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Advection mechanisms and their impact on CO2 net ecosystem exchange at three CarboEurope forest sites

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Mean characteristics of the advective CO2 fluxes are presented in a first site-to-site comparison and the principal mechanisms that are responsible for these fluxes are investigated. Extensive field measurements were performed at three CarboEurope forest sites with different topography (Renon/Ritten, Italian Alps, Italy; Wetzstein, Thuringia, Germany; Norunda, Uppland, Sweden) to evaluate the relevant terms of the carbon balance by measuring CO2 concentrations and the wind field in a 3D multi-tower cube setup [1]. The same experimental setup (geometry and instrumentation) and the same methodology for the calculation of the advective fluxes were applied to all the three experiments in order to provide a reliable base for a comprehensive site to site comparison. We present mean diurnal/nocturnal courses of all relevant terms of the carbon balance equation, i.e. turbulent flux, storage change and horizontal and vertical advection. It is shown that all sites are affected by advection in different ways and strength. The size of the averaged non-turbulent advective fluxes was of the same order of magnitude as the turbulent flux measured by eddy-covariance technique, but with considerable scatter. Situations with and without advection were closely related to local or synoptic meteorological conditions, to land use patterns and the topography of the respective site. At the Renon site (alpine slope), advection is driven by a consistent slope wind system which results in positive advection during the night and slightly negative advection during the day. At the Wetzstein site (top of a ridge), advection occurs only during cross-ridge flows and can be explained with the theoretical framework of “flows over canopy covered hills”. Taking into account advection

for long-term NEE estimates at these two sites will reduce the reported CO2 sink. Things are more complex at the Norunda site, despite the nearly ideal conditions for EC-measurements (flat, good fetch). Large negative advection during calm and stable nights was observed together with considerably high CO2 concentrations and largest horizontal concentration gradients in the crown space, but the main steering process is still subject to speculations.

[1] Feigenwinter, C. et al., 2008, Comparison of horizontal and vertical advective CO2 fluxes at three forest sites. Agric. Forest Meteorol., 148, 12-24