hess-2021-519	Submitted on Oct 2021
Lysimeter based evaporation and condensation dynamics in a Mediterranean ecosystem	
Handling Editor	Lixin Wang
Manuscript type	Research article
Status	Final response (HESS discussion)

Author's response to anonymous Referee #1

(Referee comments in black, *author's response in blue italic*)

General comments

The authors provide a complete description and photographs of the large lysimeter. The reader can better understand the observed process. As other reviewers have pointed out, the overestimation of NRW is due to the design of the instrument, not the technology itself. Although, instrumental and methodological uncertainty can affect results, it is more important to distinguish the composition of NRW and its occurrence time in arid areas, especially in different seasons. At present, more attention has been paid to NRW's role in water balance and single component in arid regions. But in the dry period without precipitation, its quantity and frequency are ignored. Disentangling individual NRW fluxes is an important way to find the controlling factors. This paper analyzes not only the composition of NRW and its controlling factors, but also the seasonal and diurnal contribution of NRW to water input. The study is of great significance to the survival of organisms in arid areas. So, the paper is acceptabl.

We thank the reviewer for taking the time and for the appreciation of our work.

hess-2021-519	Submitted on Oct 2021
Lysimeter based evaporation and condensation dynamics in a Mediterranean ecosystem	
Handling Editor	Lixin Wang
Manuscript type	Research article
Status	Final response (HESS discussion)

Author's response to Referee #2 Giora Kidron Report #2

(Referee comments in black, *author's response in blue italic*)

General comments

The authors presented an interesting, well written and a thorough account presenting data from a set of lysimeters in central Spain. The data presented are important and I enjoyed reading the ms.

We thank the reviewer for the appreciation of our work.

Saying that, and especially due to the potential importance of the ms, there are still some issues that require clarification.

Major points

1. A major possible drawback may stem from the inherent failure of the lysimeter to adequately mimic the heat regime of the intact soil. This issue was recently addressed in Agric Forest Met (2021). While large lysimeters may have an advantage over microlysimeters in this respect, I wonder if the authors compared the temperatures within the lysimeter and the intact soil, particularly the surface temperatures. Whether undertaken or not, this information should be provided in the Discussion.

We thank the reviewer for bringing up this potential issue, and we agree that this should be elaborated on in the manuscript. We prefer to avoid an additional comparison between the temperature inside and outside of the lysimeters, particularly because the respective surface temperature measurements are not colocated and hence not directly comparable. Therefore we preferred to include a paragraph in the discussion (T_s denotes surface temperature) (lines 358 - 363):

"Despite the current version of large weighing lysimeters being designed with lower boundary control in order to prevent temperature deviations from the surrounding soil, the extent to which heat loss through their walls will affect NRW has yet to be evaluated at sites with suitable instrumentation, particularly since NRW is sensitive to deviations in T_s (Yokoyama et al., 2021). Such a comparison was not possible in our instrumental setup because T_s was derived from measurements in one location only, which was situated outside the lysimeters (Figure A1)."

And in this regard, it is not clear what Ts stands for and how it was measured.

T_s stands for surface temperature and is already introduced in line 25 since it is the first time mentioned in that section (introduction). Its calculation, however, is described in line 115 with the referring equation that is given in Appendix A2.

Furthermore, did the authors calculate the Td in accordance with the comparison done between the temperature sensors at 1 and 0.1 m? If this is the case, the dew data reflect possible condensation at 10 cm height above ground, which may adequately represent short grassland. However, it does not adequately represent the soil surface which will exhibit warmer temperatures. This issue should be discussed in the Discussion section.

Thank you very much for your question and suggestion. Indeed we calculate T_{dew} in accordance with the comparison, as described in line 169. Motivated by the reviewers suggestion we added the following sentence to the Discussion section (lines 92-394)

"The chosen temperature offset added to T_{dew} was used in this study to account for the mean vegetation height. The soil surface, however, will exhibit warmer temperatures during the day. The height of the condensation surface should therefore always be considered."

2. Some of the figures provide a general picture, but more precise data will be of great help. Please provide detailed composite graphs similar to Figure 3, in which rain, fog, dew and vapor are indicated. Please provide one graph (graph A) with data during a week without rain and graph B with data that include a rain event during the beginning of the week and data that shows the distribution of the different types of NRW during the remaining week. These graphs will help the reader to assess the differences between dewfall and distillation.

As suggested by the reviewer we included the following sentence and the respective figure in the Appendix:

"Example lysimeter weight evolution and the assigned flux categories for a week with and without rain is shown in Figure D1 in the Appendix."

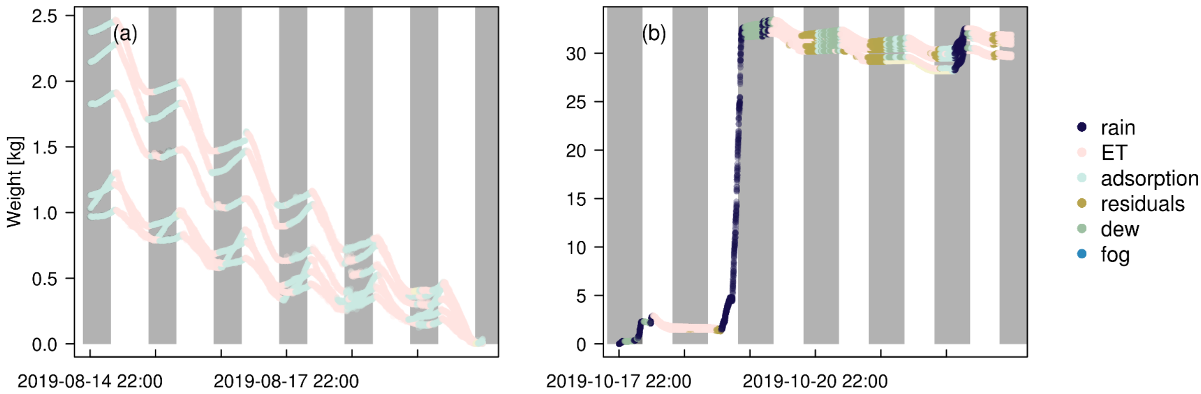

Figure D1. Lysimeter weights (normalised over the shown time period for each lysimeter by subtracting the respective minimum weight) exemplary shown for (a) a week without rain from August 15th. to August 20th., 2019, and (b) a week with several rain events from October 18th., to October 23th., 2019. The color code shows the respective flux that was assigned to the preceding weight change. Grey shaded areas illustrate nights.

3. Please indicate in table (or graph) the monthly distribution of the number of days in which the daily NRW was >0.1 mm. 0.1-0.2 mm, >0.2 mm; indicate also the maximum recorded daily NRW. Was it linked to rain?

We included the graph based on your suggestion with the following description of its content:

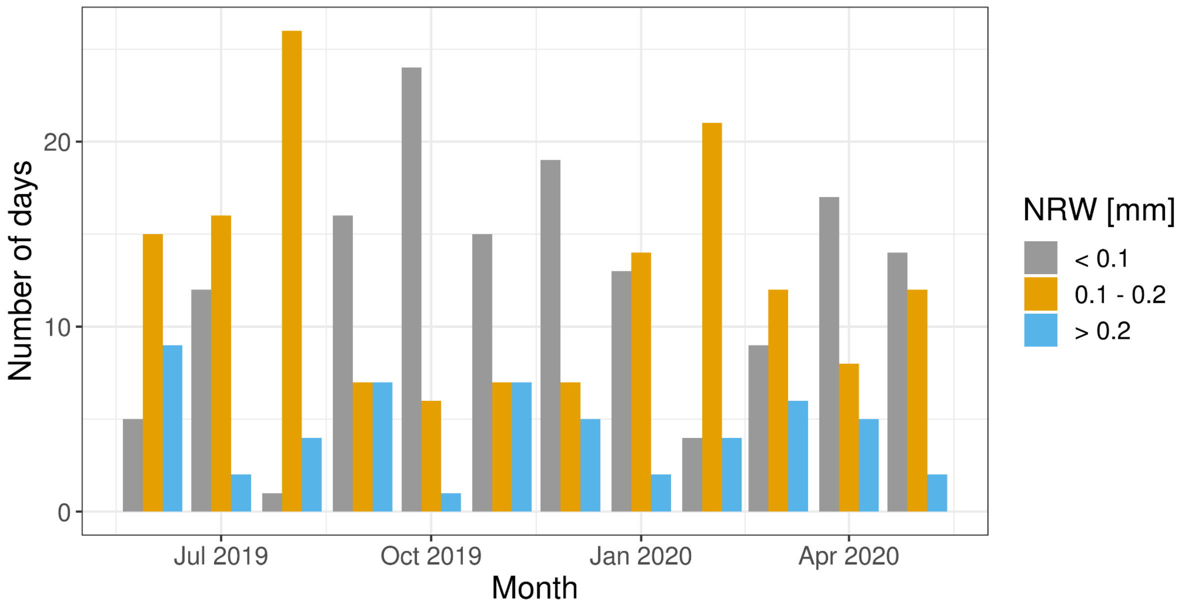

Figure E1. The number of days per month with average NRW input < 0.1, 0.1 - 0.2, and > 0.2 mm d^{-1}.

“On most days, the average NRWI is < 0.2 mm/day (Figure E1). Yields of > 0.2 mm per night are observed on 54 days distributed throughout the year. In late summer NRWI is predominantly between 0.1 and 0.2 mm day^{-1} while over the winter, the yields are typically

small and < 0.1 mm day^{-1}. The maximum recorded daily NRWI was 2.42 mm day^{-1} on May 13th, 2020 between several small, consecutive rain events."

4. Discussion. Please assess the possible use of NRW by plants, biocrusts and soil microorganisms. Also, expand on the relationships between lysimeter measurements and calculations carried out by eddy covariance.

Based on the suggestion of the reviewer we expanded the paragraph (lines 372 - 378) to have a more detailed assessment of the possible use of NRW. It is now moved to lines 412-434 in order to avoid splitting the discussion about the decision tree-based NRW classification. Since biocrusts are not present in Majadas, which is now reported in line 85, we don't expand on this life form.

"The role of dew has often been reported as moistening plant surfaces with direct leaf water uptake (Tomaszkiewicz et al., 2015). Our results show that in Majadas, dew occurs predominantly at a time of the year when top SWC ranges between relatively wet values of 20 to 35 %. Therefore, we assume that in this ecosystem dew as plant water supply is generally less relevant as has been reported for desert vegetation (e.g. Hill et al., 2015). Dew may benefit plants indirectly for example by cooling the leaves during early summer or facilitating nutrient uptake over leaf tissues (Dawson and Goldsmith, 2018). Although we only investigated grassland, this could also be relevant for Quercus ilex, which is confirmed to allow water penetration from the upper leaf surface into the leaf interior (Fernández et al., 2014).
As opposed to dew, soil vapor adsorption occurs at low Ψ when grassland in Majadas has already senesced. Therefore, a potential ecological relevance would rather be to enhance microbial activity and trigger respiration from soil or (standing) litter (Evans et al., 2019; Gliksman et al., 2017; Dirks et al., 2010, McHugh et al., 2015). However, the highest CO_2 emissions during summer in terms of volume are expected to be caused by rain pulses (López-Ballesteros et al., 2016). Reports exist also on nighttime CO_2 uptake during adsorption but the underlying biogeochemical processes are not yet clear (Lopez-Canfin et al., 2022). Future research is necessary to disentangle and quantify the ecosystem response to the different types of NRW."

Minor points

1. L 35-37. Please expand. Condensation at RH <100%?

We thank the reviewer for pointing out that this sentence is not clear. We expanded the sentence and hope it is more precise now (lines 34 - 40):

"In close contact with soil, the water vapor in the soil air is influenced by capillary and adsorptive forces (Tuller et al., 1999). These forces increase in relevance as the soil dries out. They reduce the saturation vapor pressure (e_{sat}, kPa) as a function of soil dryness (Edlefsen et al., 1943), leading to an earlier phase change of water from vapor to liquid within the soil, compared to free air. Under such conditions, the rH value of the near-surface air outside the soil is well below 100 %, and condensation processes are classically not considered, but soil air can condensate."

2. L. 80. What is the source of vapor for dewfall?

We are unsure how this information is relevant in line 80 (Section Site description), maybe the reviewer meant to refer to a different line? Furthermore, to our knowledge, this question cannot be answered without a field campaign using water stable isotopes which is beyond the scope of this study.

3. L 85. Please describe the growth dynamics of the vegetation along the year, specifically cover and height above ground. Also indicate whether biocrusts are present in the site.

We thank the referee for this suggestion. We tried to include it as specifically as possible. However, since we don't have direct measurements of the fractional cover of our herbaceous vegetation, we included the information on fractional vegetation cover indirectly by reporting the leaf area index (lines 83-93).

"The herbaceous layer consists of native annual grasses, forbs, and legumes (Migliavacca et al., 2017). The growing season for the herbaceous layer begins after the first rains after summer (typically in mid-October) and is inhibited by low temperatures in winter before peaking in spring before the dry season (Luo et al., 2020). During the dry season, the herbaceous species are inactive until the return of rain (Perez-Priego et al., 2018), and bare soil is visible below the dry biomass. The mean leaf area index of the herbaceous vegetation ranges between 0.25 ± 0.07 m^2 m^{-2} in summer to 1.75 ± 0.25 m^2 m^{-2} at the peak of the growing season in spring (El-Madany et al., 2021) with the same seasonal dynamics in vegetation height that varies between 0.05 m and 0.20 m (Migliavacca et al. 2017). Biocrusts are not present at the site."

4. L 100. "soil temperature is controlled with a heat exchange system". Please expand.

We have added the following sentence (lines 110-112):

"Buried at the bottom of each lysimeter, 6 m tubing systems are connected to tubing systems buried at the same depth in the surrounding soil. Pumping of water through the system in a closed loop regulates the soil temperature within each lysimeter column by heat exchange (Podlasly & Schwärzel, 2013)."

5. l 117. Define Ts

This issue has been already addressed above in our reply to major point 1. Thank you.

6. Fig. 3: please check the compatibility between 3a and 3d. For instance, while 3a showes very little rain between June and August, Fig. 3d points at a high contribution of rain.

Indeed the amount of rain in 3a is small in comparison to the contribution of rain in some winter weeks, however, in relation to the amount of adsorbed water from the soil it is still much larger.