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# The neutral Buoyancy heights of Plinian and co-ignimbrite eruptions

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Atmospheric residence time, interaction with radiation and chemical processes as well as the sedimentation of volcanic ash and sulphate particles depend on the injection height and it is important to calculate this parameter as exactly as possible. Explosive volcanic eruptions form buoyant plumes after sufficient entrainment has taken place. If explosive energy is high, overshooting may take place and the maximum height of a plume therefore may be much higher than the Neutral Buoyancy Height that determines the lateral spread and settling of volcanic material. If a (buoyant) Plinian eruption plume cannot be formed due to too high density of the particle-gas mixture for a given initial vertical momentum, the eruption column will collapse. A secondary, so called co-ignimbrite plume can be formed from the developing pyroclastic flow at horizontal scales much larger than the initial eruption. In previous work one-dimensional, often stationary plume models based top hat profiles were used to study the behaviour of such Plinian and co-ignimbrite eruptions. Such simulations result in unrealistically deep penetrating columns and the formation of umbrella clouds from which ash is falling out is parameterised using arbitrary assumptions. Here we will present results from the three-dimensional plume model ATHAM of the development of eruption columns under different realistic initial and environmental conditions and compare with results of simpler models. Clearly, Neutral Buoyancy Heights are strongly overestimated when common stationary top hat models are applied. These deliver reasonable results only in case of small eruption energy. They are lacking effects of variable entrainment, wind shear etc., which would lead to higher variability than suggested.
Depending on the size of the hot ash-air mixture from which the co-ignimbrite develops, single or multiple plumes develop and the maximum height of neutral buoyancy is reduced considerably in the latter case. Entrainment and wind shear have strong influence on the plume development.