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Uncertainty analysis of carbon exchange modeling in a forest due to kB^{-1} parameterizations

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The difference in turbulent transfer efficiency between momentum and scalars, represented by the parameter kB^{-1}, has been the subject of considerable interest in micrometeorology. Various different parameterizations have been proposed, but the impact of uncertainty in this parameter on modeling carbon exchange has not been previously estimated. Here we implemented 11 different kB^{-1} parameterizations in an ecosystem model coupled to a dynamic vegetation model and compared them on the basis of the simulated gross primary productivity (GPP) for a forest canopy. The tested parameterizations included not only the popularly used schemes that set kB^{-1} as a constant or a only a function of Reynolds number, but also schemes that express kB^{-1} as a function of plant phenology as well. We found that kB^{-1} was sensitive to changes in the friction velocity over a tall canopy, and the various formulations afforded a wide range of kB^{-1} values. In fact, a few schemes afforded an aerodynamic resistance for carbon that was as large as canopy resistance. Consequently, differences of up to 300 mgC $m^{-2}year^{-1}$ were seen in the annual GPP. In addition, the incorporation of leaf area index with friction velocity in the kB^{-1} parameterization showed the potential to reduce systematic errors in the simulated GPP. However, overall model performance in estimating GPP, based on a Taylor diagram, did not change substantially with kB^{-1} parameterization.