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Biogeosciences Discussions

Interactive comment on "Changes in carbon fluxes and pools induced by cropland expansion in South and Southeast Asia in the 20th century" *by* B. Tao et al.

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In our original manuscript, we only addressed the effects of land cover change but excluded the land management practices such as nitrogen fertilization and irrigation, which are tightly associated with the land cover change and associated carbon fluxes. In the revised manuscript, after addressing the referees' comments and suggestions, we extended our study period to 2005 and made a major revision on the manuscript by including fertilization and irrigation effects on cropland carbon storage. As shown in the previous version of the manuscript, the land cover change (without considering land management practices) could result in a source of 0.18 Pg C/yr during 1901-

2000, which is comparable to the previous estimates by other investigators; however, if we consider land management practices, the land use change could release less carbon, especially in South Asia where land management practices contributed to approximately 30% reduction in carbon emission. Therefore, in the revised manuscript we pointed out that land management practices could play an important role in reducing the carbon emissions due to land cover change in the South and Southeast Asia.

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Short comments:

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This paper addressed a long studied but still very interesting scientific question on effects of land use/cover change on carbon fluxes and pools by using an integrated ecosystem model. Since 1950s South and Southeast Asia have experienced dramatic land use/cover change, where the most significant land conversions include the expansion of croplands by replacing secondary forests. Modeling impacts of land use change on carbon fluxes and dynamics is critical to understanding the associated processes and environmental consequences. I partly agree with some concerns raised by the above referees that only addressing land conversion impact is not innovative. If the authors could include land management effects (e.g., nitrogen fertilization mentioned in the text) into the revised version, it would be a good addition to existing literatures in terms of land use impacts analysis. Actually, integrating land use/cover change into process-based modeling is a promising future direction. Process-based analysis of interaction between ecosystem functioning and structure and land use/cover change is much more important than just giving a number of carbon release from land use. In my opinion, this paper was generally well written and the authors' findings are interesting and meaningful to the carbon research community. However, before taking further actions there are some important issues that should be addressed.

[Response: thanks for your positive comment and suggestion; the original manuscript focused on land conversion (from natural vegetation to cropland) effects on carbon stocks. As suggested, we added simulation experiments of land management practices including N fertilization and irrigation in our revised version. The related description and analysis was added in the revised manuscript.]

Some specific comments:

1. As raised by the above 3 reviewers, more detailed information is needed about some data sources in Section 2.3. The authors used averaged climate data to drive model to an equilibrium state, but didn't state the climate data sources. As a spin-up scheme can significantly influence the simulated results, how was it used in this study?

[Response: we added missing information about input data in the revised version. Also, please find detailed information in the answers to the same question raised by the 1st and 2nd referees.

For the spin-up scheme, in this study, on the basis of the data from 1948 to 1977, we generated a set of randomly repeated detrended climate data to represent climate conditions during the period 1901–1947. Long-term average climate data from 1961 to 1990 were used to represent the initial climate state in 1900. Climate data from 1901 to 1947 were used for model spin-up after equilibrium which could avoid sudden vibrations in model results due to simulation mode changes from equilibrium mode to transient mode. This method has been used and published in our previous papers (Tian et al., 2010a, b; 2011a, b; Ren et al., 2011; Xu et al., 2010). We have added these descriptions in the revised manuscript.]

2. The "Method" section mentioned that an agricultural module was specifically developed to simulate impacts of agricultural activities (such as seeding, planting, irrigation,

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fertilization, tillage, genetic improvement and harvest) and environmental factors on carbon, water and nitrogen cycles in agricultural ecosystems. Were those agricultural activities considered in the simulation in this study?

[Response: to fully understand the impacts of land cover and land use change on terrestrial carbon budgets, we developed a middle-complex agricultural module that is capable of simulating the responses of carbon, water and nitrogen cycles to major agricultural activities (such as seeding, planting, irrigation, fertilization, tillage, genetic improvement and harvest) and environmental factors (climate change, increased CO2, elevated tropospheric ozone pollution etc.) (Tian et al. 2011a, b; Ren et al. 2011). In this study, we simplified some agricultural activities (e.g. planting and harvesting) and even didn't include some of them (e.g genetic improvement), due to data limitation and the topic of this study that originally focused on the influences of cropland expansion rather than land management practices. We revised the description and explained it in Method section.]

3. How was MODIS 1 km classification product integrated into the DLEM? What re-sampling methods were used?

[Response: we aggregated 1km MODIS product to 0.5 degree by determining the relative fractions of each land cover types in each 0.5 degree grid cell. The land cover type with the largest fraction was identified in the half degree map. More detailed information can be found in the reply to the 2nd referee. We also added associated description in the revised manuscript.]

4. Authors should provide more details about the phenology scheme for crops used in the DLEM.

[Response: thanks for your comment; more details about the phenology scheme for crops used in DLEM can be found in our recent published work (Ren et al., 2011). Nine major crop types (i.e. wheat, corn, soybean, cotton, groundnuts, millet, barley, sorghum, and rice) and three rotation types (one, double, and triple harvesting) in

South and Southeast Asia were simulated in this study. On the basis of the global distribution map of major crops at a 5min spatial resolution (Leff et al. 2004), we generated major crops' distributions at a half degree resolution. The MODIS 8-day LAI products (MOD15) during 2000–2008 (http://modis.gsfc.nasa.gov/data/dataprod) in conjunction with observation and survey data sets, were used to identify rotation type and the contemporary patterns of phenologic metrics. We have applied such a method into historical studies over the globe including Southern United States (Tian et al., 2010a), North American continent (Tian et al., 2010b; Xu et al., 2010), and China (Ren et al., 2011; Tian et al., 2011a, 2011b). We have added associated description to state it more clearly in the revised manuscript]

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