Geophysical Research Abstracts
Vol. 17, EGU2015-5401, 2015
EGU General Assembly 2015

Improved determination of volcanic SO_2 emission rates from SO_2 camera images

Angelika Klein, Peter Lübcke, Nicole Bobrowski, and Ulrich Platt
Institute of Environmental Physics, University of Heidelberg, Heidelberg, Germany

SO_2 cameras determine the SO_2 emissions of volcanoes with a high temporal and spatial resolution. They thus visualize the plume morphology and give information about turbulence and plume dispersion. Moreover, from SO_2 camera image series emission rates can be determined with high time resolution (as will be explained below), these data can help to improve our understanding of variations in the degassing regime of volcanoes.

The first step to obtain emission rates is to integrate the column amount of SO_2 along two different plume cross sections (ideally perpendicular to the direction of plume propagation); combined with wind speed information this allows the determination of SO_2 fluxes. A popular method to determine the mean wind speed relies on estimating the time lag of the SO_2 signal derived for two cross sections of the plume at different distances downwind of the source. This can be done by searching the maximum cross-correlation coefficient of the two signals.

Another, more sophisticated method to obtain the wind speed is to use the optical flow technique to obtain a more detailed wind field in the plume from a series of SO_2 camera images. While the cross correlation method only gives the mean wind speed between the two cross sections of the plume, the optical flow technique allows to determine the wind speed and direction for each pixel individually (in other words, a two-dimensional projection of the entire wind field in the plume is obtained).

While optical flow algorithms in general give a more detailed information about the wind velocities in the volcanic plume, they may fail to determine wind speeds in homogeneous regions (i.e. regions with no spatial variation in SO_2 column densities) of the plume. Usually the wind speed is automatically set to zero in those regions, which leads to an underestimation of the total SO_2 emission flux. This behavior was observed more than once on a data set of SO_2 camera images taken at Etna, Italy in July, 2014. For those data the cross-correlation method leads to a more realistic result, which was close to simultaneously measured SO_2 fluxes calculated from spectra taken by a zenith looking differential optical absorption spectroscopy (DOAS) instrument traversing underneath the plume. In the analyzed data the flux determined with the cross-correlation method was twice the flux determined with the optical flow algorithm. We further investigated the potential error in the SO_2 flux determination caused by a slant view on the plume. This is a situation commonly encountered when observing volcanic SO_2-fluxes by remote sensing techniques. Frequently it is difficult to determine the precise angle between wind direction (i.e. plume propagation direction) and observation direction. We find that in volcanic plumes with an inclination that differs more than 20 degree from the assumed wind direction, can cause an error in the determined SO_2 flux can deviate from the true value by more than 10 percent.