The collapse condition of a volcanic eruption column suggested by a simple integral model

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An integral model of a turbulent plume is modified to include the effect of the significant volume expansion for improving the understanding the fundamental behavior of a volcanic eruption column. The model predicts that the upward velocity of a plume is constant along the height if the buoyancy flux linearly increases with height in a uniform environment. The dimensional analysis based on the proposed model suggests that a buoyancy-generating plume starting with a negative buoyancy flux, Bo, can be sustainable only when the momentum flux from a origin is greater than a value that is proportional to Bo squared and inversely proportional to V' to the 4/3 power. Here, V' is the increasing rate of a volume flux per unit height. Otherwise, the momentum flux is exhausted at a height and a flow going back to the supplied source is developed. This condition may play a key role in collapsing an eruption column to generate a large-scale pyroclastic flow.