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Atmospheric Measurement Techniques
Discussions

Interactive comment on "The AOTF-based NO_2 camera" *by* Emmanuel Dekemper et al.

J.-F. Smekens (Referee)

j.f.smekens@opgc.univ-bpclermont.fr

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General comments

This manuscript describes the development of a new imaging instrument specifically designed to retrieve Slant Column Densities (SCD) of Nitrogen Dioxide (NO2) in gas plumes. The technique relies on the use of an Acousto-Optical Tunable Filter (AOTF) to create image pairs of a scene at two very close wavelengths showing a strong difference in the absorption cross-section of NO2 in the visible blue spectrum. The method is very innovative and offers a wide range of application for pollution monitoring, as well as for volcanological applications. I strongly recommend the publication of this manuscript and have only a few specific comments and recommendations that could improve the general discussion and its relevance to the volcanological community.

Specific comments

P2, L10 – It is certainly true there have been many developments in the SO2 camera technique in the last decade. However I would remain cautious in stating that the main technique for volcanological applications has shifted to SO2 cameras. Most observatories still rely on scanning spectrometers and the DOAS technique for the quantification of fluxes, and there have been great advances in the temporal resolution of scanning spectrometer arrays as well. To this day, very few SO2 cameras are used for continuous monitoring, in part due to the large amount of data they generate.

P8 - I would recommend a clarification as to the temporal resolution of the instrument, and that introduced by the mathematical methodology. Perhaps a more complete description of the averaging technique can be included in paragraph 3.3, stating the wavelengths used in the following example, exactly how long the exposure time were (0.5s?), how long it takes to acquire the 8 image pairs, and how many images were used to achieve an acceptable SNR. In the discussion, I also recommend adding a brief paragraph about the effect of exposure time on the SNR, and whether using fewer image pairs taken with a longer exposure time would help increase the temporal resolution. I realize the subject is mentioned several times throughout the manuscript, but sometimes with conflicting information.

P9, L25 – Here you state that the plume must remain optically thin for a successful application of the method. Indeed, heavy condensation of a plume near the vent has caused significant interference when using SO2 cameras, usually leading to the underestimation of the SCD. Although the AOTF method operates differently, a similar effect could be taking place here and influence your conclusions about the rate of conversion of NO to NO2. Could you comment on the optical thickness of the plumes in your example, and perhaps include a photograph of the scene?

P12 – Here you discuss the dynamic behaviour of the plume and the conversion of NO to NO2. It could be useful to include a time series of fluxes or concentrations taken at a given height above the stacks, in order to explore the dynamic nature of the plume. My understanding is that the temporal resolution of 3 minutes is due to the averaging of multiple pairs of consecutive images. It occurs to me that a lower temporal resolution could be achieved by using a moving average technique.

P11 – On the use of this new instrument for the correction of SO2 camera data, your point is well taken. It would be quite valuable to employ this technique to correct SO2 camera measurements. However, the (near) simultaneity of acquisition of images in both wavelengths is in my opinion one of the biggest advantages of the SO2 camera, and one that allows us to truly investigate dynamic processes on very short timescales. Not only is the temporal resolution of the AOTF NO2 camera much lower, it provides an average of many images over 3 minutes, which will be difficult to reconcile with images from an SO2 camera produced at a rate of over 1 Hz. I would suggest adding a brief discussion on the practical application of such a correction OF SO2 camera data using the AOTF instrument.

The averaging of multiple image pairs is a strong limitation of the method presented here. Based on the images presented in figure 5, it seems they were acquired over a period of over 3 minutes. With a plume velocity of 5 m s-1, and based on the size of the field of view, it occurs to me that features image at the beginning of the acquisition will have moved outside of the FOV long before the end of the acquisition. If the plume is unsteady, and the emission rate varies during this 3 minute period (I strongly suspect that it does), this could have a significant impact on the interpretation of the SCD maps. Perhaps this is due to confusion in my understanding of the averaging process. But if it is not, could you clarify how this will affect your interpretation of the images, the calculation of the emission rates and the associated errors?

Technical corrections

I have not found any technical corrections beyond those already identified by Reviewer 1.

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