

A *Matlab* implementation of the Carey and Sparks (1986) model to estimate plume height and wind speed from isopleth maps

Sebastien Biass, Gholamhossein Bagheri, Costanza Bonadonna

Department of Earth Sciences, University of Geneva, Switzerland

Correspondence: sebastien.biasse@unige.ch

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Introduction

This file presents a *Matlab* implementation of the Carey and Sparks (1986) model to estimate i) the plume height above sampling altitude and ii) the wind speed at the tropopause based on the compilation of isopleth maps. Figures 16 A-D of Carey and Sparks (1986) were fitted using polynomial methods and interpolated for continuous ranges of clast sizes and densities.

In addition, we assess the influence of the particle shape on the final results. This was achieved by matching the terminal velocity of a particle with given flatness and elongation obtained with the new drag correlations presented by Bagheri and Bonadonna (submitted) with the terminal velocity of particles calculated with equation (3) of Carey and Sparks (1986).

Usage

The script can be used in two ways. Firstly, by typing:

```
>> get_height_CS86
```

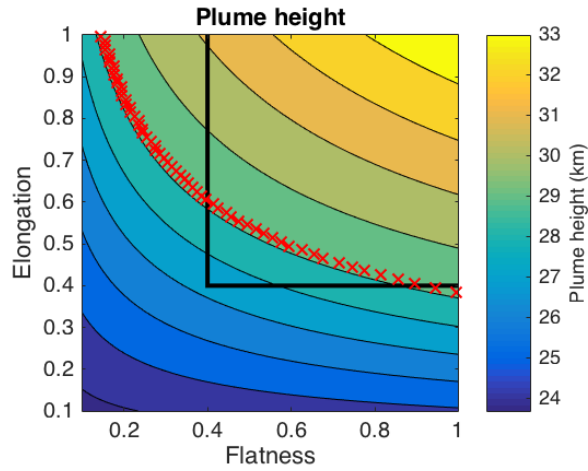


Figure 1: Plume height (km above mean sampling altitude) as a function of elongation and flatness.

a GUI will open, where the user can enter the 4 critical inputs, namely:

- Isopleth downwind range (km)
- Isopleth crosswind range (km)
- Clast diameter (cm)
- Clast density ($kg\ m^{-3}$).

By doing so, the resulting plume height (km above mean sampling altitude) and wind speed at the tropopause ($m\ s^{-1}$) are displayed on the screen and plotted following Figure 1. The second option is to use the script as a function, where both input and output parameters must be specified in the command line:

```
>> [ht, wd] = get_height_CS86(dw, cw, diam, dens)
```

Figure 1 shows the resulting plume height as a function of particles elongation and flatness. The black square represents the valid field for volcanic lapillis (Bagheri et al. 2015). The red crosses represent the combinations of flatness and elongation that results in a drag coefficient that is the closest to the constant drag coefficient of 1.054 used by Carey and Sparks (1986). Figure 1 illustrates how the method of Carey and Sparks (1986) consider highly irregular particle shapes (i.e. close to the non-spherical area of the lapilli domain).

Caveats

This script relies on polynomial fits of Figure 16 of Carey and Sparks (1986). Figures 16 A to D were then interpolated, making the script able to work on a continuous range of clast size and density. However, the user should be careful not to use this script outside of the interpolation zone. For instance, for a density of $2,500 \text{ kg m}^{-3}$, the valid clast size is comprised in the interval $[0.8 \text{ cm}; 6.4 \text{ cm}]$.

Citation

If this script was useful, please cite the *VHub* submission! This script was first developed in the context of the *TError* package (Biass et al. 2014), so check it out too (<http://scholarcommons.usf.edu/siv/vol1/iss1/2/>)!

References

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- Carey S, Sparks R (1986) Quantitative models of the fallout and dispersal of tephra from volcanic eruption columns. *Bull Volcanol* 48:109–125.

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