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Interactive comment on "Predicting landscape-scale CO_2 flux at a pasture and rice paddy with long-term hyperspectral canopy reflectance measurements" *by* J. H. Matthes et al.

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"This is a very interesting and original paper using the full spectrum reflectance (400-900nm) to predict landscape-scale (or maybe it would be better "ecosystem-scale"?) CO2 fluxes at a pasture and at a rice field. PLSR using reflectance values is without doubt providing high potential, as it is exploiting all the spectrum in the VIS-NIR, and this is clearly demonstrated in the paper. In particular, relevant information on the predictive power of spectral observations at increasing flux integration intervals are provided. However, the paper is not providing any type of comparison between the

PLSR presented method and the "traditional" Spectral Vegetation Index (SVI) approach in estimating carbon fluxes. A simple graph/table comparing the performance of PLSR with a few standard indices which showed a good performance according to many authors such as e.g. Gitelson, Rossini, etc. (such as NDVI, NDVIgreen, NDVIred edge e.g. based on MODIS, Sentinel2 bands) would be of great interest to the reader. I understand that this is not the main focus of the study, but this additional information would, in my view, significantly strengthen the paper."

We agree with this point, and have added Table 3 (attached as a Figure to this comment), comparing the correlation of SVIs with the carbon flux measurements from this study. Using the same method of training with a random 80% of the dataset and validating with 20% of the dataset, we evaluated both the training correlation between GPP and NEE and the predictive power of the resulting relationships with SVIs. For SVIs, we tested NDVI (Rouse et al 1974), MODIS NDVI, NDVIgreen (Gitelson et al 1996), NDVIrededge (Gitelson & Merzlyack 1994), and PRI (Gamon 1992). For Table 3, we included the training and validation correlation (R2) for the MODIS NDVI because of its wide applicability and NDVIrededge because it had the highest training and validation R2 values for the tested indices. The full range of statistics for all the SVIs will be included as a Supplementary Table.

Overall, the SVIs performed reasonably well at predicting CO2 fluxes at all the sites and at the Rice, although R2 values were lower than those obtained by PLSR modeling. At the Pasture, PLSR modeling significantly outperformed the predictive power of SVIs, due to the increased canopy complexity at this site. We now include a comparison of SVI performance versus PLSR performance in the Discussion section.

"... To this regard, it would be good to add a discussion on the advantages and disadvantages (expected -in the introduction- and observed -in the analyzed datasets discussion-) of using full spectrum PLSR vs. SVIs more traditional approaches ... Hence, it should be mentioned that to retrieve relevant information, the re- flectance values in the SVI approach are generally weighted against a reference band, as in the case, for istance- of CIred-edge, PRI or WBI. This is one of the reasons why the "best" bands for PLSR may not correspond to the "best" bands for SVIs. Also, normalisation in the SVI approach is used and it is also important e.g. to limit the effects of slightly different illumination conditions during the different observation days shen spectral measurements are carried out: reflectance temporal trends can be a bit noisy, but normalised SVIs trends are generally much less affected by noise."

This point is well taken, and we have added a brief discussion at the end of Discussion 4.1 pointing to some of the differences and limitations of SVIs compared with PLSR methods. In particular we address this comment regarding the limitations of PLSR in comparison with SVIs when reflectance spectra are noisy.

"Specific comments Methods/Site Characteristics section 2.1, page 5085: adding some photos of the investigated sites/instrumentation would help the reader understanding the site and the measurements characteristics such as spatial heterogeneity, measurements set ups, etc."

We now point the reader to Figure 3 within this section, which includes four photographs of typical field conditions to understand site heterogeneity.

"Section 2.2: a discussion regarding the bi-hemispherical reflectance measurements advantages and limitations and the possible impact in the authors' observations could be added (see e.g. Meroni et al, 2011 - REVIEW OF SCIENTIFIC INSTRUMENTS)."

We agree with this comment, and have added a brief description of the use of bi-hemispherical reflectance filters in the Methods section 2.2. We point out that the use of bi-hemispherical reflectance filters limit the amount of soil reflectance at high solar angles compared to unfiltered reflectance measurements, but that bi-hemispherical filters can have a slight impact on reflectance measurements collected in early morning or evening.

"At page 5092, the authors mention that intra-site variability during an individual sampling event is particularly high in the NIR. The authors should explain more in detail why this is happening."

We have added a sentence to this section indicating that the higher NIR variability at the pasture site is due to higher spatial variability in canopy structure at the pasture compared to the rice paddy, which is a monoculture with a simple crop phenological cycle.

"Page 5093: "The NIR reflectance at the pasture had a stable mean during the year". This comment is quite general. It would be better to analyze and discuss the NIR trends and explain the variations more in detail. Maybe adding a trend of a simple greenness SVI -such as NDVI- would help to identify and clarify the complexity of the VIS-NIR wavelenghts response to canopy phenology."

This is an excellent idea. We have added a subpanel to Figure 4 for each site showing the pattern in MODIS NDVI and edited the Results/Discussion to facilitate interpretation of these patterns.

"Page 5094: It is interesting to see that for shorter timescales is the highest VIP score at around 700nm, while for longer timescales NIR is providing more relevant information. According to such results, spectral regions related to structure (and not to chlorophyll absorption) provide relevant information to monitor GPP. This finding was also presented in a BG discussion paper by Balzarolo et al. (http://www.biogeosciencesdiscuss.net/11/10323/2014/bgd-11-10323-2014.pdf) and I think should be discussed by the authors."

Thank you for pointing us to this recent paper, and we now include it in our Discussion section.

"Page 5096: to investigate temporal trends, measurements should be carried out at fixed points. This should be highlighted and discussed in more detail in the paper."

We believe that we have adequately described our sampling methods at each site within Methods section 2.2. Spectra were captured at randomized locations within the flux footprint during each sampling date in order to best match the spatial scale of the CO2 flux measurements, which measure ecosystem processes at the landscape-scale.

"Page 5099, line 5: is the Pasture (as it is not irrigated) water limited and sometimes affected by water stress? This maybe would explain part of the variability which is not explained by the model."

This is a good point, and we have added this possible explanation to our list of ecosystem processes that make predicting CO2 flux with canopy reflectance at the Pasture more complex than the Rice.

"Page 5101, line 26: "... could be used in conjunction with a spectrometer capable of makind wider spectral reflectance measurements at eddy covariance sites to evaluate areas of the NIR spectrum at longer wavelengths". As in the previous lines you were mentioning the importance of investigating the "infrared area" correlated with structural components and fiber, lignin, cellulose. Did you mean SWIR instead of NIR? Within the EUROSPEC Cost Action, a spectrometer measuring in the SWIR was developed (Sensors 2015, 15(1), 1088-1105; doi:10.3390/s150101088)"

Yes, we did mean the SWIR region, and now include this new paper as a reference within this section.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/12/C3319/2015/bgd-12-C3319-2015-supplement.pdf

Interactive comment on Biogeosciences Discuss., 12, 5079, 2015.

Site	Flux	MODIS NDVI fit	NDVIre fit	PLSR fit	MODIS NDVI pred	NDVIre pred
All	GPP_inst	0.18	0.22	0.87	0.50	0.57
All	GPP_day	0.44	0.53	0.87	0.55	0.65
All	GPP_week	0.42	0.50	0.86	0.56	0.64
All	GPP_month	0.32	0.38	0.63	0.49	0.56
All	wc_inst	0.50	0.57	0.84	0.49	0.57
All	wc_day	0.51	0.58	0.84	0.45	0.54
All	wc_week	0.53	0.59	0.83	0.48	0.56
All	wc_month	0.54	0.59	0.81	0.53	0.58
Pasture	GPP_inst	0.09	0.13	0.94	0.29	0.38
Pasture	GPP_day	0.26	0.34	0.97	0.35	0.45
Pasture	GPP_week	0.22	0.30	0.53	0.29	0.38
Pasture	GPP_month	0.13	0.19	0.91	0.18	0.25
Pasture	wc_inst	0.30	0.39	0.43	0.31	0.40
Pasture	wc_day	0.26	0.35	0.38	0.31	0.41
Pasture	wc_week	0.25	0.31	0.44	0.29	0.36
Pasture	wc_month	0.17	0.22	0.79	0.20	0.25
Rice	GPP_inst	0.48	0.54	0.85	0.46	0.49
Rice	GPP_day	0.57	0.69	0.92	0.56	0.62
Rice	GPP_week	0.62	0.72	0.84	0.60	0.65
Rice	GPP_month	0.60	0.68	0.89	0.59	0.63
Rice	wc_inst	0.49	0.56	0.77	0.47	0.52
Rice	wc_day	0.51	0.60	0.86	0.49	0.55
Rice	wc_week	0.56	0.64	0.85	0.54	0.58
Rice	wc_month	0.63	0.69	0.8	0.60	0.64

Fig. 1.

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