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Interactive comment on “Effects of soil rewetting and thawing on soil gas fluxes: a review of current literature and suggestions for future research” by D.-G. Kim et al.

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Dear Referee #2:

First of all, we authors appreciate your insightful comments and suggestion on the manuscript bg-2011-222.

In this response letter, at first we described major addition and change in the revised manuscript and then we responded to each of comments and suggestions addressed by you and two other referees.

First, there are new additions in the revised manuscript as following: 1. Rate of soil

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flux change following rewetting and thawing events by ecosystems types; Table 2 and relevant texts were inserted.

2. Section '3.6 Overall change of gases fluxes following rewetting and thawing' was removed. On the other hand, section '4. Effects of rewetting and thawing on soil gas fluxes: compiled dataset analysis' was added. The section 4 includes two new findings and relevant discussion with two new figures and two new tables as following:

a. Pre-change flux versus flux change by gas type and event type (rewetting and thawing); Figure 5, Table 4 and respective discussion in the manuscript.

b. Mean annual temperature versus flux change, by gas and event type; Figure 6, Table 5 and respective discussion in the manuscript

3. Number of studies used for the analyses in this study: Table 1 and 3, texts in section '2 Methodology'

4. Importance of NO and NH₃ gas fluxes in addition to greenhouse gas CO₂, CH₄ and N₂O; Introduction section

5. A figure showing soil CO₂ flux increase following rewetting change observed with high temporal resolution measurements in the field; now Figure 2

6. Conclusion section was revised (i.e., including new results)

7. References: references were added as suggested by reviewers and recently published studies

Second, there are substantial changes in the revised manuscript as following:

1. Detail description on uncertainties of CO₂ and N₂O fluxes in section 5.1 and 5.2 were moved to relevant places in section 3.

2. Previous sections 5.1 and 5.2 were merged with section '5.1. Uncertainties in understanding the responses and mechanisms' and revised throughout the section.

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3. Mechanisms were distinguished between biological and physical in section 3.

4. Section '5 A Blog for open discussion and web based open databases' was shortened and moved to 'Supplementary information'.

Finally, we acknowledged three reviewers' constructive and valuable comments in the 'Acknowledgments' section.

We responded to each of your comments and suggestions as following:

1. Why all the gases? Is the incorporation of NO, and NH₃ necessary? I understand CO₂, N₂O, and CH₄, but I failed to understand how the incorporation of multiple gases really is novel or enhances the impact of the review. I would much rather see the reviews focus on a few gases and delve into their analyses more. Alternatively, if these gases are not removed, I suggest that the reviewers justify why these gases are necessary.

Response: We appreciated the comment and we believed that it may be hard to improve our understanding on the topics without comprehensive understanding NH₃ and NO gases as well as greenhouse gases CO₂, CH₄ and N₂O. So we added the importance of them as following (line 111-119):

These gases also play crucial roles in atmospheric chemistry, with the notable characteristic that CO₂, CH₄ and N₂O are greenhouse gases (GHG). Noteworthy, soil NH₃ emissions are of main interest since they constitute a significant loss of N in agricultural soils (Nelson, 1982; Francis et al., 2008), causing soil acidification (Van der Eerden et al., 1998; Rennenberg and Gessler, 1999), eutrophication through atmospheric deposition (Bobbink et al., 1992), and is an indirect source of N₂O (Martikainen, 1985). Nitric oxide is indirectly involved in global warming and contributes to the net production of radiatively active tropospheric ozone and the formation of acid rain (Williams et al., 1992). Nitric oxide is also important in controlling the oxidizing capacity of the troposphere, thereby affecting the fate of carbon monoxide, CH₄ and nonmethane hy-

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drocarbons (Liu et al., 1987).

References

Bobbink R, Heil GW, Raessen MBAG (1992) Atmospheric deposition and canopy exchange processes in heathland ecosystems. *Environ Poll* 75: 29–37.

Francis DD, Vigil MF, Moiser AR (2008) Gaseous losses of nitrogen other than through denitrification. In: J.S. Schepers and W.R. Raun, editors. *Nitrogen in Agricultural Systems*. Agronomy Monograph 49. American Society of Agronomy Madison, WI, USA, pp. 255–279.

Liu, S. C., M. Trainer, F. C. Fehsenfeld, D. D. Parrish, E. J. Williams, D. W. Fahey, G. Hubler, and P. C. Murphy (1987), Ozone production in the rural troposphere and the implications for regional and global ozone distributions, *J. Geophys. Res.*, 92, 4191–4207, doi:10.1029/JD092iD04p04191.

Nelson DW (1982) Gaseous losses of nitrogen other than through denitrification. In: Stevenson, F.J. (Ed.), *Nitrogen in Agricultural Soils*. American Society of Agronomy, Madison, WI, USA, pp. 327–363.

Rennenberg H, Gessler A (1999) Consequences of N deposition to forest ecosystems - Recent results and future research needs. *Water Air Soil Pollut* 116: 47–64.

Van der Eerden L, De Vries W, Van Dobben H (1998) Effects of ammonia deposition on forests in the Netherlands. *Atmos Environ* 32: 525–532.

Williams, E. J., G. L. Hutchinson, and F. C. Fehsenfeld (1992), Nitrogen oxides and nitrous oxide emissions from soil, *Global Biogeochem. Cycles*, 6, 351–388, doi:10.1029/92GB02124.

2. What did you learn from all of this literature? Most of the manuscript just lists different studies and details their findings. Although interesting, this is not why I read a review. There really is a lack of not only highlighting common patterns between the

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gases (so compartmentalized by gas) but introducing anything new. If someone has gone to a monumental effort to compile all this data I want to know the new links and ideas that you have found. If the major finding was that gas fluxes are variable resulting in large increase to no-significant changes following a rewetting or thaw event then why do the review. We already know this and that is why so many people study it. Dig deeper what is something novel that you found from your study. Please, consider comparing the different gases more or possibly talking about them together in the context of environmental drivers such as (labile carbon substrate availability, oxygen availability, or temperate) instead of in separate driver sections.

Response: We have conducted various statistical analyses to find out more useful information from the collected database including testing relation between gas flux response and environmental variables such as labile carbon substrate availability, oxygen availability, or temperate as the reviewer suggested. Through analysing collected data, we found some results as below and we added them in the manuscript.

1) rate of soil flux change following rewetting and thawing events by ecosystems types, 2) Pre-change flux versus flux change by gas and rewetting or thawing, 3) Mean annual temperature versus flux change, by gas and rewetting or thawing.

3. I liked the figures and am wondering why these were not highlighted more in the text. Also, consider adding a few more histograms that not only have the number of studies like fig 4, but the % change of the various gas fluxes on a second Y axis. You could include histograms for 1) the amount of water added or better the change in air-filled pore space of the different soils in the studies since many of the gases depend on anaerobic environmental conditions; 2) temperature; and 3) carbon substrate availability since this is what drives much of these changes.

Response: We have conducted various statistical analyses to consider the comments but we were not able to find meaningful results which can be represented as histograms or other type of figures besides 1) Pre-change flux versus flux change by gas and

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rewetting or thawing, and 2) Mean annual temperature versus flux change, by gas and rewetting or thawing. The new findings were described as figures and texts.

4. I almost stopped reading after I finding out that section 3.6 was only a couple of sentences. Please expand this section. This is what will enhance the review. See some of my suggestions from the previous section.

Response: In the section (4. Effects of rewetting and thawing on soil gas fluxes: compiled dataset analysis) we removed the previous result and added the two new findings with figure and relevant discussions.

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