"L-band vegetation optical depth as an indicator of plant water potential in a temperate deciduous forest stand" by Nataniel Holtzman et al.

Reply to Reviewer 1

General comments:

The manuscript presents the use of tower-based radiometer data in L-band to test the link between estimated VOD from one polarization and plant water potential over the red oak forest. The manuscript reports on an experiment carried out during the 2019 growing season in central Massachusetts, United States. The manuscript is well written and contains worthwhile material that brings up the diurnal variation in VOD and its relationship with the diurnal plant water potential cycle. These results are credible and could further the understanding of the crop water dynamics. However, the intensive fieldwork to collect leaf water potential data has been done for 4 days in July which was quite short in time and it was not enough to make a firm conclusion. Although short filed work experiments have been performed, the presented results can be used in future analysis. Therefore, I think this work can be accepted for publication.

Response: We thank the reviewer for their thoughtful review.

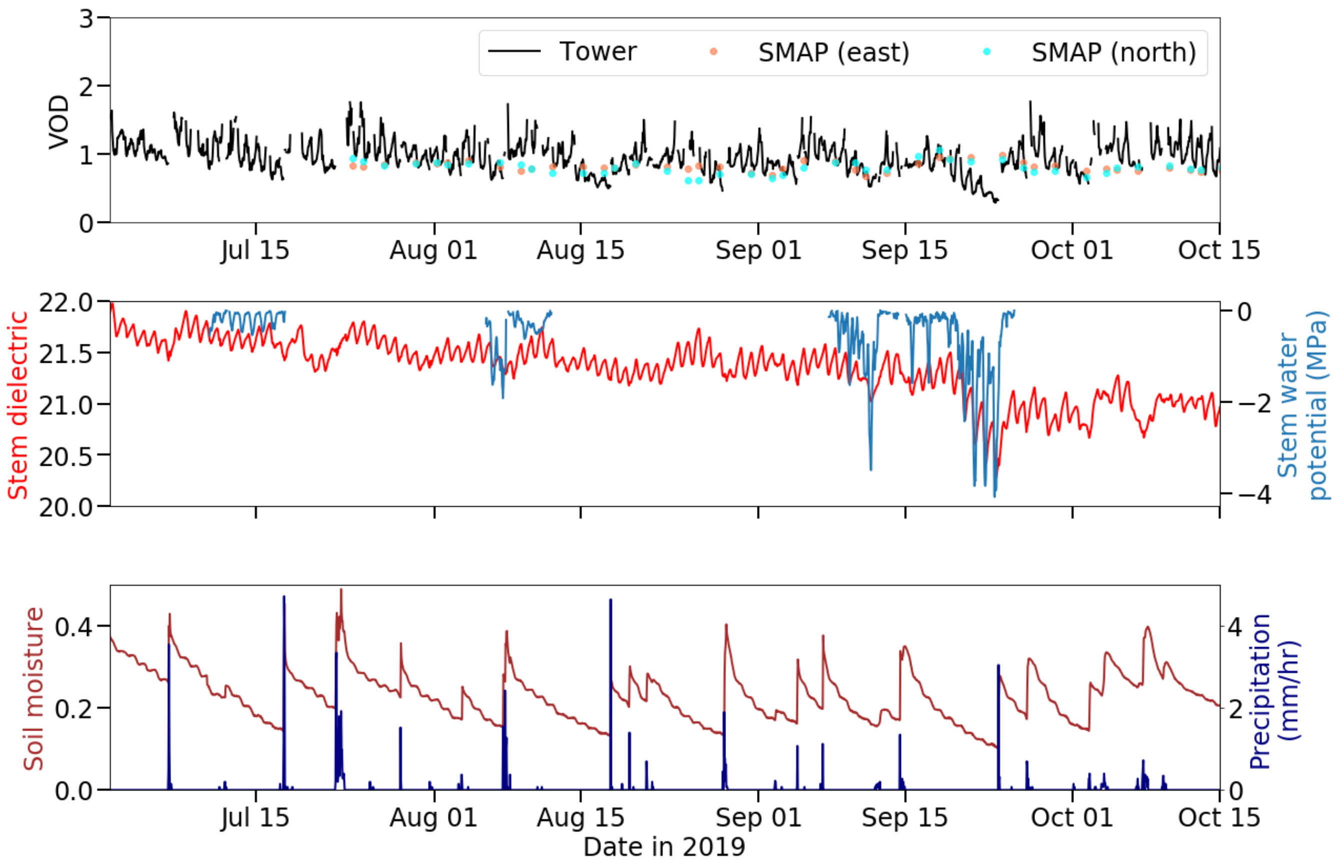
Specific comments

1- Please add the Precipitation data and dew data in the manuscripts or supplemental information.

Response: We thank the reviewer for catching our oversight in not including information on the source of the precipitation data. We have added a sentence at Line 202 that reads: "For this purpose, we used precipitation data from the Fisher Meteorological Station at Harvard Forest, located in an open field approximately 1.3 km from the site of the radiometer." In addition, we have added a plot of precipitation to the bottom panel of Supplemental Figure 2, as shown below.

The dew data comes from leaf wetness sensors we installed in the canopy, as described in lines 143-146: "Five LWS leaf wetness sensors (METER Environment) were installed in the tower at canopy level on July 10. Each sensor recorded a binary reading (wet or dry) every 10 minutes. Hours where the majority of sensor-minutes were wet were considered wet for the purposes of our analysis; all other hours were considered dry."

Our data submission to the NSIDC archive includes CSV files containing the full time series of precipitation and leaf wetness sensor data. This data is now publicly available at https://nsidc.org/data/SV19MA_VOD/versions/1 with a DOI of 10.5067/2PZJDURUJLWF.



Supplemental Figure 2. Time series of VOD, stem xylem dielectric constant at 70 MHz, stem xylem water potential, soil moisture, and precipitation at Harvard Forest.

2- It would be nice if you compare VOD results from SMAP satellite with your data for the study area to illustrate the effect of scale on VOD estimation and especially shows how much VOD estimation would be different between your data and SMAP on the evening overpasses.

Response: This is a very good suggestion; thank you. We have added a comparison to a SMAP VOD product and plotted the corresponding data in the revised Supplemental Figure 2 (shown above).

In the methods section at lines 239-244 we added the following:

> “Finally, we compared our tower-based single-channel VOD retrievals with VOD retrieved from SMAP satellite data using the multi-temporal dual-channel algorithm (MT-DCA) (Konings et al., 2017). The spatial resolution of this SMAP dataset is 9 km. The SMAP pixel containing the Harvard Forest tower site is masked out in the MT-DCA data, as are the adjacent pixels to the west and south, because of proximity to a water body (the Quabbin Reservoir). Thus, we compared our tower-based VOD to the MT-DCA VOD from the adjacent SMAP pixels to the east and north of the tower site.”

In the results section at lines 278-286 we also added the following:

> "As illustrated in Supplemental Figure 2, the magnitude of VOD retrieved from the tower-based radiometer using the single-channel algorithm is similar to VOD retrieved from the SMAP satellite over nearby pixels using the MT-DCA. This close match adds to our confidence that our retrieved VOD is in a realistic range for the Harvard Forest site. However, VOD from the tower radiometer shows more detailed temporal dynamics than what is seen from SMAP. For example, between August 7 and August 15 the tower VOD first increases and then decreases, following the changes in stem dielectric. In contrast, SMAP VOD shows little change over that time period, likely due to spatial heterogeneity within the SMAP footprint that does not affect the tower radiometer footprint."

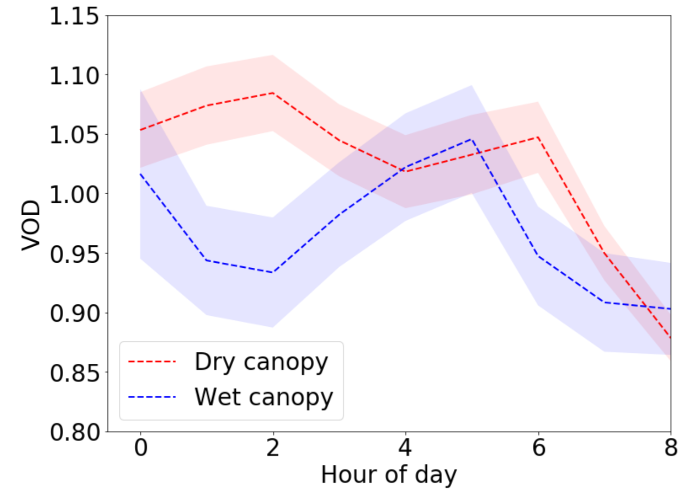
Unfortunately, evening VOD retrievals from the multi-temporal dual-channel algorithm are not available.

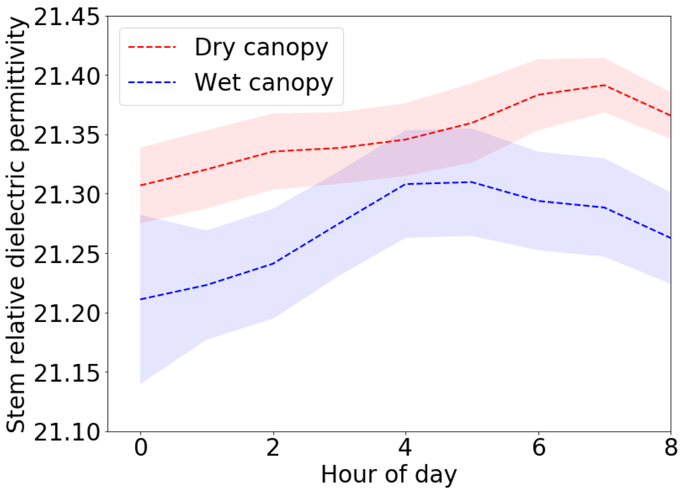
3- Although some of the previous studies have indicated that the presence of dew cannot affect the VOD, some studies presented its effect on VOD estimation. It would be nice if you can make a plot and add it in the supplementary in which shows the averaged VOD value at each hour from midnight to early morning for example from 12 to 6 for two conditions of the wet and dry canopy. It will help to better investigate the effect of dew on VOD estimation.

Response: We thank the reviewer for the suggestion. The figure below shows VOD as well as stem relative dielectric permittivity, averaged at each hour of the morning (shading represents 1 standard error of the mean). The difference between wet and dry canopy conditions in mean VOD is not significant (t-test, $p > 0.05$) at any hour except for 1 AM and 2 AM, during which VOD is significantly lower when the canopy is wet. However, the wet and dry canopy observations represent distinct sets of days, with different plant hydraulic conditions (i.e. leaf and stem water potential), so they are not necessarily directly comparable. It is impossible to say whether any VOD differences are due to differences in canopy wetness or due to differences in those plant hydraulic conditions.

Indeed, as shown in the lower panel of the figure below, the wet canopy observations are on days with a lower stem dielectric on average, i.e. a smaller internal vegetation water content. Note that leaf water potential is also expected to vary between these wet and dry canopy days, but leaf water potential measurements were not available on most days include in this plot. Overall, the patterns in the hourly VOD analysis cannot be attributed to the presence of canopy wetness alone.

Because the results of this hourly VOD analysis do not provide any additional information about the effects of canopy wetness, we have not included it in the revised manuscript.





4- In figure 3, the temporal variation in VOD is different for each day. It would be nice if you could discuss the reason for the different daily trends. Also, the decreasing trend that you mention from July 11 through July 14 is not visible from the graph and it would be useful if you can fit a line to show that trend in the supplementary material.

Response: We have added a discussion of the different daily patterns of VOD at lines 282-285:

> "There is additional variation on VOD on top of this general diurnal pattern, which is at least partially attributable to transient meteorological conditions. For example, around 1 PM on July 10, the weather at the site changed from sunny to cloudy for an hour, leading to temporarily decreased transpiration rate and thus causing plant water potential and VOD to increase during that hour (Figure 3)."

We thank the reviewer for noticing that the decreasing trend mentioned in the manuscript is not visible. To avoid confusion, we have now deleted it.

5- In figure 7, you fit a line to the scatter plots and consider a linear relationship. By checking data of 3 months, we can see that the data in September shows some linear trend as the fitted line shows but the data of June and July are not fitted to that line. So, I think it would be better for this plot that you will use the Spearman rank correlation method and also shows the correlation for each month separately.

Response: We have added a table (shown below) in the supplemental information, with both Pearson and Spearman correlations for each separate month, for each of the three scatter plots in figure 7.

Stem water potential and stem dielectric

Period	R	ρ
All	0.65	0.47
July	0.53	0.58
Aug	0.40	0.28
Sept	0.66	0.51

Stem dielectric and VOD

Period	R	ρ
All	0.68	0.60
July	0.31	0.36
Aug	0.33	0.41
Sept	0.74	0.69

Stem water potential and VOD

Period	R	ρ
All	0.65	0.54
July	0.32	0.31
Aug	0.66	0.53
Sept	0.71	0.64

Supplemental Table 1. Pearson correlations (R) and Spearman rank correlations (ρ) for the three pairs of variables shown as scatter plots in Figure 7, for all data and individually for each of the three periods that the stem psychrometers were installed (corresponding to three months).

We also added the following text to the discussion section 4.1 at line 401:

> "Looking at the three installations separately, the highest correlations between all 3 pairs of variables are found in September (Supplemental Table 1). This may be due to dry conditions at that time creating a wider range of stem water potential and stem dielectric values, providing increased signal during September for the same amount of noise."