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Biogeosciences Discussions

Interactive comment on "CloudRoots: Integration of advanced instrumental techniques and process modelling of sub-hourly and sub-kilometre land-atmosphere interactions" *by* Jordi Vila-Guerau de Arellano et al.

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Response to reviewer RC1

Answer: We thank reviewer 1 for the thorough reading and his/her comments. We have taken the majority of his/her comments into account. Below (and in blue) we have provided a point-to-point responses.

The authors proposed a concept of CloudRoots to investigate CO2 and H2O transfers from a leaf scale to the regional scale, connecting results from various techniques of

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different spatial scales. The authors' intention to bridge researches from multiple disciplines at different scales together is novel because doing so is essential for further understanding land-atmosphere interaction. Many interesting results and insights are introduced across the manuscript, and I suppose the work will give a great contribution to land-atmosphere interaction research. Let me provide some comments that hopefully improve the manuscript.

Page 1 L20 (and related to photosynthesis parameters) I suppose the necessity of accurate leaf parameters to describe photosynthesis and stomatal conductance is such an obvious fact, and I am afraid if it can be any interesting finding. Instead, can the authors provide any insights with respect to how accurate leaf parameters are important for ABL? Leaf parameters greatly vary even among C3 plants (e.g., Miner et al., 2017), and it is quite common to see a global-scale terrestrial ecosystem model using different leaf parameters by different vegetation types (e.g., Sun et al., 2014). The original article by de Pury and Farquhar (1997) already manifests the importance of N effects on a photosynthetic capacity, and that may explain a large part of the differences in Am and alpha0 between the campaigns listed in Table 3. If the authors discuss how tuned leaf parameters affects ABL, I tempt to suggest looking at a parameter that determines stomatal conductance in the A-gs model in addition to two parameters already introduced. I suppose f0 is the one (P247 in Vilà-Guerau de Arellano et al., 2015), and it can be determined by the outputs of LI6400. For example, Ikawa et al., (2018) reports a leaf parameter for stomatal conductance (ml in their paper in Table 4) of rice considerably affects ABL temperature.

Answer: Following the advice of the referee we have extended and elaborated more on the impact of the optimized constants of the A-gs model using the CloudRoots data on the surface fluxes and the boundary layer height. We have added new information in section 3.6 to show that indeed the new constants used in the photosynthesis and stomatal resistance model presented at Table 3 influence and improve the model results compare to the observations. In particular, light-use efficiency ($\alpha0$). A reference is also included to show the relevance to connect leaf processes to surface and boundary-layer scale processes. To further support this we have included two new figures in the supplementary material to show the different on the evolution of fluxes and boundary-layer height between the default and the optimized CloudRoots constants.

L25 resolution of?

Corrected

L26 non-linear behavior to what?

Corrected L28 please spell out ET when introduced for the first time

Corrected

L29 inferred

Corrected

Page 2

L2 evapotranspiration of total ET?

Corrected L9 Isn't "stomatal responses" a part of "surface and boundary-layer dynamics"?

We have rephrased the sentence

L17 Similarly, "wind" is a part of boundary-layer dynamics? It may be better to replace "BL dynamics" with other specific terms.

We have rephrased the sentence

L22 first is redundant

Corrected

L24 How large is a grid of weather and climate models?

We have included this information.

Page 3

L10 diurnal variability of CO_2-H_2O flux partition

Corrected

L17 first is redundant

Corrected

L24 evapotranspiration or ET? Are they different?

Corrected

Page 6

L5 mm instead of mm m-2, assuming 1 gram of H_2O is 1 cubic centimeter. [0.1g]/[(0.2ˆ2*pi/4)m2] = [0.1cm3] /[(0.2ˆ2*pi/4)m2] = 0.1/ (0.2ˆ2*pi/4)/1000 mm

We have corrected the units.

L21 were

Corrected

L23 which leaf? Fully expanded? Or totally random in a canopy?

Corrected

L28 Please use the SI unit instead of ppm for CO_2 concentration.

Corrected

Page 7

L1 Parameterization based on a rapid A-Q curve depends on stomatal conductance. I advise to include an average gsw value during the measurement of PAR = 0 – 200 umol m-2s-1.

Answer: https://www.licor.com/env/support/LI-6800/topics/rapid-light-curve.html We have included these information in the paper

L14 superscript -2

Corrected

Page 8 Answer: Following the advice of the referee we have rewritten part of section 2.3.6 on the description of the scintillometer observations and the data analysis behind it,

L15 Considering the expertise of the authors, I will leave it to them whether to call it MO length or O length. http://glossary.ametsoc.org/wiki/Obukhov_length

We have corrected the name of the length scale: Obukhov length scale

L15-16 Please check the sentence.

We have rephrased the sentence L22 Please check the sentence.

We have rephrased the sentence

Page 9

L11 2.105 may be too precise.

2.105 was incorrect. We have put the right value. It is 2.4 m.

Page 10

L22 were

Corrected

L5 what surface? Plant-canopy?

Corrected

L19 Fig. 5

Corrected

L24 Table 3 and it is already mentioned in L20.

Corrected

Page 12

L27 Without knowing local time (or solar time), it is difficult to catch up discussion.

We have added the times to facilitate the reading

Page 13

L6 Fig. 3

Corrected

L10 How was latent heat flux from EC? Was it also high in IOP3 despite small gsw?

We have added additional information on the latent heat flux measurements observed during IOP 3 (still with large values of ET). The large decreased of ET occurred one week later.

L18 internal CO2 concentration

Corrected

L25 Fig. 5

Corrected

Page 14

L10 subscript 2

Corrected

L20-21 The presence (and not absence) of the local maxima increases thermal stability?

Corrected

Page 15

L7 Please check the unit

Corrected

L16-17 Please note that detail profile does not necessarily provides accurate values of gross primary production at least given our limited knowledge of plant canopy micrometeorology, though the profile approach is still useful for understanding mechanisms (e.g., Drewry et al., 2014).

We have rewritten the sentence to be more precise and we have included the reference

L19 soil respiration or Rs?

Corrected

L26-27 Ep?

It has been clarified

L27 What is the sub-optimal performance?

We have added a sentence to explain better the sub-optimal performance. It is due to the assumptions in the partition method. Figures 7 and 9 have been also updated to correct some typos in the legends.

Page 16

L25 It is a quite interesting topic that LE and CO_2 flux behave differently under diffuse and direct radiations. Can CO_2 flux also be included in Fig 10 to ensure the opposite pattern? It may be worth looking at a bulk stomatal conductance estimated from latent heat flux to delineate the effects of conductance and VPD (e.g., Dolman et al., 1991).

Answer: Following the advice of the referee we have included an complementary figure to show the effect of clear and cloudy skies on the net primary production as a function of the photosynthetic active radiation during the same period. Section 3.3.1 has been modified accordingly.

Page 17

L6 reaches

Corrected

L7 I prefer to know this information of time earlier.

We have placed the sentence before to facilitate the reading

Page 20

I am afraid 3.4.2 needs a substantial improvement in the clarification. I was totally lost in the latter part of 3.4.2 and not able to understand how ET was estimated from SIF in Fig 16. I was not also able to understand what information authors want to convey by Fig 15. What is the correlation? It does not look like a correlation coefficient (0-1), and I do not see any relationships between x and y-axis either.

Answer: Following the advice of the referee we have rewritten the entire two sections to determine the variability of ET on space. We have divided the use of SIF in two sections: temporal and spatial variability. For the latter, we have rewritten the entire section 3.5 to explain better the method and the correlation between the estimations of ET and the SIF measurements. A more simple ne figure 15 has been made to facilitate the visualization of the relationships between ET and SIF.

Page 21

L4 delete “it”

Corrected

L23 H or SH? Also some are italic and some are not.

We have been more consistent. It should be H.

L27 Can it be simply because that the greater the net heat received by both horizontal and vertical fluxes (surface flux and advection), the faster the ABL height grows?

Answer: Our explanation was referring to the sensible heat flux. The advection of warmer air leads to a reduction of H since the gradient between the skin temperature and the atmospheric temperature reduces.

Page 22

L26 I apologize in advance for the lack of knowledge in the operational theory of scintillometer, but is the scintillometer measurement free from the concern of low frequency component? The spatial scale of 86.8 m over 60 secs by the Eurasian measurements may be still smaller than the low-frequency scales that would not be captured by EC measurements (greater than a spatial scale that would be inferred by the scale of tower height, wind speeds and time periods of 30 mins)?

Answer: As mentioned before section 2.3.6 has been rewritten to gain clarity. In short: The scintillometer method is based on structure parameters which are defined in the inertial range of the turbulent spectrum. Scintillometers determine the structure parameter looking at roughly one eddy size and average that effect in both time (relatively short compared to EC) and space (relatively long compared to EC). Essential to the method is that in contrast to EC it does not rely on resolving all eddy scales that contribute to the flux. The method does rely on MOST to link structure parameters to fluxes.

Answer: There was some text in the method section (2.3.6) on this:

Answer: "The added value of DBLS fluxes over the traditional EC method is that they

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converge to statistically stable flux estimates at much shorter flux averaging times of 1 minute or less, while the EC technique typically requires flux averaging times of 10 to 30-minutes (Hartogensis et al, 2002; van Kesteren et al., 2013b)."

This has been extended with:

"The essence behind this is that the flux estimate is based on structure parameters which are defined in the inertial range of the turbulent spectrum. As such the flux estimates rely on a limited range of the turbulent scales that contribute to the flux rather than all as is the case with the EC method."

Page 24

P24L16 those for the Corrected

Page 25

L1 It sounds contradicting to the importance of using accurate leaf parameters. Maybe the variations of crop coefficients (K) are so small among different vegetation covers (0.7-1.1) compared to the difference between vegetative and non-vegetative (0 – 0.2) areas (Table 4)?

Answer: The section has been completely rechecked and rewritten. It now included a new classification of the land-use around CloudRoots.

Figs and Tables

Fig 4 Check the number of the fig.

Corrected

Fig. 7 I assume the dashed lines are canopy heights.

We have added this information in the figure caption

Fig. 16 Was this ET estimated by SIF? I still did not understand how it was estimated.

We have clarified this in the new section 3.5

Table 1 Height of wind measurements?

We have indicated in the caption of Table 1 that all the meteorological measurements were obtained at the height of 2.4 $\pm$ 0.1 m.

Table 2 Please check units.

Checked and corrected

Table 3 Which was determined by A-PAR and which was by A-Ci?

We have added this information

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