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Interactive comment on "The importance of micrometeorological variations for photosynthesis and transpiration in a boreal coniferous forest" *by* G. Schurgers et al.

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We would like to thank the reviewer for the judgement of our work, and for providing useful remarks for improving our manuscript. Below, the reviewer's comments are answered. For a submission of a revised version, a detailed list of changes to the manuscript will be provided together with these comments.

p. 12446/15-16:
The fact that part of the analysis is conducted on 5-day periods is only mentioned later in the results section (from p.12453/15). It would be good to adapt the text in order not to confuse the reader.

The 5-day period mentioned here is not related to the 5-day periods that we use as case studies. For the subtraction of the respiration, the whole data set is distributed in periods of 5 days to compute a temperature dependence that is specific for the time of year. Apparently, this has raised confusion, and we will alter the section to clarify this.

p. 12448/6:
"Instead" is here confusing, since you do use the 2004-2010 data to derive your 'updated' fdif-ftrans relationship.
Sentence will be altered, and "However" will be removed from next sentence as well to read "The latter were used to reparameterize a relationship between . . . by Spitters et al. (1986). The boundaries between ..."

p. 12449/12:
Could you provide the equation used to get J?
J is computed as

$$J = \frac{I + J_{max} - \sqrt{(I + J_{max})^2 - 4\theta I J_{max}}}{2\theta} \quad (1)$$

Equation will be added to the manuscript.

p. 12449/16-18:
The sentence is difficult to understand at once, consider rephrasing it (e.g., replacing "here" by "in Eq. (3)", etc.). In addition, "all respirations" or "all respiration components" would be more correct.
Sentence will be altered to "Because of the comparison with the NEE-derived photosynthesis flux, which has all respiration components subtracted, there is no accounting for the leaf's dark respiration in the computation of A_c or A_j."

section 2.2.2:
How is the transpiration flux modelled ?
The transpiration flux was computed as a function of the concentration gradient of water vapour between the stomata (assumed to be saturated) and the canopy air, applying

the stomatal resistance (based on the stomatal conductance) and the aerodynamic resistance in series. This will be added to the manuscript.

p. 12454/7-8:
Any thoughts on why ?
Vertical mixing and advection are presumably less during nighttime, which would cause the larger difference between within-canopy and above-canopy conditions.

p. 12454/16-20:
Is there a corresponding figure ?
No, because of the small difference between the simulations, we did not consider it necessary to show. Statement "(not shown)" will be added to the sentence.

pp. 12454/21-28 - 12455/18:
From the time series (Fig. 5d), no large differences between the different cases are visible. The relative deviation plotted in Fig. 5e and 5f is indeed much clearer, but their references come too late in the text. In addition, please consider dividing the long sentence p. 12455 1-6 into shorter sentences.
In the revised version, Figs. 5e and 5f will be introduced earlier, and the sentence will be broken into shorter ones: "However, when applying within-canopy (8.5 m, simulation HOM_HUM_IC) or above-canopy (28 m, simulation HOM_HUM_AC) humidity instead of the canopy-average value (Fig. 5d), transpiration can be over- or underestimated within the canopy (Fig. 5e-f), in particular in late evening, night and early morning, in line with the observed gradients for humidity (Fig. 5a). The lower humidity above the canopy, which causes the largest deviations, causes an overestimation of transpiration of up to 80% during the abovementioned time of the day (e.g., during the night from 19 to 20 May). Applying the above-canopy conditions yields reasonable results in the top of the canopy, but overestimates transpiration in the lower canopy (Fig. 5e). The use of within-canopy humidity causes reasonable results for the lower canopy (with no deviations for the actual height of the measurements, 8.5 m), but with the top of the canopy depicting an underestimation of transpiration (Fig. 5f)."

p. 12455/16-20:
This statement/summary is somewhat too blunt, as its demonstration only comes later in the same section...
The statement here refers to a similar analysis for temperature (on an annual basis) as given above for humidity. We have added a statement "(not shown)" to this sentence as well to clarify that.

p. 12457/2:
"optimal" is a rather subjective term here, all the more that the LUE distribution results in this case from a modelling inconsistency.
"Optimal" was not chosen well here. What we meant to say was a homogeneous (or even) distribution of the light, which results in the highest (or optimal) light use efficiency. This will be changed.

p. 12457/12:
"linear" might be more descriptive than "even".
"even" will be replaced by "homogeneous".

p. 12457/14-18:
Why don't you use the same criterion of clear/cloudy days as in Fig. 7 ?
Figs. 7 and 8 will be altered to use the same criterion (clear conditions are defined as $f_{dif} < 0.5$; cloudy conditions as $f_{dif} >= 0.5$ - this has the advantage as well to include all data, not leaving out a certain range of fractions), this has little impact on the outcome. The distinction between solar angles, as made in Fig. 7, is not possible for Fig. 8, because Fig. 8 applies CO_2 assimilation and PAR integrated over the entire day.

p. 12458/3:
Aboveground autotrophic respiration also occurs at night.
Sentence will be altered to "... during nighttime, when CO_2 assimilation has stopped, but heterotrophic and autotrophic respiration continue, while vertical mixing is reduced

in the canopy."

p. 12458/18-19:
I would rephrase this part of the sentence to make it clearer, e.g. : [...] photosynthesis largely takes place at the top of canopy, where the relative deviation of CO_2 concentration from the above-canopy value is small (Fig. 9c and e) [...]".
Will be changed accordingly.

p. 12458/25-28:
I do not understand this sentence. If stomata are closed in the model as described in (3), how can the transpiration be overestimated ?
This sentence indeed contains a mistake and should read "In the cases where photosynthesis is underestimated in the lower canopy, the simulations yield an underestimation of traspiration as well because of the lower CO_2 concentration."

section 3.5:
It would be good to better define the different variability metrics used here (and maybe the sample size), e.g. by completing the end of section 2.3.
Section 2.3 will be expanded to explain the computation of the variability metrics: "The simulated temporally varying vertical profiles of CO2 assimilation and transpiration were averaged per day and integrated over the canopy (AHET), averaged per half-hourly period of the day and integrated over the canopy (DHET), or averaged over both days and hours for each layer in the profile (HET), and the distributions (presented as percentiles) were computed." Moreover, sample sizes (AHET: 277 – not all days had sufficient half-hourly values to be taken into account; DHET: 48; HET: 25) will be added to the figure caption of Fig. 10.

Section 4:
The authors shoud consider rewriting the discussion section. Indeed, at present it mostly appears to be a summary of the results sections (especially the first paragraph) to which are added results from the litterature without clearly making

the link with the discussion of the present results. The first paragraph should go to the conclusions, while reorganizing the later paragraphs would make much clearer the authors' reflexion with respect to the current scientific state of the art, and potentially increase the impact of this study.
The discussion section will be altered as suggested, with less repetition from the results and a more direct comparison of the results with the literature.

p. 12465/3:
This is a rather strong assumption, so that it would be good to have some justification and/or associated references.
A uniform distribution over all leaf angles (spherical or isotropic distribution) is a common assumption to describe a generic canopy in large-scale models, see e.g. Cowan (1968) or Leuning et al. (1995). References will be added to the text.

Technical corrections
We thank the reviewer for the technical corrections, these will be addressed in the revised manuscript.

References

Cowan, I. R.: The interception and absorption of radiation in plant stands, Journal of Applied Ecology, 5, 367–379, doi:10.2307/2401567 , 1968.

Leuning, R., Kelliher, F. M., De Pury, D. G. G., and Schulze, E. D.: Leaf nitrogen, photosynthesis, conductance and transpiration: scaling from leaves to canopies, Plant, Cell and Environment, 18, 1183–1200, 1995.

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