Project title: Ozone-gravity wave interaction in the stratosphere

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Abstract

Upward propagating gravity waves (GWs) are an important driver of the time-mean circulation of the middle atmosphere (10-100km). Recent measurements have shown that the increase in GW potential energy density with height is much stronger during daylight than night-time, or during summer than winter (e.g., stronger by a factor of >3), which requires an improvement of current gravity wave drag (GWD) parameterizations used in general circulation models (GCMs). The basic idea of the project is that the interaction of mesoscale vertical ozone transport and ozone-dependent temperature perturbations in the upper stratosphere (here called ozone-gravity wave interaction), initially forced by upward propagating GWs, could be responsible for such an amplification of GW amplitudes. Incorporation of this process in GCMs can potentially improve the quality of the circulation in the middle atmosphere compared to observations, as well as surface climate conditions via stratosphere-troposphere coupling.

The first aim of the project is to incorporate a parameterization of ozone-gravity wave interaction into the Earth-System-Model MPI-ESM-MR (provided by the MPI-Met, Hamburg), and to perform model simulations over some decades with and without this process to examine the effects on the time-mean annual cycle of the stratosphere-troposphere circulation system under current climate conditions. The parameterization can easily be introduced into the used GWD. Then, simulations will be carried out for the 21st century to examine the effect of the parameterized process on the long-term changes in the stratosphere-troposphere circulation system in case of a moderate and a strong scenario of increasing greenhouse gases.