Climate4you update YEAR 2018

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

Year 2018 and 2017 global surface air temperature overview

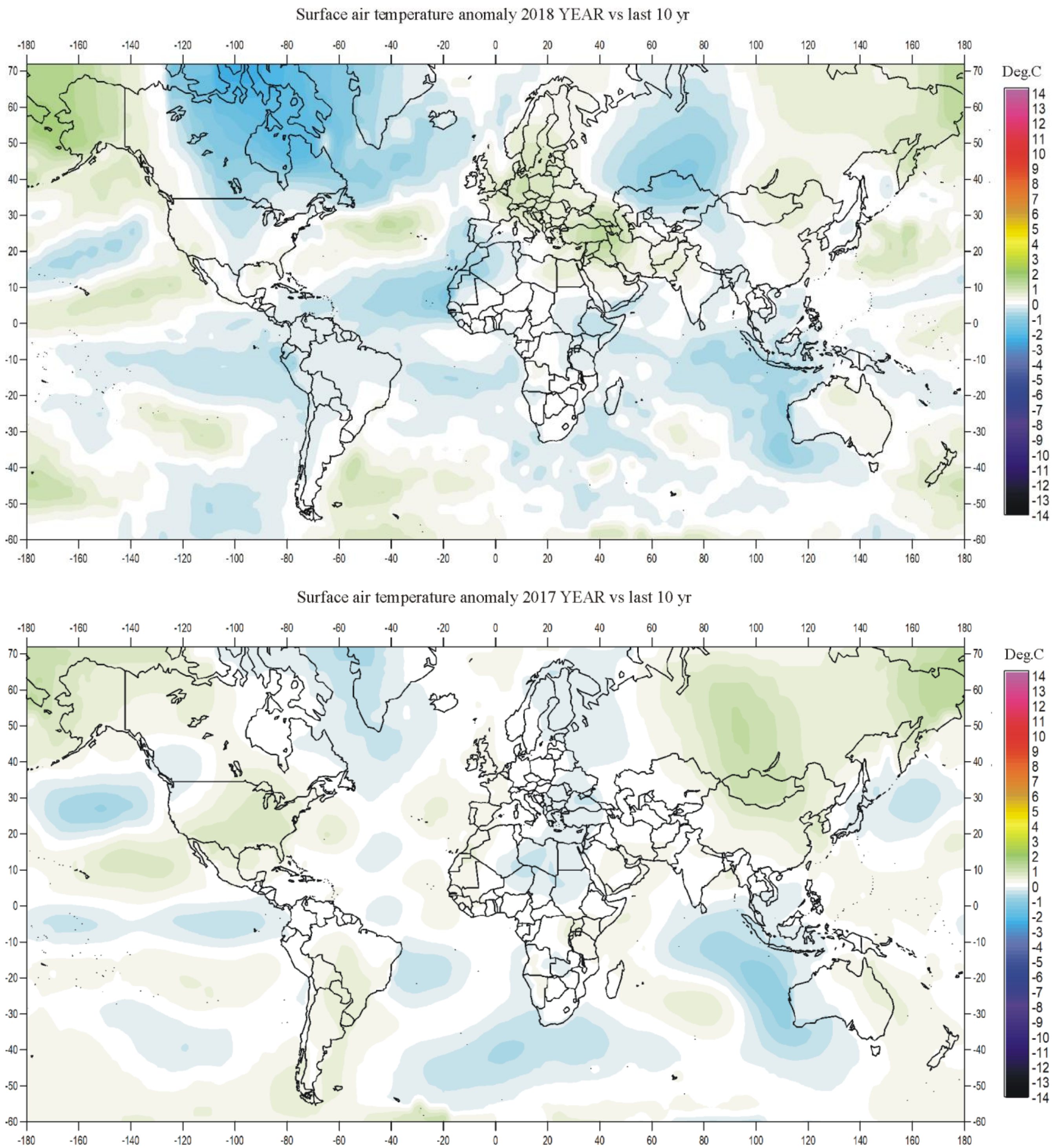


FIGURE 1. Year 2018 (upper panel) and 2017 (lower panel) surface air temperature compared to the average for the previous 10 years. Green-yellow-red colours indicate areas with higher temperature than the average, while blue colours indicate lower than average temperatures. Data source: Goddard Institute for Space Studies (GISS) using Hadl_Reyn_v2 ocean surface temperatures.

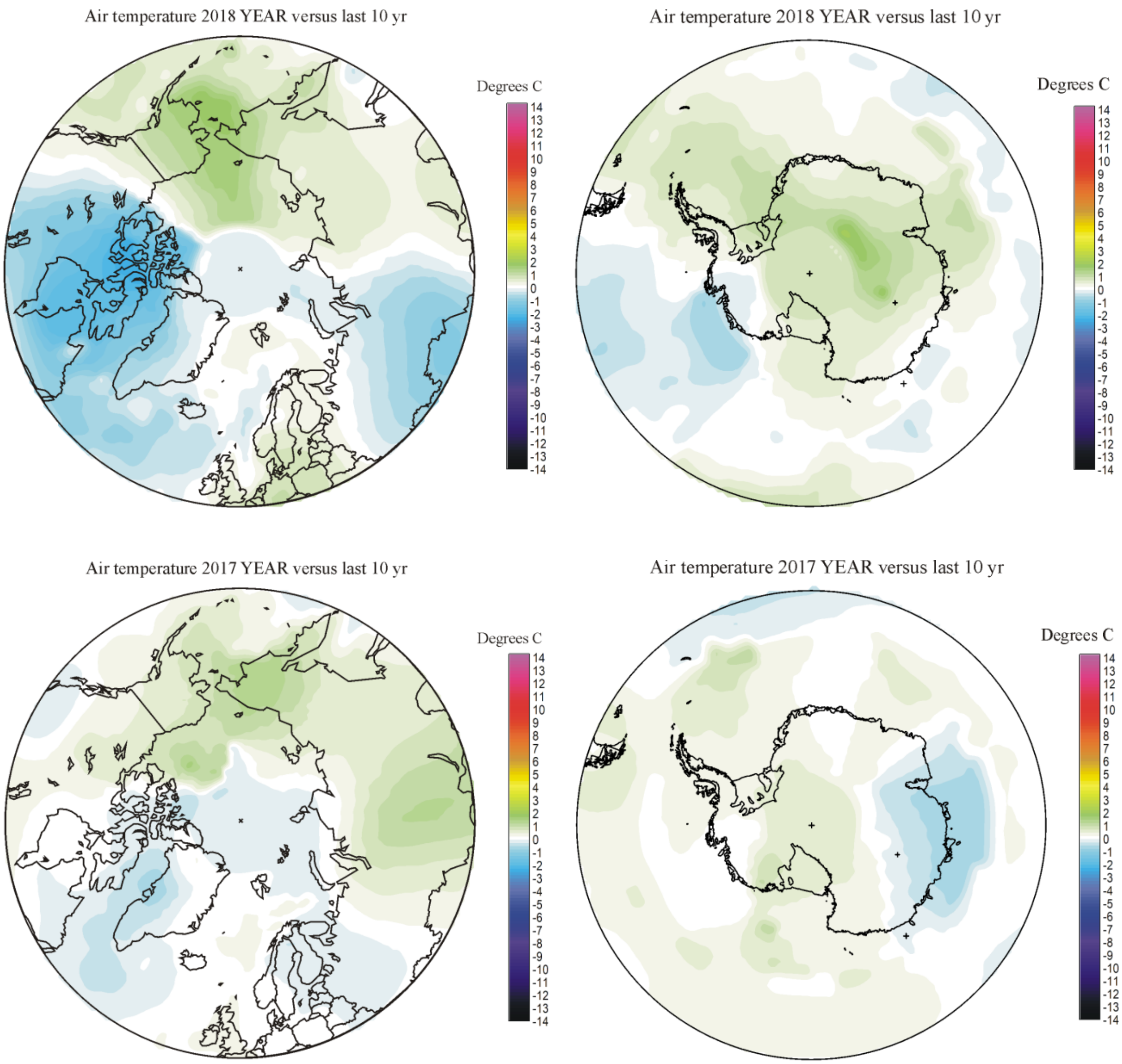


FIGURE 2. Year 2018 (upper panel) and 2017 (lower panel) Polar region surface air temperature compared to the average for the previous 10 years. Green-yellow-red colours indicate areas with higher temperature than the average, while blue colours indicate lower than average temperatures. Data source: Goddard Institute for Space Studies (GISS) using Hadl_Reyn_v2 ocean surface temperatures.

Comments to the Year 2018 global surface air temperature overview

This newsletter contains graphs showing a selection of key meteorological variables for the year 2018. All temperatures are given in degrees Celsius.

In the above maps showing the geographical pattern of surface air temperatures, the last previous 10 years (2008-2017) are 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 profoundly affected by the cold period 1945-1980. Most comparisons with this time period will automatically appear as very warm, and it will be difficult to decide if modern surface air temperatures are increasing or decreasing?

Comparing instead with the last previous 10 years overcomes this problem and displays the dynamics of ongoing modern change. This decadal approach also corresponds to the typical memory horizon for many people.

The average global surface air temperature for 2018.

On average, the global surface air temperature for year 2018 was near the average of the past ten years, but cooler than in both 2016 and 2017. The warm years 2015 and 2016 were affected by the recent El Niño episode playing out in the Pacific Ocean and culminating in early 2016. Already in 2017, the global surface air temperature was slowly dropping back towards the pre-2015-16 level, a gradual change that has been continued throughout 2018.

The Northern Hemisphere was characterised by regional temperature contrasts and more than in 2016, especially north of 30^{o}N. The most pronounced development in 2018 was the appearance of a large area of relatively cold conditions in the Canada and Greenland regions. Also, western Russia was relatively cold in 2018. In contrast, most of Europe, Siberia and Alaska had somewhat above average temperatures, compared to the previous 10 years.

Near the Equator surface air temperatures were generally below or near the average for the previous 10 years. Only in the western Pacific temperatures were relatively high.

In the Southern Hemisphere surface air temperatures were near or below the average for the previous 10 years. Especially the Indian Ocean west of Australia and most of the South Atlantic had temperatures somewhat below the average. However, at about 50^{o}S, temperatures were relatively high in the South Atlantic and part of the Pacific Ocean, affecting the average 2018 temperature in New Zealand.

In the Arctic, regions in the Canada-Greenland sector in 2018 had below average temperatures. The Siberian and Alaska sectors in contrast had above average temperatures. The Arctic temperature pattern for 2018 is, however, to some degree influenced by a likely GISS-interpolation artefact, resulting in an unreal circular temperature pattern north of 80^{o}N.

The Antarctic continent was mainly characterised by above average temperatures in 2018, with only part of West Antarctica having temperatures below the average for the past 10 years. A likely interpolation artefact also here appears to influence the temperature pattern south of 80^{o}S.

Summing up for 2018, global average air temperatures are slowly approaching the level characterising the years leading up to the recent 2015-16 El Niño episode. Thus, the global surface air temperature peak of 2015-16 appears predominantly to be caused by this Pacific oceanographic phenomenon.

At the end of the year 2018, atmospheric CO_2 are still increasing (p.17), solar activity decreasing (p.18), and the global air temperature apparently doing little except responding normally to ongoing oceanographic variations.

Lower troposphere temperature from satellites, updated to year 2018

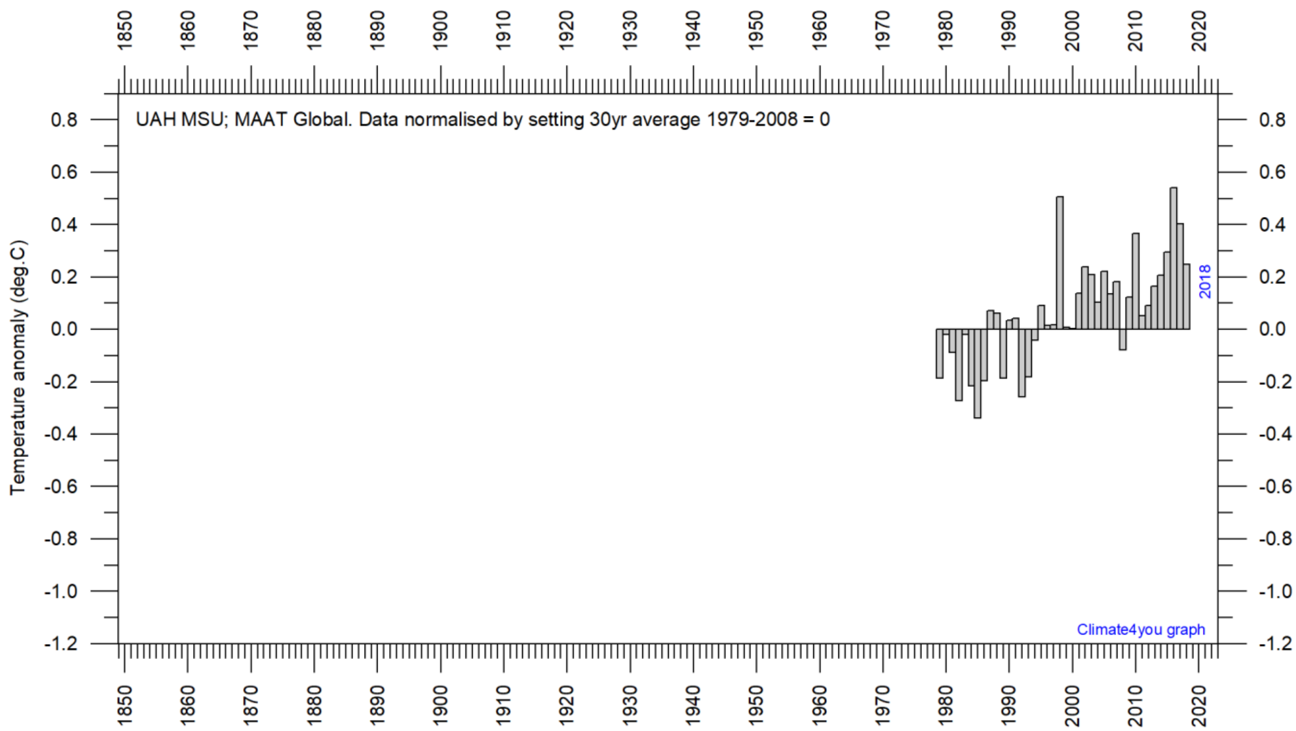


FIGURE 3. Mean annually lower troposphere temperature anomaly (thin line) since 1979 according to [University of Alabama](#) at Huntsville, USA. The average for 1979-2008 (30 years) has been set to zero, to make comparison with other temperature data series easy.

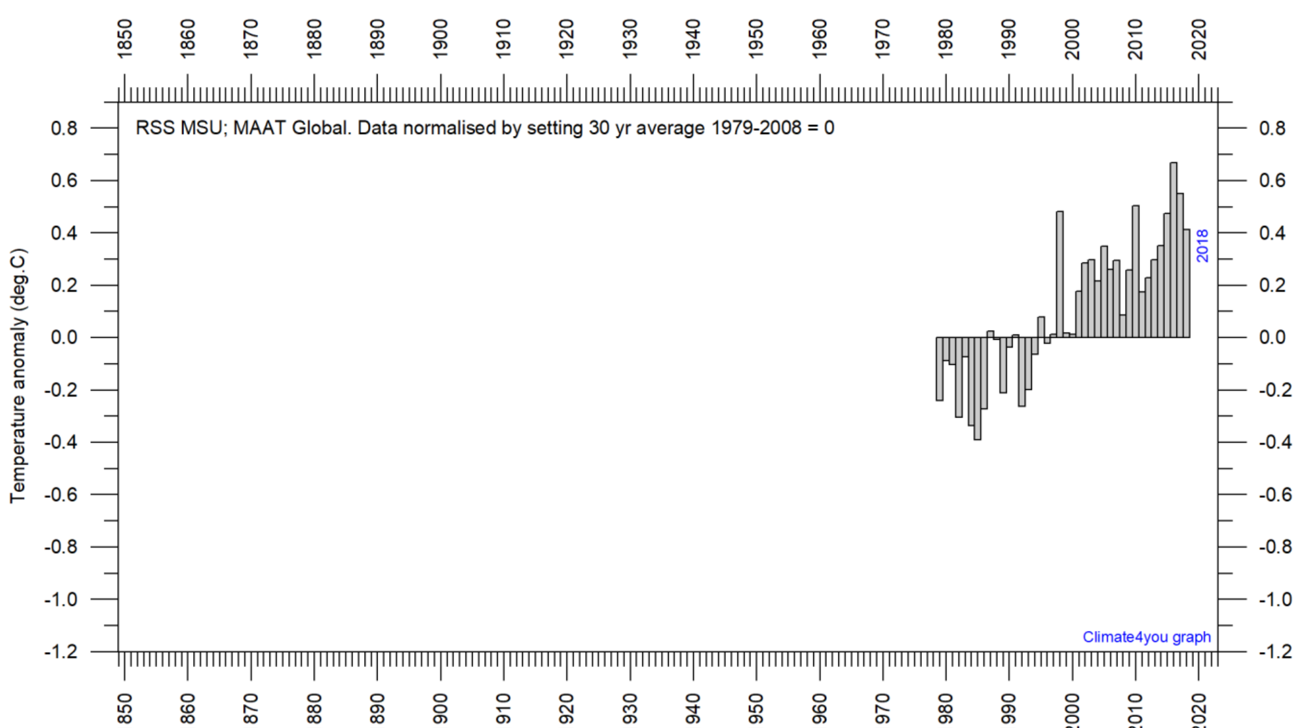


FIGURE 4. Mean annual lower troposphere temperature anomaly (thin line) since 1979 according to according to [Remote Sensing Systems](#) (RSS), USA. The average for 1979-2008 (30 years) has been set to zero, to make comparison with other temperature data series easy.

Global surface air temperature, updated to year 2018

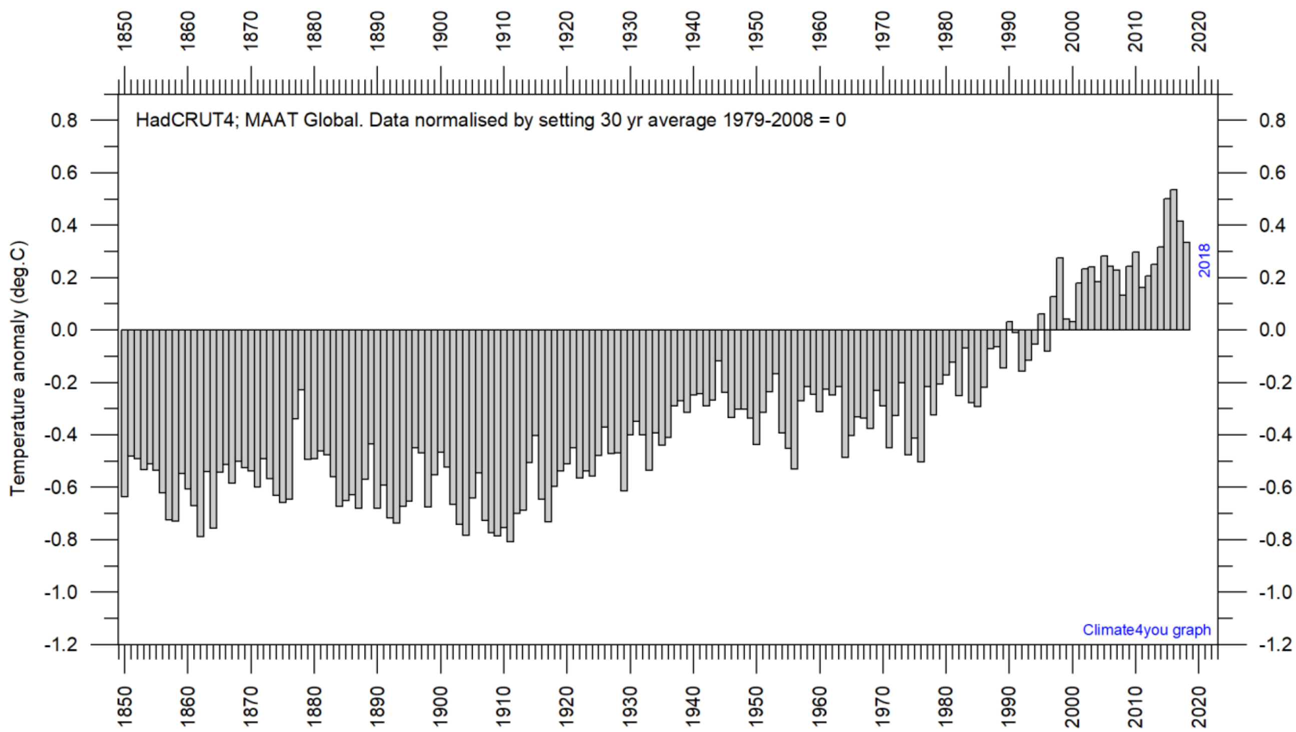


FIGURE 5. Mean annual global surface air temperature (thin line) since 1850 according to according to the Hadley Centre for Climate Prediction and Research and the University of East Anglia's [Climatic Research Unit](#) ([CRU](#)), UK. The average for 1979-2008 (30 years) has been set to zero.

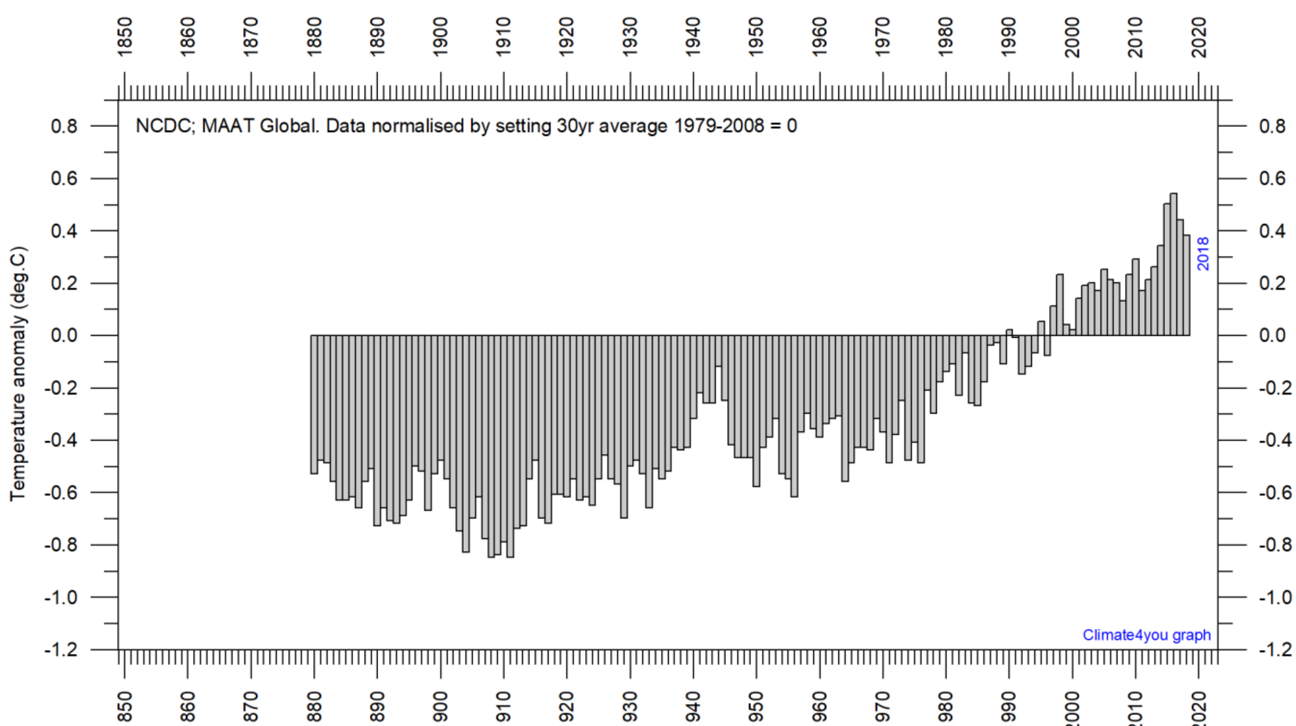


FIGURE 6. Mean annual global surface air temperature since 1880 according to according to the [National Climatic Data Center](#) (NCDC), USA. The average for 1979-2008 (30 years) has been set to zero, to make comparison with other temperature data series easy.

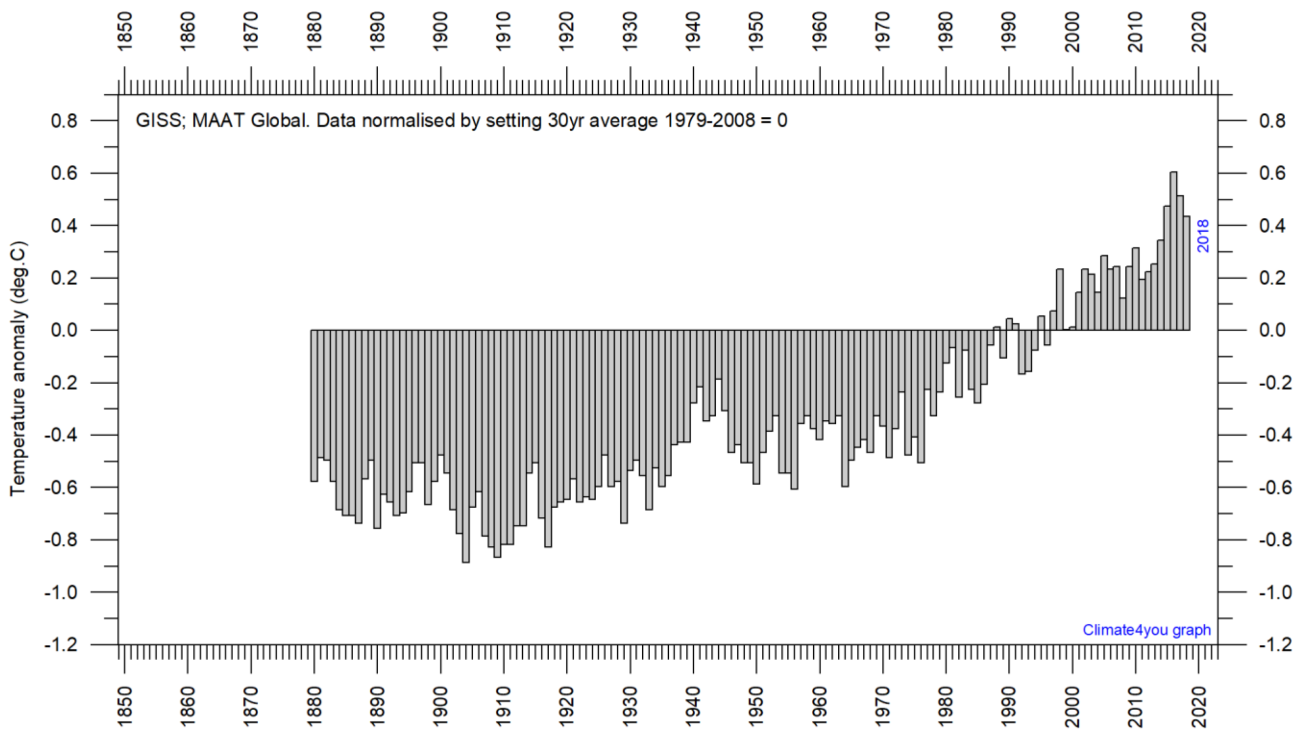


FIGURE 7. Mean annual global surface air temperature (thin line) since 1880 according to according to the [Goddard Institute for Space Studies](#) (GISS), at Columbia University, New York City, USA. The average for 1979-2008 (30 years) has been set to zero, to make comparison with other temperature data series easy.

Reflections on the significance of the 2018 global annual surface air temperature

According to the surface stations 2018 ranks as one of the warmest years since 1880 and 1850, but cooler than both 2017 and 2016. Also, according to the satellite records 2018 was warm, although again less so than last year.

The recent large El Niño terminated during 2016, and global temperatures are by the end of 2018 essentially back to the general level characterising the situation before 2015.

Quite often -but not always- a warm El Niño episode is followed by a cool oceanographic reversal, known as La Niña, which also will influence global air temperatures, but now towards lower values. In fact, a weak La Niña episode established itself in late 2017, lasting until early 2018 (Fig. 15). Towards the end of 2018, however a new weak - at least until now - El Niño has initiated and will presumably affect global air temperatures toward higher values in at least early 2018.

Air temperature changes do not only play out at the surface, but also at higher levels in the atmosphere. The current CO2 hypothesis projects that the initial and largest temperature increase should affect the upper Troposphere, at 6-8 km altitude. However, since 1979 the earth's surface has warmed faster than the upper Troposphere, implying that the surface heating observed is not due to added atmospheric CO2, but is mainly caused by one or several other factors (see Fig. 8 and 11).

Comparing surface air temperatures with data from satellites at the end of 2018

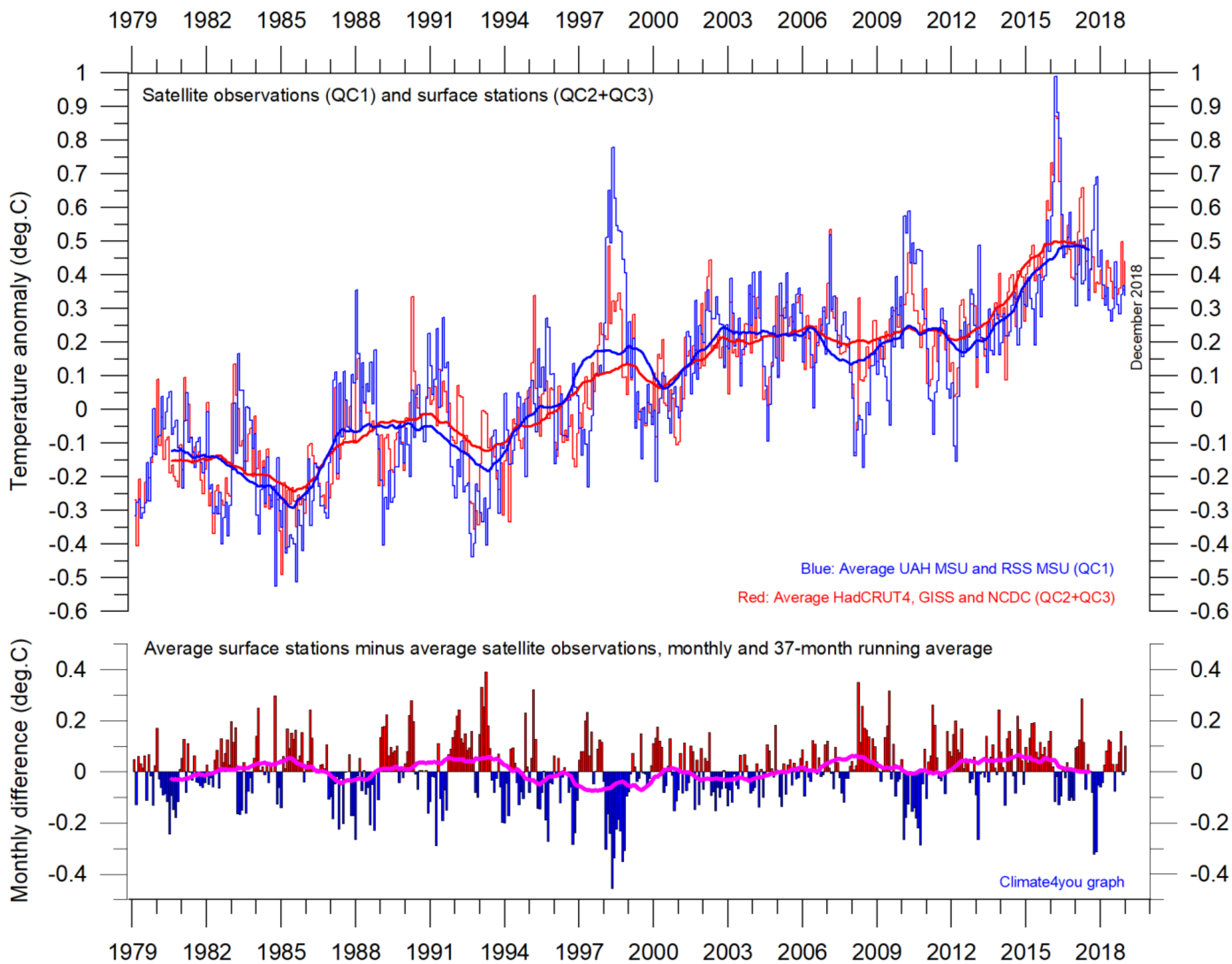


FIGURE 8. Plot showing the average of monthly global surface air temperature estimates (HadCRUT4, GISS and NCDC) and satellite-based temperature estimates (RSS MSU and UAH MSU). The thin lines indicate the monthly value, while the thick lines represent the simple running 37-month average, nearly corresponding to a running 3-yr average. The lower panel shows the monthly difference between surface air temperature and satellite temperatures. As the base period differs for the different temperature estimates, they have all been normalised by comparing to the average value of 30 years from January 1979 to December 2008.

Global satellite temperature trends calculated for different periods until December 2018

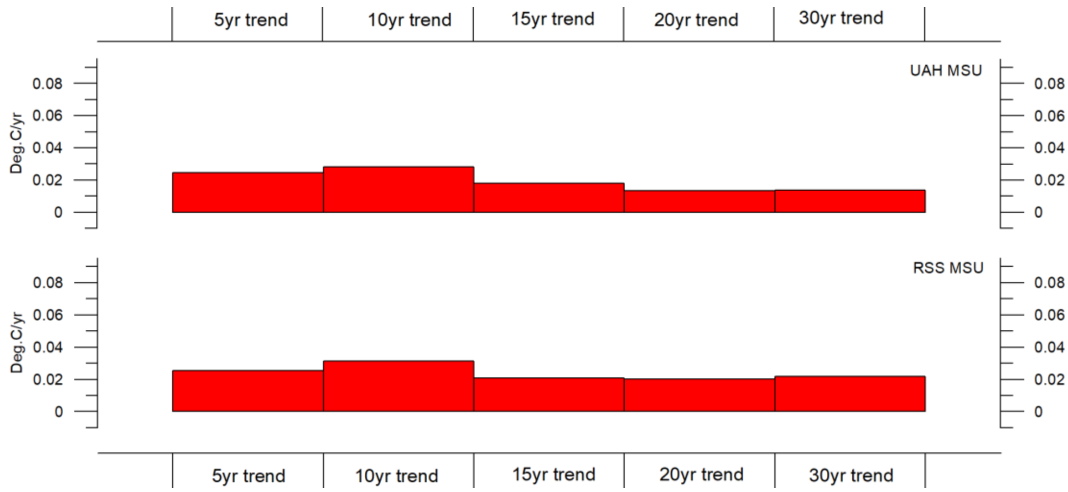


FIGURE 9. Diagram showing the latest 5, 10, 20 and 30 yr linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for two satellite-based temperature estimates (UAH MSU and RSS MSU).

Global surface air temperature trends calculated for different periods until December 2018

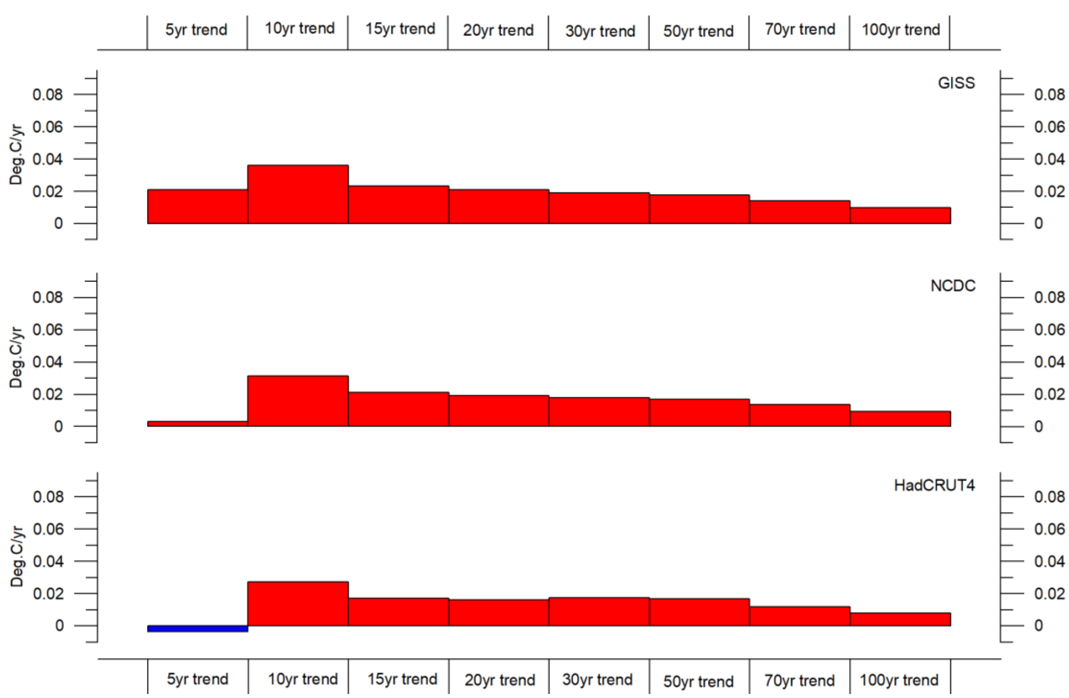


FIGURE 10. Diagram showing the latest 5, 10, 15, 20, 30, 50, 70 and 100-year linear annual global temperature trend, calculated as the slope of the linear regression line through the data points, for three surface-based temperature estimates (GISS, NCDC and HadCRUT3).

Troposphere and stratosphere temperatures from satellites at the end of 2018

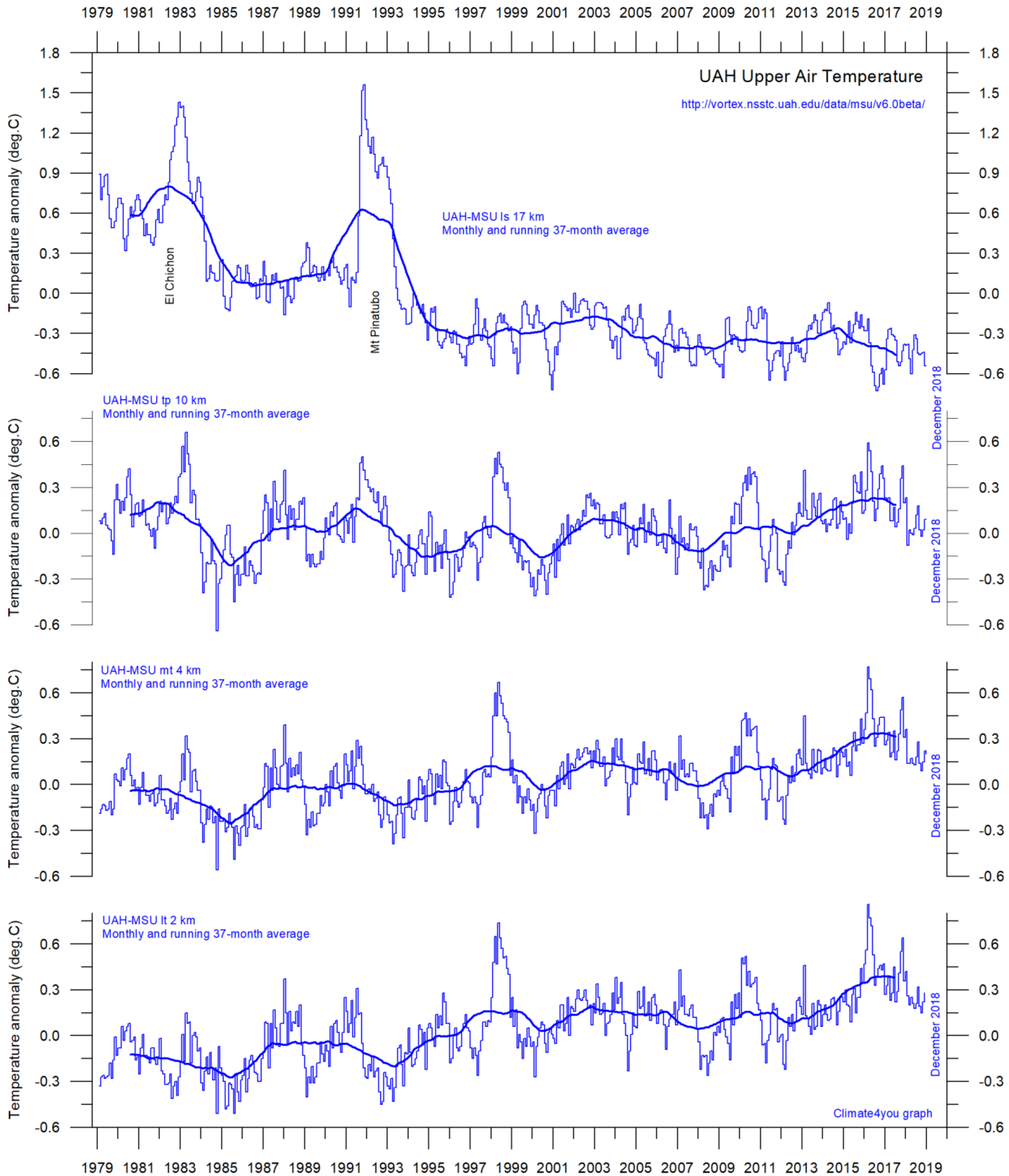


FIGURE 11. Global monthly average temperature in different according to University of Alabama at Huntsville, USA. The thin lines represent the monthly average, and the thick line the simple running 37-month average, nearly corresponding to a running 3-year average.

Sea surface temperature anomaly at the end of the years 2018 and 2017

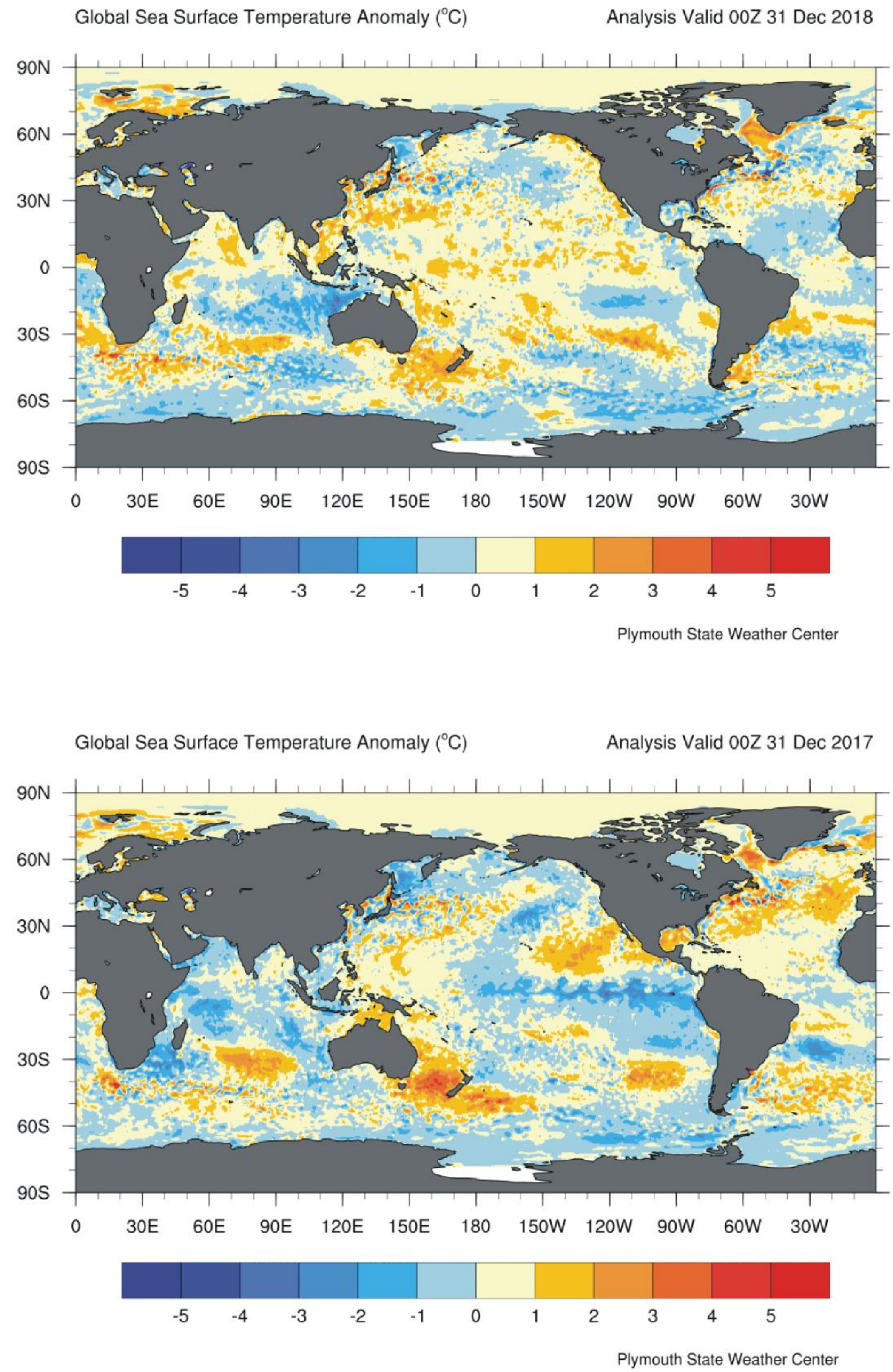


FIGURE 12. Sea surface temperature anomaly in late December 2018 and 2017, upper and lower panel, respectively. Reference period: 1977-1991. Map source: Plymouth State Weather Center.

Ocean temperatures, uppermost 1900m, updated to December 2018

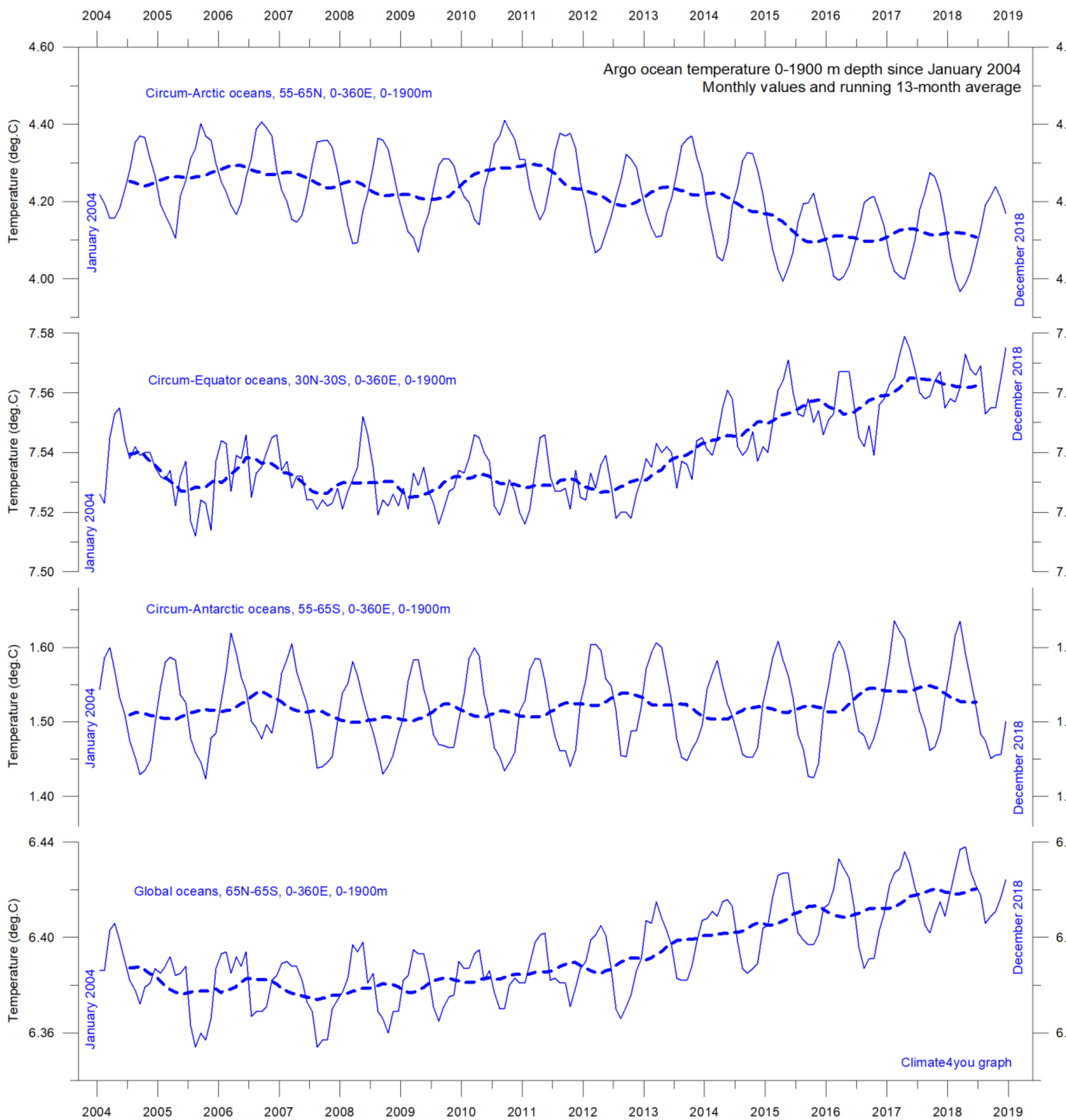


FIGURE 13. Diagram showing average 0-2000m depth ocean temperatures in selected latitudinal bands, using [Argo](#)-data. The thin line shows monthly values and the stippled line shows the running 13-month average. Source: [Global Marine Argo Atlas](#).

La Niña and El Niño episodes, updated to October-December 2018

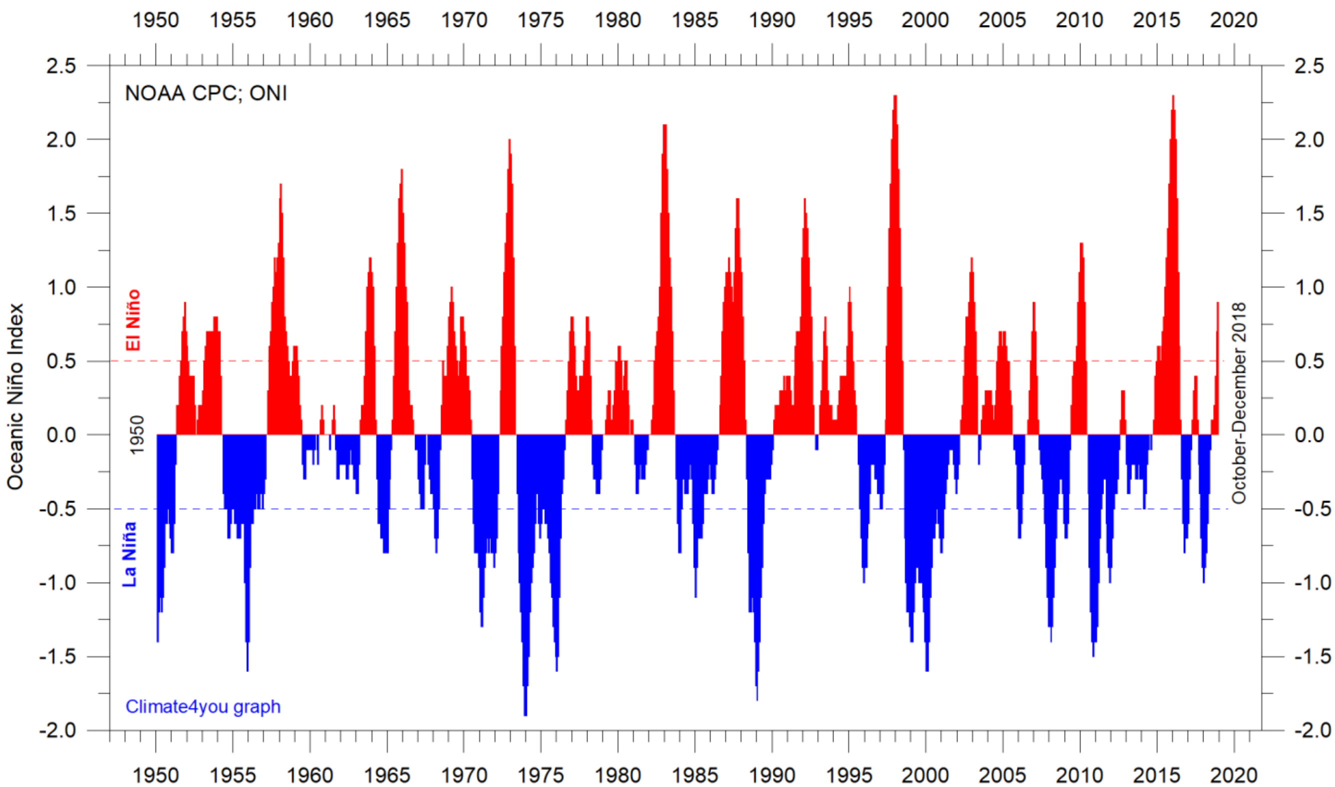


FIGURE 16. Warm (>+0.5°C) and cold (<0.5°C) episodes for the Oceanic Niño Index (ONI), defined as 3 month running mean of ERSST.v3b SST anomalies in the Niño 3.4 region (5°N-5°S, 120°-170°W)]. Base period: 1971-2000. For historical purposes cold and warm episodes are defined when the threshold is met for a minimum of 5 consecutive over-lapping seasons.

The large El Niño episode 2015-16 has now ended and are followed by changing La Niña and El Niño episodes. At the end of 2018, the index is moving towards the warm situation, El Niño, as is shown by Figure 15 above. It is clear from the diagram that the recent 2015-16 El Niño is among the strongest El Niño episodes since the beginning of the record in 1950. Considering the entire record, however, recent variations between El Niño and La Niña episodes are not abnormal in any way.

PDO - Pacific Decadal Oscillation, updated to 2017

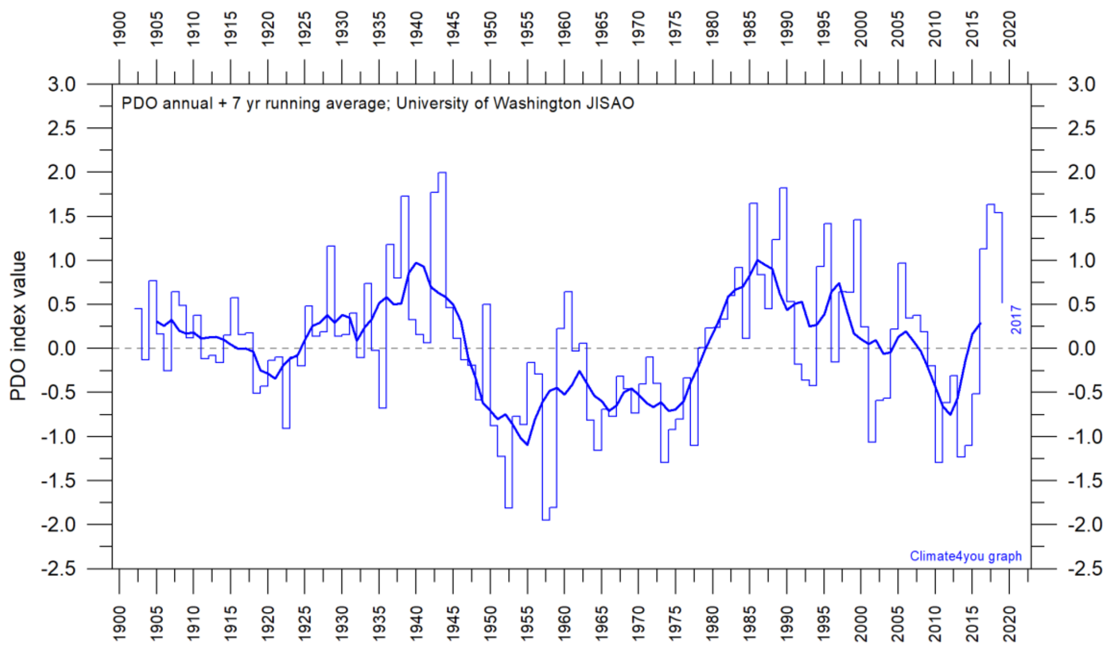


FIGURE 14. Annual values of the Pacific Decadal Oscillation (PDO) according to the Joint Institute for the Study of the Atmosphere and Ocean (JISAO), a Cooperative Institute between the National Oceanic and Atmospheric Administration and the University of Washington. The PDO is a long-lived El Niño-like pattern of Pacific climate variability, and the data series goes back to January 1900. The thin line indicates annual PDO values, and the thick line is the simple running 7-year average. Please note that the annual PDO is not yet updated beyond 2017.

AMO (Atlantic Multidecadal Oscillation) Index, updated to 2018

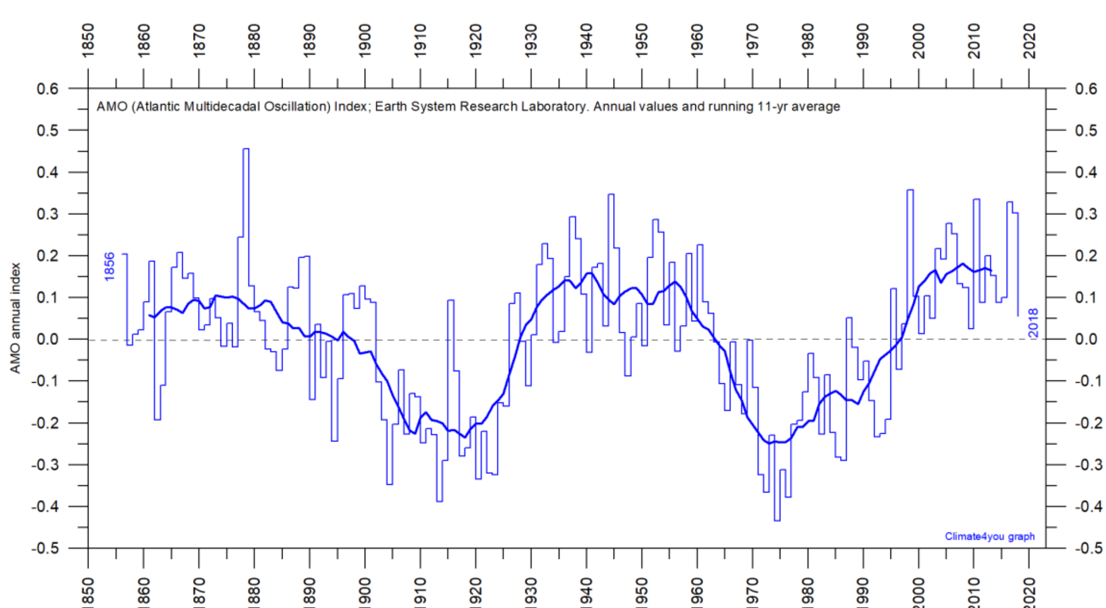


FIGURE 15. Annual Atlantic Multidecadal Oscillation (AMO) detrended index values since 1856. The thin line indicates the annual values, and the thick line is the simple running 11-year average. Data source: Earth System Research Laboratory at NOAA.

Annual accumulated cyclone energy (ACE) Atlantic Basin, updated to 2016

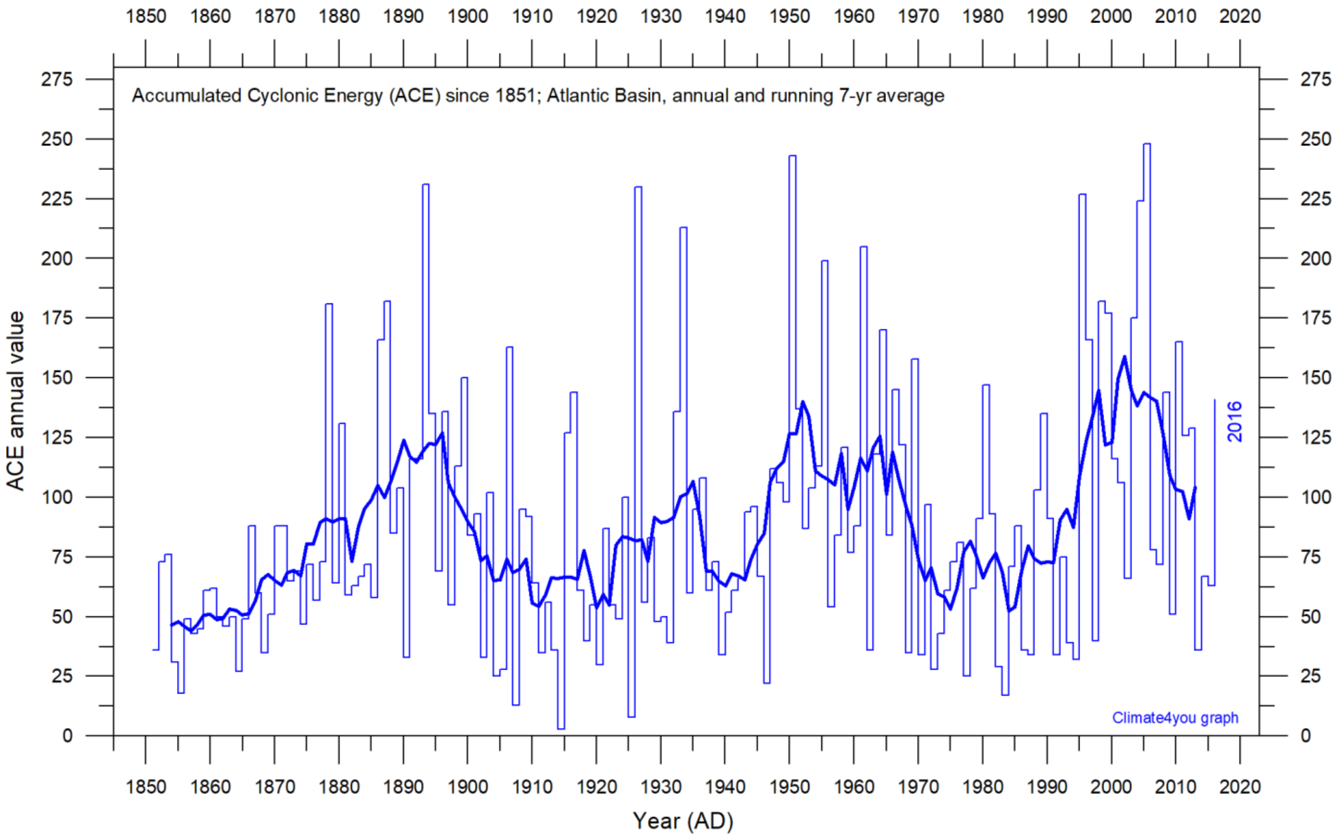


FIGURE 17. Accumulated cyclonic engergy (ACE; Atlantic basin) per year since 1850 AD, according to data from the [Atlantic Oceanographic and Meteorological Laboratory, Hurricane research Division](). Thin lines show annual ACE values, and the thick line shows the running 7-yr average. Please note that this data series is not yet updated beyond 2016.

The Atlantic Oceanographic and Meteorological Laboratory ACE data series goes back to 1850. A Fourier analysis for the Atlantic Basin (figure above) show the ACE series to be strongly influenced by a periodic variation of about 60 years' duration. At present, since 2002, the Atlantic ACE series is displaying an overall declining trend, but with large interannual variations. The North Atlantic hurricane season often shows above average activity when La Nina conditions are present in Pacific during late summer (August-October), as was the case in 2017.

Arctic and Antarctic sea ice extension, updated to December 2018

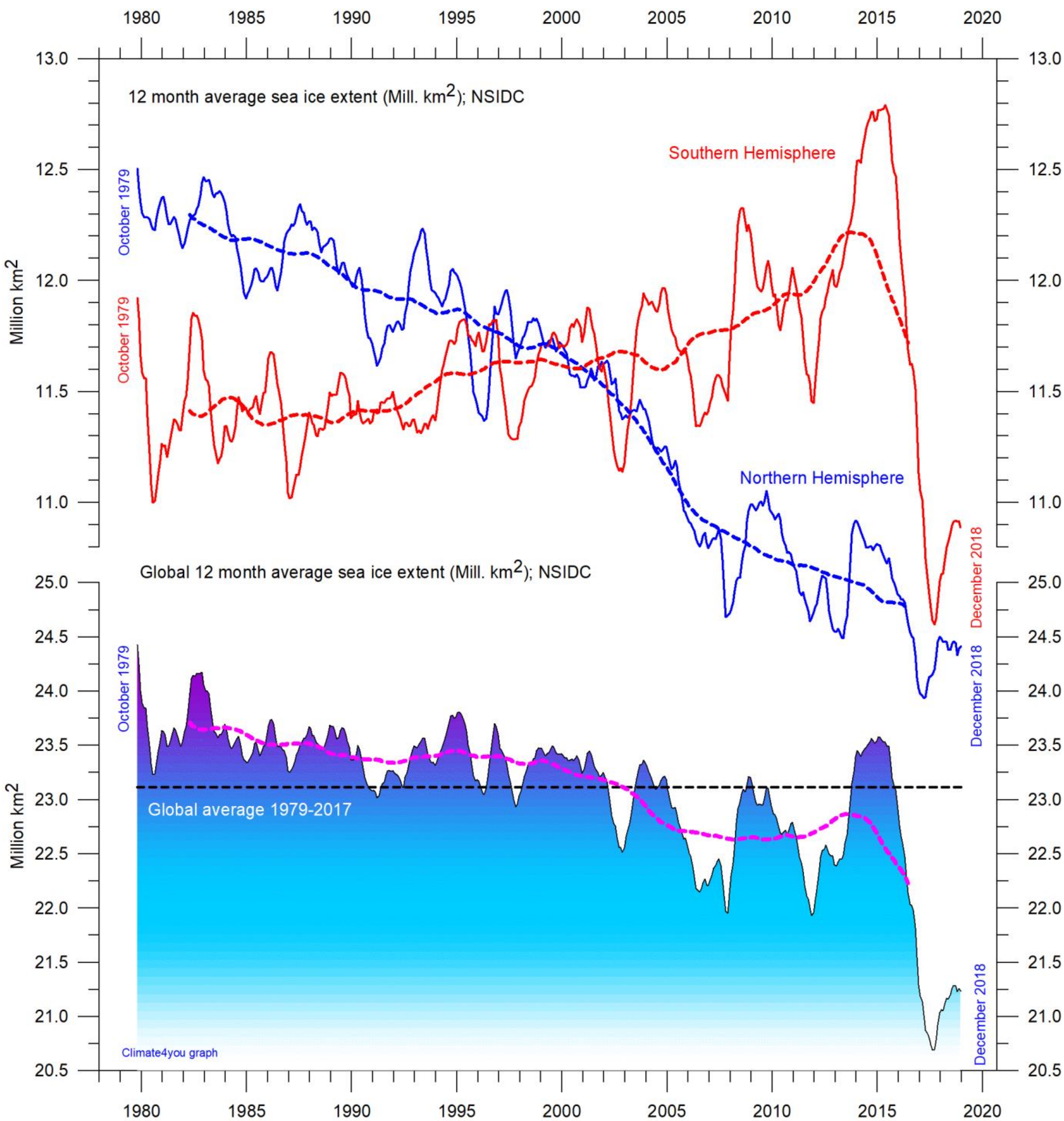


FIGURE 18. Global and hemispheric 12 month running average sea ice extension since 1979, the satellite-era. The October 1979 value represents the monthly average of November 1978 - October 1979, the November 1979 value represents the average of December 1978 - November 1979, etc. The stippled lines represent a 61-month (ca.5 years) average. Last month included in the 12-month calculations is shown to the right in the diagram. Data source: National Snow and Ice Data Center (NSIDC).

Northern Hemisphere snow cover, updated to December 2018

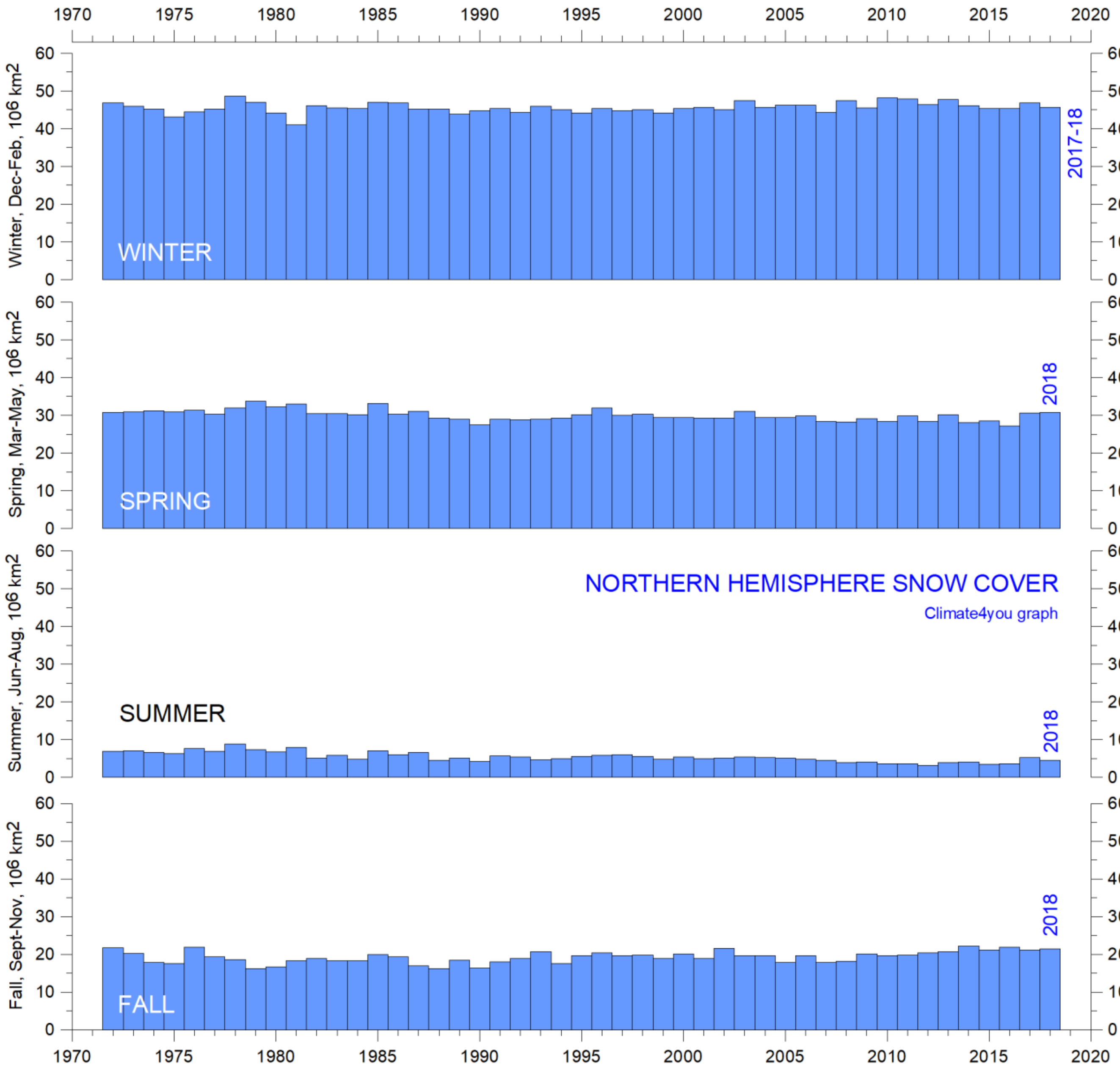
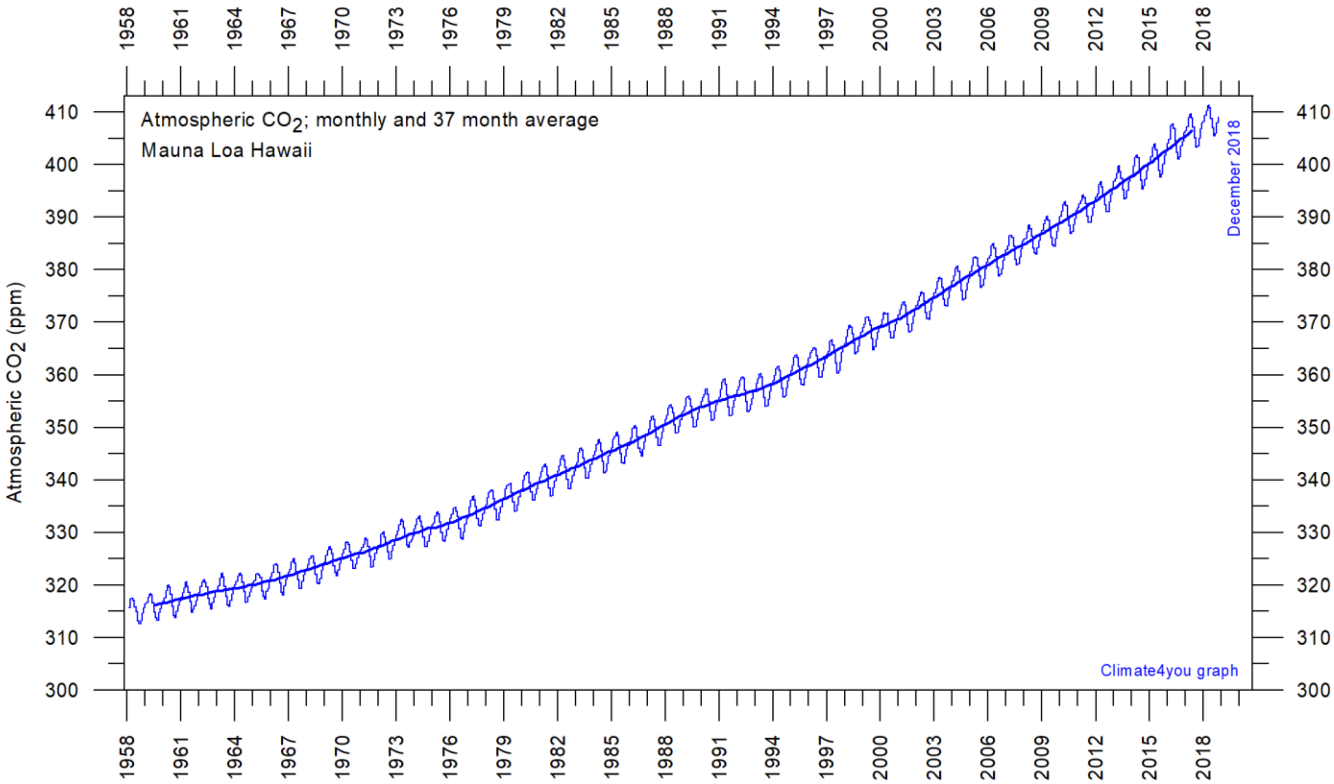


FIGURE 19. Northern Hemisphere seasonal snow cover since 1972 according to [Rutgers University Global Snow Laboratory](#).

Atmospheric CO2, updated to December 2018



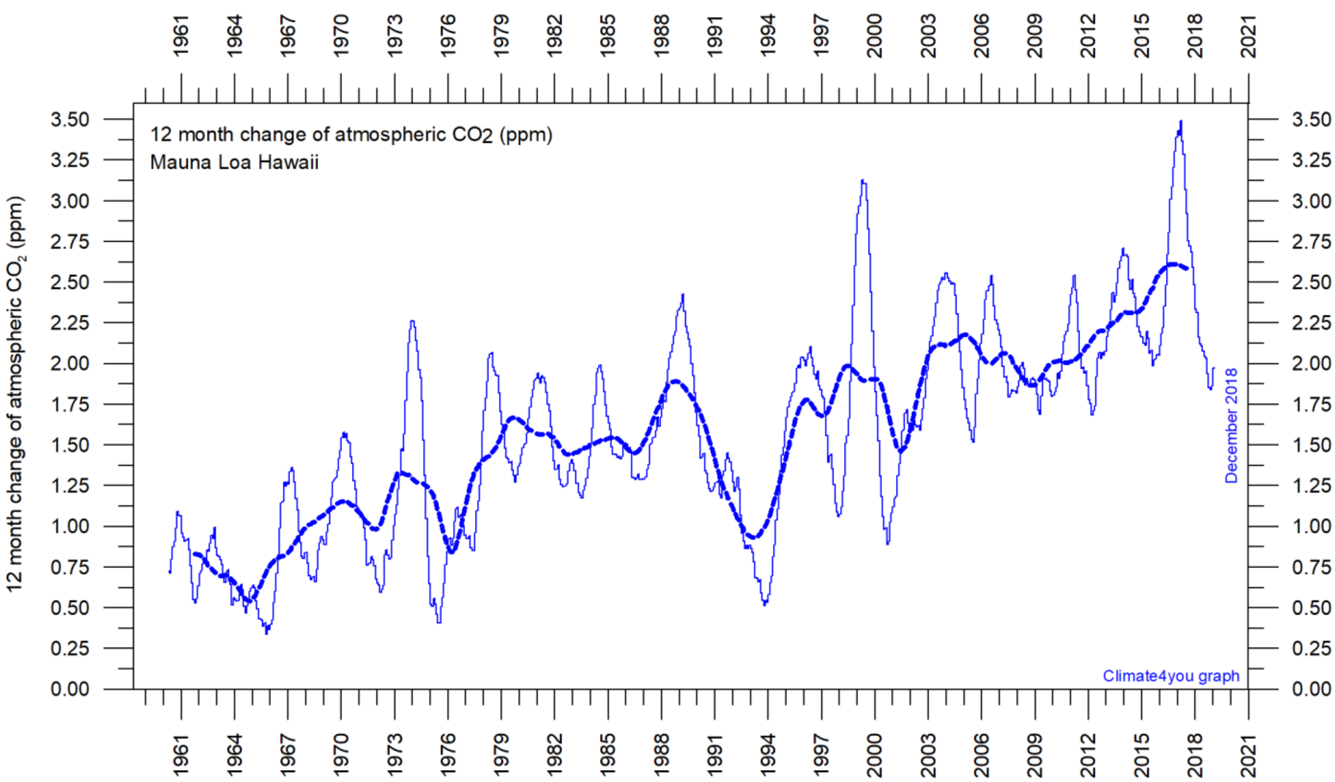


FIGURE 20. Monthly amount of atmospheric CO_2 (upper diagram) and annual growth rate (lower diagram); average last 12 months minus average preceding 12 months, thin line) of atmospheric CO_2 since 1959, according to data provided by the [Mauna Loa Observatory](), Hawaii, USA. The thick, stippled line is the simple running 37-month average, nearly corresponding to a running 3-year average.

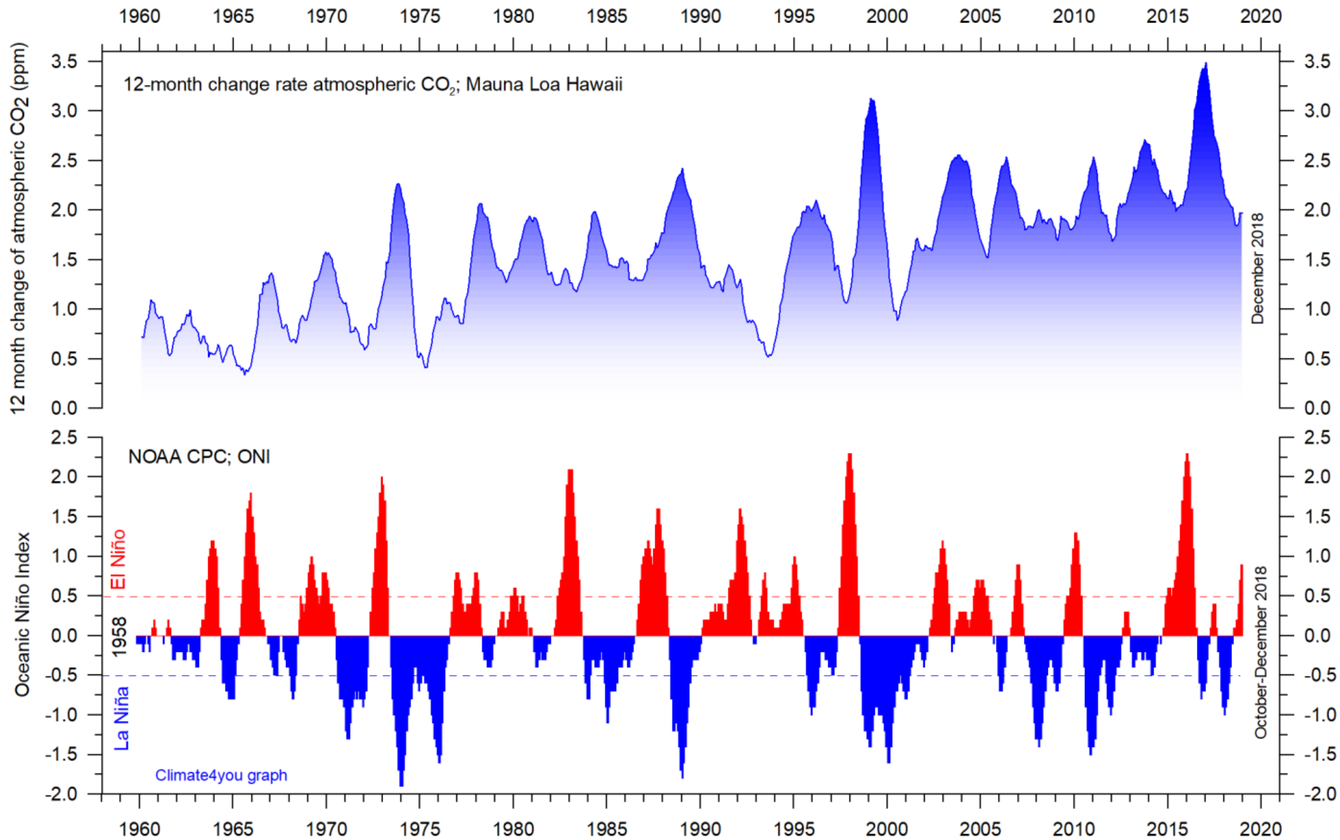


FIGURE 21. Visual association between annual growth rate of atmospheric CO_2 (upper panel) and Oceanic Niño Index (lower panel). See also Figure 16 and 20, respectively.

Number of daily sunspots since 1900, updated to December 31, 2018

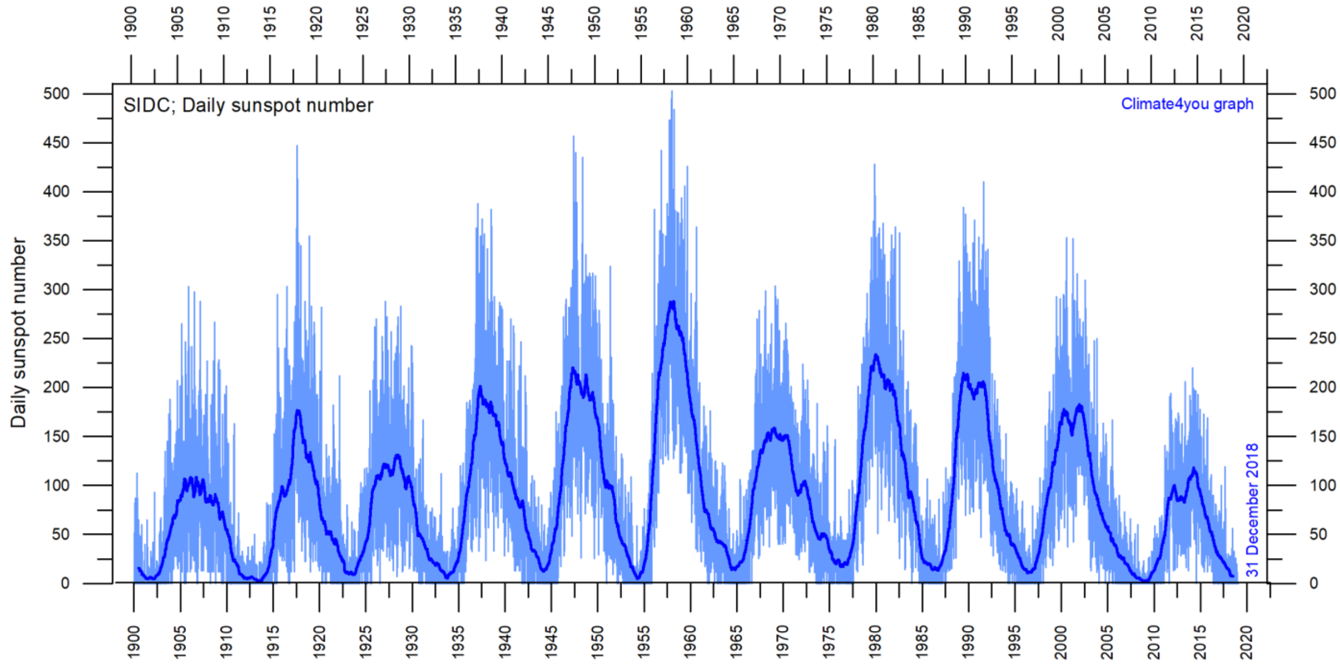


FIGURE 22. Daily observations of the number of sunspots since 1 January 1900 according to [Solar Influences Data Analysis Center](http://sidc.oma.be/) (SIDC). The thin blue line indicates the daily sunspot number, while the dark blue line indicates the running annual average.

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

Yours sincerely,

Ole Humlum

(Ole.Humlum@gmail.com)

Arctic Historical Evaluation and Research Organisation, Longyearbyen, Svalbard

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