

How shifting cloud patterns are exacerbating climate change

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In a warming climate, cloud patterns are changing in ways that amplify global warming. A team of researchers led by Professor Johannes Quaas from Leipzig University and Hao Luo and Professor Yong Han from Sun

Yat-sen University in China have discovered increasingly asymmetric changes in cloud cover—cloud cover decreases more during the day than at night.

This asymmetry means that the cooling effect of clouds is decreasing during the day and their warming effect is increasing at night, adding to global warming. The researchers have published their [new findings](#) in the journal *Science Advances*.

Clouds: More than just a meteorological phenomenon

During the day, clouds reflect sunlight back into space, cooling the Earth's surface. At night, on the other hand, they act like a blanket, trapping in the heat. This keeps the surface of the Earth warm. "This is why clouds play a decisive role in the Earth's climate," says meteorologist Quaas.

In their study, the scientists used satellite observations and data from the sixth phase of the Coupled Model Intercomparison Project (CMIP6), which provides comprehensive [climate models](#) and scenarios. These models cover historical data from 1970 to 2014 and projections up to the year 2100.

"As [cloud cover](#) decreases more during the day than at night on a global scale, this leads to a decrease in the short-wave albedo effect during the day and an increase in the long-wave greenhouse effect at night," explains Hao Luo, lead author of the study.

Climate models and their importance

Climate models are essential for understanding and predicting the complex processes and interactions within the climate system. They help

scientists develop possible future scenarios and analyze the impact of various factors such as greenhouse gases, aerosols and clouds on the climate.

Quaas emphasizes, "The asymmetry of how cloud cover changes is an important newly discovered factor. Our study shows that this asymmetry causes a positive feedback loop that amplifies global warming."

According to the researcher, clouds are changing as a result of climate change. Overall, there are slightly fewer clouds, which means more global warming.

The mechanisms behind the asymmetry

This daily asymmetry in cloud cover can be attributed to various factors. One major cause is the increasing stability in the lower troposphere as a result of rising greenhouse gas concentrations. This stability means that clouds are less likely to form during the day, while they remain stable or even increase at night.

Yong Han, co-author of the study, explains, "The change in cloud cover is not evenly distributed throughout the day. By day, when [solar irradiance](#) is strongest, we observed a greater reduction in clouds. At night, when the Earth's surface normally cools down, cloud cover retains the heat and thus amplifies the greenhouse effect."

Looking to the future

"Our findings show that there is an even greater need to reduce [greenhouse gases](#), because not only does cloud cover respond to warming, it also amplifies warming through this new effect," warns Quaas.

The scientists believe that further studies are needed to better understand changes in cloud cover. The ongoing studies at Leipzig University are also looking at changes in vegetation and its biodiversity, for example, as well as the role of decreasing air pollution.

More information: Hao Luo et al, Diurnally asymmetric cloud cover trends amplify greenhouse warming, *Science Advances* (2024). [DOI: 10.1126/sciadv.ado5179](https://doi.org/10.1126/sciadv.ado5179)

Provided by Leipzig University

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