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Interactive
Comment

Interactive comment on "Modeling impacts of management alternatives on soil carbon storage of farmland in Northwest China" *by* F. Zhang et al.

F. Zhang et al.

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We appreciate the reviewer for his or her detail comments. The responses to each of the comments are provided as follows:

1. Based on the suggestion of the reviewer, we plotted two figures to demonstrate how manure amendment and crop residue incorporation impact SOC dynamics for a selected site in Hequ County of Shanxi Province. In Figure 1, when 3000 kg farmyard manure-C/ha was added into the soil on the end of April, the manure was immediately partitioned into the soil resistant litter pool and the soil humads pool based on C/N ratio of the manure. The resistant litter and humads continuously decomposed although with different rates. During the microbe-driven decomposition, a part of the organic C in the litter or humads pool became CO2 emitted into the atmosphere, and a part of the organic C became of microbial biomass. After death of the microbes, their body was

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transferred into the humads pool. Through further decomposition, the decomposed humads became humus. Sine either the microbial C pool or the humads pool has a relatively quick turnover rate, the sizes of the two pools can maintain relatively stable across the season. The decomposition processes of microbe and humads also produce CO2. After harvest, the fresh crop residue (e.g., roots and above-ground litter) were incorporated into the soil that increased the sizes of the labile and resistant litter pools. Driven by the addition of manure and crop residue litter as well by the decomposition of the litter, microbial, and huamds pools, the total SOC content slightly increased during whole year simulation. The main increased part is the humus, which is passive with very low rate of decomposition.

Figure 1. Impacts of manure amendment on SOC pools (i.e., litter, microbes, humads and humus) during a one-year simulation for a millet field at Hequ County, Shanxi Province http://static.flickr.com/77/188551621_44a417e8eb_b.jpg

Figure 2. Impacts of straw incorporation on SOC pools (i.e., litter, microbes, humads and humus) during a one-year simulation for a millet field at Hequ County, Shanxi Province http://static.flickr.com/77/188551621_44a417e8eb_b.jpg

Figure 2 demonstrates the impacts of straw incorporation on the SOC pools. Differing from manure amendment, straw addition didn't increase the soil humads pool. The added straw was partitioned into labile and resistant pools based on its C/N ratio. Along with the decomposition of the labile and resistant litter, their pools gradually reduced, and most of their organic C became CO2, and a part of the organic C finally entered the humus pool through the microbial assimilation and decomposition.

We hope the two figures illustrate how the DNDC simulates impact of manure amendment or crop residue incorporation effect SOC dynamics. We are going to include the above-discussed figures and text into our manuscript to meet the demand from the reviewer.

2. For the validation cases, the key parameters including manure or fertilizer application

have been indicated in the text for some case. For example, the application rate of farmyard manure was 22,500 kg/ha for Hequ, and 30,000 kg/ha for Qujing. We will add the following information for the cases where some parameters are missing: The application rates of farmyard manure for Jinqu, Xinyi and Taojiang were 3,000, 2,800 and 5,000 kg C/ha, respectively.

3. Conventional (or continuous) flooding was applied for all the rice fields in the validation cases. The rice residue incorporation rate depends on the rice litter production, which is quantified by DNDC through simulating the crop biomass growth and partitioning.

4. There could be options to reorganize the manuscript. However, for this paper with a focus on regional analysis, we prefer to regard model validation as well sensitivity test as a part of preparation for the regional simulations. So we think having the two sections remaining in Chapter 2 (Materials and Methods) may make more sense.

5. Adopting the suggestion from the reviewers, we have included the modeled N2O and CH4 fluxes into the discussion of this manuscript (see details in our responses to Reviewer #2 at this website).

6. As A process-based model, DNDC simulates crop yield and litter production by tracking crop biomass growth and partitioning based on the local climate, soil and management conditions. The amount of crop residue incorporated could vary from year to year. So the crop residue incorporation rate is only defined as a percent of the total above-ground litter (i.e., leaves and stems) but not the absolute amount. For case 1, 50% of the above-ground crop residue was incorporated.

7. For case 2, 50% of the above-ground crop residue was incorporated. The comparison between crop litter and manure amendment can be referred to the two figures shown above.

8. No water management was described in the source paper that used for case 3.

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However, we set continuous flooding for this case as its time span is about 100 years. For the simulated triple-cropping system in this case, we set no irrigation for the upland crop (rapeseeds) and continuous flooding for the two rice seasons. We will add this description into the manuscript for clarification.

9. This case shown in Fig. 4 was of a conversion of upland soil to wetland soil. At the initial time, the SOC was low due to the long-term upland cultivation. After converting the soil into a rice paddy, its SOC content increased rapidly at the early phase due to (1) higher litter production and (2) lower decomposition rate under the anaerobic conditions. But the increase rate of SOC gradually decreased along with the increase in the total SOC content, and finally approached to a equilibrium. This trend is generally true for all cropland soils and has been discussed in a former paper in detail (Li et al., 1994). However, the above-description will be added into the manuscript.

10. Continuous flooding was applied for the two rice seasons from Feb 20th to June 25th and from July 10th to Nov 1st. This will be added in the manuscript.

11. Case 3 and case 4 differ each other in the observed time span (100 vs. 10 years), climate (29 N vs. 22 N), soil (SOC 0.0063 vs. 0.015 kg C/kg), farming practices (rice-rice-rapeseed vs. rice-rice rotation), and land-use history (converted from upland crop vs. continuous rice paddy). The differences caused different dynamics of SOC in the soils. In Table 1, SOC content for case 4 should be 12 g/kg. We have correct the error in the modified manuscript. During the simulated first 10 years, SOC increased from 0.0063 to 0.012 and from 0.013 to 0.015 kg C/kg for case 3 and case 4, respectively. For case 5 shown in Figure 6, the observed SOC decreased in the last 4 years (1998-2001). There was no any description to explain the phenomenon in the original paper reporting the experiment (Fu et al., 2003). DNDC was not able to simulate the decline although the 15-year general trend was captured by the model.

12. The sensitivity test was conducted only for upland crop in this paper as the test for rice paddy has been recently reported in detail in a former paper (Li et al., 2002). [Li

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C., Mosier A., Wassmann R., Cai Z., Zheng X., Huang Y., Tsuruta H., Boonjawat J., Lantin R.: Modeling greenhouse gas emissions from rice-based production systems: Sentivity and upscaling. Global Biogeochemical Cycles, 18:19 1-19 19, 2004].

13. Partitioning of SOC pools is theoretically based on the organic components of soil organic matter, such as carbohydrates, lipids, protein, cellulose, semi-cellulose, lignin etc. But, unfortunately, most soil survey data didn't provide this kind of information. An empirically established formula is adopted in DNDC to partition total SOC into litter, humads and humus pools based on a fixed proportion 0.025:0.025:0.95. This proportion has been tested for all the soil types with accepted results.

14. The SOC contents recorded in the database were used as initial SOC values in 2000 for each county in the modeled region. Through the whole year simulations for each cropping system in each county, the SOC contents at the end of the year was quantified for each cropping system in each county. The difference in the SOC contents at the beginning and the end of 2000 is the annual change in SOC.

15. The modeled SOC dynamics across the domain Shaanxi is only a snap shop for year 2000. During the long-term cultivation from several hundred years until 1950s, the farmers in Shaanxi Province sustained their soil fertility mainly relying on manure amendment and crop residue incorporation. The soils in south Shaanxi accumulated a lot of SOC due to the humid weather, fertile soils, and paddy rice planting. Meanwhile, the soils in the north Shaanxi contained SOC at much lower levels due to the crucial weather and low crop productivity. During the past about 5 decades, partially due to the availability of synthetic fertilizers, manure application was gradually abandoned and crop residue was burned. Decrease in SOC has been a general trend across the province. Given the trend, the decreased rate in the southern soils has been higher than the northern soils due to the difference in the initial SOC contents. The higher the initial SOC content, the faster the SOC decreased. That is the result simulated with the baseline scenario reported in this paper.

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16. The temperature listed in Table 1 is the annual accumulative temperature. To avoid misleading, we have changed them into annual average daily temperature by dividing by 365. The original data were obtained from the National Meteorological Agency of China.

17. The unit of SOC in table 1 is “g C/ kg soil”. We elide the C and soil into “g/kg” (g kg-1). Following the comment, we have changed “g/kg” to “g C kg-1“. The SOC content of 6.34 g C kg-1 in Jinqu is also 0.00634 kg C kg-1, which is consistent with the Fig. 4.

Table 1. Characteristics of the filed sites used for validation of DNDC http://static.flickr.com/77/188551621_44a417e8eb_b.jpg

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