Numerical Multi-scale Methods in Geosciences

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Project: Modern Multi-scale Finite Element Methods in Parts of ESMs, their Feedback on Dynamical Cores, and Large-scale Canopies Simulations

Abstract. Simulations of complex systems such as the atmosphere or the ocean require coarse meshes due to computational constraints. This is particularly true over long time scales. Capturing realistic dynamics also requires to take into account (parameterized) physical processes across many (possibly not well-separated) scales that can in general not be resolved. Thus the influence of small-scale processes has to be taken care of by different means. State-of-the-art dynamical cores which represent the influence of subscale processes by employing heuristic coupling of scales. This, however, unfortunately often lacks mathematical consistency.

In this project we test the feedback and the computational scalability of modern multi-scale finite element aproaches implemented in parts of a complex system – in our case a simple 3D dynamical core. We aim to improve the mathematical consistency of the upscaling process that transfers information from the subgrid to the coarse scales of the dynamical core and to test new massively parallel implementations. As a first realistic application we embed small-scale LIDAR data (DEM) into a regional model of the city of Hamburg to effectively simulate the effect of canopies complementing and improving other approaches.

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