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Monitoring of volcanic SO2 emissions using the GOME-2 satellite instrument

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Volcanic eruptions are a major hazard to the local population near large volcanoes and to aviation. They also play an important role in global climate change. Atmospheric SO2 is an important indicator for volcanic eruptions and volcanic activity like passive degassing. Space based atmospheric sensors like GOME-2 on MetOp and OMI on EOS-Aura make it possible to detect the emissions of volcanic SO2 in near-real time (NRT) and monitor volcanic activity and eruptions on a global scale. This is important as satellites are often the first, and sometimes the only, source of information on volcanoes in remote locations because ground based monitoring is carried out only for a limited number of volcanoes.

The GOME-2 instrument provides measurements of the SO2 columns with a spatial resolution of 80x40 km^2 and a global coverage within about one day. Volcanic sulfur dioxide emissions are routinely derived from solar backscatter measurements in the ultra-violet spectral range around 320 nm, applying the Differential Optical Absorption Spectroscopy (DOAS) method. This retrieval technique uses the high spectral resolution of the instruments to determine the total column density of SO2. DLR provides GOME-2 SO2 columns in NRT, i.e. less than two hours after sensing, which makes possible detection and tracking of volcanic eruption plumes as a valuable tool for aviation warning. Furthermore, the ability to monitor changes in volcanic degassing behavior is of great importance for early warning of volcanic activity, as large increases in SO2 fluxes are often an indicator for new episodes of volcanic unrest. As the standard DOAS method is restricted to optically thin conditions, current research activities focus on the use of a direct fitting algorithm for retrieving SO2 from GOME-2 data using shorter wavelength regions to achieve a higher sensitivity for low SO2 amounts typically observed in degassing situations.

The GOME-2 measurements of volcanic SO2 are currently being used in the DUE/ESA project GlobVolcano that uses satellite monitoring to support early warning of volcanic risk and within the a new Volcano Fast Response System (Exupéry) developed within the framework of the German Geotechnology Program that includes both ground-based and space-based measurements of different volcanic parameters.

In this contribution, we present exemplary results of SO2 retrieved from GOME-2 with DOAS and direct fitting approach, including analyses and comparisons for volcanic events. Further initial validation results for GOME-2 SO2 observations will be shown. Finally we will present the use of the operational GOME-2 SO2 data for early warning of volcanic hazards within GlobVolcano and the Exupéry system.