Anonymous Referee #3

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General comments:

This manuscript provides a biogeochemical analysis for an interesting land-use transition in the Sanjiang region of China, during the conversion from wetlands to rice agriculture during the past five decades. While the area and time period in this study are interesting, the paper would greatly benefit from improved clarity in several areas. Although the introduction provides an excellent literature review for why wetlands are biogeochemically important, the authors should introduce some mechanistic hypotheses or questions at the end of the introduction to help motivate their analysis.

There are also several areas of the Methods section that are difficult to follow and/or overly vague, primarily: 1) The theoretical distinction between what the authors call the "regional" budget in comparison with the "area-weighted" budget, and the motivation for this distinction, 2) The description of the empirical water table model and how this was projected under future climate scenarios, 3) The passing references to calibrating models without a rigorous description of the procedure used to do this, and 4) In what situations the CH4MOD versus CH4MOD$_{wetland}$ model was used in the calculations. All of these sections must be clarified in order to improve the comprehension of this analysis for readers.

Reply: We greatly appreciate the helpful comments from the referee. Because the four questions here are also raised in the "specific comments", we present our explain to the questions in the itemized replies. For the first and second question, please see the reply of the second and the third specific comment, respectively. For the third question, we had detailed the process of model calibration in a paper of Li et al. (2010) published earlier. In this paper, we focused on the model application on the Sanjiang Plain. More details about model

calibration and validation are in Li et al. (2010) for $CH4MOD_{wetland}$ and Huang et al. (2004) for CH4MOD, respectively. For the last question, CH4MOD was used to simulate CH_4 flux from rice paddies; While $CH4MOD_{wetland}$ was used to simulate CH_4 flux from marshland.

Specific comments:

1. The authors should improve the end of the introduction by introducing some motivating questions for the analysis. They might move the mechanistic descriptions in Section 3.3.1 to much earlier in the paper.

Reply: In this paper, we focused on methane emissions associated with the marshland conversion and climate change on the Sanjiang Plain, northeast China. Marshland conversion and climate change, especially temperature and precipitation, would influence the regional CH_4 budget (page 5889, lines 3-12). The motivation of the study was to explore the individual and synthetic impacts of those factors on methane budget via modeling. Though not explicitly stated, the motivating question was addressed in the context of the introduction (page 5890, lines 6-7).

Section 3.3.1 described the changes in climatic factors from 1950-2009. Some brief mechanistic description was presented in the section in order to help readers understand the modeling results more easily.

2. The distinction between the "regional" budget and "area-weighted" budget that the authors introduce in Section 2.2.3 is confusing. For example, on line 188, the authors state "the concomitant impact of marshland conversion could not be isolated" and in the next paragraph on line 200, "we sought to isolate the impact of marshland conversion." This is needs clarification.

Reply: The "area-weighted" CH_4 flux means CH_4 emissions per hectare. While the regional CH_4 emission is the product of the CH_4 flux and the marshland area. CH_4 flux is influenced by the climate factors while marshland conversion is facilitated by anthropogenic activities. Equation (3) (page 5894, line 12) clarified the way to calculate the regional CH_4 emissions ($\boldsymbol{T^i}$). So the regional CH_4 emission is influenced by both the climatic factors and marshland conversion.

Because the regional CH_4 emission was the product of the CH_4 flux and the marshland area, "the concomitant impact of marshland conversion could not be isolated" when we quantified the impact of climatic factors on **regional CH_4 emissions**. However, when we quantified the impact of climatic factors on CH_4 fluxes; we focused on the impact of climatic factors on CH_4 fluxes. So "we sought to isolate the impact of marshland conversion". Here the word "peel off" may be more suitable than "isolate".

3. The description of the empirical water table model needs to be much clearer and more specific. Why are the authors using Wetland DNDC, another biogeochemical model, to simulate the water table? The authors mention using both the Priestly-Taylor and Penman-Monteith ET formulae; how did they obtain net radiation or ground heat flux for these calculations? Was this compared to any field data for validation? How was the water table simulated under future climate conditions, where net radiation and ground heat flux might change? The authors mention calibrating the model by "trial and error" but this needs to be much more specific – what criteria were used to determine appropriate parameters?

1) ***The description of the empirical water table model needs to be much clearer and more specific. Why are the authors using Wetland DNDC, another biogeochemical model, to simulate the water table?***

Reply: Section 2.2.2 (page 5892, lines 16-25; page 5893, lines 1-12) is the description of the empirical water table model, which is part of the Wetland-DNDC model. The $CH4MOD_{wetland}$ used in the present study had been validated with observations in the subject region and can produce reliable simulation results. But $CH4MOD_{wetland}$ doesn't simulate changes in water table. In this study, we used the hydrological submodel of Wetland-DNDC to generate water table position. The hydrological submodel of Wetland-DNDC is suitable for a small scale region such as the study region in this paper (Li et al., 2004). It requires fewer inputs and has already been validated in a bog located in Minnesota, USA from 1961-1990 (Zhang et al., 2002). In this study, the scheme of linking the empirical water table model with the $CH4MOD_{wetland}$ performed good for the total annual/seasonal CH_4 emissions (Fig. 3b).

2） The authors mention using both the Priestly-Taylor and Penman-Monteith ET formulae; how did they obtain net radiation or ground heat flux for these calculations? Was this compared to any field data for validation?

Reply: The net radiation was calculated with the meteorological observations (the maximum and the minimum air temperature, hours of sunshine and relative humidity). All of these meteorological data were acquired from the China Meteorological Administration (CMA) (http://cdc.cma.gov.cn/) (page 5898, lines 8-10). And on the Sanjiang Plain, the ground heat flux was calculated as 0.24 of the net radiation (Sun et al., 2008). The description of the methodology is in page 5893 lines 3-7. The database is described in page 5898, lines 7-13 and page 5898, line 28, page 5899, lines 1-2. We also compared the simulated net radiation and ET with the measurements of the daily evapotranspiration on the Sanjiang Plain during the period from 2005 to 2007 (Zhao et al., 2008; Jia et al., 2010) (Fig. 1). The result is not showed in this paper due to the limit of the length of the article.

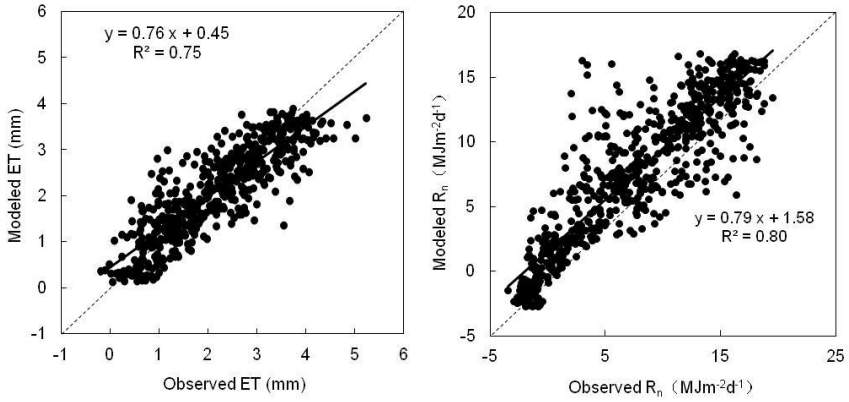

Fig. 1 Observed vs. simulated ET and net radiation on the Sanjiang Plain.

3) How was the water table simulated under future climate conditions, where net radiation and ground heat flux might change?

Reply: Future climate datasets used to drive the water table empirical model were outputs of FGOALS, which were provided by the State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics (LASG), Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences (CAS). The net radiation and ground heat flux change along with the future climate conditions projected by the FGOALs.

4) The authors mention calibrating the model by "trial and error" but this needs to be

much more specific – what criteria were used to determine appropriate parameters?

Reply: We detailed the calibration method of $CH4MOD_{wetland}$ in Li et al. (2010). For the water table empirical model, according to Zhang et al. (2002), lateral water flow parameters were calibrated by comparing the simulated and measured water table. The parameters were calibrated in terms of minimum mean deviation between the simulated and the observed water table position.

4. There should be a few more sentences about the field data that the authors are using to validate their model. How were the data collected? On line 312 the authors refer to "273 datasets" but I assume they mean 273 data points, or something like that.

Reply: Details of model validation had been addressed in a paper of the authors (Li et al., 2010) published earlier. We explained the field data used to validate the model in section 2.3.2 (page 5898, lines 20-28; page 5899, lines 1-2). Field measurements of the water table and the annual CH_4 flux in marshlands of *Deyeuxia angustifolia* from 2003 to 2004 and *Carex lasiocarpa* from 2003 to 2005 (Hao, 2006; Song et al., 2007) were used to calibrate and validate the empirical water table model. Measurements of the daily evapotranspiration and net radiation on the Sanjiang Plain during the period from 2005 to 2007 (Zhao et al., 2008; Jia et al., 2010) were used to validate the intermediate results of the empirical water table model. The field measurements data were provided by the Sanjiang Wetland Experimental Station, Chinese Academy of Sciences (page 5911, lines 4-5). On line 312, "273 datasets" means the 273 daily CH_4 flux measurements.

5. At the end of Section 3.3.2 of the discussion it is difficult to follow the authors line of reasoning to their conclusions. I think that some of this difficulty stems from the fact that the distinction between the "regional" and "area-weighted" budgets are unclear.

Reply: In section 3.3.2, we evaluated the impact of marshland conversion and climate change on regional CH_4 emissions (page 5905, lines 4-5), but not CH_4 fluxes. All of the "cumulative CH_4 reduction" in this section means cumulative reduction in regional CH_4 emissions. Please also refers to the reply to "the specific comment 2".

6. In Section 3.4.1, the authors describe a trend in the projected precipitation values that is not apparent, as there appears to be large precipitation variability in the future. If they are comparing the mean precipitation during this time period to the present, the means might not be significantly different, and the authors should think about incorporating some method to analyze future variability in precipitation rather than the mean value.

Reply: We agree with the referee that no significant trend in precipitation was projected within the period from 2010-2100 in the RCP scenarios (Fig. F1 in Supplement F) (page 5908, lines 14-16). While the trend of precipitation is not significant, more attentions should be on inter-annual variations. In supplementary material, we made some primary predictions of the inter-annual variations of CH_4 fluxes under different RCP scenarios (Fig. F2 in Supplement F). These inter-annual variations may mainly due to the yearly variations of precipitation (page 5909, lines 16-18).

Technical corrections:

1. ***Line 136: In the citation "Tayler" should be "Taylor"***

   Reply: We have changed "Tayler" to "Taylor" (Page 5893, line 4).

2. ***p. 5894 Equation 3: If the factor of 10^9 is simply units conversion, it might be left out of the equation.***

   Reply: 10^9 is the conversion of kg (the right of the equation) to Tg (the left of the equation).

3. ***Line 248: Should indicate the amount of increase in agricultural area from the cited reference***

   Reply: The amount of increase in agriculture area from Su & Zhang (2008) is ~2.5 Mha, which is showed in Fig.4.

4. ***Figure 4: does the category 'Upland' refer to agriculture, or just a catch-all for everything else?***

   Reply: The 'Upland' refers to the catch-all croplands except for rice paddies.

5. ***Figure 6: It would be better to choose a symbol rather than a column to represent the decadal mean***

   Reply: We have changed the column to a star symbol.

6. Line 417: "meadow" isn't really a soil type

Reply: We have changed "meadow" to "meadow soil" (page 5903, line 23).

7. Figure 5a: y-axis has a typo

Reply: We have changed the typo of the y-axis.

References:

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