

The Sky Is Not Falling: Pollution in eastern China cuts light, useful rainfall

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New research shows that air pollution in eastern China has reduced the amount of light rainfall over the past 50 years and decreased by 23 percent the number of days of light rain in the eastern half of the country. The results suggest that bad air quality might be affecting the country's ability to raise crops as well as contributing to health and environmental problems.

The study links for the first time high levels of pollutants in the air with conditions that prevent the light kind of [rainfall](#) critical for agriculture. Led by atmospheric scientist Yun Qian at the Department of Energy's Pacific Northwest National Laboratory, the study appears August 15 in the *Journal of Geophysical Research-Atmospheres*.

"People have long wondered if there was a connection, but this is the first time we've observed it from long-term data," said Qian. "Besides the health effects, [acid rain](#) and other problems that pollution creates, this work suggests that reducing [air pollution](#) might help ease the [drought](#) in north [China](#)."

Drier Times

China's dramatic economic growth and pollution problems provide researchers an opportunity to study the connection between air quality and climate. Rain in eastern China -- where most of the country's people and pollution exist -- is not like it used to be.

Over the last 50 years, the southern part of eastern China has seen increased amounts of total rainfall per year. The northern half has seen less rain and more droughts. But light rainfall that sustains crops has decreased everywhere. A group of climate researchers from the U.S., China and Sweden wanted to know why light rain patterns haven't followed the same precipitation patterns as total rainfall.

Previous work has shown that pollution can interfere with light rain above oceans, so the team suspected pollution might have something to do with the changes over land. Light rain ranges from drizzles to 10 millimeters of accumulation per day and sustains agriculture. (Compared to heavy rain that causes floods, loss of light rain has serious consequences for crops.)

While the light rains have diminished, pollution has increased dramatically in China in the last half of the 20th century. For example, while China's population rose two and a half times in size, the emissions of sulfur from fossil fuel burning outpaced that considerably -- rising nine times.

Sky Gremlins

Air pollution contains tiny, unseen particles of gas, water and bits of matter called aerosols. Aerosols -- both natural and human-caused-- do contribute to rainfall patterns, but the researchers needed to determine if pollution was to blame for China's loss of rain and how.

To find out, the team charted trends in rainfall from 1956 to 2005 in eastern China, which has 162 weather stations with complete data collected over the entire 50 years.

From this data, the team determined that both the north and south regions of eastern China had fewer days of light rain -- those getting 10

millimeters per day or less -- at the end of the 50 year timespan. The south lost more days -- 8.1 days per decade -- than the north did, at 6.9 days per decade. However, the drought-rattled north lost a greater percentage of its rainy days, about 25 percent compared to the south's 21 percent.

"No matter how we define light rain, we can see a very significant decrease of light rain over almost every station," said Qian.

Up Up & In the Way

To probe what caused the loss of rainfall, the team looked at how much water the atmosphere contained and where the water vapor traveled. Most parts of eastern China saw no significant change in the amount of water held by the atmosphere, even though light rains decreased. In addition, where the atmosphere transported water vapor didn't coincide with light rain frequency.

These results suggested that changes in large-scale movement of water could not account for the loss of the precipitation. Some of pollution's aerosols can seed clouds or form raindrops, depending on their size, composition and the conditions in which they find themselves. Because these skills likely contribute to rainfall patterns, the researchers explored the aerosols in more depth.

Cloud droplets form around aerosols, so the team determined the concentration of cloud droplets over China. They found higher concentrations of droplets when more aerosols were present. But more droplets mean that each cloud droplet is smaller, in the same way that filling 10 ice cream cones from a quart of ice cream results in smaller scoops than if the same amount were put in only five cones.

This result suggested that aerosols create smaller water droplets, which in

turn have a harder time forming rainclouds. The team verified this with computer models of pristine, moderately polluted or heavily polluted skies. In the most heavily polluted simulation, rain fell at significantly lower frequencies than in the pristine conditions.

An examination of the cloud and rain drops showed that these water drops in polluted cases are up to 50 percent smaller than in clean skies. The smaller size impedes the formation of rain clouds and the falling of rain.

Qian said the next step in their research is to examine new data from the DOE's Atmospheric Radiation Measurement Climate Research Facility in the central eastern Chinese city of Shouxian. The data was collected from April to December of 2008.

"This work is important because modeling studies of individual cases of pollution's effect on convective clouds have shown varying results, depending on the environmental conditions," said coauthor Ruby Leung. "The ARM data collected at Shouxian should provide more detailed measurements of both aerosols and clouds to enable us to quantify the impacts of aerosols on precipitation under different atmospheric and pollution conditions."

More information: Yun Qian, Daoyi Gong, Jiwen Fan, L. Ruby Leung, Ralf Bennartz, Deliang Chen, and Weiguo Wang, Heavy pollution suppresses light [rain](#) in China: observations and modeling, *J. Geophys. Res.*, VOL. 114, D00K02, [doi:10.1029/2008JD011575](https://doi.org/10.1029/2008JD011575)

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