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Interactive comment on “A data assimilation framework for constraining upscaled cropland carbon flux seasonality and biometry with MODIS” by O. Sus et al.

Anonymous Referee #1

Received and published: 24 October 2012

General comments

This paper describes two uses of MODIS remote sensing data to inform a crop model simulating the carbon cycle dynamics of maize-soybean crop rotation agriculture in the US Midwest. This is an important study addressing questions as to how to use data to improve crop models and their representation in global biogeochemical models using data assimilation techniques. MODIS vegetation index data are used to (i) estimate a sowing date model parameter in a simple optimization process; and (ii) update model state estimates using an EnKF at a FLUXNET test site and at 104 points across an 800km² study area.

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Interactive Discussion

Discussion Paper

Interactive
Comment

Whilst the overall layout is fine, the overuse of parentheses makes this manuscript very difficult to read. If the information in the parentheses is required at this point, then incorporate it into a proper sentence. If it isn't required, then it should be left out. The discussion is overly long, and needs to be shortened through tighter editing and removing repetitive information.

Additional, pertinent information is required about the crop model used, noting that in the referenced paper the model description runs to over three pages and thus too long for use in this context. In particular, a clear description of the role of sowing date is required, and the sensitivity of any model parameters that may play a role controlling the timing between sowing date and emergence/early growing season LAI, and overall seasonality and magnitude of LAI.

It is clear the authors believe that sowing date is a (the?) key control over LAI seasonality but without further information and discussion it is not possible to assess the credibility of this assertion. This concern must be addressed in a revised version of this manuscript.

The relative importance of the sowing date estimation versus state estimation is alluded to, but needs to be more clearly articulated.

On several occasions the authors suggest they accurately quantify regional carbon flux, emphasizing its variability and difference from the FLUXNET site. Whilst it is obviously the case the model suggests this there is no evidence (tall tower or atmospheric inversion regional flux estimates, regional yield estimates) that is accurate?.

Specific comments

P11140 L12 Here, and elsewhere, this is a strange use of the term 'variational data assimilation'?

P11140 L13 Here, and in many, many other places is an inappropriate use of parentheses in sentence construction.

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P11140 L14 Here, and elsewhere the authors suggest that the model ?accurately? quantified the regional carbon flux, but there is little support for this statement given that validation data consists of flux tower NEE that is not regional and the comparison against the NASS data is not great, and as the authors describe somewhat problematic.

P11141 L23 EC flux measurements are hardly novel?

P11142 L3 And also recent Richardson paper. Global Change Biology (2012) 18, 566?584, doi: 10.1111/j.1365-2486.2011.02562.x

P11142 L24 What is 'sufficient'?

P11143 L12 Need the description of the Bondville site which is on the next page here.

P11144 L23 The SPA model is not coupled to the C mass balance model as you imply in this reference Williams et al., 2005.

P11144 L28 To increase appeal to a general readership familiar with models of natural ecosystem dynamics and carbon cycling, but not crop modeling, some more detail about the SPAC model is required here.

P11146 L25 Somewhere you should say MOD13Q1/MYD13Q1 products include red reflectance and NIR reflectance which you need to calculate RDVI at 250m resolutions. I believe that previous products only had the indices (ie NDVI and EVI) readily available at this spatial resolution.

P11147 L11 What additional uncertainty does using uniform meteorology over an 800km² study area introduce?

P11147 L14 It would be helpful to have a figure showing an example of these 80 curves and the MODIS data. It is difficult to know what the spread is like, the shape of the curves and the range of sum of squared differences.

P11147 L16 Over what time period is LAI compared? The growing season? The rest of the calendar year?

Interactive
Comment

P11147 L24 'state vector contained all above- and belowground biometric variables' But there is no further discussion of how these were updated by the EnKF other than LAI and NEE, which is extremely difficult to interpret in this context due to identifiability issues. Are the other components of the state vector significantly updated? Does that make sense?

P11148 L3 Need a sentence here on what you actually did to calculate the uncertainty. After all Hollinger and Richardson use two approaches, twin towers and temporal separation. It's not immediately obvious how either of these approaches would be applied to the MODIS data.

P11150 L2 Here modeled C3 grass growth is said to be reduced by assimilation, but on L17 say there is little information in the MODIS data for these fallow periods?

P11153 L11 Shouldn't MS rotations be different from Bondville as that is the reverse cropping pattern? Not sure of the point here.

P11154 L13 I don't follow the argument here. How would using early growing season LAI observations for optimizing sowing date affect the DA procedure during senescence? I understand that you would want to use MODIS data during the senescence period with the sequential approach but that is quite separate.

P11154 L25 I don't follow the argument here.

P11155 L1 Is this preventing an explanation of the difference seen here in model performance between the crop types in 2002?

P11155 L14 Do you mean 'constraints' here, or rather validation or testing data?

P11156 L1 MODIS DA is suddenly being applied as a term for using the EnKF, but earlier in the manuscript was used for both sowing date optimization and state adjustment with the filter.

P11156 L28 'less reliable' than what?

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P11158 L9 This speculation about tall tower fluxes is not required or helpful here.

Interactive comment on Biogeosciences Discuss., 9, 11139, 2012.

BGD

9, C5106–C5110, 2012

Interactive
Comment

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