Applying UV cameras for SO2 detection to distant or optically thick volcanic plumes

Christoph Kern[1], Cynthia Werner[2], Tamar Elias[3], A. Jeff Sutton[3]

[1]USGS Cascades Volcano Observatory, USA, [2]USGS Alaska Volcano Observatory, USA, [3]USGS Hawaiian Volcano Observatory, USA

E-mail: ckern@usgs.gov

Ultraviolet (UV) camera systems represent an exciting new technology for measuring two dimensional sulfur dioxide (SO2) distributions in volcanic plumes. The high frame rate of the cameras allows the retrieval of SO2 emission rates at time scales of 1Hz or higher, thus allowing the investigation of high-frequency signals and making integrated and comparative studies with other high-data-rate volcano monitoring techniques possible. One drawback of the technique, however, is the limited spectral information recorded by the imaging systems. Here, a framework for simulating the sensitivity of UV cameras to various SO2 distributions is introduced. Both the wavelength-dependent transmittance of the optical imaging system and the radiative transfer in the atmosphere are modeled. The framework is then applied to study the behavior of different optical setups and used to simulate the response of these instruments to volcanic plumes containing varying SO2 and aerosol abundances located at various distances from the sensor. Results show that UV radiative transfer in and around distal and/or optically thick plumes typically leads to a lower sensitivity to SO2 than expected when assuming a standard Beer-Lambert absorption model. Furthermore, camera response is often non-linear in SO2 and dependent on distance to the plume and plume aerosol optical thickness and single scatter albedo. The model results are compared with camera measurements made at Kilauea Volcano (Hawaii) and a method for integrating moderate resolution differential optical absorption spectroscopy data with UV imagery to retrieve improved SO2 column densities is discussed.