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Ash clouds stripes: mechanisms and implications for dispersion and detection.

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Occasionally, volcanic clouds show horizontal structures (or stripes) oriented perpendicular to the prevailing wind direction. This phenomenon has been observed by satellite images and reported at several volcanoes worldwide (e.g., Klyuchevskaya in Kamchatka and Eyjafjallajokull in Iceland) and it was particularly evident at Mt. Etna during different eruptions in 2001 and 2006 where stripes 2 km to 5 km wide were documented and interpreted to be waves. A variety of possible forcing mechanisms exist, including mountain waves and Kelvin-Helmholtz instabilities, and create atmospheric waves either by heating or dynamic effects.

The aim of this study is two-fold: first to analyze different driving mechanisms, and second to study how the waves affect dispersion and the detection of ash clouds. To this end, we use an Eulerian fully-compressible non-hydrostatic atmospheric model (WRF) at high resolution (200m x 200m) and initialized with an atmospheric sounding profile. The simulated wind field is then coupled (one way) with a Lagrangian particle model (LPAC) to simulate the transport of both passive tracers as well as particles with mass. Results are compared with MODIS satellite images.

The Etna test cases show how high resolution weather data are critical to reproducing stripes structures in the plume. In ash cloud models, vertical diffusion is typically ignored and plumes are assumed to disperse only due to horizontal diffusion. Our results provide evidence that wave-like phenomena exert a significant control on aerosol and ash dispersal, by influencing vertical diffusion and particle settling velocity and consequently ash residence time in the atmosphere.