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Interactive comment on "Mitigating N_2O emissions from soil: from patching leaks to transformative action" *by* C. Decock et al.

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Authors general comment: Thank you for your positive and constructive feedback. We propose below in more detail how we would like to address the comments and improve the manuscript.

Referee comment 1: The discussion Decock and colleagues is a well written piece of thought provoking challenges, issues and the need of interdisciplinary science for N2O emissions reduction. This is of very high importance and clearly will be a great challenge for soil scientist involved in N2O emissions research. The need to balance emission reductions with food and energy security is one of the main challenges facing researches and policy makers. The discussion article provides an interesting view

point and what is required to achieve that from the respective research themes. However, I do feel that the discussion lacks a section on bringing these research themes together and how this could be achieved. How will the mix of sciences help a sustainable reduction in N2O emissions, fundamentally how will mitigation be achieved in this way. The authors cover all aspects independently in the various sections but it would be good to have a final synthesis of mitigation approach and what are realistic targets that could be achieved with this interdisciplinary approach, and where those targets would be the greatest.

Authors response 1: Thank you for this insight. When writing the manuscript, we had thought that between the specific examples in each of the sections and the figures conceptualizing the relationships between the sections, the message would be clear. But, we agree with your comment that we leave the reader a bit hanging at the end, with no concrete suggestions on how interdisciplinary research could be done, and acknowledgement of what common barriers are. We suggest to include a short section referring back to figure 1 and 2, and highlighting some of the literature on interdisciplinary research, its barriers, and opportunities, applied to the context of N2O emission reductions. The suggestion to list realistic targets is of great interest, but beyond the scope of the current manuscript. We cite some literature, exploring realistic targets from a biophysical point of view (e.g., Snyder et al. 2014; Stehfest et al. 2009). However, uncertainty ranges on such targets remain large. Furthermore, to properly refine such targets and set realistic goals in a complex socio-environmental system, we are convinced that a thorough transdisciplinary research project would be required, with researchers representing different disciplines as highlighted in our manuscript, as well as stakeholders from public and private sectors.

Specific comments:

Referee comment 2: P906 L15. Field measurements of N2O fluxes are common and carried out in all sorts of environments, different systems, crops, at different scales. The authors mention that more are needed, but I'm wondering how much more is

needed here? In theory there will always be a corner in the world somewhere, where a eddy covariance tower, a flux chamber has not been installed. To understand N2O emissions will every crop, every agricultural system in every geographical location need to be monitored in order to fully understand N2O emissions? is the existing dataset that is out there in published work, dating back decades underused to aid the modelling aspect. I see a never ending "requirement" for more field emissions monitoring. Surely that is not sustainable from a research perspective, and how much more science will we gain by just monitoring one more agricultural system? Are new technologies a better target for investment, eg remote sensing, rather than more flux chambers?

Authors response 2: We fully agree that a random, never-ending stream of N2O monitoring projects will not help with reaching actual N2O emission reduction targets. This is exactly why we do not directly state that more N2O monitoring projects are required, but rather that close collaboration with modelers, policy makers, etc. is essential to identify where efforts for experimental biophysical research, both in terms of monitoring and elucidating mechanisms, should be focused (e.g., p 906 lines 15-18, p 907 lines 24-26). In this way, a strategic allocation of investments in measurements could be achieved. At the same time, we highlight the importance of certain cropping systems and geographic regions for food and nutrition security and provisioning of fuel and energy (e.g. developing countries, bio-energy crops), which have been underrepresented in current efforts to monitor and quantify N2O emissions under business as usual and alternative land management. In addition, it has only been in the last decade or so that more intensive measurements of field-scale N2O emissions have taken place, targeting N2O emissions peaks following agronomic and weather events. Many older studies fail to capture the distinct temporal patterns of N2O emissions, therefore under- or overestimating actual emissions. When using established datasets for modeling efforts, data quality needs to be assured. In summary, we do feel there is still a need and place for new and continued N2O monitoring projects, but this should only follow careful consideration on where efforts are essential for devising comprehensive N2O emission reduction strategies.

Referee comment 3: p907 l11. Jointly design experiments. How would that work realistically? Think this is a difficult challenge. And should be further explored. I do believe this is the right way to go, but are the research funders/institutions/ providing the foundations for that kind of approach.

Authors response 3: We very much appreciate the reviewer's comment that fostering inter- and transdisciplinary research is not self-evident, and acknowledge that the difficulties and challenges associated with conducting this type of research are underrepresented in the current version of the manuscript. As mentioned in the response to comment 1, we propose to include a section on opportunities and challenges associated with trans- and interdisciplinary research as it relates to the general topic of our manuscript. This includes reference to the academic reward systems, required time allocation for coordination and facilitation of interdisciplinary projects, institutional barriers, and opportunities through adjusted funding schemes, competence centers, etc.

Referee comment 4: p909 L25. The word chosen here are clever regarding developing countries being "resource limited". But fundamentally or part of that limitation is lack of N fertilizers. Using "N fertilizer" is not an attractive word for this discussion as its aim is to use less and increase N sue efficiency. But many parts of the world are in lack of synthetic fertilisers (mainly for economic reasons). but fixing this issue would enhance food production in areas that need it most. I think this need mentioning, despite that overall "we" wish to reduce N fertilizer use. Think for developed countries this rule applies, but for developing countries it is only fair that N fertiliser should be more readily accessible at either subsidised costs. Although only short term-mid term solution but nonetheless a solution (or part of) food security and alleviating mal nourishment.

Authors response 4: We fully support the view that in many developing countries, addressing food security will involve increasing N input rates to fulfill crop requirements. We by no means intended to camouflage this observation, and propose to edit the text to be more explicit about the need for modern inputs, including sufficient synthetic

and/or high quality organic fertilizer inputs, high quality seed, access to crop protection measures, etc. The point we wanted to make is that current estimates on increases in N2O emissions following such intensification are based on IPCC emission factors, while the actual impact of improved cropping systems in developing countries on N2O emissions is just starting to be addressed, and may be smaller than expected. Furthermore, food security is often used as an excuse for pushing boundaries in cropping systems in industrialized countries, while the real need (socio-economic) and opportunity (biophysical) for intensification is clearly in developing countries, where both the yield gap as well as the projected population increases are the greatest.

References

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Stehfest, E., Bouwman, L., van Vuuren, D. P., den Elzen, M. G., Eickhout, B., and Kabat, P.: Climate benefits of changing diet, Climatic change, 95, 83-102, 2009.

Interactive comment on SOIL Discuss., 2, 903, 2015.