For clarity purpose, we have listed the reviewer's comments in bold italics, authors' response in the normal font. The changes made in the manuscript are in normal italics font.

We have added one new Table 1. Table 3 (old Table 2) has further been modified. In addition, we have added two new figures: Figure 1 (old Figure S1, which has further been modified based on the reviewers comments) and Figure 4 (old Figure S2). The numbers for the rest of the figures have been changed accordingly: Figure 2 (old Figure 1), Figure 3 (old Figure 2); Figure 5 (old figure 3), Figure 6 (old Figure 4), and Figure 7 (old Figure 5).

Authors' Response to the Reviewer #3 Comments

1. Some proof reading and corrections related to grammar is needed.

Responses: The text has now been proof read and several grammatical errors have been corrected in the revised manuscripts.

2.(1) the introduction several earlier studies where crop modules have been added to existing models are mentioned but there is no mention of how the approaches used in this paper differ from previous approaches and (2) also not how the ISAM model differs from other Land Surface Models.

Response: (1) In the revised manuscript we have now added a discussion as to how the newly implemented processes and parameterizations differ from previous crop growth modeling studies discussed in the introduction.

The newly implemented algorithms, which are described in detail in section 2, differ in many ways from the algorithms considered in previous crop growth modeling studies, some of which are discussed above. For example, while the classification of different phenology stages and LAI in the ISAM and most of the other models discussed above are determined according to the fraction of accumulated heat units, the extended version of the ISAM model also considers additional phenology stages, such as silk emergence, to account for the impact of water stress on crop yield at a critical stage for grain production. Following the methods of Agro-IBIS and SiB-CROP models, the ISAM estimates LAI based on leaf carbon by multiplying leaf biomass carbon with specific leaf area (SLA). Moreover, the ISAM model makes a distinction between the green LAI and the standing dead LAI in LAI simulation. The carbon assimilated into the leaf is distributed to stem, root and grain with fixed fractions at each phenology stage in all models, except for the ISAM and SiB CROP. Following the methods of ISAM and SiB-Crop, which simulates the variation of the allocation fractions with cumulated heat units, the extended ISAM further simulates the responses of the allocation fractions to other environmental factors, including water, light and nutrients availability. All but STICS-ORCHIDEE and JULES-SCUROS models simulate the root growth and canopy height based on the prescribed canopy height and root depth and distribution. The STICS-

ORCHIDEE and JULES-SCUROS models calculate the temporal variability in root growth and canopy height based on the root and aboveground biomass variability. While ISAM model adopts the STICS-ORCHIDEE and JULES-SCUROS algorithms to calculate the root growth and canopy height, it also calculates vertical and horizontal root growth in soil layers in response to available soil moisture. Overall, relative to crop simulation schemes in other land surface models discussed above, the dynamic crop growth processes implemented in the ISAM account for the coupling between carbon biomass dynamics of leaf, stem, root and grain and vegetation structure (LAI, canopy height and root depth and distribution), as well as environmental factors (temperature, water, light, nutrient) variability.

(2) As for the differences between the ISAM and other land surface models, a previous version of the ISAM is used in various model intercomparison studies (Hunzinger et al., 2012; Richardson et al., 2012; Schaffer et al., 2012; Goncalves et al., 2013; Kauwe et al., 2013). These studies discuss in detail the differences of between different land surface models. A statement to this effect has now been added now in the revised text.

This paper builds upon and extends the approaches of the studies discussed above into ISAM, which has been extensively used in various model inter-comparison studies (Hunzinger et al., 2012; Richardson et al., 2012; Schaeffer et al., 2012; De Goncalves et al., 2013; Kauwe et al., 2013)

3.In the methods section I find it hard to differentiate between what is the description of the "standard" ISAM model and what is new in this study. I would like to see a clearer separation of these two. The section describing the original ISAM model should be shortened leaving a stronger focus on "what is new"

Response: We now added an overall description at the beginning of the section 2.2 to clarify the new processes implemented in this study. The section 2.2 separates the extended model from the "standard" ISAM described in section 2.1.

2.2 Implementation of Dynamic Crop Growth Processes in the ISAM

The ISAM, as described by El-Masri et al. (2013), was extended to enable the explicit study of dynamic crop growth processes, specifically accounting for the effects of light, water, and nutrient stresses on C3 and C4 crop growth and water and energy fluxes under the soybean corn rotation system. In particular, we implement crop specific phenology schemes, dynamic carbon allocation processes, and dynamic vegetation structure growth processes (LAI, canopy height and root depth and distribution). In the following, we describe each individual dynamic process as it has been implemented in the ISAM for the current study.

2.2.1 Phenology development

2.2.2 Carbon allocation

2.2.3 Calculation of LAI, Canopy Height and Root Depth

The text for sections 2.2.1-3 is the same as it was in the original manuscript.

4.Of the four main processes that are new to the model, there is a large focus on phenology and carbon allocation in the paper reflecting the number of equations for these in the Appendix. Even so, it would be nice to have some more information about the calculation of LAI, canopy height and root depth in the text.

Response: As suggested, we have now added the description of methods used to calculate the LAI and canopy height. The description of the method to calculate the root depth was already given in the section 4.2 of the original manuscript, which we have now moved to the section 2.2.3.

Total LAI in the model is the sum of green and standing dead LAI, which is calculated as a function of total leaf carbon and specific leaf area (SLA) (Eq. A36). The green LAI is calculated by multiplying the green leaf carbon masses with SLA (Eq. A37) and the standing dead LAI is calculated by subtracting green LAI from the total LAI (Eq. A38). Canopy height, which is used to parameterize atmospheric turbulence above the canopy in the model, is calculated by scaling the maximum canopy height (Ha) with the accumulated aboveground biomass (Arora and Boer, 2005) (Eq. A39). Canopy height increases from 0 to Ha with increased aboveground biomass. Root depth and root distribution in each soil layer vary temporally and spatially with accumulation of root biomass (Arora and Boer, 2003) (Eqs. A40-43). The parameter α appearing in equations (A41-42), which ranges from 0 to 1, determines the rate at which root density varies horizontally and the root depth grows vertically with increased root biomass (Arora and Boer, 2003). As α approaches 1, the more the roots tend to grow vertically. The parameter bb appearing in equations (Eqs. A41-42) determines the root distribution under no water stress. Since the allocation of assimilated carbon to root is sensitive to soil water availability (Eq.A21), ISAM simulated root growth and distribution in each soil layer are dynamically sensitive to soil water availability within each soil layer according to Eqs. A41-42. The reduced soil water content in the root zone induces water stress, which leads to increased carbon allocation to roots and thus rapid increasing of root biomass according to Eq. A21. Following Eqs. A41-42, both root depth and root density in each soil layer increase with increased root biomass.

5.* (1) *No description of the calibration of the model is present in the paper. This is clearly needed. (2) Also, it would be interesting to know which of the calibrated parameters that strongest influence the model fit in relation to the different variables (fluxes, LAI, leaf and plant biomass, and yield). (3) An option would also be to perform a cross validation, by also tuning the model using the Bondville data (if all variables are available) and to test the result against the Mead data. Following this it would be interesting to see if the "best parameter values" would differ depending on the dataset used for the calibration.

Response: (1) As for your comments, we have added model calibration description in section 3.1. In addition, we have moved the description of root distribution parameters calibration part from section 4.2 to section 3.1. A new Table (Table 1) is also added to list the calibrated model processes and calibrated parameters in each process.

Calibrations of dynamic crop phenology, carbon allocation and vegetation structure growth (LAI, canopy height and root depth and distribution) processes are performed in five steps. First, the daily LAI data is calculated by interpolating biweekly-measured LAI data. Second, the model is run with prescribed daily LAI to calibrate the amount of initial carbon fraction allocated to the leaf, stem, root and grain (Table 1). This is achieved by comparing observed and measured leaf carbon biomass, aboveground biomass and grain yield. Third, instead of using prescribed observed LAI, the model simulates the daily LAI. We then calibrate the parameters that are used in the dynamic phenology simulations (Table 1) by comparing modeled LAI and measured LAI data. These parameters are especially important for capturing seasonal variability in LAI and thus carbon and energy exchange between the canopy and atmosphere. Fourth, canopy height equation parameter, m (Table 1), is calibrated by comparing simulated and measured canopy height. Finally, the parameters used for the calculations of the dynamic root growth and distribution (Table 1), which have strongest effect on both carbon and energy fluxes simulations under water stress condition, are calibrated by comparing the observed and calculated root biomass distribution. Since there is not much information available in literature about the root biomass distributions for corn and soybean for the growing seasons studied here, here we use corn root profiles measured for three specific dates in 1980 at the Mead site (Newell and Wilhelm, 1987) to calibrate root growth direction parameter (α) and root distribution parameter (bb) for corn. Due to the lack of site-specific climate forcing data in 1980, we use 1980 NLDAS-2 climate forcing data (Mitchell et al., 2004) to drive the model for this calibration. All other information, such as management seeding rate, planting time etc., is taken from Newell and Wilhelm (1987). For soybean, we calibrate α and bb by comparing measured and modeled soil water content. Calibration is performed by minimizing the total sum of the squares of the difference between simulated and observed data for corn and soybean at the Mead, NE site. This was realized through automatic optimization using PEST, which is a nonlinear parameter optimization program and can be used with any model (Watermark Numerical Computing, 2005).

Table 1. Calibrated processes and parameters and their original and updated values. The two data values in original and calibrated columns are for corn and soybean, respectively.

Calibrated process	Equations	Parameters	Parameters Values Original	Calibrated
Carbon allocation to leaf, stem root and grain	Eqs. A19-26	Al_0	0.5, 0.5	0.5, 0.3
		As_0	0.2, 0.2	0.2, 0.32
		Ar_0	0.3, 0.3	0.3, 0.38
		Al_{r1}	0.0, 0.0	0.0, 0.0
		As_{r1}	0.4, 0.4	0.45, 0.35
		Ar_{r1}	0.2, 0.2	0.10, 0.20
		Ag_{r1}	0.4, 0.4	0.45, 0.45

		Al_{r2}	0.0, 0.0	0.0, 0.0
		As_{r2}	0.0, 0.0	0.0, 0.0
		Ar_{r2}	0.5, 0.5	0.45, 0.65
		Ag_{r2}	0.5, 0.5	0.55, 0.35
		Al_{v2m}	0.5, 0.5	0.79, 0.85
		As_{v2m}	0.2, 0.2	0.10, 0.12
		Ar_{v2m}	0.3, 0.3	0.11,0.03
		$k1_{v2}$	1.0, 1.0	1.0, 9.5
		$k2_{v2}$	1.0, 1.0	2.4, 0.0
		$k1_{r1}$	1.0, 1.0	1.0, 2.1
Phenology simulation	Eqs. A3-A7	GDD_{max}	1700°C, 1700°C	1620°C, 1670°C
		$GDD0_{min}$	125°C, 125°C	170°C, 210°C
		HUI_{v1}	0.15, 0.15	0.10, 0.15
		HUI_{v2}	0.21, 0.18	0.19, 0.17
		HUI_{r1}	0.38, 0.67	0.63, 0.69
		HUI_{r2}	0.71, 0.89	0.80, 0.85
		HUI_{v2m}	0.38, 0.18	0.38, 0.20
		HUI_{r1m}	0.71, 0.89	0.69, 0.79
		D_e	15, 15[days],	22, 22[days],
		D_{v1}	24, 24 [days]	17, 17[days],
		D_{v2}	51, 51[days],	51, 53[days],
		D_{r1}	30, 30[days],	37, 28[days],
		D_{r2}	30, 30[days],	32, 30[days],
Canopy height simulation	Eq. A39	m	0.35, 0.35	0.385
Root growth and distribution	Eqs. A41-42	α	0.7, 0.7 (Arora, 2003)	0.7, 0.7
		bb	0.87, 0.87 (Arora, 2003)	0.53, 0.53

(2) To address this comment, we have now specifically stated the importance of each calibrated parameter and its effect on different processes and different variables (see newly added Table 1 and revised text above.

(3) We agree with you that cross validation is a good way to examine whether the parameters depend on the calibrated sites that used. However, instead of using the cross validation method, here we calibrated the model using the observed data for the Mead, NE site only. We have now specifically stated this in the text. In our case the best set of model parameters are calculated based on the Mead site. So, Mead and Bondville sites calculations are done using the identical set of parameters. The only difference between the calculations for these two sites is the input climate data and site specific soil and other biophysical properties. In order to address this point, we have revised the text.

The hourly-measured carbon, heat and water exchanges between atmosphere and canopy, and biweekly-measured LAI, leaf carbon, biomass and annual yield *(ftp://cdiac.ornl.gov/pub/ameriflux/ data/Level2/Sites_ByName/Mead_Rainfed/) at Mead rainfed site, Nebraska (41.18°N, 96.44°W) (Suyker et al., 2004), are used to calibrate the processes and parameters of the extended version of the ISAM model. Then we use the calibrated parameters along with Ameri-Flux data from Bondivlle, Illinois (40.00°N°N, 88.29°W) (Hollinger et al., 2005) (ftp://cdiac.ornl.gov/pub/ameriflux/ data/Level2/Sites_ByName/Bondville/) to evaluate the model performance for carbon (GPP) and energy fluxes (net radiation (Rn) at the top of canopy, latent heat (LH) and sensible heat (H) fluxes) between atmosphere and canopy at both diurnal and seasonal scale, and seasonal LAI.*

6. The model is not benchmarked against other models and the effect the addition of various processes new to the model has on model fit is thusly not tested (with the exception of root dynamics). The phenology and carbon allocation approaches implemented in this study may have been compared against other approaches elsewhere but no justification of the selection of the approaches used in this paper is made. The same is true for canopy height and LAI.

Responses: We have now introduced benchmark experiments to evaluate the statistical significance of each of the implemented dynamic crop growth process and the overall performance of the dynamic crop model scheme on the section 4.2. Sections 4.2.1, 4.2.2, 4.2.3 and 4.2,5 are results discussion for new added benchmark experiments, whereas section 4.2.4 is the same as the text as the section 4.2 of the previous manuscript. The Table 3 (old Table 2), which has now been modified based on the reviewers comments) in the original manuscript has now extended to include Willmott values for additional model simulations

*"**4.2 The Effects of Different Dynamic Processes on Modeled Results***
In this section we evaluate the importance of four dynamic process considered in this study, (1) dynamic carbon allocation, (2) dynamic LAI, (3) dynamic root distribution and (4) dynamic scale height by performing following additional model simulations:

ISAM-Static: This model is based on fixed carbon allocation, prescribed LAI, prescribed canopy height, as well as prescribed root depth and root allocation faction in each soil layer. All these four processes have been included in the original version of ISAM (El-Masri et al., 2013).

ISAM-StaticC: Same as ISAM-Dynamic experiment, but the carbon allocation parameterization is based on fixed carbon allocation scheme as assumed the original version of the ISAM.

ISAM-StaticLAI: Same as ISAM-Dynamic experiment, but uses prescribed LAI development as assumed in the original version of the ISAM.

ISAM-StaticR: Same as ISAM-Dynamic experiment, but uses pre-determined root depth and root fraction for each soil layer in space and time as assumed in the original version of the ISAM.

ISAM-StaticH: fixed canopy height parameterization, but uses fixed canopy height parameterization as assumed in the original version of the ISAM.

In the original version of the ISAM (El-Masri et al., 2013), referred to here ISAM-Static, the carbon allocation fractions for leaf, stem, root and grain pools for each phenology stage are assumed to be the same values as in the case of ISAM-Dynamic but without accounting for limitation of water, light and nutrients (Table A1) and these fraction values are assumed to be the same for each model year run. The LAI is not dependent on the carbon allocation simulation as in the case of ISAM-Dynamic experiment, rather the LAI values in the original version of ISAM are attained from multiyear average site-specific MODIS land product subsets (ORNL DAAC, 2011). The root distribution in the ISAM-Static is calculated based on the root depths at which plants have 50% of their total root biomass and a dimensionless shape-parameter for describing root profile (Schenk and Jackson, 2002). Since the static root distribution case assumes no temporal variation in root fraction in each soil layer, we use average value of three observed corn root profiles (see section 3) to calibrate the static root distribution case. The fixed canopy heights in the ISAM-StaticH experiment are assumed to be the maximum canopy height of specific vegetation type (Ha) from Ameri-Flux data sets (Table A1).

In order to evaluate the performance of integrated effects of dynamic crop growth processes implemented in this study (ISAM-Dynamic case) and the individual dynamic crop growth processes, we compare the Willmott indexes (dr_d) for carbon and energy fluxes based on individual five experiments discussed above with the estimated dr_d for ISAM-Dynamic case (Table 3).

4.2.1 Static versus Dynamic Crop Growth Processes

The Willmott index values (dr_d) for daily mean GPP, Rn, H and LH fluxes in ISAM-Dynamic case are higher than that in ISAM-Static case and several are much closer to 1, except for no apparent improvement in dr_d values for corn GPP and Rn fluxes at the Bondville site (Tables 3 (or old table 2)). These results suggest that the implementation of dynamic crop growth scheme in ISAM significantly strengthens the ability of model to capture seasonal variability in measured carbon and energy fluxes for crops. No differences in dr_d values for corn GPP and Rn fluxes at the Bondivlle site for ISAM-Dynamic and ISAM-Static experiments are due to that fact that processes considered in both experiments are unable to capture a crop lodging effect, as discussed in section 4.1.

4.2.2 Static versus Dynamic Carbon Allocation

Figures 1b, e, h, k show that the estimated aboveground biomass for corn and soybean are in much better agreement with measurement for ISAM-Dynamic case than for ISAM-StaticC case. In addition, ISAM-Dynamic case better captures the seasonal variability in leaf carbon mass, as indicated by LAI (Figures 1a, d, g, j), and the root carbon biomass (Figures 1h, k) than the ISAM-StaticC case. The improvements in estimated seasonal aboveground biomass, leaf and root carbon biomass for ISAM-Dynamic case are more for soybean than for corn at both sites. These results indicate that the dynamic carbon allocation scheme in the ISAM-Dynamic case is able to capture the response of carbon allocation to water, temperature, light stresses, leading to a better simulation of aboveground total biomass and leaf carbon amount. With better simulated seasonal variability in carbon allocations, the dr_d values for GPP, H and LH calculated based on

ISAM-Dynamic case are generally closer to 1 than based on ISAM-StaticC case (Table 3), except for corn GPP at Bondville site. No improvement in corn GPP at Bondville for ISAM-Dynamic is because the model is unable to capture the sharp reduction in GPP due to crop lodging with gusty wind, as discussed in section 4.1, even after accounting the dynamic processes. Nevertheless, our results suggest that implementation of the dynamic carbon allocation parameterizations improves the model estimated results for GPP, H and LH fluxes, especially for soybean.

4.2.3 Static versus Dynamic LAI

Figures 1a, d, g, j show that prescribed LAI usually underestimates LAI over the growing seasons at both the Mead and Bondville sites. In addition, prescribed LAI is not able to partition ground vegetation LAI and crop LAI, leading to a wrong estimates of growing season length for the crop. The underestimation of the LAI over the growing season results in underestimation of the amount of solar radiation absorbed by the canopy, leading to underestimation of GPP and LH, but overestimation of H. In contrast, the ISAM-Dynamic version of the model, which accounts for the dynamic green and brown LAI parameterizations, is able to capture observed seasonal variability in LAI (Figures 1a, d, g, j). As a result of this, ISAM-Dynamic based GPP, Rn, H and LH fluxes for corn and soybean at both sites are in much better agreement with the observations than in the case of ISAM-StaticLAI, except for corn GPP and Rn at the Bondville site. The dr_d *values for ISAM-Dynamic are higher by 2-13% for Rn, 3-41% for GPP, 18-39% for H and 19-35% for LH at both sites than for ISAM-StaticLAI case (Table 3). The improvement for soybean is usually larger than for corn. The less improvement for corn GPP and Rn at the Bondville can be attributed to the fact that ISAM-Dynamic and ISAM-Static cases are unable to capture gusty wind effect on LAI.*

4.2.4 Static versus Dynamic Root Distribution

Text in this section is same as it was in the original manuscript

4.2.5 Static versus Dynamic Canopy Height

Table 3 shows that dr_d *values have small differences between ISAM-StaticH and ISAM-Dynamic cases, relative to comparisons discussed above, indicating that the implementation of dynamic canopy height simulation does not apparently improve the carbon and energy fluxes for these crops. This is perhaps due to the fact that there is no large seasonal variability in canopy height for corn and soybean. Thus, replacing prescribed canopy height to seasonally variable canopy height does not significantly change the atmospheric turbulence above the crop canopy or the carbon and energy fluxes.*

Table 3. The Willmott index (dr_d*) to quantify the degree to which observed daily mean GPP and energy fluxes are captured by the model for corn and soybean at the Mead and Bondville sites. The n is the number of observation at the daily step.*

Data	Sites	Crop	*n*	dr_d *(ISAM-Dynamic)*	dr_d *(ISAM-Static)*	dr_d *(ISAM-StaticC)*	dr_d *(ISAM-StaticLAI)*	dr_d *(ISAM-StaticR)*	dr_d *(ISAM-StaticH)*
GPP	Mead, NE	Corn	235	**0.86**	0.50	0.77	0.61	0.57	0.84
		Soybean	232	**0.83**	0.60	0.70	0.63	0.72	0.83

	Bondville, IL	Corn	232	**0.71**	0.69	0.71	0.69	0.71	0.71
		Soybean	207	**0.92**	0.81	0.83	0.83	0.81	0.92
Rn	Mead, NE	Corn	235	**0.89**	0.81	0.89	0.84	0.88	0.89
		Soybean	232	**0.90**	0.80	0.87	0.82	0.88	0.86
	Bondville, IL	Corn	232	**0.83**	0.82	0.82	0.81	0.83	0.82
		Soybean	193	**0.93**	0.81	0.81	0.82	0.81	0.92
H	Mead, NE	Corn	235	**0.71**	0.31	0.66	0.57	0.30	0.71
		Soybean	232	**0.68**	0.47	0.46	0.49	0.50	0.68
	Bondville, IL	Corn	178	**0.47**	0.19	0.29	0.40	0.19	0.40
		Soybean	135	**0.77**	0.61	0.61	0.62	0.61	0.77
LH	Mead, NE	Corn	235	**0.87**	0.50	0.81	0.70	0.55	0.80
		Soybean	232	**0.77**	0.57	0.63	0.59	0.64	0.76
	Bondville, IL	Corn	178	**0.50**	0.37	0.42	0.42	0.40	0.49
		Soybean	135	**0.88**	0.65	0.65	0.65	0.64	0.87

7. (1) An easy test of the phenology and leaf allocation, and also the calculations of LAI would be to compare simulated LAI against measurements (Figure S1) using both the crop version of ISAM as well as the original version simulating soybean as C3 and corn as C4 grass (if these plant functional types are available in ISAM) (cf. Fig.5 in Lindeskog et al. 2013). (2) It would also be interesting to compare the climate sensitivity of both modeled and measured fluxes in order to see how much of the variation in these fluxes can be explained by changes in input climate variables. This could also help explain the differences in model fit between GPP, and latent and sensible heat. (3) Include an evaluation of other submodules, or at least justify the selection of these submodules

Response: (1) Yes, the ISAM model considers C3 and C4 grasses and crops and the carbon assimilation and other parameterization for C3 and C4 crops are different as describe in the model description section.

The Figure S1 (now named as Figure 1) has now been moved to the main text and further modified to include the modeled results for static LAI (ISAM-StaticLAI) and static carbon allocation (ISAM-StaticC). The results for all these cases are now compared with measured data. The added texts are in sections 4.2.2 and 4.2.3 of the revised manuscript (See response to comment 6 above).

(2) We have done a detailed climate sensitivity analysis for the ISAM calculated carbon and energy fluxes in our two upcoming papers (Barman et al., 2013a; 2013b). Therefore, we have not repeated the climate sensitivity analysis in this study.

(3) Other ISAM sub-modules in the ISAM model, such as the hydrological cycle sub-module, the energy balance sub-module, etc., have also been evaluated in previous references (Barman et al., 2013a, 2013b; El-Masri et al., 2013). The details of references referred here can be found in the reference list.

8.Redo (or better describe) the comparison of the DynamicR and StaticR submodules. In the comparison between the DynamicR and StaticR submodels it is shown that using

the DynamicR submodel generates the largest model fit. It is interesting to see that the model results differ depending on which submodel is being used. However, it is not clear whether the ISAM-StaticR model also has been calibrated using the same data ISAM-DynamicR. If not, the comparison would be of a calibrated model against a non-calibrated model and thus not a fair one.

Response: We understand your concern, but the ***StaticR submodel*** has also been calibrated using the same set of data that has been used to calibrate the ***ISAM-DynamicR*** (now renamed as ISAM-Dynamic) submodel. To further clarify this point, we have revised the text.

The root distribution based on the ISAM-StaticR is calculated based on the root depths at which plants have 50% of their total root biomass and a dimensionless shape-parameter for describing root profile (Schenk and Jackson, 2002). Since the ISAM-StaticR case assumes no temporal variation in root fraction in each soil layer, we first average the three observed corn root profiles used in ISAM-Dyanmic root parameters calibration (section 3) and then use this averaged root profile to calibrate the ISAM-StaticR.

9. Expand the discussion to include a comparison with earlier studies mentioned in the introduction

Response: Since the models mentioned in the introduction address the simulation at different sites or for different crop types (e.g., wheat), it's not possible to directly compare the results of the ISAM with other model results.

10. Specific comments:
(1) 9898, 6-13 A very long sentence. Revise

Response: The sentence has been revised.

In particular, we implemented crop specific phenology schemes and dynamic carbon allocation schemes, which accounted for light, water, and nutrient stresses while allocating the assimilated carbon to leaf, root, stem and grain pools. The dynamic vegetation structure simulation better captured the seasonal variability in LAI, canopy height and root depth. Moreover, we implemented dynamic root distribution processes in soil layers, which better simulated the root response of soil water uptake and transpiration.

(2) 9901, 20-25 The seven vegetation pools are mentioned twice here which is a bit confusing

Response: We have revised the sentence to make it clear.

Carbon assimilation is allocated into vegetation, litter and soil organic matter (SOM) *pools. The C cycle is then coupled with complete N cycle. The N cycle model accounts for major N processes, including N deposition, N fixation, N mineralization, N immobilization, nitrification, denitrification and leaching (Yang et al., 2009).*

(3) 9904, 20-23 To me data description belongs to section 3.1 rather than here

Response: The soil database referred in this sentence is for global-level simulation, which is not a part of this analysis. Therefore, instead of moving this sentence to section 3.1, we have deleted this sentence and added the statement of site soil data description in the section 3.1.

The soil texture data for each site are attained from Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/).

(4) 9908 Section 3 from where was climate data obtained and which variables were used?

Response: The data for 6 climate variables, including mean surface air temperature, precipitation rate, incoming shortwave radiation, long-wave radiation, wind speed and specific humidity, are attained from Ameri-Flux sites. The statement to this effect is added.

The model requires hourly/half-hourly data for the following climate variables: mean surface air temperature, precipitation rate, incoming shortwave radiation, long-wave radiation, wind speed and specific humidity. These data for each site are obtained from the AmeriFlux database.

(5)9910 3 The refined Willmott's Index is a relatively new measure and most people (including me) will not be familiar with this index. Therefore it is good that this is described in detail. But it would perhaps be useful to further warrant the selection of this index instead of other more commonly used indices (cf. Medlyn et al. 2005).
Response:

Response: We have now added additional text, describing the advantages of the refined Willmott's index over those discussed in Medlyn et al.'s paper (2005).

The Willmott index is a more advanced method to evaluate the land surface model performance than previously reported methods (e.g., Medlyn et al., 2005). Some of the statistical methods widely used to evaluate model performance with observed data, are Pearson correlation coefficient (r), coefficient of determination (r^2), mean absolute error (MAE), root mean square error (RMSE), and others. These traditional methods, however, are not always optimal for evaluating the model-data agreement or disagreement. For example, r or r^2 methods can indicate the overall linear covariation between data and model results, but needs to combine with the slope and intercept of linear regression together to evaluate the degree to which the observed results is captured by the model.

However, Willmott's index is sensitive to differences between the measured and modeled values and itself can express the degree to how much measured variation can be captured by the model (Willmott, 1981). MAE and RMSE are dimensional measures of disagreement, thus are not independent of data scale and unit. However, dr is a standardized measure of the model disagreement. It is able to calculate the difference between the magnitude of the mean model bias and the observed deviation. The Willmott's index is similar to the model efficiency (ME), which could also estimate the proportion of model bias to measured deviation. However, dr is more natural measure of mean model bias than ME. Unlike ME, which expresses the model bias as the sum of squared differences between modeled and observed data and thus may upscale the modeled biases, dr expresses the model bias as the sum of absolute value of differences between modeled and observed data (Willmott and Matsuura, 2005). Another advantage of the refined Willmott index is that it is bounded on both the upper and lower ends. The refined index with an easily interpretable lower limit of −1.0 and an upper limit of 1.0, the range of index is doubled (Willmott et al., 2011). Many other existing indices, including the original Willmott index (Willmott, 1981), are bounded end (usually by 1.0) but sometime lack a finite lower bound, which makes assessments and comparisons of poorly performing models difficult.

(6) 9942 Fig 2. Please caption rephrase for clarity

Response: We have revised the figure caption for Fig 2, which is now Fig 3 in the revised manuscript.

Figure 3. Measured and model simulated daily mean gross primary productivity (GPP), net radiation (Rn) top of the canopy, sensible heat (H), latent heat (LH), and soil water (SW) under corn and soybean rotation at Mead and Bondville. Each flux for individual sites is represented by a set of two figures. For corn, the top panel figure shows the flux values for the 2001 growing season and the bottom panel for 2003, whereas for soybean the top panel figure shows the flux values for the 2002 growing season and the bottom panel for 2004.

(7) References missing in the text

Response: Arora 2003: We have cited this reference on Page 9, Line 267 with a name error. But we have corrected the citation in the revised text.

Climate Champaign 2003: This reference has been cited on Page 17, Line 512, but we have cited the URL link, instead of title. Now we have provided the correct citation.

Goulden et al.,1996: This reference is now cited on Page 18, Line 538.

Jain et al. 2009: This reference has been cited on Page 5, Line 131 and Page 2, Line 49. But we made an error when citing author's name, which have corrected now.

Sacks and Kucharik 2011: The reference has been cited on Page 2, Line 63. But the author’s name is misspelled, which we have corrected now

Willmott 1981: The reference has been cited in the revised text.

Zeng and Decker 2009: we have deleted this reference from reference list.

(8) References missing in reference list

Response: Missing references have now been added to the reference list.