Geophysical Research Abstracts
Vol. 20, EGU2018-5010, 2018
EGU General Assembly 2018

A Consistent "3D" turbulence parametrization in a circulation model

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Preliminary results from the application of our recently developed extension of the Dynamic Smagorinsky model (DSM) are presented. The DSM serves as a parameterization for subgrid-scale momentum diffusion in a general circulation model (GCM). Due to gravity, the horizontal and vertical scales have to be treated differently. While for the turbulent vertical diffusion of horizontal momentum a classical Smagorinsky approach is common, the respective horizontal diffusion in the free atmosphere is usually neglected. Our extension includes in contrast to the standard approach a test filter for the Smagorinsky parameter that is separated from the resolution scale to exclude potential interactions, and a dynamic approach for the vertical diffusion based on the ideas of stratified turbulence.

We show how to formulate the generalized DSM as subgrid-scale horizontal momentum diffusion to run stably a GCM without hyperdiffusion. Furthermore, the idea of stratified turbulence is applied to find a dynamic approach also for the vertical diffusion. Both improvements allow for a realistic spectrum of kinetic energy (almost) up to the resolution scale. The aim of our investigations is to extend our model into the MLT for a study of GW spectra with respect to the scaling ratio of stratified macro-turbulence. Therefore, we show the performance of the DSM up to the lower stratosphere and discuss the implications from the scale-invariance criterion for LES parameterizations on the approach for dynamic vertical diffusion.