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Stratospheric aerosol optical depth: comparison of global model results with SAGE II and HALOE observations in the visible and near-, far-infrared channels

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Stratospheric aerosols have been recognized to play an important role in the global climate system by influencing the Earth radiative balance and by providing a surface for heterogeneous chemistry. The accurate modeling of the shape and characteristics of the stratospheric aerosol layer requires the knowledge of their microphysical properties and the atmospheric distribution of their tropospheric precursor gases (SO2, OCS). The background aerosol distribution in the stratosphere may be sporadically perturbed for a time period of about five years after major explosive volcanic eruptions, that may inject in the stratosphere large amounts of SO2 and H2S. The most extensive coverage of the stratospheric aerosol distribution has been made using instruments on board of satellites (SAGE and HALOE in particular). Here we compare the distribution of stratospheric aerosols calculated by five global models with aerosol modules on-line against satellite observations. The results of two 3-D models (MPI and ULAQ) and three 2-D models (AER, LASP, UPMC) are used for this comparison, for both non-volcanic and volcanically perturbed conditions. The comparison is made in terms of aerosol extinction and optical depth: these are calculated using Mie scattering programs where the model calculated aerosol mass distribution is used as input as a function of the particle radius. The size distribution calculated in the models is the final product of several physical and chemical mechanisms (emission of gas precursors, large-scale transport, oxidation and photolysis of precursors, aerosol formation via homogeneous and heterogeneous nucleation, aerosol growth via coagulation and gas condensation and aerosol removal via gravitational settling and tropospheric washout. The comparison of stratospheric aerosol optical depth with satellite observations is used to evaluate the performances of the models and to identify gaps in our understanding of aerosol processes and/or deficiencies in their representation in models. The Pinatubo eruption of June 1991 is used as case study for the volcanically perturbed stratosphere.