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Satellite observations of secondary sulphate aerosols from volcanic activity: Sensitivity analyses and first retrievals using the Met-Op IASI instrument

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Volcanic activity, including passive degassing and eruptive paroxysms, is one of the main sources of perturbation of the atmospheric composition. Among their different emissions, volcanoes are a source of gaseous and particulate sulphur. Sulphate aerosols, in particular, have the potential to interact with the radiative balance at different spatio-temporal scales. Observing sulphur compounds and sulphur-containing particles in a volcanic plume is a difficult task because a volcanic plume is a mix of different gaseous and particulate effluents, and because sulphur-containing gases and particles have similar spectral signatures [Sellitto and Legras, 2016]. For example, existing methods to retrieve volcanic sulphur dioxide (SO_2) usually neglect the radiative impact of the subsequently formed Secondary Sulphate Aerosols (SSA) and vice-versa.

To further investigate these possible interactions, in the first part of this study, we assess the combined sensitivity of simulated observations to the SO_2 emissions and the subsequently formed SSA after idealized stratospheric and tropospheric eruptions. Three TIR satellite instruments are used as target observing systems: the Infrared Atmospheric Sounding Interferometer (IASI), the MODerate resolution Imaging Spectro radiometer (MODIS) and the Spinning Enhanced Visible and InfraRed Imager (SEVIRI). The results of these sensitivity analyses show that the radiative interferences, produced by the simultaneous presence of SO_2 and SSA on the outgoing TIR, is significant after few days from the eruption. In particular, neglecting SSA may bias SO_2 retrievals [Guermazi et al., 2017]. Instrument with a high spectral resolution, like IASI, proved apt to retrieve SO_2 and SSA total masses as independent quantities and with limited uncertainties [Guermazi et al., 2017]. In the second part of this contribution, we apply the outcomes of this sensitivity analysis to the retrieval of SSA from real IASI observations for the first time using the AEROIASI framework, used in the past to retrieve the mineral desert dust burden in 3D (Cuesta et al, 2015). We adapt this method for observing sulphate aerosols. This new scheme, AEROIASI-Sulphates is applied to selected eruptions of Mt Etna volcano. Results are presented and critically discussed.

References:

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