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Carbon budget over 12 years in a production crop under temperate climate

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Carbon dioxide (CO_2) exchanges between crops and the atmosphere are influenced by both climatic and crop management drivers. The investigated crop, situated at the Lonzée Terrestrial Observatory (LTO, candidate ICOS site) in Belgium and managed for more than 70 years using conventional farming practices, was monitored over three complete sugar beet (or maize)/winter wheat/potato/winter wheat rotation cycles from 2004 to 2016. Continuous eddy-covariance measurements and regular biomass samplings were performed in order to obtain the daily and seasonal Net Ecosystem Exchange (NEE), Gross Primary Productivity, Total Ecosystem Respiration, Net Primary Productivity, and Net Biome Production (NBP). Meteorological data and crop management practices were also recorded. The main objectives were to analyze the CO_2 flux responses to climatic drivers and to establish the C budget of the cropland.

Crop type significantly influenced the measured CO_2 fluxes. In addition to crop season duration, which had an obvious impact on cumulated NEE values for each crop type, the CO_2 flux response to photosynthetic photon flux density, vapor pressure deficit and temperature differed between crop types, while no significant response to soil water content was observed in any of them. Besides, a significant positive relationship between crop residue amount and ecosystem respiration was observed.

Over the 12 years, NEE was negative (-4.34 $\pm$ 0.21 kg C m-2) but NBP was positive (1.05 $\pm$ 0.30 kg C m-2), i.e. as soon as all lateral carbon fluxes – dominated by carbon exportation – are included in the budget, the site behaves as a carbon source. Intercrops were seen to play a major role in the carbon budget, being mostly due to the long time period it represented (59 % of the 12 year time period). An in-depth analysis of intercrop periods and, more specifically, growing cover crops (mustard in the case of our study), is developed in a companion poster (ref. abstract EGU2017-12216, session SSS9.14/BG9.46/CL3.13).

Although in line with preceding studies, the large C loss rate observed at LTO (NBP = + 87 $\pm$ 25 kg C m-2 yr-1) raises several questions as it corresponds to 1.8 % of the C stock in the top soil: is it realistic? Wouldn't it be affected by an undetected systematic error? If correct, could soil properties be preserved on the long term? This result at least calls for extensive C stock inventory for (in)validation.