Author reply to the comment by P.Ojanen on the manuscript

bg-2013-76: “A fertile peatland forest does not constitute a major greenhouse gas sink” by Meyer et al.

We thank P Ojanen very much for his constructive comment on the calculation of the soil C balance. We agree that for completion the term R_{LR} would need to be considered in the equation 5:

$ECO_2 = R_{SOM} + R_{LL} + R_{decay} + R_{LR}$

However, due to the trenching, all roots of all diameter sizes have been cut and are consequently decomposed by microbes. This flux is considered in the calculation of R_{decay}. Of course, we cannot exclude that root litter remains in the soil matrix, which has been decaying over the past years and of which minor tissue parts are still existing and are being decomposed (=R_{LR}). We are certain though, that this flux will be very small and negligible compared to the huge flux from the large amount of fresh trenched root litter. Nevertheless, it is of course “included” in the measurement ECO_2.

It was suggested that introducing the litter production from roots and aboveground plant parts (L_R and L_L) should be included in the calculation assuming non-steady-state. This would change equation 6 to:

$NEE = AGB_{inc} + BGB_{inc} + L_L + L_R - (R_{SOM} + R_{LL} + R_{LR})$

Instead of assuming steady-state between litter inputs and outputs:

$NEE = AGB_{inc} + BGB_{inc} - R_{SOM}$

R_{SOM} was estimated by a trenching experiment so that in the measured total efflux E_{CO2} the respiration from decomposing trenched roots is included ($R_{SOM} = E_{CO2} - R_{decay} - R_{LL}$). Considering L_R in the overall balance calculation arises a major problem: the flux estimate of R_{decay}, as well as the measured CO_2 efflux ECO_2, derive from the artificial experimental conditions from the trenching. A model assumption of L_R derives from an assumed undisturbed ecosystem since applied root turnover rates are estimated from actively growing roots (neglecting the impact the measurement of root turnover might have on the system). Thus, when both fluxes, R_{decay} and L_R are considered in the overall soil balance, we combine two fluxes deriving from “different systems” which will exclude each other: Roots which are trenched will not produce litter according to a modelled L_R and vice versa. The inclusion of L_R will therefore likely lead to an overestimation of the total litter input to the soil since the decay from fresh root litter is already considered in R_{deacy}. In any case, it will lead to a further uncertainty, which is not quantifiable. We are therefore convinced that under circumstances which allow to steady state, this approach will produce the more reliable result.

We agree though that the assumption of a steady state between soil inputs and outputs can be argued. To further elucidate the uncertainties, we alternatively calculate the soil C balance according to the suggestion of P Ojanen assuming non-steady-state and including root litter, however excluding the flux from R_{decay}, since these two fluxes cannot be considered together
so that:

$NEE_{calc} = AGB_{inc} + BGB_{inc} + L_L + L_R – ECO_2$

Root turnover is estimated by:
Fine roots:
0.34 -1.11 $year^{-1}$ based on Finer and Laine (1989) and Brunner et al (2012)
Coarse roots:
0.02 - 0.1 $year^{-1}$ based on minima and maxima given by Chen et al. (2001)

Result:
Mean total root litter
L_R = 5.9 (±3.4) t C $ha^{-1}a^{-1}$

Since
L_L = 2.9 (±1.0) t C $ha^{-1}a^{-1}$
ECO_2 = 13.0 (±1.7) t C $ha^{-1}a^{-1}$

$L_L + L_R – ECO_2$ = 4.2 (±3.3) t C $ha^{-1}a^{-1}$

since $AGB_{inc} + BGB_{inc}$ = 8.2 (±1.7) t C $ha^{-1}a^{-1}$
this results in an NEE of (=$AGB_{inc} + BGB_{inc} + L_L + L_R – ECO_2$)

NEE_{calc} = - 3.94 (±3.7) **t C $ha^{-1}a^{-1}$**

Due to high uncertainty in the chosen root turnover rates, the overall uncertainty amounts to the size of the flux itself. Assuming the lowest turnover rates produces an NEE very close to our estimate -0.2 t C $ha^{-1}a^{-1}$ including R_{decay} and assuming steady state.

Overall, assuming non-steady-state and applying a soil C balance calculation based on modelled root litter production is highly sensitive to the turnover rates chosen. Furthermore, the problem arising here is that the measured heterotrophic efflux (ECO_2) derives from a disturbed ecosystem, which has a bias due to trenched roots, i.e. it is likely an overestimation.

We therefore consider the assumption of a steady state and the inclusion of the additional flux from trenched roots as the more reliable method. A bias due respiration from older root litter which decomposes in the soil matrix cannot be excluded. But at the current state of knowledge we see no better approach to get an estimate of the heterotrophic CO_2 efflux.