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Comparative analysis of matter and energy fluxes determined by Bowen Ratio and Eddy Covariance techniques at a crop site in eastern Germany

K. Brust, M. Hehn, and C. Bernhofer

TU - Dresden, Institute for Hydrology and Meteorology, Chair of Meteorology, Tharandt, Germany
(kristina.brust@tu-dresden.de)

The measurement of atmospheric fluxes is an important means to evaluate ecosystem exchanges. In 2009 and 2010, fluxes and gradients of heat, water vapour, and CO_2 over winter barley and rapeseed were measured simultaneously at the Klingenberg cropland site in Germany. A Bowen Ratio (BR) system was employed alongside to an existing Eddy Covariance (EC) tower. The BR system is required to account for the longer response time of the chemiluminescence analysers measuring other trace gases, e.g. NO_x.
To test and evaluate the application of the NO_x measurement setup, the two independent systems (BR/EC) are compared with respect to energy and CO_2 fluxes. We show a regression and differences analysis, diurnal cycles of the obtained fluxes, and interpret their coherence to the growth stage of the crops.
The regression analysis depicts that differences between the systems are largest for latent heat LE (BR detects apparently higher LE due to the forced closure of energy balance), whereby the matter fluxes of CO_2 show fairly little differences. Both measurement systems are able to capture the fluctuations of fluxes adequately well. Additionally, a multiple linear regression revealed that differences between the obtained fluxes are not induced by atmospheric conditions.
The results of the differences analysis for sensible and latent heat point out that the observed differences of fluxes between both systems are mainly due to deviations in the mean, while differences in variability and timing/shape are of smaller importance. The differences of CO_2 fluxes between both measurement systems are particularly caused by deviations in timing and shape, which can be explained with the linear cross-correlation coefficient (R^2=0.8). From the good results of the comparison of matter fluxes (CO_2) we conclude that the use of the Bowen Ratio method is applicable to other matter fluxes (like NO_x).