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Investigation of Volcanic Ash with Simulated Satellite Images Using the 3D Radiative Transfer Model MYSTIC

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The occurrence of volcanic ash over Europe in 2010 and 2011 had a huge impact on Europe's aviation industry. Thus an increased interest in gaining information about volcanic ash suspended in the atmosphere demands for remote sensing methods, which are capable of quantifying the measurements related to eruption plumes. Remote sensing methods have been proposed to retrieve volcanic ash mass concentration e.g. from brightness temperature differences of thermal infrared satellite channels. Aim of this study is to determine the detection limit of these methods; that is, to calculate thresholds of the mass concentration which can actually be detected under given viewing and atmospheric conditions. The 3D radiative transfer model MYSTIC (Monte Carlo code for the physically correct tracing of photons in cloudy atmospheres), part of the libRadtran software package, is used to simulate satellite images in the visible as well as the infrared spectrum as measured by SEVIRI (Spinning Enhanced Visible and Infrared Imager) instruments on board of Meteosat Second Generation (MSG) systems. All calculations are performed on a grid with a pixel edge length of 560 m using downscaled COSMO-DE data. In order to reduce noise and computation time a new variance reduction method based on importance sampling has been introduced in MYSTIC. This method allows to calculate radiances for different ash concentrations based on the same photon paths. By investigating the simulated satellite images we can determine the detection limit of volcanic ash mass concentration under various realistic background conditions. The results serve as input to an ash detection algorithm so that retrieved mass concentrations can be used to determine the detection efficiency subject to the input parameters.