We finally have an explanation for 2023's record-breaking temperatures

A decline in low-lying cloud cover means Earth is absorbing more solar radiation, which could explain 0.2°C of missing heat scientists have been struggling to account for

By Madeleine Cuff on December 5, 2024

There was a sharp fall in the number of low-lying clouds in 2023. Busà Photography/Getty Images

Changes in cloud cover may account for why global temperatures for the past two years have exceeded the predictions of climate models.

2023 and 2024 saw temperature records repeatedly smashed, with both years now showing average temperatures around 1.5°C above the pre-industrial level. Climate change plus an El Niño weather pattern are partly to blame, but neither factor fully explains the extraordinary warmth.

Now, researchers believe the answer lies in a sharp drop in low-lying cloud cover in 2023. This change reduced Earth's albedo – the planet's ability to reflect solar radiation back into space – causing an increase in temperatures.

Earth's albedo has been declining since the 1970s, largely due to the melting of polar ice caps, which help to bounce sunlight back into space. But analysis of satellite data by Helge Goessling at the Alfred Wegener Institute in Germany and his colleagues revealed that 2023's planetary albedo hit a record low.

Goessling and his colleagues then used a combination of weather observations and modelling to understand the causes of this drop, and found there had been a sharp fall in the number of low-lying clouds in 2023. The change was particularly pronounced in the Atlantic Ocean, which experienced some of the most unusual temperature extremes in 2023.

"We were able to get an indication of where the clouds are actually changing, at which altitude in the atmosphere," says Goessling. "It really is quite striking that this, this decrease of the cloud cover, is mostly happening in the lower levels."

The findings could explain the additional 0.2°C of missing heat scientists have been struggling to account for, once the impacts of background climate change and the 2023 El Niño are tallied. "It's another piece of the puzzle, and I think quite an important one," says Goessling. Even though the study only assessed data from 2023, the findings may also explain why global temperatures have remained extremely high throughout 2024, despite El Niño fading earlier this year.

Paulo Ceppi at Imperial College London says the study is timely because climate scientists are keen to understand the drivers of the recent record warmth. "I think they make a pretty compelling case that albedo changes, in specifically low clouds, have been a major contributor to the changes in the radiation budget – and therefore temperature," he says.

The next question is why low-lying clouds are disappearing. Broadly, there are three explanations. It could be due to a global reduction in aerosol pollution, which helps clouds form and persist. Alternatively, it could be the result of global warming changing how clouds behave. Or it could simply be natural variability in the climate.

Understanding which of these three factors is dominant is crucial, because it influences how sensitive Earth's climate is to greenhouse gas pollution. If the lack of clouds is due to a climate change feedback, then the impact will accelerate in the coming years, pushing global temperatures higher than expected. "The answer does have pretty profound implications for what we expect about future climate change," says Ceppi.

Journal reference: