



Optical characterization of UV multispectral imaging cameras for SO₂ plume measurements

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Only a few years ago spectral imaging cameras for SO₂ plume monitoring were developed for remote sensing of volcanic plumes. We describe the development from a first camera using a single filter in the absorption band of SO₂ to more advanced systems using several filters and an integrated spectrometer. The first system was based on the Hamamatsu C8484 UV camera (1344 x 1024 pixels) with high quantum efficiency in the UV region from 280 nm onward. At the heart of the second UV camera system, EnviCam, is a cooled Alta U47 camera, equipped with two on-band (310 and 315 nm) and two off-band (325 and 330 nm) filters. The third system utilizes again the uncooled Hamamatsu camera for faster sampling (~10 Hz) and a four-position filter-wheel equipped with two 10 nm filters centered at 310 and 330 nm, a UV broadband view and a blackened plate for dark-current measurement. Both cameras have been tested with lenses with different focal lengths. A co-aligned spectrometer provides a ~0.3nm resolution spectrum within the field-of-view of the camera.

We describe the ground-based imaging cameras systems developed and utilized at our Institute. Custom made cylindrical quartz calibration cells with 50 mm diameter, to cover the entire field of view of the camera optics, are filled with various amounts of gaseous SO₂ (typically between 100 and 1500 ppm•m). They are used for calibration and characterization of the cameras in the laboratory. We report about the procedures for monitoring and analyzing SO₂ path-concentration and fluxes. This includes a comparison of the calibration in the atmosphere using the SO₂ cells versus the SO₂ retrieval from the integrated spectrometer.

The first UV cameras have been used to monitor ship emissions (Ny-Ålesund, Svalbard and Genova, Italy). The second generation of cameras were first tested for industrial stack monitoring during a field campaign close to the Rovinari (Romania) power plant in September 2010, revealing very high SO₂ emissions (> 1000 ppm•m). The second generation cameras are now used by students from several universities in Romania.

The newest system has been tested for volcanic plume monitoring at Turrialba, Costa Rica in January, 2011, at Merapi volcano, Indonesia in February 2011, at Lascar volcano in Chile in July 2011 and at Etna/Stromboli (Italy) in November 2011. Retrievals from some of these campaigns will be presented.