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Plot scale variability in the diurnal patterns of transpiration at a montane forest site in the Fichtelgebirge, Germany

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To investigate the interactive effects of canopy structural and optical properties on vegetation/atmosphere exchange, validated models are necessary that allow for canopy heterogeneity in structure and physiological traits. We used a three dimensional (3D) canopy light absorptance model (STANDFLUX, Ryel et al. 1993, Falge et al. 1997) to illustrate how reflection and transmission properties of needles interact with canopy structure and produce probability density functions (PDFs) for light transmittance, transpiration, and net photosynthesis in horizontal canopy layers of the Weidenbrunnen site, a 54-year-old Picea abies (L.) Karst. stand. The stand is located in the Lehstenbach catchment, a subcatchment of the Eger catchment. Model parameterization was obtained for the intensive campaigns of the EGER project in fall 2007 and early summer 2008. Simulation results for the biosphere exchange of latent heat in the horizontal canopy layers were compared with analogous PDFs of latent heat fluxes as measured by eddy covariance above and below the canopy, yet limited by the ergodic assumption during the assimilation of eddy covariance data (time for space substitution). Comparisons of the model results with eddy covariance estimates for latent heat exchange are analyzed with respect to coupling stages of the subcanopy and canopy of this managed montane forest. 3D distribution of tree biomass are key for defining surfaces for source or sink strength of (trace) gases, and 3D irregularities in the canopy are crucial for defining potential flow paths for advection processes within the canopy. For the future, airborne photographs or remote sensing scenes for the Lehstenbach catchment must be evaluated together with extended model simulations to determine the spatial variability of biosphere gas exchange.

The results are a contribution to the EGER project (Exchange Processes in Mountainous Regions, Deutsche Forschungsgemeinschaft), which investigates the role of process interactions among different scales of soil, in-canopy and atmospheric processes for mass and energy budgets of vegetated surfaces.