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Towards the simulation of gravity waves using the One-Dimensional Turbulence model

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A current problem in the parameterisation of middle atmosphere gravity waves in weather and climate models is the breaking limit, where turbulence induced small scale effects can cause breaking on a larger scale. Usually different forcings can produce these small scale turbulence with a mechanism as follows: With a continuous forcing small scale turbulence can evolve into large scale vortices whose order of magnitude depends on the forcing time scale and the flow conditions. If this turbulent scale enhancement reaches the magnitude of the gravity wave length wave breaking is possible. Thereby a preliminary unknown minimum forcing duration is important. There are at least two possible forcings causing turbulence in gravity wave dynamics. At the breaking point a local unstable stratification occurs and decays again when the wave is traveling ahead. If this forcing time reaches a required minimum duration large vortices and hence breaking occurs. Furthermore Kelvin-Helmholtz instabilities through local shear layers can cause the breaking. Rieper et.al. (2011) introduced a 3D pseudo-incompressible solver including an implicit LES scheme to describe the dynamics of gravity waves. Such LES simulations have problems to describe the turbulent scale enhancement, because the important small scale effects are modeled using numerical truncation errors. Increasing resolution reduces these problems and leads to DNS simulations which are in principle able to describe wave breaking phenomena including a fully developed turbulence spectrum, but they are only realisable within limited local and temporal extension due to the heavy computational demand. A possible solution to avoid these restrictions is the One-Dimensional Turbulence (ODT) model (Kerstein 1999). As long as the turbulent forcing generating wave breaking is dominated by one spatial direction ODT is able to consider the full 3D turbulent spectrum, but it doesn't take wave characteristics into account. Coupling the ODT approach with a 3D solver enables to describe the breaking of vertical gravity waves with a large spatial extension and a fully developed turbulent spectrum. On the poster we sketch the ansatz of an one-way coupled approach using the pseuso-incompressible solver by Rieper and an ODT implementation by Schmidt et.al. (2011). Furthermore we are presenting first results of breaking gravity waves in vertical direction.

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