Interactive comment on "Plant water resource partitioning and xylem-leaf deuterium enrichment in a seasonally dry tropical climate" by Lien De Wispelaere et al.

Anonymous Referee #2

Plant water resource partitioning and xylem-leaf deuterium enrichment in a seasonally dry tropical climate" by Wispelaere et al. reported isotope data from a data scarce region and used the data to investigate the variations of plant water use both spatially and temporally. The study was carefully conducted and the manuscript is generally well written. I think this would be a valuable contribution to Biogeosciences. At the same time, I think some aspects of the work need to be improved before it could be accepted for publication.

We thank the reviewer for his/her appreciation of our work and for its careful review and constructive comments and suggestions. We address the reviewer individual comments and suggestions below. Our responses to your comments have been bolded and text added to the manuscript has been italicized here for visual clarity.

1. The novelty of the study needs to be further emphasized in the Abstract. The objectives and results are clear here, but it reads more like a regional case study. The novelty or importance needs to be emphasized to warrant a publication in an international journal.

We thank the reviewer for this valuable suggestion. We adapted the Abstract to further emphasize this:
"Our observations have important implications for the interpretation of δ^2H of plant leaf wax n-alkanes (δ^2H_{wax}) from paleohydrological records in tropical East Africa, given that the temporal variability in the isotopic composition of precipitation is not reflected in xylem water and that leaf water deuterium enrichment is a key factor in shaping δ^2H_{wax}. The large interspecies variability in xylem-leaf enrichment (24 ± 28 ‰) is potentially troublesome, taking into account the likelihood of changes in species assemblage with climate shifts."

2. Line 53. This statement requires modification. Based on field observations from a dryland region, a recent study showed that fractionation doesn't occur during root water uptake and it likely occurs during the water redistribution after water uptake. Please refer to Zhao et al. Significant difference in hydrogen isotope composition between xylem and tissue water in Populus euphratica. Plant Cell Environment 2016, for more details.

Amended according to reviewers' suggestion.

3. "Study site" section could be incorporated into the "Materials and Methods" section.

Amended according to reviewers' suggestion.

4. The sampling time is not clear in the Method section. The non-steady condition in the morning could result in very different isotope signatures of the leaves. More details are needed for the sampling time.

We are aware that large diurnal variations in the isotopic composition of leaf water can occur. Therefore, our samples were taken as much as possible between 10 a.m. and 3 p.m., a shorter time span was technically not feasible.

"Leaves were sampled between 10 a.m. and 3 p.m. to eliminate additional variability induced by previously reported large diurnal variations in the isotopic composition of leaves (Cernusak et al., 2002; Li et al., 2006; Kahmen et al., 2008)."

5. Why grass stems were not sampled? It would be a nice comparison between the stem and leaf water isotopic compositions for grasses.

For grasses, it was difficult to separate xylem and leaf water. Sampling of grasses was done by taking out the whole plant which consisted mainly of green leaves and thus represented leaf water.

"The whole plant was sampled which consisted mainly of green leaves and thus represented leaf water."

6. The authors used laser spectroscopy method to quantify the isotopic compositions of rainfall, groundwater and plant waters. However, recent studies have showed the potential issues of organic contamination of the spectral signal in the laser spectroscopy method (e.g., West et al. 2010, RCM, 24: 1948-1954, Zhao et al. 2011, RCM 25: 3071-3082). Particularly, Zhao et al. 2011 showed that the isotopic composition differences could be up to 76% for leaf waters between IRMS and laser spectroscopy methods in water-stressed environments. In light of these earlier findings, I think the authors of this study should at least validate some of the leaf water isotope measurements.

We are aware of the potential issues of organic contamination of the spectral signal in laser spectroscopy. Therefore, a microcombustion module, directly connected to a high precision vaporizer, was used in our measuring device to eliminate organic interferences by combusting the organic compounds. The text was adapted to:

"The δ^2H and $\delta^{18}O$ values of water samples were determined using Cavity Ringdown Spectrometry (WS-CRDS, L2120-i, Picarro, USA), coupled with a vaporizing module (A0211 high-precision vaporizer) and a microcombustion module, which eliminates interference of organic compounds (Martín-Goméz et al., 2015)."

7. I like the concept the evaporation distance. If it is cited from others' work, a reference is needed here. Otherwise, the authors should make it clear that "we developed the evaporation distance…". The evaporation distance calculation doesn't seem to be correct. I think the "2H" should be "18O" in the equation. Please double check.

"The isotopic signatures of xylem water were further characterized with a parameter describing the relative degree of evaporation. We developed the evaporation distance, defined as ED and calculated as the distance from the LMWL along an evaporation line, scaled to the δ^2H axis (Eq. 4)."

The equation of the evaporation distance is correct, the equation simply measuring the distance to the LMWL, the distance along the $\delta^{18}O$ axis is multiplied by the slope of the LMWL to scale it on to the δ^2H axis.

8. There are multiple factors considered in this study, e.g., plant family, growth form, leaf phenology, habitat, how ANOVA was used for analysis is not clear to me.

Multi-way ANOVA was used to look for interactions between parameters. Based on these interactions, the significance of the separate predictor variables was further tested with one-way analysis of variance (ANOVA) with the aid of R. Tukey post-hoc comparisons were used to further examine differences.

9. There are limited rainfall events in the study period and 2014 is an abnormal year. In this context, I think using air trajectories to take a look the source air region of the precipitation could be useful in the interpretation. This reference could be useful in this regard. Soderberg et al. 2013. Using atmospheric trajectories to model the isotopic composition of rainfall in central Kenya. Ecosphere.

We thank the reviewer for this valuable suggestion. We looked at air trajectories with the aid of the HYSPLIT model and added this new information in the manuscript:

***"*The HYSPLIT model (Draxler and Hess 2004), developed by NOAA, confirmed that there is a distinctly different trajectory for precipitation in November and December (northeast) and April, May and July (southeast). To compute air parcel trajectories, the model required data from the NOAA meteorological database, and trajectories were modeled 310 hours backwards in time starting from the end of the respective month."**

10. The plants at the lakeshore produced higher evaporation distance than other two locations. However, the deuterium enrichment from xylem to leaf was smaller for plants at the lake shore compared with other two locations. This is counter-intuitive and needs to be better explained.

The plants at the lake shore are protected by the crater rim, so less evaporation and transpiration (smaller fractionation between xylem and leaf water) are expected compared to plants in e.g. the savannah. The higher evaporation distance at the shore is related with plants taking up an important fraction of the lake as source water. The lake has a large surface area that can easily evaporate, resulting in more enriched water available for plants and thus higher evaporation distances.

The observation that plants at the shore are taking up (enriched) lake water is already explained in section 4.2, while the following sentence is added in section 4.3:

"Differences in $\varepsilon_{l/x}$ between habitats are not surprising, as the plants at the lake shore are protected by the rim and less transpiration is expected compared to plants in the savannah and on the crater rim."

Minor comments:

Title: I think "leaf-xylem deuterium enrichment" makes more sense.

We understand the confusion, so the title is changed to:
"Plant water resource partitioning and isotopic fractionation during transpiration in a seasonally dry tropical climate"

Line 91 What is "Voi"?

Voi is a town located 80 km east of Lake Challa.

Line 195 Comparing with global meteoric water line is useful, it would be more meaningful to compare the local meteoric water line with other studies in this region (e.g., Soderberg et al. 2013. Ecosphere).

The following line was added to the text:
"Compared to the global meteoric water line ($\delta^2H = 8.1*\delta^{18}O + 10.3$ ‰, Rozanski et al., 1993) and the LMWL of central Kenya ($\delta^2H = 8.3*\delta^{18}O + 11.0$ ‰, Soderberg et al., 2013), the LMWL of the study region ($\delta^2H = 7.1*\delta^{18}O + 10.7$ ‰, n = 18) has a slightly lower slope and intermediate intercept (Fig. 3)."

The "3" and "4" in "C3' and "C4" should be subscripted throughout the manuscript.

Amended according to reviewers' suggestion.