Volcanic ash may have a bigger impact on the climate than we thought

September 11 2020

A plume of ash and dust rises from Pavlof Volcano on the Alaskan Peninsula in 2013. Credit: NASA

When volcanos erupt, these geologic monsters produce tremendous clouds of ash and dust—plumes that can blacken the sky, shut down air traffic and reach heights of roughly 25 miles above Earth's surface.

A new study led by the University of Colorado Boulder suggests that such volcanic ash may also have a larger influence on the planet's climate than scientists previously suspected.

The new research, published in the journal *Nature Communications*,

examines the eruption of Mount Kelut (or Kelud) on the Indonesian island of Java in 2014. Drawing on real-world observations of this event and advanced computer simulations, the team discovered that volcanic ash seems to be prone to loitering—remaining in the air for months or even longer after a major eruption.

"What we found for this eruption is that the volcanic ash can persist for a long time," said Yunqian Zhu, lead author of the new study and a research scientist at the Laboratory for Atmospheric and Space Physics (LASP) at CU Boulder.

Lingering ash

The discovery began with a chance observation: Members of the research team had been flying an unmanned aircraft near the site of the Mount Kelut eruption—an event that covered large portions of Java in ash and drove people from their homes. In the process, the aircraft spotted something that shouldn't have been there.

"They saw some large particles floating around in the atmosphere a month after the eruption," Zhu said. "It looked like ash."

Ash covers rooftops in Yogyakarta, Indonesia, in the wake of the 2014 eruption of Mount Kelut Credit: CC photo via Wikimedia Commons

She explained that scientists have long known that volcanic eruptions can take a toll on the planet's climate. These events blast huge amounts of sulfur-rich particles high into Earth's atmosphere where they can block sunlight from reaching the ground.

Researchers haven't thought, however, that ash could play much of a role in that cooling effect. These chunks of rocky debris, scientists reasoned, are so heavy that most of them likely fall out of volcanic clouds not long after an eruption.

Zhu's team wanted to find out why that wasn't the case with Kelut.

Drawing on aircraft and satellite observations of the unfolding disaster, the group discovered that the volcano's plume seemed to be rife with small and lightweight particles of ash—tiny particles that were likely capable of floating in the air for long periods of time, much like dandelion fluff.

"Researchers have assumed that ash is similar to volcanic glass," Zhu said. "But what we've found is that these floating ones have a density that's more like pumice."

Disappearing molecules

Study coauthor Brian Toon added that these pumice-like particles also seem to shift the chemistry of the entire volcanic plume.

Toon, a professor in LASP and the Department of Atmospheric and Oceanic Sciences at CU Boulder, explained that erupting volcanos spew out a large amount of sulfur dioxide. Many researchers previously assumed that those molecules interact with others in the air and convert into sulfuric acid—a series of chemical reactions that, theoretically, could take weeks to complete. Observations of real-life eruptions, however, suggest that it happens a lot faster than that.

NASA's unmanned Global Hawk aircraft, which observed ash lingering in the air after the eruption. Credit: NASA/Dryden/Carla Thomas

"There has been a puzzle of why these reactions occur so fast," Toon said.

He and his colleagues think they've discovered the answer: Those molecules of sulfur dioxide seem to stick to the particles of ash floating in the air. In the process, they may undergo chemical reactions on the surface of the ash itself—potentially pulling around 43% more sulfur dioxide out of the air.

Ash, in other words, may hasten the transformation of volcanic gasses in the atmosphere.

Just what the impact of those clouds of ash are on the climate isn't clear. Long-lasting particles in the atmosphere could, theoretically, darken and even help to cool the planet after an eruption. Floating ash might also blow all the way from sites like Kelut to the planet's poles. There, it could kickstart chemical reactions that would damage Earth's all-important ozone layer.

But the researchers say that one thing is clear: When a volcano blows, it may be time to pay a lot more attention to all that ash and its true impact on Earth's climate.

"I think we've discovered something important here," Toon said. "It's subtle, but it could make a big difference."

More information: Yunqian Zhu et al. Persisting volcanic ash particles impact stratospheric SO2 lifetime and aerosol optical properties, *Nature Communications* (2020). DOI: 10.1038/s41467-020-18352-5

Provided by University of Colorado at Boulder