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CORRECTION TO THIS ARTICLE

An earlier version of this report gave the incorrect location of Mount Pelée. It is on the island of Martinique. This version has been corrected.

Scientists find it difficult to predict volcano behavior

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The year of the earthquake has suddenly become the year of the volcano.

The eruption in Iceland is not large as volcanoes go, but the cloud over Europe has shed light on the awkward overlay of human commerce and a hot, churning, unpredictable Earth. It raises the question of what governments can do to prepare for -- and adapt to -- wild-card geological events that not only affect airliners but can also alter the planet's climate for years at a stretch.

The volcano with the difficult name of Eyjafjallajokull is not powerful enough to change the climate -- it has ejected material only as high as about 20,000 feet and would need to launch the ash to at least 33,000 feet to have global climatic effects, according to the [National Oceanic and Atmospheric Administration](#) (NOAA).

Now airports are beginning to open again in Britain and the Netherlands, but no one can be entirely sure what will happen next in Iceland. Eyjafjallajokull could incite an eruption of its larger neighbor, Katla, which hasn't erupted since 1918 and might be ready to rumble. In all three historically recorded eruptions of Eyjafjallajokull -- in 920, 1612 and 1821 -- Katla erupted soon thereafter.

"The eruption that's going on right now is small in comparison to what we expect Katla would be like," said Jay Miller, a volcanologist at Texas A&M University.

Events in recent days have demonstrated the inherent uncertainties of volcano science. Although volcanoes are far more predictable than earthquakes, they remain quirky, with each one having its own personality. Scientists rely primarily on past performance to predict future activity for any given location. The Iceland volcano initially produced little ash, but a new vent opened beneath a glacier and the situation turned explosive. What precisely happened is still being researched, but it appears that meltwater and magma produced steam quite suddenly and the volcano popped its top like a shaken soda bottle.

No one knows how much material will be ejected, or how high into the atmosphere it will travel. Scientists using computer models are frantically trying to track plumes of ash that become widely and chaotically dispersed even as new ones shoot up. No one knows whether the ash will reach the airspace over the United States and affect domestic travel, though that doesn't seem to be an imminent threat. The ash has reached eastern Canada, however.

"I think there might be some nicer sunsets by the end of this week over North America," said Stan Benjamin, director of the Forecast Research Branch of NOAA's Global Systems Division.

One [National Weather Service](#) scientist, Gary Hufford, told reporters in a conference call Tuesday that it can be difficult to tell with satellite imagery how much ash is in the air and whether the airspace is safe for jetliners.

"The volcanic ash science still has many limitations," he said.

Asked whether he would be comfortable flying in Europe, Hufford paused and said, "I would be cautious."

The lengthy shutdown of many European airports continues to surprise travelers and scientists.

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"It is kind of amazing. I imagined this in a big eruption. I didn't imagine it in a small eruption," said John Eichelberger, head of the [U.S. Geological Survey's](#) Volcano Hazards Program, who is stranded in Paris, where he had attended a meeting on volcanoes.

On Tuesday, the [British Civil Aviation Authority](#) revised its position to say that commercial jets could fly through areas that have low levels of ash. One top travel [lobbyist](#) said he suspected that officials had overreacted.

"Are we all certain that we're using the best scientific evidence? Are we aware of the economic impact of these decisions?" said Geoff Freeman, senior vice president of the [U.S. Travel Association](#).

Air travel is particularly vulnerable to these geological events because the shortest international routes in the Northern Hemisphere take planes near Iceland, which seethes with volcanoes, and near the many cauldrons that line the Pacific "Ring of Fire." The booming economies of Asia are also putting more planes over volcanoes in Indonesia, Papua New Guinea and the Philippines.

"Volcanic risk is actually rising, not because we're not doing our jobs, but because people are putting themselves nearer volcanoes, particularly with air travel," said Marianne Guffanti, a geologist with the USGS.

Said volcanologist Michael Rampino of New York University: "We live under the constant threat of some geological hazard. The more we all become technologically dependent upon others in other parts of the world, the more the problem shows up."

Chris Waythomas, a USGS volcanologist based in Alaska, said it is easy to detect when a volcano is active but much harder to know what it will ultimately do, how long an eruption will continue and how big it will be.

"There are surprises. Mount St. Helens, 1980: No one expected a major flank collapse to occur," Waythomas said. That collapse depressurized the magma chamber below and caused the mountain to explode laterally.

The United States has 169 volcanoes, most of them in Alaska, the Aleutian Islands and in territories in the Pacific Ocean (scientists will brief the [Congressional Hazards Caucus](#) on Wednesday). Geologists warn that scenic Mount Rainier, near Seattle, is one of the most hazardous.

One of the planet's largest volcanoes is the huge caldera that feeds the hot springs and geysers of Yellowstone. Although it has been restless in recent months with hundreds of small earthquakes, there is no sign of the kind of dramatic doming of the ground that would indicate a major surge of magma and a potential eruption. The caldera last had a full-blown, catastrophic explosion about 640,000 years ago. The last significant eruption, known as the Pitchstone Plateau lava flow, took place 70,000 years ago. Jacob Lowenstern, the scientist in charge at the USGS [Yellowstone Volcano Observatory](#), said tourists shouldn't stay away for fear of what's happening below.

Volcanoes can be mass killers. The relatively small eruption of the Nevado del Ruiz in Colombia in 1985 created a mud flow that buried more than 23,000 people in the town of Armero. Hot gas and ash from Mount Pelée on the island of Martinique rolled down the slopes and incinerated 30,000 people in 1902.

Vesuvius, the volcano that buried the Roman city of Pompeii, is widely viewed as another disaster waiting to happen. It erupts about

every 400 years and hasn't had a large eruption since 1641, Rampino said. Hundreds of thousands of people live beneath it and could be hit with what are known as pyroclastic flows -- extremely fast-moving, dense clouds of hot ash and rock that flow down the mountain.

"They'd have 15 minutes' warning," Rampino said. "It would destroy everything in its path. It's like an ash hurricane that's 800 degrees Celsius."