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Combining scintillometry and scalar turbulence measurements to obtain minute interval mass fluxes of H2O and CO2

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The goal of this study is to test an alternative method to determine turbulent H2O and CO2 fluxes, which has a faster statistical convergence than the classical eddy-covariance method. The reason to develop such a tool is that eddy-covariance is questionable under non-stationary conditions, e.g. in the intermittent stable boundary layer or rapidly changing cloud-cover. The eddy-covariance method requires an integration time of at least 20 minutes under statistically stationary conditions, see e.g. Aubinet et al. (2000). Under non-stationary conditions this record length may not be available. Howell and Sun (1999) showed that strength of intermittency increases with stability, but, surprisingly, intermittency also occurs under weakly stable conditions, see Kondo et al. (1978). Also, by taking extremely short flux averaging intervals of one minute or even less, we would like to investigate the response time of a crop in terms of the H2O and CO2 flux to rapid changing radiation conditions, i.e. rapidly changing cloud cover.

In our new method, that we forward as an alternative to eddy covariance, we suggest a hybrid set-up that combines a point-sensor for scalar H2O and CO2 with a dual-beam laser-scintillometer (DBLS). We used a LiCor7500 open path fast response H2O/CO2 sensor. The H2O/CO2 sensor forms the basis for estimating the turbulent exchange scale for H2O and CO2. The DBLS gives the friction velocity and stability. With the DBLS turbulence is averaged both in time and space allowing short averaging flux intervals down to a couple of seconds (Hartogensis et al., 2002).

We will discuss a number of path-ways to combine the scintillometer and point-scalar measurements and demonstrate their potential in obtaining short ($\sim$minute) interval mass fluxes of H2O and CO2. The first path-way is based on structure parameters of H2O and CO2. The second path-way uses the variance of H2O and CO2 and applies the ideas posed by De Bruin et al. (1999). The third path-way is based on the energy balance and requires additional measurements of net radiation and soil heat flux.

The data presented was gathered over a sugarbeet field during the third TR32 IOP of the 2008 measurement campaign near Merken, Germany.

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