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FPluMe: An integral eruption column model based on the Buoyant Plume Theory

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Estimates of mass flow rate from volcanic eruption columns are crucial for ash dispersion models, used to assess hazard on population and civil aviation. We present a practical model of eruption column model based on the Buoyant Plume Theory (BPT) that accounts for the effect of the atmospheric wind that results in the bending over of the plume trajectory and increases the entrainment of ambient air. The model solves the equations for the conservation of mass, momentum and energy in terms of averaged variables, accounting for fallout and re-entrainment of tephra from and into the column and particle aggregation.
For some given atmospheric conditions and a wind profile, the model can be used to determine the height at which volcanic plumes spread in the atmosphere if mass flow rate at the vent is known, or to estimate mass flow rate when the eruption column height is known. For a given column height, if wind effects are not properly accounted for, the values of the mass flow rate can be significantly underestimated. Our model calculations are compared with proposed semi-empirical relationships between the plume height and the source mass flux that account for the atmospheric wind effect.