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Causes for Changes in the Brewer-Dobson Circulation derived from Chemistry-Climate Model Simulations

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An acceleration of the Brewer-Dobson Circulation (BDC) in the future due to higher greenhouse gas (GHG) concentrations is evident from literature (e.g. Butchart et al., 2010). Various independent model simulations of future climate project a younger mean age of stratospheric air and an intensified upward mass-flux in the tropics, which is widely used as an index of the BDC-strength.
Causes for the simulated trend are still under debate, like for example changes in the generation and propagation of planetary waves, or the role of gravity waves, and their varying contributions to the circulation change. A convenient method to distinguish the contributions from different wave types to the total mass-flux is the application of the 'downward-control principle' first introduced by Haynes et al. (1991).
The goal of this study is to analyse and interpret the past and future evolution of the BDC. Results from sensitivity simulations with the Chemistry-Climate Model (CCM) EMAC-FUB (i.e. EMAC CCM with 39 layers and FUBRad parameterization) for past, present and projected future GHG concentrations as well as prescribed sea surface temperatures (SSTs) will be presented. The model has been integrated over at least 20 years for each sensitivity study. The role of reduced (past) and increased (future) GHG concentrations and SSTs on the BDC will be assessed by comparing the results from the past and future simulations with a reference simulation for the year 2000.
In order to separate the contributions of different waves to the change pattern, we adopted the 'downward-control principle' to our model data. In addition, the part of change due to fast mixing processes in contrast to the relatively slow BDC has been assessed by analysing 'age of air' tracers from the different simulations.