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The carbon budget of a winter wheat field: An eddy covariance analysis of seasonal and inter-annual variability

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Agro-ecosystems cover large areas of the global land surface. Hence, they show a high potential of mitigating greenhouse gas emissions while optimizing agricultural management. As a consequence, there is a strong demand in understanding carbon fluxes from arable land as affected by regional environmental and climate influences as well as management practices. In this study we used a two year data set of eddy covariance measurements (Oct. 2007 to Oct. 2009) on a winter wheat field located in Western Germany to assess the seasonal and inter-annual variability of carbon fluxes as affected by meteorological variables and land management. During the period under study, which was comprised of two full growing seasons, eddy covariance measurements together with various soil, plant, and meteorological measurements were performed. A combined flux partitioning / gap filling method including uncertainty estimates were applied with respect to short-term and seasonal effects to derive complete time-series of net ecosystem exchange (NEE) of carbon, gross primary production (GPP), and ecosystem respiration (Reco). Despite different management dates and meteorological conditions, annual NEE resulted in 270 ± 22 g C m^2 in both years. Although the period from sowing to harvesting was more than 20 days shorter in the first year, GPP was higher by ±220 g C m^2, mainly as a result of the later start of senescence. In the annual carbon budget this was compensated by a stronger heterotrophic respiration after the harvest of sugar beet grown on the field before the study period. Taking into account the carbon losses due to removal of biomass during harvest, the winter wheat field acts as a carbon source with respective net biome productivities (NBP) of 246 and ±201 g C m^2 $\pm a^1$. To complete the carbon balance relevant for global climate, carbon consumption required for field operationsand crop production (fuel, production of fertilizer, drying of grain etc.) are taken into account.