Convective Gravity Waves Modeled by a Transient Gravity-Wave Parameterization in ICON

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INTRODUCTION

Gravity waves (GWs) are observed to be intermittent with significant spatio-temporal variations in their amplitudes and characteristics (e.g., Hertzog et al. 2012). In GW parametrizations (GWP), details of GW-mean flow interaction depend on the representation of the GW intermittency/variability (Bühler 2003).

Convection is an important source of GWs, which is highly intermittent in its activity. We couple the convective sources to a transient GW model, MS-GWaM, implemented in a global model (see the poster by G. Bölöni et al.) to parameterize convective GWs with realistic characteristics and intermittency.

The intermittency of parameterized GWs and the impact of transient GW modeling on the intermittency are investigated.

EXPERIMENTS

Model: Icosahedral Nonhydrostatic Model (ICON)

– NWP physics + upper-atmosphere physics
– Model lid: 150 km (physical top at 110 km)
– Resolutions: ~160 km, T220
– Non-orographic GWP: replaced by MS-GWaM ( Bölöni et al. 2016) coupled with convective + background sources
– Convection parametrization: Bechtold et al. (2008)

Convective–source GW (CGW) spectra

– Formulation by Song and Chun (2005)
– The spectra depend on convective heating profiles, which are retrieved from the convection parametrization in ICON, and on the background-flow profiles.
– The momentum-flux spectra at cloud-top levels are calculated when/where sub-grid deep convections are diagnosed, and launched in MS-GWaM.


– TR: experiment using (transient) MS-GWaM
– ST: experiment using a steady-state version of MS-GWaM

RESULTS

Time evolution of CGW momentum flux: diurnal cycle of convections and GWs over Borneo

(a) Gini coefficient for GW fluxes at 20, 50, and 80 km

(b) Monthly mean GW fluxes at 20 km

GW intermittency

– CGWs: (solid) eastward flux (dotted) westward flux
– BGWs (background GWs): isotropic

REFERENCES


SUMMARY

– Transient modelling of GWs results in dispersion of CGWs in time.
– This mitigates the CGW intermittency in the tropics, which is excessive in the steady-state model.
– The intermittency in the extratropics is largely increased by the transient modelling for the GWs from the background source.
– The modelled GW intermittency is quantitatively similar to the observed at 20 km.