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Regional forest-atmosphere carbon exchange via atmospheric budgets and flux-tower upscaling

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An overarching goal of a long-term regional study of ecosystem-atmosphere carbon cycling in a mixed forest ecosystem in the upper Midwestern region of the United States is to develop methods needed to observe ecosystem-atmosphere exchange of carbon dioxide at scales relevant to the global carbon balance, yet small enough to allow the mechanisms responsible for the observed fluxes to be determined. The Chequamegon Ecosystem-Atmosphere Study (ChEAS) brings together chamber flux, sap flux and biometric measurements at the plot scale (1 m^2), multiple stand-level (1 km^2) eddy-covariance flux towers, landscape-scale (10-100 km^2) eddy-covariance flux measurements from the WLEF tall tower, multiple regional (10^3-10^5 km^2) atmospheric boundary layer (ABL) budget approaches using tall tower mixing ratio measurements, and a regional (10^5 km^2) ABL budget using a network of CO2 mixing ratio measurements. Flux measurements have been up-scaled to a regional scale using two independent methods and compared to ABL budget methods. This presentation 1) summarizes the methods recently applied to for this study, including nocturnal and daytime boundary layer budgets using tall tower CO2 profile data, and aggregation of flux measurements using forest classification schemes and stand-level flux data from either tall-tower flux footprint decomposition, or multiple stand-level flux observations; and 2) presents a comparison of these methods during the growing season. The top-down and bottom-up methods agree to within approximately 0.5 gC m^{-2} d^{-1} for regional growing season flux estimates. Major sources of uncertainty include the assumption of horizontal heterogeneity required for the simple atmospheric budget estimates, the accuracy of the footprint employed in the flux footprint decomposition, and the accuracy and sufficiency of forest classification schemes. This work is a component of the North American Carbon Program's midcontinental intensive regional study.