Response to reviewer # 2 of the manuscript "On the impact of canopy environmental variables on the diurnal dynamics of the leaf and canopy water and carbon dioxide exchange" by González-Armas et al.

First of all, we would like to thank the anonymous reviewer for his/her constructive assessment of the manuscript. We have considered the points raised by the reviewer and adjusted the manuscript accordingly. For clarity, the specific comments of the reviewer are repeated in black font and then addressed by us in blue font. In *italics font and between quotation marks "",* we write how we plan to modify the manuscript. From that text, we use blue to indicate parts of the non-edited manuscript that will remain the same, in ~~red and crossed format~~ we indicate parts that will be removed in the edited version and in green font new additions.

Comments

The paper uses the field data on the alfalfa and modelling to study the CO2 and water vapor exchange at leaf, canopy and boundary-layer scales. The observations carried out on one clear day were further perturbed by inducing a cloud passage, entrainment of dry air and advection of cold air by the model. In addition, the tendency equations were used to explain the revealed responses in the exchange rates.

The paper is generally very clearly written and brings an important insight by its original approach. I have only the following minor comments regarding the first part of the paper and Results and Discussion parts are clear in their message:

1. Lines 44-45: The scales are explained. Is there any certain horizontal larger scale for analyses, especially for advection?

   As pointed out, there are multiple scales that affect the state of the atmospheric boundary layer (ABL) at La Cendrosa and thereby also the surface fluxes. As mentioned by the reviewer, there are different regimes of advection of heat and moisture, for instance, sea breeze is regularly present over La Cendrosa. More details about salient weather characteristics of the region are presented by (Boone, et al., 2021). The area is also subject to thermal heterogeneity due to the presence of an irrigated region and a rain-fed region. We considered these larger scales into our coupled land-ABL model through the addition of some terms in the governing equations. Those terms are mainly advection of specific humidity and heat, the lapse rates of scalers of the free troposphere and the jumps of the scalars. Our approach was similar to that used by (Mangan, et al., 2023) to quantify and distinguish surface fluxes depending on the local, landscape or regional dominant scales. And in our present research we focus on the fluxes from the leaf up to the local scale. Additionally, in Fig. 1 of the manuscript, we introduce the main spatiotemporal scales involved in our study.

   To acknowledge this point, we have decided to include a sentence in the introduction:

   (In the introduction, lines 51-54)

   "The ABL reacts to the dynamics of the surface and imposes forcings to it. Apart from surface processes, the ABL state also depends on non-local processes such as

entrainment of air from the free troposphere, advection of heat and moisture, and subsidence motions created by the influence of synoptic weather patterns."

2. Fig. 1: TRleaf and An should be explained in Fig. caption. Why two arrows in the middle picture are not arrows but just triangles? To which solid and dashed lines are referred to in the caption? They are not lines but arrows.

   We agree with the comments and consequently, we have edited the caption and figure. Firstly, we have introduced TR_{leaf} and A_n in the caption. Secondly, the two triangles have been replaced by arrows in the new edited figure. Lastly, we have rewritten the part of the caption related to the solid and dashed arrows since, thanks to the comments, we have realized that it was not clear. The edited caption reads now as:

   "Figure 1. Scheme of the three levels considered to study the exchange of water (represented in blue arrows) and carbon (represented in black arrows): (1) leaf level, (2) canopy level and (3) atmospheric boundary layer. The exchanges of water and CO_2 at leaf level are represented by the leaf transpiration (TR_{leaf}) and net CO_2 assimilation (A_n) respectively. At the atmospheric boundary layer level, several processes are included in the scheme such as advection of heat and moisture, and entrainment of air from the free troposphere. Advection and entrainment are indicated by solid arrows if they are contributing to higher concentrations of water or CO_2 in the boundary layer and dashed arrows if they contribute to lower concentrations. ~~*Solid lines represent a positive contribution whereas dashed lines represent a negative contribution.*~~ *In the scheme, we represent advection of moist and CO_2 enriched air and entrainment of drier and CO_2 depleted air from the free troposphere.* ~~*Note that the opposite can also occur. The entrainment of free tropospheric air generally introduces drier and CO_2 depleted air from the free troposphere and that is why it is represented with dashed lines*~~*."*

3. Line 108, Are there some more reasons for selection of that one day, beside that it is cloudless?

   The main reason to choose the 17/07/2021 as our studied day is because intensive leaf gas exchange measurements (shown in Fig. 4 of the submitted manuscript) were carried out. The other days, detailed information about the leaf gas exchange at La Cendrosa was missing.

4. Line 181, Was the measured LAI the total all-sided or half-sided or the projected one?

   LAI was estimated with the ceptometer called ACCUPAR LP-80. The measurement of LAI was indirect because we do not measure leaf material by collecting samples. Instead, LAI was estimated based on an optical method. The instrument consists of two parts that measure PAR: (1) an external PAR sensor and (2) a probe containing 80 independent sensors, spaced 1 cm apart. The external PAR sensor was placed above the canopy to register the incident radiation whereas the probe was placed below the canopy. That measurements are used to estimate the canopy transmittance and to finally infer LAI with certain model that is explained on section 9.3 of the instrument manual (Decagon Devices, Inc., 2013).

The measured LAI with this method is an effective LAI because it is assumed that leaves are randomly distributed (Fang, Baret, Plummer, & Schaepman-Strub, 2019). Generally, LAI is defined as one half of the total green leaf area per unit horizontal ground surface area. That quantity is what the optical method aims to quantify. However, by inferring LAI from the PAR canopy transmittance, it is not distinguished the shade caused by a green leaf than that caused by any other vegetative tissue. Regarding classifying the measured LAI as half sided or projected LAI, (Barclay, 1998) classified the methods that infer LAI from canopy transmittance with similar instruments as projected LAI of inclined leaves.

5. Table 2: why the unit for the thermal diffusivity is missing?

   It was a mistake. Now, we have added to Table 2 the units of thermal diffusivity of the skin layer which are: W m^{-2} K^{-1}.

6. Table 3: why the cuticular minimum conductance is unitless?

   This was also a mistake. We have now added the units to Table 3 which are: m s^{-1}.

7. Why is the CO_2 compensation concentration value multiplied by the density of the air?

   The multiplication was performed as a unit conversion to transform from ppm to a density. The density units are the ones used in the equations of the A-g_s model (Ronda, De Bruin, & Holtslag, 2001). However, we think that indicating this conversion in Table 3 can be misleading. Because of that, we have opted to write the variable in ppm units since those are the most common units used in literature.

8. Lines 277-278: I don't understand the meaning of "but we did not…present in observations.".

   In this piece, we wanted to explain two things. The first was that the radiative perturbation of the PAR-CLD sensitivity experiment was inspired on measurements during another day of the campaign were clouds present. In the revised manuscript, we have included information of this cloudy day in the Supplementary Material. The second point was that we did not represent sudden changes in radiation in PAR-CLD experiment. That sudden changes are also generally observed in cloudy conditions. However, we opted to not include them because in our model the stomata react instantaneously to the environmental variables. Because of that, fast changes in radiation may cause the tendencies to diverge and obscure their interpretation.

   Unlike the first point, we think the second point regarding fast fluctuations fits better the discussion section rather than the methods section. Because of that, we have finally decided to remove it from methods and mention it only in discussion section (lines 451-452).

Bibliography

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