

Interactive comment on “Seasonal variation in vegetation water content estimated from proximal sensing and MODIS time series in a Mediterranean Fluxnet site” by G. Mendiguren et al.

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Title: Seasonal variation in vegetation water content estimated from proximal sensing and MODIS time series in a Mediterranean Fluxnet site

Note to reviewers:

We would like to thank both reviewers for their comments and valuable suggestions that help us to improve the clarity of the manuscript. We have followed the recommendations of the referees and made changes accordingly. Changes can be seen colored

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in the new manuscript version. In red the parts that have been removed from the previous version and in green the new text that has been included. Detailed answers to each of the comments of the referees can be found below.

Comments to reviewer 2:

The abstract does not give a concise summary of the paper. It only covers methods and results but the authors should clearly state why they are doing these analysis and presenting these results as well as the implications of her conclusions and findings.

- Following the recommendation from the reviewer, we have modified the abstract clarifying paper's objectives and remarking the implications of the results found.

2. The introduction does not clearly state the original contribution of this work. Does this paper builds on previous key work? Which are the knowledge gaps it is trying to fill in?

- We have rewritten the introduction stressing the gaps our work is trying to fill in. In our work we aim to compare three different metrics of vegetation water content. Each of the compared metrics offer information at different level, and therefore the spectral relationships might vary. To make the results comparable we considered that samples should be collected simultaneously to remove part of the uncertainty, per se imposed in field data collection. In the study we also compared different protocols to collect the samples. Even this decision made the reading of the paper a bit more complex, we considered that it is important to evaluate different protocols to ensure the consistency of the measurements taken in the field. We also used new subscripts to designate the different samples collected in the field and aiming making the reading of the paper easier.

- Regarding the remote sensing part, we compared empirically derived models based on spectral indices with other methods based on RTM inversion.

3. The methods section lack on detail/justification in some aspects:

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a. Why do the authors compute FMC/EWT from a subsample and the quadrat? What do the authors want to prove with this? Is this important? Again, the research question is not clear. This distinction between quadrat and subsample add complexity to the paper so it should be clearly justified.

- In the new version of the manuscript we have added information trying to clarify the use of different protocols used in the field data collection. As there is not a consensus in this issue, we found it interesting to test the effect of two different field protocols in the results when comparing field and proximal/remote sensing data. As far as we know, no previous works have intended this exercise.

- New text included in Page 4, line 11 to Page 4, line 21.

b. The authors should explain more in detail the methodologies from Trombetti and Jurdao they are applying and presenting in this paper. For example, Jurdao et al 2013 derived FMC in woodlands in the Mediterranean and Eurosiberian region using two different Look up Tables (LUT). The authors do not specify which LUT they are using (I assume they are using the LUT developed for the Mediterranean region?). Also, the authors must justify the selection of those methods. Why did you select Jurdao's method that was developed for closed woodlands and not other more suitable for dehesa type ecosystem? This is definitely something that should be discussed in the discussion section. The apparent worst performance of the RTM models in comparison to the empirical equations may be related to this.

- The reviewer is totally correct. In the case of Jurdao we used the LUT developed for the Mediterranean region. As far as we know there is no method specifically designed for dehesa, as in principle is similar to a Wooded grassland ecosystem. Dehesa can vary in density of tree and therefore that's why we considered appropriated to use this LUT. In addition this LUT was calibrated in Spain, but not using any sample from our study site. In the new version we have included a new section to explain the RTM based estimates. Page 10, line 11 to Page 11, line 11 and discussed deeper in the

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discussion section in Page 17, line 12 -21.

- c. The authors should explicitly present in the results section the equations they derive for the empirical models.

- Following reviewer's recommendation empirical fitting equations are now presented in table 2. - Page 25.

4. Results do not appear to be well discussed in relation to previous published works (e.g. how the author's findings may contribute to clarified/complement previous findings) and are difficult to follow because the research questions is not clearly identified in the introduction and the implications of their findings are barely discussed. The results presented around FMC/CWC derived using the quadrat/subsample samples are difficult to follow and not well justified. Are the authors trying to conclude which is the better methodology in order to propose a standard sampling protocol? The authors Should also improve the description of the results and avoid qualitative or vague terms (see specific comments)

- Following previous comment the introduction has been modified to better identify the research question addressed in this work. We have also rewritten the discussion section in order to better state the implications of the results found.

- We have reviewed the results section avoiding qualitative terms, as recommended

5. Figures do not have clear captions. The authors should carefully work on figures caption so they are self-contained. Figures 2, 4 and 5 are difficult to read. I would suggest the authors to increase the size of figure 2 and simplify figures 4 and 5. Is it important to include here the results from the quadrat and the subsample? The authors should only consider only the most relevant information.

- We followed the recommendations of the reviewer and modified the figures captions. In order to improve readability, figure 2 has been enlarged. In figure 4 and 5 we removed the non-relevant information and now in the case of figure 5 we only display

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the information regarding the R2 between the field metrics and the models generated using the spectral indices from MODIS and proximal sensing. In figure 6 similar information is plotted, but instead of R2 we showed the RRMSE values. In both cases as the results obtained after bootstrap we have included the confidence interval.

Specific comments: The line and page numbers refer to those provided in the printer-friendly version that I downloaded from the website.

Page. 5505 Line 6. Include “a” before “Mediterranean” - Done. Page. 5505 Line 12. “Due to the high seasonal Dm variability: : :” This sentence seems to be out of context. - We have rephrased the sentence. In the new version the sentence is as follows: “Dm variability was high which demonstrate that a constant annual Dm value should not be used to predict EWT from FMC as other previous studies did.” - Page 2, line 14- 15

Page. 5505 Line 14 onwards. GEMI, GVMI, etc. need to be defined. - Acronyms have been defined.

Page 5508. Line 4. “Secondly, the model performance...”. Which models do the authors refer to? They have not presented any model yet. - We tried to say in this sentence that we compared the performance of the different empirical fitting equations used in the empirical calibration. We have changed part of the text in the paragraph to clarify this. - Page 6, line 5- 7.

Page 5509 Line 20.” Each EWTsample and a sub-sample from each quadrat : : :” This is confusing. My understanding is that EWT sample refers to the EWT derived from the sub-sample? Why do the authors then write here EWTsample and a sub-sample from each quadrat, isn't that the same? - As explained in page 5509-line 15 we used a 25x 25 cm quadrant to collect vegetation samples. As we need to obtain the Leaf Area, one of the parameters necessary to calculate EWT we made the decision of trying to different sampling strategies, one was to use a sub-sample from the total sample collected within the quadrant and the other was to collect only a small sample nearby the quadrant. Even with a small quadrant as the one used in our field campaign, it

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is extremely difficult to scan the entire sample collected so we wanted to know the impact of using two different approaches to select the small sampled to be used for the estimation of leaf area. We have included in the manuscript some additional text to clarify and simplify this point. We have use now new nomenclature to designate the different samples out of quadrant (OQSample) and inside quadrant (IQSample) Page 7 lines 15 to page 8, line 18. - A diagram to help understanding the new names and where and how the samples are treated in the laboratory is now included in figure 2. Page 27

Page 5510, Line 14. “ where LAI is the leaf: : :and EWT is obtained from eq (2). Again I am confused. Do the authors refer to EWTsample. - The equation in the manuscript has been corrected. In the first approach the CWC was obtained from EWT sample (as in equation 2). -

Page 5511. Lines 24-26 and Page 5512 Lines 1-8. The description of the indices and the comparison with the RTM models do not belong to the “Field sampling “ section. These should be moved to data analysis. The same applies to Page 5512 Lines 26-28 in MODIS data section. - In the new version of the manuscript we have included a specific section with the description of the spectral indices and RTM models. Page 10, line 5 to page 10, line 10

Page 5513. Lines 23-25. “As recommended in Steyerberg: : :” should be moved to line 20 before defining the RMSE.

- We moved the reference. Page 11, line 31 to page 12 to line 2.

Page 5515. Line 1. “: : :comparison between the spectral indices: : :”. Spectra indices should be replaced by empirical approach (along the manuscript) since Jurdao and Trombetti also used spectral indices in their RTM modelling.

- We fully agree with the reviewer. We have substituted spectral indices all over the text when necessary to avoid misunderstandings.

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Page 5515. Lines 27. "EVI performed better". Do the authors mean that EVI was the index with the highest correlation coefficient with FMCe and FMCq when using the reflectance from MODIS?

- That's it. That is what we meant to say. We have corrected the text in the manuscript.
- Page 13 Line 30-31

Page 5516. Lines 11-12. "RTM was closer to the empirical models" Do the authors mean that RTM performed similarly to the empirical models?

- Yes, we do. We have rewritten the sentence to clarify this. Page 14, lines 16 to 18

Page 5516. Line 16. Figure 6 should be Figure 8. - Corrected in the manuscript

Page 5517. Lines 17. " : : : LAI which is even higher correlated than those : : ". Higher correlated to what? - We meant correlated to spectral information. We have rewritten this sentence to clarify this point. Page 15, line 27-31

Line 5518. Lines 22-23. "RTM only overcomes empirical approaches when structural information constrains the model inversion)". I agree however I do not think this statement justifies the worst performance of RTM in comparison to the empirical models in your study since the method the authors used (Jurdao et al 2013) includes such structural information. I suspect that Jurdao/Trombetti methods did not work well in this study because they were not designed to be applied in Mediterranean dehesas). - We did not intend to justify with this sentence that this is the reason why the RTM based estimates perform worse than the empirical models. We included some lines to better explain. Pages 17, lines 12-21. - The other statement was very strong and might not be true in all cases as the empirical methods also depend on the number of samples etc. so we removed it. - Empirical models have the great advantage of being calibrated with the data collected in situ, and therefore was expected this result. Jurdao includes some structural information based on GEOSAIL, but this information is used in the generation of the LUT. To obtain FMC what the method does briefly is to compare

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the reflectance values against the generated LUT. The one that is more similar based on a merit function is used to assign the FMC value. Among the advantages of using this technique is that it can be easily run without too much computation time after the LUT was generated and therefore offers the possibility of running it at large scales. - We believe that there is still a lot of place for improvement, not just in FMC but also in CWC. Testing other inversion techniques, using multiple observations or using more robust algorithms not based on LUT such as optimization algorithms might help to improve the estimates, however, these methods are usually computationally expensive and therefore they lack sometimes in operability. Table 1. I suggest the authors to improve the caption of the figure so the reader can quickly understand what Bx means. The authors should also explain what NIRREC and SWIRRec stand for. - As the referee suggests, the changes have been implemented in the table. In the caption information has been added about what Bx means. We have also included a note explaining what NIRREC stands for and removed SWIRREC as it was a typing error in the formula. In the note it is also mentioned the bands used for NIRREC and SWIR.

Figure 6. The authors should also explain what RTM FMC (Grassland and oak) means and why it is different from RTM (grassland). - As the referee suggests, an explanation on the difference between the RTM FMC (Grassland and oak) and (grassland) has been included in the figure caption.

Please also note the supplement to this comment:
<http://www.biogeosciences-discuss.net/12/C4575/2015/bgd-12-C4575-2015-supplement.zip>

Interactive comment on Biogeosciences Discuss., 12, 5503, 2015.

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