

3.2 Development of multiscale modeling capabilities within WRF: Validation on idealized cases and a diurnal cycle of the CWEX-13 field campaign.

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Realistic modeling of atmospheric boundary layers requires representation of a broad range of scales ranging from synoptic and mesoscale two-dimensional eddies down to three-dimensional boundary-layer turbulence. However, existing challenges associated with disparate-scale atmospheric modeling have precluded systematic and robust use of multiscale methodologies. These deficiencies have motivated the recent development of the cell perturbation method (Muñoz-Esparza et al., BLM2014). Our proposed method uses a novel stochastic approach based upon finite amplitude perturbations of the potential temperature field applied within a region near the inflow boundaries of the LES domain. The focus of this presentation is to show the capability of the cell perturbation method to significantly accelerate the generation of realistic turbulence in the context of mesoscale-to-LES coupling (or generation of inflow conditions for LES models) with a negligible computational cost. Additionally, we present our recent research on the generalized version of the cell perturbation method based on dimensionless parameters related to the mesoscale inflow conditions (Muñoz-Esparza et al., POF2015). Finally, we present validation through novel multiscale simulations of an entire diurnal cycle during the CWEX-13 field campaign in central Iowa (Lundquist et al., 2014) using the Weather Research and Forecasting model in a multiple nest configuration with grid resolutions progressively refined from 9 km to 8 m. Our multiscale simulations exhibit very good agreement with in situ lidar wind profiler and sonic anemometer measurements at the CWEX-13 site throughout the diurnal cycle, demonstrating the great potential of multi-scale modeling in the context of real-world atmospheric boundary layer flows.