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Discussions

Interactive comment on "Asynchronism in leaf and wood production in tropical forests: a study combining satellite and ground-based measurements" *by* F. Wagner et al.

F. Wagner et al.

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General comments: The work attempted in this manuscript is or great value and relevant to the audience of Biogeosciences. A greater understanding of the controls of seasonal patterns of wood and litter production, which remains poorly understood, is of great importance if we wish to improve how we model tropical systems. However, I advise that the manuscript requires substantial work before publication. Primarily the style in which the manuscript is written needs changing; the authors should try to simplify and formalise their writing style, provide more concise, less confusing descriptions and properly proof read the document as it contain numerous misuses of words and

typos. Also figures and tables need to be properly explained in order to interpret the results.

Dear Reviewer # 1, thank very much for your impressive review. We have followed most of your comments and now the paper is more concise and clearer.

Specific comments:

1. Tree selection and representativeness: You state that you used 256 trees in your methods, but you do not state how these trees were selected and the habitats they were selected from. Stahl et al 2011 use trees from seasonally flooded and terra firme plots, do you mix trees across these environments? If so how do you expect this to influence your results, as there must be a different seasonality of woody growth between these environments if water is a growth driver? FW: Yes we mix trees across seasonally flooded and terra firme habitats in a single forest plot. In Wagner 2012 (Plos One), we used the same dataset and we found no difference in seasonal growth behavior between trees located in seasonally flooded and in terra firme plots.

Is an average tree from these plots representative of an average tree across the multiple forest types in French Guiana? FW: Here we assume than an average tree from Paracou is representative of an average tree across the Paracou forest type only. In Wagner et al 2010 (Biotropica), we studied the accuracy of the AGB gain and DBH growth estimates regarding to time and space scale. Figure 1 is extracted from this paper. In our forest, the tree density averages 620 trees ha (Bonal 2008). Our sample of 256 trees is roughly equivalent to a surface of 0.41 ha with a total period of censuses of 3 years. This leads to a CV (mu/sigma) of c. 25% on the growth estimates. This value is conservative given that in the current study, all trees were equipped with dendrometers. Finally, our sample is not completely representative of the real stem diameter distribution but, in this work, we are more interested by the seasonal variation of wood production than to its real absolute value.

Figure 1 : CV of DBH growth as a function of time between census and surface of the

sample at Paracou

Also not having plot level data for woody growth means you are comparing EVI and MODIS data on an area basis with tree growth data which cannot be scaled to an area basis. Potential biases introduced by such tree sampling should be discussed in the paper. FW: We apply our woody growth model calibrated with the data of Paracou to all the pixels of the Paracou forest type. So yes, the woody growth values were scaled to an area basis. But here again, we do not aim to compare values of EVI to the value of wood production but we aim to analyze how EVI and wood production co-vary in time. We precise it in the section Method/ Data analysis/ Modeling wood production: 'Note that the calculated value of wood production cannot be used to estimate the monthly value of wood production per ha. However, in this study the absolute wood production per ha value was of secondary importance as we were more interested in the seasonal variation of wood production.' In discussion I add the following paragraph : 'As this is a pioneer research, we have to acknowledge that spatial and temporal scaling of the data used here are critical to produce general predictions. In this study, we make the strong assumption that an average tree from our sample is representative of an average tree across the forest type of Paracou. As showed in Wagner et al (2010) at Paracou, diameter growth, and hence woody biomass growth, can be estimated with relative small sampling areas. For example the coefficient of variations of diameter growth is < 20 % for a surface of 0.5 ha censused every 2 years. Furthermore, our sample is a mix of trees across seasonally flooded and terra firme habitats, typicals of this forest type (Sabatier et al., 1997). However, we know that 256 trees won't totally reflect the complex forest structure and biomass. For this reason, we focus in this paper only on the seasonal variations of woody biomass growth. Another potential bias could be use of datasets with different temporal resolution that lead us to use linear approximation. The result of this approximation could slightly influence the value and timing of the peaks and of the lowest points. However, here again, we are not interested by the absolute values of these variables but by the co-variation between EVI and woody growth at a seasonal scale. Additional works are needed to fill the gap

between improving knowledge from correlation studies and modeling for prediction.'

2. Data comparisons: Why was the CRU data used rather than the data from the eddy covariance tower, which is situated very close to the plots which you are studying. FW: In order to link tree growth with climate dataset that can be extrapolated to all the French Guianan forest types, we needed to calibrate a tree growth model with the global climate dataset available at this regional scale. This is why we choose to use CRU data instead of Guyaflux climate data. I added the sentence 'In order to link tree growth with climate dataset that can be extrapolated to all the French Guianan forest types, we needed to calibrate a tree growth model with the global climate dataset available at this regional scale'.

How does the CRU data compare to the tower data? FW: The variable with a G in the name is from the CRU dataset, the other is from the Guyaflux climate dataset Precipitation: cor(datacor$pre,datacor$preG)=0.9357332

Potential evapotranspiration : cor(datacor$pet,datacor$petG)= 0.8345688

Minimal temperature : cor(datacor$tmn,datacor$tmnG)= 0.6330517

Mean temperature : cor(datacor$tmp,datacor$tmpG)= 0.9619317

Maximal temperature : cor(datacor$tmx,datacor$tmxG)= 0.9322334

Also is it possible to show comparisons between EVI and NDVI measured on the tower? FW: EVI is computed with the reflectance blue, nir and red however on the tower we measured only red and nir reflectance. The comparison of NDVI of from the Guyaflux tower in Paracou and from Modis NDVI was done by Hmimina et al, 2013. Whereas the Normalized Difference Vegetation Index (NDVI) is chlorophyll sensitive only, the enhanced vegetation index (EVI) is an 'optimized' index designed to enhance the vegetation signal with improved sensitivity in high biomass regions such as tropical forests.

Figure 2 : Hmimina et al comparison of NDVI values from in situ and Modis measurements. Hmimina et al state that 'In the tropical forest (Fig.7 in the original article but

here see Figure 2), the MODIS NDVI time series exhibited strong noise, so none of the temporal features detected in ground-based NDVI time series could be found in the MODIS NDVI data. And in the evergreen forests, in situ NDVI time series describe the phenology with high ïňĄdelity despite small temporal changes in the canopy foliage.' However, MODIS NDVI is unable to provide consistent phenological patterns.' Also can the authors compare MODIS data to LAI data measured on the plots? This would provide a lot more confidence in the use of MODIS. As there is an abundance of ground data available on these plots it seems sensible that prior to the analysis a comparison with these data should have been done.

Figure 3 : Mean and standard deviation of LAI measurements on the 10 Guyaflux plots, methods described in Bonal et al 2008 FW: LAI had been measured 7 times between 2005 and 2012 on the 10 plots in the tower Guyaflux footprint. Results are in Figure 3. To highlight the temporal change in LAI, in 2011 and 2012, measurements were performed in March, in the middle of the wet season, and in September in dry season when the litterfall peaked. The values of LAI are not statistically different between the different seasons. In this study, we assumed that litterfall fluxes are a better index of leaf renewal than LAI at Paracou.

3. Bark thickness: I acknowledge that determining the effects of bark expansion and shrinking on growth is very difficult to do and I appreciate the authors trying to resolve this issue. However, I would suggest that the density and structure of the bark is an equal if not greater determinant for its capacity to expand and shrink than the thickness. FW: We have the measure of bark density for 222 of these trees so we have made an analysis of growth seasonality for low and high bark density trees. The results are presented in the figure below. Correlation coefficient of the wood production for the two groups, high and low trunk bark density, is of 0.87.

Figure 4: Monthly variation of wood production (percentage of maximum value) for the trees in the first and in the last quantile of bark thickness (a) and bark density (b). The results are consistent with our former results on bark thickness. This figure 4 is added

to the paper.

Also bark expansion will be positively correlated with water availability, as is growth, so would you not expect there to be similar variation between trees with thick and thin bark no matter whether bark expansion is large or small? Thus does the relationship in Figure 1 really tell us that bark expansion and contraction has no effect on growth? FW: we observed that trees with high or low trunk bark density or thickness have the same growth pattern (correlation coefficient of respectively 0.80 and 0.87). If there was a shrinking or swelling, trees with a very high bark density and/ou very low bark thickness should show less relative variation than trees with low bark density and/or high bark thickness. But this is not what we have observed in our dataset.

4. Explanation of cross correlation (p8256-8267): The explanation of how you did your cross correlation is very difficult to understand, particularly to somebody who has never performed this analysis. Also looking at table 4 is no help, as the table is poorly explained. I believe you have done the following, but am still not 100% certain: a. Taken a time series of 2 data types and correlated them b. Performed a cross correlation on these, lagging the correlation both forwards and backwards in time, to find the point at which the maximum correlation occurs. FW: Yes and in the next step, we compute a confidence interval to determine if the maximum correlation (positive or negative) observed is statistically significant c. You have then taken both data time series and randomly re-ordered them and then re-performed a cross correlation above. FW : Yes but here we only resampled one of the variable and then re-performed a cross correlation above, and do that 1000 times. d. You repeat 1000 times e. You then use your 1000 replicates to generate confidence interval based on the 5 and 95% limits on the ranges of the 1000 values for each lag period. FW : yes f. You test whether your initial cross correlation with the correct time series peaks outside of your CI limit created from the 1000 randomly ordered time-series. Is this what you did? FW : yes, g. If so, please can you show and example figure showing a cross correlation and the CI limit. FW : please see Figure 5.

Figure 5 : Cross-correlation between wood production (∆AGB) and EVI. In the article we only report the maximum positive and negative coefficient of correlation (cor+ and cor-). In blue the CI limit. Also please can you mention the maximum lag you used during your cross correlation as it would seem to me that your results in Table 4 should be highly dependent on the maximum lag you used. FW: added 'As our time series have an annual seasonality, we choose a maximum lag of 185 days.'

Interpreting Table 4 is very difficult. The authors do not explain what corr+, corr-, lag cor+, lag cor-, IC+ and IC- actually are, or what any of the units may be and what the bold typeface means. FW: text of the table changed to 'Cross correlation between the mean predicted wood production for the pixels of MODIS corresponding to the forest type of Paracou (_AGB), the mean enhanced vegetation index (EVI) corresponding to the forest type of Paracou, relative extractable water (REW) at Paracou, leaf fall measured at Paracou, mean temperature (tmp) and global radiation (Rg) , both measured from the flux tower at Paracou. cor+ and cor- are the maximum positive and negative cross correlation coefficient between the two time series, lag cor+ and lag cor- are the respective time lags corresponding to the maximum positive and negative coefficient of correlation (cor+ and cor-) in days and CI+ and CI- are the 95% interval of the null hypothesis for cor+ and cor-. If the correlation coefficient falls in the 95% interval, we cannot reject the null hypothesis of uncorrelated variables.' I removed the bold typeface. Also there is no explanation as to the significance of having both a +corr and –corr in bold (which I presume is related to significance). The authors need to re-do this table and the explanation of the cross correlation. Can I suggest that the table also uses different numbers of stars for differing level of significance rather than listing IC (which should be CI) values. Also maybe plot out the correlations of the significant variables for the reader. Currently it is difficult to fully assess the results of the paper without a better explanation of this. FW: we also add some explanations data analysis section of the method : 'We computed cross correlation coefficients between EVI, ∆AGBparacou;m, leaf fall, global solar radiation, REW and temperature to determine the maximum correlations, positive and negative (cor+ and cor-), and lagged

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times corresponding to these maximums (lag cor+ and lag cor-) between the times series. As our time series have an annual seasonality, we choose a maximum lag of 185 days. For the construction of the time series, we used the mean of EVI and ∆AGB of the pixels corresponding to the forest type of Paracou at each of the MODIS times, and all the variables were linearly approximated at a daily scale. The level of statistical significance for the maximum positive and negative correlations (cor+ and cor-) was computed by a bootstrap procedure. As I prefer the table representation for this results, I add another sentence in the Table 4 legend to give an example of cor+/cor-,CI+/CI- and lag+/lag- interpretation. 'As an example, the maximum positive correlation coefficient between ∆AGB and EVI is 0.71. This correlation is significant, i.e. > to the positive confidence interval (CI+) of 0.059. The time lag of 109.00 (lag cor+) indicates that the peak ∆AGB occurred 109 days after the peak of EVI.'

5. The authors state that the correlation between litter-fall and radiation is important, but their correlation is only 0.36, does this not suggests that 74% of the variance remains unexplained? What else explains this variance? FW: Here we are more interested by the time lag between the peak of irradiance and the peak of litterfall. As the two annual curves have different shapes, this explains why the shared variance is not high. (see figure 4) It would be nice to see a plot of the litter-fall radiation correlation with a R2 and P value. FW: We have made the plot, see the following Figure 6, but this is not very relevant because litterfall peaks only for values of solar radiation above 21, the relation is not linear and we think that the important information in the paper is only that the peak of litterfall occurs in the same time that the solar radiation peak.

Figure 6 : Association between solar radiation and litterfall at the Paracou site. Red line is a cubic smoothing spline.

Also it would be apt to discuss how general this relationship is. i.e. does data from papers such as Chave et al 2010 show that litter-fall happens around the same peak period in dry season for other forests? FW: In the paper of Chave et al 2010, the authors found a weak but significant correlation between litterfall seasonality and rainfall

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seasonality but the summarized results given in the article are not sufficient to decipher if litterfall happens around the same solar peak period for other Amazonian forests.

6. Using EVI (P8259-8260, L25-6): Is solar zenith angle the only problem with EVI? FW: The other important problem when using EVI is a bias due to the sensor view angle. However a correction is made from the view angle bias in the Modis EVI 13Q1 used in this study with the Constrained View angle - Maximum Value Composite (CV-MVC) (CVA-MVC) algorithm. From the Modis user guide 'The CV-MVC is an enhanced MVC technique, in which the number of observations (being set to 2 at the moment) with the highest NDVI are compared and the observation with the smallest view angle, i.e. closest to nadir view, is chosen to represent the 16-day composite cycle.' http://www.ctahr.hawaii.edu/grem/mod13ug/sect0005.html

I add the sentence : 'For the MOD13Q1 datasets, the bias of EVI due to the sensor view angle is corrected with the Constrained View angle - Maximum Value Composite (CVA-MVC) algorithm (Solano et al., 2010)' in the Satellite data section of the Methods.

The authors do not discuss studies such as those by Asner and Alencar 2010 and Anderson et al 2010 and others which discuss the problems of using EVI. Can the authors provide any type of evidence that EVi is an accurate measure of leaf production? FW: Contrarily to Asner, Samanta, Saleska, Anderson, and all the litterature on both EVI and leaf phenology, here we have the observed litterfall data to provide the field validation of the satellite observation. Furthermore, in French Guiana, the renewal of leaves is effective in a period close to one month (Loubry et al 1994, 24.5 +/- 16 days with observations on 330 trees in French Guiana). Our results show that EVI is an accurate measure of the seasonality of leaf production-renewal and this is one of the main results of this article.

Otherwise it may be appropriate to discuss other potential problems with using EVI. FW: Following your comments 6, I add the sentence 'For the MOD13Q1 datasets, the bias of EVI due to the sensor view angle is corrected with the Constrained View angle

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- Maximum Value Composite (CVA-MVC) algorithm (Solano et al., 2010)' in the in the Satellite data section of the Methods

7. Multiple types of EVI data (Figure 2): Why do you use EVI for all these forest types? Do you average all these forest types in your overall EVI data in Figure 3? If so why? Surely the study plots on which you have data only represent the high forest with regular canopy category. Either explain why you use all these forests types when you do not have data for all of them, or only use appropriate EVI data. FW: In figure 3b, EVI is the same than in Figure 2 'high forest wit regular canopy', the forest type of Paracou. In the legend of the Figure 2 . I added 'The forest type 'high forest with regular canopy' correspond to the type of Paracou.'

Figure 3 is here to give the full details for Paracou site and Paracou forest type, Figure 2 is here to show that we have a similar pattern of EVI variation in all FG forest types. However as we don't have other field data we can only hypothesize that similar processes occur. In discussion we add the following sentence: "As we observed the same seasonal pattern of EVI in all the forest types of French Guiana (Fig.~\ref{EVItype}), we can hypothesize that for all these forest types, leaf renewal follow the same seasonal pattern than the leaf renewal of the Paracou forest type."

Technical comments: 1. P8248 L11, 'Magnitude' is the incorrect word for this sentence, do you mean EVI increased with leaf renewal. FW: change to "EVI increased with leaf renewal"

8. P8248 L25: 'On the other hand' is a very colloquial phrase for a scientific paper. FW: 'On one hand' and 'On the other hand' change to 'First' and 'Second'

9. P8249, L5: 'Tree growth occurs in two ways' should be followed by a colon not a full stop, as it is the start of a list. FW: done

10. P8249,L6-7 inert a comma and the word 'which' after 'Primary growth' FW:done

11. P8249, L7 insert comma and 'and' after 'root development'. FW: done

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12. P8249, L7 inert a comma and the word 'which' after 'Secondary growth' FW: done

13. P8249, L7 Incorrect use of the word 'gathers' FW: change to 'corresponds to'

14. P8249, L13 'We will study their' state exactly what you will study do not use their. FW: change to 'We will study the seasonality and the temporal decoupling between leaf and wood production.'

15. P8249, L25 Do you mean photosynthetic capacity? FW: yes, change to 'photosynthetic'

16. P8249, L25 Replace 'were' with have been FW: done

17. P8249, L26 'in the heart of the dry season'. Can you replace heart with middle throughout the document if this is what you mean? FW: change to 'observed in the dry season' and 'during the middle of the dry season' in results

18. P8249, L25-28: this sentence needs re-writing it is poorly written. FW: change to 'Flushes of new leaves with increased photosynthetic capacity have been observed in the dry season and appeared correlated with seasonal peaks in solar irradiance.'

19. P8250, L1: by secondary growth do you mean woody growth in stems? If so maybe just use the term woody growth or woody stem growth throughout. FW: yes by secondary growth we mean woody growth in stems

20. P8250, L4: Remove the word 'obviously' it is not necessary. FW: done

21. P8250, L8: Do not need the word 'Most' FW: done

22. P8250, L10: Again if starting a list you need a colon not a full stop. FW:done

23. P8250, L13: 'key role in the forest's'. Which forest's? FW:change to 'key role in the tropical forests' response'

24. P8250, L21-22: But also see Doughty et al 2008 & 2011 who find evidence of down regulation of biochemical processes with increased leaf temperature in tropical

forests. FW: sentence changed to 'Some works suggest that reductions in photosynthetic rate may occur at temperatures above 30 °C and are driven by reductions in stomatal conductance in response to higher leaf-to-air vapour pressure deficits (Lloyd and Farquhar, 2008) or by a direct down regulation of biochemical processes during CO2 fixation (Doughty et al., 2008; Doughty, C. E., 2011).

25. P8250, L26-28: This sentence starting 'This increase' is difficult to understand FW: change to 'These higher concentrations were'

26. P8250, L28-29: I don't' really understand what you are trying to say with this sentence, why was it 'more variable at times'. Also you should provide a clear link to the sentence before, remembering the difference between measuring NSC as in Wurth et al and measuring photosynthesis as in Stahl et al 2013. FW: change to 'In French Guiana, carbohydrates production appeared more variable as even photosynthesis decreased in the dry season'

27. P8251, L1-3: you don't need the word 'Very' at the start of the sentence and you could link sentences 1 and 2 of this paragraph to make it easier to read. FW: I delete 'Very' and link the sentence 1 and 2 of this paragraph 'Recently, significant advances in understanding tree growth and within-tree C cycling have been made in temperate forests, Richardson et al. (2013) found that NSC were both highly dynamic and about a decade old.'

28. P8251, L4: What do you mean by 'reasonable'? FW: change to 'good'

29. P8251, L7: Get rid of the 'While' at the start of the sentence. FW: done

30. P8251, L18: 'Modis' should be in capital and acronym explained here not on the next page. FW: change to "the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor

31. P8251, L18-19: I am not sure about using the words 'apparent paradox' but if you use you should remind the reader of what it is, i.e. why is wood production and leaf

production at different times a year a paradox. You have not clearly stated this. FW: change to 'asynchronism'

32. P8251, 19: 'Biomass productivity' should be 'biomass production' FW: change to production

33. P8251, L19: can you use another word instead of time overlap as this is slightly confusing when you are actually talking about a shift in resource allocation over time. FW: change to 'reflects a shift in the use of carbohydrates in tropical trees'

34. P8252, L25: It would be good to provide a summary of your methods here and describe how they will be laid out. FW: change the sentence to 'In addition, we used a∼typology of French Guiana forest \citep{Gond2011} to link the MODIS pixels to a forest type and to describe the seasonal variations of EVI in each forest type.'

35. P8252, L25: Word missing in sentence starting 'This typology' FW: sentences change to 'In addition, we used a typology of French Guiana forest (Gond et al., 2011) to analyze EVI variation between forest types. This typology is defined with data from the VEGETATION sensor onboard the SPOT-4 satellite (1-km spatial resolution).'

36. P8252, L17: Missing word 'are' FW: Sentence change to 'Vegetation indices are optical measures of vegetation canopy greenness, a composite property of canopy structure, leaf area, and canopy chlorophyll content '

37. P8253, L15: Why do you use an approximate sign rather than an equal's sign in all your equations? Surely if it is a model it should be =. FW: Changed ∼ to =

38. P8254, L15: Does the log sign on both sides of this equation not cancel out? FW: This refers to the original equation and parameter estimation of Molto et al 2012. To keep the coherence with his notation and we keep it like this

39. P8254, L15-17: Sometimes you use H without a hat to indicate height and sometimes H with a hat over. FW: H without a hat is the 'real' height of the tree whereas H with a hat is the estimated value of height with the Molto model.

40. P8255, L4 & L11: Both of these equations create a ABGparacou one with a t and one with an m, but one states it is wood production of paracou and the other wood production from MODIS dara. This is confusing as they look very similar and also t symbolises time in your equations. Can I suggest you use something like BD (biomass dendrometer/DBH) and BM (biomass MODIS). FW: I added 'The mean wood production of our sampled population for each census time t was computed with the number of trees nt at the census time t' and change m to tm in all the equation

41. P8256, L9-10: What are MODLAND-QA and VI usefulness? FW: Quality assessment (QA) is an integral part of the MODIS Land production chain. The objective of MODLAND QA is to evaluate and document the scientific quality of the MODLAND products with respect to their intended performance. The VI usefulness index (VI_usefulness) is a higher resolution quality indicator than the MODLAND QA and its value for a pixel is determined from several conditions, including 1) aerosol quantity, 2) atmospheric correction conditions, 3) cloud cover, 4) shadow, and 5) sun-target-viewing geometry.

In the methods, I added the two sentences : ' MODIS Land quality assessment (MODLAND_QA) evaluate and document the scientific quality of the MODLand product. The MODIS Vegetation Indices usefulness index (VI_usefulness) is a higher resolution quality indicator than the MODLAND_QA and its value for a pixel is determined from several conditions, including 1) aerosol quantity, 2) atmospheric correction conditions, 3) cloud cover, 4) shadow, and 5) sun-target-viewing geometry.'

42. P8255, L11: I don't understand why you have chosen this equation form, why ' ABGparacou,m +1'. FW: we add +1 to avoid zero or negative value of the log of delta_agb, this is a common methods, see Herault 2011 (J ecol) for example.

Also why so many parameters, what is the logic behind including them all FW: here we are not interest by the most parsimonious model but by the most accurate model in order to precisely reproduce the growth variation pattern.

, and please explain what they all mean under the equation, or refer to Table 1 FW I made a reference to Table 1.

Was AIC used to thin this model? FW: We would have use AIC if we were searching for the more parsimonous model but, again, it's not the case here.

As I Also why do you assume that the model is linear? FW: Here we want to build a predictive model, we could have choose a lot of different modeling framework but linear modeling is a simple and robust method and our experience show that the linear models perform well with this dataset, see Wagner et al 2012

43. P8256, L16: Has 'n' not already been used for the number of trees in previous equations, maybe choose another letter so as not to re-use. FW: changed n to k

44. P8256, L18: You use a summation symbol with the letter i, but it does not appear anywhere in the equation thus you seem to be summing nothing. Please check your equation. FW: I added i in index of EVI

45. P8256, L21: Do you mean from the 'R package season'? FW: yes, change to 'R package season'

46. P8256, L16: Sometimes you use 'leaf fall' and sometimes 'leaffall' in the document. Leaffall is incorrect. Also perhaps litter-fall is a more standard term to use. FW: leaffall change to leaf fall

47. P8257, L16: Please quantify rather than using 'increased quickly' FW: changed to 'increased from its lowest to its highest annual values in 3.5 months'

48. P8257, L23: What is a cosinor test? This is not explained in the methods. FW: added 'This method is called cosinor test' in the Seasonality analysis part of the Methods

49. P8258, L10: Remove the word 'meanwhile'. FW: Done

50. P8258, L12: Is significantly a better word than highly? FW: not agree, here sig-

nificantly do not refers to the high value of the coefficient of correlation between REW and deltaAGB which is of 0.8, I add the sentence 'and this association is statistically significant'

51. P8258-9, L28-1: This sentence is hard to understand. You can just simply state that the carbon flux from litter-fall is of a similar magnitude to the carbon flux from woody growth. In doing this you can combine with the second sentence of this paragraph, rather than repeating yourself. FW: sentences change to 'The mean annual productivity of leaves and wood at Paracou are respectively 2.4±1.4 and 2.2±0.4Mg C ha-1 yr-1 (Bonal et al., 2008; De Weirdt et al., 2012; Rutishauser et al.,2010; Wagner et al., 2010b). Here, we showed that these two biomass fluxes, which have the same range in terms of C amount, occurred separately in time.'

52. P8259, L7: You have not introduced the ideas of greening-up of the amazon in your introduction but you discuss it a lot from now on with the words 'so called'. In this first sentence and first use of the term, you do not use quote marks and do not reference greening –up as you do later on. FW: I add quote marks to the first use of greening

53. P8259, L16-20: Simplify sentences and combine FW: change to 'However, these values of leaf production represent very short-term carbon pools as all leaves are expected to fall after a while and, contrary to wood production, cannot be directly connected to long-term variation of the biomass stock.'

54. P8259, L19: 'After a while' is not very scientific! FW: more details on the quantification of leaf aging of are given in the next sentence

55. P8259, L20-21: You need a reference for tropical leaf ages. FW: I added the original reference for these numbers Caldararu et al 2012.

56. P8260, L6: by index of canopy photosynthetic capacity do you mean EVI? FW: yes, change to 'EVI'

57. P8260, L15: 'In the end' is not necessary FW: deleted

58. P8261, L10: 'wood production presents'?? Surely 'wood production has a complex link to leaf production' is a better way to say this. FW: change 'presents' to 'has'

59. P8261, L20: Do you have data on leaf maturity times? If not I do not understand how you are inferring leaf maturity from your data? FW: we make the hypothesis that tree grow faster when leaves are fully mature and not too-aged. Leaf production peaks 109 days before peak of wood production. This seems to indicate that the leaves become fully mature during this period. Sentence change to 'If we make the assumption that wood production occur mainly when leaves are fully mature, then the time lag between peaks of EVI and wood production (109 days, Table~\ref{crosscor}) indicated the mean time needed for leaves to become fully mature.'

60. P8261, L22-24: This sentence needs simplifying and re-writing. FW: sentence change to '(i) The highest wood production is observed after the greening in the early wet season when water availability is high (Fig. 3) and when new leaves are fully matured, i.e. ecosystem photosynthetic capacity is at its maximum (Stahl et al., 2013)'

61. P8261, L26: Productivity of what, leaves or wood? FW: added 'wood productivity'

62. P8261-8262, L28-9: This can be simplified and cut down. In essence you are you just saying that wood production could be indirectly linked to irradiance via a shift in resource allocation from wood to leaves as irradiance increases. FW sentence change to '(ii) Wood production could be indirectly linked to irradiance via a shift in resource allocation from wood to leaves during the peak of irradiance in early dry season (Fig. 3)'

Also try to cite some sources of ground based evidence for resource re-allocation e.g. from Malhi et al papers and not just remote sensing papers. FW: sentence change to 'This is consistent with the results of Huete et al. (2006), which indicated a strong influence of radiation on leaf phenology and previous ground based studies in tropical forests which have highlight an exchange of leaves and a reduced wood production during drier month (O'Brien et al., 2008; Rice et al., 2004; Krepkowski et al, 2011) .

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63. P8262, L9-16: Again this section needs simplifying. Also this is the first time you mention a connection between wood production and temperature and it is not discussed in your results section. Therefore this section needs to be removed or discussed more explicitly in results. FW: in the result I add the sentence 'Mean temperature (tmp) has a significant positive correlation with global radiation without any time lag, and show the same pattern of correlation than global radiation toward wood production (Table 4).' and in discussion 'At La Selva (Clark et al., 2010), annual growth was found to be sensitive to variations of 1–2 °C in mean annual night-time temperature. In our site, mean daily temperature is highly correlated to daily global radiation (Table 4). Temperatures remain rather high (daily mean temperature never less than 23 ° C) and seasonal variations in these temperatures remain rather limited (Fig. 3f). Here, we assume that the effect of temperature seen on wood production (Table 4) is more likely due to its correlation with global radiation rather than an effect on a biological process.'

64. P8262, L19: 'A few months later' than what? FW: added 'later the peak of EVI'

65. P8262, L19: Remove 'or stopped' FW: done

66. P8262, L24: The Tapajos forest is not an ecosystem. FW: deleted ecosystems

67. P8262, L26-28: I don't think numbers are necessary here as it is an explanation not a list. FW: numbers removed

68. P8262-8263, 28-22: This section is difficult to read and complicated. You need to simplify this section and connect the pieces of information you are discussing directly to your results or remove them. Currently it is very hard to see the purpose of this section in your paper. FW: I add sentences to link this discussed information to our results and a sentence to clarify the message. 'Our results of the dynamic and interactions of leaf and wood production in dry season (Fig. 3 and Fig. 4) could be explained by the different costs or limiting factors of leaf or wood tissues production.' 'We do not have any evidence of carbon limitation in dry season at Paracou but wood production could be limited by water availability as wood production is highly correlated with this

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variable (Table 4), previously reported as the main driver of tree growth with the same dataset (Wagner et al., 2012).' And 'Understandings the NSC dynamic and how NSC concentrations are related to leaf phenology and wood production are current topics in forest ecophysiology.'

69.P8263-8264, L24-19: I suggest you re-write the conclusion. Currently there is one sentence on your results and 9 sentences on work in other studies and future work! The conclusion is for the conclusions of your paper. FW: I add the sentence 'This decoupling between the leaf renewal and the wood production seems associated to the seasonality of their respective assumed drivers at Paracou, irradiance and soil water availability.' We remain convinced that ESA-FLEX mission will provide tools of great interest for our community so we keep it in conclusion but I simplify the sentence to 'In the near future, new techniques for the study of chlorophyll content and photosynthetic activity by remote sensing will be available from airborne and space-borne sensors as well (e.g., the ESA-FLEX scientific mission European Space Agency, 2008; Meroni et al., 2010; Delegido et al., 2011) and should give direct measurements of the production of carbohydrates by trees'

70. Table 2: Are you referring to MODIS wood production or actual wood production? Please make this clear in all figures and tables and in the text. FW: Table 2, I add the sentence 'calibrated with the field measurements of wood production in the Paracou forest' and Table 4 'Cross correlation between the mean predicted wood production for the pixels of MODIS corresponding to the forest type of Paracou(AGB), the mean enhanced vegetation index (EVI) corresponding to the forest type of Paracou, relative extractable water (REW) at Paracou, leaf fall measured at Paracou, mean temperature (tmp) and global radiation (Rg) , both measured from the flux tower at Paracou'

71. Table 3: please explain your column headings amplitude of what? Also I suggest you put high and low phase and explain what they are. FW: Tables 3, I added the sentences 'N is the number of observations used in the analysis. Amplitude is the difference between the higher and the lower points of the sinusoid fitted in the cosinor

analysis. Phase and low phase are respectively the month of highest/lowest the value of EVI according to the sinusoid fitted in the cosinor analysis. A P value < 0.05 indicates that a statistically significant existence of a seasonal pattern cannot be rejected.'

72. Table 4: See Specific comments above. Also please note confidence interval should be abbreviated to CI not IC. FW: We changed legend text and IC to CI

73. Figure 1: What are the grey bars, they are not explained. Also the key in the plot only shows the solid line. FW: I added the sentence 'Monthly sum of precipitations are represented with grey bars.' The key in the plot shows the solid and the dashed lines

74. Figure 2: This plot is not properly discussed in the text. FW: I had a sentence in the discussion section 4.3 following your Specific comments 7 : 'As we observed the same seasonal pattern of EVI in all the forest types of French Guiana (Fig. 2), we can hypothesize that for all these forest types, leaf renewal follow the same seasonal pattern than the leaf renewal of the Paracou forest type.'

Also you do not explain what the lines and the dots are. FW: done

75. Figure 3: You do not explain what the lines and the dots are FW: done

Please also note the supplement to this comment:
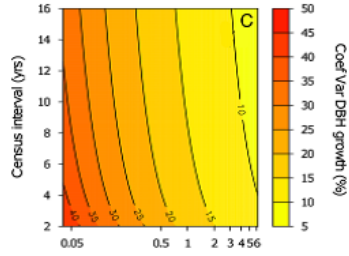http://www.biogeosciences-discuss.net/10/C4581/2013/bgd-10-C4581-2013-supplement.zip

Fig. 1. CV of DBH growth as a function of time between census and surface of the sample at Paracou
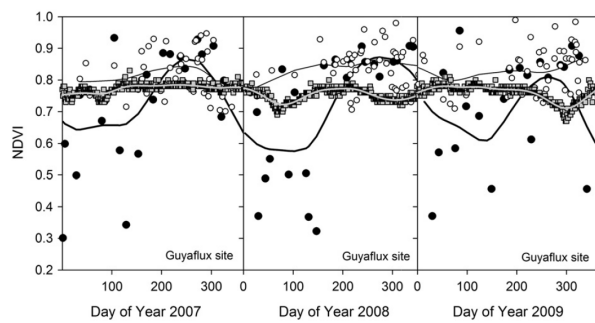
Fig. 7. Time series of in situ NDVI (gray squares), daily MODIS NDVI (empty circles) and 16-day composite MODIS NDVI (filled circles) over the tropical forest in French Guyana. Continuous curves represent the series of cubic splines fitted to the NDVI data.

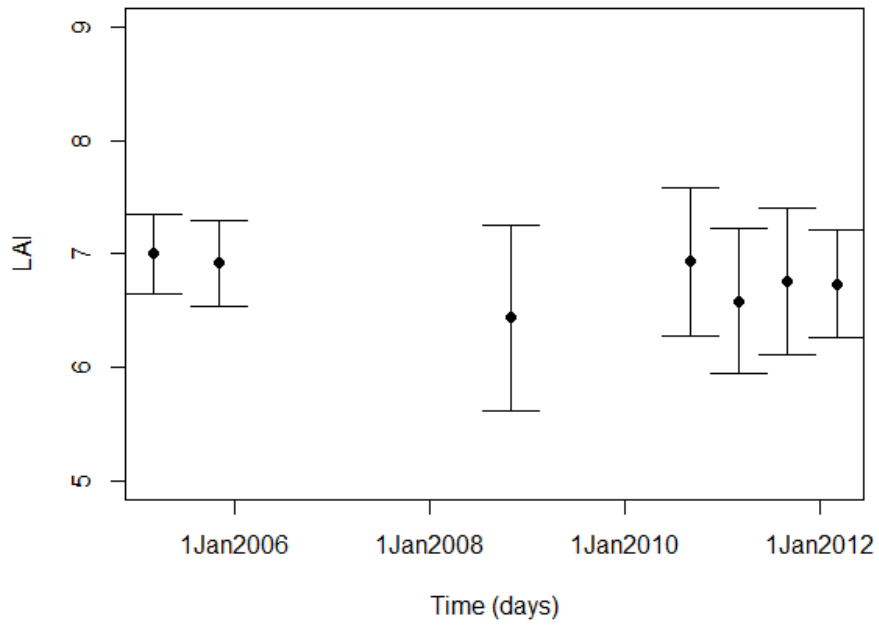**Fig. 2.** Hmimina et al comparison of NDVI values from in situ and Modis measurements.

Fig. 3. Mean and standard deviation of LAI measurements on the 10 Guyaflux plots, methods described in Bonal et al 2008
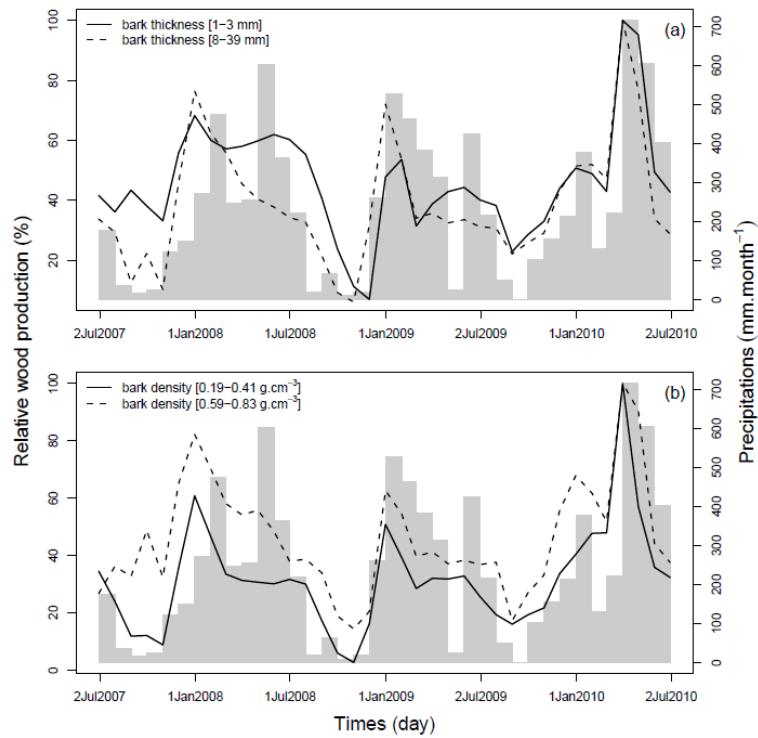
Fig. 4. Monthly variation of wood production (percentage of maximum value) for the trees in the first and in the last quantile of bark thickness (a) and bark density (b).

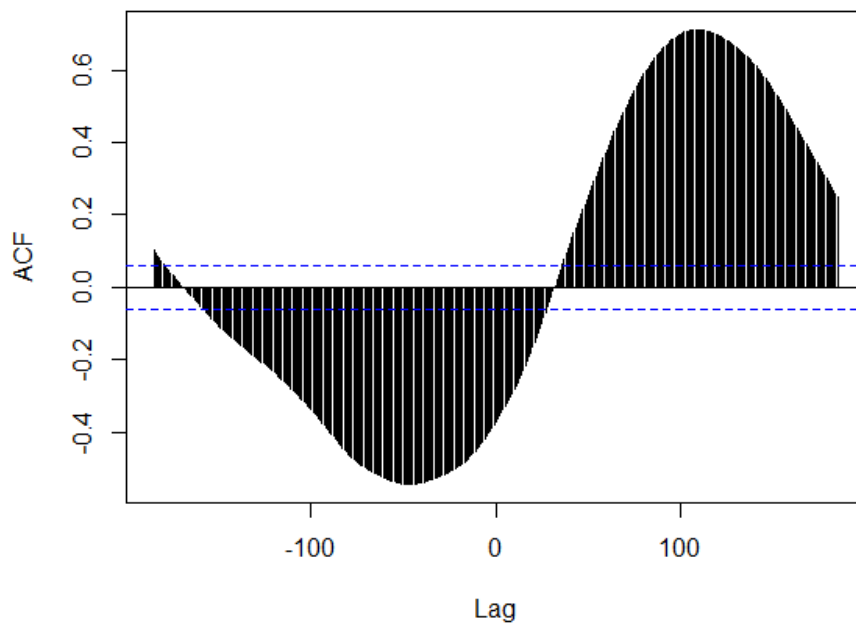**Cross-correlation between wood production and EVI**

Fig. 5. Cross-correlation between wood production (ΔAGB) and EVI. In the article we only report the maximum positive and negative coefficient of correlation (cor+ and cor-). In blue the CI limit.
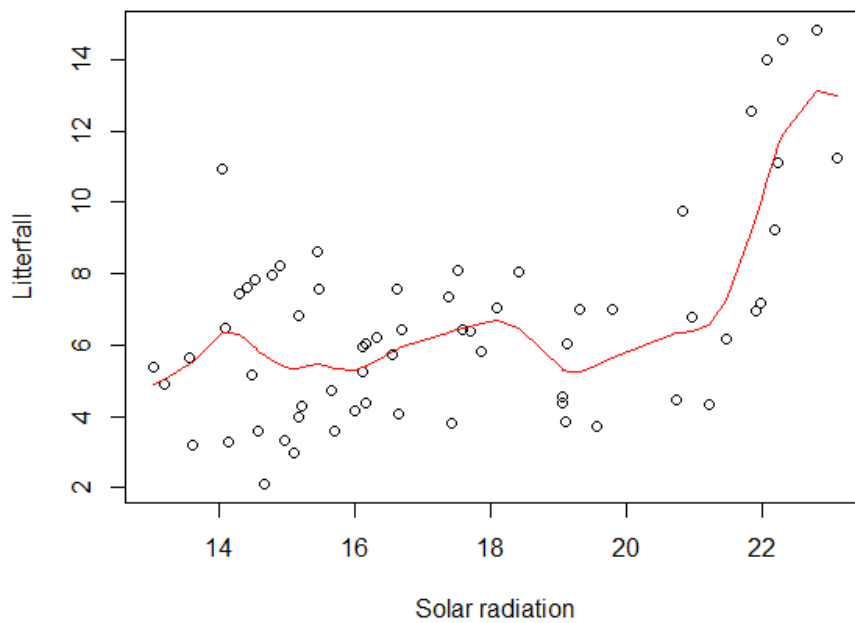
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Fig. 6. Association between solar radiation and litterfall at the Paracou site. Red line is a cubic smoothing spline.

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