Climate change expected to shift location of East Asian Monsoons

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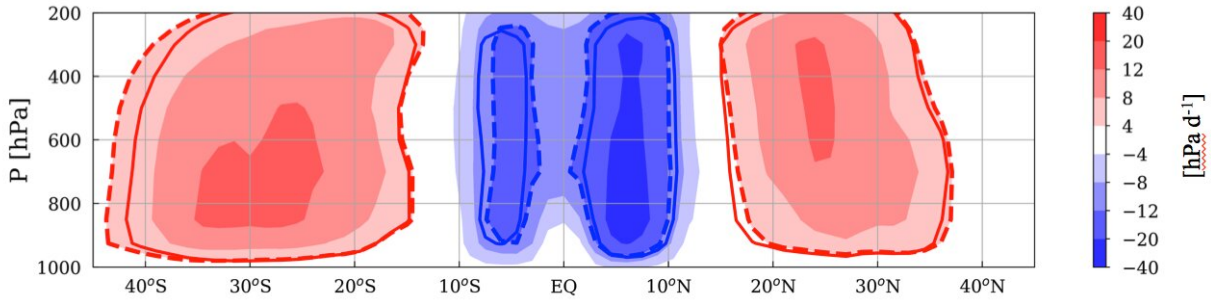

In the Hadley cell, moist air rises in the deep tropics (blue) while dry air descends in the subtropics (red). In a future warmer climate (dashed lines), the dry areas will expand while the moist areas will contract. The deep-tropical contraction interacts with the subtropical expansion and affects monsoons that occur in Asia, according to a new Berkeley Lab study. Solid lines show today's climate. Credit: Berkeley Lab

More than a billion people in Asia depend on seasonal monsoons for their water needs. The Asian monsoon is closely linked to a planetary-scale tropical air flow which, according to a new study by Lawrence Berkeley National Laboratory (Berkeley Lab), will most likely shift geographically as the climate continues to warm, resulting in less rainfall in certain regions.

Berkeley Lab researchers Wenyu Zhou and Da Yang, along with Shang-

Ping Xie of Scripps Institution of Oceanography at UC San Diego, used global climate models to study the so-called Hadley cell, which is the name of this tropical atmospheric circulation pattern. Their model results suggest that the East Asian Monsoon will shift geographically as the climate continues to warm, and that enhanced warming at the equator will drive this shift. Their study was published recently in the journal *Nature Climate Change*.

The Hadley cell consists of two components—moist air that rises at the equator, or the deep tropics, causing heavy precipitation during monsoons, and dry air that descends in the subtropics on either side of the equator, resulting in dry conditions in the subtropics. Under anthropogenic warming, the dry subtropical part will expand towards the north and south poles, while the moist deep tropical part will get smaller, according to global climate models.

For this study, the researchers used a worst-case climate change scenario, as defined by the U.N. Intergovernmental Panel on Climate Change, to model the climate in the last 30 years of the 21st century.

By investigating changes in the Hadley cell during different seasons, the researchers found that the occurrence of monsoon rains will shift towards the equator. "Previous studies suggested that, on average, the Hadley cell will expand poleward in warmer climates. However, we show a different behavior in the summer months—a contraction towards the equator in June-July, due to the effect of the enhanced warming at the equator," said Zhou.

This unexpected contraction could have profound impacts on the subtropical regional climate. Rainfall in East Asia currently peaks in the summer months. "The monsoon is an important water resource to East Asia and large parts of China," said Yang. "So how it moves or changes with climate will have a huge impact on water resource management and

on the daily lives of people in these areas."

Looking forward, this study opens the door for new research directions, the researchers say. "We are beginning to investigate the impact on other regional features such as the North-American monsoon and the hurricane tracks," said Zhou.

And while this early-summer contraction was evident in their computer modeling, another important question is whether it can be seen in real-life observations. Their preliminary results suggest that over the past 30 years these patterns have been dominated by natural variability. The effect of global warming has not been apparent yet. "In other words, the consequences of climate change, as suggested in this study, are waiting to be seen," Yang said.

More information: Wenyu Zhou et al, Enhanced equatorial warming causes deep-tropical contraction and subtropical monsoon shift, *Nature Climate Change* (2019). DOI: 10.1038/s41558-019-0603-9

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