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Settling dynamics of natural ash particles: insight from laboratory high speed imaging

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Existing experimental and numerical models of ash sedimentation from volcanic plumes consider aerodynamic properties of particles as a function of their shape, density and size. However, rather than individually, particles are often observed to settle through zones of high particle concentration associated with gravitational instabilities (e.g., particle-rich fingers) where sedimentation is controlled by the properties of the bulk down-flow of settling particles. In order to investigate the differences in the aerodynamic behaviour of ash particles when settling individually or in mass, we performed systematic large-scale ash settling experiments.
Natural basaltic ash from Etna (Italy, sampled in July 2014) and trachytic, pumiceous ash from Laacher See (Germany, 12.900 y BP) was used as starting material. For Etna, we used particles in the classes 0-125 and 125-500 μm, for Laacher See, we used 40-90 and 500-1000 μm. For each class, we released 40-500 g of sample from heights of 2 to 5 m with different, controlled volumetric flow rates, in an unconstrained open space and at minimal air movement. All experiments were recorded with a high-speed camera at 2000 fps. A vertical laser sheet crossing the flow enhanced visibility of particles. After release, particles were observed to cluster, leading to locally enhanced fall velocities.
High-speed imaging, manual and automatic tracking analyses are being used to provide full characterization of particle settling dynamics as a function of particle concentration in the flow, density and particle size. SEM analysis will provide particle shape characterization. The main results are i) measured settling velocities of individual particles increase with increasing particle concentration; ii) particle sorting during sedimentation is observed. This suggests that particle dispersion during fallout may be one reason explaining larger than theoretical depletion rates of fine particles from volcanic ash clouds.