Towards a transient gravity wave drag parametrization in atmospheric models

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The aim of the presented work is to improve the parametrization of subgrid-scale gravity wave (GW) drag on the resolved flow of climate and numerical-weather-prediction models. Current GW parametrization schemes are using the steady-state approximation for the wave field and therefore assume an instantaneous GW propagation neglecting direct interactions between the GWs and the resolved flow in the course of the propagation. As such these schemes rely on wave breaking as the only mechanism to exert a drag on the resolved flow. Theory shows that dropping the steady-state assumption leads to non-linear GW-meanflow interactions (further on direct GW-meanflow interaction) where the meanflow is forced even in the absence of wave breaking, whereas the meanflow in turn modulates the smaller scale wave field due to wind shear and stratification gradients (Achatz et al., 2017). In idealized simulations it indeed turns out that by applying a transient GW model (i.e. by dropping the steady-state assumption) the contribution of direct GW-meanflow interaction to the GW drag can be as important as that of wave breaking (Bölöni et al., 2016). This motivates the implementation of a transient GW model (further on named MS-GWaM: Multi Scale Gravity Wave Model) to a state-of-the-art global circulation model (GCM) enabling to evaluate the consequences of direct GW-meanflow interactions in a realistic atmospheric circulation. The GCM in which MS-GWaM has been implemented is the Icosahedral Nonhydrostatic Model (ICON) developed jointly by the German Weather Service and the Max-Planck Institute for Meteorology. MS-GWaM in ICON runs stably and provides substantially different GW drag in comparison with the benchmark steady-state parametrization available in the model. Seasonal simulations with ICON-MS-GWaM provide reasonable zonal mean middle atmospheric circulation and temperature structures in comparison with climatology such as SPARC observations and the HAMMONIA GCM.

Key words: gravity wave dynamics, wave-meanflow interaction, parametrization

References

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