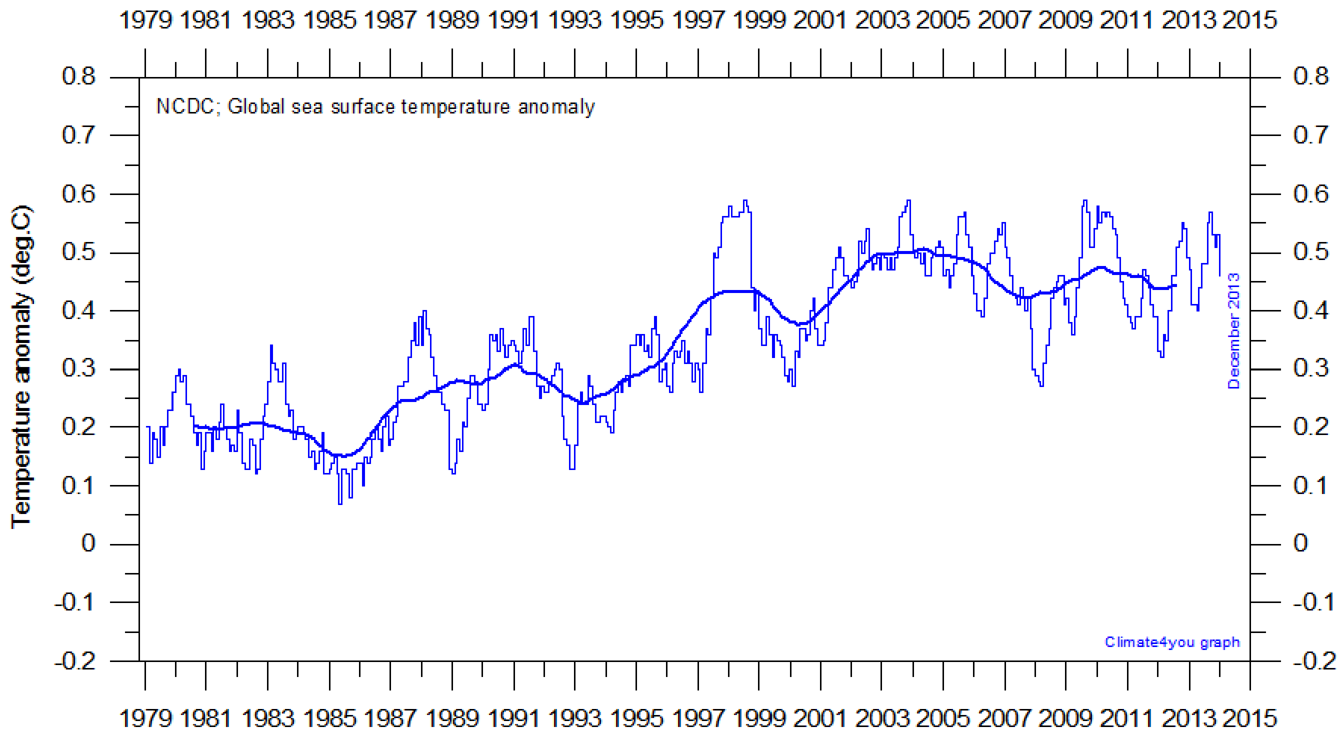
However, this does not reflect similar changes in the total heat content of the atmosphere-ocean system. In fact, global net changes can be small and such heat exchanges may mainly reflect redistribution of energy between ocean and atmosphere. What matters is the overall temperature development when 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.

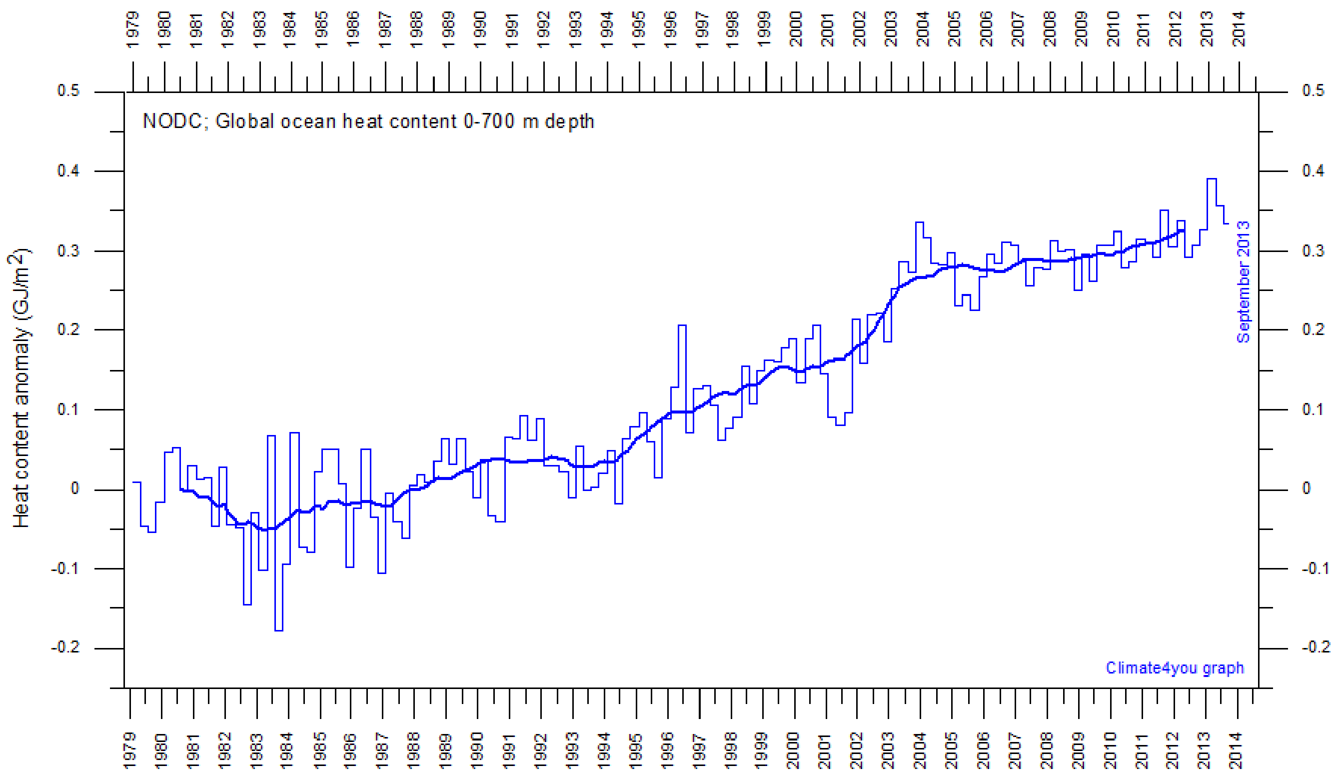


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit](#) ([CRU](#)), UK. Base period: 1961-1990. The thick line is the simple running 37 month average.

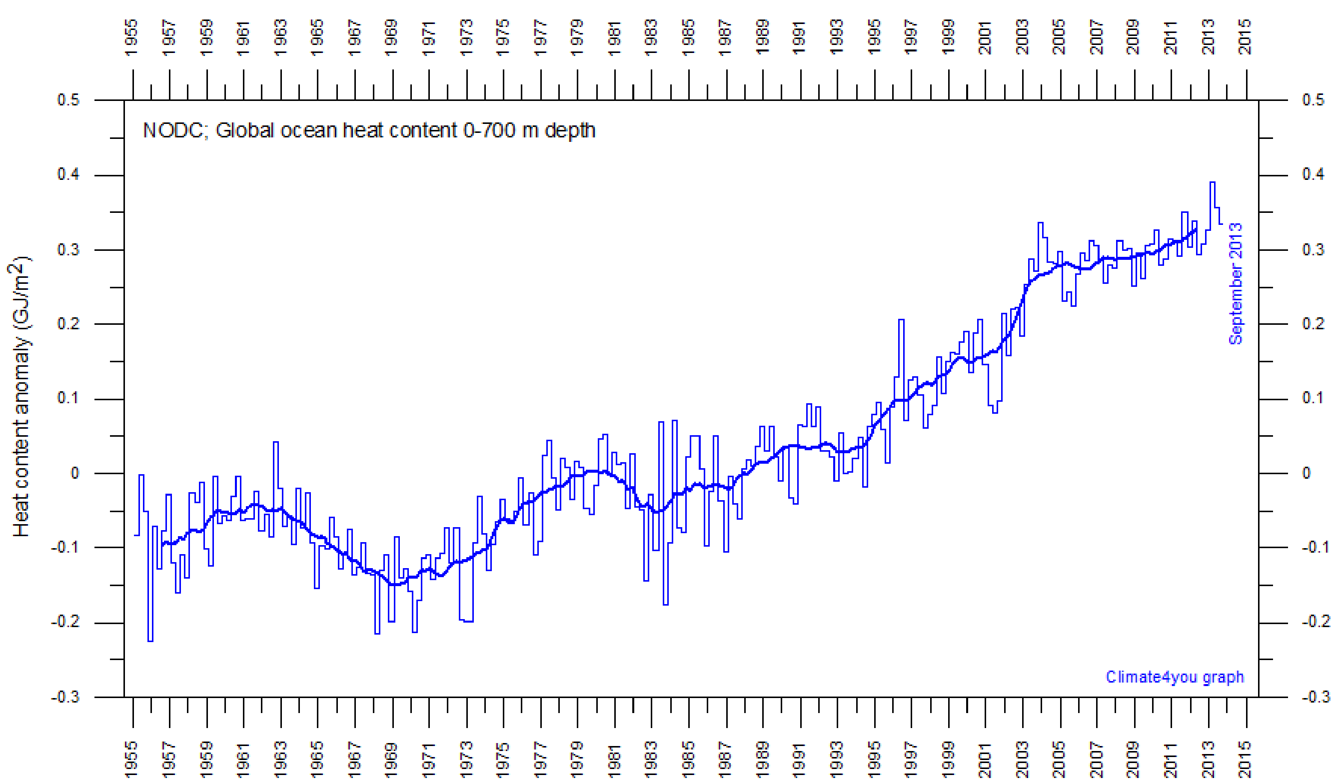


Global monthly average sea surface temperature since 1979 according to the [National Climatic Data Center](#) (NCDC), USA. Base period: 1901-2000. The thick line is the simple running 37 month average.

Global ocean heat content uppermost 700 m, updated to September 2013

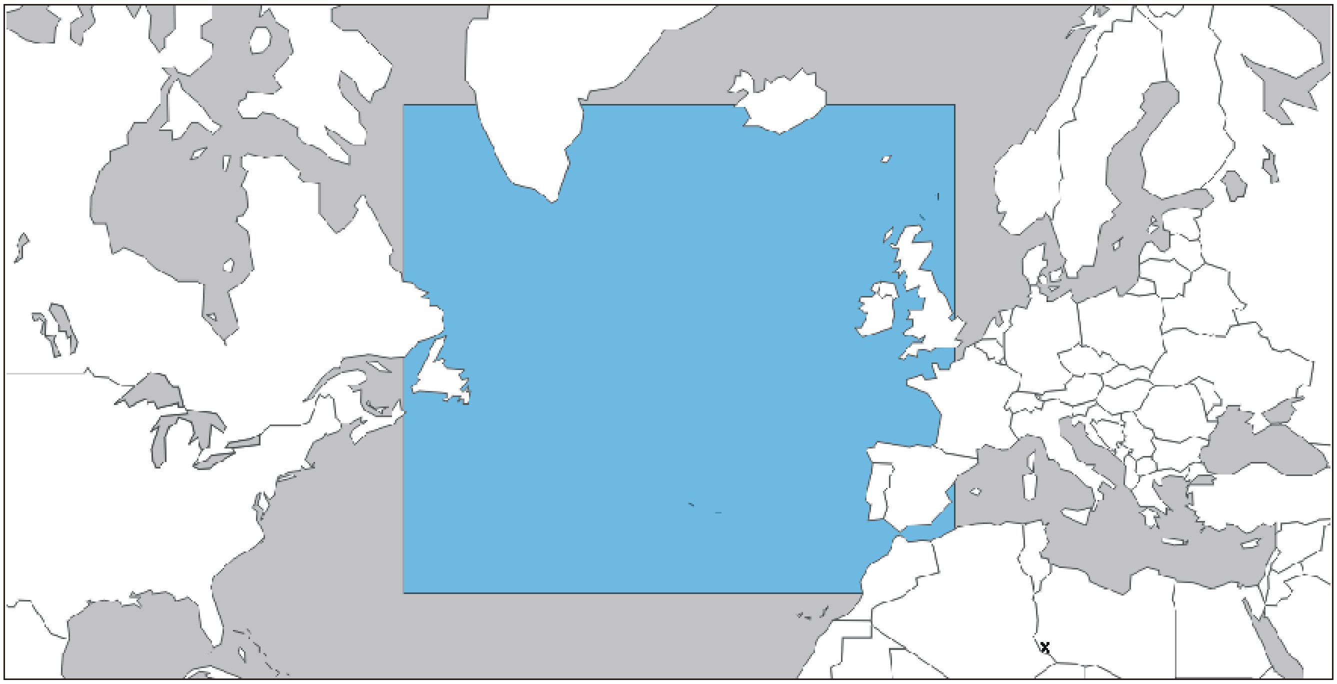


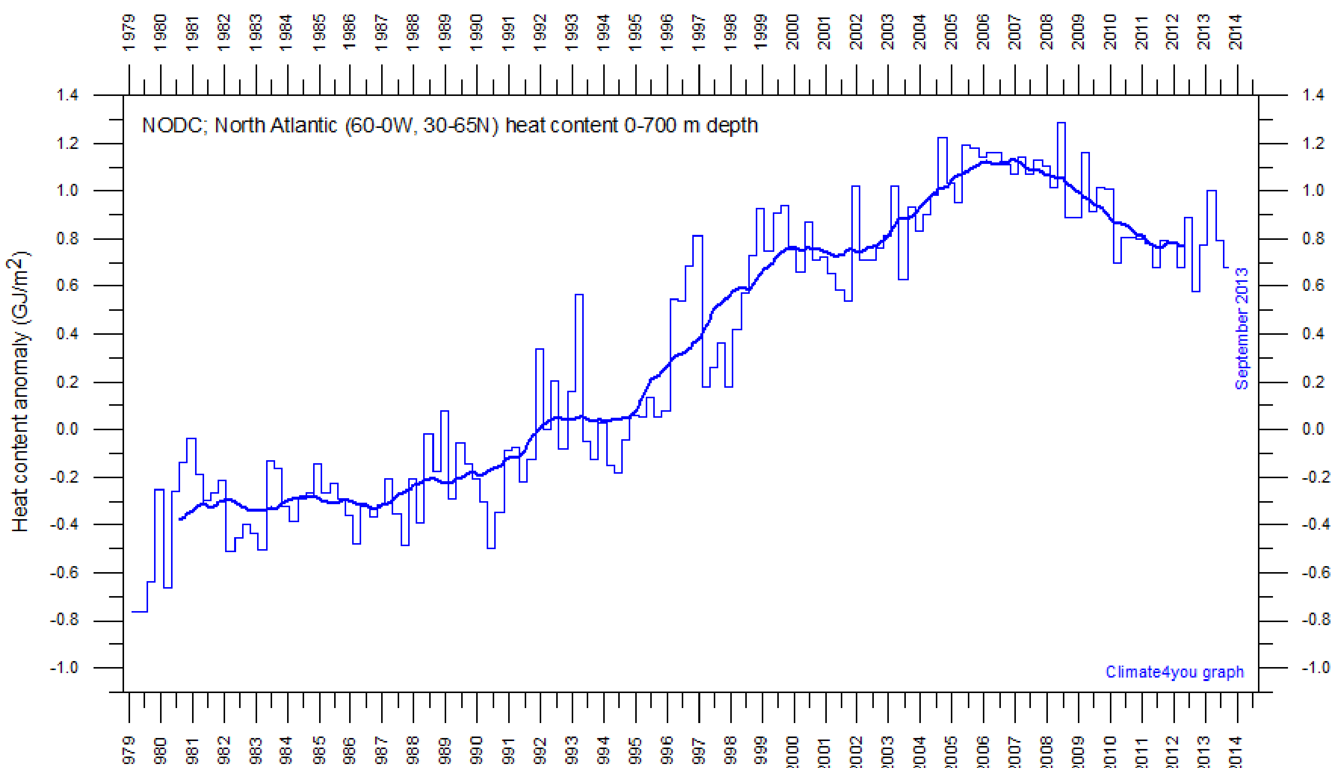
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the oceans since January 1979. Data source: National Oceanographic Data Center(NODC).



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).

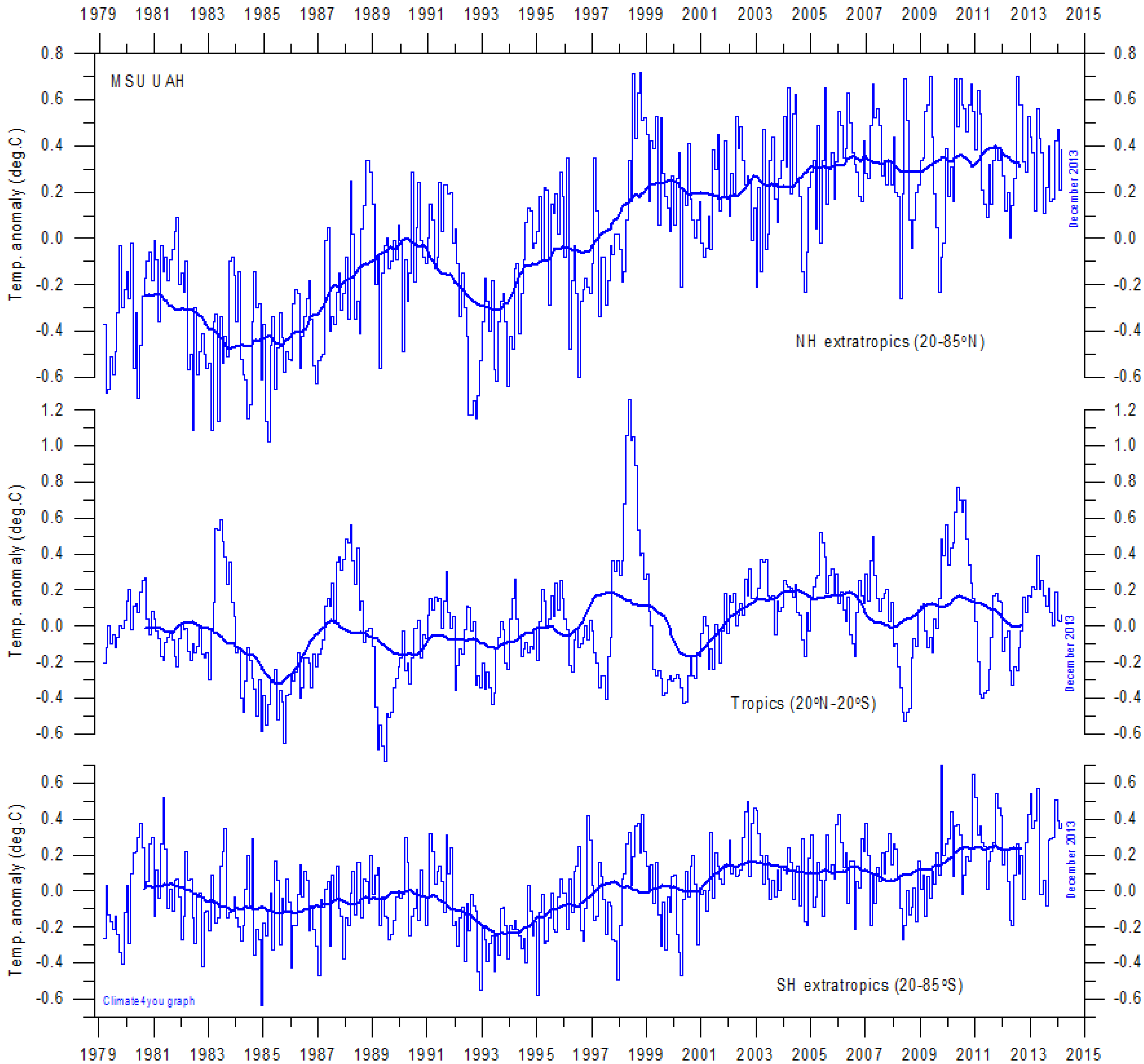
[North Atlantic heat content uppermost 700 m, updated to September 2012]





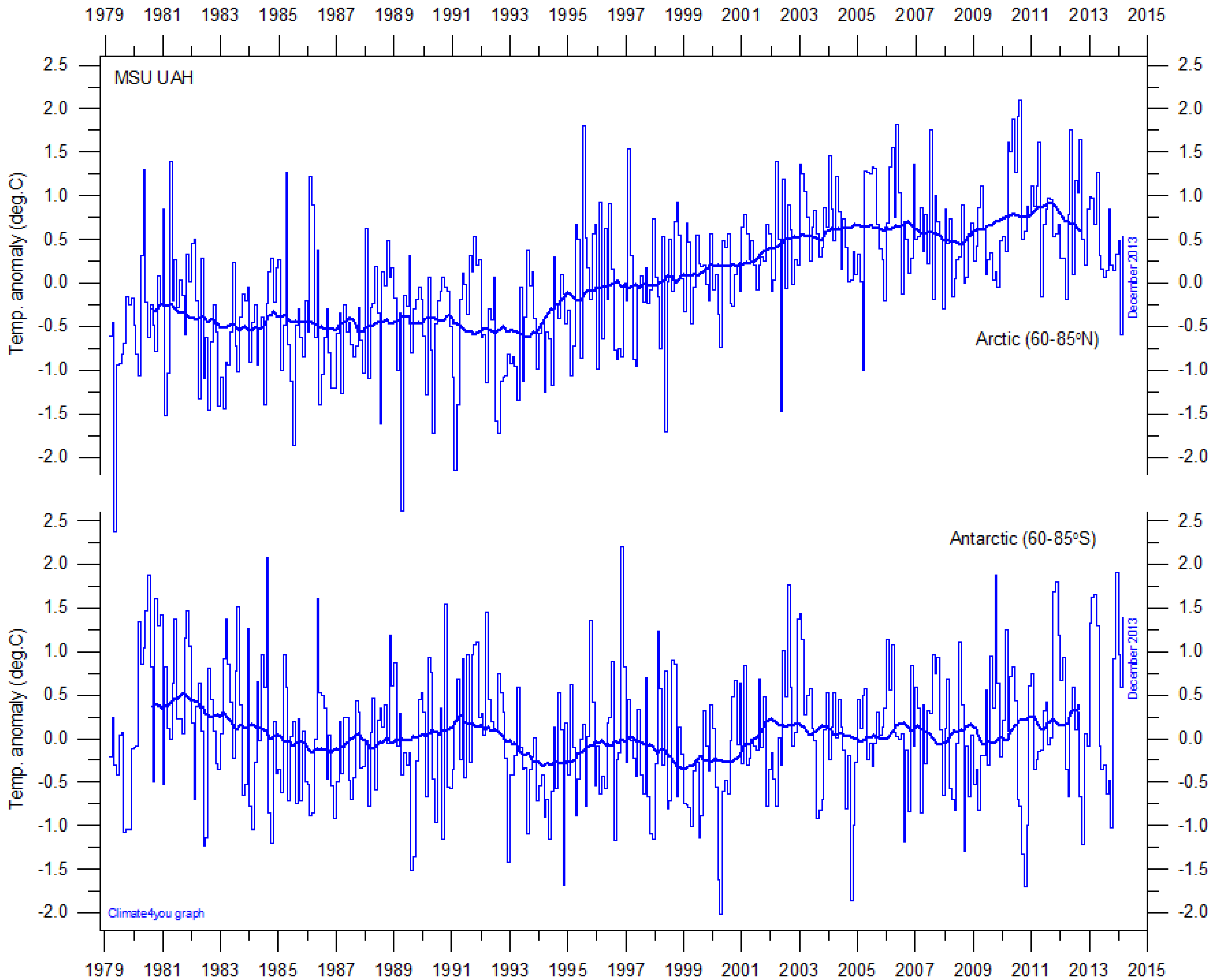
Global monthly heat content anomaly (GJ/m2) in the uppermost 700 m of the North Atlantic (60-0W, 30-65N; see map above) *ocean since January 1979. The thin line indicates monthly values, and the thick line represents the simple running 37 month (c. 3 year) average. Data source: [National Oceanographic Data Center] (NODC).*

Zonal lower troposphere temperatures from satellites, updated to December 2013



Global monthly average lower troposphere temperature since 1979 for the tropics and the northern and southern extratropics, according to [University of Alabama](#) at Huntsville, USA. Thin lines show the monthly temperature. Thick lines represent the simple running 37 month average, nearly corresponding to a running 3 yr average. Reference period 1981-2010.

[Arctic and Antarctic lower troposphere temperature, updated to December 2013](#)



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). Thin lines show the monthly temperature. 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 2013

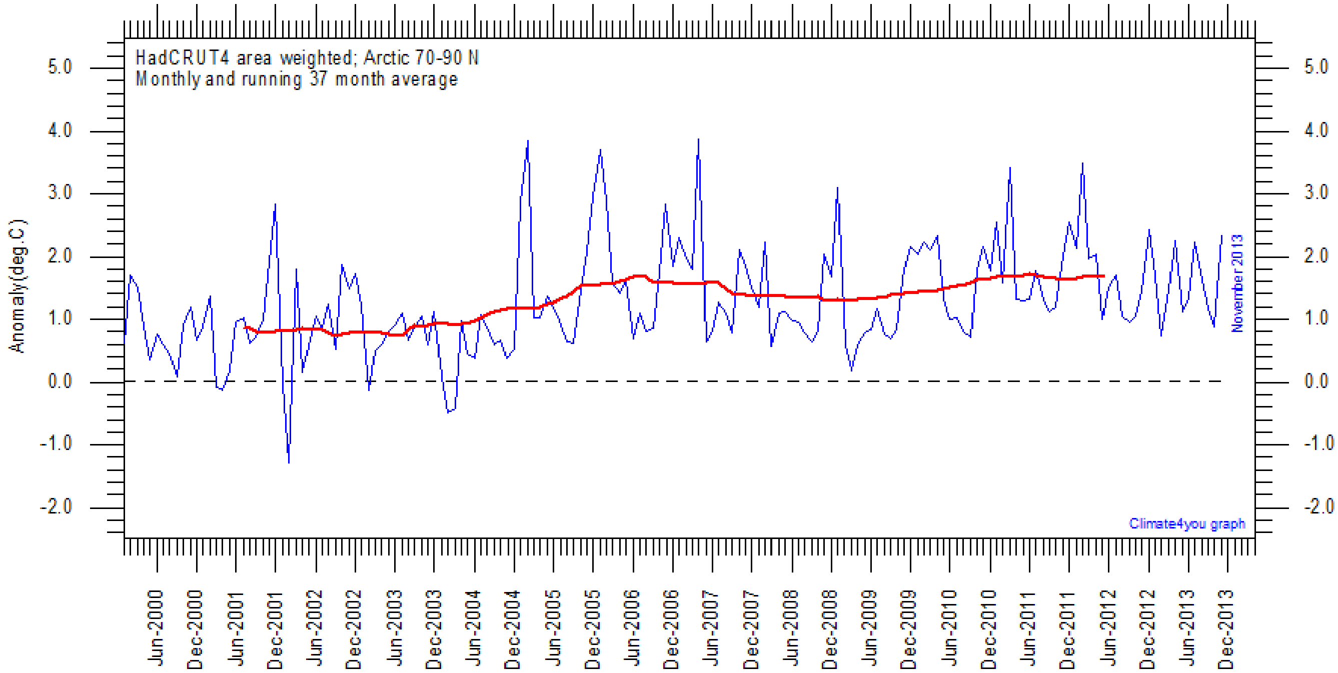


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

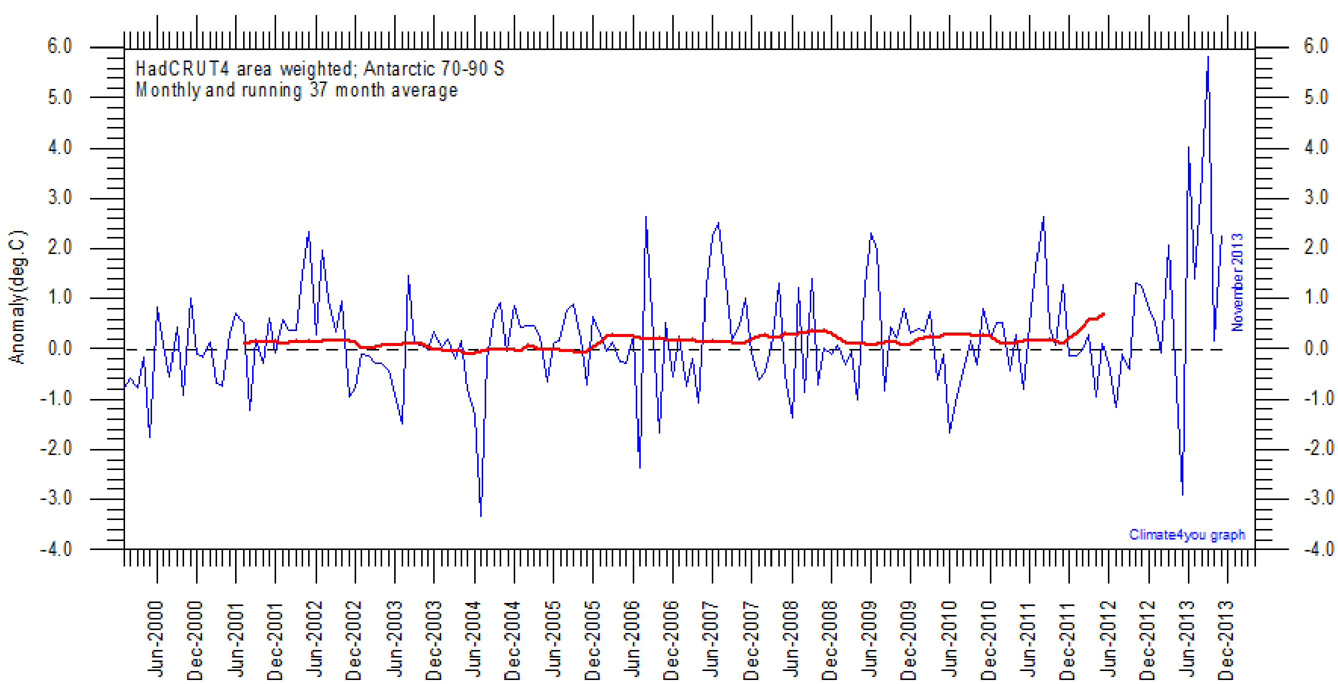


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 2000, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

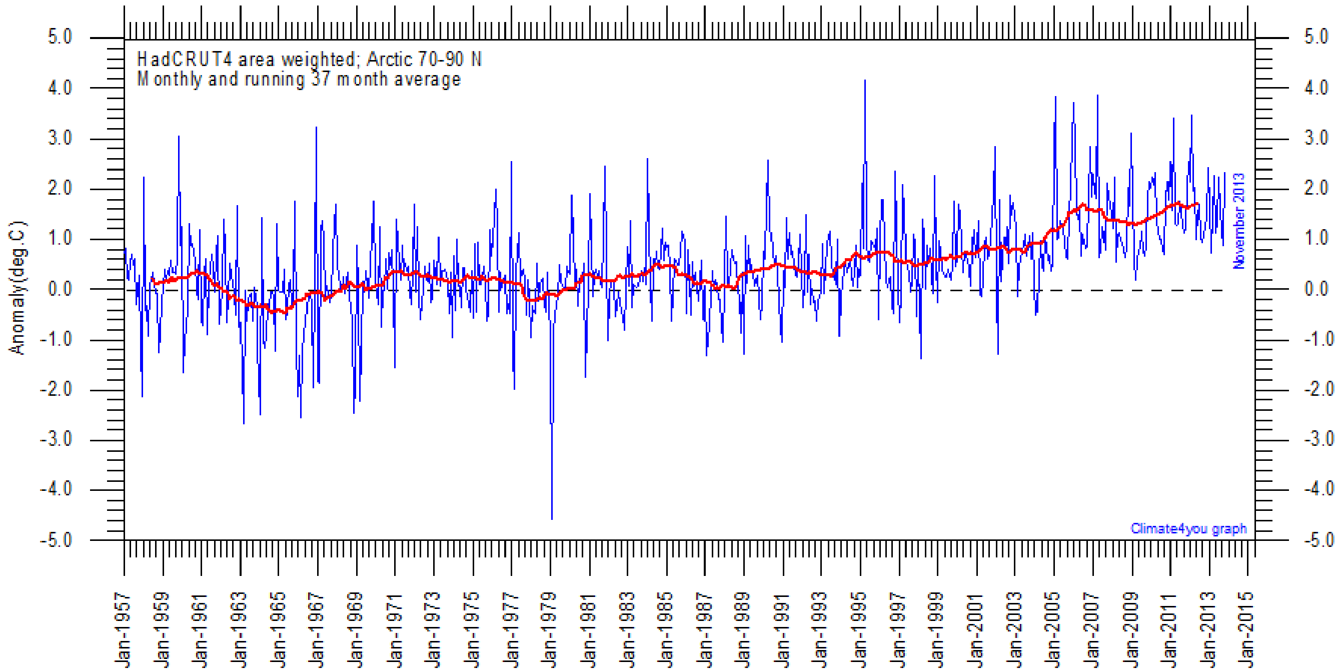


Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

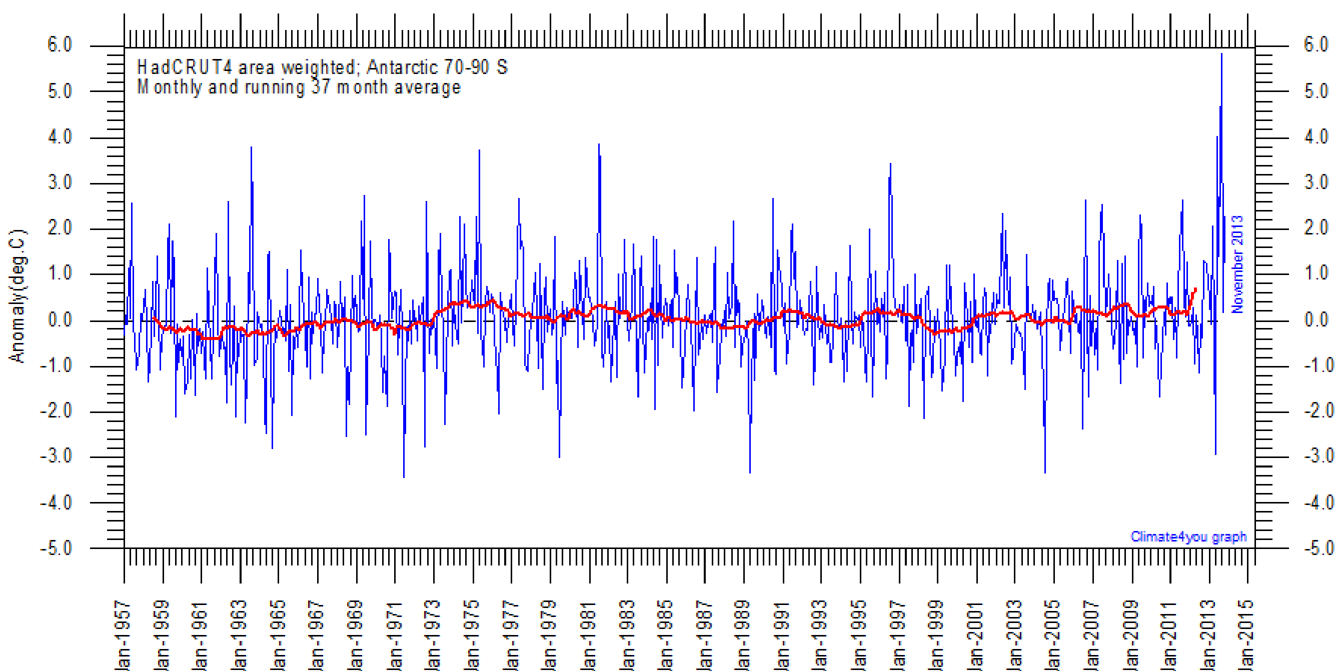


Diagram showing area weighted Antarctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1957, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average.

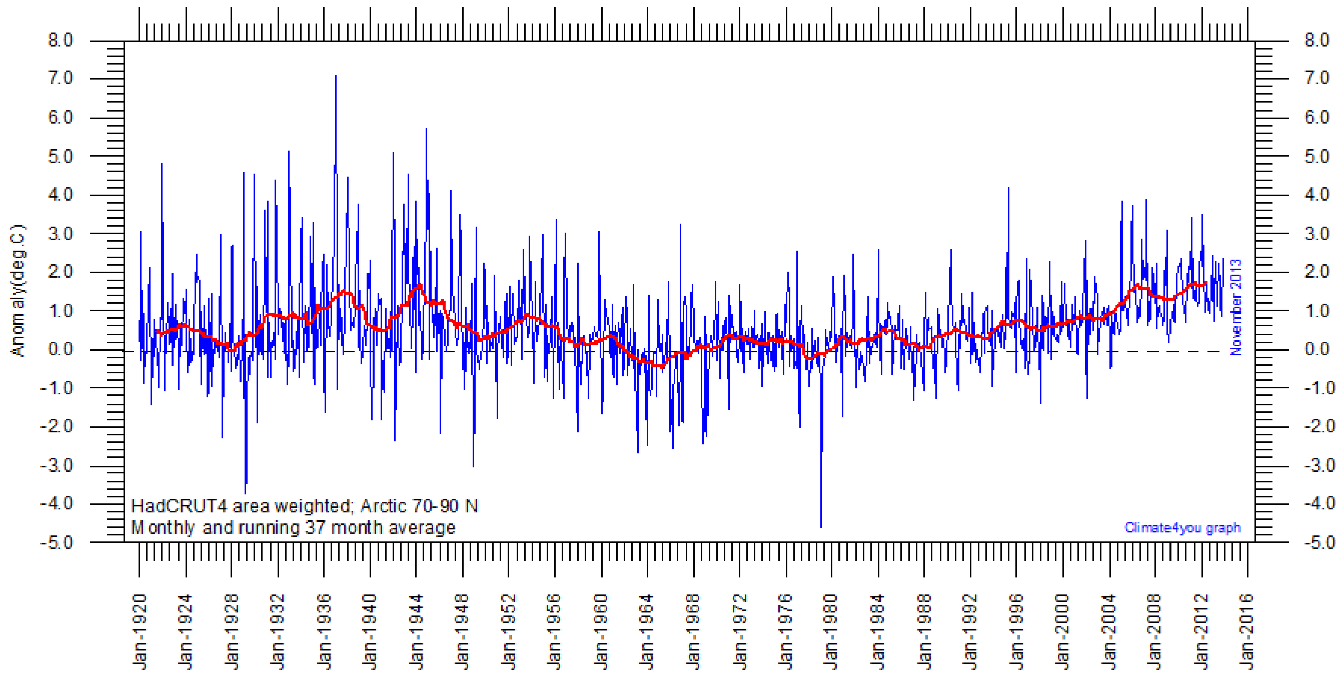


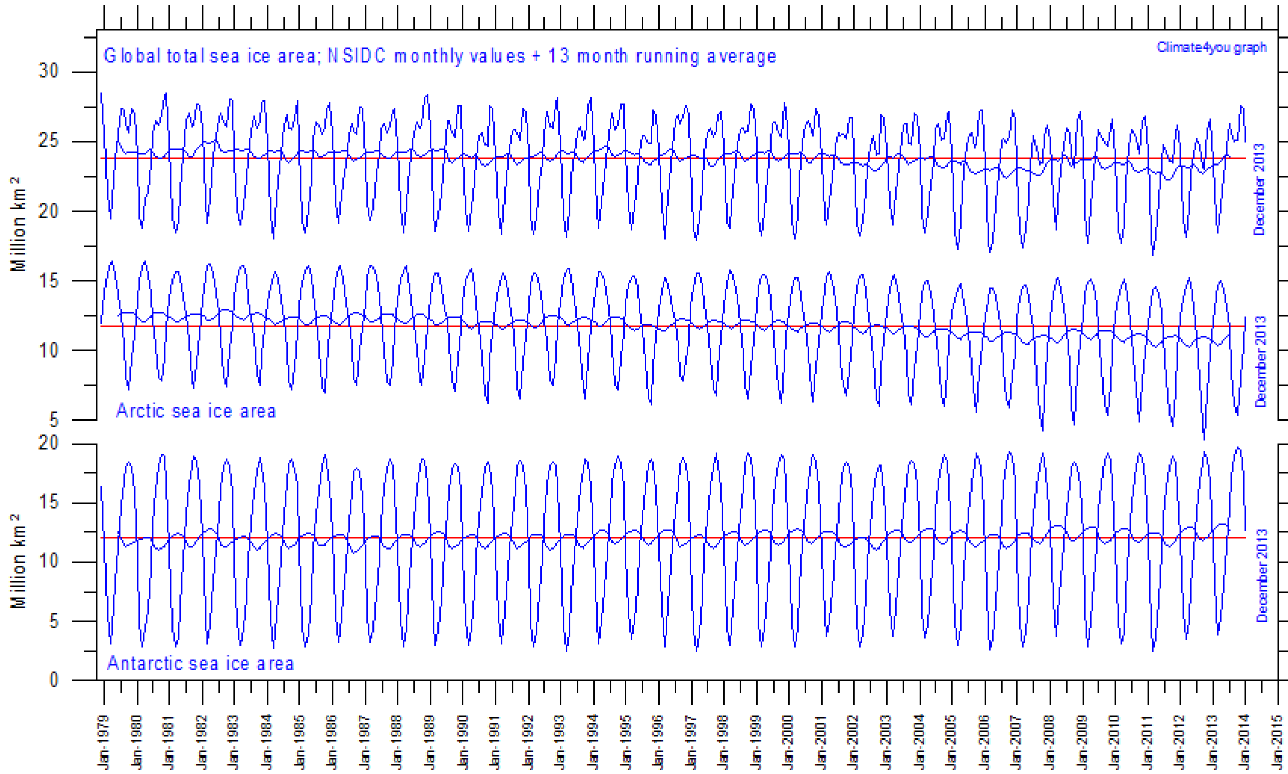
Diagram showing area weighted Arctic (70-90°N) monthly surface air temperature anomalies ([HadCRUT4]) since January 1920, in relation to the WMO [normal period] 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 37 month (c.3 yr) average. Because of the relatively small number of Arctic stations before 1930, month-to-month variations in the early part of the temperature record are larger than later. 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. The period since 2000 is warm, about as warm as the period 1930-1940.

As the HadCRUT4 data series has improved high latitude coverage data coverage (compared to the HadCRUT3 series) the individual 5°x5° grid cells has been weighted according to their surface area. This is in contrast to Gillet et al. 2008 which calculated a simple average, with no consideration to the surface area represented by the individual 5°x5° grid cells.

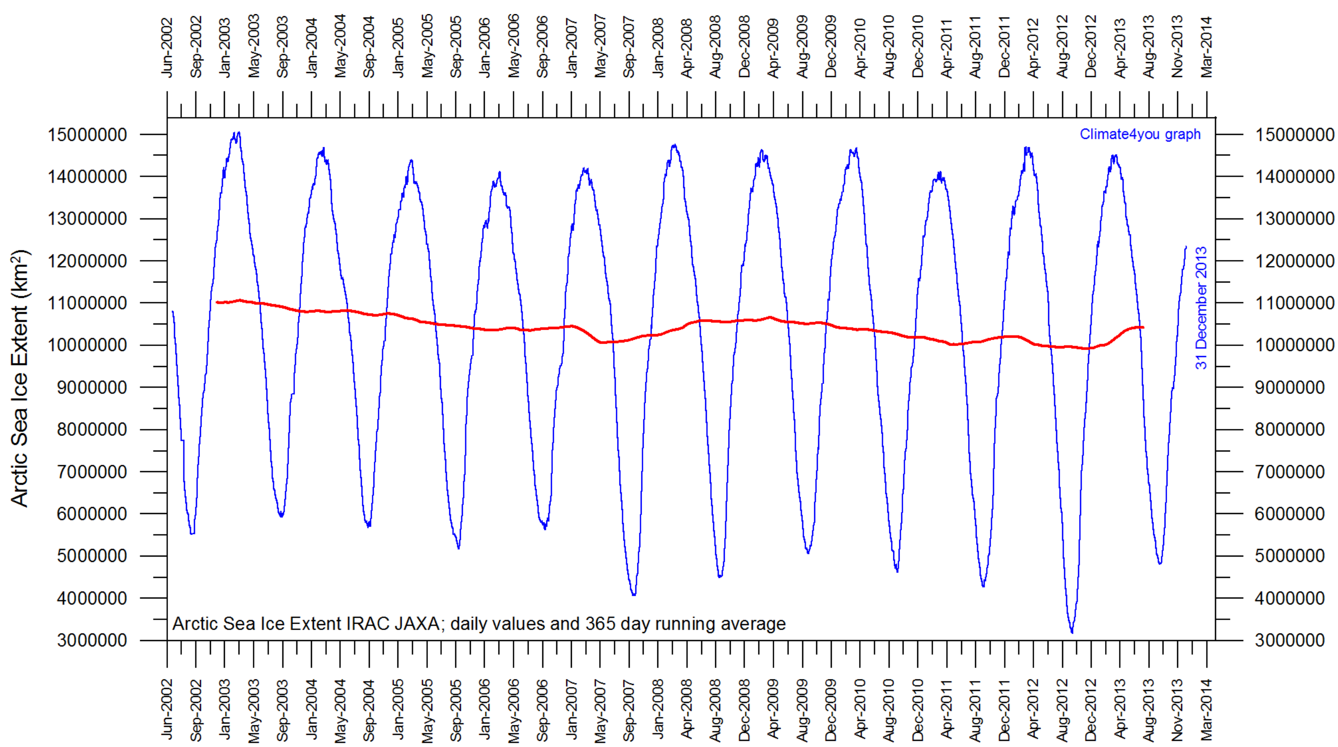
Literature:

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.

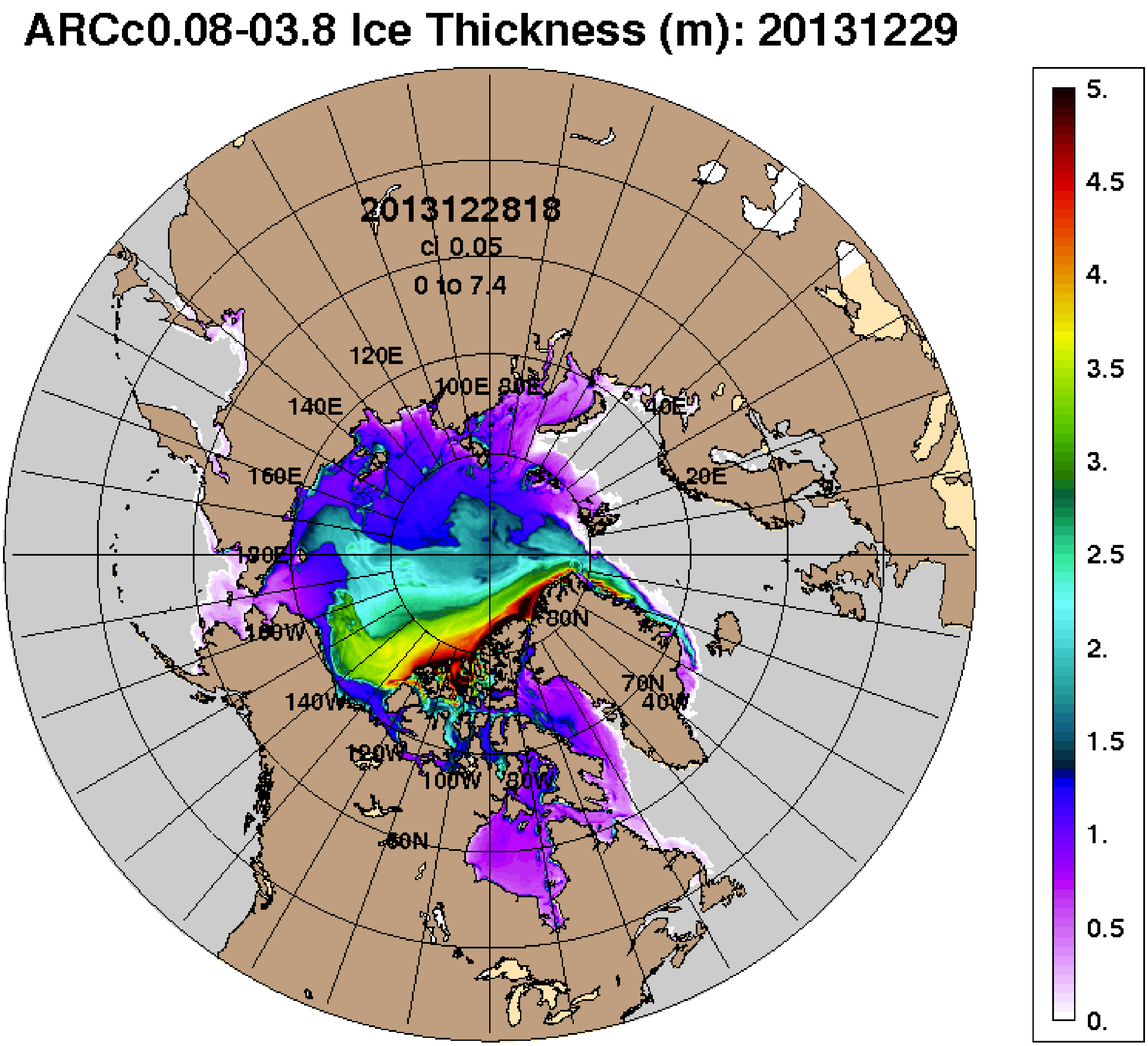
Arctic and Antarctic sea ice, updated to December 2013



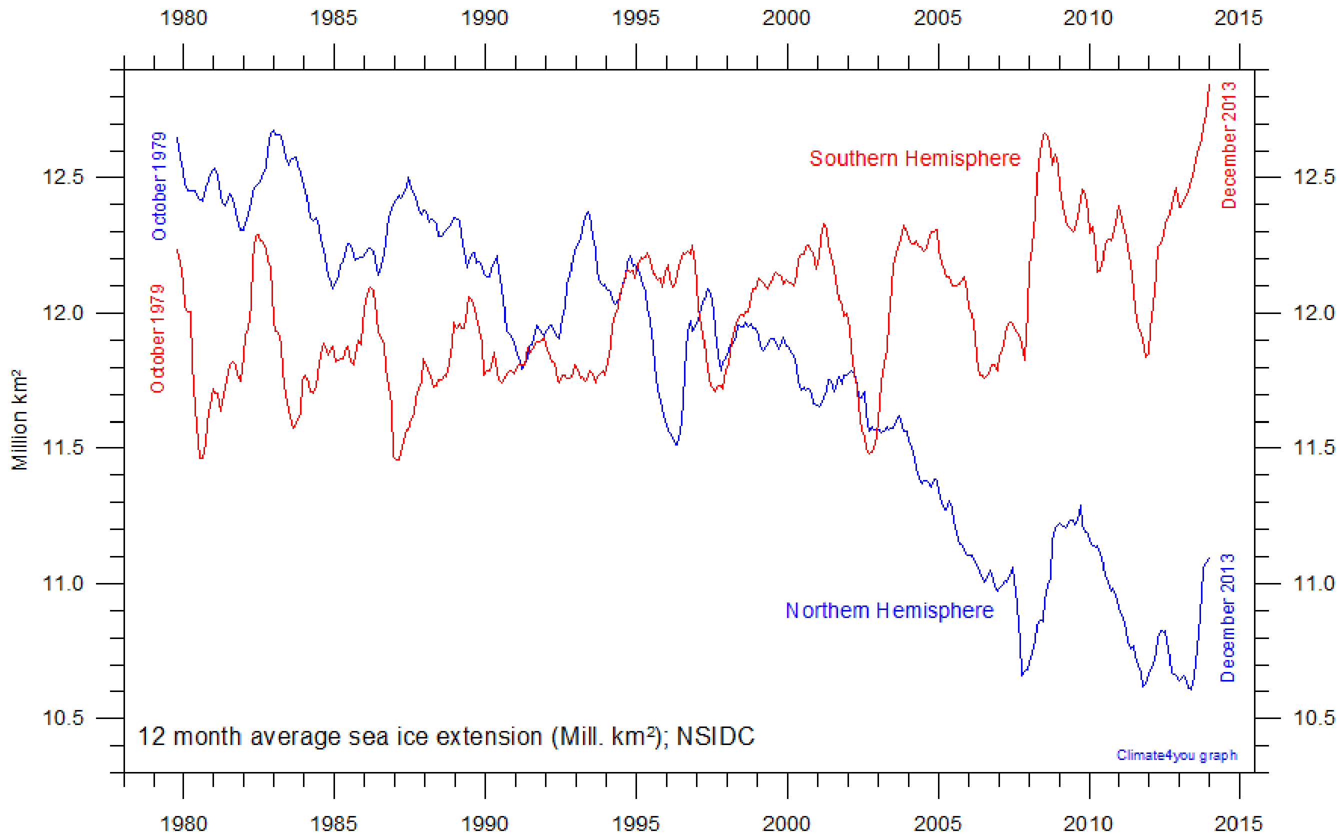
Graphs showing monthly Antarctic, Arctic and global sea ice extent since November 1978, according to the National Snow and Ice data Center (NSIDC).



Graph showing daily Arctic sea ice extent since June 2002, to 31 December 2013, by courtesy of Japan Aerospace Exploration Agency (JAXA).

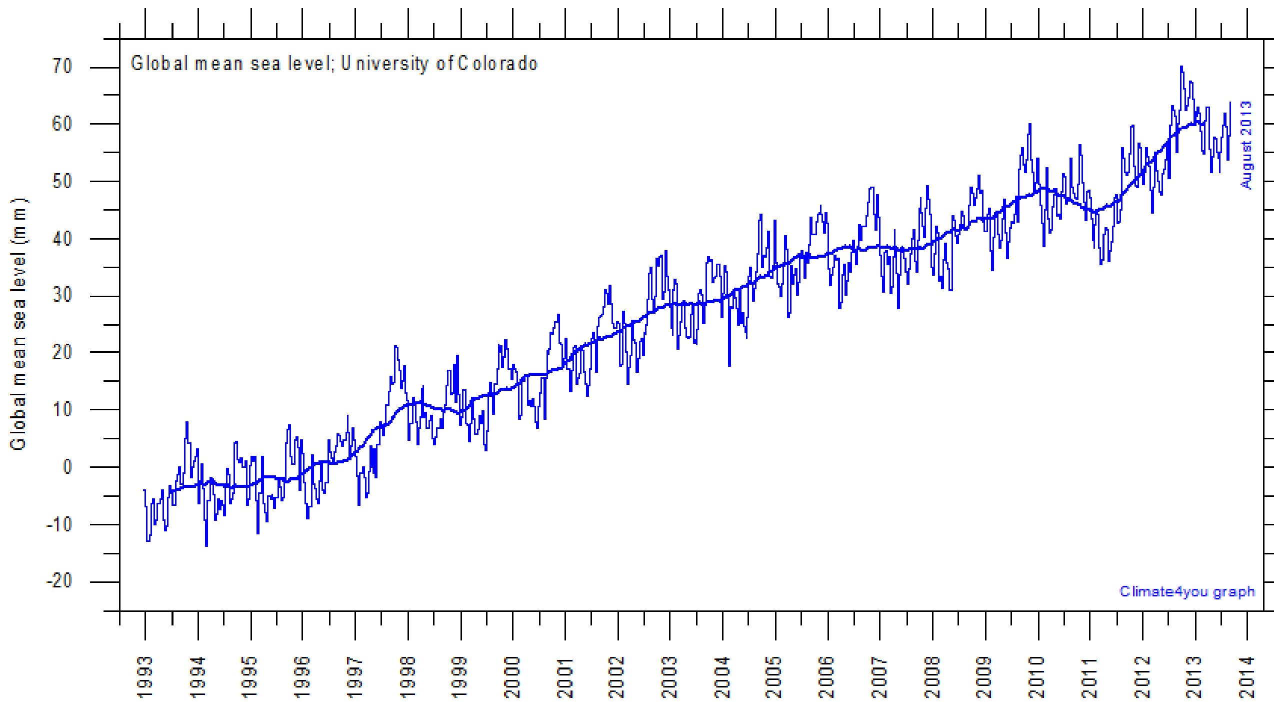


Northern hemisphere sea ice extension and thickness on 29 December 2013 according to the [Arctic Cap Nowcast/Forecast System](#) (ACNFS), US Naval Research Laboratory. Thickness scale (m) is shown to the right.

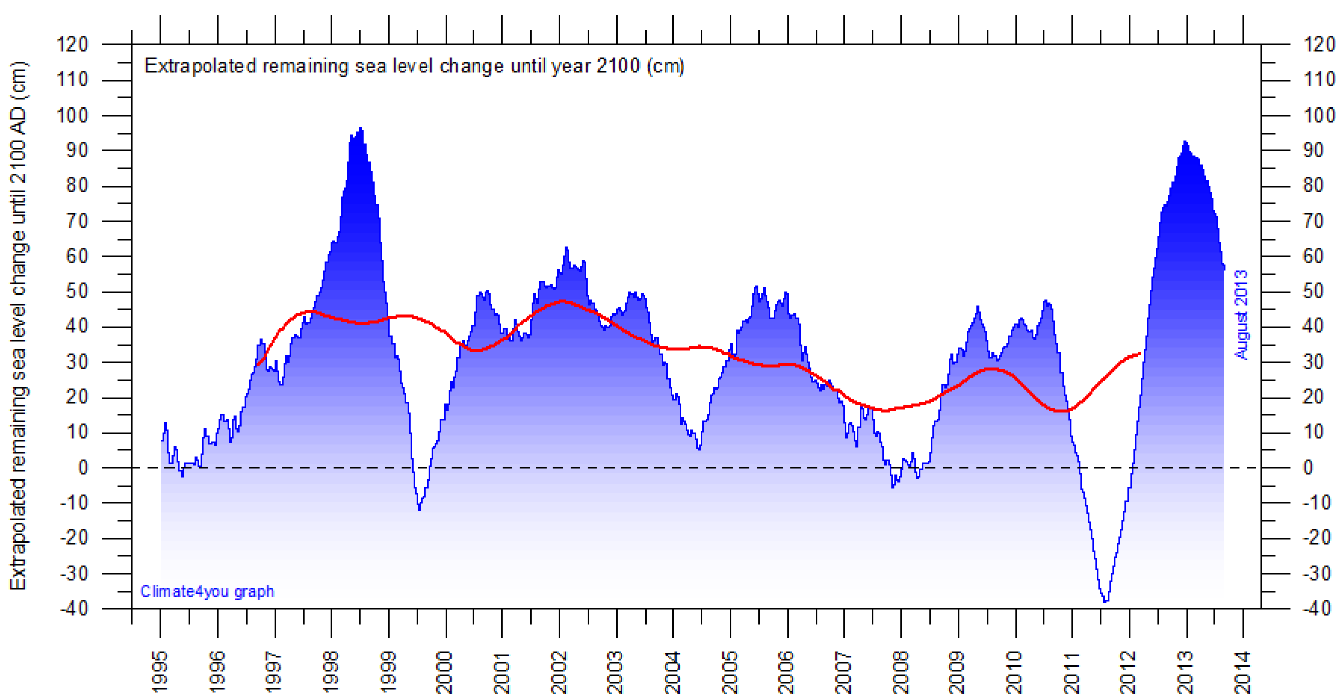


12 month running average sea ice extension in both hemispheres since 1979, the satellite-era. Data source: National Snow and Ice Data Center *(NSIDC).*

Global sea level, updated to August 2013

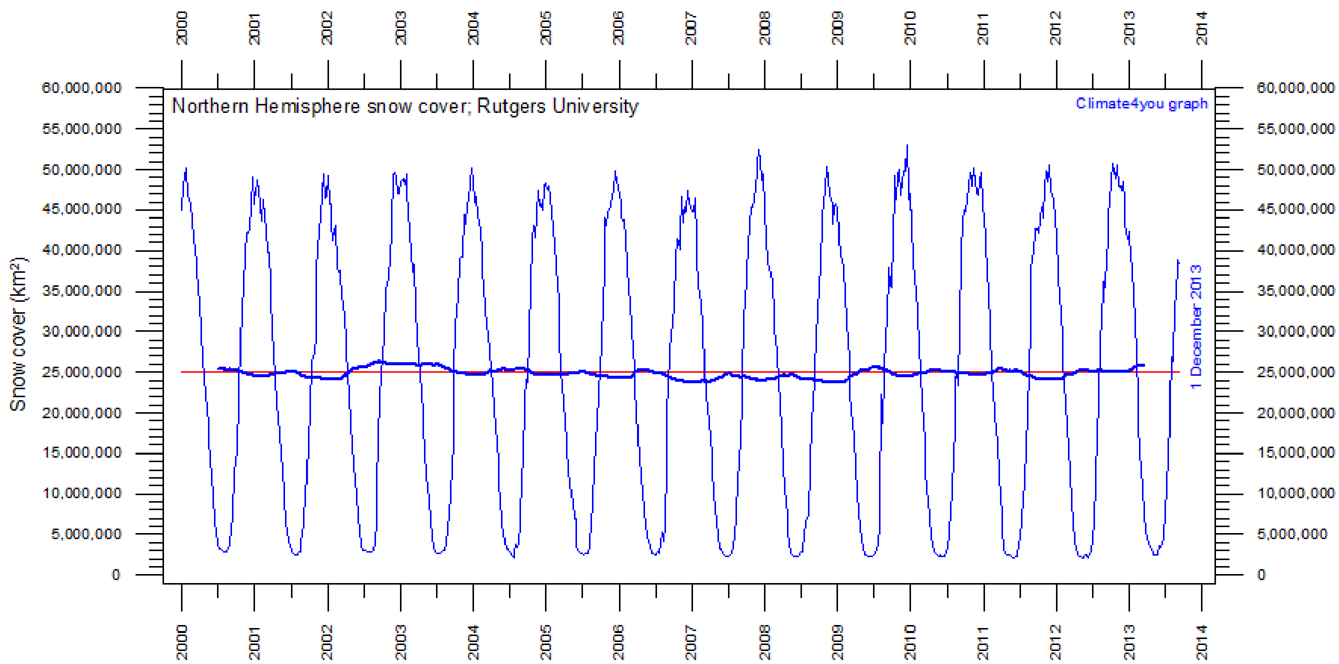


Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.

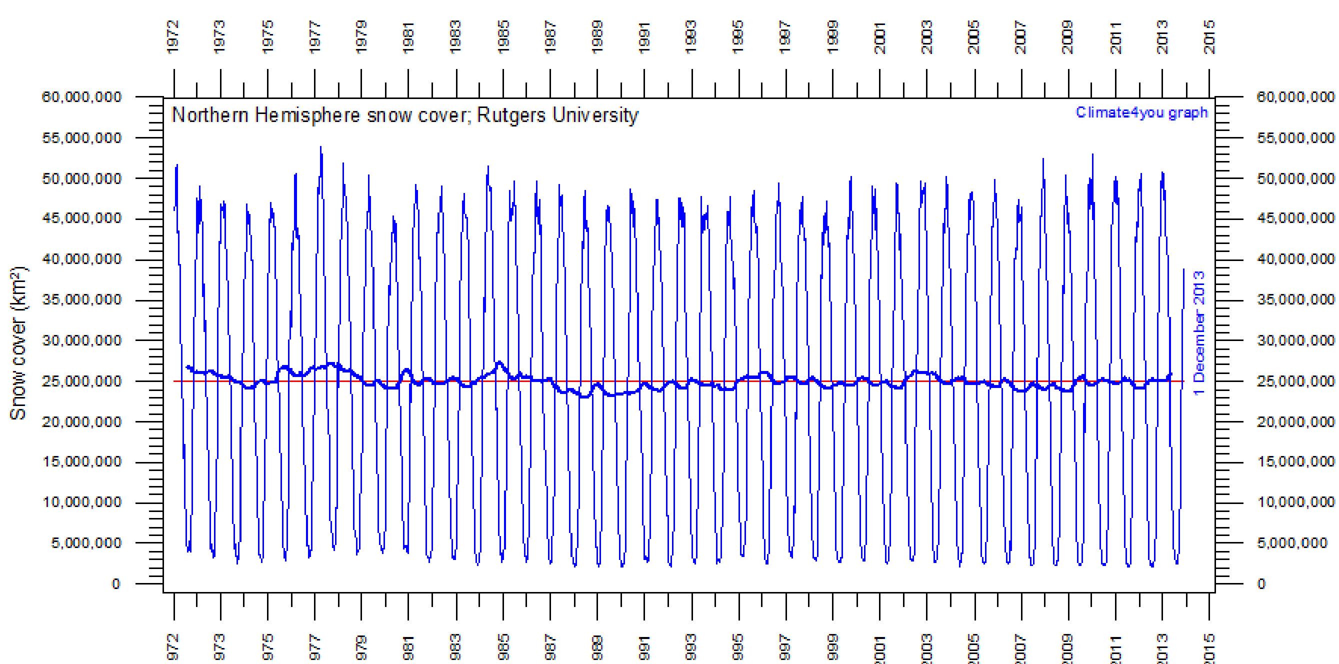


Forecasted change of global sea level until year 2100, based on simple extrapolation of measurements done by the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder](), USA. The thick line is the simple running 3 yr average forecast for sea level change until year 2100. Based on this (thick line), the present simple empirical forecast of sea level change until 2100 is about +31 cm.

Northern Hemisphere weekly snow cover, updated to early December 2013

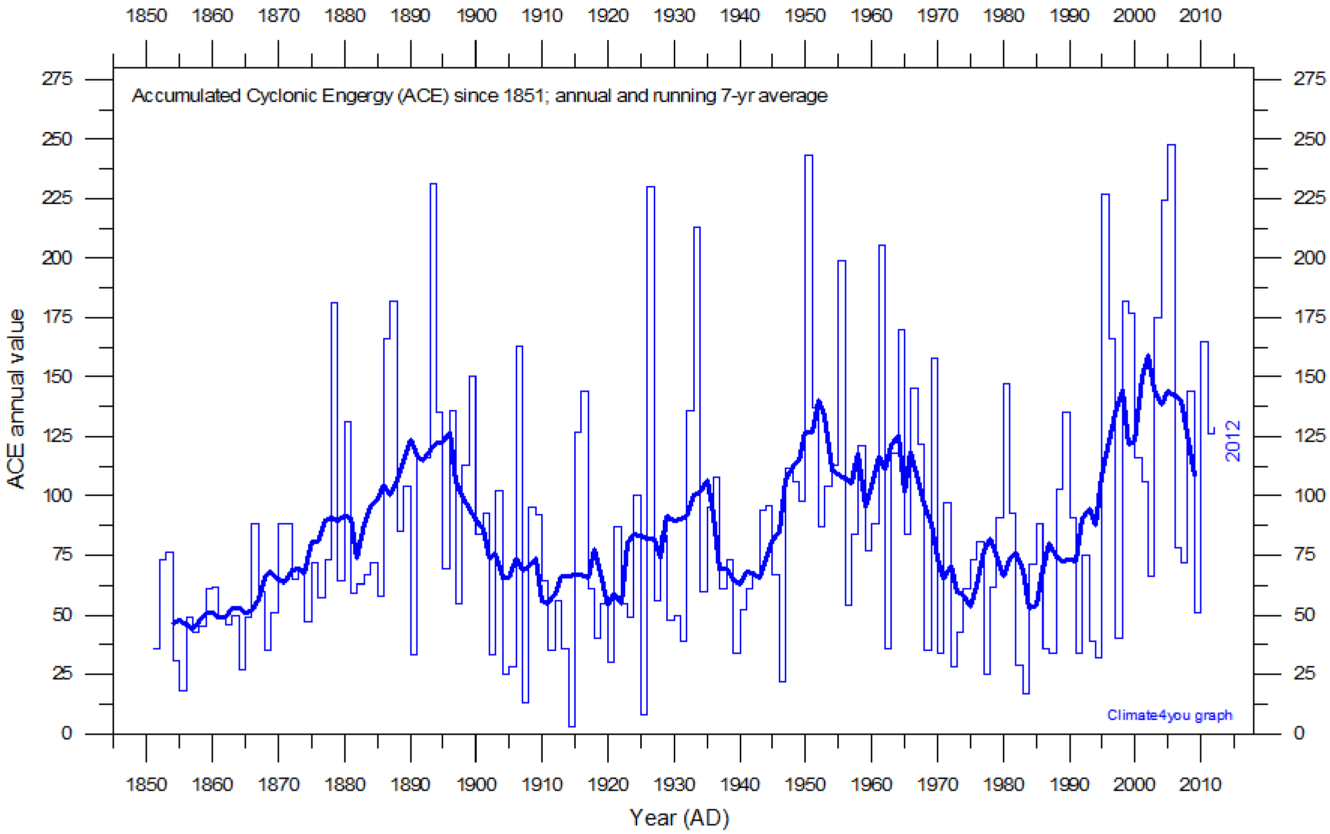


Northern hemisphere weekly snow cover since January 2000 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53 week average (approximately 1 year). The horizontal red line is the 1972-2012 average.



Northern hemisphere weekly snow cover since January 1972 according to Rutgers University Global Snow Laboratory. The thin blue line is the weekly data, and the thick blue line is the running 53 week average (approximately 1 year). The horizontal red line is the 1972-2012 average.

Annual accumulated cyclone energy (ACE) Atlantic Basin



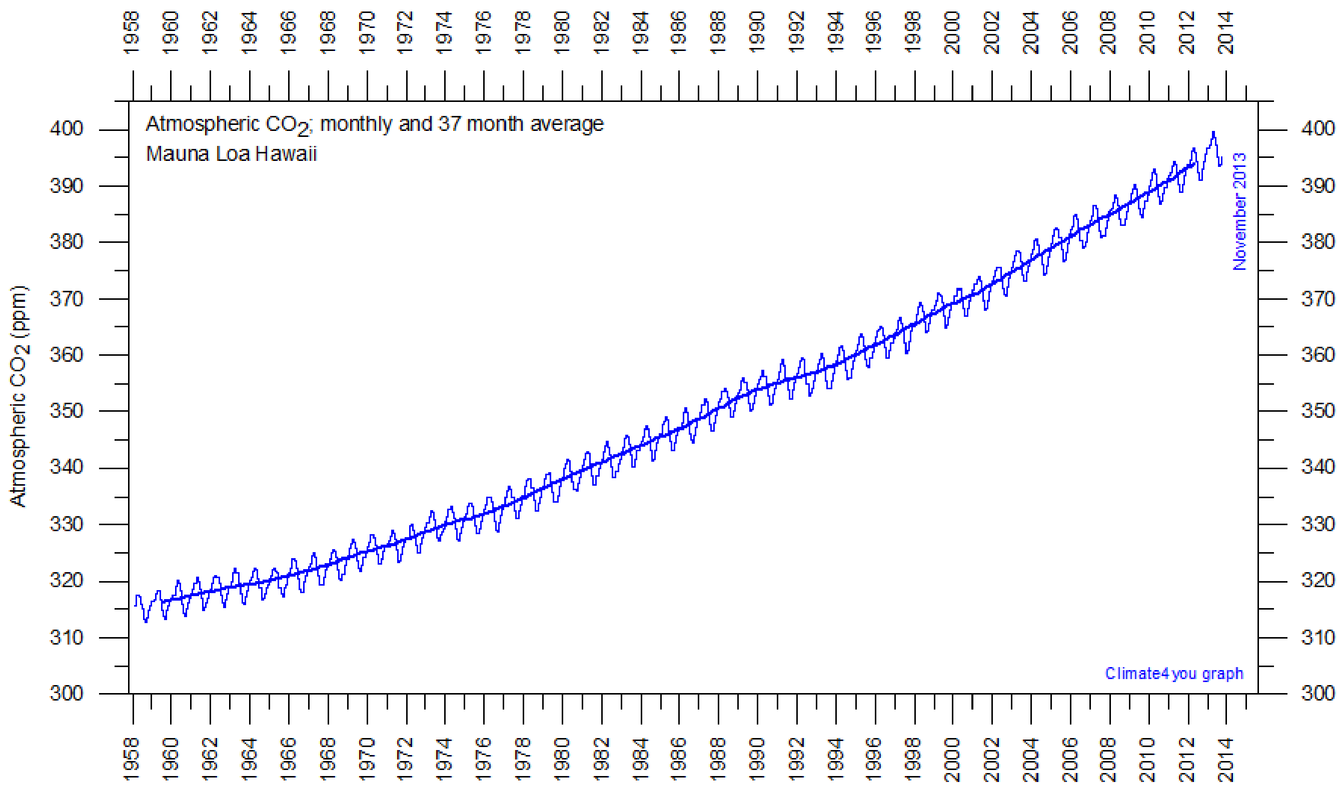
Accumulated cyclonic engergy (ACE; Atlantic basin) per year since 1850 AD, according to data from the [Atlantic Oceanographic and Meteorological Laboratory, Hurricane research Division](). Thin lines show annual ACE values, and the thick line shows the running 7-yr average. Last year shown: 2012.

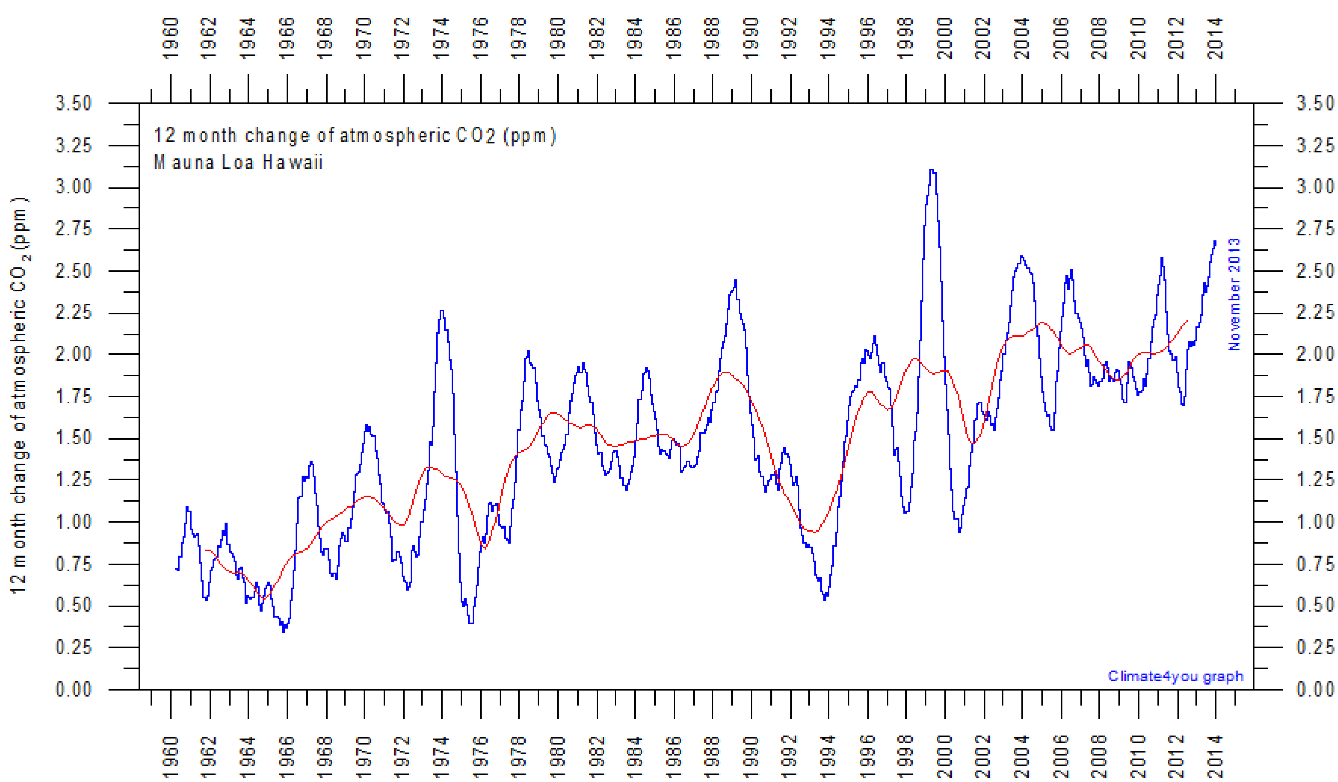
Accumulated cyclone energy (ACE) is a measure used by the National Oceanic and Atmospheric Administration (NOAA) to express the activity of individual tropical cyclones and entire tropical cyclone seasons.

ACE is calculated as the square of the wind speed every 6 hours, and is then scaled by a factor of 10,000 for usability, using a unit of 10^4 knots^2. The ACE of a season is the sum of the ACE for each storm and takes into account the number, strength, and duration of all the tropical storms in the season.

The damage potential of a hurricane is proportional to the square or cube of the maximum wind speed, and thus ACE is not only a measure of tropical cyclone activity, but also a measure of the damage potential of an individual cyclone or a season.

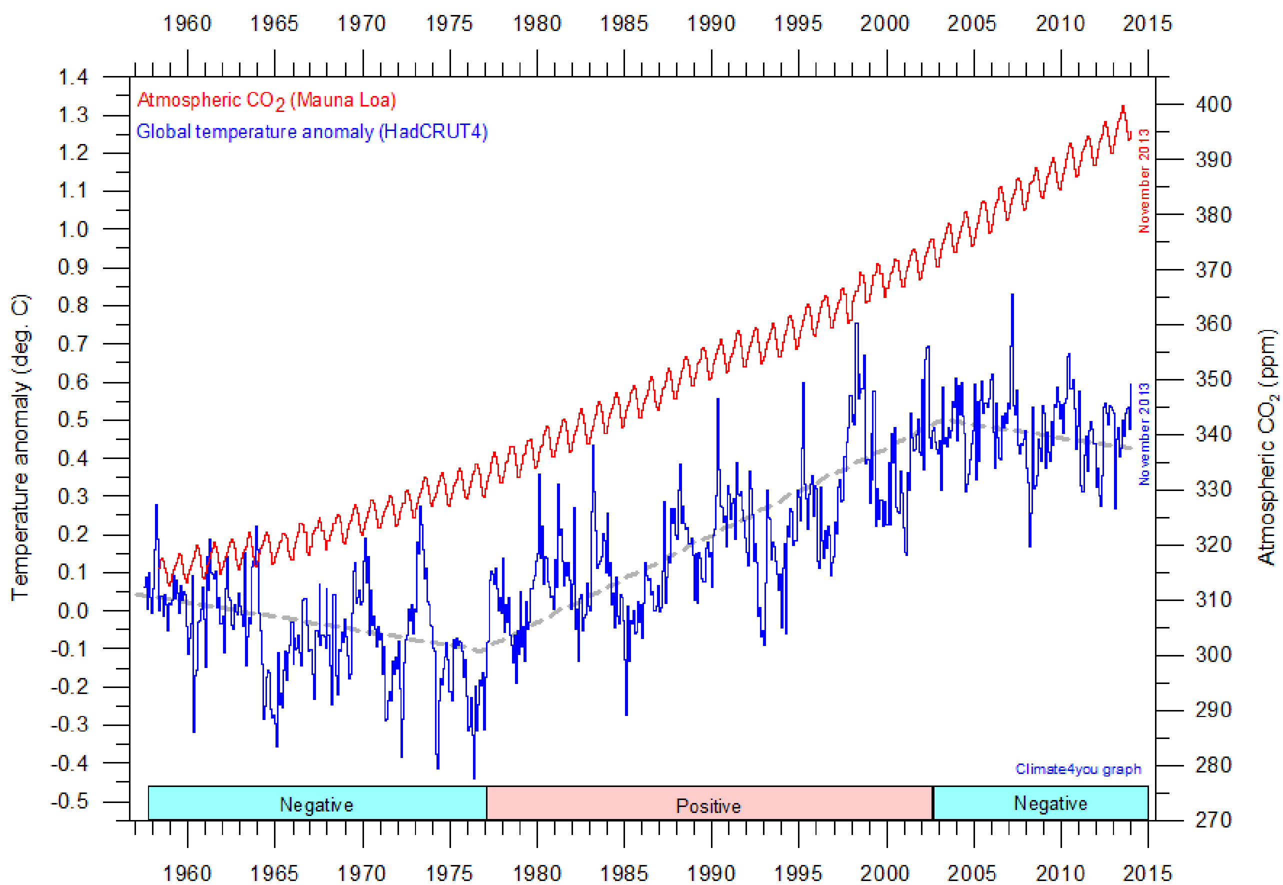
Atmospheric CO_2, updated to November 2013

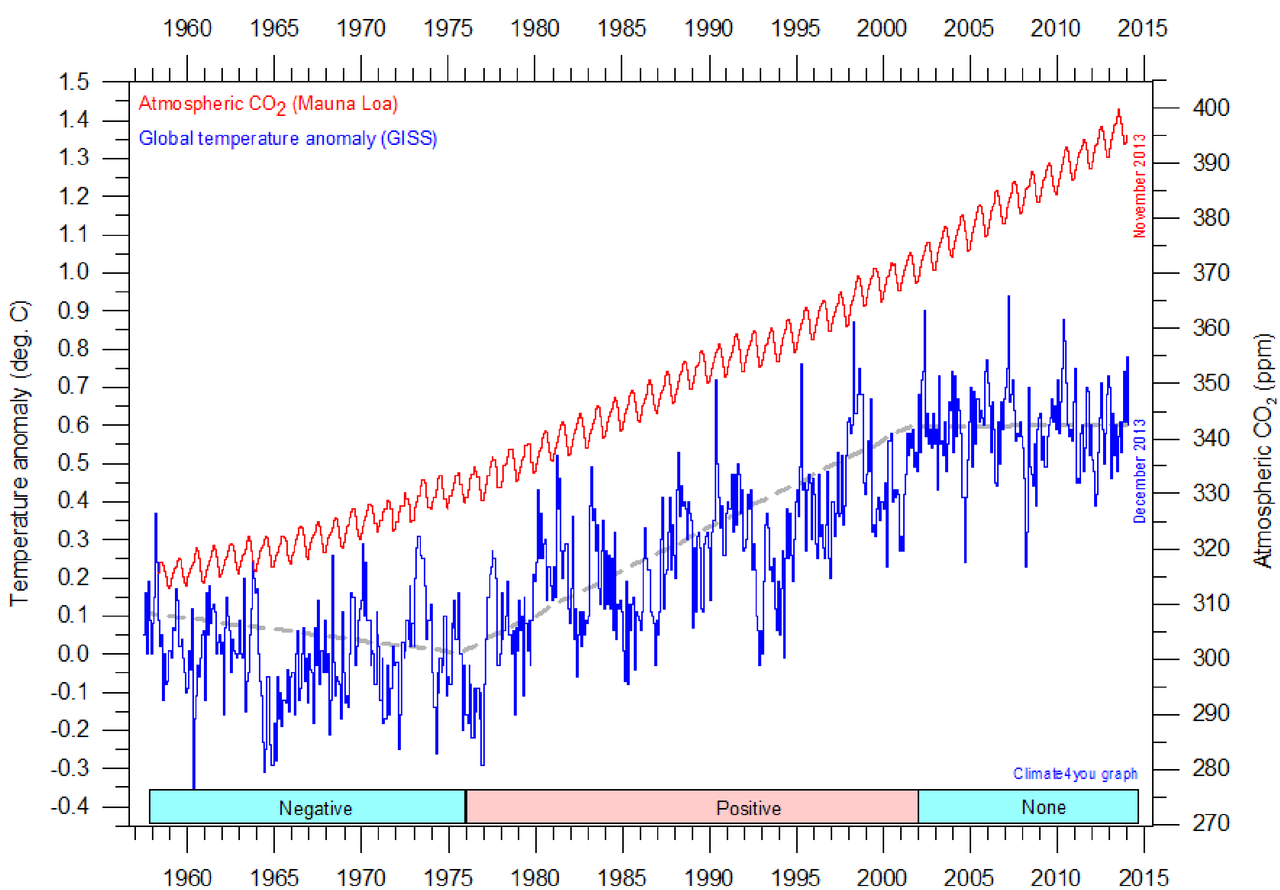


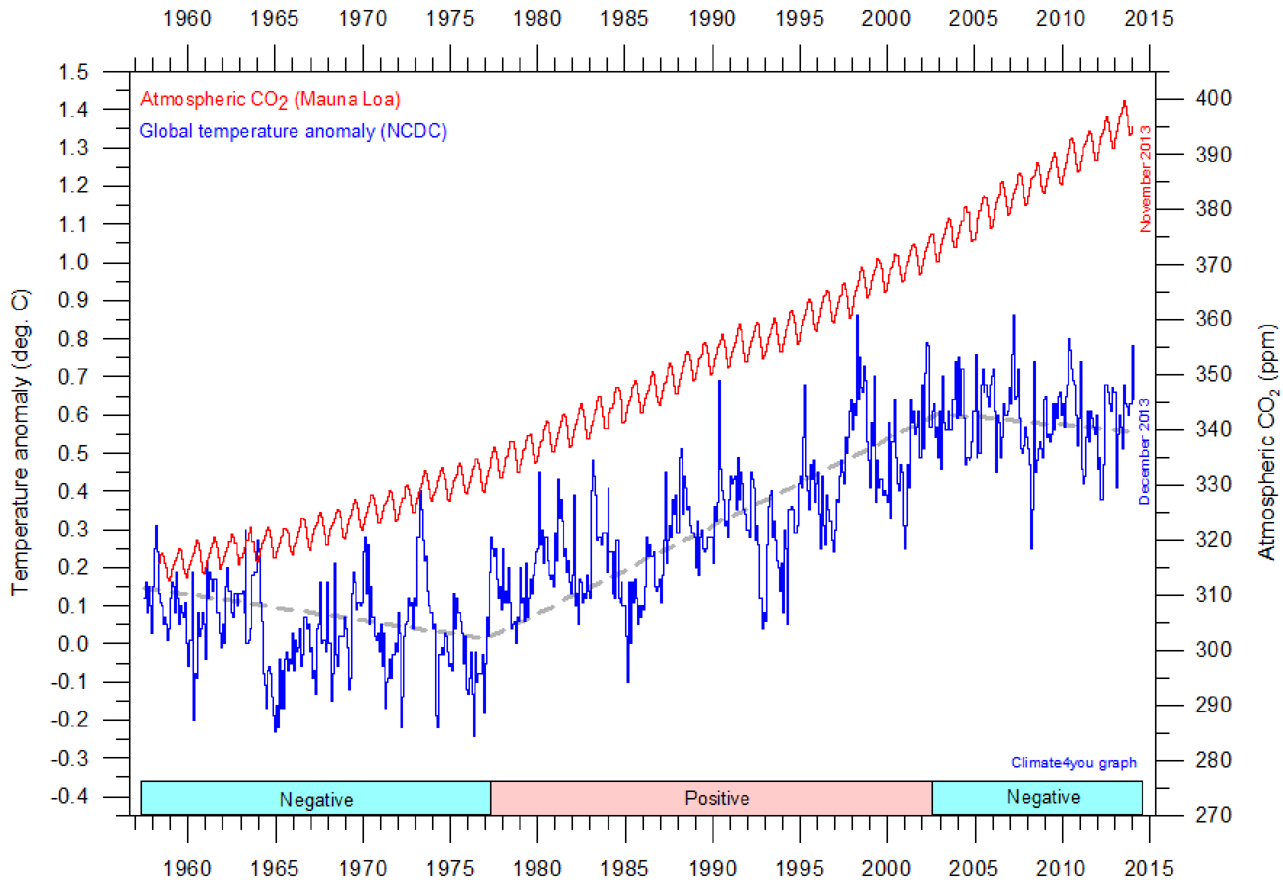


Monthly amount of atmospheric CO_2 (upper diagram) and annual growth rate (lower diagram); average last 12 months minus average preceding 12 months, blue line) of atmospheric CO_2 since 1959, according to data provided by the [Mauna Loa Observatory](), Hawaii, USA. The red line is the simple running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

Global surface air temperature and atmospheric CO_2, updated to December 2013







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 direct 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 HadCRUT4 diagram is not yet updated beyond November 2013.

Most climate models assume the greenhouse gas carbon dioxide CO_2 to influence significantly upon global temperature. It is therefore relevant to compare different 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, 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 meteorological record value may well be the result of other phenomena.

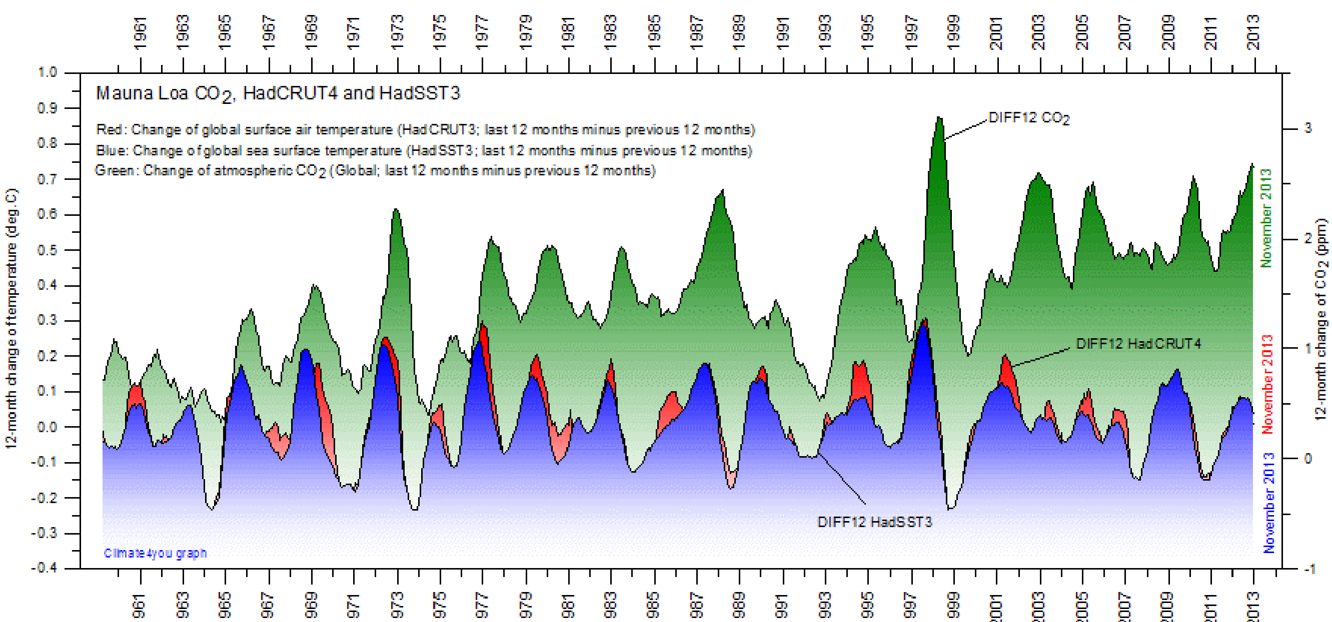
What exactly defines the critical length of a relevant time period to consider for evaluating the alleged importance of CO_2 remains elusive, and is still a topic for discussion. However, the critical period length must be inversely proportional to the temperature sensitivity of CO_2, including feedback effects. If the net temperature effect of atmospheric CO_2 is strong, the critical time period will be short, and vice versa.

However, past climate research history provides some clues as to what has traditionally been considered the relevant length of period over which to compare temperature and atmospheric CO_2. After about 10 years of concurrent global temperature- and CO_2-increase, IPCC was established in 1988. 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, politic support for the hypothesis would have been difficult to obtain.

Based on the previous 10 years of concurrent temperature- and CO_2-increase, many climate scientists in 1988 presumably felt that their understanding of climate dynamics was sufficient to conclude about the importance of CO_2 for global temperature changes. From this it may safely be concluded that 10 years was considered a period long enough to demonstrate the effect of increasing atmospheric CO_2 on global temperatures.

Adopting this approach as to critical time length (at least 10 years), the varying relation (positive or negative) between global temperature and atmospheric CO_2 has been indicated in the lower panels of the diagrams above.

The phase relation between atmospheric CO_2 and global temperature, updated to November 2013



12-month change of global atmospheric CO_2 concentration (Mauna Loa; green), global sea surface temperature (HadSST3; blue) and global surface air temperature (HadCRUT4; red dotted). All graphs are showing monthly values of DIFF12, the difference between the average of the last 12 month and the average for the previous 12 months for each data series. Changes in temperatures are seen to take place 9-12 months before corresponding changes in atmospheric CO_2. Last month included in analysis: November 2013.

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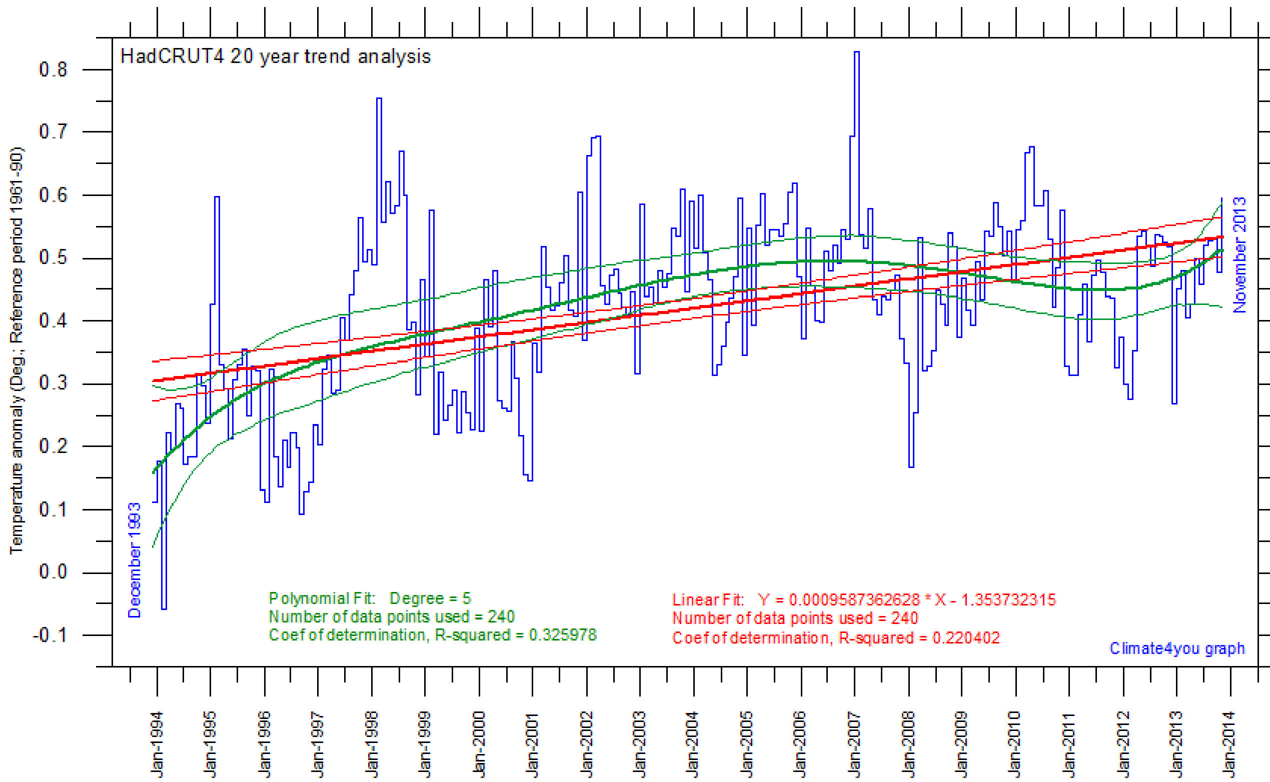
Last 20 year monthly surface air temperature changes, updated to November 2012



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 (note that the linear trend is the monthly trend).

It is quite often debated if the global surface temperature still increases, or if the temperature has levelled out during the last 10-15 years. The above diagram may be useful in this context, and demonstrates the differences between two often used statistical approaches to determine recent temperature trends. Please also note that such fits only attempt to describe the past, and usually have limited predictive power.

[Climate and history; one example among many](#)

Year 1820 and 2013: The discovery of the Antarctic and recent surprises of Antarctic sea ice variations in December 2013

Figure 1. A commemorative coin of Bank of Russia dedicated to the first Russian Antarctic expedition (left). Admiral Faddey Faddeyevich Bellingshausen around 1835 (right).

In January 1773 James Cook crossed the Antarctic Circle and became the first to circumnavigate Antarctica. He did not observe land, but fragments of bedrock embedded in floating icebergs demonstrated that a southern continent must exists somewhere further south. However, because of the rather unfriendly climate, he commented '*I make bold to declare that the world will derive no benefit from it*.

The first sighting of the Antarctic continent presumably was done on 27 January 1820, when the Russian naval officer Captain Thaddeus Bellingshausen with two ships managed to reach a position further south than 69^{o}S, and in the far distance saw an '*icefield covered with small hillocks'*.

This Russian South Polar Region expedition was authorized by Emperor Alexander I in 1819. The Russian naval authorities selected Captain Bellingshausen to lead it, as he was recognised as an experienced captain and explorer, and also as a prominent cartographer. The expedition was intended to explore the Southern Ocean and to look for land in the proximity of the South Pole.

The two ships of the expedition, the 985-ton sloop-of-war Vostok ('*East'*) and the 530-ton support vessel Mirny ('*Peaceful'*) left the naval base at Kronstadt on 4 June 1819. The expedition crossed the Antarctic Circle on 26 January 1820; the first known crossing since Cook in 1773. Two days later, on 28 January 1820, the expedition discovered the Antarctic mainland approaching the Antarctic coast to the position 69º21'28"S 2º14'50"W, which is within 30 kilometres from the Antarctic coast. Here they observed land with ice-fields in the far distance.

Returning to Kronstadt on 4 August 1821, Bellingshausen was promoted to Counter Admiral. He later fought in the Russo-Turkish War of 1828–1829 and attained the rank of Vice Admiral in 1830. In 1831 he published two books on his Antarctic expedition, called '*Double Investigation of the Southern Polar Ocean'* and the '*Voyage Around the World'*, respectively. The Bellingshausen Sea on the west side of the Antarctic Peninsula is today named after Captain Bellinghausen.

However, for long time there was dispute about who actually was the first to set eyes on Antarctica, as two British naval officers, William Smith and Edward Bransfield, also saw Antarctica on January 30th the same year, and somewhat later, but still in 1820, the American sealer Nathaniel Palmer made land sighting on November 16th.

Bellingshausen's diary, his report to the Russian Naval Minister on 21 July 1821 and other documents, accessible at the Russian State Museum of the Arctic and Antarctic in Saint Petersburg, Russia, were later carefully compared with the log-books of the other claimants by the British polar historian A. G. E. Jones in his 1982 study '*Antarctica Observed*'. Jones concluded that Bellingshausen, rather than the Royal Navy's Edward Bransfield on 30 January 1820 or the American Nathaniel Palmer on 16 November 1820, was indeed the discoverer of the long sought-after Terra Australis.

The first reported landing on continental Antarctica was on 7 February 1821 by the American sealer Captain John Davis, though this is not acknowledged by all historians. However, in the winter of 1821, for the first time ever a party of men spent a winter in Antarctica. One officer and ten men from the British sealing ship '*Lord Melville*' involuntary had to spend the winter on King George Island - part of the South Shetlands group - north of the Antarctic Peninsula. Their ship had been driven offshore by a storm and was unable to return to pick them up again. They were eventually rescued the following summer of 1822. In 1823 the British whaler James Weddell discovered the sea today named after him and then reaches the most southerly point at that time 74° 15' S. After that, no one else again managed to penetrate the Weddell Sea for 80 years.

This sudden burst of Antarctic exploration activity 1820-23 suggests that sea ice conditions then must have been relatively good around the Antarctic continent, to enable within a few years all these sightings and landings. This is noteworthy, as the time around 1820 (shortly after the Napoleon wars) presumably was characterised by relatively cold conditions in the Arctic.

Since 1823, there have been many expeditions to the Antarctic continent; some meeting good sea ice conditions and a relatively easy approach towards the coast, and others experiencing difficult conditions with thick and extensive sea ice. Clearly, the Antarctic sea ice has been exposed to considerable natural variations since the first sighting in 1820. However, detailed satellite observations on the Antarctic sea ice extension only began as late as in 1979.

The latest report on Antarctic sea ice variations appeared in December 2013 (Antarctic summer), when the Russian research vessel MV Akademik Shokalskiy, carrying an Australian research team, journalists and turists, became beset by ice while heading away from Commonwealth Bay on the Antarctic coast. The purpose of the Australian expedition was to study the effects of 20th-century climate change in the region, including changes of sea ice and other oceanographic conditions. Their ship Akademik Shokalskiy (Fig. 2) was designed and built in Finland for polar and oceanographic research, and regularly operates cruises of East Antarctica and along the Russian Coast.

Figure 2. MV Akademik Shokalskiy stuck in the Antarctic sea ice, December 2013.

Commonwealth Bay is an open bay almost 50 km wide at the entrance between Point Alden and Cape Gray in East Antarctica. It was discovered in 1912 by the Australian Antarctic Expedition under Douglas Mawson, who established the main base of the expedition at Cape Denison at the head of the bay, after approaching the bay by sailing across open water. The bay was named by 1912 Australian Antarctic Expedition after the Commonwealth of Australia. The December 2013 Australian Antarctic Expedition was meant to retrace the route the explorer Douglas Mawson took in 1912.

However, the modern 2013 expedition was not meeting ice conditions like experienced by the 1912 expedition, but on their way out 24 December was beset by thick sea ice. Akademik Shokalskiy then needed the Chinese icebreaker Chinese icebreaker Xue Long (the '*Snow Dragon*') to rescue them, but the Xue Long then got caught in the ice. Eventually, the Aurora Australis icebreaker managed to get close to the Xue Long, to rescue the rescuers, and evacuated passengers from Akademik Shokalskiy by helicopter. On January 7, 2014, a major crack developed in the sea ice, and both Akademik Shokalskiy and Xue Long managed to work their way out of their predicament.

It thus all ended up being rather complicated, and evidently Antarctic sea ice variations may surprise even the most experienced polar scientist.

As mentioned, detailed satellite observations of Antarctic sea ice variations only began as late as in October 1979. Could this data series, though still rather short, have yielded useful information about the likely December 2013 sea ice conditions around the Antarctic?

The diagram below (Fig. 3) shows a 12-month running average of the monthly sea ice extension in the Southern Hemisphere (red) and in the Northern Hemisphere (blue). Sea ice in both hemispheres experience large annual variations for obvious reasons, wherefore this seasonal signal has been removed by calculating a 12-month average, and the resulting data series are therefore only displaying variations of longer duration than one year.

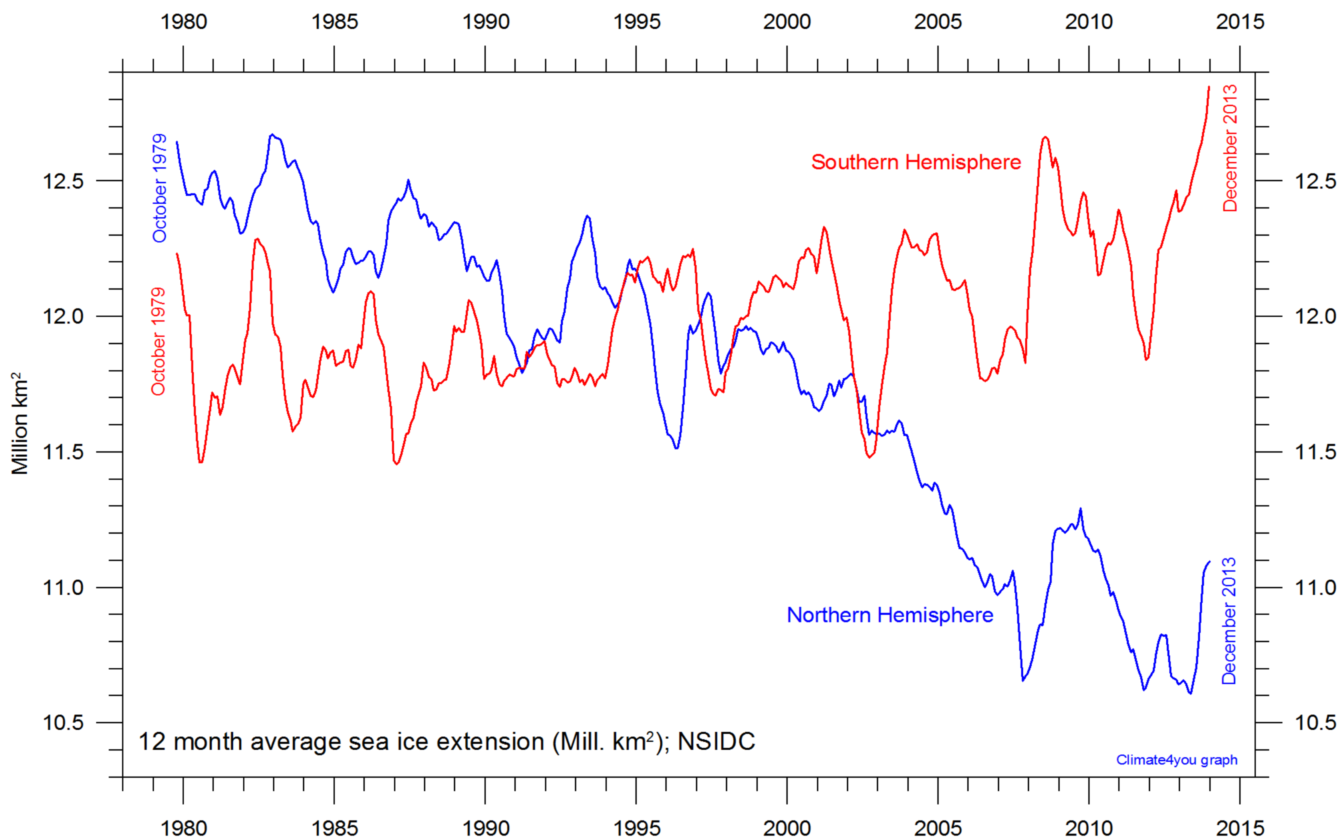


Figure 3. Twelve-month running average sea ice extension in both hemispheres since 1979, the satellite-era. Data source: National Snow and Ice Data Center (NSIDC).

Interesting enough, the two 12-month average graphs show opposite development to each other. While the often published Northern Hemisphere modern trend towards smaller sea ice extension is clearly displayed by the blue graph, so is a coinciding increase of Southern Hemisphere sea ice extension also very clear, although less often discussed by news media.

It is especially clear that the Antarctic sea ice conditions just now appear to be heading towards a maximum for the entire record since 1979. On this background it is not entirely surprising that MV Akademik Shokalskiy met difficult ice conditions in December 2013.

The opposed sea ice development at the two poles is interesting, as it demonstrates the continued operation of a bi-polar seesaw, as previous shown by ice cores from Greenland and the Antarctic (Blunier et al. 1998, Blunier and Brook 2001) and by modern meteorological observations (Chylek et at. 2010). In addition, this seesaw is in contrast to forecasts made by climate models, where warming and reduced sea ice extension should by now characterise both poles. Thus, the above sea ice diagram advocates that any influence of anthropogenic CO_2-induced climate change still is subordinate to natural climatic variations.

However, much more interesting knowledge on sea ice variations may be extracted from the two 12-month average data series shown in figure 3. Visually both graphs are apparently characterised by variations playing out within 4-5 years, superimposed on the overall trends towards larger or smaller sea ice extension, respectively. Actually, the December 2013 Australian Antarctic Expedition was confronted by the consequences of one of these shorter Antarctic sea ice variations just now approaching a future peak value, and such shorter variations are therefore not entirely without importance.

Superficially, inspecting the above diagram (Fig. 3), it may appear as if these Arctic and Antarctic sea ice variations possibly relate to each other to some degree, but Fourier and wavelet analyses are needed to conclude anything on this. The two following diagrams figure 4 and 5 shows the results of such Fourier and wavelet analysis for the observed sea ice extension in the two hemispheres.

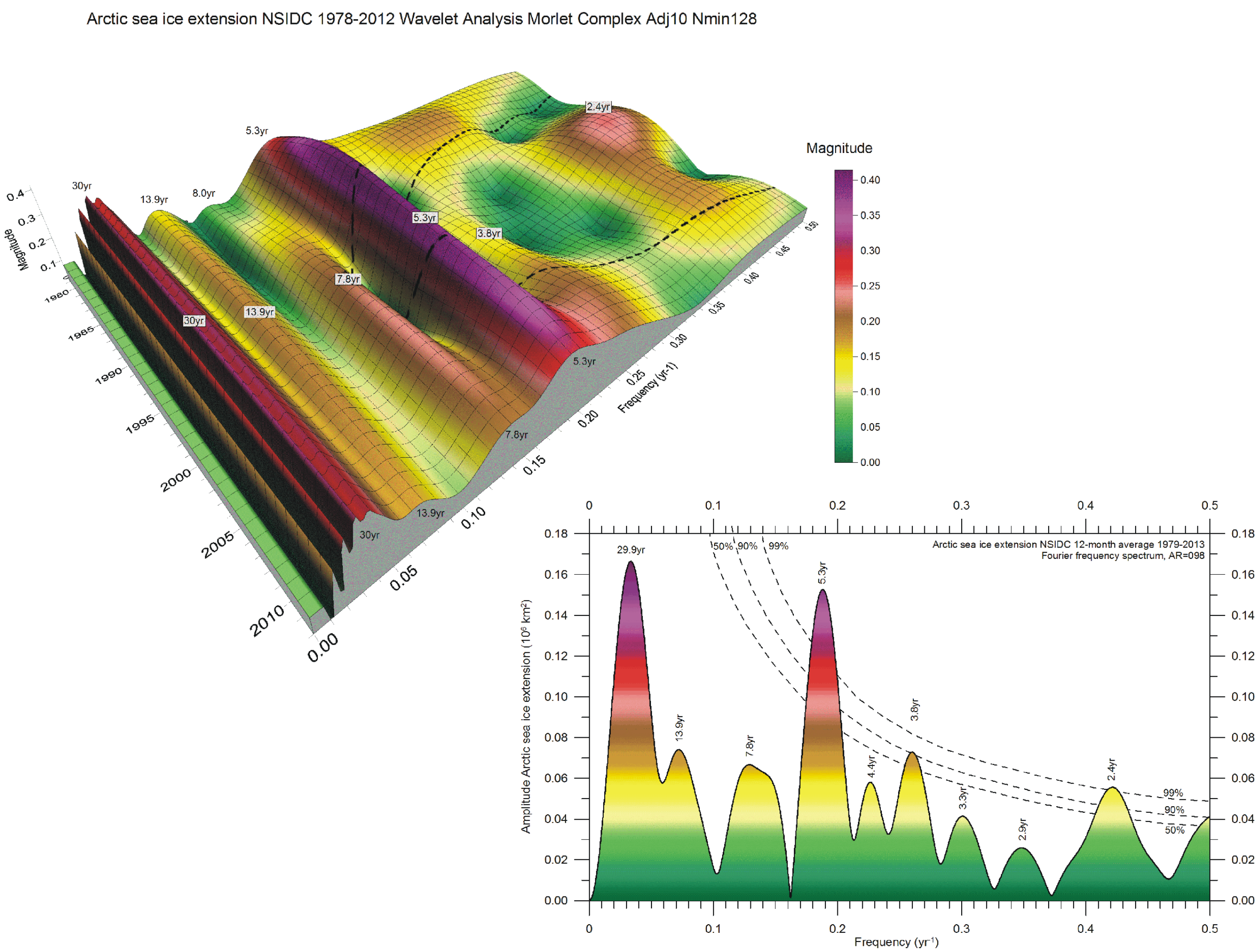


Figure 4. Fourier analysis (lower right; using Best Exact N composite algorithm) and wavelet analysis of the Northern Hemisphere (Arctic) detrended 12-month sea ice extension series. The horizontal stippled lines in the Fourier diagram indicate peak-based critical limit significance levels, while the colour scale indicates increasing amplitude. This Arctic record is dominated by periods of about 29.9 and 5.3 year length. In statistical sense, due to the still limited length of the record, only the 5.3 year peak is significant, and important throughout the entire observation period, as shown by the wavelet analysis. Only frequencies lower than 0.5 year-1 (periods longer than 2 years) are shown in both diagrams.

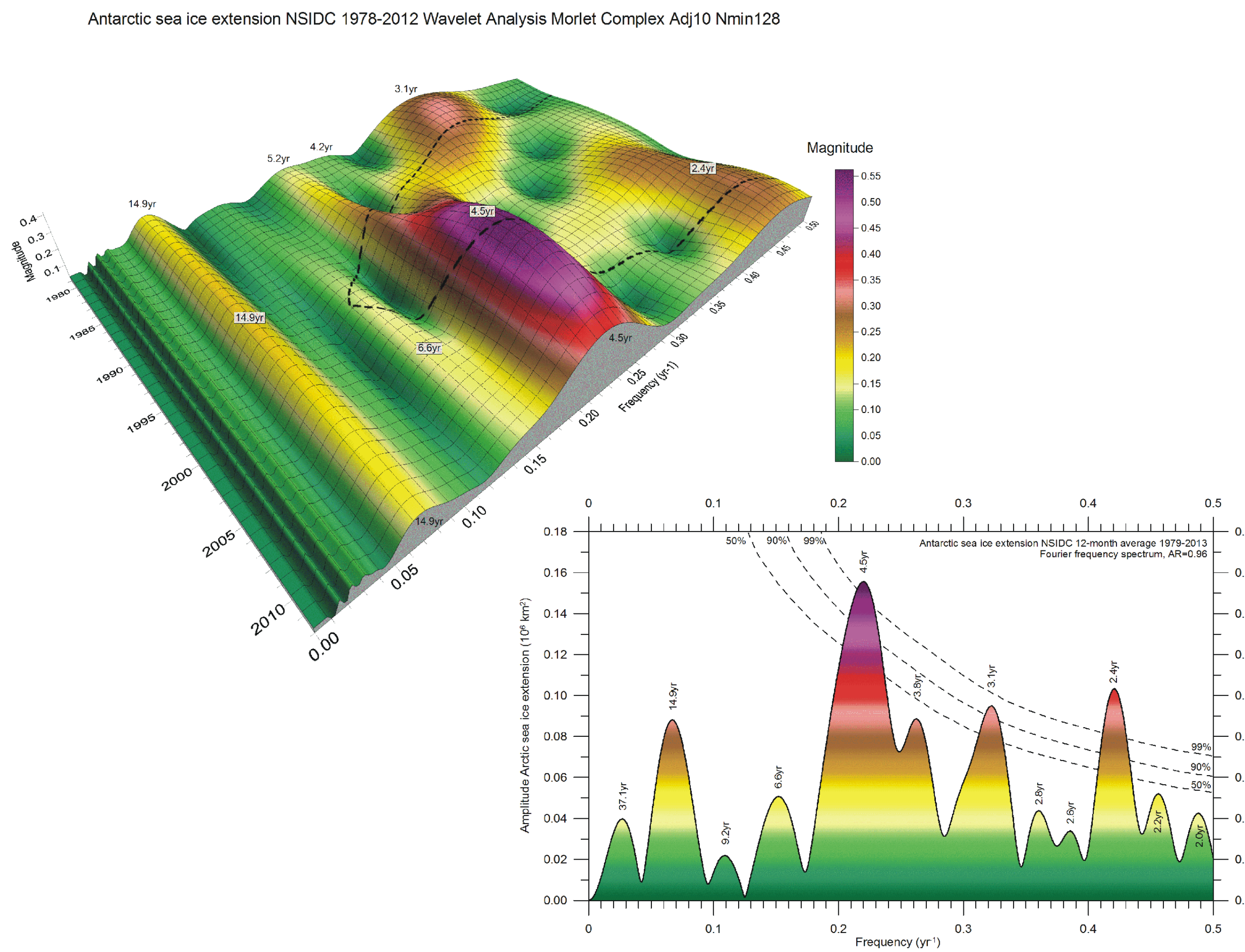


Figure 5. Fourier analysis (lower right; using Best Exact N composite algorithm) and wavelet analysis of the Southern Hemisphere (Antarctic) detrended 12-month sea ice extension series. The horizontal stippled lines in the Fourier diagram indicate peak-based critical limit significance levels, while the colour scale indicates increasing amplitude. This Antarctic record is dominated by periods of about 4.5, 3.1 and 2.4 year length, all statistically significant. In recent years especially the 4.5 year period is important. Only frequencies lower than 0.5 year^{-1} (periods longer than 2 years) are shown in both diagrams.

Ignoring the long-term decreasing trend, the Arctic sea ice extension is seen to be dominated by a statistical significant 5.3 year variation (Fig. 4), which is responsible for the current increase of sea ice in the Arctic. This natural variation has been important throughout the entire observational period since 1979.

The present Arctic sea ice increase can therefore be expected to end in the near future, presumably within 1-2 years, after which a decrease might well again dominate. Also a nearly 30 year variation is clear in the data, although – due to the short record length – not being significant in a statistical sense. However, this is not indicating that this variation is without scientific importance. In this context it is noteworthy, that similar or related periodic variations can be found in other types of climate-related data, suggesting the above 30 year period to be real. As one example, a clear about 60 year variation can be identified in the accumulated cyclonic energy (ACE) for the Atlantic basin (see Climate4you update November 2013), equivalent to 2x30 years. Thus, there is reason to consider the possibility that the Arctic sea ice extension may also be controlled by an about 30 (or 60) year natural variation, and that the overall declining trend visible in figure 2 therefore may decrease in the near future, to be followed by a subsequent increase. Time will show.

The dynamics of the Antarctic sea ice extension (Fig. 5) is seemingly rather different from that characterising the Arctic sea ice. Ignoring the long-term increase, the development is mainly controlled by an about 4.5 year variation, which is approaching its maximum value in the near future. This dominant variation is apparently a relatively new development, and only appears in the wavelet diagram from about 1993. The next couple of years might therefore be characterised by a lack of new Antarctic sea ice extension record values, and such may now lie 4-5 years ahead, when the next 4.5 year peak is likely to occur, superimposed on the overall rising trend.

However, what is really interesting is the observation that the sea ice at the two poles apparently is controlled by rather different dynamics, and they therefore appear not to be coupled directly to one mutual development.

This observation represents another argument for characterising the sea ice developments in the two hemispheres as being mainly controlled by natural variations, and not by any overall CO_2-driven global warming.

The next step towards a better understanding of this is of cause to look for other phenomena following the rhythms of the two identified sets of dynamics, to identify the potential physical explanations for the opposite changes observed at the two poles. Chylek et al. 2010 were pointing towards shifting oceanographic conditions in the Atlantic Ocean as one possible candidate for further research.

Finally, a short comment on the long-term trend towards smaller and larger sea ice extension in the two hemispheres is presumably appropriate at this point. For obvious reasons it is not likely that these modern sea ice developments (increase and decrease) will continue linearly into the future. The contrasting sea ice development at the two poles demonstrates the continuing dominance of a natural, bi-polar seesaw: It is therefore likely that the trends seen in the still rather short satellite records only represent fragments of two longer variations.

Thus, the two apparent linear (but opposite) sea ice developments are likely artefacts of the two short data series. As new data are added, we might therefore slowly better be able to characterise the real character of the overall variations, and from this, to generate better forecasts of the near-future developments in the sea ice extension in the two hemispheres. Eventually, we might perhaps even be able to understand why the time around 1820-23 appears to have been characterised by relatively benign sea ice conditions along at least parts of the Antarctic coast, leading to the historical bust of new geographical discoveries outlined above.

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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

Yours sincerely,

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