

# Future subtropical warming accelerates tropical climate change

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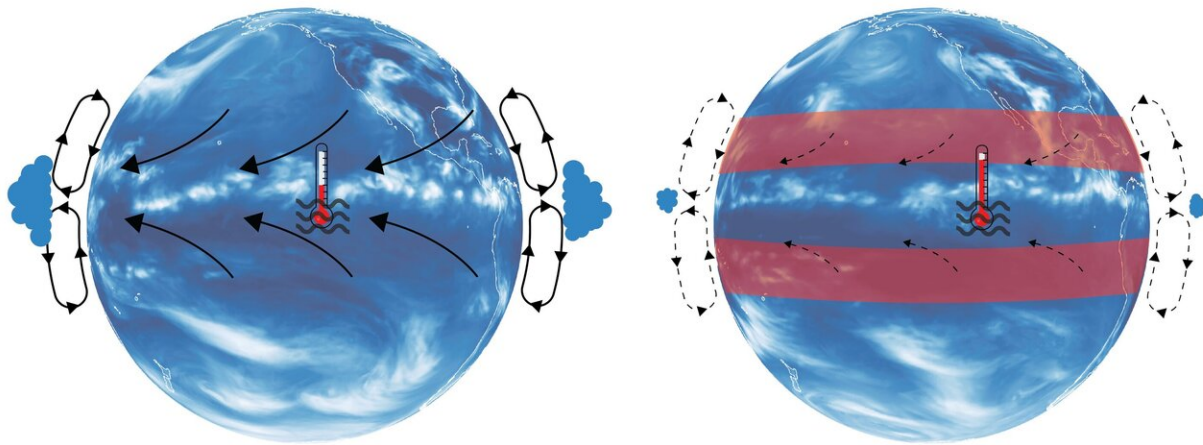


Illustration of atmospheric Hadley cell under present-day conditions (left). Subtropical warming leads to a weakening of the Hadley cell (right), less clouds in most of the tropics, a reduction in the upwelling of cold ocean water, and a resulting increase in tropical temperatures. This process explains the accelerated tropical warming found in climate models in response to increase greenhouse gas emissions. Credit: Elke Zeller

In response to future fossil fuel burning, climate computer models simulate a pronounced warming in the tropical oceans. This warming can influence the El Niño phenomenon and shift weather and rainfall patterns across the globe. Despite being robustly simulated in computer models of the climate system, the origin of this accelerated tropical

warming has remained a mystery. A new study published this week in the journal *Nature Climate Change* concludes that climate change outside the tropics is the main culprit.

Earth's future [warming](#) will not be identical everywhere. Atmospheric and oceanic circulation changes, as well as cloud processes, will determine which regions will warm faster and which ones will experience a delayed warming relative to the global mean. Focusing on the [tropical regions](#), a team of scientists from the IBS Center for Climate Physics (ICCP) at Pusan National University in South Korea, along with their international collaborators, has now developed a new method that separates the contributions from local and remote physical processes that cause warming in a given region.

The team found that the expected future warming in the tropics (15oS-15oN) originates mostly from warming that occurs in [subtropical regions](#) (16oN-32oN and 16oS-32oS). "To understand this surprising phenomenon, one has to understand how different areas interact with each other climatically," says Dr. Malte Stuecker from the ICCP and lead author of the study.

In the subtropical regions air in the upper atmosphere is sinking, creating high pressure at the surface (see Figure). At an altitude of about 10-15 km, this sinking motion sucks in tropical air. The resulting large-scale atmospheric circulation is referred to as the Hadley cell and its surface branch, known as trade wind circulation, transports relatively dry subtropical air back to the tropics. Due to the effects of earth's rotation, trade winds also cause upwelling of cold subsurface waters in the tropical Pacific and Atlantic.

"In response to increasing greenhouse gas emissions, future subtropical warming will slow down the atmospheric Hadley cell," adds Stuecker. This will lead to a weakening of the surface trade winds, less upwelling

of cold ocean water, and a resulting warming of the sea surface. In addition, a weaker Hadley cell also means that less humid air is rising, and cloud coverage is reduced in most of the tropics, increasing the amount of sunlight reaching the surface. "This can further exacerbate future warming in the tropics," says Axel Timmermann, Director of the ICCP and co-author of the study.

To arrive at these conclusions, the authors used a computer model of the global climate system and ran it for present-day and future CO<sub>2</sub> conditions. By imposing the extra energy related to the CO<sub>2</sub> change, either in the tropics or subtropics, the team then found that human-induced subtropical warming causes about 40% more future tropical surface ocean temperature change than if the same amount of extra energy would enter Earth's atmosphere directly in the tropics.

The study presents a new paradigm to understand the patterns of future global warming and the arising regional differences. "Warming in one area can affect the degree of warming in another place. We are starting to appreciate how strongly different areas are connected in the climate system," says co-author Prof. Fei-Fei Jin from the University of Hawai'i, U.S..

The new *Nature Climate Change* study also points out the possibility that a future reduction of air-pollution in Asian countries may lead to regional warming in the subtropics, which in turn could trigger a warming cascade that might even affect the tropics. However, more research needs to be conducted to quantify the influences of air quality control on [climate](#).

**More information:** Strong remote control of future equatorial warming by off-equatorial forcing, *Nature Climate Change* (2020). [DOI: 10.1038/s41558-019-0667-6](https://doi.org/10.1038/s41558-019-0667-6) , [nature.com/articles/s41558-019-0667-6](https://www.nature.com/articles/s41558-019-0667-6)

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