Technische Universität Braunschweig

MUSEN

Hierarchical Shallow Water Moment Equations: Modeling, Analysis and Numerical Simulations

Lecture of

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Okerhochhaus, Pockelsstraße 3,
seminar room, ground floor

Geophysical flows and free-surface flows can be challenging due to their multiscale nature. Numerical simulations are often based on a large variety of separate models for specific tasks depending on the scale of interest. This model variety poses significant difficulties both for the analysis and for the numerical solution. We thus need to rethink mathematical modelling for future numerical simulations of free-surface flows.

In this talk, we will introduce hierarchical moment models as a flexible way to derive hierarchies of models for geophysical flows. The new hierarchical models are based on an expansion of the velocity flow profile in terms of polynomials. The equations for the expansion coefficients constitute a hierarchical system which includes the standard shallow water equations but also allows for more accuracy when taking into account more equations. The general derivation procedure results in structural similarity of the models, which facilitates physical insight, model adaptivity, and the development of efficient numerical methods. We will exemplify the hierarchical models for 1D and 2D application cases including their analysis and the extension to complex fluids. We further highlight runtime and accuracy improvements with respect to standard shallow water equations using new model reduction techniques and asymptotic-preserving numerical schemes.