Geophysical Research Abstracts
Vol. 19, EGU2017-2040, 2017
EGU General Assembly 2017

Impact of 3-D orographic gravity wave parameterisation on stratosphere dynamics

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Stratosphere dynamics are strongly influenced by gravity waves (GWs) propagating upwards from the troposphere. Some of these GWs are generated through flow over small-scale orography and can not be resolved by common general circulation models (GCMs). Due to computational model designs, their parameterisation usually follows a one dimensional columnar approach that, among other simplifications, neglects the horizontal propagation of GWs on their way up into the Middle Atmosphere. This causes contradictions between models and observations in location and strength of GW drag force through their dissipation and as a consequence, also in stratospheric mean flow. In the EMAC (ECHAM MESSy Atmospheric Chemistry) model, we have found this deficiency to cause a too weak Antarctic polar vortex, which directly impacts stratospheric temperatures and thereby the chemical reactions that determine ozone depletion.
For this reason, we adapt a three dimensional parameterisation for orographic GWs, that had been implemented and tested in the MIROC GCM, to the MESSy coding standard. This computationally light scheme can then be used in a modular and flexible way in a cascade of model setups from an idealised version for conceptional process analyses to full climate chemistry simulations for quantitative investigations. This model enhancement can help to reconcile models and observations in wave drag forcing itself, but in consequence, also in Brewer-Dobson Circulation trends across the recent decades. Furthermore, uncertainties in weather and climate predictions as well as in future ozone projections can be reduced.