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Unexpected sensitivity of the annual net ecosystem exchange to the high frequency loss corrections in a grazed grassland site in Belgium

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Although widely used to measure CO_2 and other gas fluxes, the eddy covariance technique still needs methodological improvements. This research focuses on the high frequency loss corrections, which are especially important when using a closed-path infrared gas analyzer.

We compared three approaches to implement these corrections for CO_2 fluxes and evaluated their impact on the carbon balance at the Dorinne Terrestrial Observatory (DTO), an intensively grazed grassland site in Belgium. The carbon balance at DTO is also the object of a separate analysis (Gourlez de la Motte et al., Geophysical Research Abstract, Vol. 18, EGU2016-6813-1, 2016). In the first approach, the computation of correction factors was based on the measured sensible heat cospectra ('local' cospectra), whereas the other two were based on theoretical models (Kaimal et al., 1972). The correction approaches were validated by comparing the nighttime eddy covariance CO_2 fluxes corrected with each approach and in situ soil respiration measurements.

We found that the local cospectra differed from the Kaimal theoretical shape, although the site could not be considered 'difficult' (i.e. fairly flat, homogeneous, low vegetation, sufficient measurement height), appearing less peaked in the inertial subrange. This difference greatly affected the correction factor, especially for night fluxes. Night fluxes measured by eddy covariance were found to be in good agreement with in situ soil respiration measurements when corrected with local cospectra and to be overestimated when corrected with Kaimal cospectra.

As the difference between correction factors was larger in stable than unstable conditions, this acts as a selective systematic error and has an important impact on annual fluxes. On the basis of a 4-year average, at DTO, the errors reach 71-150 g C m-2 y-1 for net ecosystem exchange (NEE), 280-562 g C m-2 y-1 for total ecosystem respiration (TER) and 209-412 g C m-2 y-1 for gross primary productivity (GPP), depending on the approach used.

This shows that the cospectrum choice is critical for frequency correction application and that local cospectra should be preferred to theoretical ones.

Keywords: Eddy-covariance, high frequency loss, cospectral correction, soil respiration, carbon dioxide flux, net ecosystem exchange.