Reply

In blue we copied the referee's comments, in black our reply.

General comments

This paper deals with an interesting phenomenon, visible vapor plumes from wet forest. It is commonly seen in Japan at the time of rainfall and/or just after the cessation of rainfall. It is often observed from my office, and one of my colleagues and I have tried to make a plan to observe it. Even so, we could not come up with the idea and approach to clarify the conditions or mechanisms. Though authors used conventional instrumentation, the results are clear and reasonable. Now that authors have shown the methodology, we realize how apparent it really is. Anyway, authors succeeded in clarifying the conditions and the mechanism that the plumes are formed, though there are still many unknown processes to elucidate. I appreciate the smart way of observations and analyses. This manuscript is well written and is worth publishing in this journal with minor revision.

Reply:

The authors appreciate the time and comments given by the referee. Indeed, this process happens worldwide in different ecosystems and climatic conditions. However, there is few research done about it. We will include all the suggestions and corrections in the revised version of the manuscript.

Specific comments

1) Page 1, Introduction

There are some researches that show evaporation from forest works as a moisture pump that transports water vapor from the ocean to the inland on a continental scale (Makarieva and Gorshkov, 2007; Makarieva et al., 2013a). Those studies claim that the amount of precipitation in the inland of the continent covered with forest is almost the same with that at the coastal area because of the biotic pump mechanism. Please cite those papers.

Reply:

We appreciate the suggestion of adding the "biotic pump mechanism" in the introduction. We will improve the introduction with the following modifications:

Page 1, Line 17:

"… 2007), where the forest presence at continental scale induced the "biotic pump mechanism" that favored the maintenance of similar precipitation amounts between inland and coastal environments (Makarieva and Gorshkov, 2007; Makarieva et al., 2013a). Meanwhile, the vertical transport …"

Page 1, Line 18:

"… (Trzeciak et al., 2017) that in large ecosystems influence the formation …"

Page

2) Page 6, line 5

"The parameters ΨS and ΨL were determined using the vapor pressure deficit of the air on each height (Stull, 2016)". ΨS is calculated using the vapor pressure deficit (even if it is zero), but how is ΨL estimated? Under the condition of visible vapor plumes the relative humidity (RH) is 100% or more and the vapor pressure deficit is zero. I tried to find the method in Stull (2017; the 2016 version has been revised and seems to be unavailable), but could not.

Reply:

The estimation of both parameters is available in “Section 4.3 Total Water” of Stull (2017). You can check this url to access the document: https://www.eoas.ubc.ca/books/Practical_Meteorology/
It is important to mention that the parameters Ψ_s and Ψ_L are referred in Stull (2017) as r_s and r_L. Now that is available the revised version, we will update the references with Stull (2017). Here, it was a description mistake from our side. Instead of using the VPD, we used the saturation and actual vapor pressures to determine both parameters. Consequently, we propose to improve the sentence in page 6, line 5. Also, we will include the required equations to estimate these two parameters. The sentence improvement goes as follow:

“… The parameters Ψ_s and Ψ_L were determined with equations 7 and 8, respectively. These equations requires to know the mass of the liquid water in the air ($m_{\text{liq.air}}$), the mass of the dry air ($m_{\text{dry.air}}$), the density of the air (ρ_{air}) and the density of the liquid water content of the air (ρ_{LWC}). These variables were determined using the saturation and actual vapor pressures of the air (Stull, 2017). …”

$$\Psi_s = \frac{m_{\text{liq.water}}}{m_{dry.air}} \qquad (7)$$

$$\Psi_L = \frac{\rho_{\text{LWC}}}{\rho_{air}} \qquad (8)$$

3) Results and Discussion
RH in the visible vapor plumes is 100% or more, i.e. saturation or super saturation. However, the plumes continue to grow and evaporation does not stop, because plumes are not stagnant but are moving upward; water vapor along with visible vapor plumes are removed toward the higher altitude due probably to the mechanism proposed by Makarieva et al. (2013b), i.e. condensation in clouds with drastic reduction in volume of vapor caused by the phase change. At the same time some part of the ambient air is unsaturated, and I think splash droplets keep evaporating because of this unsaturated air. The negative temperature gradient may be caused by the latent heat of vaporization of splash droplet evaporation in the canopy, but it is difficult to know if it is the result of the evaporation or originated from other causes. Authors described visible water vapor plumes only from phenomenological point of view, but the above-mentioned inferred mechanisms that plumes are maintained is worth describing.
Reply:
Thanks for pointing out these mechanisms that complement the “splash droplet evaporation” process during the formation of visible vapor plumes. We will include them in page 8, line 32 as follows:

“… As plumes are not stagnant and continue moving upwards thanks to air convection, the water vapor is removed from the understory towards higher altitudes. The water condensation at the canopy level drastically reduced the volume of water vapor due to the phase change (Makarieva et al., 2013b). This allowed the ambient air to remain unsaturated and keeping the “splash droplet evaporation” process providing continuously more water vapor. ”

4) Page 7, line 19
"because of its timing"; this expression is ambiguous and difficult to follow what it meas. Please add a sentence to explain the detail, like "i.e. mist might be formed early in the morning 2018-03-21 and 2018-03-22 but the time lapse video did not work at those times (Table B1)."
Reply:

Thanks for pointing out this phrase. Following your recommendation we will add the following sentence in page 7, line 19:

"…7:00 a.m. Mist might be formed early in the morning during the sampling dates 2018-03-21 and 2018-03-22. However, the time lapse video did not work at those times (Table B1). These mist …"

5) Page 8, line 28
"there are two sources of aerosols at LSBS". Please add one more source of aerosols. Recent studies proved that a numerous number of bioaerosols are released from forests upon rainfall. For example, Huffman et al. (2013) mentioned in Conclusions, "Our observations indicate that rainfall can trigger intense bursts of bioparticle emission within the forest canopy and massive enhancements of atmospheric bioaerosol concentrations by an order of magnitude or more, from the onset of precipitation through extended periods of high surface wetness after the rainfall (up to one day)." Bioaerosols are integral source of aerosols relevant to rainfall in forest, and please cite paper(s) dealing with this issue at least Huffman et al. (2013).
Reply:
Thanks for this suggestion. We will improve the discussion with the following improvements and additions:

Page 8, line 28:
"… there are different sources of …"

Page 8, line 29:
"… Loescher et al., 2004). A second"

Page 8, line 30:
"… LSBS. Additionally, it cannot be discarded the presence of bioparticles (e.g., airborne bacteria, fungi, pollen, plant fragments, organic compounds) as a source of aerosols from the forests (Huffman et al., 2013, Pöschlet al., 2010, Valsan et al., 2015). The high intensity rains may induce the bioparticles burst from the forest canopy. These bioparticles have been in Australia (Bigg et al., 2015), India (Valsan et al., 2015), Mexico (Rodriguez-Gomez et al., 2020), and the Amazon (Pöschlet al., 2010). Also, convective rains transport from the free troposphere into the boundary layer a portion of the required aerosols …"

Technical corrections

6) Page 1, line 10
$\Delta\Theta/\Delta z$ -> $\Delta\theta/\Delta z$
Reply:
Thanks, we will change it.

7) Page 1, line 10
Zlcl,43; "Z" is notated in capital letter, but it is in small letter on page 6, line 15 and equation 7. It holds true throughout the manuscript. Please unify the notation.
Reply:
Thanks for making note of this. We will unify the notation with "z".

8) Page 2, line 2 Pease insert "is" between "This" and "because".
Reply:

Thanks. We will include it.

9) Page 4, line 9 "TS.5"; I think "TS.0" is correct. Please confirm.

Reply:

The variable $T_{s.5}$ is correct. This section described the estimation of superficial soil temperature ($T_{s.0}$) because the soil data from the field was collected at 5 cm depth.

10) Page 4, line 11 "TSS"; There is no description on the definition of TSS. Please clarify.

Reply:

Thanks for making note of this. This should be $T_{s.0}$, so we will change it in the revised version of the manuscript.

11) Page 5, Equation 1 "zS"; There is no description on the definition of zS. Please clarify.

Reply:

Thanks. This is a typo in the manuscript. It should be z_b, and we will change it.

12) Page 6, line 2 Please insert "C" between "◦ " and ")".

Reply:

Thanks. We will change it.

13) Page 6, line 4 moist -> saturated

Reply:

Thanks. We will change it.

14) Page 7, line 13 Please insert "mm" between "0.2" and "d-1".

Reply:

Thanks. We will add it.

15) Page 7, line 18 identify -> identified

Reply:

Thanks. We will change it.

16) Page 10, line 16 Spellman (2010) -> (Spellman, 2012)

Reply:

Thanks. We will change it.

17) Page 11, line 10 -0.5 ◦C m-1 -> -1 ◦C m-1

Reply:

Thanks. We will change it.

References

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