How do gravity wave parameterizations influence atmospheric transport in current generation global climate models?

In the terrestrial atmosphere, internal gravity waves (GWs) are a naturally occurring and ubiquitous, though intermittent phenomenon. In addition, GWs are asymmetrically distributed around the globe. In current generation global climate models (GCMs), GWs are usually smaller than the model grid resolution and the majority of their spectrum therefore must be parameterized. To some extent, the intermittency and asymmetry of a spatial distribution of the resulting GW drag (GWD) is present also in the parameterization outputs (in particular for orographic GWD (oGWD)). As the GW parameterization schemes in GCMs are usually tuned to get the zonal mean climatology of particular features right, an important question emerges: which impact do GW parameterizations have on the individual models atmosphere? The presentation will concern the impact of spatiotemporally intermittent GW forcing on the model middle atmosphere, with a special focus on the extra-tropical lower stratosphere region (LS). The LS region is characterized by a strong interplay of chemical, physical and dynamical processes. To date, the representation of this dynamically active region in models frequently mismatches observations. Although we can find a climatological maximum of oGWD in the LS, the role of GW forcing for the transport and composition in this region is poorly understood.

This presentation will combine observational evidence, idealized modeling and statistical analysis of GCM outputs to study both the short-term and long-term model response to the GW forcing. In detail, the so-called compensation mechanism between resolved and unresolved waves is studied. It is shown that this mechanism emerges as even more complex and universal than previously thought. The results presented will question the relationship between the advective part of the Brewer-Dobson circulation and the zonally asymmetric GW forcing, and a so-far neglected link between oGWD and large-scale quasi-isentropic stirring will be discussed.