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The effects of resolved and parameterized waves on the Brewer-Dobson circulation

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Climate models show a better agreement in the total residual circulation of the stratosphere and mesosphere than in the attribution of planetary waves (PWs) and gravity waves (GWs). For a future with increasing greenhouse gas concentrations, model simulations uniformly indicate an acceleration of the Brewer-Dobson circulation (BDC). However, they vary concerning the magnitude of and the causes for the projected BDC changes. Earlier studies found a compensatory effect of changes in orographic GWs (OGWs) and PWs on the BDC. This is a possible explanation why models are in better agreement concerning the total mass transport and the total BDC change than regarding the individual wave contributions to these changes.

In this study we examine the relative roles of GWs and PWs for the BDC in the ECHAM/MESSy Atmospheric Chemistry (EMAC) chemistry-climate model. We show results from three EMAC timeslice simulations for the recent past (year 2000): a reference simulation, and two simulations in which either OGWs or non-orographic GWs (NGWs) have been switched off. With this set of simulations we are able to separate the influences of OGWs and NGWs on temperature and zonal wind, and to examine a possible compensation of GWs and PWs in the driving of the stratospheric and mesospheric branches of the BDC.