Climate4you update June 2009

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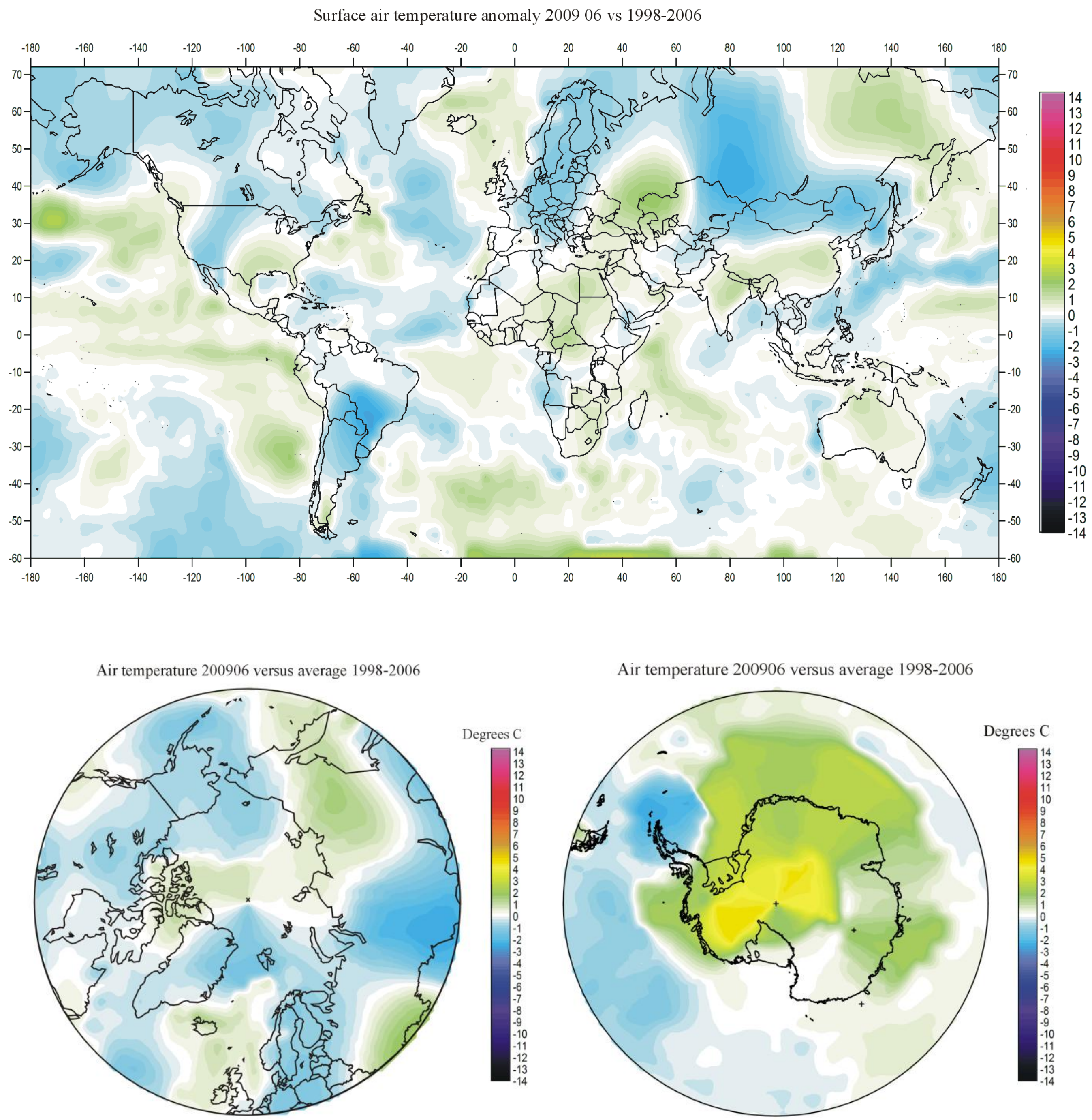
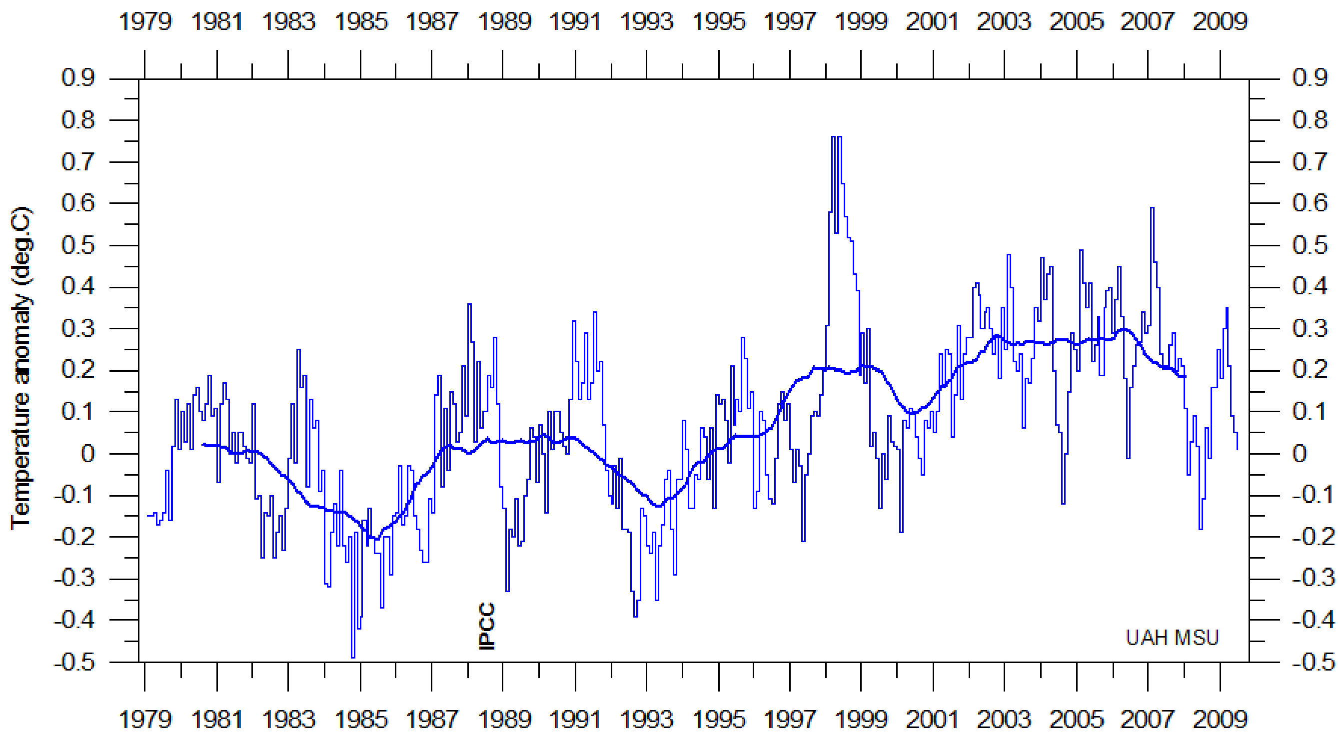
June 2009 global surface air temperature overview

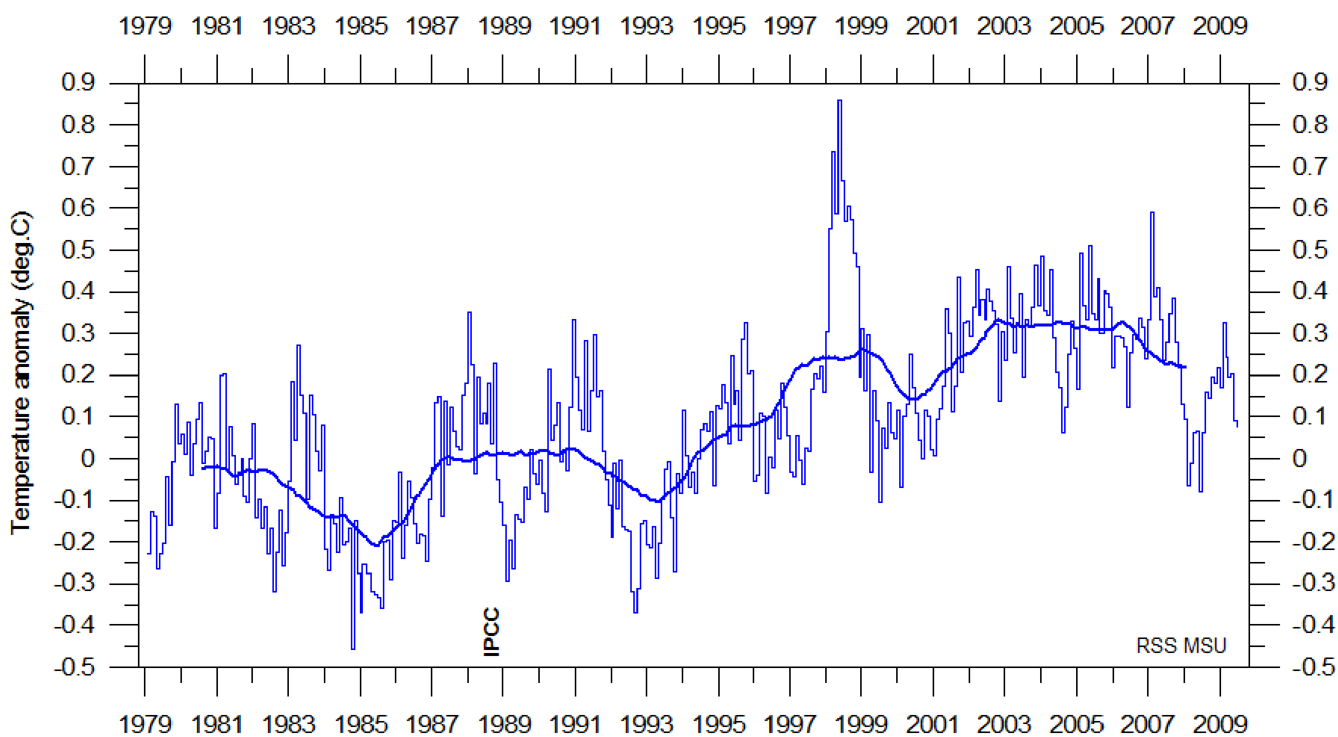


June 2009 surface air temperature compared to the average for June 1998-2006. Green.yellow-red colours indicate areas with higher temperature than the 1998-2006 average, while blue colours indicate lower than average temperatures. Data source: [Goddard Institute for Space Studies](http://www.giss.nasa.gov/) (GISS)

Lower troposphere temperature from satellites, updated to June 2009

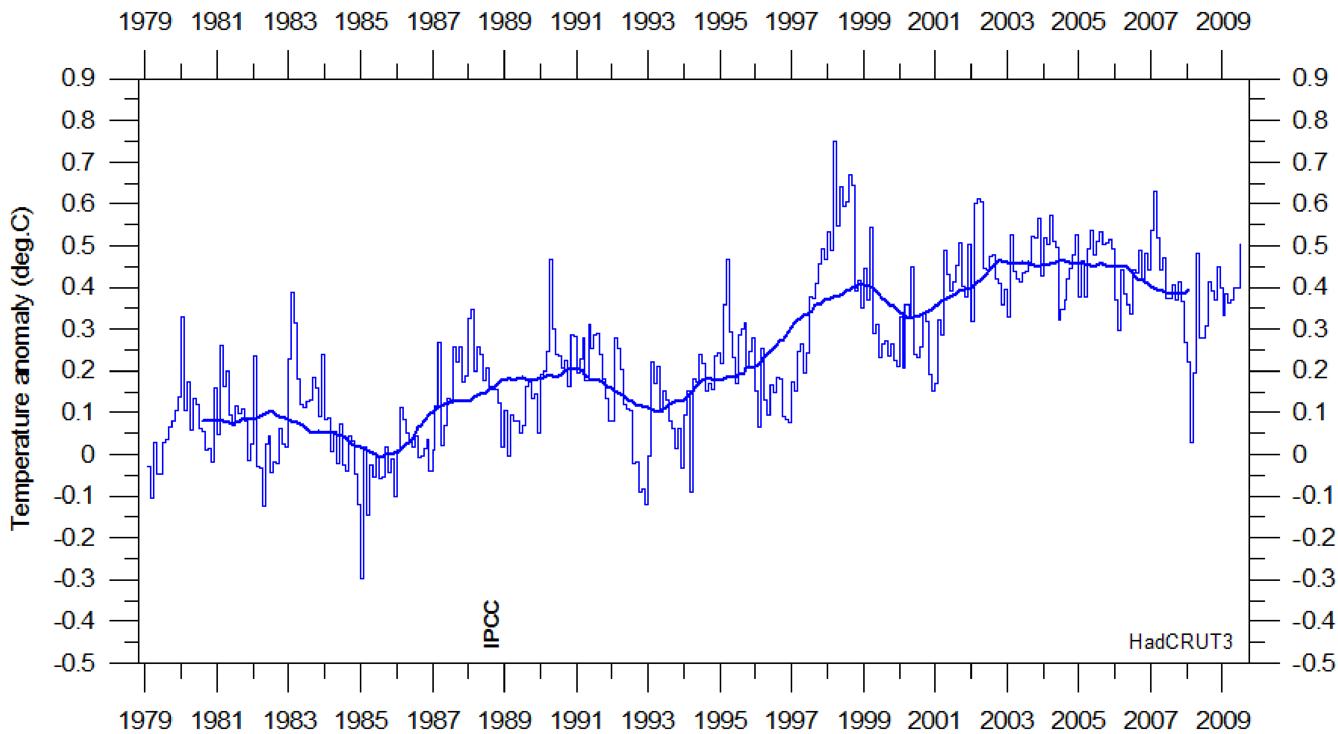


Global monthly average lower troposphere temperature (thin line) since 1979 according to [University of Alabama] at Huntsville, USA. The thick line is the simple running 37 month average.

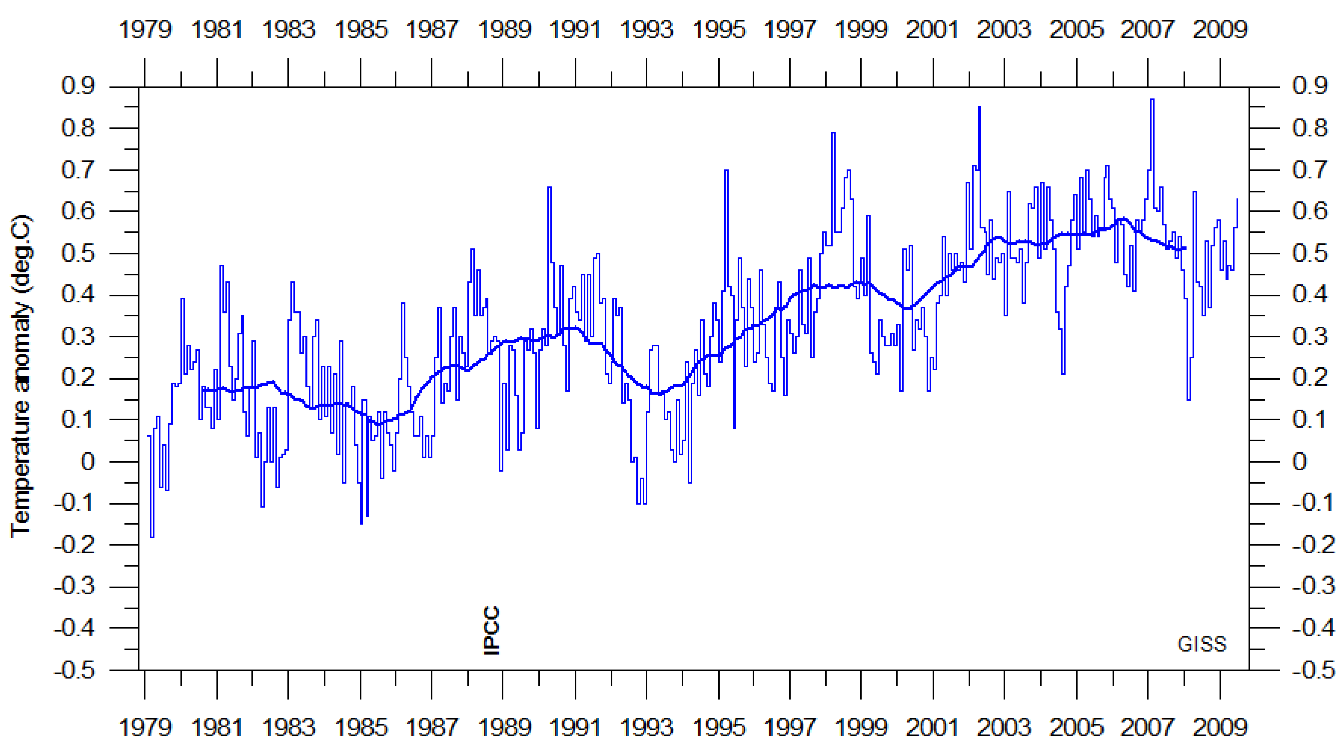


Global monthly average lower troposphere temperature (thin line) since 1979 according to according to [Remote Sensing Systems] (RSS), USA. The thick line is the simple running 37 month average.

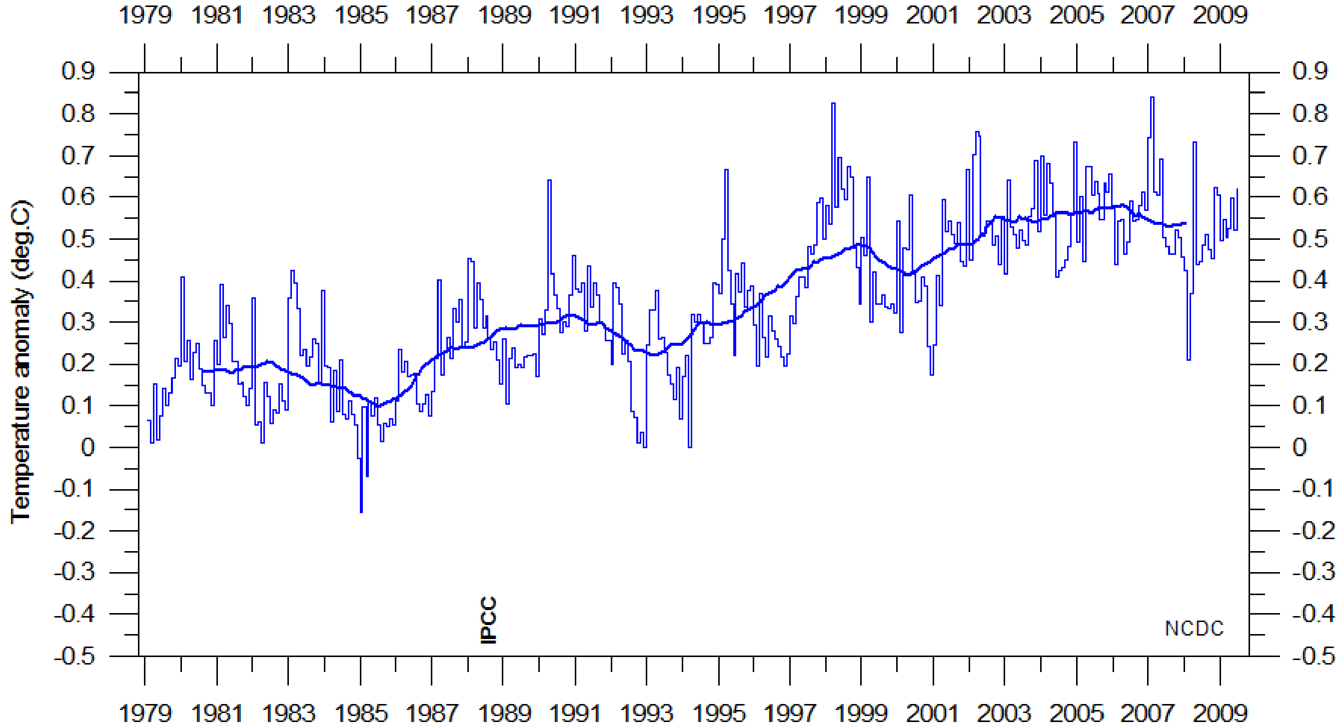
Global surface air temperature, updated to June 2009



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.

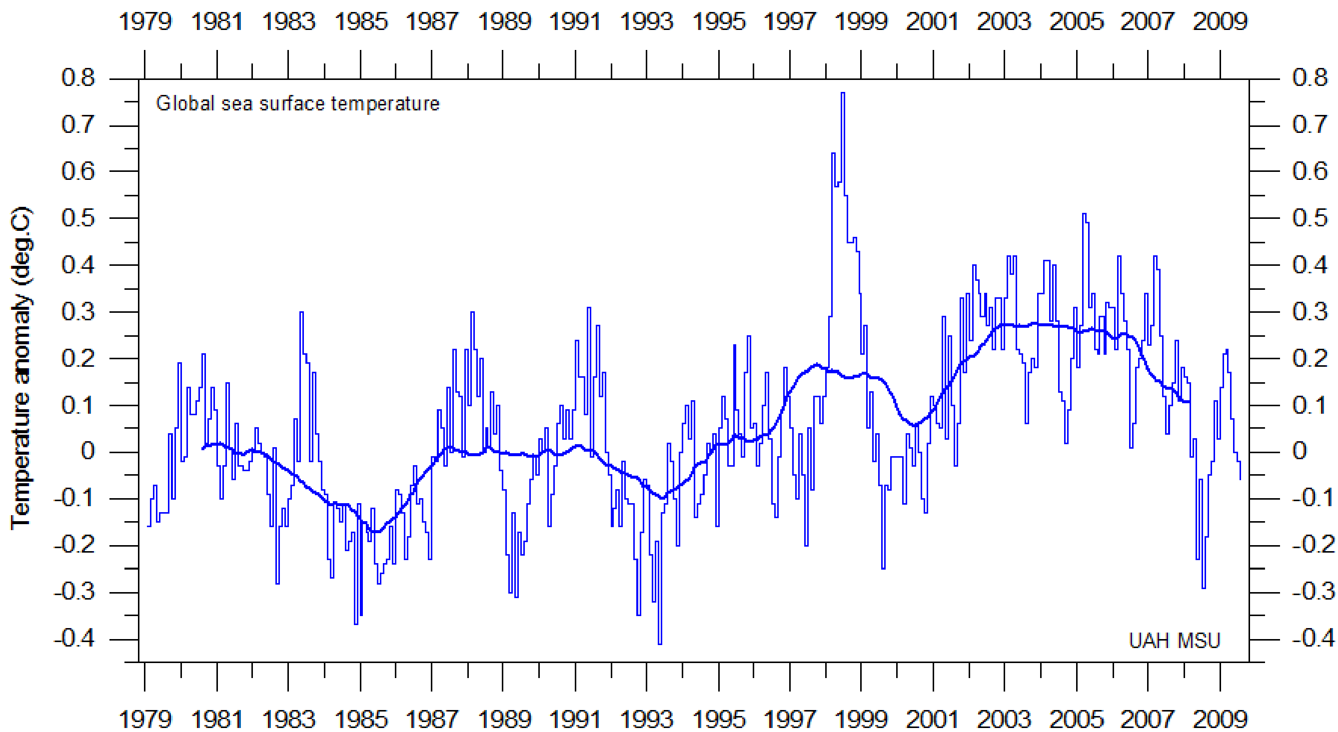


Global monthly average surface air temperature (thin line) since 1979 according to according to the Goddard Institute for Space Studies (GISS), at Columbia University, New York City, USA. The thick line is the simple running 37 month average.

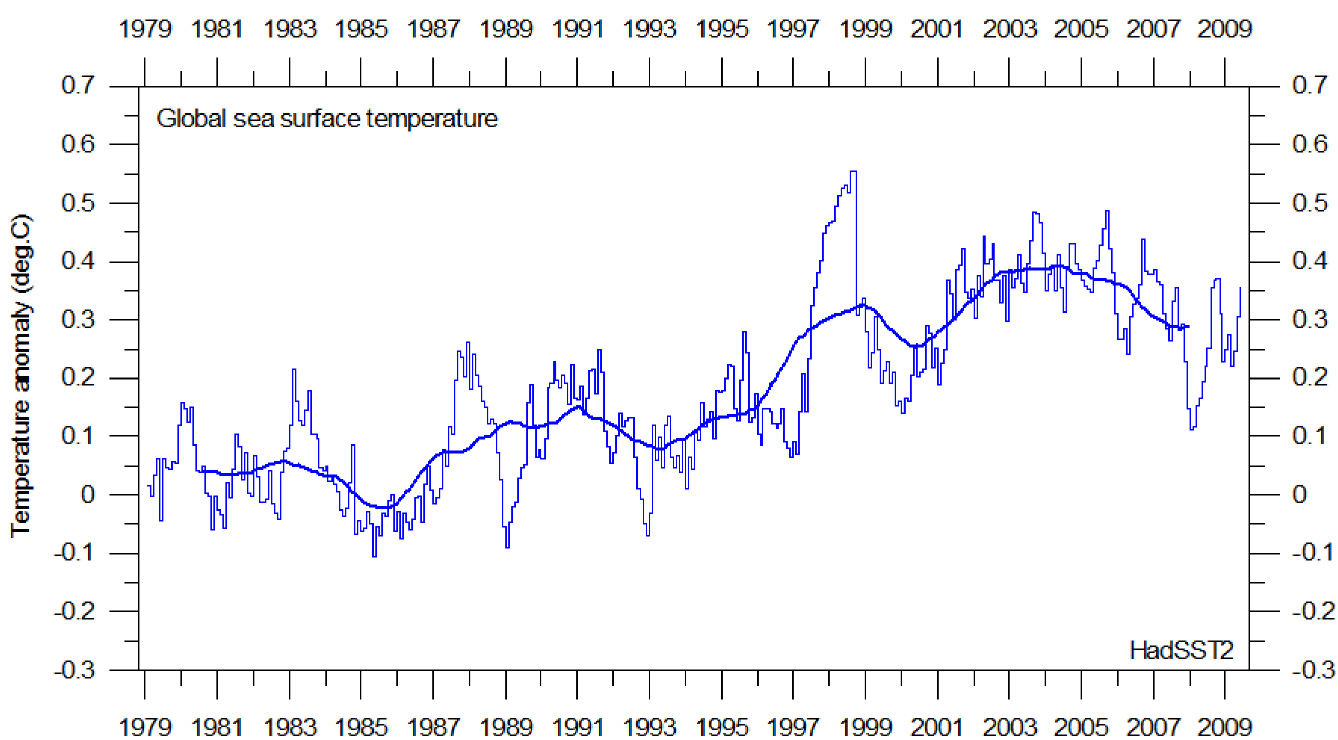


Global monthly average surface air temperature since 1979 according to according to the [National Climatic Data Center](#) (NCDC), USA. The thick line is the simple running 37 month average.

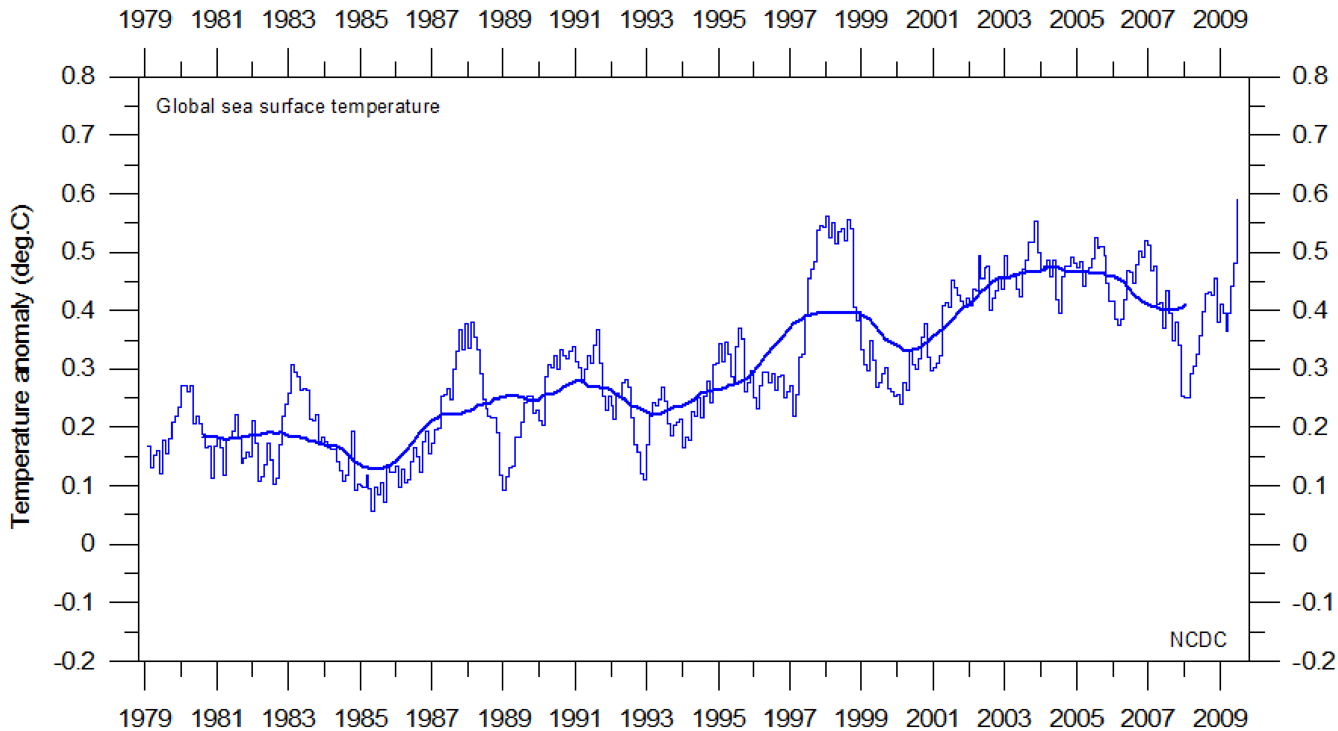
[Global sea surface temperature, updated to June 2009]



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.

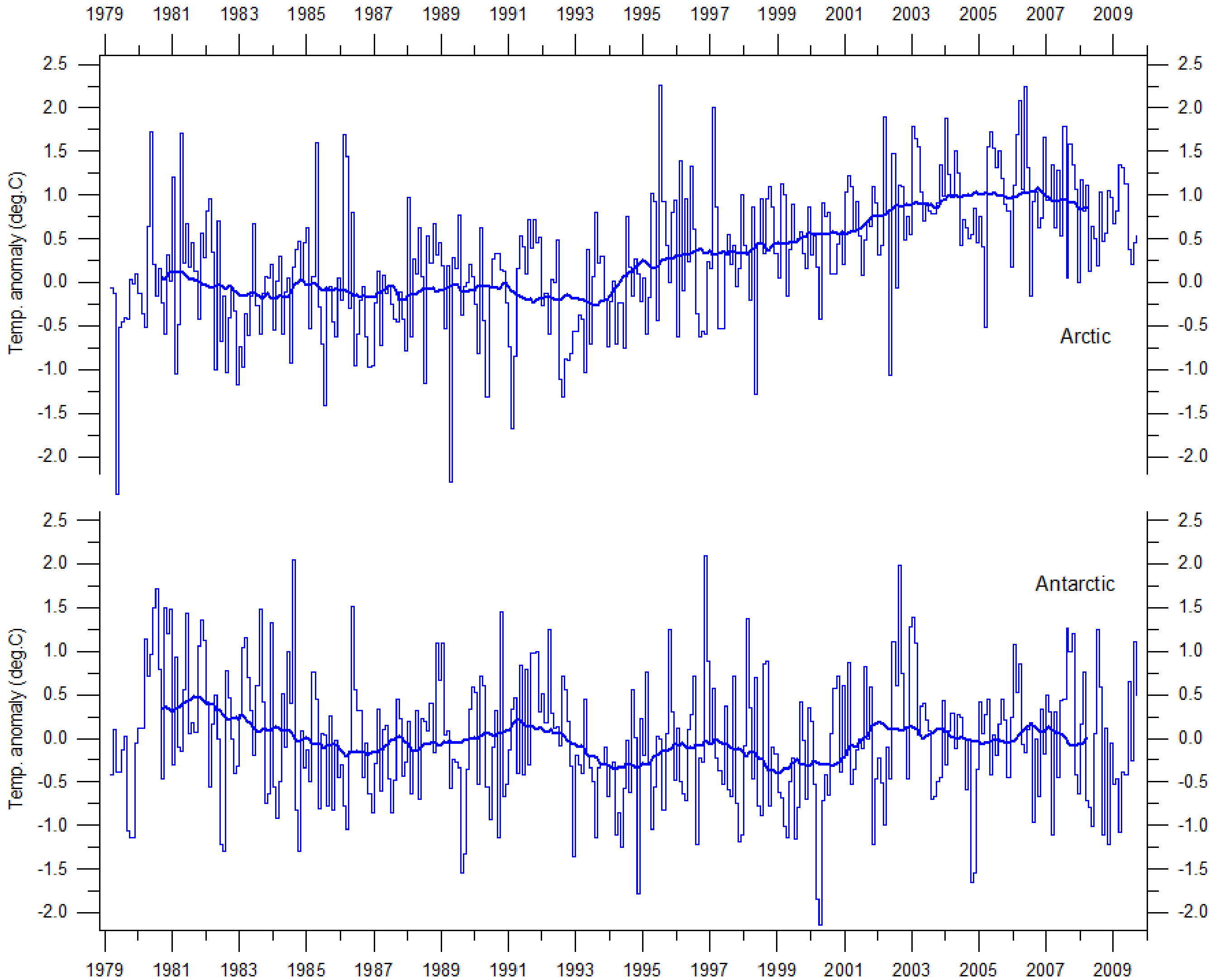


Global monthly average sea surface temperature since 1979 according to University of East Anglia's [Climatic Research Unit] ([CRU]), UK. Base period: 1961-1990. The thick line is the simple running 37 month average. Updated to May 2009 only.



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

Arctic and Antarctic lower troposphere temperature, updated to June 2009



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 June 2009]

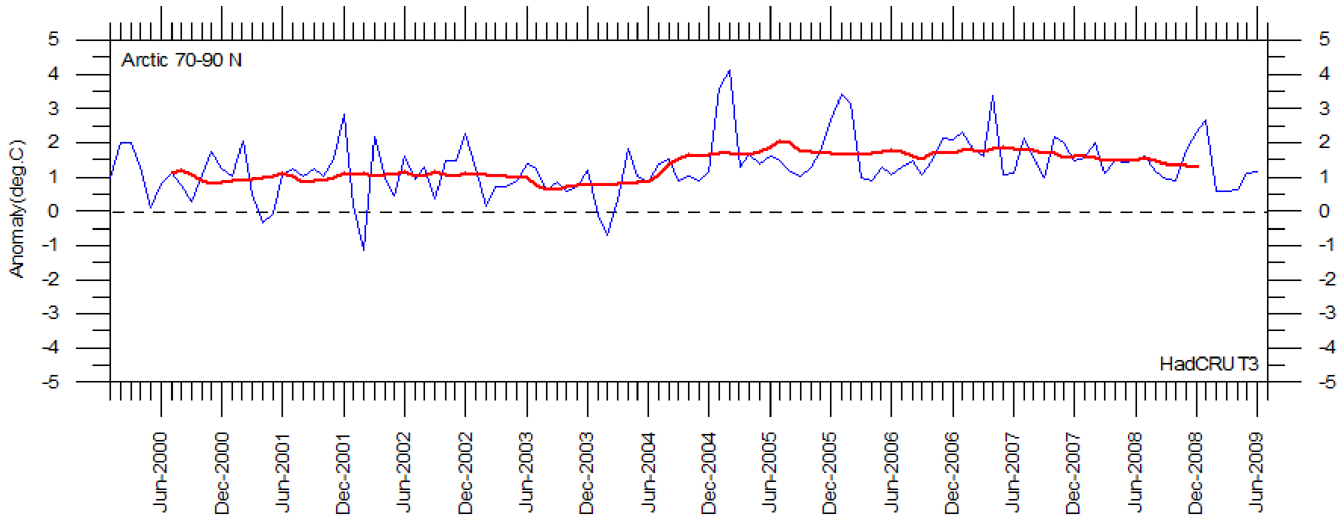


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley Centre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

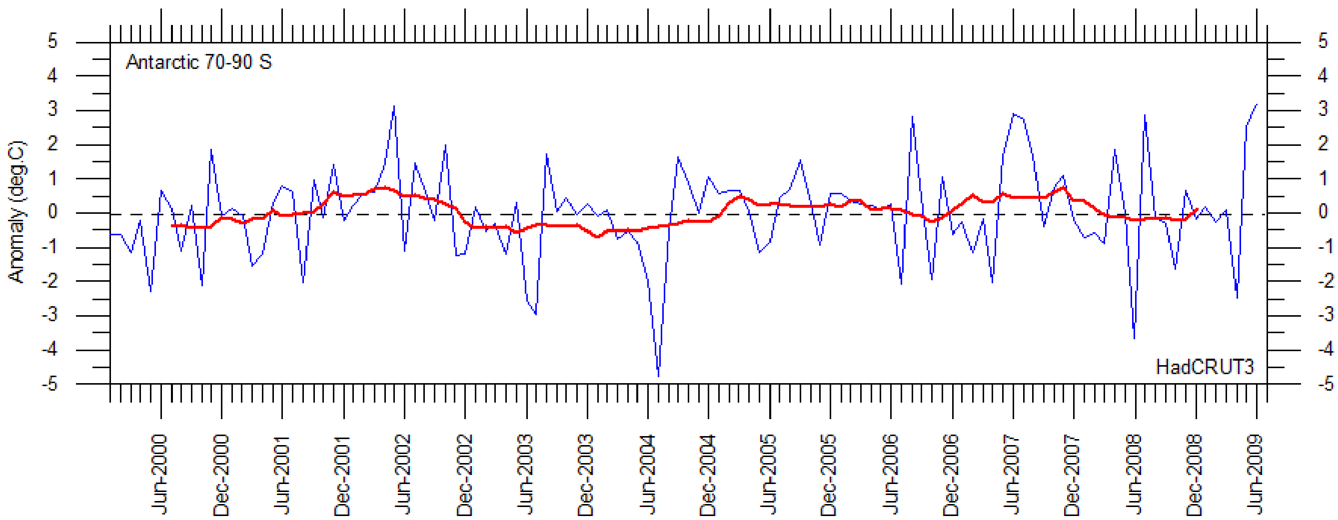


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 2000, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. Data provided by the Hadley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

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

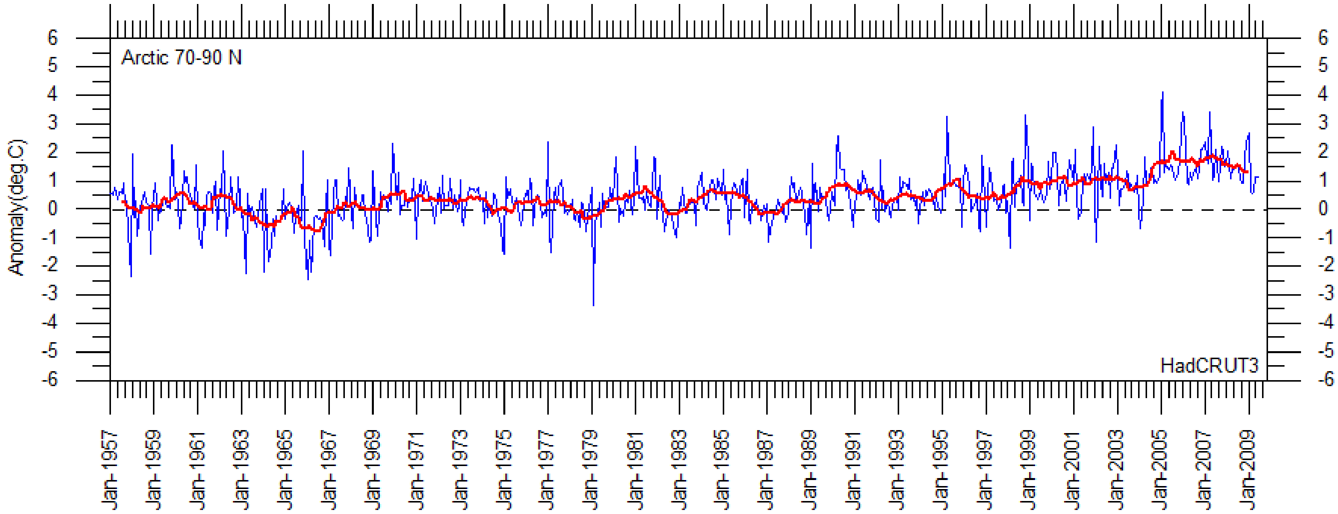


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 has been chosen as starting year, to ensure easy comparison with the maximum length of the realistic Antarctic temperature record shown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

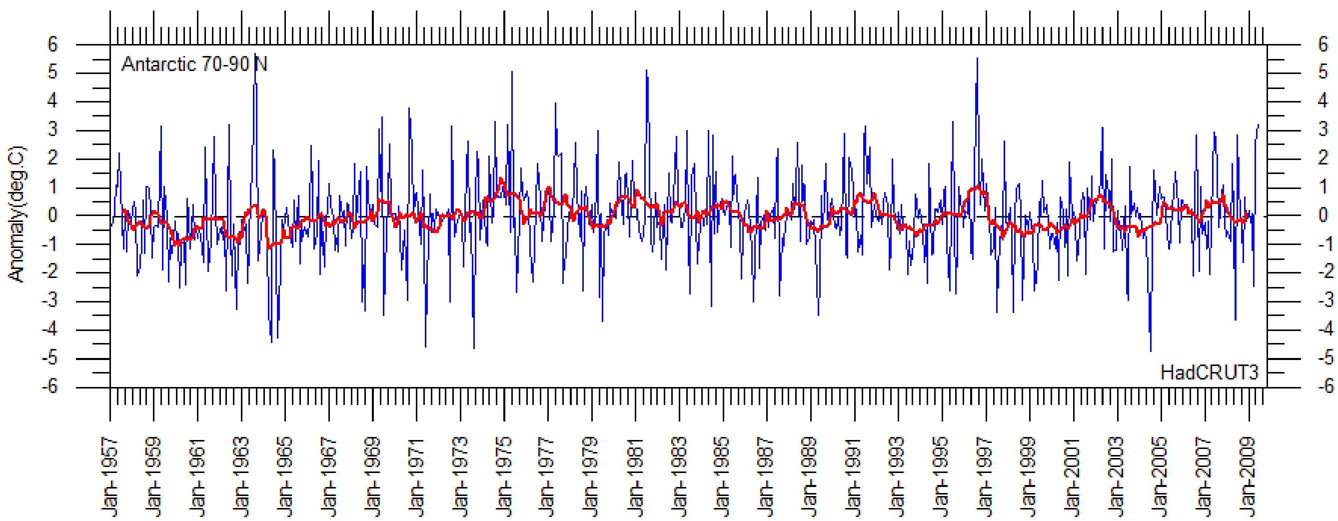


Diagram showing Antarctic monthly surface air temperature anomaly 70-90°S since January 1957, in relation to the WMO reference "normal" period 1961-1990. The year 1957 was an international geophysical year, and several meteorological stations were established in the Antarctic because of this. Before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

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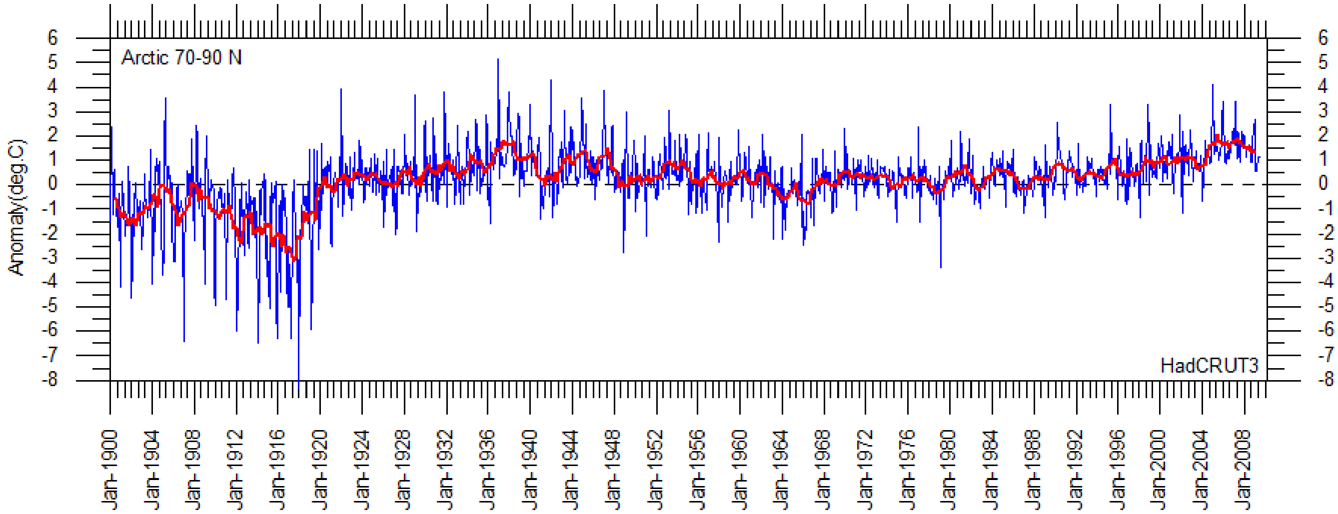
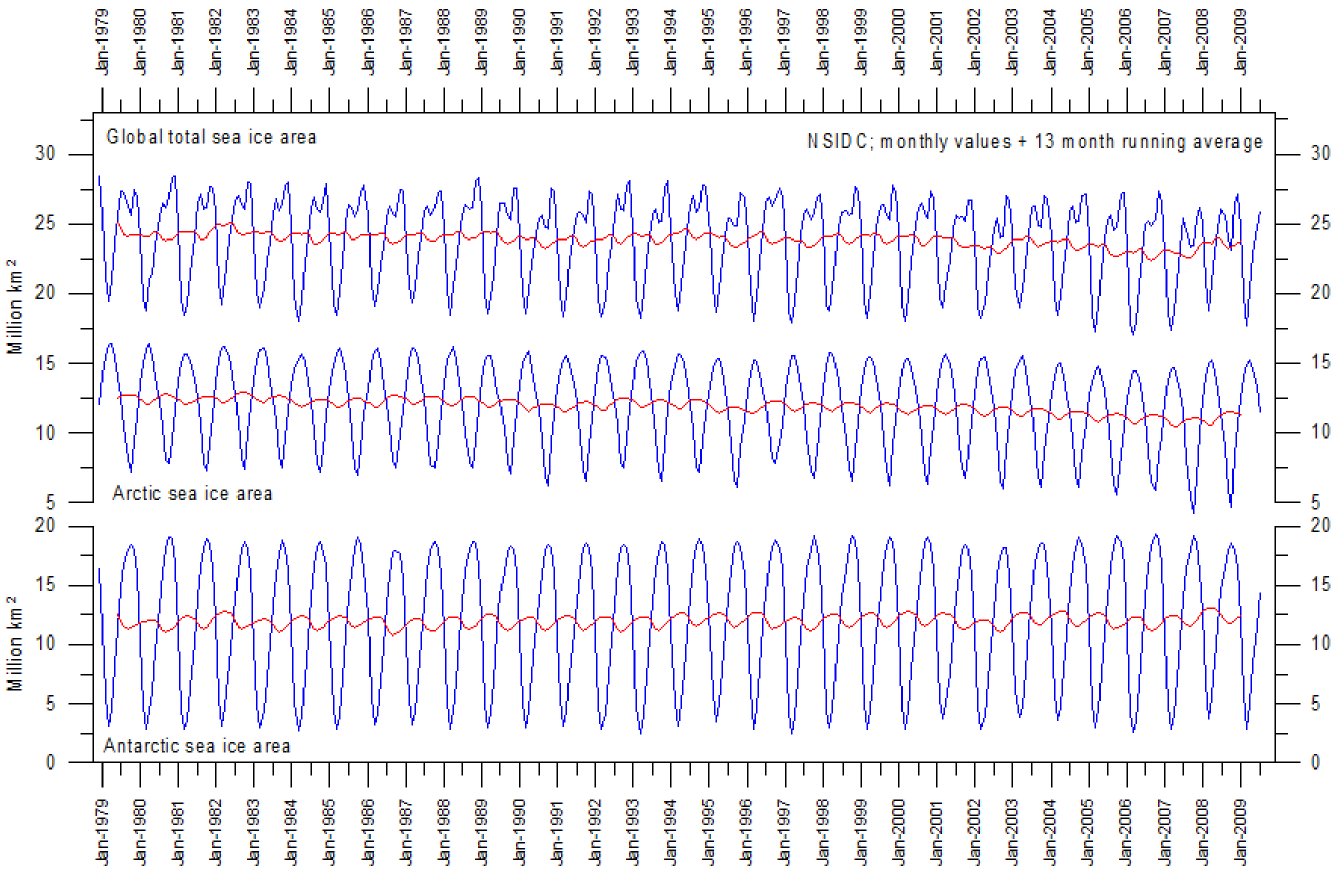
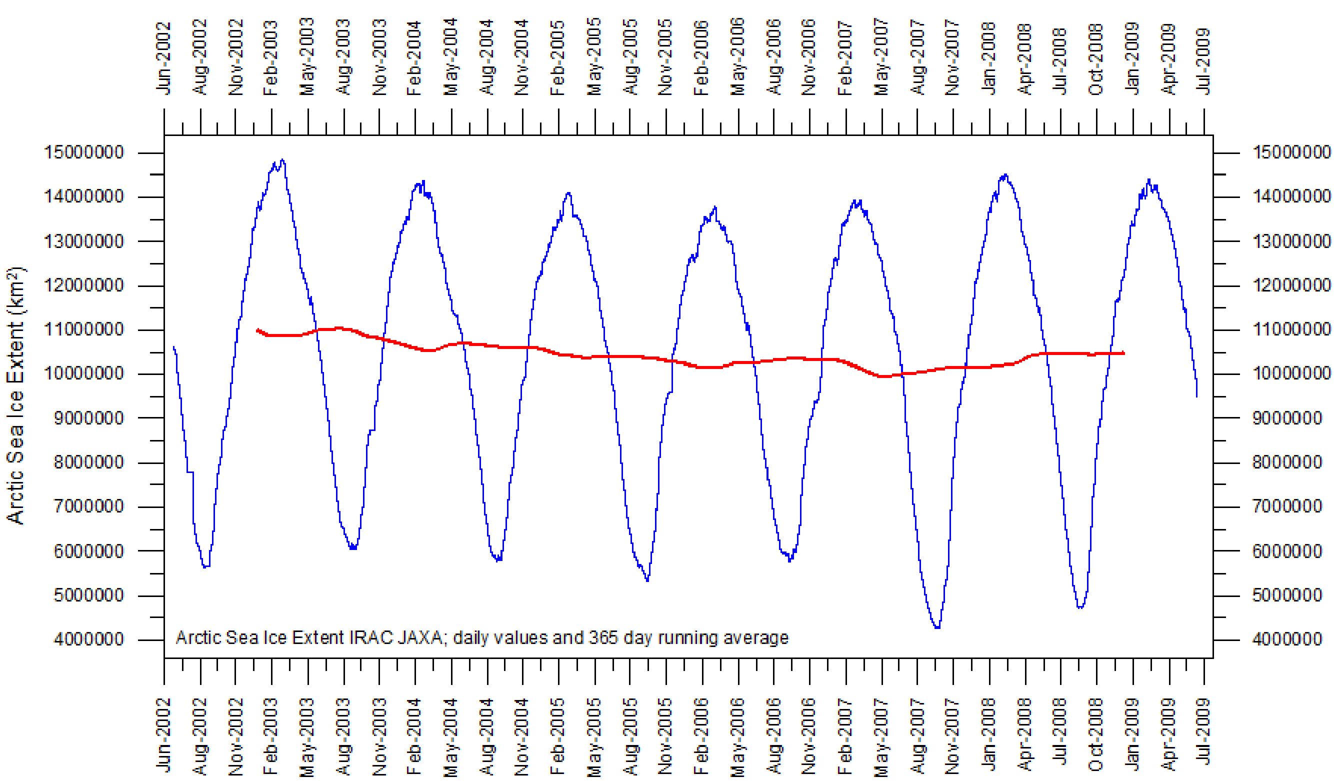


Diagram showing Arctic monthly surface air temperature anomaly 70-90°N since January 1900, in relation to the WMO reference "normal" period 1961-1990. The thin blue line shows the monthly temperature anomaly, while the thicker red line shows the running 13 month average. In general, the range of monthly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

Arctic and Antarctic sea ice, updated to June 2009

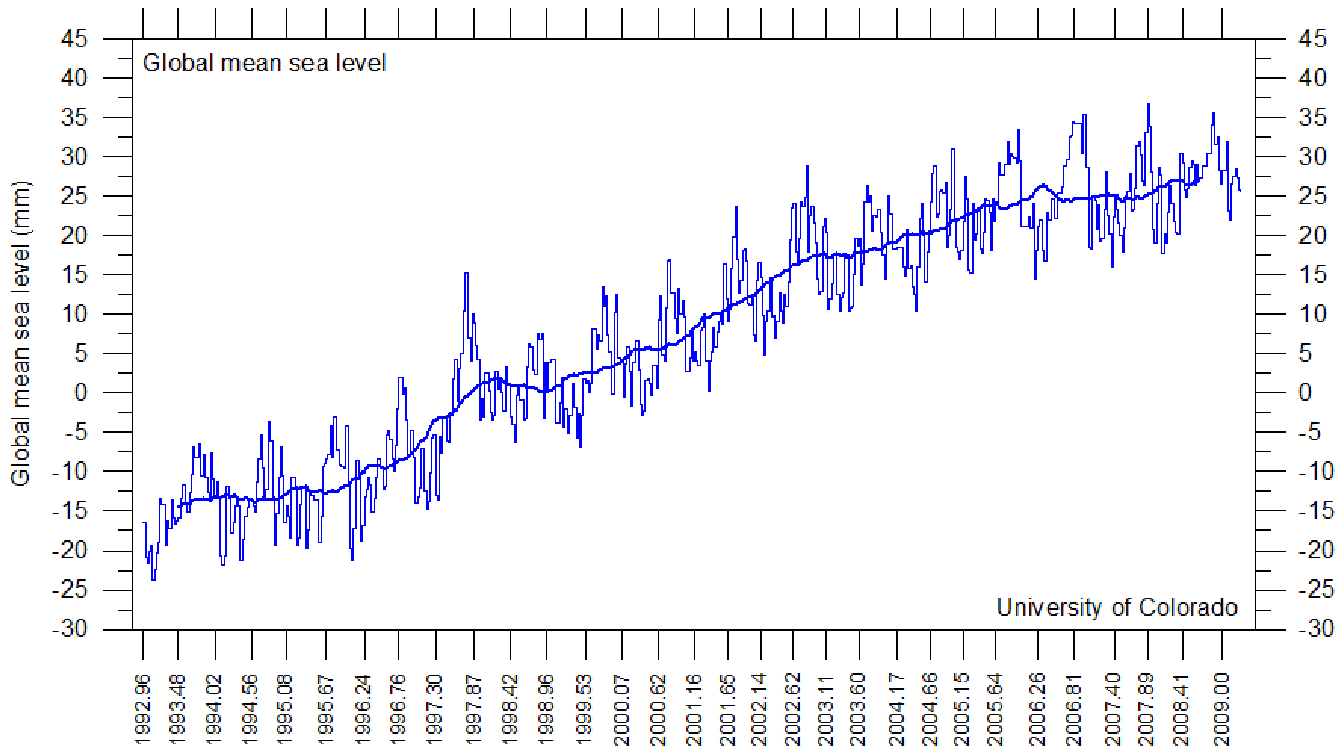


Graphs showing monthly Antarctic, Arctic and global sea ice extent since November 1978, according to the [National Snow and Ice data Center]() (NSIDC).

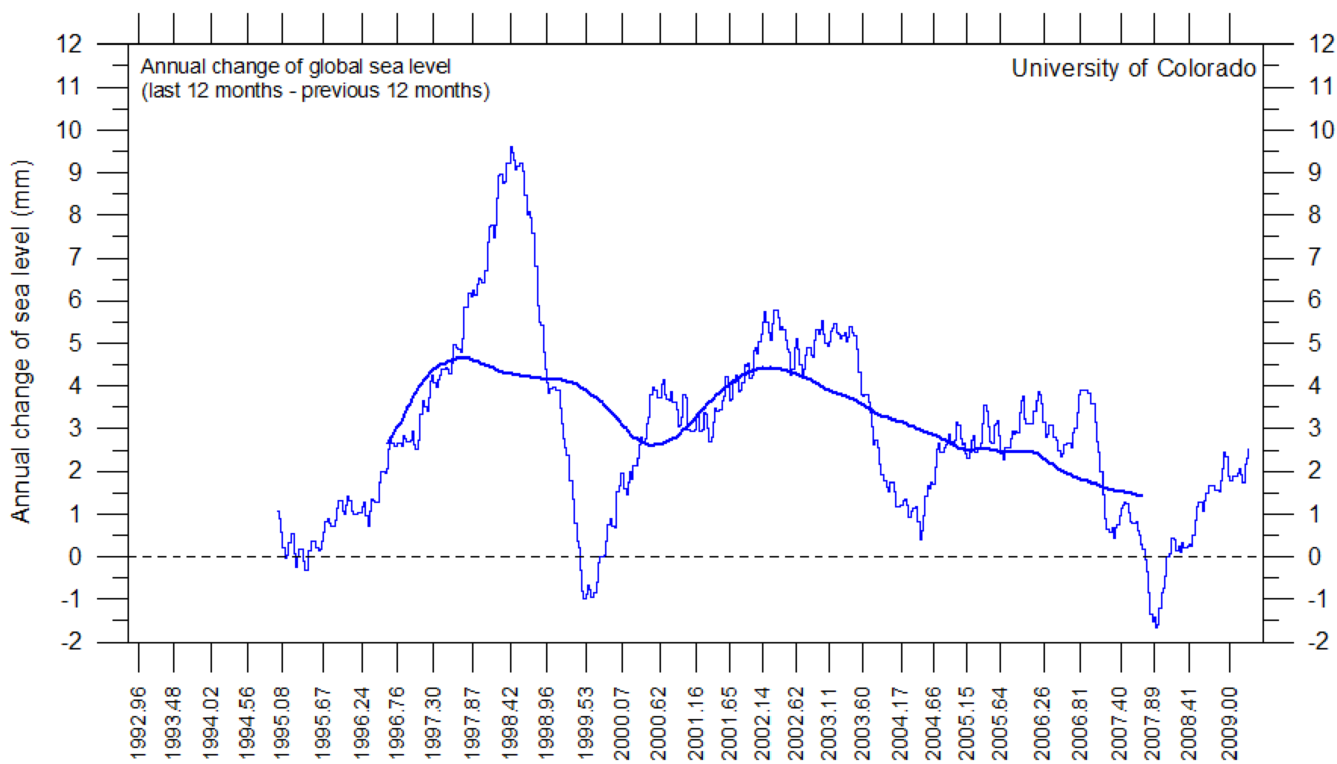


Graph showing daily Arctic sea ice extent since June 2002, by courtesy of [Japan Aerospace Exploration Agency]() (JAXA).

[Global sea level, updated June 2009]

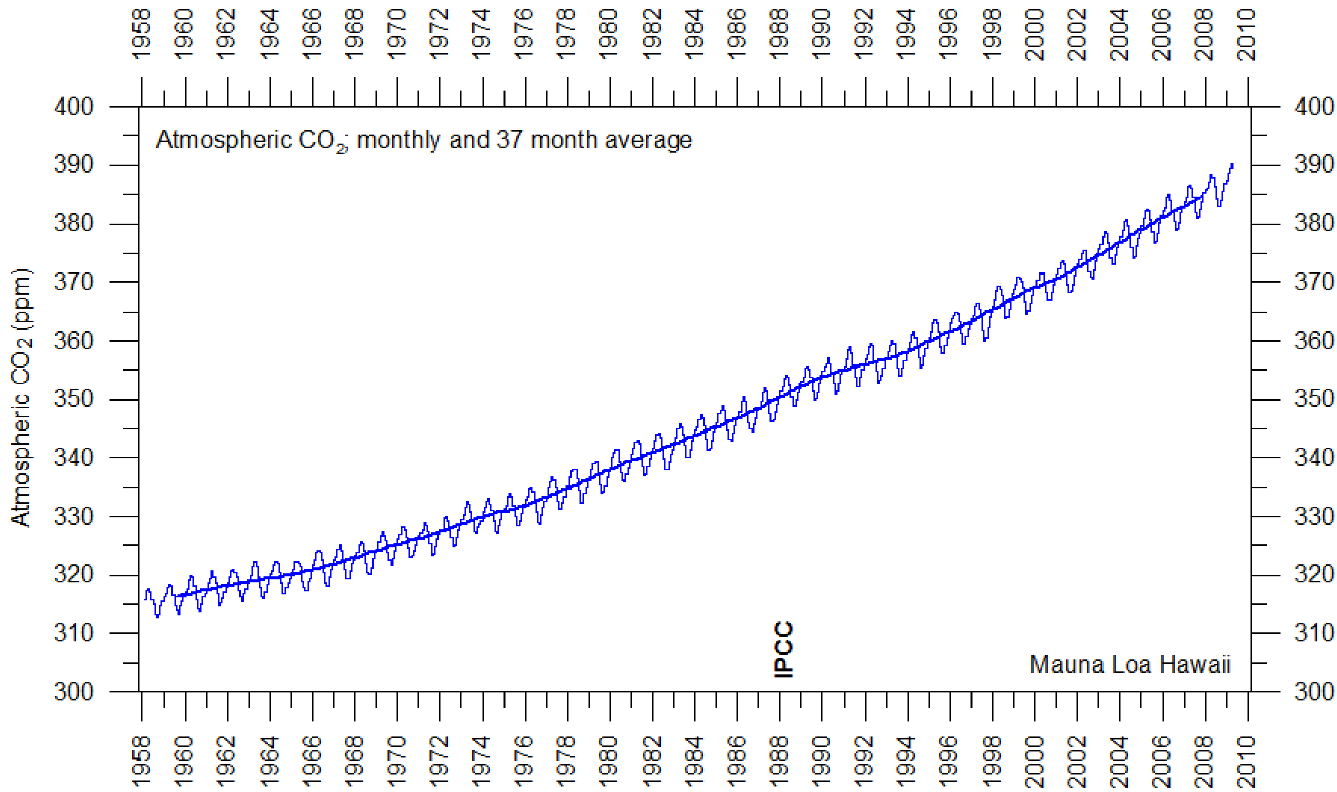


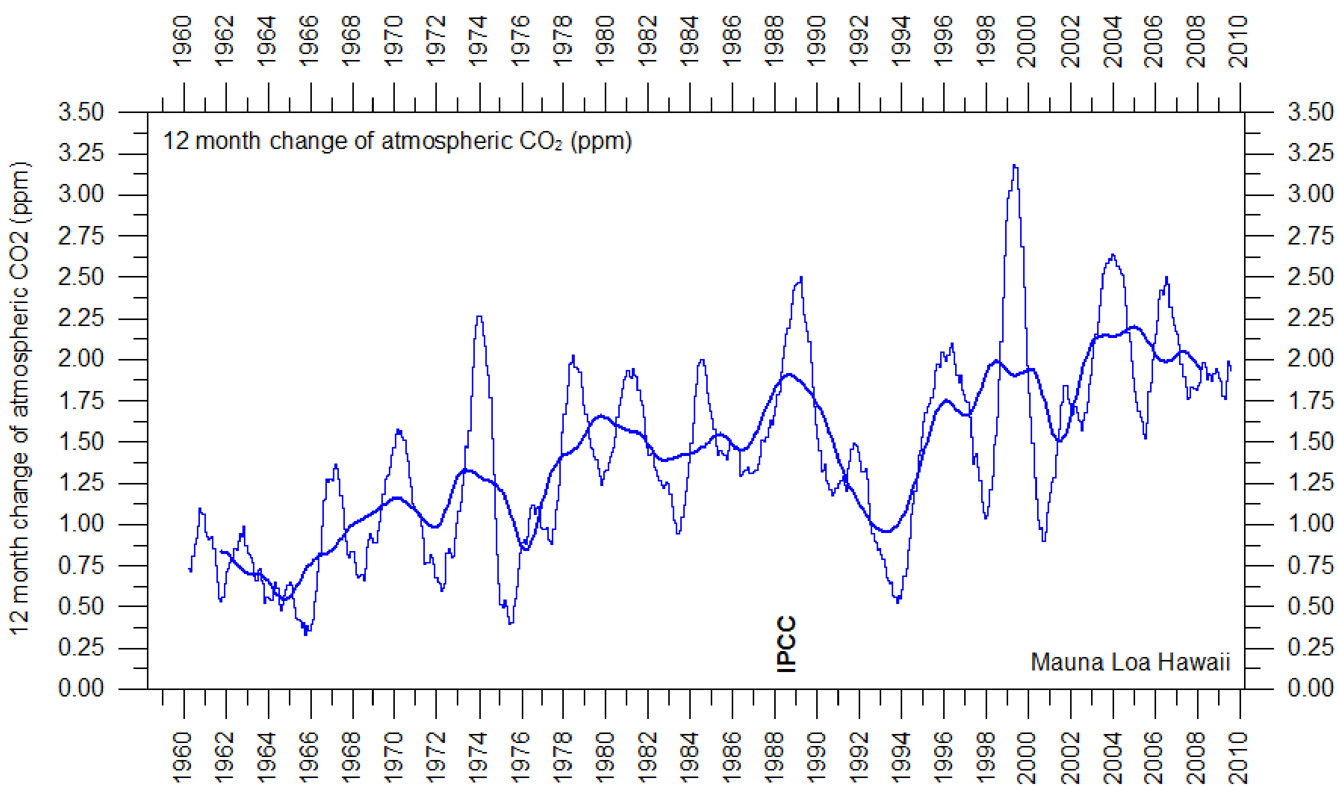
Globa lmonthly sea level since late 1992 according to the Colorado Center for Astrodynamics Research at [University of Colorado at Boulder], USA. The thick line is the simple running 37 observation average, nearly corresponding to a running 3 yr average.



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

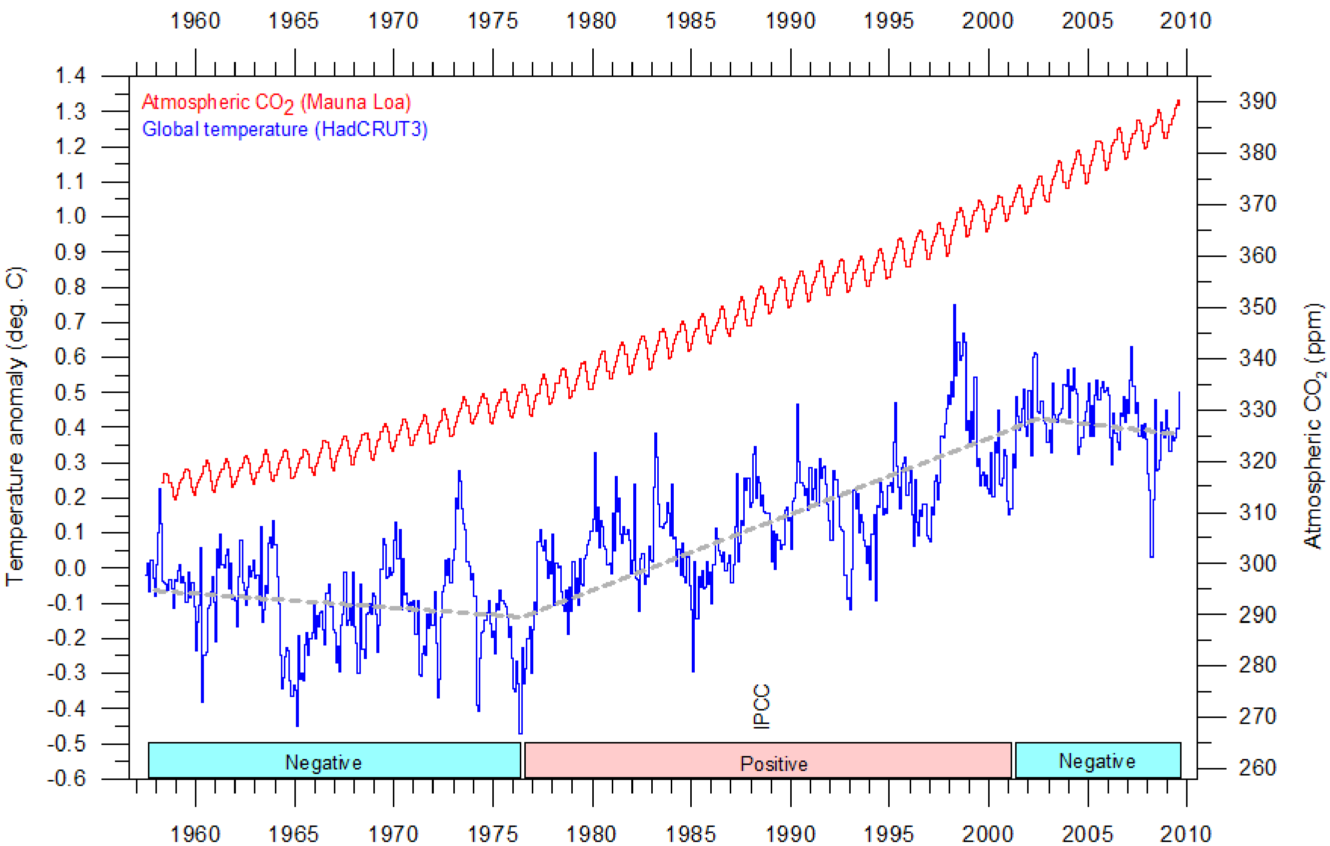
Atmospheric CO_2, updated to June 2009

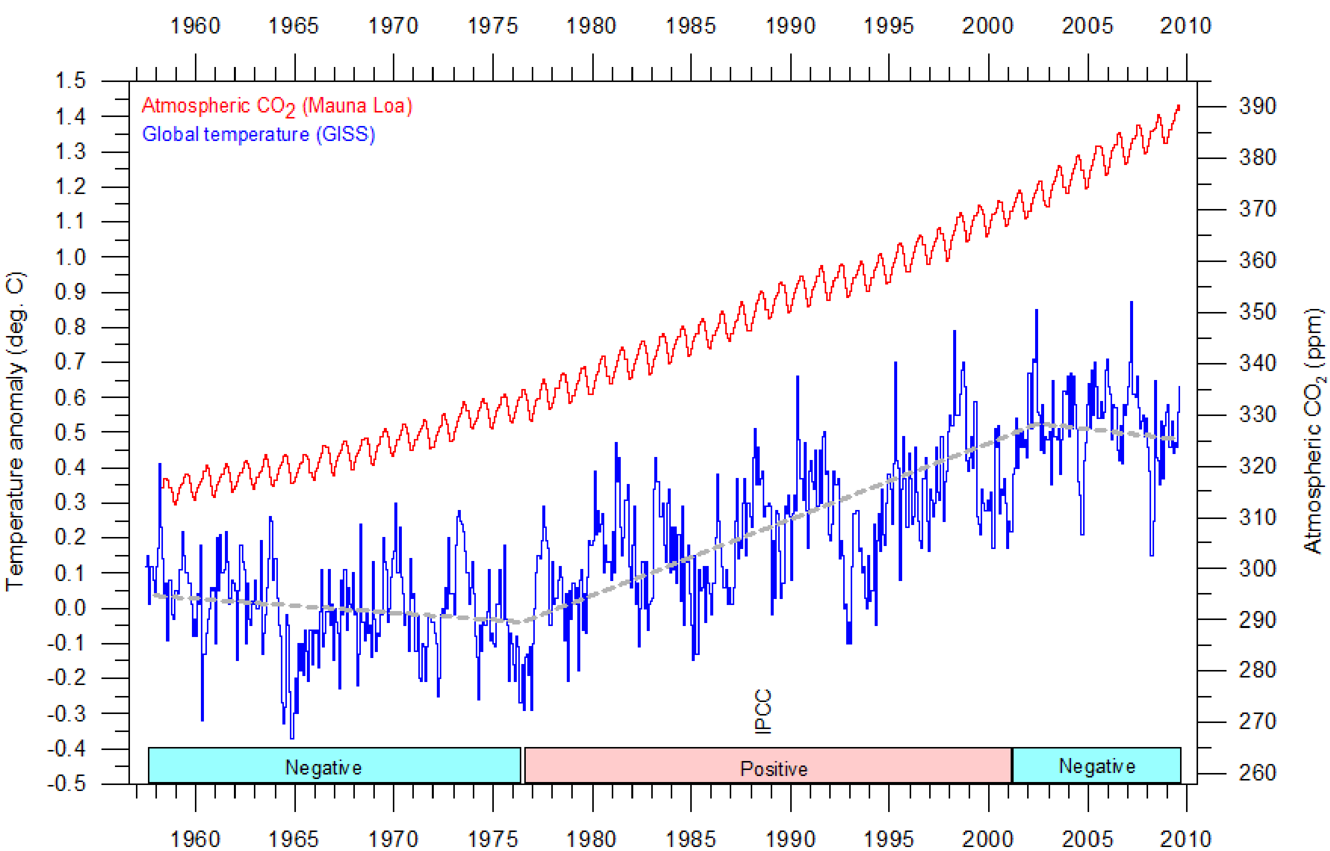


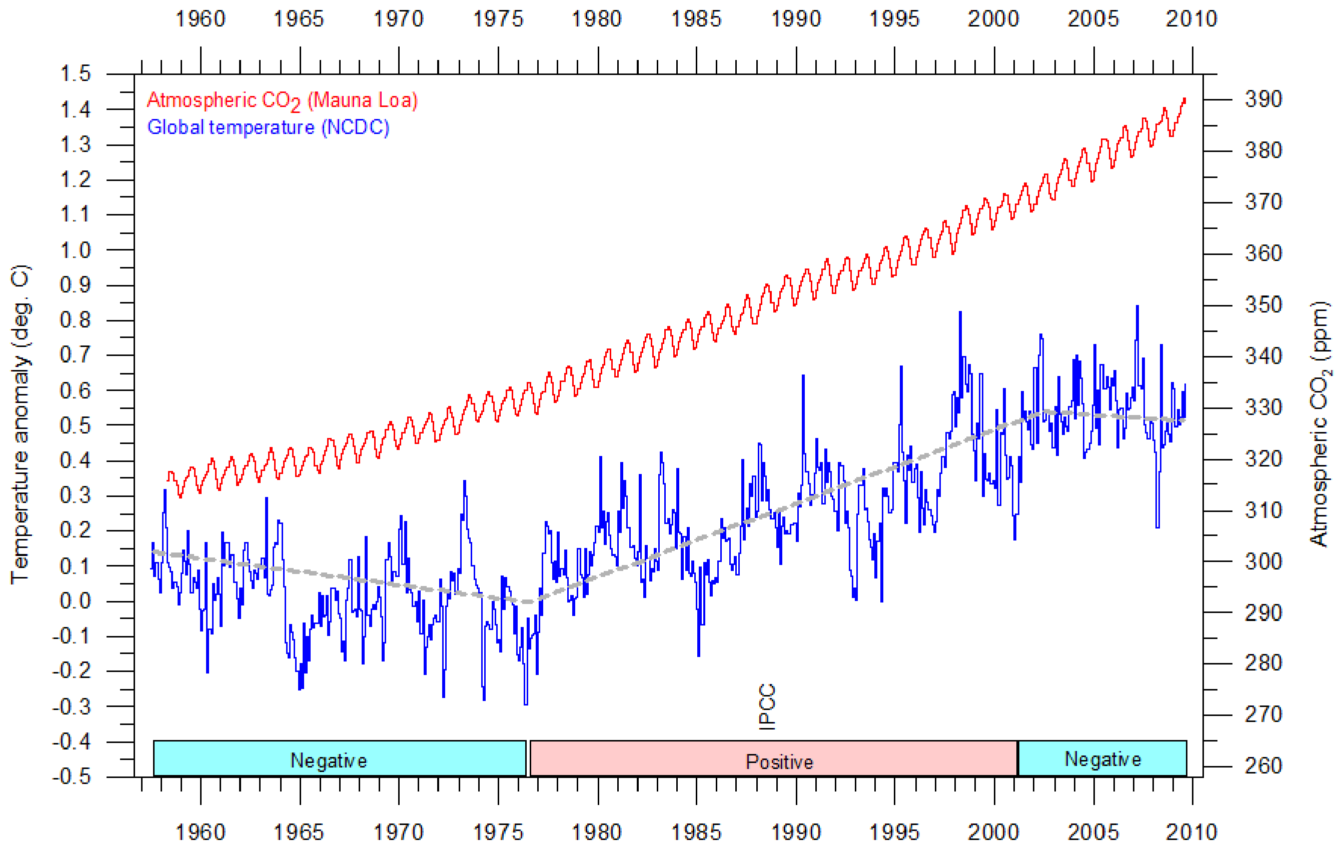


Monthly amount of atmospheric CO_2 (above) and annual growth rate (below; average last 12 months minus average preceding 12 months) of atmospheric CO_2 since 1959, according to data provided by the [Mauna Loa Observatory](), Hawaii, USA. The thick line is the simple running 37 observation average, nearly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

Global surface air temperature and atmospheric CO_2, updated to June 2009







Diagrams showing HadCRUT3, GISS, and NCDC monthly global surface air temperature estimates (blue) and the monthly atmospheric CO_2 content (red) according to the [Mauna Loa Observatory](), Hawaii. The Mauna Loa data series begins in March 1958, and 1958 has therefore been chosen as starting year for the diagrams. Reconstructions of past atmospheric CO_2 concentrations (before 1958) are not incorporated in this diagram, as such past CO_2 values are derived by other means (ice cores, stomata, or older measurements using different methodology, and therefore are not directly comparable with modern atmospheric measurements. The dotted grey line indicates the approximate linear temperature trend, and the boxes in the lower part of the diagram indicate the relation between atmospheric CO_2 and global surface air temperature, negative or positive.

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

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

What exactly defines the critical length of a relevant time period to consider for evaluating the alleged high importance of CO_2 remains elusive, and is still a topic for debate. The critical period length must, however, be inversely proportional to the importance of CO_2 on the global temperature, including feedback effects, such as assumed by most climate models.

After about 10 years of global temperature increase, IPCC was established in 1988. Presumably, several scientists interested in climate then felt intuitively that their empirical and theoretical understanding of climate dynamics was sufficient to conclude about the importance of CO2 for global temperature. However, for obtaining public and political support for the CO_2-hyphotesis the 10 year warming period leading up to 1988 in all likelihood was important. Had the global temperature instead been decreasing, public support for the hypothesis would have been difficult to obtain. Adopting this approach as to critical time length, the varying relation (positive or negative) between global temperature and atmospheric CO_2 has been indicated in the lower panels of the three diagrams above.

Climate and history; one example among many

1941: Operation Barbarossa, the German invasion of USSR

German Panzers in southern Russia July 1941 (left). Map showing the German advance until December 1941.

At 22 June 1941 the German Wehrmacht invaded the Soviet Union (USSR). As noted in his dairy by the German Minister of Propaganda, Joseph Goebbels, this was the identical date to that chosen by Napoleon for his invasion of Russia, only 129 years later. Before the invasion, on Reichskanzler Adolf Hitler's insistence, the German High Command (OKW) had developed a strategy to avoid repeating Napoleon's mistakes. Hitler himself was especially worried about the possibility of an early and cold Napoleon-like winter. He therefore organized a workshop with participants from the German High Command and German meteorologists. On the background of global warming experienced since 1920, however, the general opinion was that the risk of a very cold winter was relatively little.

Summer, the season in which Operation Barbarossa began, was the most favourable period for military operations in European Russia. Days were long and warm, nights pleasantly cool, and only in the southern regions was the heat intense. Moors and swamps dried up, and all roads were easily passable. River discharge and water depth went down, making river crossings feasible without major problems. All arms, therefore, enjoyed optimum mobility. Even in summer, however, sudden thunderstorms could almost instantly change passable unpaved roads and open terrain into mud traps. Once the rain ended, dirt roads would dry out rapidly and could again be used by vehicles, provided that overeager drivers had not ploughed them up while still soft. During the dry periods dust often wreaked havoc on motor vehicles, clogging dust filters. But on the whole, the summer season was optimal for mobile warfare.

Spectacular German successes therefore characterized the initial phase of the Barbarossa campaign. Despite local hard Russian resistance, advances were swift. Then, from early August, the appearance of new Russian tanks superior to the German Panzers, began to slow the German advance. The German Army, even though outnumbered by the Soviet Army in soldiers, artillery and armed vehicles, still remained superior on the tactical level, and kept on pressing forward in a number of offensives. Northeast of Kiev a huge Soviet Army group 12th September were surrounded and taken prisoner in the largest encirclement achieved by either side in the entire campaign. More than 600,000 Russian soldiers were send into captivity. Nearly one third of the Soviet Army, as it had been at the outbreak of the war, was now eliminated. But notwithstanding such military successes, Adolf Hitler and the German High Command alike were taken aback by the continued strength of the Russian resistance. It became clear to them that they greatly had underestimated the number of enemy tanks and the ability of USSR to feed new divisions and new technology into the battle.

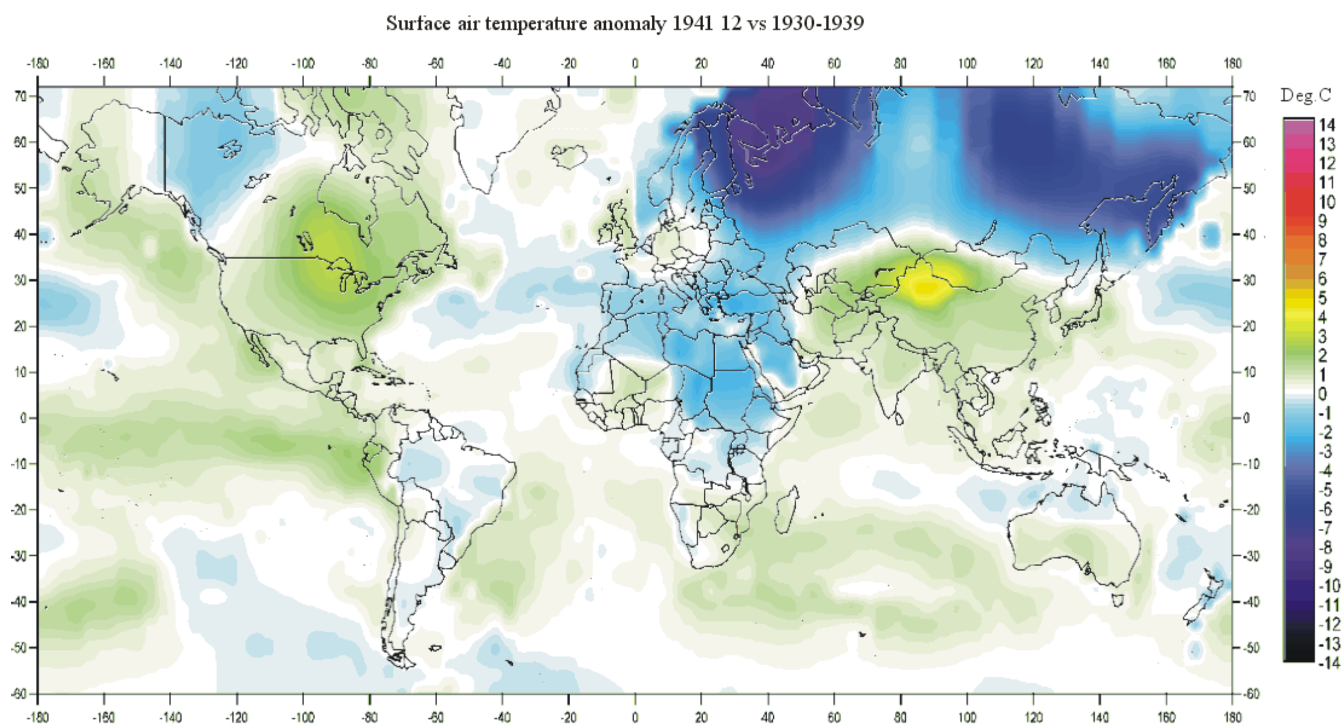
During their retreat, what they could not evacuate, the Soviet Army destroyed. Thousands of mines, steelworks and engineering plants were abandoned. Food that could not be transported was torched. By the end of 1941 the total Soviet production sank to a mere fraction of the level attained before the German invasion. The overall levels of output were never restored throughout the conflict with Germany. The Soviet war effort, however, was sustained on the remarkable expansion of armaments and heavy-industrial output in the Urals and beyond (Overy 2006).

The victory at Kiev had encouraged many of the German General Staff to believe that one more Kesselschlact would finish the Russian Army off. October 1941, however, brought a very early onset of winter in Russia, actually a few days earlier than experienced by Napoleon in 1812. On 7th October the first snow fell in western Russia. It melted rapidly, but it provoked Generaloberst Heinz Guderian to send the German Armed Forces High Command (Oberkommando der Wehrmacht; OKW) an enquiry for winter clothing. He was told that he would receive it in due course, and "not to make further unnecessary requests of this type". Guderian's army group never received any winter clothing.

Early October major German offensives were launched toward Vyazma and Bryansk 250 km southwest of Moscow. On the third day a complete break-through was accomplished, and the road to Moscow appeared wide open. Weather forecasts were, however, unfavourable and the figures for German vehicle breakdown disquietingly high. During the last three weeks of October adverse weather conditions with heavy rain, snow showers, damp and penetrating mists made movement almost impossible on two days out of three (Clark 1995).

The German army had no conception of mud as it exists in European Russia. Hitler and the OKW still believed that the mud could be conquered by brute force, an idea that lead to serious losses of vehicles and equipment. Motor vehicles broke down with clutch or engine trouble. Horses became exhausted and collapsed. Few Panzers was still operational. Large-scale operations quickly became impossible. The muddy October season 1941 probably was more severe than any other muddy season experienced during the whole German-Russian conflict in World War II (Raus 2003). Presumably the extreme mud period 10-25 October 1941 contributed as much as the following unusual cold winter to the failure of Operation Barbarossa.

A sudden frost in late October cemented one of the German 6th Panzer Division's crippled panzer columns in frozen mud, and it never again moved (Raus 2003). For the still operational units, however, the frost once again made mobile operations possible, and the German Army resumed the advance towards Moscow. Blizzards and the increasing cold, however, made the conditions for the ordinary German line divisions verging on the impossible. Many of the German soldiers were without any clothing to supplement their uniforms except denim combat overalls. The impact of the cold was intensified by the complete absence of shelter; the ground was impossible hard to dig, and most of the buildings had been destroyed in the fighting or burned by the retreating Russians. The engines of the German Panzers and other vehicles have to be run more or less continuously, in order to protect them from freezing. The state of the German fuel supplies rapidly became wretched.



Map showing the deviation of the average surface air temperature December 1941, compared to average conditions 1930-1939. Russia and Siberia was exposed to very low temperatures, compared to the meteorological planning horizon for Operation Barbarossa (1930-1939). At the same time, UK, USA and huge areas of Canada enjoyed above average temperatures. Data source: NASA Goddard Institute for Space Studies (GISS).

Hard Russian resistance and the cold winter finally brought Operation Barbarossa to a halt in the vicinity of Moscow, early December 1941. On 2 December 1941, the German 5th Panzer Division had penetrated to within 14 km from Moscow and 24 km from Kremlin, standing at the villages Dmitrov and Jokroma shortly north of the city (Raus 2003). At that time the Wehrmacht was still not equipped for winter warfare. Just like in Napoleon's campaign, frostbite and disease now caused more casualties than combat. Some of the German divisions were now at only fifty percent strength. The bitter cold also caused severe problems for their guns and equipment, and weather conditions grounded the Luftwaffe, to make a difficult supply situation worse.

The Austrian General Raus, who was rapidly earning himself a reputation as one of the German army's foremost tacticians of armoured warfare, recorded the daily mean temperature near Moscow during the first part of December 1941 as follows (Raus 2003): 1 December -7^{o}C, 2 December -6^{o}C, 3 December -9^{o}C, 4 December -36^{o}C, 5 December -37^{o}C, 6 December -37^{o}C, 7 December -6^{o}C, 8 December -8^{o}C.

Later in December temperatures again fell to no less than -45°C, and General Raus's 6th Panzer Division reported moderate and severe frostbite cases at the rate of 800 per day. The lowest temperature reported during the entire Russian campaign was -53°C, measured northwest of Moscow on 26 January (Raus 2003).

There is no reason to distrust this information on air temperatures. Contrary to common belief, German panzer divisions were not made up by panzer regiments only, but also integrated a suite of other type of units like infantry regiments, motorcycle battalions and artillery regiments. And any artillery regiment would be accompanied by meteorological units, which by balloons and other means measured temperature and wind from ground level to several kilometres altitude, to enable calculation of correct firing data. The trajectory of long-range artillery grenades would easily take them 5-6 km into the troposphere, or higher. So, in all likelihood, the information on air temperatures was measured by people with meteorological training, using proper equipment. Also Russel (1980) concludes that December 1941 was unusually cold.

The German equipment started to fail when the temperature dropped to -20°C (Ziemke 1987). At that temperature the ordinary recoil fluid used by the artillery and anti-tank weapons started to freeze, as did the lubricating oil on small arms and machine guns. This proved disastrous when the Germans had to repel ferocious counter-attacks by Russian infantry. Often only hand grenades would work. Vehicle, aircraft and even locomotive engines became extraordinary difficult to start. Tank turrets would not turn, and truck and tank engines had to be kept running constantly, which meant that a tank which did not move at all still consumed as much fuel in two days as a tank operating in battle normally did in one. In contrast, the Soviet T-34 tank, first encountered in June 1941, but only now beginning to appear in large numbers, had a compressed-air starter which could turn and start the engine even in the coldest weather (Bellamy 2007). In addition, its very wide tracks spread its weight so that it could roll over ditches and depressions holding 1.5 m of snow.

Just when the sudden temperature drop early December 1941 was beginning to take its toll among the German soldiers still in need of proper winter equipment, the Red Army 5 December launched a massive counterattack on the Moscow front with fresh divisions just arrived from Siberia. The Wehrmacht was pushed back from Moscow. Also the operations near Leningrad further to the northwest were severely affected by the extraordinary cold conditions. Hitler himself for the first time expressed the opinion that it perhaps would be impossible to defeat the USSR (Clark 1995). Never again would the German Wehrmacht be able to take the offensive along the entire eastern front.

It is unclear whether, as was the case with the D-Day landings in France in June 1944, Russian meteorologists were directly involved in the decision of when the Russian counteroffensive should be launched. According to German Intelligence gathered afterwards in 1942, Marshal Timoshenko had reportedly said that the Russians should go over to the attack when the first days of cold had broken the backbone of the German Army. Marshal Zhukov supposedly added that he expected the start and subsequent course of the offensive to depend on freezing off German equipment (Bellamy 2007). Russian meteorologists at that time were among the world leaders in long-range weather forecasting, and it is very likely that the Russian High Command (the Stavka) understood to make use of this meteorological knowledge. At least, from a meteorological point of view, the timing of the Russian counter-offensive at Moscow was perfect.

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

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