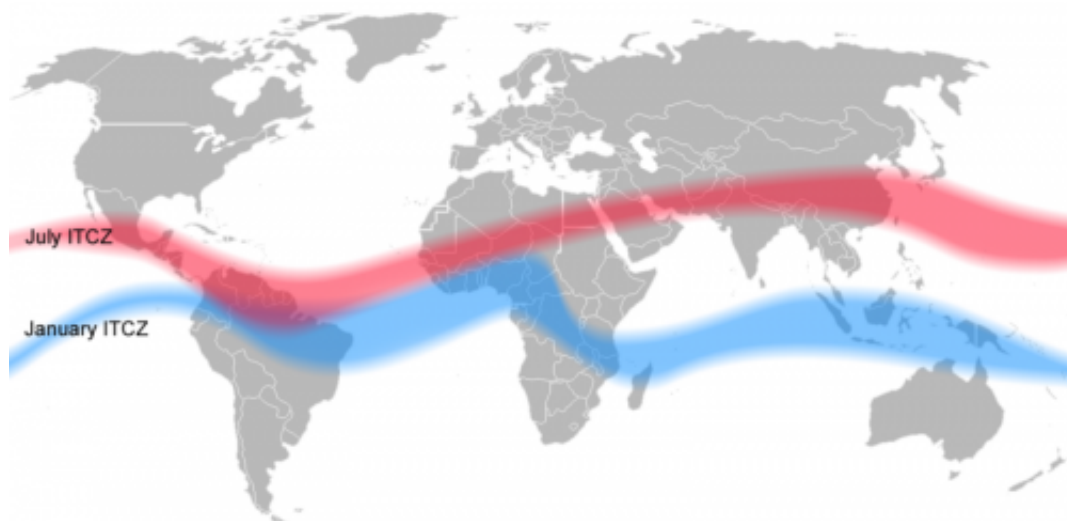


# Wind and rain belts to shift north as planet warms, research says

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During boreal summer, Earth's tropical rain belt migrates north. A similar but prolonged shift could happen if the north continues to heat faster than the south, disrupting global rainfall patterns. Credit: Mats Halldin

As humans continue to heat the planet, a northward shift of Earth's wind and rain belts could make a broad swath of regions drier, including the Middle East, American West and Amazonia, while making Monsoon Asia and equatorial Africa wetter, says a new study in *Proceedings of the National Academy of Sciences*.

The study authors base their prediction on the warming that brought Earth out of the last ice age, some 15,000 years ago. As the North

Atlantic Ocean began to churn more vigorously, it melted Arctic sea ice, setting up a temperature contrast with the southern hemisphere where sea ice was expanding around Antarctica. The [temperature gradient](#) between the poles appears to have pushed the [tropical rain](#) belt and mid-latitude jet stream north, redistributing water in two bands around the planet.

Today, with Arctic sea ice again in retreat, and the northern hemisphere heating up faster than the south, history could repeat itself. "If the kinds of changes we saw during the deglaciation were to occur today that would have a very big impact," said the study's lead author, Wallace Broecker, a climate scientist at Columbia University's Lamont-Doherty Earth Observatory.

Marshaling climate data collected from around the world, from tree-rings, polar ice cores, cave formations, and lake and [ocean sediments](#), Broecker and study coauthor, Aaron Putnam, a climate scientist at Lamont-Doherty, hypothesize that the wind and rain belts shifted north from about 14,600 years ago to 12,700 years ago as the northern hemisphere was heating up.

At the southern edge of the tropical rain belt, the great ancient Lake Tauca in the Bolivian Andes nearly dried up at this time while rivers in eastern Brazil slowed to a trickle and rain-fed stalagmites in the same region stopped growing. In the middle latitudes, the northward advance of the jet stream may have caused Lake Lisan, a precursor to the Dead Sea in Jordan's Rift Valley, to shrink, along with several prehistoric lakes in the western U.S., including Lake Bonneville in present day Utah.

Meanwhile, a northward shift of the tropical rains recharged the rivers that drain Venezuela's Cariaco Basin and East Africa's Lake Victoria and Lake Tanganyika. Stalagmites in China's Hulu Cave grew bigger. Evidence for a stronger Asian monsoon during this time also shows up in

the Greenland ice cores.

The process worked in reverse from about 1300 to 1850, the study authors hypothesize, as northern Europe transitioned from the relatively warm medieval era to a colder period known as the Little Ice Age. Ocean circulation slowed, and sea ice in the North Atlantic Ocean expanded, the climate record shows. At the same time, rainfall declined in Monsoon Asia, leading to a series of droughts that have been linked to the decline of Cambodia's ancient Khmer civilization, China's Ming dynasty and the collapse of kingdoms in present day Vietnam, Myanmar and Thailand.



Western China is growing drier, turning lakes like this one to dust. If wind and rain patterns shift north as the study predicts, drying in this region could continue. Credit: David Putnam

In the [southern hemisphere](#), the reconstruction of glacier extents in New Zealand's Southern Alps suggests that the mid-latitudes may have been colder during medieval times, supporting the idea of a temperature contrast between the hemispheres that altered rain and wind patterns.

A similar migration of Earth's wind and rain belts happens each year. During boreal summer, the tropical rain belt and mid-latitude jet stream migrate north as the northern hemisphere heats up disproportionately to the south, with more continents to absorb the sun's energy. As the northern hemisphere cools off in winter, the winds and rains revert south.

Sometimes the winds and rains have rearranged themselves for longer periods of time. In the 1970s and 1980s, a southward shift of the tropical rain belt, attributed to air pollution cooling the northern hemisphere, is thought to have brought devastating drought to Africa's Sahel region. The tropical rain belt has since reverted back, and may be moving north, the study authors say, as suggested by a number of recent droughts, including in Syria, northern China, western U.S., and northeastern Brazil.

Consistent with the study, at least one climate model shows the tropical rain belt moving north as carbon dioxide levels climb and temperatures warm. "It's really important to look at the paleo record," said Dargan Frierson, an atmospheric scientist at University of Washington whose modeling work supports the authors' hypothesis. "Those changes were huge, just like we're expecting with global warming."

The study authors acknowledge that their hypothesis has some holes. In the past, changes in [sea ice](#) cover drove the temperature gradient between the two hemispheres while today rapidly rising industrial carbon emissions are responsible. So far, there is also no clear evidence that ocean circulation is increasing in the North Atlantic or that the monsoon rains over Asia are strengthening (though there is speculation that sulfate

aerosols produced by burning fossil fuels may be masking this effect).

As air pollution in the [northern hemisphere](#) declines, temperatures may warm, creating the kind of temperature contrast that could move the winds and rains north again, said Jeff Severinghaus, a [climate scientist](#) at Scripps Institution of Oceanography who was not involved in the study.

"Sulfate aerosols will probably get cleaned up in the next few decades because of their effects on acid rain and health," he said. "So Broecker and Putnam are probably on solid ground in predicting that northern warming will eventually greatly exceed southern warming."

**More information:** Hydrologic impacts of past shifts of Earth's thermal equator offer insight into those to be produced by fossil fuel CO<sub>2</sub>, *PNAS*, [www.pnas.org/cgi/doi/10.1073/pnas.1301855110](http://www.pnas.org/cgi/doi/10.1073/pnas.1301855110)

Provided by Columbia University

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