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Multilevel Investigation of Subcanopy Respiration Flux by Relaxed Eddy Accumulation Conditional Sampling above and within a Spruce Forest

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This work investigates the subcanopy respiration flux (R_e), which reflects mainly CO_2 soil efflux, at the coniferous Weidenbrunnen FLUXNET site, located in the Fichtelgebirge Mountains (Northern Bavaria) and is applying a recently developed Relaxed Eddy Accumulation (REA) conditional sampling approach to high frequency eddy covariance data. Data was collected within the framework of the EGER (ExchanGE processes in mountainous Regions) project and during the first Intensive Observation Period (IOP1). The project is focused on the detailed quantification of relevant processes within the soil-vegetation-atmosphere system by observing diurnal and annual cycles of energy, water and trace gases. Five days were selected from IOP1 (20.09.2007 to 24.09.2007) and high frequency times series of wind vector , water vapor and CO_2 were recorded at five sampling heights below, within and above the forest canopy.

Eddies transporting respiration flux information from the ground to the air above the canopy are considered to possess a unique and detectable CO_2 and water vapor signature. Due to the characteristic vertical profiles of CO_2 and water vapor concentrations, they are enriched in CO_2 and water vapor compared to the mean concentrations measured above the canopy. The method used is based on the assumption that these eddies are transported past the sensor levels without being altered by surrounding eddies. It combines REA with hyperbolic dead bands and quadrant analysis, extracting the respiration events from the overall dataset. The overall REA formulation and its statistics were checked. The REA method is likely to overestimate fluxes due to overestimation of the β- coefficient used in relaxed eddy accumulation approaches. R_e- events were identified and extracted from the data with hyperbolic thresholds of H = 0.25 and 0.5. For daytime conditions and above canopy systems the results were in the same order of magnitude to expected respiration fluxes, with H = 0.5 yielding best results. The estimates at the below canopy systems and during nighttime conditions were too large. The time fraction of daytime respiration events was $<$ 10% and correlation coefficients ($r_{c,q}$) approached -1, resulting in periods with no respiration signal extractable (22% of daytime data). The R_e- signal above the canopy was correlated to net fluxes near ground, but the explained variance was small ($\sim$5%). Canopy storage of CO_2 seemed negligible, but partial reassimilation by understory vegetation might occur, leading to underestimation of respiration.