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Discussions

Interactive comment on "Interpreting canopy development and physiology using the EUROPhen camera network at flux sites" *by* L. Wingate et al.

L. Wingate et al.

lisa.wingate@bordeaux.inra.fr

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The breakpoint analysis for transition dates presents an interesting alternative for extracting transition dates, but is not strongly justified in the paper. As the authors admit, the maximum number of breakpoints must be specified, as well as the minimum segment size. This places a two parameter constraint on the fit, where as thresholding and other techniques only place one. In addition, though the first and final breakpoint locations correspond well to leaf out and senescence, the middle breakpoints don't seem to correspond to phenological transitions. Figures 4-8,10 all note that the breakpoint changes identify "important transitions", though it is unclear from the data presented that these transitions are actually important for the canopy or ecosystem.

Response: We agree that the breakpoint analysis requires some arbitrary (but sen-

sible) constraints on the time-series, regarding the maximum number of breakpoints or the minimum segment size. We are convinced that the method could be improved and adapted for each site. However, the application of a general parameterization of the method as in this study provided good results in terms of detection of transition days. Actually the method presented here is already an improvement of a method we had tried before using the bcp package that required even more arbitrary (i.e. not physically identifiable) information and seemed to require site-by-site adjustments.

We do not completely understand why the referee considers that using simple thresholds would be superior or less parametric, because we believe that we would need to specify a minimum segment size for a threshold to be detected or require some sort of rescaling of the timeseries using extrema (or percentiles) and then arbitrary thresholds. Fitting the data with parametric functions and then thresholds on the derivatives of the fit would also require several a priori assumptions. Furthermore, fitting methods or threshold approaches would not have worked on managed grasslands, thus for this study breakpoint analysis that would provide a common extraction method with fairly good results across all ecosystems. As said above we do not claim that our method is the best for detecting transition dates in the time-series of color indices, but it is for sure the best we could find so far for an application on a large network and we are very open about using another method if it can be proved to be more appropriate.

We agree that transitions in the green fraction identified by our method are not always obviously linked to changes in canopy structure or physiology. The identified breakpoints are thus not all "important" in this sense, but nonetheless real. We thus removed the qualification "important" in the legends of figures 4-8 and 10 (i.e. "Vertical dashed lines indicate breakpoints corresponding to transitions in the green fraction").

The RGB signal modeling of section 3.2 is overshadowed by network-wide analysis of section 3.1. It would be nice to understand more of how the work in section 3.2 was performed, including a full description of the algorithm, parameter values and uncertainties, parameter starting ranges that link PROSAIL results and camera sensor properties to output color fraction curves (Fig 12, panel 3). The results shown in Figure 12 are impressive, and this section of the paper is likely to be of greatest interest to readers, but readers are left without the tools necessary to reproduce or extend the results.

Response: We thank the referee for highlighting that figure 12 and the modelling section that accompanies it is likely to be of great interest to readers. We also understand that a better description of the tools used in the section could be given. In order to address this and also encourage the testing of the model at other sites we created a repository containing the documented code and data needed to generate Fig. 12 (and also Figs. 11, 13, 14, S1, S2, S3, S7 and S8) on a Bitbucket account (https://bitbucket.org/jerome_ogee/webcam_network_paper). Should the paper be accepted for publication in Biogeosciences, this code will be open to public access. Our hope is that by placing it in a git repository the research community will actively contribute to the improvement of the code and tools to assess its sensitivity. We will place the link information for this git repository in the methods section 2.3 of the paper and again in the legend of Fig. 12.

Fig 12, panels 1-2 need to include standard deviation envelopes around the curves for Chl, Car, C_brown, and N.

Response: As pointed out by the referee in his/her appraisal of the present manuscript, one of our aims was to provide a potential mechanistic framework that tries to link the seasonal RGB fraction datasets collected by the network of cameras to plant function. For the seasonal time-series presented in Fig. 12 we ran the model in the forward mode and prescribed how each of the parameters Chl, Car, C_brown, and N were hypothesised to vary seasonally. As these are virtual estimates from the literature we did not feel at this point a fully blown uncertainty analysis was required. However, we do provide a repository for the code and the seasonally prescribed parameter set. Another study using real pigment measurements and their uncertainty with PROSAIL is also underway.

When discussing the sensitivity analysis of the RGB signal modeling, the note about the impact of diffuse light and leaf inclination angle could use further detail and discussion. Why is it that these two parameters, along with at least 4 others have an impact on the green signal, but not blue or red?

Response: This comment seems to be a little inconsistent with the text in the manuscript. We wrote that the green fraction was affected by at least 5 model parameters (Chl, Car, Cbrown, LAI and N) and that diffuse light and leaf inclination seemed to affect the blue and red fractions but not the green fraction (see last sentence at the end of first paragraph in section 3.2.1). We referred to Fig. S6 (now S7) to justify this statement. In order to best address the referee's comment we did however elaborate more on the effect of diffuse light and leaf inclination angle on the RGB signals. In the case of diffuse light the difference in the RGB response is a direct consequence of the spectra used in our analysis for direct and diffuse light (Fig. S3). From the spectra shown in this figure we can deduce that more diffuse light will bring more blue and less red, thereby influencing directly the red and blue fractions and less so the green fraction. We felt it important to highlight this influence of diffuse light on colour fractions given the large changes in sky conditions that are often experienced in the field between one day and the next. The lack of sensitivity of the green fraction to diffuse light is probably one of the best reasons for using the green fraction for phenology studies. We have added a little bit of text to clarify this point in section 3.3. In the case of leaf inclination angle our statement was based on results shown in Fig. S6 (now S7) and in response to previous studies that had suggested leaf inclination may have a role to play on the green signal. From Fig. S6 it looked like this parameter was clearly not the most sensitive one probably because of the view angle of the camera (nearly horizontal). The idea that more sensitivity could be found at other view angles was added to the text although more tests would be needed to verify this possibility.

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