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Modelling unsteady volcanic eruption columns and vulcanian eruption columns

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The well-known steady model that describes the structure and composition of a volcanic eruption column, due to Woods[1], has been coupled with the unsteady plume model of Scase et al.[2] to produce a simple model capable of predicting the temporal evolution of unsteady volcanic eruption columns[3]. The model is presented and is verified by comparison with data taken from observations from one of the 7th February 2009 eruptions of Santiaguito (Caliente Vent).

A steady model cannot be used to model a volcanic eruption whose conditions at the vent have changed during the course of the eruption. That is to say that if the conditions that produced the upper section of a volcanic eruption column no longer persist, no steady model will be able to represent the eruption column – a full unsteady model is required. There are numerous reasons why conditions at a volcanic vent may change during an eruption, examples include; depletion of gas supply, caldera formation due to a magma chamber collapse, compositional changes during the eruption, change in height of the fragmentation level, erosion of the conduit on eruption time scales *etc.*

One natural application for an unsteady eruption column model is to model vulcanian eruptions. Typically these short-lived and often periodic eruptions peak in discharge approximately 10–30 s after eruption, followed by a period of declining discharge. Flow rates typically fall to negligible values within a time scale of hundreds of seconds from peak discharge. The observed eruption of Santiaguito (Caliente Vent) on 7th Feb 2009 produced such a vulcanian plume.

Field measurements were taken from the Santiaguito Volcano Observatory 6.3 km SSW of the active Caliente dome. Simultaneous time series measurements of the gas and ash mass fluxes were taken using a filtered UV camera[4]. Using these measurements as boundary condition inputs for the unsteady eruption column model, along with standard values for atmospheric and volcanic gas properties, the front position was predicted. The predicted position of the front was compared with the observed position and the agreement was seen to be good.

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