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Volcanic ash aggregation: new strategies for a theoretical description

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Particle aggregation is considered as a key process that may affect dispersal and sedimentation of volcanic ash, with significant implications for the associated hazards. For instance it is well known that aggregation has a major role in particle sedimentation affecting the residence time of volcanic ash in the atmosphere. So far the theoretical description of volcanic ash aggregation is commonly related to the solution of the Smoluchowski Coagulation Equations (SCE), a set of Ordinary Differential Equations (ODEs) which basically describe the change in time of an initial grain-size distribution due to the interaction of "single" particles. The complete solution of SCE is conditioned by our general knowledge of the physics of interaction between classes of particles (kernels) and our capability to solve a set of equations which is theoretically infinite. One of the possible approaches to the solution of SCE is to reduce the continuous particle distribution to a finite number of classes. This perspective is particularly close to our initial field data in volcanology, the so called Total Grain Size Distribution (TGSD). Nevertheless the common one-dimensional approach seems to not be appropriate for the complexity of volcanic ash aggregates. We propose a new approach to aggregation problems based on non-addictive properties for the Population Balance Equations. In particular, we focused on the problem of different features between single particles and aggregates. This algorithm has been applied to observed volcanic eruptions (i.e. Eyjafjallajokull 2010, Sakurajima 2013 and Mt. Saint Helens 1980) to investigate the sensitiveness of our model with respect to the input parameters (total grain-size distribution, collision kernels, sticking efficiencies). Constrains on these parameters come from field observations and laboratory experiments.