



Moonlight DOAS for nighttime studies of volcanic plumes

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Differential Optical Absorption Spectroscopy (DOAS) in the ultraviolet and visible wavelength region has become a widespread tool not only to study the chemistry of trace gases such as sulphur dioxide (SO_2) and halogen oxides (e.g. BrO, ClO, OCIO) in volcanic plumes, but also for volcano monitoring by observing SO_2 fluxes.

During daylight hours either direct or scattered sunlight can be used for measurements. At night other light sources have to be used, the two main possibilities being artificial ones and the moon. While artificial lighting has several important advantages, such as otherwise not available wavelength regions (e.g. deep UV) and a known light path, it is limited to measurements at the crater rim in most circumstances in volcanic environments, which is a potentially dangerous place, and limits the investigation of plume chemistry to the nearer source region. To study the composition of the plume further downwind at night, the moon is the only available source of light.

Within the NOVAC (Network for Volcanic and Atmospheric Change) project, passive scanning DOAS instruments in the UV wavelength region were developed and deployed at several degassing volcanoes. We adapted these instruments, however, to track the moon and thus to conduct direct light measurements.

As the speciation of bromine and other halogenic oxides relies on photodissociation of their respective elementary molecules, a discrepancy between day and nighttime chemistry is expected. While emissions during the day have been studied for some time now, little is known about the reactions occurring at night.

We present direct moonlight measurements carried out at Mount Etna during November/December 2009. SO_2 slant column densities (SCD) of up to $2 \cdot 10^{18} \text{ molecules/cm}^2$ were detected and spectra are analyzed for halogen compounds. The results are compared to direct sunlight measurements undertaken in the same period. Our maximum nighttime BrO/ SO_2 ratio is significantly lower than the ones obtained during daytime in the same period, thus further supporting the current ideas of the halogen and atmospheric chemistry in volcanic plumes.