

## **Rotating volcanic plumes**

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In contrast to the classical models of strong volcanic plumes, where the plume is assumed to be non-rotating, we provide direct evidence that the entire plume rotates about its axis. By drawing analogy with the meteorological phenomenon of a tornadic thunderstorm, we argue that the plume rotates due to the interaction between the updraft in the plume and the shear in the atmosphere, resulting in the formation of a cyclonically rotating columnar vortex—a "volcanic mesocyclone." The volcanic mesocyclone provides a unified explanation to a disparate set of poorly understood phenomena in volcanic plumes, including the development of lobate umbrellas, the spawning of tornadoes, and the formation of lightning sheaths. We conclude by illustrating how the volcanic mesocyclone entails a fundamentally different plume dynamics than that inferred from the classical models.