Impact of CO$_2$ storage flux sampling uncertainty on net ecosystem exchange measured by eddy covariance

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Complying with several assumption and simplifications, most of the carbon budget studies based on eddy covariance (EC) measurements quantify the net ecosystem exchange (NEE) by summing the flux obtained by EC (FC) and the storage flux (SC). SC is the rate of change of CO$_2$ concentration, within the control volume below the EC measurement level, given by the difference in the quasi-instantaneous profiles of concentration at the beginning and end of the EC averaging period, divided by the averaging period. The approaches used to estimate SC fluxes largely vary, from measurements based on a single sampling point (usually located at the EC measurement height) to measurements based on several sampling profiles distributed within the control volume, either along a single profile or in the three-dimensional space. Measurement accuracy reasonably increases with the sampling intensity, though limited resources often prevent complex measurement systems.

In this study we use the experimental dataset collected during the ADVEX campaign in which turbulent and non-turbulent fluxes have been measured in three forest sites by the simultaneous use of 5 towers. Our main objective is to quantify the impact of SC uncertainty due to an inappropriate sampling on concurrent NEE estimates. Results show that different measurement methods may produce substantially different SC flux estimates. Consequences on half-hourly data are noticeable with underprediction that in the worst cases span from 20% to 65% and mean absolute errors equaling the 15-40% of the typical night-time FC fluxes. However, the effect of such errors on longer time-scales is sensibly reduced.