

Interactive comment on “Modelling spatial and temporal dynamics of GPP in the Sahel from earth observation based photosynthetic capacity and quantum efficiency” by Torbern Tagesson et al.

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A. Summary

This paper uses data from six eddy covariance flux sites distributed across the Sahel of West Africa to examine patterns in space and time of carbon fluxes (GPP) as characterized by two key canopy-scale parameters (maximum photosynthetic uptake, called F_{opt} in this paper, and initial quantum yield, termed α). The authors also explore the relationships between the two GPP parameters and a variety of satellite vegetation indices providing (in theory at least) opportunities for spatial upscaling of the site-based results. This is an interesting paper reporting useful results.

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B. Main Points

1. Regional GPP estimation. It is a pity the authors didn't take the final step to evaluate GPP across the region using the fitted models. At least, we don't see a map of these estimates, only point-based comparisons with the 6 field sites. In Section 2.4.1 the authors describe a "full model" for the regression tree used to characterize fluxes and predict F_{opt} and α at the field sites. In Section 2.4.2 they continue to describe an approach to derive parameters on a pixel-by-pixel basis where not all edaphic data (e.g. soil moisture) are available. However, we don't see the results of this analysis in the form of a map or other representation. Could this be added?

2. Prior work: The authors should refer to some considerable prior work that will be relevant to this analysis. See Global Change Biology 4, 523-538 (1998) and numerous HAPEX-Sahel papers in the J. Hydrology 1997 for earlier and quite detailed analysis of flux measurements in Sahelian vegetation. The GCB paper, for example, analyzes F_{opt} and α as a leaf-level variable in considerable detail. Note that the canopy-scale F_{opt} and α investigated here incorporate the effects of changing LAI during the season. This rather complicates the situation for this analysis, as the authors state on line 351.

3. Peak uptake rates: the field measurements at some sites seem abnormally high. The earlier data in the GCB paper references above was for a southern Sahel site with LAI likely higher than any of these sites, but with maximum F_{opt} of only $\sim 15\text{-}20 \mu\text{mol m}^{-2} \text{s}^{-1}$.

4. Possible unit issues: this is an impertinent question, but looking at the massive multipliers between the author's estimates and independent estimates in Figures 2 (incoming PAR) and 3 (GPP) I couldn't help wondering if there might be some unit issues. In the case of PAR the conversion of PAR in W/m^2 to $\mu\text{mol m}^{-2} \text{s}^{-1}$ varies somewhat based on solar angle and atmospheric conditions but is typically $4.2 \mu\text{mol/W}$. This is more than the 3.09 of the fitted slope, but is it really possible that the ERA

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PAR product is underestimating actual incoming PAR so consistently by a whopping 70% ! Similarly for Figure 3, if the MODIS product is in units of g/m²/day carbon and the authors have retained their data in units g/m²/day CO₂ this would give an inherent slope in Figure 3 of $12/44 = 0.273$. Again this doesn't entirely account for their calculated slope of 0.17, but might be worth double-checking.

C. Minor Points

Line 42: While it is appropriate to mention that significant inter-annual variability in global carbon cycle arises in semi-arid regions relating to rainfall variability and fire (particularly in the mesic savannas, more so than the Sahel; eg. Williams et al Carbon Balance and Management 2007), it would be an exaggeration to state that the semi-arid regions are “driving long-term trends”.

Line 52: “continuous cropping” is very rare in the Sahel (outside of areas with irrigation opportunities, anyway). In the drier northern regions pastoralist communities may attempt a dryland crop, but with little expectation of success. Even in the wetter southern Sahel where the crop site in this paper is located, most fields are fallowed. In the highly populated regions near the capital city of Niger, rotations have reduced, but it would be wrong to imply that “continuous cropping is practiced” widely.

Line 107: “find evidence” is awkward here. Perhaps substitute “characterize”.

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