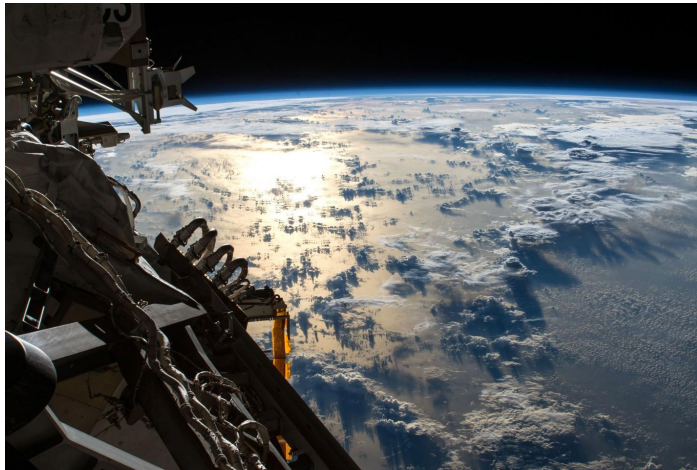


Decline of Reflective Low Clouds May Have Contributed to Recent Record Heat

A new study links decreasing cloud cover over the ocean to last year's spiking heat, adding to research showing Earth's loss of luster is increasing warming.

By [Bob Berwyn](#) on December 5, 2024



The sun's glint reflects off the Pacific Ocean shadowed by a line of cumulonimbus clouds as the International Space Station orbits about 253 miles above the Earth's surface. Credit: NASA

Earth has often been described by astronauts as a glistening marble floating in a black void, but the planet has lost some of its sheen in recent decades, especially with the well-documented decline of ice and snow in polar and mountain regions. New research published today shows the planet is also dulling from a steady decline of low-elevation clouds over some ocean regions.

And a duller planet absorbs more incoming solar radiation, said Helge Gössling, a climate researcher at the Alfred Wegener Center and lead author of [the Science paper](#) linking the overall decline of the planet's reflectivity in 2023 with a simultaneous surge of the global average temperature.

The findings, Gössling said, suggest that the sharp drop of low-elevation cloud cover over some ocean regions could account for most of the sudden spike of global temperatures in 2023, when the Earth's fever jumped 0.17 degrees Celsius (0.3 degrees Fahrenheit) above the previous temperature record set in 2016.

Several factors are driving the decline of the Earth-cooling low marine cloud layers, he said, including climate cycles like El Niño, as well as a drop of sulfate aerosol emissions from shipping and other industrial sources. But he said he was most worried that the study affirms

other research showing that global warming itself is driving the loss of clouds by diffusing distinct layers of the atmosphere that promote the formation and persistence of low-elevation marine clouds.

If the drop in the proportion of solar radiation being reflected back to space—called albedo—is due to feedbacks between global warming and low clouds, “we should expect rather intense warming in the future,” Gössling said. “We could see global long-term climate warming exceeding 1.5 degrees Celsius sooner than expected.”

Up to now, climate models have been highly uncertain about the feedback between warming temperatures and changes in cloud cover, said [Zeke Hausfather](#), a climate researcher with Berkeley Earth who was not involved in the new study.

He said the paper provides a useful assessment of measured changes in cloud cover, but still “raises as many questions as it provides answers.”

“We still do not know for sure that these changes in cloud behavior are not due to short-term variability,” Hausfather said, “or if they represent a new ongoing change to the climate system.”

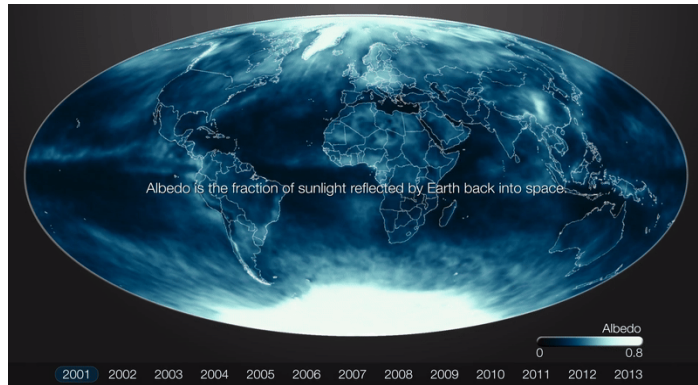
If the cloud cover decline measured in the new study represents an ongoing change, “it remains difficult to disentangle how much might be due to changing human aerosol emissions versus a feedback from human greenhouse gas emissions. But in either of those cases, it is not good news,” he said, because it would suggest that the climate is more sensitive to greenhouse gases than widely thought.

Not the First Warning

The research led by Gössling is not the first warning about accelerated warming, and it’s not the first to suggest strong links between reductions of shipping emissions and regional global warming hotspots. A [study](#) published last May in the Proceedings of the National Academy of Sciences described how a reduction of industrial aerosol emissions in China worsened ocean heat waves in the Pacific.

Another [study](#) published in Earth System Dynamics last week specifically modeled how changes to rules on shipping emissions in 2020 help explain the anomalous 2023 warming, concluding that the significant reductions in sulfate aerosol emissions from ships “have been a major contributing factor to the monthly surface temperature anomalies during the last year.”

When famed climate scientist James Hansen warned of that effect in 2021 and [projected a steep acceleration of warming](#), his findings were criticized by some other scientists as over-emphasizing the role of sulfate aerosols. But aerosol-focused research since then, as well as continued warming into 2024, seems to support his conclusions.



This animation shows variations in Earth’s reflection of sunlight, called albedo, from month to month, based on NASA satellite measurements over a 12-year period.

In any case, the big temperature jump that began in 2023 and continued through much of 2024 still can’t be fully explained, even with the new study, said [Gavin Schmidt](#), director of NASA’s Goddard Institute for Space Studies. In a November [editorial](#) in The New York Times, Schmidt and Hausfather wrote that the recent warming “appears to be higher than our models predicted (even as they generally remain within the expected range).” The continued lack of a consensus explanation for the spike is making scientists uneasy, they wrote, because the implications of faster warming include more deadly climate extremes.

Schmidt said the new study helps explain, and fills in some of the knowledge gaps, about the recent warming by linking it with Earth’s dwindling reflectivity.

“But we still aren’t able to say why the albedo has been changing so much,” he said. “Is it aerosols, cloud feedbacks or volcanoes? So there is still more to do before we can say what this means going forward.”

Gössling said the “explanation gap” for 2023 remains “one of the most intensely discussed questions in climate research.” His study combined satellite data from NASA with climate reanalysis data, in which a range of observational data is combined with a complex weather model, to make a detailed analysis of how the global energy budget and cloud cover at different altitudes have changed since 1940.

Co-author Thomas Rackow, with the European Centre for Medium-Range Weather Forecasts, said both datasets showed Earth’s record dullness in 2023, following an observed trend of declining reflectivity in recent years. But dwindling polar ice only accounts for about 15 percent of that decline, so they zeroed in on the loss of low-level marine clouds in the northern mid-latitudes and the tropics.

The Atlantic Ocean, where the most unusual temperature records were observed in 2023, really stood out, the researchers said. The ocean surface temperatures in the eastern North Atlantic were one of the “main drivers of the latest jump in global mean temperature,” Gössling said, and the warming correlated with areas where cloud cover also declined significantly.

The fact that mainly low clouds are responsible for the reduced albedo, rather than higher-altitude ones, has important consequences, he said. High-elevation clouds contribute to warming by keeping the warmth emitted from the surface in the atmosphere. That's "essentially the same effect as greenhouse gases," he said.

"But lower clouds don't have that same effect," he added. "If there are fewer low clouds, we only lose the cooling effect, making things warmer."