Numerical simulations of atmospheric tephra dispersal at mesoscale - implications for assessment of total erupted mass from the December 2006 and 2009 explosive events at Bezymianny Volcano, Kamchatka

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In explosive eruptions, the total amount of fragmental material and its grain size characteristics are the key parameters commonly used to quantify numerous environmental effects produced by volcanic ejecta. The calculation of total erupted mass (or 'magnitude') of the explosive eruptions is commonly a difficult task, as substantial amount of pyroclastic material comes into the atmosphere in the form of highly fragmented airborne products, known as volcanic ash, subjected to atmospheric dispersal by a spectrum of atmospheric motions that are commonly poorly constrained at mesoscale in a high-mountain area of a volcano location. In this study, we use a lagrangian stochastic Hybrid Particle and Concentration Trasport (HYPACT) model, and Regional Atmospheric Modeling System (RAMS6.0), a state of the art numerical hydrodynamic model, to simulate atmospheric motions and tephra dispersal and fallout at mesoscale for the December 24, 2006, and December 16, 2009, eruptions of Bezymianny Volcano (Kamchyatka). A series of high-resolution numerical experiments was conducted to quantify effects of source geometry, regular advection by wind, turbulent mixing, and particle settling on the spatial distribution of the associated ash-fall deposits. It is shown, that the topography-induced mesoscale perturbations of the synoptic scale background airflow produce first-order effect on tephra-fall patterns in a wide range of particle sizes affecting both coarse and aggregated fine-ash fractions. The model-calculated tephra-fall deposits are compared against field data to assess total erupted mass from, and fine ash content of, these eruptions through linear regression approach. We conclude, that the developed numerical technique, although being not free of some subjective elements, can provide important information on eruption source parameters in addition to commonly used methods of classical sedimentological analyses, as it produces a necessary constrains on atmospheric transport conditions in the both proximal and distal areas around the volcano.