Center for Environmental & Applied Fluid Mechanics

"Multiscale Simulations of Flows in Atmospheric Boundary Layers from Mesoscale to Microscale: Challenges and Opportunities"

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Abstract: An accurate characterization of the full complexity of atmospheric boundary layer structure and evolution is needed for a range of applications including wind engineering, renewable energy, transport and dispersion of pollutants, wildland fire prediction, urban climate, etc. High performance computing capabilities now enable detailed studies of heterogeneous boundary layers using multiscale simulations. Nevertheless, the coupling of large-scale simulations with turbulence resolving, microscale simulations presents a number of challenges. To address some of these challenges we have developed a three-dimensional planetary boundary layer parameterization to better represent turbulence in the so called "gray zone," at grid scales between 100 m and a couple of kilometers. We have also developed and demonstrated a cell perturbation methodology that provides an effective way to develop turbulence when transitioning from a mesoscale to a microscale simulation. Finally, the development of a graphical processing unit (GPU) based large-eddy simulation model, FastEddy®, enables addressing uncertainty through an ensemble LES approach. These developments will be demonstrated on idealized as well as multiscale simulations based on the Perdigão field study in complex and heterogenous terrain.

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