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Biogeosciences Discussions

Interactive comment on "Incorporation of crop phenology in Simple Biosphere Model (SiBcrop) to improve land-atmosphere carbon exchanges from croplands" *by* E. Lokupitiya et al.

E. Lokupitiya et al.

Received and published: 7 May 2009

Referee #1

Comment: The use of NDVI to estimate LAI is known to result in low biomass estimates for intensively managed crops. This caused problems for models that are being developed to estimate carbon fluxes. This paper represents one method that can be used to overcome this issue. The ue of crop-specific phenology models is developed, applied, and documented in this paper. This paper contributes to an advancement in our ability to model carbon fluxes from croplands.

Response: We appreciate these positive comments very much.

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Comment: I see two issues that can use clarification: 1. The phenology models developed here seem to represent optimum growth based on temperature and precipitation. If there are reduced or augmented yields associated with management (e.g. weed control, herbivory, fertilizer application, etc.), they will not be captured here. It is worth clarifying this. It may be beneficial to consider the use of inventory data (in future model development) that captures average annual variation in crop yields. 2. In Figure 7, the observed is slightly less than the predicted. This is what I would expect given my #1 comment, above, and this is reasonable and positive result. In Figure 7b for Bondville, the predicted biomass in DOY 225 is increased, and the observed biomass is the inverse. It may be worth including a sentence or two in the discussion as to why you think this relationships occurs.

Response: We appreciate this comment, and the following sentences to this effect were included within the Results and Discussion section of the revised manuscript. The growth in SiBcrop is dependent on variation in weather and the assimilation, which is limited by enzyme kinetics (Farquhar et al, 1980) and stomatal physiology (Collatz et al 1991, 1992). The model does not capture any impact from herbivory or weed control, etc. Thus the slight deviation of the predicted values from observed data might be indicative of the exact field conditions which might also reflect the latter. Since the current version of SiBcrop is based on the assumption that the crop plants are not nutrient limited, it also does not capture any impact from fertilizer application.

Referee #2

General comments

Comment: This paper describes the development of crop phenology models for a climate model land surface scheme, to replace the currently used NDVI data. The paper presents a well-written and interesting discussion of how the model has been validated against observed datasets, and makes a useful contribution to the literature. I do not have significant suggestions to improve the paper.

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Response: We appreciate these positive comments on the manuscript.

Comment: It would be good to see more explicit estimates of uncertainty in the observations. The presentation of variability in the data might also be enhanced, perhaps with model/observation comparisons presented as solid lines for means, and error bars or an 'envelope' representing the spread? It would also be good to see some statistics on model fit (e.g. RMS error and R2), particularly for the data presented on figures 5,7,8,9, and 10.

Response: We incorporated the error bars and statistical evaluations (R-sq and RMS error) for the relevant figures and overall comparisons in the revised manuscript. Few sentences regarding these analyses were also added towards the end of the section 2.2.2. A new table (Table 2 in the revised manuscript) was created with the R-sq and RMSE for all the comparisons relevant to maize and soybean, and the table was referred within the text. Due to lack of a substantial number of data points for comparing LAI and biomass at ARM-SGP site with wheat, the R-sq and RMSE was estimated only for the sub-hourly NEE predicted by Sib crop (and these values were included within the text in section 3.2.

Comment: The authors should also make it clearer whether the current model was intended to represent maize, soybean and wheat only for the Mid West USA, or for these crops more widely.

Response: This comment was addressed in the revised manuscript. The current version of SiBcrop was developed to be used within the continental United States, and model evaluation in this particular study was done using three AmeriFlux eddy covariance flux tower sites in the US midwest. However, we plan on wider use of the model, and thus further model testing using more sites at locations with different climates and weather variability is warranted.

Comment: It would be useful to expand on potential reasons for some of the model's shortcomings,e.g. overprediction of maximum LAI at Mead in some years, and under-

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estimation of CO2 uptake at sub-hourly scales.

Response: This comment was addressed in the Results and Discussion section of the revised manuscript, along with the similar comment from Referee #1.

Comment: Finally, a table comparing the basic characteristics of existing linked crop - climate/land surface model approaches would be useful in the introductory section (e.g. scale, number/type of crops, fundamental approaches, other schemes used, data inputs, timestep..).

Response: We summarized several such models within an existing paragraph and a new paragraph.

Specific comments

Comment: P1906, Line 10: There are several sources of literature which could be cited here e.g.: Betts R. Integrated approaches to climate-crop modelling: needs and challenges. Phil Trans R Soc B 2005; 360: 2049-2065. Desjardins RL, Sivakumar MVK, de Kimpe C. The contribution of agriculture to the state of climate: Workshop summary and recommendations. Agric Forest Meteorol 2007; 2-4: 314-324. (and the special issue from which the paper comes) Hansen JW, Challinor A, Ines AVM, Wheeler T, Moron V. Translating climate forecasts into agricultural terms: advances and challenges. Clim Res 2006; 33: 27-41.

Response: We incorporated these references within the revised manuscript.

Comment: P1907, first paragraph: Further work describing coupled climate-crop modelling: Challinor AJ, Wheeler TR, Slingo JM, Hemming D (2005) Quantification of physical and biological uncertainty in the simulation of the yield of a tropical crop using present day and doubled CO2 climates. Phil. Trans. R. Soc. B 360: 2085-2094. doi:10.1098/rstb.2005.1740. Bondeau, A., Smith, P.C., Zaehle, S., Schaphoff, S., Lucht, W., Cramer, W., Gerten, D., Lotze-Campen, H., Müller, C., Reichstein, M. & Smith, B. 2007. Modelling the role of agriculture for the 20th century global terrestrial

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carbon balance. Global Change Biology 13: 679-706.

Response: We incorporated these references within the revised manuscript.

Comment: Please make sure the figure legends are consistent - for instance red/black are used interchangeably e.g. in figure 11 where the meaning of black/red differs in b) to the other parts of the plot.

Response: We corrected this figure in the revised manuscript, and checked/revised all the other figures, as well.

Interactive comment on Biogeosciences Discuss., 6, 1903, 2009.