Response to comments from reviewer RC3

Note that reviewer's comments are in black font, and responses in blue font.

The paper is handling an important topic in ecohydrology – the nocturnal water loss of ecosystems.

We appreciate the positive opinion on the relevance of the manuscript.

The tools used in comparison are appropriate but not convincingly comprehensive. The processes that might cause differences in derived NWL between EC measurements and modelled data should be investigated more thoroughly by diving e.g. into variable footprints, processes handled in the models, gap-filling problems for ET from EC during night, and general night-time problems present in EC data.

We expanded our discussion of these points. Note that differences between EC and modelled data are expected due to the stark difference in spatial resolution. This was mentioned on page 10 lines 6–7, and now also in the introduction of the revised manuscript.

I clearly would desire uncertainty estimates for NWL especially as we are dealing with very low fluxes. Fortunately, NWL can only take place under well mixed conditions which gives trust in the nocturnal EC data used for the analysis. But we have to consider that ET (measurements and post-processing) has unfortunately hardly been the main focus of the FLUXNET data set. So, we should be aware that so far, we do not have well established gap filling procedures for ET at night, especially under stable conditions. Thus, the paper lacks uncertainty estimates for the nocturnal fluxes determined by EC.

We appreciate the insight. We acknowledge the difficulties to adequately measure latent heat flux during the night with EC systems, as mentioned on page 4, lines 12–16. The relatively good agreement of NWL climatology from EC and lysimeter data suggests that meaningful estimates can be obtained with EC measurements.

We now include some uncertainty estimates of EC NWL in Figure 2, based also on comments from the other reviewers. Four different NWL estimates from FLUXNET sites are shown: without energy balance correction, and with the 25, 50 and 75th percentile of the distribution of energy balance corrected fluxes.

Specific comments: Introduction: What are the processes causing nocturnal water loss? Which kind of energy is converted into ET at night? And why is it so important to deal with? It should be mentioned that a water loss is accepted (during day-time) by gaining carbon. Is there any advantage for the plants or the ecosystem to lose water at night? Or just no possibility to avoid? The authors mainly summarize previous work here.

We expanded the introduction to include the suggested points. It now includes the following statements: "Nocturnal water loss may occur as evaporation from soil and canopy, snow sublimation, or plant transpiration through stomatal and cuticular conductance. It is also recognized that vapor pressure deficit, temperature, wind speed, longwave radiation and surface resistance influence nocturnal ET (Monteith, 1965; Penman, 1948)" and "Possible advantages of plant water loss with no associated carbon gain include capacitance refilling,

embolism removal, nutrient uptake, hydraulic redistribution and oxygen supply (see Zeppel et al., 2014)".

Page 2, Line 18/19: 'Both ET and dew correspond to a latent heat flux and can prove difficult to disentangle depending on the temporal resolution of the data.' These fluxes are in opposite direction, even if the net ET might comprise a combination of both, for energetic reasons these processes hardly occur simultaneously. Could you describe more clearly what exactly is meant?

We reformulated the sentence to clarify this. We agree that it is likely that they do not occur simultaneously, but they are likely to co-occur during e.g. the 3-hour temporal resolution of the modelled data. Thus, for simplicity and conciseness, we focus on the net flux.

Page 3, Line 21: if weight increase without rain measured is considered as rain or snow, we have to ask how reliable are the rain measurements? Or otherwise you should provide any further explanation for the procedure. And maybe the frequency of occurrence or the amount of water switched from dew to rain.

We include one additional explanatory sentence. It is possible that because of the 0.1 mm resolution of the rain gauge, no precipitation is recorded, while the lysimeter mass increases. Also, dew formation might be more favored to occur over vegetation than rain gauges. Moreover, it is also possible that the registered weight increase was due to something different than water input, e.g. a bird. In any case, the frequency is ~4 % of the hourly intervals when the dew was estimated, and the amount is ~4 mm yr^{-1}.

Page 3, Line 27ff: we have to consider that ET has never been the main focus of the FLUXNET data set. This statement should not imply that all ET data from FLUXNET are less reliable. But we should be aware that so far, we do not have well established gap filling for ET at night, especially under stable conditions. Fortunately, NWL can only take place under well mixed conditions which gives trust in the nocturnal EC data used for the analysis. Most probably the majority of the data used for the analysis were measured anyway. But it would be quite interesting to see the relation of measured and gap-filled data used for the data-analysis, not only for the Rietholzbach site but also for the FLUXNET analysis. This information gives also a hint related to the uncertainty of the derived nocturnal fluxes.

We appreciate the insights. As indicated in the text, on average across all analyzed FLUXNET sites, latent heat flux is measured in 60 % of all nighttime intervals, whereas gap-filling is required in the remaining 40 %.

An alternative to gap-filled fluxes would be to estimate a mean hourly NWL rate from the non-gap-filled observations and obtain total sums by multiplying the mean by the total number of nighttime hours. However, this has its own disadvantages. In any case, results are rather similar with both options.

Page 4, Line 8: for night-time data?

We expanded the text. The energy balance correction is applied to both daytime and nighttime data. It uses only half hours with timestamps between 22:00–02:30 and 10:00–14:30. See full details at https://fluxnet.fluxdata.org/data/fluxnet2015-dataset/data-processing/

Page 4, Line 14-15: move this sentence to the acknowledgements, even though appreciated by myself.

Ok.

Page 5, Lines 4ff: this section should be improved by quantitative uncertainty values.

We expanded the text and modified Fig. 2 to include information about the uncertainty of the NWL estimates from the FLUXNET data.

Page 6, Line 14: '. . .across sites cannot easily be explained by annual average. . ..'

We modified the text.

Page 7, Line 1: can you be sure that EC data are reliable under 'snowy and windy conditions'? EC assumption might not be fulfilled, sonic data are often disturbed under such conditions.

Our intention here is to point out that conditions at these specific sites are in general snowier and windier than at other sites. Although it could indeed be that these particular sites include more gap-filled data than the average.

Page 10, lines 1ff: for EC estimates no uncertainty is considered. How large are the uncertainties related to the fluxes under consideration?

We now include uncertainty information within Figure 2 and the corresponding text.

Page 11, lines 5ff: here it is correctly said that nocturnal measurements can be affected by low turbulence conditions. But nocturnal fluxes are not treated by the energy-balance correction, as also correctly said before. In the discussion part, also the uncertainty of EC data should be discussed.

We now also refer to the uncertainty of NWL from EC data here.

Figure 1, caption: should include the site name.

We added the site name to the caption.

Figure 2: caption to be extended. What exactly is show? Always consider that reader often concentrate on the figures of a paper only and thus need more information. In addition, in c), the colors of the tiny dots are difficult to distinguish with normal page size. But I also fear, this is not a 'spatial distribution' but rather a 'distribution of sites with . . ..'

We modified Figure 2 and the caption as well.