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Lagrangian transport simulations of volcanic sulfur dioxide emissions: impact of meteorological data products

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Sulfur dioxide (SO_2) emissions from strong volcanic eruptions are an important natural cause for climate variations. We applied our new Lagrangian transport model Massive-Parallel Trajectory Calculations (MPTRAC) to perform simulations for three case studies of volcanic eruption events. The case studies cover the eruptions of Grímsvötn, Iceland, Puyehue-Cordón Caulle, Chile, and Nabro, Eritrea, in May and June 2011. We used SO_2 observations of the Atmospheric Infrared Sounder (AIRS/Aqua) and a backward trajectory approach to initialize the simulations. Besides validation of the new model, the main goal of our study was a comparison of simulations with different meteorological data products. We considered three reanalyses (ERA-Interim, MERRA, and NCAR/NCEP) and the European Centre for Medium-Range Weather Forecasts (ECMWF) operational analysis. Qualitatively, the SO_2 distributions from the simulations compare well with the AIRS data, but also with Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) and Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) aerosol observations. Transport deviations and the critical success index (CSI) are analyzed to evaluate the simulations quantitatively. During the first 5 or 10 days after the eruptions we found the best performance for the ECMWF analysis (CSI range of 0.25 – 0.31), followed by ERA-Interim (0.25 – 0.29), MERRA (0.23 – 0.27), and NCAR/NCEP (0.21 – 0.23). High temporal and spatial resolution of the meteorological data does lead to improved performance of Lagrangian transport simulations of volcanic emissions in the upper troposphere and lower stratosphere.

Reference: Hoffmann L., Rößler, T., Griessbach, S., Heng, Y., and Stein, O., Lagrangian transport simulations of volcanic sulfur dioxide emissions: impact of meteorological data products, J. Geophys. Res., 121(9), 4651-4673, doi:10.1002/2015JD023749, 2016.