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Model simulations and satellite observations of radiative effects of lower stratospheric aerosol from volcanoes, air pollution and desert dust in the period 2002 to 2011

Christoph Brühl, Jennifer Schallock, Jos Lelieveld, and Klaus Klingmüller
Max-Planck-Institut für Chemie, Abt. Luftchemie, Mainz, Germany (christoph.bruehl@mpic.de)

Decadal simulation in the framework of SPARC/SSIRC with the atmospheric chemistry - general circulation model EMAC, with modal interactive aerosol, shows that sulfate particles from about 230 volcanic eruptions dominate the interannual variability of aerosol extinction in the lower stratosphere and of radiative forcing at the tropopause. The EMAC model simulates sulphate from 3D volcanic SO_2 plumes based mostly on observations by MIPAS on ENVISAT. To explain the total stratospheric optical depth observed by satellites (including GOMOS on ENVISAT), desert dust and organic and black carbon, transported to the lowermost stratosphere by the Asian summer monsoon and tropical convection, need to be accounted for. In the upper troposphere and lower stratosphere over the Asian summer monsoon air pollution from road traffic appears to be the largest contributor to black carbon. Absorbing aerosol dominates the local radiative heating. We show the contributions by different aerosol types and in different spectral regions.