Statistical Analysis of the Distribution of Ballistic Deposits using the BALLISTA Model

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We present a statistical analysis of an inversion model using BALLISTA. BALLISTA is a program for simulating ballistic trajectories and ground deposition with many particles in 3D. It is a forward model, which means that it simulates the particles being ejected from the vent and falling on the ground. However, in many cases, we need to estimate the ejection conditions based on the information of particles on the ground. Therefore, it is necessary to create an inversion model.

We need to compare the distributions of the observed particles and the simulated particles, and then quantitively assess the difference between them. The Hausdorff distance is applied for this evaluation. The Hausdorff distance is often used in image analysis and is a mathematical construct to measure the "closeness" of two sets of points that are subsets of a metric space. The distributions of observed and simulated particles were represented by the convex hull which is drawn by Grass GIS without subjective discrimination, and their Hausdorff distance is calculated. Each simulation results in different distributions because the BALLISTA model is stochastic. Therefore, we investigated the value change of the Hausdorff distances by varying the drag coefficient, ejection velocity and investigate the variation caused by the stochastic nature of rerunning the same simulation. This analysis is applied to the ground distribution of ballistic projectiles from the Tongariro 2012 eruption which is documented by Fitzgerald et al. (2014). We discuss the ejection conditions obtained for the Tongariro case, and how many simulations are necessary for reaching the convergence of the Hausdorff distance.

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