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Soil trace gas emissions (CH4 and N2O) offset the CO_2 uptake in poplar short rotation coppice

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The need for renewable energy sources will lead to a considerable expansion in the planting of dedicated fast-growing biomass crops across Europe. Among them poplar (Populus spp) is the most widely planted as short rotation coppice (SRC) and an increase in the surface area of large-scale SRC poplar plantations might thus be expected. In this study we report the greenhouse gas fluxes (GHG) of carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N2O) measured using the eddy covariance technique in a SRC plantation for bioenergy production during the period 2010-2013. The plantation was established in April 2010 on 18.4 ha of former agricultural land with a density of 8000 plants ha-1; the above-ground biomass was harvested on February 2012 and 2014.The whole GHG balance of the four years of the study was 1.90 ($\pm$ 1.37) Mg CO_2eq ha^{-1}; this indicated that soil trace gas emissions offset the CO_2 uptake by the plantation. CH4 and N2O almost equally contributed to offset the CO_2 uptake of -5.28 ($\pm$0.67) Mg CO_2eq ha^{-1} with an overall emission of 3.56 ($\pm$ 0.35) Mg CO_2eq ha^{-1} of N2O and of 3.53 ($\pm$ 0.85) Mg CO_2eq ha^{-1} of CH4. N2O emissions mostly occurred during a single peak a few months after the site was converted into SRC and represented 44% of the entire N2O loss during the entire study. Accurately capturing these emission events proved to be critical for correct estimates of the GHG balance. The self-organizing map (SOM) technique graphically showed the relationship between the CO_2 fluxes and the principal environmental variables but failed to explain the variability of the soil trace gas emissions. The nitrogen content in the soil and the water table depth were the two drivers that best explained the variability in N2O and CH4 respectively. This study underlines the importance of the "non-CO_2 GHG" on the overall balance as well as the impact of the harvest on the CO_2 uptake rate. Further long-term investigations of soil trace gas emissions should also monitor the N content and the mineralization rate of the soil as well as the microbial community as drivers of the emissions.