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Comparison of energy fluxes from eddy covariance and scintillometer over an agricultural field

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In this study we compare turbulent energy fluxes obtained from eddy covariance (EC) (LI-7500A, LI-COR + Windmaster, Gill Instruments) and large aperture scintillometer (BLS900, Scintec) over an agricultural field (wheat field, straw and bare soil). As the EC method provides direct measurements of sensible heat (H_{EC}) and latent heat (LE_{EC}) fluxes we use it as a reference method. The EC method enables to determine fluxes within a footprint centered around the point of measurement in the middle of the field. The scintillometer provides an estimation of sensible heat flux (H_{SC}), derived from air refractive index fluctuation integrated over the measurement path length, in this case 570 m diagonally across whole field. The reference measurements of the radiation balance components consist of 4-component net radiometer for net radiation (Rn) (NR01, Hukseflux), three soil heat flux plates for soil heat flux (G) monitoring (HFP01, Hukseflux), including thermocouples for quantification of the heat storage above the soil heat flux plates. The scintillometer-based latent heat (LE_{SC}) is calculated as a residuum from available energy (Rn-G) and H_{SC}, provided by scintillometer. The measurement of radiation balance components was located at the top of 3.5 m mast with the EC system, while the soil heat flux plates were collocated around in 5 cm depth. The site is a flat, rectangular agricultural field (app. 16.5 ha), in the north-eastern Austria, Danube river lowland (48.21N, 16.622E), sown with winter wheat during growing season 2019. The measurement campaign was established in February 2019 with aim for multi-seasonal monitoring. The EC measurement height is 2.7 m, the scintillometer transmitter and receiver are fixed on 4 m masts, facing towards each other from NW and SE corners of the field.

Comparison of the EC-based turbulent fluxes (H_{EC}+LE_{EC}) and the available energy (Rn-G) during the period March to Mid-June showed a very good agreement, resulting in the energy balance closure of 0.96 (R^2 = 0.93). This suggest high accuracy and robustness of the measurement setup together with the ability of the EC method to capture all scales of eddies responsible for energy transport at this site. The comparison of methods indicates that H_{SC} overestimated H_{EC} by 10 % (R^2 = 0.74) and LE_{SC} underestimated LE_{EC} by 13 % (R^2 = 0.81). Related to Rn, the H_{EC}, LE_{EC} and G fluxes accounted for 22 % (R^2 = 0.53), 59 % (R^2 = 0.70) and 15% (R^2 = 0.62) of the Rn flux, respectively. We assume that the combination of EC and scintillometer method has a potential to bring deeper insight into the analysis of the energy balance closure problem.