Testing a large-eddy simulation code for atmospheric flows over topography

In computational fluid dynamics, including geophysical fluid dynamics, the primary issues are accuracy, computational efficiency, and, especially, the handling of complex geometry. Most geophysical flows involve complex three-dimensional geometry and turbulence. A grid that is not well suited to the problem can lead to unsatisfactory results, instability, or lack of convergence. The immersed boundary method (IBM) has recently been demonstrated to be applicable to complex geometries while requiring significantly less computation than competing methods without sacrificing accuracy. The IBM specifies a body force in such a way as to simulate the presence of a surface without altering the computational grid.

In our research group, the modern fluid dynamics code microHH (http://microhh.org) is used to study small-scale atmospheric phenomena. MicroHH has been developed at Wageningen University and MPI Hamburg and is written in C++. Recently, a specific variant of the IBM has been implemented into microHH (based on Tseng and Ferziger, 2003). It can be used for both large-eddy simulation (LES) and direct numerical simulation (DNS) of turbulent flows. In this thesis, the recent implementation shall be thoroughly tested for LES and DNS over two- and three-dimensional topographies. If time permits, the applicability of Monin-Obukhov similarity theory (MOST) to slope flows over steep terrain may be investigated.

The work will consist of performing and analysing simulations of flows over idealized topography using microHH in LES and DNS mode. The simulations will be based on standard and own test cases (e.g. linear mountain waves, steep slopes, etc). Experience in computer programming and numerical modeling of fluid flow is required.

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