4 Oct 2024

Vol. 35, No. 6

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Global Temperature Report: September 2024

Global climate trend since Dec. 1 1978: +0.16 C per decade

September Temperatures (preliminary)

Global composite temp: +0.96 C (+1.73°F) above the seasonal average

Northern Hemisphere: +1.21 C (+2.18 °F) above seasonal average

Southern Hemisphere: +0.71 C (+1.28°F) above seasonal average

Tropics: +0.97 C (+1.75°F) above seasonal average

August Temperatures (final)

Global composite temp: +0.89 C (+1.60°F) above the seasonal average

Northern Hemisphere: +0.96 C (+1.73°F) above seasonal average

Southern Hemisphere: +0.81 C (+1.46°F) above seasonal average

Tropics: +0.88 C (+1.58°F) above seasonal average

Notes on data released October 4, 2024 (v6.0, with 1991-2020 reference base)

[Please note that we provide these data out of our own initiative, and are only able to produce these updates at times convenient to our working schedules.]

This year's recent global temperature changes continue to surprise us as September's value rose from August to +0.96 °C (+1.73°F). After reaching a peak in April, which is fairly common for El Niño years, the value fell through June, but then began, unexpectedly, to gradually rise from

there. This makes September 2024 warmer than last September and thus the warmest September in the satellite record (April 2024 is still the warmest single month at +1.05°C). Heads are scratching as we look to various explanations as to why the 2023-24 El Niño did not cool off as had been the case in the previous events. Often mentioned is the Hunga Tonga underwater volcano in January 2022 (at this point the largest volcanic eruption in the 21st century) that launched tremendous amounts of water vapor into the stratosphere to possibly create a greenhouse blanket that prevents heat energy from exiting the planet as efficiently as usual. However, the jury is still out on that one. We are also checking on any unaccounted-for satellite instrument drift that may have occurred.

The sight increase in September's warmth over August is seen most strongly over the Northern Hemisphere's land masses which achieved a record anomaly of +1.53 °C which in turn boosted the global land anomaly to +1.39 °C, slightly warmer than last month's record of +1.35 °C. While the La Niña cooling still continues somewhat in the tropical Pacific Ocean waters, the remaining parts of the globe have not yet participated. To see the latest on the La Niña see: https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf.

One may pause for a thought experiment here. The global average tropospheric temperature departure in Jan 2023 was -0.03 °C and the peak was reached in Apr 2024 at +1.05°C. There are about 8,000 kg of air in the troposphere over an average area of 1 m^2. Given the specific heat of dry air, this indicates that between Jan 2023 and Apr 2024 the troposphere above each 1 m^2 of earth gained a net of about 8 million extra joules of energy (relative to normal) which increased the temperature about 1 °C. Since the impact of CO2 on the energy budget was essentially constant in these 16 months, what caused the increase? Most of those joules likely came from the El Niño-warmed ocean temperatures, but without that warmth since April (the tropical Pacific has cooled somewhat) why is the atmosphere still so warm, particularly over the continents? Were there fewer clouds that allowed extra joules as sunlight to enter the climate system? Is there a lingering impact from the submarine volcano Hunga Tonga which injected water vapor into the stratosphere, reducing the normal rate of energy lost to space? Or, also quite likely, is there some unidentified process that alters the heat balance in the atmosphere that we are missing? Interesting questions.

The planet's warmest atmospheric temperature departure in September occurred over central China with a value of +4.6°C (+8.3°F). In addition to China's very warm anomalies, Western Russia, most of Canada, middle South America and the far South Atlantic Ocean also participated. The tropics were also above average throughout.

With a reading of -3.9 °C (-7.0°F), the coolest departure from average was found over the ocean region between Terra Del Fuego (Cape Horn) and Antarctica. A modestly cool region also occupied the coastal area and adjacent seas around East Antarctica.

The conterminous US warmed from August as the lower-48 averaged +1.56 °C (+2.81°F). The main axis of warmth stretched from the Desert Southwest to the Northern Plains. It was again

relatively cooler in Alaska, so the 49-state August average came in at +1.30 °C (+2.34°F). [We don't include Hawaii in the US results because its land area is less than that of one satellite grid square, so it would have virtually no impact on the overall national results.]

Background notes.

New Reference Base Jan 2021 and forward. As noted in the Jan 2021 GTR, the situation comes around every 10 years when the reference period or "30-year normal" that we use to calculate the departures is redefined. With that, we have averaged the absolute temperatures over the period 1991-2020, in accordance with the World Meteorological Organization's guidelines, and use this as the new base period. This allows the anomalies to relate more closely to the experience of the average person, i.e. the climate of the last 30 years. Due to the rising trend of global and regional temperatures, the new normals are a little warmer than before, i.e. the global average temperature for Januaries for 1991-2020 is 0.14 °C warmer than the average for Januaries during 1981-2010. So, the new departures from this now warmer average will appear to be cooler, but this is an artifact of simply applying a new base period. It is important to remember that changes over time periods, such as a trend value or the relative difference of one year to the next, will not change. Think about it this way, all we've done is to take the *entire* time series and shifted it down a little.

To-Do List: There has been a delay in our ability to utilize and merge the new generation of microwave sensors (ATMS) on the NPP and JPSS satellites, but we are renewing our efforts as Dr. Braswell is now focused on this task. In addition, the current non-drifting satellite operated by the Europeans, MetOP-B, has not yet been adjusted or "neutralized" for its seasonal peculiarities related to its unique equatorial crossing time (0930). While these MetOP-B peculiarities do not affect the long-term global trend, they do introduce error within a particular year in specific locations over land.

Dr. Christy and Dr. Roy Spencer, an ESSC principal scientist, use data gathered by advanced microwave sounding units on NOAA, NASA and European satellites to produce temperature readings for almost all regions of the Earth. This includes remote desert, ocean and rain forest areas where reliable climate data are not otherwise available. Dr. Danny Braswell has reconstituted the code which converts the satellite radiances to temperature values and Dr. Rob Junod assists with visuals in the preparation of these reports.

The satellite-based instruments measure the temperature of the atmosphere from the surface up to an altitude of about nine kilometers above sea level. Once the monthly temperature data are collected and processed, they are placed in a "public" computer file for immediate access by atmospheric scientists in the U.S. and abroad.

The complete version 6 lower troposphere dataset is available here:

http://www.nsstc.uah.edu/data/msu/v6.0/tlt/uahncdc_lt_6.0.txt

Archived color maps of local temperature anomalies are available on-line at:

http://nsstc.uah.edu/climate/

Neither Christy nor Spencer receives any research support or funding from oil, coal or industrial companies or organizations, or from any private or special interest groups. All of their climate research funding comes from federal and state grants or contracts.

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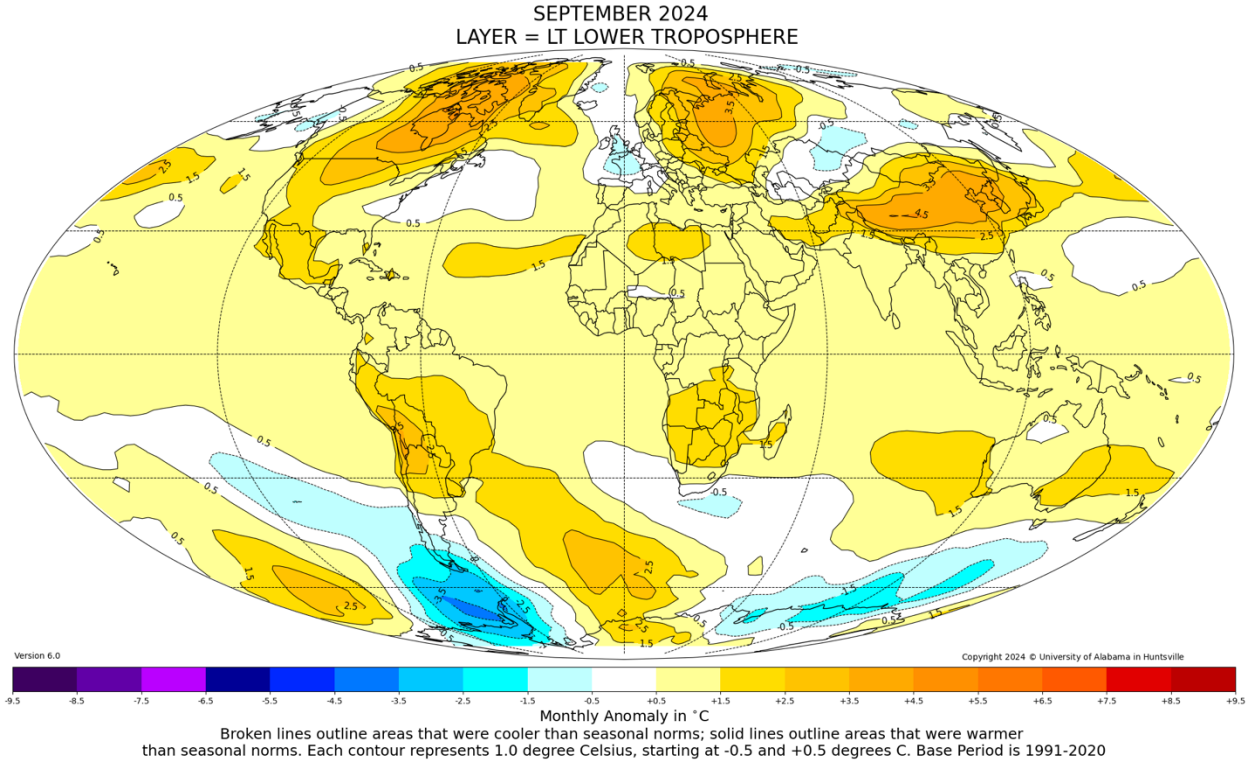

Figure. Lower tropospheric temperature anomalies for September 2024

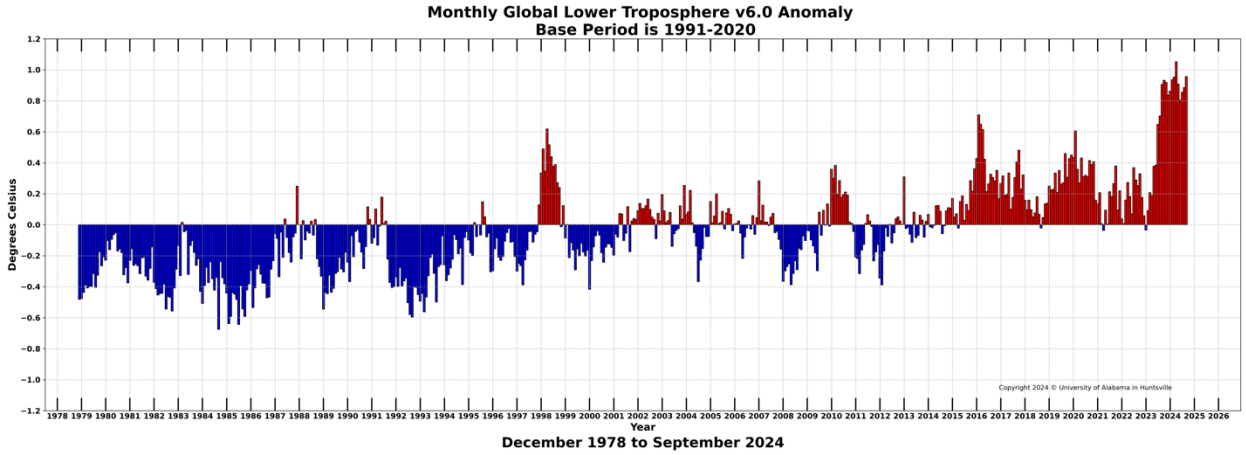

Figure. Bar chart of global monthly lower tropospheric temperature anomalies.