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A coupled model for eruption column and volcanic ash dispersion and deposition

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Volcanic ash fallout poses a serious threat to people living near active volcanoes and may cause undesirable effects such as collapse of roofs by ash loading, respiratory sickness, air traffic problems or damage to agriculture. Reliable computational models able to describe the temporal evolution of fallout are an important tool to forecast and mitigate. We propose an Eulerian transport model, called FALL3D, for the dispersion of volcanic ashes from the umbrella region. The atmospheric transport model is based on the solution of the advection-diffusion-settling equation coupled with (i) a Limited Area Model (LAM) for the wind field and, (ii) a model for the eruptive column based on the buoyant plume theory. The turbulent diffusivity tensor is parameterised on the basis of the K-theory. The wind and temperature fields given by the LAM are assimilated to the finer scales using the meteorological processor CALMET. The resulting equations are solved using a fully explicit third-order upwind scheme in a terrain-following coordinate system. The model can be used for forecasting ash concentration from volcanic plumes in the atmosphere and ash loading on the ground. Inputs to the model are the topography, the meteorological field data as given by the LAM, the mass eruption rate and the settling velocity distribution. A test application to the Etna 2001 volcanic eruption is presented.