Geophysical Research Abstracts
Vol. 18, EGU2016-3847, 2016
EGU General Assembly 2016

FPLUME-1.0: An integral volcanic plume model accounting for ash aggregation

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Eruption Source Parameters (ESP) characterizing volcanic eruption plumes are crucial inputs for atmospheric tephra dispersal models, used for hazard assessment and risk mitigation. We present FPLUME-1.0, a steady-state 1D cross-section averaged eruption column model based on the Buoyant Plume Theory (BPT). The model accounts for plume bending by wind, entrainment of ambient moisture, effects of water phase changes, particle fallout and re-entrainment, a new parameterization for the air entrainment coefficients and a model for wet aggregation of ash particles in presence of liquid water or ice. In the occurrence of wet aggregation, the model predicts an "effective" grain size distribution depleted in fines with respect to that erupted at the vent. Given a wind profile, the model can be used to determine the column height from the eruption mass flow rate or vice-versa. The ultimate goal is to improve ash cloud dispersal forecasts by better constraining the ESP (column height, eruption rate and vertical distribution of mass) and the "effective" particle grain size distribution resulting from eventual wet aggregation within the plume. As test cases we apply the model to the eruptive phase-B of the 4 April 1982 El Chichón volcano eruption (México) and the 6 May 2010 Eyjafjallajökull eruption phase (Iceland). The modular structure of the code facilitates the implementation in the future code versions of more quantitative ash aggregation parameterization as further observations and experiments data will be available for better constraining ash aggregation processes.