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Numerical studies of microphysical modulations of stratospheric aerosol within ROMIC-ROSA

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The stratospheric aerosol layer (so-called Junge layer) is an inherent part of the Brewer-Dobson circulation (BDC). Stratospheric aerosols play a large role in the Earth's climate system because they interact with catalytic cycles depleting ozone, directly alter the atmosphere's radiative balance and modulate the strength of polar vortices, in particular when this system is perturbed. In terms of mass the layer is predominantly composed of liquid sulphate-water droplets and is fed from the oxidation of gaseous precursors reaching the stratosphere either by direct volcanic injections (mainly supplying SO_2) or troposphere-stratosphere exchange processes. In volcanically quiescent periods, latter processes predominantly maintain the so-called background state of aerosol layer through oxidation of OCS above 22 km, and SO_2 below.

The Junge layer begins to develop 2-3 km above the tropopause and reaches a height of about 35 km, with a largest vertical extent in the tropics and spring-time polar regions. Above the TTL, the layer's vertical extent varies between 2 km and 8 km (about 35% of its mean vertical expansion), depending on the phase of the QBO. The QBO-induced meridional circulation, overlying the BDC, and accompanied signatures in the stratospheric temperature directly affect the life cycle of stratospheric aerosol. Mainly by modulating the equilibrium between microphysical processes which maintain the layer. Effects caused by QBO modulations of the advective transport in the upwelling region of the BDC are smaller and difficult to quantify, because the overlying sedimentation of aerosol is also being modulated and counteract the aerosol lofting.

Here we show results from numerical studies performed within the project ROMIC-ROSA (Role of Stratospheric Aerosol in Climate and Atmospheric Science). We further explored relationships between QBO forcing and aerosol processes in the lower stratosphere. We examined whether similar process interferences can be caused by variations of the incoming spectral solar irradiance, which modulates the production of H2SO4 vapour from precursor oxidation and photolysis. Such effects are thought to be stronger in the upper regions of the Junge layer, where modulations of the H2SO4 saturation vapour pressure alter the balance between competing processes of aerosol growth and evaporation. Our model results are compared to aerosol extinction observations from the Envisat/SCIAMACHY limb sounder, which has been released in a new version.