

Reduced US air pollution will boost rainfall in Africa's Sahel, says study

May 22 2017



Land at the northern edge of Africa's Sahel could become more suitable for farming if sulfur emissions in the United States continue to rapidly decline, says a new study. Here, farmers near Segou, Mali, plant maize at the start of the rainy season. Credit: Francesco Fiondella/International Research Institute for Climate and Society, Columbia University

Falling sulfur dioxide emissions in the United States are expected to substantially increase rainfall in Africa's semi-arid Sahel, while bringing slightly more rain to much of the U.S., according to a new study in the *Journal of Geophysical Research: Atmospheres*.

Pollution filters placed on [coal-fired power plants](#) in the United States starting in the 1970s have dramatically cut emissions of sulfur dioxide, a toxic gas that contributes to acid [rain](#) and premature deaths from respiratory and cardiovascular diseases. If U.S. [sulfur dioxide emissions](#) are cut to zero by 2100, as some researchers have projected, rainfall over the Sahel could increase up to 10 percent from 2000 levels, computer simulations published in the study suggest.

"Reducing emissions in one region can influence rainfall far away because our global atmosphere is interconnected," said the study's lead author, Dan Westervelt, an [atmospheric scientist](#) at Columbia University's Lamont-Doherty Earth Observatory. "We show that the health and environmental benefits of U.S. clean air policies extend to global climate as well."

Sulfur dioxide simultaneously cools and dries earth's climate by reflecting sunlight back to space and suppressing heat-driven evaporation near the ground. Though prior research has linked high sulfur emissions in Europe and Asia to the Sahel's severe droughts of the 1970s and 1980s, this study is the first to look at how U.S. emissions influence precipitation in various regions globally.

The researchers ran three independent global climate models to compare the relative impact of the United States cutting its human-caused sulfur emissions to zero and keeping its emissions at 2000-2005 levels. In the zero-emissions scenario, all three models showed a slight increase in average global rainfall, with higher levels in the United States and other northern-hemisphere regions. In the Sahel, two models found that wet-

season rainfall increased by 5 to 10 percent, with one producing a rainy season two-and-a-half days longer.

"We were surprised to find that removing sulfur emissions in just one country would significantly influence rainfall on another continent, thousands of miles away," said study coauthor Arlene Fiore, an atmospheric scientist at Lamont-Doherty.

The added rainfall came as the tropical [rain belt](#) returned to its normal, northernmost position above the equator during northern hemisphere summer, the models showed, consistent with earlier research. The rain belt ordinarily shifts north when the northern hemisphere heats up during summer, but when sulfur emissions are high, cooler temperatures in the north stop the rain belt from migrating as far.

Cutting U.S. emissions to zero was enough to move the rain belt roughly 35 kilometers north, placing more of the Sahel in its path, the researchers found. "We did not expect to see such a clear, significant influence on the Sahel," said Westervelt. "This northern shift of the tropical rain belt could mean that cropland at the Sahel's northern edge could become more productive in the future."

Though two of the three models were generally consistent, they disagree on exactly how much rain different regions can expect as U.S. sulfur emissions go to zero, says study coauthor Drew Shindell, an atmospheric scientist at Duke University. "We have just one real-world example—historic data—to rely on, making it very challenging to quantitatively link emissions to response," he said.

The influence of rising carbon emissions is another complicating factor. The technology to trap carbon dioxide, unlike [sulfur](#) dioxide, is still far from being cost-effective. So while carbon dioxide levels continue to climb, falling [sulfur emissions](#) impose a climate "penalty"—less human-

caused cooling to offset human-caused warming from [carbon dioxide](#).

"It's still a good idea to cut SO₂ with pollution control equipment on coal-fired power plants for the sake of public health, but even better would be to move away from coal-fired power plants entirely to reap the benefits of public health and climate change mitigation," said Shindell.

More information: D. M. Westervelt et al. Multimodel precipitation responses to removal of U.S. sulfur dioxide emissions, *Journal of Geophysical Research: Atmospheres* (2017). [DOI: 10.1002/2017JD026756](#)

Provided by Columbia University

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