Multiscale numerical methods for geoscientific subgrid-scale process representation

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Abstract

Numerical climate, ocean, or atmospheric modeling tools need to represent processes on a large variety of spatial and temporal scales. Several processes even cannot be represented in the resolution range of corresponding solvers. In order to preserve essential structures of such unresolvable, yet influential, subgrid processes, a novel multi-scale finite element method has been developed for linear advection-diffusion equations (1,2). Recently, we extended this framework to coupled non-linear equation sets.
Here, we would like to present an outline of the general problem of multiscale problems, and following on this the idea of the multi-scale finite element methodology. Building on this idea, we present recent progress of the application of this methodology to the non-linear shallow water equations, solved on different scales as a demonstrator application.
1. K. Simon, J. Behrens (2020): Multiscale Finite Elements for Transient Advection-Diffusion Equations through Advection-Induced Coordinates, Multiscale Modeling & Simulation, 18:2. DOI:10.1137/18M117248X.
2. K. Simon, J. Behrens (2021): Semi-Lagrangian Subgrid Reconstruction for Advection-Dominant Multiscale Problems with Rough Data, Journal Sci. Comp., 87:2. DOI:10.1007/s10915-021-01451-w.

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