Responses to comments of Referee #2

General comments

Question (Q)

The topic of the paper is quite important for reliable quantification of carbon budgets on regional to continental scales, i.e. scales corresponding to those of climate anomalies as well as scales relevant for political reasons. The stated objective of the paper is to assess the performance of vegetation indices to predict seasonal fluxes and to develop an upscaling approach. However, the paper does not show that those objectives have been achieved. I have to second the first reviewer in saying that for this, a proper assessment of model performance is required, that specifically addresses the capability of the model to capture seasonal dynamics as well as to capture spatial gradients, using appropriate statistical measures. The analysis should go further than the current manuscript: using the eddy covariance data, diagnostic model parameters should be optimized, and the impact of using footprint weighting should be objectively assessed. If there is no significant difference, there is no real justification in using the more complex high resolution model, at least for the investigated site. To justify the term "upscaling", multiple sites at different locations need to be included. I would therefore recommend to reject the paper from publication.

Answer (A)

A major revision has been made following the referee's comments. The revised manuscript really enhance our capabilities to make use of the growing eddy-covariance databases, and at the same time improve validation of remote sensing products in term of accurately estimating landscape/regional GPP. The presentation was significantly improved as well. The optimization of the satellite-based algorithm using a data-model fusion technique with assistance of EC flux tower footprint modeling largely reduced the biases in GPP estimations. The remotely sensed GPP using the optimized algorithm can explain 92 % of the seasonal variations of EC observed GPP. The developed upscaling algorithm was verified in the EC-tower footprint area and applied to a large area of 30 km × 30 km.

Minor comments:

Q:

The term model-data-fusion is usually used for approaches that combine different data streams in a quantitative way with the aim of constraining unknown (or less well known) parameters. It is unclear which parameters have been optimized in this study. The authors show a comparison of a diagnostic model for GPP (weighted by footprints) with EC derived GPP, but a simple comparison is not a model-data-fusion.

A:

The upscaling framework was presented clearly in the revised version. *See Section 3*. The model parameter optimization algorithm using the Ensemble Kalman filter (EnKF) data-model assimilation technique was described in Section 3.4.2.

Nine parameters were optimised (*see Table 3*) and the parameters were allowed to vary seasonally.

Q:
The statement "The footprint integrated GPP values were closer to EC derived GPP values than the "equally" integrated GPP and the tower pixel's GPP values though their differences were small" seems not justified without any uncertainty estimate or statistical information. How significant are the claimed differences? For the annual mean, the modeled GPP for the Tower pixel seems to agree better with the EC derived GPP than the footprint weighted modeled GPP. This questions the whole approach of using footprint weighted averages.
A:
The revised version is significantly different from the previous version. The revised manuscript focuses on the upscaling based on Landsat data and data-model assimilation. The issue on the tower location biases has been removed. We didn't compare the differences between the footprint weighted and equally integrated GPP in the new version. The presentation of the results in the revision were reorganised and significantly improved. All associated uncertainties and biases were quantitatively assessed. These biases include EC measurements and C flux partitioning (*see Section 2.2.2, page 9 line 18 –page 11 line 21*), the time-series data of vegetation indices from LANDSAT satellite images (*see Section 2.3.3, page 13 and page 15 lines 9-14*), the VPM model's inputs (*see page 27 lines 5-10*) and footprint modeling (*see page 25 line 14 – page 26 line 15*). The modeling results were statistically assessed and quantitatively compared with EC-derived GPP and the MODIS products (*see Section 3.5, page 20 line 18 – page 21 line 13 and Section 4.3, page 22 line 3 – page 23 line 20*).

Q:
The description of the diagnostic model seems to indicate that most of the model is very similar to the VPM model (Xiao et al., 2004). It should be clearly state what the differences to the VPM are.
A:
You are right. The algorithm used in this study is the adapted VPM model.

Q:
Footprint: it is unclear if the cumulated bi-weekly values includes day and night time periods. For GPP at least one should not include night time footprints.
A:
The model was run at half-hourly time steps during daytime when photosynthesis is on. *See Section 3.3.*

Some detailed comments:
Pg 11320, ln 11: remove comma in "it has been proved that, it is an extremely"
Pg 11322 ln 8: replace "the result of unique southeast monsoon" by "the result of a

unique southeast monsoon"
Pg 11322 ln 9: the numbers given for slopes should have units.
A:
All the corrections were followed in the revised version. Thanks.