Response to Reviewers' Comments

Anonymous Referee #1

General comments

China's ecosystems have long been influenced by human disturbances. Study of the impact of climate change on carbon cycle of Chinese ecosystems must consider the changed land use and land cover. Regional studies and preliminary national works about the impact of land use change on carbon in Chinese vegetation have been reported, but a comprehensive synthesis is further needed. This manuscript attempted to analyze both impacts of climate change and land use on carbon cycle in China based on model simulation. It is a valuable assessment. However there are still some questions that must be worked out before publication.

Comment 1: The key question the reviewer concerned is about the model. The paper used only one model, the CEVSA, to simulated carbon cycle of Chinese ecosystems. The CEVSA is of course a good model and has been validated in global and regional scales, but it still has some disadvantages. For example as said in section 4.1 the model has no simulation of soil physical structures and the ecosystem process, hasn't considered the hydrological cycle, and likely no fire simulation. All of parameters used in this study are default. How robust is the simulation?

Ans: The CEVSA model, which was run by the high-resolution meteorological datasets (including daily precipitation, temperature, cloud cover, air pressure, humidity, etc.) and land cover datasets in our study, accounts for the equilibrium sate within a 20-year time frame based on the average meteorological and LULC conditions. Although some transient processes (e.g., some fluctuations like forest fire) over a 20-year time frame could disturb this equilibrium assumption, the ecosystem would evolve into a new equilibrium state in the next stage aftermath. Albeit some transient processes cannot be addressed by the CEVSA model, the LAI information may reflect such transient implications to some extent in the iterative numerical process. Even though the CEVSA model has no direct simulation of soil physical structures and the ecosystem process in the nexus of biogeochemical and hydrological cycles, some lumped parameters/variables in the CEVSA model could still reflect the relevant information indirectly. This explanation has been added to the end of section 4.1.

Comment 2: Why must readers believe the results from this model rather than other models? Using a group of models to simulate the impacts of climate and land use changes on China's carbon cycle would be a better solution. Although the paper compared its results with ones from other models (in section 4.2), the reviewer doesn't think all of models used the same driving data.

Ans: The CEVSA model with appropriate validation and model comparisons being done before has been widely applied in China. It is not our role to reinforce these tasks of performing model validation and model comparisons on this paper. In specific, model comparisons had been done before by other scholars. We are not trying to repeat the work and compare the CEVSA with other models again to pin down that which estimate of annual net carbon sink is higher or lower.

It is envisioned that this study is designed to answer one unique science question: would the LULC impact big enough to alter the trend of carbon cycle as compared to climate change? The CEVSA that had been well calibrated and validated was thus selected, applied and driven by high resolution LULC data retrieved from remote sensing and climate data collected from ground-based meteorological stations. The reason for pulling in other papers for comparisons of estimates is to at least demonstrate that the driving data in this modeling analysis is similar to previous ones so that the comparable basis can be made possible (Piao, et al. 2009).

Piao, S.L., Fang , J.Y., et al. The carbon balance of terrestrial ecosystem in China. Nature, 458：1009-1013.（doi:10.1038/nature07944）.

Comment 3: The second question is about the land use and vegetation data. I think that the land use data was from Liu et al. 2005 a,b rather than the authors' own work. In section 2.2 it said that the land cover data was generated based on the Landsat TM images. It has originally 25 land cover classes and these classes were aggregated into six land cover categories. However the vegetation cover was generated using the AVHRR data. The number of vegetation types was not mentioned. What are the differences between these land cover and vegetation distribution datasets? Why were they generated from different remote sensing sources? What is the difference between the classification systems of land use and vegetation? How to match them? How to deal with both the land cover and vegetation distribution in the same model runs?

Ans: This study involved using two kinds of land-cover datasets: LUCC by Landsat TM images (Liu, et al. 2005) and LUCC by AVHRR (Liu et al. 2003). Of course, there are differences between these land cover and vegetation distribution datasets collected from different satellites. The types of land cover collected by Landsat TM images must be transformed beforehand to meet the input needs of the CEVSA model. In the transformation process, we combined the land cover data by Landsat TM images and land cover data by AVHRR images beforehand. Then the ultimate land cover data which were used as inputs for the CEVSA model were generated with the aid of some algorithms (see Liu et al., 2003, 2005). Figure 1 below shows the results.

PS: The first author (Zhiqiang Gao) of this paper was a Ph.D student with Prof Liu, and this study was part of the research in the same group.

Liu, J.Y., Zhang,D.F., Luo,D., and Xiao,X., 2003. Land-cover classification of China: integrated analysis of AVHRR imagery and geophysical data.INT.J.Remote sensing, 24(12):2485-2500

Liu,J.Y., H.Q.Tian, M.L.Liu, D.F.Zhuang, and J.M.Melillo(2005a), China's changing landscape during the 1990s:Large-scale land transformations estimated with satellite data, *Geophysical research letters*, *32,* L02405.

1) The Classification of LULC by Landsat TM images

10   Farmland
11   paddy field
12   dry field Forest
21   woodland

22   shrub
23   open wood
24   rest woodland Grassland
31   high covered pasture
32   medium covered pasture
33   low covered pasture Water
41   river and trench
42   lake
43   reservoir
44   permanent glacier
45   beach
46   bottomland Developed
51   city or town region
52   village residential area
53   rest construct land Barren
61   sand land
62   Gobi
63   salted land
64   swamp
65   bare ground
66   bare rock
67   the rest unused land

2) The Classification of LUCC by AVHRR data

1 Evergreen needleleaf forest
2 Deciduous needleleaf forest
3 Evergreen broadleaf forest
4 Deciduous broadleaf forest
5 Mixed forest
6 Shrub
7 High-density grassland
8 medium-density grassland
9 low-density grassland
10 Sandy desert
11 Bare Rock
12 Harsh desert
13 Swamp
14 Water body
15 Ice and snow
16 Cropland
17 Urban and built-up

3) Land cover code for CEVSA model
0 Water (and Goode's interrupted space)
1 Evergreen needleleaf forest
2 Evergreen broadleaf forest

3   Deciduous needleleaf forest

4   Deciduous broadleaf forest

5   Mixed forest

6   Woodland

7   Wooded grassland

8   Closed shrubland

9   Open shrubland

10 Grassland

11 Cropland

12 Bare ground
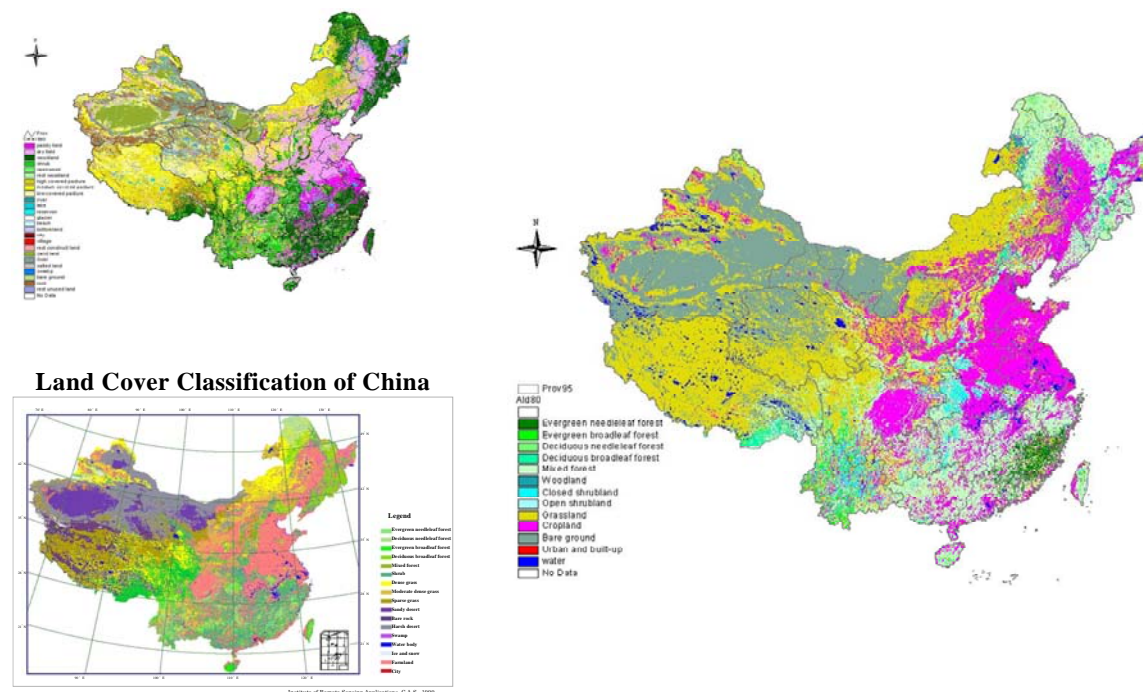
13 Urban and built-up

Fig.1 The maps of LUCC in China (Left_up: The map of LUCC by Landsat TM images; Left_down: The map of LUCC by AVHRR data; right: the map pf Land cover for CEVSA model)

Comment 4: Data sources are usually missing: What is the source of Landsat TM images in section 2.2? Where did the AVHRR data come from? Although many people know about these data sources, it's still better providing the references or web pages. In section 2.3 the authors listed several datasets, but the sources of these datasets are not available, for example, the daily climate data from 671 weather stations and the soil texture data. Are there any references for these datasets? In addition, what is the exact method of climate interpolation, the Hutchinson method or the GIS module?

Ans: The two papers （Liu et al. 2003 and Liu et al. 2005） described the datasets (land cover dataset by Landsat TM images and land cover dataset by AVHRR images), there are specific detail explains how to produce these two datasets in these two papers. The daily climate data from 671 weather stations can be obtained form this website: http://www.cma.gov.cn/lssjcx/. The soil texture data can be obtained from this website: http://www.geodata.cn. The climate interpolation was processed using GIS module (Arc/Info GRID module).

Liu, J.Y., Zhang,D.F., Luo,D., and Xiao,X., 2003. Land-cover classification of China: integrated analysis of AVHRR imagery and geophysical data. INT.J.Remote sensing, 24(12):2485-2500

Liu,J.Y., H.Q.Tian, M.L.Liu, D.F.Zhuang, and J.M.Melillo(2005a), China's changing landscape during the 1990s:Large-scale land transformations estimated with satellite data, *Geophysical research letters*, *32,* L02405.

Comment 5: Model evaluation: The CEVSA model has been successfully used in global and regional carbon simulations and has been evaluated at different spatial and temporal scales; the authors of this paper therefore followed this model. However this doesn't mean that the model does not need further evaluation in this study because the driving conditions have been changed. An evaluation of model results produced in this paper is still needed.

Ans: With a similar driving condition, one of the first author's colleague, Dr.Tao, had validated the CEVSA model with in-situ observations at different stations in China (Qian Yanzhou, Changbai shan and Yucheng in Chinese Terrestrial Ecosystem Flux Research Network (http://www.chinaflux.org/en/index/index.asp)). Since the focus of this article is to investigate the differential impacts of climate and land use/land cover changes on the carbon cycle in China (1981 - 2000), these model validation results were therefore not emphasized within our discussion in this article. Some validation results can be seen as follows for reference (Figure 1).
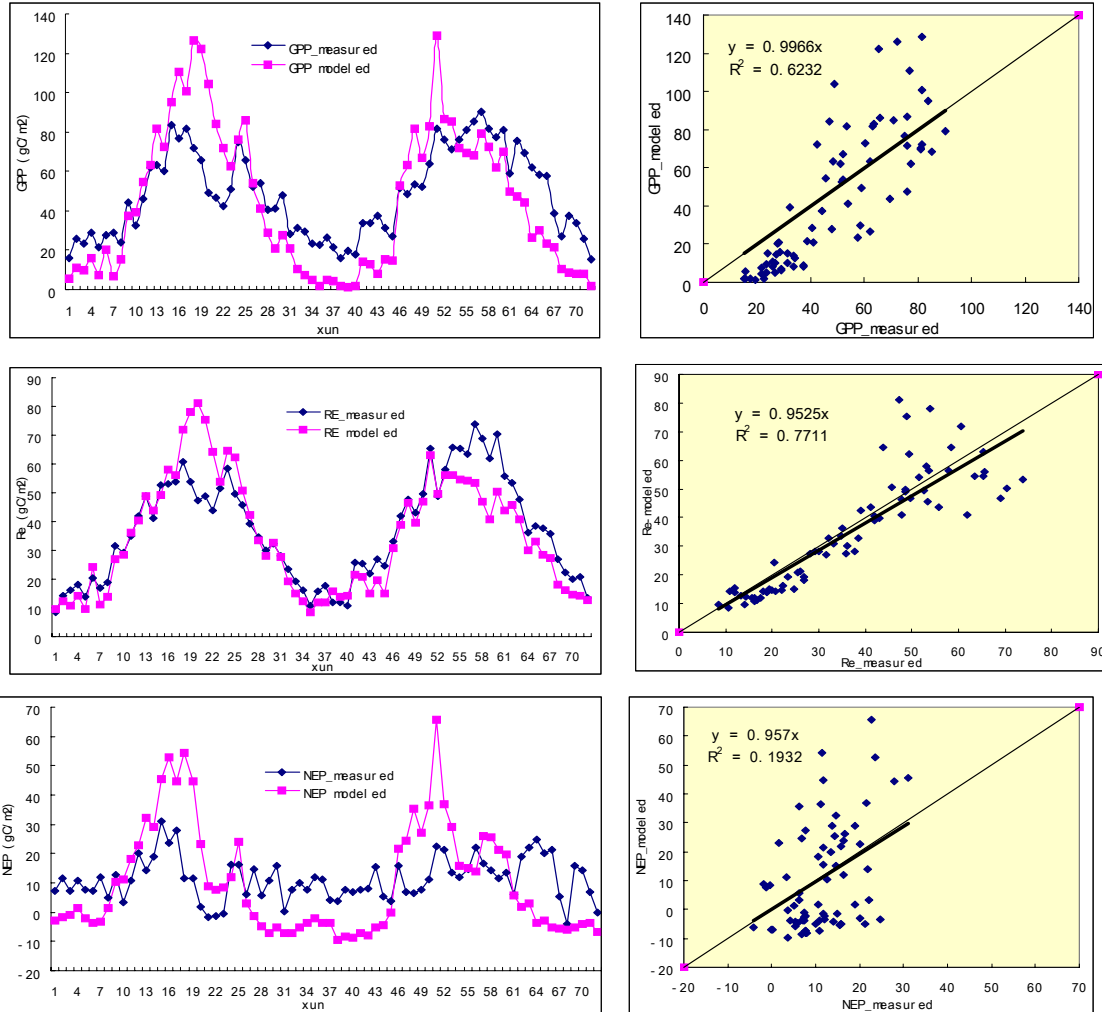
Figure 1. The comparison between simulated and observed values of GPP, Re, and NEP in coniferous forest ecosystem of Qianyanzhou station.

Comment 6: The impacts of climate changes on the carbon storage and carbon flux: In section 3.1 there are only two climate factors separately considered: the mean annual temperature and precipitation which are correlated to carbon storage and flux, significantly or not significantly. However the joint effects of heat and water on China's carbon cannot be ignored because vegetation distribution in China is mainly controlled from the southeast to the northwest by the combination of temperature and precipitation, e.g. the moisture/aridity index and the ratio of actual to potential evapotranspiration. The extreme climate conditions are other important factors which influence carbon flux. In addition to climate changes, fire is another key factor.

Ans: Thanks for the every nice comments. Yes! The joint effects of heat and water on China's carbon cannot be ignored. The extreme climate conditions are other important factors which influence carbon flux. In addition to climate changes, fire is another key factor. These are interesting questions for our study in the future. We have included these nice points in our conclusions section as below:

"However, the joint effects of heat and water on China's carbon cannot be ignored. The extreme climate conditions are other important factors which influence carbon flux. In addition to climate changes, fire is another key factor. This possible future work may certainly lead to more detailed model intercomparisons, better understanding of robust model behaviors, and better understanding and quantification of uncertainty in future climate conditions.

Comment 7: Title: what does it mean here about the 'system-based'?

 Ans: To clarify this, we have changed the title to "Assessing the Differential Impacts of Climate and Land Use/Land Cover Changes on the Carbon Cycle in the 1980s and 1990s in China."

Comment 8: In section 2.3: The first model run used actual meteorological data for every 10 days from 1971 to 2000, but the second model run used actual meteorological data of every 10-day period from 1981 to 2000. Why was climate data of different time periods used? The reasons given in the last paragraph in section 2.3 seem not true.

Ans: This is the way that enables us to retrieve the differential impacts of LUCC changes on the carbon cycle. The equilibrium simulation was designed to use average meteorological datasets and a distinct land cover database to drive the CEVSA model until equilibrium state can be reached. The first model run used actual meteorological data for every 10 days from 1971 to 2000 based on LULC data in the 1990s, whereas the second model run used actual meteorological data of every 10-day period from 1981 to 2000 based on LUCC data in the 2000s. The section 2.3 thus describes how the scenarios can be set up to analyze the impacts of climate change and LUCC on carbon cycle.

Comment 9: In section 3.2 second paragraph: the LUCC was cited from Liu et al., 2005 (or 2005a). Is this the real land cove change that the previous study presented or the current paper showed? In line 8 there is a wrong percentage (11.9.9%).

Ans: Yes. The land cove change is published firstly by Liu et al. (2005). The land cover dataset was generated with TM/ETM images by Liu's group in Chinese Academy Sciences. The percentage (11.9,9%) has been corrected. Thank you.

Comment 10: The comparisons of carbon storage and carbon flux simulated by different models: it is better providing the driving data of each model. Further comparisons, especially with those based on inventory and observations, must be considered.

Ans: Yes. This is good suggestion. But we felt that the driving datasets are huge and the limited space of journal article cannot accommodate this need. Again, our major goal in this study is not to compare different models. We have included it as out future work.

Comment 11: Table 3. Changes of NEP -0.0005 PgC (not -0.0009). The values of NPP, HR and SOC don't match.

Ans: Yes. I have corrected these errors. Thank you.

Comment 12: Figure 2. The top is LUCC in 1990s, bottom is the difference between 1980s and 1990s, the caption is between 1990-2000. Which one is correct?

Ans: There are different subcaptions associated with different maps 2(a) and 2(b). They are correct.

Comment 13: Figs 3-5: The changes of temperature and precipitation and carbon are mainly in national
level. What about the regional changes?

Ans: We have studied the changes of temperature and precipitation and carbon in regions. Since the focus of this article is designed to present the national-level research of impact of climate change and LUCC on carbon cycle, the regional research was not included in this.

Comment 14: References: These two papers should have the same contents but in different languages:
Li, K. R., Wang, S. Q., and Cao, M. K.: Carbon storage in China's vegetation and soils, Sci. China, 33(2), 72–80, 2003. / Li, K. R., Wang, S. Q., and Cao, M. K.: Vegetation and soil carbon storage in China, Sci. China, 47, 49–57, 2004.

Recent papers of Piao SL et al. published in Nature are helpful.

Ans: Yes. These two papers are relevant.   I have deleted one of them on the reference list. I have downloaded the paper by Piao S.L. et al. 2009, read, and cited in the paper. Thank you.