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An analysis of the random error affecting CO2 fluxes measured by eddy covariance

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This study focuses on random errors associated with eddy covariance flux measurements. This error is heteroscedastic, increases linearly with the flux magnitude and the error on CO2 flux decreases with increasing wind speed. As random errors accumulate in quadrature, they are less critical than systematic errors as far as flux sums are concerned. On the other hand it may affect significantly half-hour data and pose problem for modelling or analysis of flux response to environmental parameters. It is therefore useful to characterize the site and the specific conditions under which the random error is the most important.

The random error on CO2 flux was computed at two sites, one cropland and one forested site, by using the daily differencing approach (DDA, Hollinger and Richardson 2005). Relationships with flux and wind speed were compared between different periods (day vs. night, growing season vs. rest of the year) and for different flux computation methods.

First, an increase of random error with decreasing wind speed was observed at low speed. This effect was not observed during the rest period at the cropland site and disappears when a high-pass filtering is applied to the data. It may be explained by two processes: on one hand, the below canopy air layer is less efficiently mixed which can create large flux variations when CO2 sources and sinks are separated. On the other hand, mesoscale motions may exceed small-scale turbulence at low wind speed. At similar wind speeds, the random error was lower at the cropland than at the forested site, which can be due to either process: indeed, at the cropland site, the distance between CO2 sources and sinks is smaller which reduce the low mixing effect but the site is also more flat and homogeneous which reduce the impact of mesoscale movements. The possibility of mesoscale movement impact is supported by the fact that the effect disappears when applying a high pass filtering.

The random error was also found sensitive to the computational method: in particular it is larger when the flux is computed using the block average rather than the running mean, it increases when storage is taken into account and decreases when data are filtered by applying stationarity screening or u* filtering.