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Determine volcanic SO_2 plume heights from satellite observations on a global scale using meteorological wind fields

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Satellite observations nowadays provide the global monitoring of volcanic plumes via sulphur dioxide (SO_2) that is injected into the Earth's atmosphere. In turn, SO_2 may lead to the formation of sulphate aerosols that can influence climate via direct and indirect radiative effects. The quantitative retrieval of SO_2 requires an accurate plume height estimate in order to constrain total amounts for such events.

However, especially for volcanic eruptions the vertical SO_2 profile is typically unknown because of the initial conditions (e.g. individual explosions over an extended time period may lead to different gas layer altitudes). In recent years, satellite observations helped to improve global SO_2 estimates, but still large uncertainties exist. Passive satellite remote sensing instruments in the UV/vis spectral range for example offer the opportunity to observe the location of a plume in two dimensions, but information about the corresponding height is limited. To gain further information about these plume profiles is not only interesting for the quantitative interpretation of satellite observations, but also in itself (e.g. to assess the radiative effect of volcanic plumes).

Here, we present first results for a newly developed and systematic approach using the Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) in combination with data for selected volcanic SO_2 plumes originating from different volcanoes. The main plume informations retrieved by the satellite (i.e. plume location and observation time) are used as initial input parameters in order to estimate the plume's profile at the time of the measurements. The resulting trajectories can be used to constrain the eruption time and height. First comparisons show that retrieved results are in good agreement with direct local observations and reports. While the algorithm has been so far only applied to data from the second generation Global Ozone Monitoring Instrument (GOME-2), it may be generally applied to data from other satellite instruments like OMI or the upcoming TROPOMI Sentinel-5 precursor) instrument.