Scaling Studies of Surface-Atmosphere Interactions at a Very Tall Tower Site in Wisconsin

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Abstract. The strength of the diurnal and seasonal covariance between photosynthesis and atmospheric mixing has a significant influence on the simulated spatial structure of atmospheric CO₂ in global transport models, and is a major source of uncertainty in inverse calculations of the carbon budget. We have investigated this effect at a 500 m tall television transmission tower located in a mixed forest in northern Wisconsin. Micrometeorological and eddy covariance measurements have been made since 1995 at three levels (30, 122, 396 meters), and a radar wind profiler has been operating since March 1998. The resulting vertically resolved record of scalar properties, ecosystem fluxes, and boundary-layer structure is an ideal testbed for testing theoretical and modeling approaches to upscaling of ecophysiological and atmospheric processes.

The interaction between the forest and boundary layer meteorology has been simulated at the tower site with a hierarchical series of numerical experiments, including local canopy simulations driven by observed micrometeorology, large-eddy simulation, mesoscale meteorological modeling, and a global GCM. Each simulation has been compared to data collected at the site. The models are generally successful at reproducing the major features of the covariance between CO₂ flux and PBL mixing, though the GCM fails to capture the degree of accumulation of CO₂ under the nocturnal inversion.