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Interactive comment on "Global soil nitrous oxide emissions in a dynamic carbon–nitrogen model" *by* Y. Y. Huang and S. Gerber

Y. Y. Huang and S. Gerber

sgerber@ufl.edu

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Comment: This MS presents an extension to an existing model, allowing the simulation of N2O emissions, which are benchmarked against a newly compiled data set of observed emissions.

Response: Thank you for taking time for reading and commenting on our discussion paper.

Comment: I suggest that this work is not yet ready for publication. More work to evaluate and improve the model is required before final publication. When it is finally published, more information should be provided about how the modelled N cycle works, as the basic principles are not clear from this description. Response: In response to this

comment and comments from other reviewers, we moved and amended the appendix with the model description into the main text. We further added additional description of the main characteristic of LM3V-N that we thought may be relevant of the fast processes that govern the dynamics of ammonium and nitrate in soil.

Comment: Generally we might expect a publication describing a model to represent an advance in knowledge over the current state of the art. It is not clear to me how this manuscript does so. As one referee (Beni Stocker) has pointed out already, one would reasonably expect to see independent evaluation of various quantities that underlie the process of N2O emission, but this is not provided.

Response: While our work may not be vertical advancement, we add important pieces of evidence that help the scientific community understand how N2O emissions are dealt with in global models. We clearly state that we build on earlier work that put forward formulation on nitrification and denitrification. It is important that the model setup for the larger N cycle differ from model to model, and thus the implementation of similar mechanism in a different model provide critical insight. In response to another reviewer's comment, we provide a sensitivity test to critical parameters of the larger N cycle, including mechanisms that govern N input and N losses (biological N fixation, DON losses, plant uptake capacity, fire), and discuss these.

Comment: The new data compilation, oddly and without explanation, contains only about a quarter of the N2O emissions data previously compiled by Xu-Ri et al. (2012). Response: For the observational data we compiled, we try to limit the impact of human disturbance such as land use change since we do not conduct land use change simulations in this study. We explain this now better in the revised paper. The larger N cycle responds critically and long-lasting to disturbance (e.g. Bernal et al., 2012). Most of our data are from pristine ecosystem without documented land use change, or at least have no disturbance within the latest 50 years for forests and 10 years for grasslands. Therefore our selection criteria differs compared to Xu-Ri et al. (2012). Despite our careful selection our compilation has 61 data points only 5 less than Xu-Ri (2012). And

when the data-model comparison is made (in Figure 3), the goodness of fit appears to be inferior to that achieved by the model of Xu-Ri et al. (2012). Xu-Ri et al. (2012) also performed a series of sensitivity experiments that showed consistency with a wide range of published experimental findings.

Response: We have now added more details to understand model behavior and performance. This includes now a detailed sensitivity test that helps to understand how the resolution of N cycle affects N2O emissions. Further we include now time series of N2O emissions against data for a suite of sites. All these data show that resolving and predicting N2O emission is a challenge for any model.

References Bernal, S., Hedin, L. O., Likens, G. E., Gerber, S., and Buso, D. C.: Complex response of the forest nitrogen cycle to climate change, Proceedings of the National Academy of Sciences of the United States of America, 109, 3406-3411, doi:10.1073/pnas.1121448109, 2012.

Gerber, S., Hedin, L. O., Oppenheimer, M., Pacala, S. W., and Shevliakova, E.: Nitrogen cycling and feedbacks in a global dynamic land model, Global Biogeochemical Cycles, 24,doi:10.1029/2008gb003336, 2010.

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