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Fluxes of the greenhouse gases (CO_2, CH4 and N2O) above a short-rotation poplar plantation after conversion from agricultural land

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The increasing demand for renewable energy may lead to the conversion of millions of hectares into bioenergy plantations with a possible substantial transitory carbon (C) loss. In this study we report on the greenhouse gas fluxes (CO_2, CH4, and N2O) measured using eddy covariance of a short-rotation bioenergy poplar plantation converted from agricultural fields. During the first six months after the establishment of the plantation (June-Dec 2010) there were substantial CO_2, CH4, and N2O emissions (a total of 5.36 $\pm$ 0.52 Mg CO_2eq ha-1 in terms of CO_2 equivalents). Nitrous oxide loss mostly occurred during a week-long peak emission after an unusually large rainfall. This week-long N2O emission represented 52% of the entire N2O loss during one and an half years of measurements. As most of the N2O loss occurred in just this week-long period, accurately capturing these emission events are critical to accurate estimates of the GHG balance of bioenergy. While initial establishment (Jun-Dec 2010) of the plantation resulted in a net CO_2 loss into the atmosphere (2.76 $\pm$ 0.16 Mg CO_2eq ha-1), in the second year (2011) there was substantial net CO_2 uptake (-3.51 $\pm$ 0.56 Mg CO_2eq ha-1). During the entire measurement period, CH4 was a source to the atmosphere (0.63 $\pm$ 0.05 Mg CO_2eq ha-1 in 2010, and 0.49 $\pm$ 0.05 Mg CO_2eq ha-1 in 2011), and was controlled by water table depth. Importantly, over the entire measurement period, the sum of the CH4 and N2O losses was much higher (3.51 $\pm$ 0.52 Mg CO_2eq ha-1) than the net CO_2 uptake (-0.76 $\pm$ 0.58 Mg CO_2eq ha-1). As water availability was an important control on the GHG emission of the plantation, expected climate change and altered rainfall pattern could increase the negative environmental impacts of bioenergy.