

## ***Interactive comment on “On the relationship between ecosystem-scale hyperspectral reflectance and CO<sub>2</sub> exchange in European mountain grasslands” by M. Balzarolo et al.***

**Anonymous Referee #2**

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General comment:

This paper reports an experimental study for spectral assessment of grassland CO<sub>2</sub> exchange. This study utilizes several datasets in grassland sites that may be unpublished, but the study motivation, research concept and analytical methods do not include any original/innovative ones. In other words, this study seems to be a simple exercise using some new datasets based on similar research motivation, concept and methods as in preceding papers. Although a plenty of results are shown in Tables and Figures, the obtained results do not seem to include any essential findings or robust/useful re-

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lationships for remote sensing of ecosystem CO<sub>2</sub> exchange. Despite the plenty of dataset, fitting results are not validated using independent dataset. More importantly, the majority of conclusions, insights and messages are confirmation or repetition of well-reported ones in preceding papers. Since this type of datasets have been collected through so-called FLUXnet as well as many other individual experiments, similar analysis can easily be done using a new dataset by using similar analytical approach as in this paper. However, preliminary exercises are not very worthwhile in the context of science and technology as well as operational applicability. Truly comprehensive or comparative studies are strongly expected.

Therefore, unfortunately, it is difficult to recommend this paper for publication as an independent scientific paper.

Specific comments:

1. P26L6-8: This statement may be misleading because "plant functioning" can be represented by the combination of canopy structure (LAI, 3D distribution), components (chlorophyll, nitrogen, water, etc.), and biophysical/physiochemical reactions. In addition, the observational time resolution would greatly affect the definition and analysis of the "photosynthetic functioning". More precise discussion is needed.
2. P26L24-P27L10: Methodological review in this section is very insufficient. Note that a number of approaches have been investigated for remote sensing of ecophysiological variables such as chlorophyll, nitrogen, LUE, water, LAI, fAPAR, etc. not only in grassland but in the other vegetation types. From methodological point of view, it is not appropriate to limit things to grassland.
3. P26L24-P27L10: Analytical approaches of hyperspectral reflectance are 1) hyperspectral index methods, 2) multi-variable statistical methods (PLSR etc.), and 3) use of radiative transfer models (PROSAIL etc.). Hence, more comprehensive reviewing on methodologies is needed. In addition, this paper seems to focus only on a part of the approach 1) without showing any rationale. Some reasons and theoretical necessity

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should be provided.

4. P26L24-P27L10: The biophysical and ecophysiological processes for spectral reflection, transmission and absorption by ecosystems have already been understood very well in physical principle, and the major parts of such processes have been modeled. Therefore, it is already obvious that simple linear/non-linear regression models using VIs can never be applicable universally to a wide range of vegetation and/or environmental conditions. Therefore, the simple confirmation of such well-known facts using different datasets is neither new nor useful. Hence, new research should focus on 1) innovative methods to overcome such limitations, or 2) optimization for higher accuracy and applicability using simple approach. Nevertheless, this study is quite insufficient in both aspects.

5. P27L11-15: Note that some comprehensive analytical studies have already been reported for the other type of ecosystems. Therefore, the differences in spectral response between grassland and the other herbaceous or tree plants have to be investigated quantitatively. If such advanced or in-depth investigations are not included, this study may be a kind of routine exercise using preceding approaches and grassland datasets.

6. P29L14-16: This averaging around midday (10:00-14:00) is questionable because high time-resolution measurements (both remote sensing and flux data) would be needed to detect the rapid change of photosynthetic functioning (related to CO<sub>2</sub> exchange). More essentially, the analytical time-scale is not clear throughout the paper.

7. P29L21-P30L7: The error caused by these simple and conventional assumptions might not be negligible. The possible error should be assessed or discussed. Otherwise, the comparison of predictive accuracy throughout the paper would make little sense. LAI by optical method is basically Plant Area Index rather than Leaf Area Index, so there would be some problem in assessment of green-leaf area index especially during the senescent stage.

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8. S2.5: Quite similar analytical approach using hyperspectra has been reported in preceding papers (LUE, canopy nitrogen, etc.), so most readers would think that this study is a simple application of such methods to some grassland datasets. See the comments 4 and 5. Hence, first, such preceding studies should be referenced sufficiently. Second, the motivation of the application to grassland should be explained clearly with relevant logic.

9. P33L26: It is strange that graphs for SRs have triangular shape (e.g., Fig. 5). SR maps would have to have a square shape because  $R_i/R_j$  and  $R_j/R_i$  have different predictive power.

10. P37L18-20: This has been a well-known fact in remote sensing of ecosystems. Therefore, investigations should focus on reduction of such confounding factors. Unfortunately in this paper, no alternative methods, findings or insights in such aspects are obtained. Since this type of datasets have been collected through so-called FLUXnet as well as many other individual experiments, similar analysis can easily be done using a new dataset by using similar analytical approach as in this paper. However, preliminary exercises are not worthwhile in the context of science and technology as well as operational applicability. Please see the comment 4.

11. S4&5: It is difficult to find significantly original or innovative findings, insights, or message. Major parts in these sections seem to be simple confirmation or repetition of well reported facts, insights or messages by preceding papers. Please see the comments 4 and 5.

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