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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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Dear Prof. Yahui Zhuang,

We, all the co-authors of this article, highly appreciate your keen comments on this manuscript. We fully agree with your specific comments that SOC partitioning is a key feature for any process-based model. We feel sorry that this feature is not clearly mentioned in the current manuscript due to the lack of description of structure of the DNDC model. As you suggested earlier, the developers of DNDC made efforts to enhance the parameterization of SOC partitioning. In the current version of DNDC, any organic matter (e.g., crop residue, manure etc.) incorporated in the soil will be divided into four major SOC pools, namely litter, living microbes, humads (i.e., active humus) and humus. Each of the SOC pools consists of two or three sub-pools to differentiate the labile and resistant components. Since the chemical components (e.g.,

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carbohydrates, lipids, cellulose, lignin etc.) are not widely measured for the various organic matter added into the agricultural soils, DNDC adopted C/N ratio as the major indicator of the quality of fresh litter or manure. The lower the C/N ratio, the more of the litter or manure partitioned into the labile SOC pools. The description of this feature can be found in former publications of DNDC (e.g., Li et al., 1992; Li et al., 1994; Li et al., 2000). By adopting your suggestion, we have composed a new paragraph (see the attachment at the end of this letter) to amend the manuscript. In this additional paragraph, the structure of DNDC is described with a focus on the SOC partitioning issue.

In addition, we appreciate your carefully reading and listing the typos. We have corrected the errors in the manuscript.

Sincerely, Fan Zhang, Changsheng Li, Zheng Wang and Haibin Wu

Amended paragraph:

2.1 Structure of the DNDC model

DNDC is a process-based biogeochemical model, originally developed for predicting carbon sequestration and trace gas emissions for non-flooded agricultural lands. It simulates the fundamental processes controlling the interactions among ecological drivers, soil environmental factors, and relevant biochemical or geochemical reactions, which collectively determine the rates of trace gas production and consumption in agricultural ecosystems (Li et al., 1992, 1994). DNDC consists of six interacting sub-models for soil climate, plant growth, organic matter decomposition, nitrification, denitrification, and fermentation (Li, 2000). In the soil climate sub-model, DNDC models soil moisture and water flow by tracking precipitation, plant interception, ponding water, bypass flow, infiltration, transpiration, and evaporation. The plant growth sub-model simulates crop or grass productivity and litter production by tracking photosynthesis, respiration, water and N demand/uptake, and C allocation. The sub-models for nitrification, denitrification and fermentation predict production/consumption of NO, N2O, and CH4 by

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tracking a series of microbially-mediated biogeochemical reactions. The sub-model for decomposition quantifies the turnover of soil organic matter (SOM) through simulating the dynamics of eight SOM pools for soil litter, microorganisms, humads, and passive humus. As soon as fresh crop residue is incorporated into the soil, DNDC will partition the residue into very labile, labile and resistant litter pools based on C/N ratio of the residue. The lower the C/N ratio, the more of the residue will be partitioned into very labile or labile pool. Each of the SOM pools has a specific decomposition rate subject to temperature, moisture and N availability. The organic matter in the litter pools will be broken down by the soil microbes. When the microbes die, their biomass will turn into humads (i.e., active humus) pool. Humads can be further utilized by the soil microbes and turned into passive humus. During the sequential decomposition processes, a part of the organic C becomes CO2, and a part of the organic N becomes ammonium. By tracking the processes, DNDC quantifies SOM turnover in soils. Detailed management measures (e.g., crop rotation, tillage, fertilization, manure amendment, irrigation, weeding, and grazing) have been parameterized and linked to the various biogeochemical processes (e.g., crop growth, litter production, soil water infiltration, decomposition, nitrification, denitrification) embedded in DNDC.

References: (1)Li, C., S. Frolking, and T.A. Frolking, 1992, A model of nitrous oxide evolution from soil driven by rainfall events: 1. Model structure and sensitivity, Journal of Geophysical Research, 97:9759-9776. (2)Li, C., S. Frolking, and R. Harriss, 1994, Modeling nitrous oxide emissions from agriculture: A Florida case study, Chemosphere 28:1401-1415. (3)Li, C., J. Aber, F. Stange, K. Butterbach-Bahl, H. Papen, 2000, A process-oriented model of N2O and NO emissions from forest soils: 1, Model development, J. Geophys. Res. Vol. 105 , No. 4 , pp. 4369-4384. (4)Li, C., 2000, Modeling trace gas emissions from agricultural ecosystems, Nutrient Cycling in Agroecosystems 58:259-276.

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