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Stratospheric residence time and the lifetime of volcanic aerosol

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The cumulative radiative impact of major volcanic eruptions depends strongly on the length of time volcanic sulfate aerosol remains in the stratosphere. Observations of aerosol from recent eruptions have been used to suggest that residence time depends on the latitude of the volcanic eruption, with tropical eruptions producing aerosol loading that persists longer than that from extratropical eruptions. However, the limited number of eruptions observed make it difficult to disentangle the roles of latitude and injection height in controlling aerosol lifetime. Here we use satellite observations and model experiments to explore the relationship between eruption latitude, injection height and resulting residence time of stratospheric aerosol. We find that contrary to earlier interpretations of observations, the residence time of aerosol from major tropical eruptions like Pinatubo (1991) is on the order of 24 months. Model results suggest that the residence time is greatly sensitive to the height of the sulfur injection, especially within the lowest few kilometers of the stratosphere. As injection heights and latitudes are unknown for the majority of eruptions over the common era, we estimate the impact of this uncertainty on volcanic aerosol forcing reconstructions.