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## A model for ash aggregation in volcanic plumes

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We present a model to describe ash aggregates in a volcanic plume based on a solution of the classical Smoluchowski (1917) equation. The collision frequency function accounts for three different mechanisms: Brownian motion, ambient fluid shear and differential sedimentation. Since dry aggregation plays a minor role in presence of water, we consider sticking efficiency in wet conditions only, but the different binding effect of liquid water and ice is discerned. The model accounts for the fractal geometry of the aggregates as confirmed by laboratory experiments and observations. The proposed approach represents a first compromise between the full description of the aggregation process and the need to decrease the computational time necessary for solving the full Smoluchowski equation. We show results of a parametric study on the main model parameters and we estimate coagulation kernels and timescales of the aggregation process under simplified conditions of interest in volcanology. Moreover, the aggregation model is implemented in the FALL3D volcanic ash transport model and applied to the 18 May 1980 Mount St. Helens and the 17-18 September 1992 Crater Peak eruptions. The model provides a higher degree of agreement than previous fully-empirical aggregation models and successfully reproduces the depositional characteristics of the deposits investigated over a large range of scales, including the position and thickness of the secondary maxima. Further studies are carried out to investigate dry aggregation due to electrostatic forces.