Geophysical Research Abstracts
Vol. 19, EGU2017-4999, 2017
EGU General Assembly 2017

Local stochastic subgrid-scale modeling for a one dimensional shallow water model using stochastic mode reduction

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Due to the finite spatial resolution in numerical atmospheric models, subgrid-scale (SGS) processes arise. A SGS parameterization of these excluded processes might improve the model on all scales. In this study we present a model derived parameterization of these processes for the one dimensional shallow water equations.
To parameterize the SGS processes we choose the MTV stochastic mode reduction (Majda, Timofeyev, Vanden-Eijnden 2001, A mathematical framework for stochastic climate models. Commun. Pure Appl. Math., 54:891–974). For this the model is separated into fast and slow processes. Using the statistics of the fast processes, a SGS parameterization is found. To identify fast processes the state vector of the model is separated into two state vectors. One vector is the average of the full model state vector in a coarse grid cell. The other describes SGS processes which are defined as the deviation of the full state vector from the coarse cell average. If the SGS vector decorrelates faster in time than the coarse grid vector, the stochastic MTV SGS parameterization can be derived from the model equation, which is the advantage of this method compared to others. So far the method was successfully applied on the Burgers-equation (Dolaptchiev et al. 2013, Stochastic closure for local averages in the finite-difference discretization of the forced Burgers equation. Theor. Comp. Fluid Dyn., 27:297-317).
To apply the method onto the one the dimensional shallow water equations, we choose a local approach of the fine variable self-interactions. With this, we are able to derive a local SGS parameterization using MTV's method leading to a closed model wrt. the coarse variable. We show, that this model is able to fix the energy decrease for high wave numbers which appears at the coarse resolution model with neglected SGS parameterization.
In the future we plan to extend the model to two dimensions and multiple layers. Perspectively, the method can be used to derive a stochastic SGS parameterization for the Navier-Stokes equations.