Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-14-RC4, 2020

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Vapor plumes in a tropical wet forest: spotting the invisible evaporation" *by* César Dionisio Jiménez–Rodríguez et al.

Anonymous Referee #2

Received and published: 25 June 2020

This paper attempts to describe the formation process of vapor plumes in a tropical forest environment due to evaporation processes happening during rain events. This phenomenon is quite interesting and probably contributes to water cycling in tropical wet forests. However, I do have substantial doubts about the scientific quality and the overall rationale of the study. The various reasons are outlined below:

1. Scientific objectives / rationale: To my opinion, the scientific objective and the conclusions about the identification of visible vapor plumes in a Tropical Wet Forest are relatively weak and the measurement setup is not suitable to derive reliable evaporation estimates during these events. If any observer (or any camera) can identify the

vapour plumes above the tropical forest what is the novelty of this paper? What is the contribution to the scientific knowledge about water cycling in the tropics? One scientific objective could have been to estimate the contribution of these vapour plumes to the total annual evapotranspiration (ET) flux in these environments. To achieve this, more sophisticated measurements (e.g., 3D wind components) and a detailed literature study comparing the magnitude of evaporation fluxes from vapor plumes at this site in Costa Rica to ET fluxes measured by eddy covariance at other comparable tropical sites (e.g. Puerto Rico, Amazon Basin) should have been performed (Holwerda et al., 2012; Paca et al., 2019). In addition, a modelling exercise using remote sensing data (i.e. land surface temperature) would probably have been feasible. However, the authors did not attempt to investigate the role of these plumes for the hydrological cycle.

2. Experimental setup: According to the paper, the vertical air temperature profiles using the Hobo sensors were not actively aspirated, which, however, should be the case to achieve sufficient accuracy when measuring vertical air temperature profiles. Additionally, wind speed measurements were apparently entirely lacking (or were made at 10m height only, according to Jiménez-Rodríguez et al., 2020). For this type of analysis, a vertical wind speed profile within and above the canopy or 3D wind components should be measured.

3. Methodology: According to my understanding, the method used to calculate the evaporation flux within and above the forest canopy violates fundamental micrometeorological theory. The energy balance (EB) equation was used to derive evaporation within and above the canopy according to Jiménez-Rodríguez et al., 2020, although none of the EB components were directly measured in the field. The term in the energy balance equation refers to evapotranspiration, which also includes transpiration. How can it be justified that transpiration was indeed zero under these conditions? The calculation of net radiation (Rn) components within the canopy is quite complex due to multiple extinction processes. Applying the equations give in the appendix of Jiménez-

Rodríguez et al., 2020 does not seem to be reasonable to derive an in-canopy profile of Rn. Furthermore, the sensible heat flux within and above the canopy was calculated by applying flux-profile relationships, which involves estimation of the aerodynamic resistance. Flux-profile relationships are typically expressed by formulations based on the Monin-Obukhov similarity (MOST) theory within the lowest 10% of the atmospheric boundary layer where exchange fluxes are considered to be constant with height. According to MOST, the aerodynamic resistance can only be calculated in cases when a logarithmic profile of the horizontal wind speed is present (Thom, 1975; Foken, 2017) - typically some meters above the canopy. Hence, the equations applied inside the canopy are invalid. Moreover, wind speed measurements are required to derive the aerodynamic resistance. As atmospheric turbulence is random, the use of parameterizations based on ancient wind speed measurements is not feasible. Due to these fundamental aspects, the numbers provided in the paper are only a crude approximation and do not provide a basis to derive a solid scientific conclusion.

References:

Foken, T. (2017) Micrometerology, Springer, Berlin, Heidelberg.

Holwerda, F., Bruijnzeel, L.A., Scatena, F.N., et al. (2012) Wet canopy evaporation from a Puerto Rican lower montane rain forest: The importance of realistically estimated aerodynamic conductance. Journal of Hydrology 414, 1-15, doi: 10.1016/j.jhydrol.2011.07.033.

Jiménez-Rodríguez, C. D., Coenders-Gerrits, M., Wenninger, J., Gonzalez-Angarita, A., and Savenije, H.: Contribution of understory evaporation in a tropical wet forest during the dry season, Hydrol. Earth Syst. Sci., 24, 2179–2206, https://doi.org/10.5194/hess-24-2179-2020, 2020.

Paca, V.H.M., Espinoza-Dávalos, G.E., Hessels, T.M., et al. (2019) The spatial variability of actual evapotranspiration across the Amazon River Basin based on remote sensing products validated with flux towers. Ecological Processes 8(1), 6, doi: 10.1186/s13717-019-0158-8.

Thom, A.S. (1975) Vegetation and the Atmosphere. Monteith, J.L. (ed), pp. 57–109,

Academic Press, London.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-14, 2020.