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Uncertainties in Eddy Covariance fluxes due to post-field data processing: a multi-site, full factorial analysis

S. Sabbatini (1), G. Fratini (2), N. Arriga (1), D. Papale (1), and the Sites PIs and Collaborators Team
(1) Università della Tuscia, DIBAF, Viterbo, Italy (simone.sabbatini@unitus.it), (2) LI-COR Biosciences GmbH, Berlin, Germany

Eddy Covariance (EC) is the only technologically available direct method to measure carbon and energy fluxes between ecosystems and atmosphere. However, uncertainties related to this method have not been exhaustively assessed yet, including those deriving from post-field data processing. The latter arise because there is no exact processing sequence established for any given situation, and the sequence itself is long and complex, with many processing steps and options available. However, the consistency and inter-comparability of flux estimates may be largely affected by the adoption of different processing sequences.

The goal of our work is to quantify the uncertainty introduced in each processing step by the fact that different options are available, and to study how the overall uncertainty propagates throughout the processing sequence. We propose an easy-to-use methodology to assign a confidence level to the calculated fluxes of energy and mass, based on the adopted processing sequence, and on available information such as the EC system type (e.g. open vs. closed path), the climate and the ecosystem type.

The proposed methodology synthesizes the results of a massive full-factorial experiment. We use one year of raw data from 15 European flux stations and process them so as to cover all possible combinations of the available options across a selection of the most relevant processing steps. The 15 sites have been selected to be representative of different ecosystems (forests, croplands and grasslands), climates (mediterranean, nordic, arid and humid) and instrumental setup (e.g. open vs. closed path). The software used for this analysis is EddyPro™ 3.0 (www.licor.com/eddypro). The critical processing steps, selected on the basis of the different options commonly used in the FLUXNET community, are: angle of attack correction; coordinate rotation; trend removal; time lag compensation; low- and high- frequency spectral correction; correction for air density fluctuations; and length of the flux averaging interval.

We illustrate the results of the full-factorial combination relative to a subset of the selected sites with particular emphasis on the total uncertainty at different time scales and aggregations, as well as a preliminary analysis of the most critical steps for their contribution to the total uncertainties and their potential relation with site set-up characteristics and ecosystem type.