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Interactive comment on "Uncertainty analysis of gross primary production partitioned from net ecosystem exchange measurements" *by* R. Raj et al.

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We would like to thank for the constructive and helpful comments for our manuscript. We have carefully considered all comments and these will be incorporated in our revised manuscript accordingly. We have inserted our response to each comment. We use "RC" for referee's comment and "AR" for author's response.

Major comments of Referee #2:

RC 1: The residual term in equation 6 is not the uncertainty for measured NEE (P15L9-10). The so-called uncertainty for NEE is from the NRH model used in this study. Some

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statistical flux-partitioning methods (like NRH used in this study) could be used to either estimate GPP and ER or fill missing data. The authors have to carefully state the usage of their approach. Don't go too far and away from parameter uncertainty analysis.

AR 1: We do not fully agree with the referee that the residual term in equation 6 is not the uncertainty in measured NEE. The residual term contains the model representation error and the random measurement error. Richardson et al. (2008) showed that the uncertainty estimates inferred from the model residuals of the tuned empirical models, which are fitted to NEE data, are comparable to the total random measurement error in NEE data estimated using pair measurements approach (Richardson et al., 2006). In our study, we have fitted the empirical non-rectangular hyperbola (NRH) model to the measured NEE. We can expect, based on the finding of Richardson et al. (2008), that the residual term in equation 6 is comparable in magnitude to the uncertainty due to the total random error in NEE measurements at the study site. However, this is not claimed in our study as we have not compared the model residuals with the uncertainty estimates from the pair measurements approach at the study site. Such a comparison may be the potential future work at the study site. Due to the lack of such comparison, we do not say that what we estimate is the uncertainty in measured NEE. Instead, we say that this is the uncertainty in posterior prediction of NEE (section 3.4 in the manuscript) that results from both the model residuals and the uncertainty in the posterior prediction of NRH parameters. It was checked in this study whether we would obtain realistic credible intervals of uncertainty in the posterior prediction of NEE after fitting the NRH model in a Bayesian framework (section 3.4 in the manuscript). In this way, we verified that realistic credible intervals of uncertainty in partitioned GPP were also obtained. This was all well in line with the main objective of this study, namely to estimate uncertainty in partitioned GPP (and hence not in NEE). Our approach can also be used to either estimate ER or fill missing NEE data, but we focused mainly on partitioning GPP with uncertainty.

Apart from the random errors, systematic errors also give rise to uncertainty in NEE

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measurements (Moncrieff et al., 1996, Aubinet et al., 2012). We have applied the Foken classification system (Foken et al., 2005, section 3.1 in the manuscript) to filter out the low quality NEE measurements that contain high systematic errors. This reduces the systematic errors on the posterior prediction of NRH parameters and model residuals. Therefore, we expect that the posterior prediction of NEE and GPP are less influenced by the systematic errors in NEE measurements.

We will discuss all the above mentioned issues in the revised manuscript.

RC 2: The authors have to acknowledge that the uncertainty quantified in this study is just a part of GPP uncertainty sources, since some factors (such as water and nutrient limitations) were missing in the photosynthesis model. The authors only quantified the GPP uncertainty based on a photosynthesis model.

AR 2: We agree that the factors such as water and nutrient limitations are missing in the NRH model. Hence we agree with the reviewer that we only quantified uncertainty based on the photosynthesis model. However, a particular feature of our implementation is that we estimated the parameters in 10-day blocks and did not assume constant values for the whole study period. This approach is recommended by Aubinet et al. (2012), since the parameters may vary over time for example due to dependencies on factors that are not included in the model (e.g., water and nutrient limitations). Hence, although these variables are not included in the model our implementation does account for them. We have also obtained the posterior distribution of NRH parameters separately for each 10-day block during the study period and finally in the prediction of GPP. This is mentioned in the manuscript (second paragraph of section 3.3 and first paragraph of section 5.3), although we will clarify it in the revised manuscript.

RC 3: Content: The verification of the approach is important, but could go to supplementary.

AR 3: We have verified our approach in two ways: (1) we examined the trace plot of the three Markov chains and Gelman-Rubin PSRF statistics of each NRH parameter.

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This is explained briefly in the first paragraph of section 4.1 in the manuscript. We have already provided the details in sections 1 to 4 in the supplementary file; and (b) we showed the 95% credible interval of the posterior predictions of half-hourly NEE against measured half-hourly NEE. In this way, we checked whether realistic credible intervals were obtained (see also the second paragraph of AR 1). We, however, discussed this in the manuscript (paragraphs 2 and 3 in section 4.1) as we think that this is important in the context of verifying indirectly the credible intervals of GPP.

RC 4: Structure: Introduction could be more concise. For example, NEE = ER–GPP or NEP = GPP-ER. One sentence might be enough. The section 3 could be included in section 2 (Methods). The results should not include discussion. Anyway, the authors have to re-structure the manuscript.

AR 4: We will revise the manuscript to improve the readability.

Specific comments of Referee #2:

RC 5: P3 L8-9: remove ",which is partitioned from NEE,"

AR 5: We understand the concern of the referee that GPP can be obtained from other sources also. Therefore, the general statement like in line P3 L8-9 should not include the specific source of GPP via partitioning. We will remove this in our revised manuscript.

RC 6: P3 L9-11: Not only measured NEE but also derived GPP and ER are used to test the process-based models.

AR 6: We agree with the referee. We have already mentioned this in lines P3 L11 -15. We will add GPP and Reco after component flux in P3 L12 to clarify it in the revised manuscript.

RC 7: P3 L12: after component fluxes, add (GPP and Reco).

AR 7: As mentioned in AR 6, we will add this in the revised manuscript.

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RC 8: P4 L5: Better to cite the original reference for NRH photosynthesis model. Rabinowitch 1951 could be better.

AR 8: We are thankful to referee for this suggestion. We will add this reference in the revised manuscript.

RC 9: P4 L9-12: Move after P4 L3, it was still talking about RH model.

AR 9: We will address this in the revised manuscript.

RC 10: P4: L12: repeat?

AR 10: We will address this in the revised manuscript.

RC 11: P4 L24: "for the calibration of process-based models"

AR 11: We will rephrase the sentence accordingly in the revised manuscript.

RC 12: P6 L1: Rabinowithc 1951 might be better.

AR 12: We will include this reference in the revised manuscript.

RC 13: P8 L 22-P9 L7: It could go early. The authors suggested that the effects of VPD could be neglected, but I did not see any VPD term in equations 1-4 or 6.

AR 13: Some versions of equation 2 include the VPD term (e.g., Gilmanov et al., 2013); however we have removed it because VPD in our study area is always low and below the critical value where it will have an effect. That is why we have explained in P8 L23 that VPD-response function is simply multiplied with equation 2 to incorporate the effect of VPD. Further, in P8 L24 to L28 and P9 L 1 to L7, we have explained why we have not included VPD-response function in equation 2.

RC 14: P9 L16: RHS Represent?

AR 14: RHS represents right hand side. We will mention this in the revised manuscript.

RC 15: P9 L23: I'm confused. Here the authors said a non-informative prior was se-

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lected and afterwards two methods (non-informative and informative prior distributions) were compared.

AR 15: In Bayesian analysis a prior distribution is required for all parameters, i.e., for precision and for other coefficients (NRH parameters in this study). We have used the same non-informative prior distribution for precision for both choices of informative and non-informative prior distributions of NRH parameters. This will be clarified in the revised manuscript.

RC 16: P17 L1-2: Remove ", so it is important to . . . means."

AR 16: OK, we will remove this in the revised manuscript.

RC 17: P17 L7: In the Results section? The authors might combine results and discussion as one section.

AR 17: Considering the advice of both reviewers we have decided to combine the results and discussion sections into a single section. We will address this in the revised manuscript.

RC 18: P18 L20 –P19 L18: the unrealistic estimates for parameters could attribute to the statistic method itself. It's not necessary to describe the results of non-informative prior distribution, as two methods may get similar results. Except that the authors would recommend using non-informative prior distribution, it will not change the story.

AR 18: The choice of non-informative priors for NRH parameters can be easily questioned by the readers as these are not site and species specific. We believe that the recommendation about the choice of non-informative priors over informative priors only by statement is not sufficient and will not give confidence to the readers who want to use it for specific site and species. Therefore, we have compared the results, wherever it was possible, to support the choice of non-informative priors over informative priors. Actually, we do recommend the use of non-informative priors for NRH parameters. We will revise the manuscript to provide a clearer explanation of the methods in order to

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make the paper more accessible to those who are not familiar with Bayesian statistics.

RC 19: P21 L2-4: As I mentioned early, this study is not appreciate to estimate the uncertainty of NEE that has been measured through the eddy covariance technique.

AR 19: Please note our responses to AR 1, we will carefully rephrase this in the revised manuscript.

RC 20: Table 1: VPD related parameters just appeared in the text. I would suggest add to the equations.

AR20: Please refer to our response AR 13.

RC 21: Fig 2, 4, and 5: no difference I can detect for non-informative prior distributions and informative prior distributions. Again, to my opinion, there is no need to compare.

AR 21: Please see our response AR 18.

RC 22: Fig.3: The distribution of simulated GPP in the morning or in the afternoon does not give me expected information. The daily GPP distribution might be interesting, as it showed the uncertainty of estimated GPP.

AR 22: We have provided the results of the distribution of half-hourly GPP in the morning and afternoon to visualize the uncertainty within a day. These results also allowed us to see that partitioned half-hourly GPP follow the expected changes within a day with radiation. Therefore, it is important to keep these results in the manuscript. We have emphasized this even further by showing the distribution of daily GPP for two days (Fig. 3). In addition, we will move Fig. S4 from supplementary file to the manuscript to show the distribution of daily GPP over the study period.

RC 23: Fig S4-5. The key results (Fig. S4) can be put in the main paper.

AR 23: We will put Fig. S4 in the revised manuscript.

References:

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Aubinet, M., Vesala, T., Papale, D., 2012. Eddy Covariance: A Practical Guide to Measurement and Data Analysis, 1st ed., Springer, Dordrecht, the Netherlands.

Gilmanov, T.G., Wylie, B.K., Tieszen, L.L., Meyers, T.P., Baron, V.S., Bernacchi, C.J., Billesbach, D.P., Burba, G.G., Fischer, M.L., Glenn, A.J., Hanan, N.P., Hatfield, J.L., Heuer, M.W., Hollinger, S.E., Howard, D.M., Matamala, R., Prueger, J.H., Tenuta, M., Young, D.G., 2013. CO2 uptake and ecophysiological parameters of the grain crops of midcontinent North America: Estimates from flux tower measurements. Agriculture, Ecosystems & Environment 164, 162-175.

Rabinowitch, E.I., 1951. Photosynthesis and Related Processes. Soil Science 72, 482.

Richardson, A.D., Hollinger, D.Y., Burba, G.G., Davis, K.J., Flanagan, L.B., Katul, G.G., Munger, J.W., Ricciuto, D.M., Stoy, P.C., Suyker, A.E., Verma, S.B., Wofsy, S.C., 2006. A multi-site analysis of random error in tower-based measurements of carbon and energy fluxes. Agricultural and Forest Meteorology 136 (1-2), 1-18.

Richardson, A.D., Mahecha, M.D., Falge, E., Kattge, J., Moffat, A.M., Papale, D., Reichstein, M., Stauch, V.J., Braswell, B.H., Churkina, G., Kruijt, B., Hollinger, D.Y., 2008. Statistical properties of random CO2 flux measurement uncertainty inferred from model residuals. Agricultural and Forest Meteorology 148 (1), 38-50.

Moncrieff, J.B., Malhi, Y., Leuning, R., 1996. The propagation of errors in long-term measurements of land-atmosphere fluxes of carbon and water. Global Change Biology 2 (3), 231-240.

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