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Mapping tephra dispersion with a mesoscale atmospheric model (MM5): Example from the Cerro Negro Volcano, Nicaragua

M. Byrne (1), **A. Laing** (2), C. Connor (3)

(1) Dept. of Geography, University of South Florida, Florida, USA, (2) National Center for Atmospheric Research, Colorado, USA, (3) Dept. of Geology, University of South Florida, USA

Models of tephra fallout are increasingly used to assess volcanic hazards in advance of eruptions and in near-real-time. These tephra models use simplistic assumptions of the atmosphere that do not account for normal variations of wind velocity in three-dimensional space and time. This study demonstrates how a well-known mesoscale atmospheric model is used to improve forecasts of the location of the major axis of dispersion for erupting plumes.

The MM5 (Pennsylvania State University-National Center for Atmospheric Research fifth-generation Mesoscale Model) specializes in atmospheric prediction for regions on the order of ten to hundreds of kilometers. MM5 generates high-resolution wind fields based on the laws of conservation of mass, energy, momentum, and moisture, with initial conditions specified by topography, land use, global-scale atmospheric analyses, and observations. It is particularly effective at resolving circulation patterns in areas with sparse meteorological observations and/or mountainous terrain.

MM5 is used to simulate the atmospheric conditions during the 1995 eruption of Cerro Negro, Nicaragua. Estimates of particle settling velocities are used in conjunction with MM5-derived wind fields to forecast the plume track and tephra fallout. The complex wind fields generated by MM5 help explain non-linear plume dispersion axes that are observed. The results indicate that the appropriate application of mesoscale atmospheric models should ultimately improve tephra fallout hazard assessments and enhance our ability to respond effectively to volcanic hazards.