Fine ash aggregation in the atmosphere: How sensitive is it to atmospheric and volcanic conditions?

Larry G. Mastin[1], Alexa Van Eaton[1], Adam Durant[2,3,] Roger Denlinger[1]

[1]U.S. Geological Survey, Cascades Volcano Observatory

[2]Section for Meteorology and Oceanography, Department of Geosciences, University of Oslo, Blindern, 0316 Oslo, Norway

[3]Geological and Mining Engineering and Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931, USA

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Volcanic ash transport models are used to forecast tephra deposition during volcanic eruptions. Ash aggregation, if not accounted for, can affect model accuracy by altering fall velocity and thus patterns of deposition. In many models aggregation is accounted for by ad hoc changes to the grain-size distribution used as model input; for example, by representing the fine ash, smaller than ~0.063-0.125 mm, not as individual particles, but as aggregates with a specified density and log-normal size distribution. We hypothesize that the aggregate size distribution that can optimally match the mapped deposit may vary between eruptions. To test the variance, we used the Ash3d tephra model to simulate four deposits: 18 May 1980 Mount St. Helens; 16-17 September 1992 Crater Peak (Mount Spurr); 17 June 1996 Ruapehu; and 23 March 2009 Mount Redoubt. Eruptions ranged in size from VEI 3 to 5. In 192 simulations, we systematically varied size distribution, holding density constant at 600 kg m-3. For all deposits, under these inputs, the best-fit median aggregate size ranged narrowly between 0.15-0.20mm, despite large variations in erupted mass (0.25-50Tg), plume height (8.5-25 km), mass fraction of fine (<0.063mm) ash (3-59%), atmospheric temperature, and external water interaction between these eruptions. Results are similar to the widely used but less systematically derived values of Cornell et al. (1983, JVGR, 17:89-109). This close agreement suggests that aggregation rates, or the size and associated fall velocities of aggregated fine ash that is present in deposits, may be insensitive to eruptive style or magnitude. In this presentation we consider mechanisms that could explain this insensitivity and examine whether it could be more widespread.