Biogeosciences Discuss., 8, C5637–C5641, 2012
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Biogeosciences Discussions

Interactive comment on "Multiple-factor controls on terrestrial N_2O flux over North America from 1979 through 2010" *by* X. F. Xu et al.

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Received and published: 7 February 2012

Comments: I have tried to do a proper review of this paper. Although the topic of the impact of temperature, atmospheric CO2, deposition of nitrogen, radiation, ozone and N inputs is interesting and important, information on the model and its validation is lacking; interpretation of the results is therefore very difficult, especially it is difficult to understand what kind of experiments the authors have actually performed.

[Responses: Actually, in our previous papers (Tian et al., 2005; Tian et al., 2010b; Tian et al., 2010c) we have reported detailed information on our model structure, equations, parameterization, and validations. For model validations on N2O flux, please see Tian et al. 2010b, 2011. One of papers described the N2O sub-module was published in the same Journal (Tian et al. 2010b). We don't think it is necessary to present the

model and its validation again in this paper. For further validating simulation results on factorial contributions to N2O flux, we added a new table (i.e. Table 5), which compared our simulated results with other studies. We also point out that there are only a few multi-factorial control field experiments on N2O fluxes and more such field experiments are needed for model validation. The 14 simulation experiments have been performed in this study as indicated in Table 1]

Comments: The model that describes N2O processes apparently consists of one equation with 6 factors, four of which are lumped into one, and the factors ozone and N input are additional factors. Hence, the equation is a multiplication of three factors. Information on how the various factors are incorporated in the model is not provided. For example, denitrification and nitrification are modeled, but I see no relationship between these processes and N2O production, or is it the Vmax, the maximum rate of N2O production via nitrification and denitrification? Are there two Vmax values, one for each process. And is the value for Vmax a global one, or is it variable in space and time? Atmospheric CO2 concentration, ozone and absorbed photosynthetically active radiation influence N2O emissions directly. In other models such as DNDC and Daycent the effects of such factors would be dealt with in the ecosystem/carbon cycle model in which the N2O equations are incorporated, so it is peculiar that in the approach of this paper there is a direct influence. This requires explanation. The factor air temperature will have a direct effect on denitrification, but also indirectly through its influence on evapotranspiration and growth. There are many more questions that come up, but I guess the authors need to provide a better description of their model, including how the N2O calculations are built in the ecosystem model.

[Responses: Thanks for the comments. Since this study focuses on N2O fluxes, Figure 1 and model descriptions are primarily concentrated on N2O module; all the other N-related processes are not included in the text, but they were fully described in our previous publications (please see Lu et al. 2011; Tian et al. 2011b) . We agree with the comment that equation 1 might mislead readers on the model parameterization

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process of N2O. So we removed equation 1, and used a whole paragraph to describe N2O-related processes in combination with Figure 1. In the revised paragraph, we explicitly describe the direct and/or indirect effects of multiple global change factors, including ozone, elevated atmospheric COÂň2 concentration, land conversion, climate variability, and nitrogen deposition, on the N2O flux.

Reviewer also compared our model with DNDC and Daycent on simulating N2O. Actually, the DLEM is a highly-integrated process-based ecosystem model. It simulates all the major nitrogen processes including nitrification, denitrification, nitrogen fixation, nitrogen deposition, nitrogen mineralization, nitrogen immobilization etc. All controlling equations over these processes are described with detail in our previous publications (Tian et al., 2005; Tian et al., 2010b; Tian et al., 2010c; Tian et al., 2011b; Lu et al., 2012). The DNDC and Daycent simulate direct effects of atmospheric CO2 concentration and absorbed photosynthetically active radiation (PAR) on the carbon cycle. The effects of these environment factors on N2O emission are simulated through the carbon cycle and carbon-nitrogen interactions in these two models. DLEM has a roughly same mechanism in modeling multi-environmental factors' effects on N2O emissions: for example, the atmospheric CO2 directly influence photosynthesis and indirectly affect nitrogen processes including N2O flux. Of course, DLEM has specific considerations on direct-effects of environmental factors on N2O processes which are described in detail in section 2.1. Since all these information has been published in our previous papers (Tian et al., 2010a; Tian et al., 2010c; Xu et al., 2010; Tian et al., 2011a; Tian et al., 2011b), we would not repeatedly put them in the current manuscript.

To address reviewer's comments about our model, we have reorganized the model description section.]

Comments: Further lacunae in the paper are the various terms in the N cycle. The model apparently does not account for other N inputs like biological N fixation, and recycling of animal manure. There will be reasons for this, but it needs to be discussed at least. It is also unclear how N inputs influence growth of plants in agricultural and

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natural ecosystems.

[Responses: Again, our model does simulate all major nitrogen cycles including nitrogen fixation, mineralization, and immobilization, and manure on cropland and pasture. Please see our previous papers for detail information (Tian et al., 2010c; Tian et al., 2011b; Lu et al., 2012). In this application of DLEM model, we did not account for recycling of animal manure due to lack of spatially-explicit data]

Comments: Some discussion on how the model performs should be included. A remark that the spatial patterns are similar to other models is not sufficient. So a comparison with measurements and with other models is needed, if possible at the scale of individual grids, or counties, states and the total for North America. That should give some more confidence in the results, before starting to think about model experiments.

[Responses: Thanks for the comments. We need to repeat that we have conducted plenty of model validations at both site- and regional levels which were reported in our previous papers (Tian et al., 2010c; Tian et al., 2011b). This paper exclusively focuses on the factorials contributions to the spatial and temporal variations in N2O fluxes.]

Comments: The section describing the model experiments is completely unclear. I read it three times and still have no idea what exactly has been done.

[Responses: Thanks for the comments; we have revised this section.]

Reference cited Lu, C., Tian, H., Liu, M., Ren, W., Xu, X., Chen, G., Zhang, C., 2012. Effect of nitrogen deposition on China's terrestrial carbon uptake in the context of multifactor environmental changes. Ecological Applications DOI: 10.1890/10-1685.1. Tian, H., Chen, G., Liu, M., Zhang, C., Sun, G., Lu, C., Xu, X., Ren, W., Pan, S., Chappelka, A., 2010a. Model estimates of net primary productivity, evapotranspiration, and water use efficiency in the terrestrial ecosystems of the southern United States during 1895-2007. Forest Ecology and Management 259, 1311-1327. Tian, H., Liu, M., Zhang, C., Ren, W., Chen, G., Xu, X., Lu, C., 2005. DLEM-The Dynamic Land Ecosystem Model

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User Manual. Auburn, AL, USA. Tian, H., Liu, M., Zhang, C., Ren, W., Xu, X., Chen, G., Lu, C., Tao, B., 2010b. The Dynamics Land Ecosystem Model (DLEM) for simulating terrestrial processes and interactions in the context of multifactor global change. Acat Geographica Sinica 65, 1027-1047. Tian, H., Melillo, J.M., Lu, C., Kicklighter, D.W., Liu, M., Ren, W., Xu, X., Chen, G., Zhang, C., Pan, S., Liu, J., Running, S., 2011a. China's terrestrial carbon balance: contributions from multiple global change factors. Global Biogeochemical Cycles 25, Doi:10.1029/2010GB003838. Tian, H., Xu, X., Liu, M., Ren, W., Zhang, C., Chen, G., Lu, C., 2010c. Spatial and temporal patterns of CH4 and N2O fluxes in terrestrial ecosystems of North America during 1979-2008: application of a global biogeochemistry model. Biogeosciences 7, 2673-2694. Tian, H., Xu, X., Lu, C., Liu, M., Ren, W., Chen, G., Melillo, J.M., Liu, J., 2011b. Net exchanges of CO2, CH4, and N2O between China's terrestrial ecosystems and the atmosphere and their contributions to global climate warming. Journal of Geophysical Research 116, DOI: 10.1029/2010JG001393. Xu, X., Tian, H., Zhang, C., Liu, M., Ren, W., Chen, G., Lu, C., Bruhwiler, L., 2010. Attribution of spatial and temporal variations in terrestrial ecosystem methane flux over North America. Biogeosciences 7, 3637-3655.

Interactive comment on Biogeosciences Discuss., 8, 10935, 2011.