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The interannual variability of the stratospheric aerosol layer as seen in MAECHAM5-SAM2

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In the lower stratosphere the interannual variability of gaseous constituents is dominated by the quasi-biennial oscillation (QBO). Although the QBO is a phenomenon of the equatorial stratosphere, the QBO affects the atmospheric dynamics and thus trace gas concentrations in all latitudes, from the tropical stratospheric reservoir (TSR) to the polar vortex. In tracers such effects are reflected by concentration gradients and by the formation of characteristic concentration patterns dependent on the phase of the QBO, the annual cycle, tropopause exchange processes and chemical pathways. In recent years QBO effects e.g. in CH_4 and O_3 were studied widely. Little attention was given to QBO modulations in lower stratospheric particulate matter. However, SAGE and HALOE observations of tropical stratospheric aerosol extinctions exposed a typical biennial signal that could be linked to the QBO.

We are presenting the first comprehensive modeling study of QBO effects in the global stratospheric aerosol layer under non-volcanic conditions, using the size resolved aerosol-climate model of the middle and upper atmosphere MAECHAM5-SAM2. Our model studies show that in the vicinity of descending equatorial zonal winds QBO induced anomalies were found in all prognostic and diagnostic aerosol parameters as well as in concentrations of sulphate aerosol precursor gases. Qualitatively QBO modulations in the modeled aerosol mixing ratio correspond to modulations found in space-borne observations of aerosol extinction. Phase shifts and phase inversions in the modelled aerosol parameter anomalies are caused by non-linearities in QBO controlled process interactions. QBO induced anomalies in the aerosol number concentration are a function of particle size. Enhanced reversible gas-to-particle partitioning (condensation, evaporation) has been found in regions above the aerosol concentration maximum, which is linked to QBO modulations in both thermodynamic quantities and advective transport. Observational findings of the upper and lower transport regimes for stratospheric tracers out of the TSR are reproduced by the model, while the secondary circulation associated with the QBO can be identified by the modelled aerosol concentration gradients.