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Interactive comment on "Net soil–atmosphere fluxes mask patterns in gross production and consumption of nitrous oxide and methane in a managed ecosystem" *by* W. H. Yang and W. L. Silver

W. H. Yang and W. L. Silver

yangw@illinois.edu

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The referee's comments are shown in quotes below and followed by our response to each comment.

"One of the great strengths of the pool dilution approach is that it enables investigators to develop much better estimates of biogeochemical process rates where bidirectional activity (i.e. simultaneous production and consumption) may confound individual rate measurements. Use of pool dilution techniques also enables investigators to clarify the relationship between a biogeochemical process and its driving (independent) variables. This is particularly important in field studies, where establishing the relationship between a biogeochemical process and its (potential) control variables is non-trivial, and made more difficult by the complex interplay between simultaneous production/consumption activity and the action of multiple, potentially interacting and/or confounding environmental drivers.

One of the on-going challenges facing the pool dilution technique is further developing its application to field settings. While there are numerous examples of laboratory-based pool dilution experiments (particularly for N-cycling studies), there are far fewer examples of field applications of this approach. I would argue, however, that further development of field-based pool dilution techniques is an important 'frontier' for field-based biogeochemistry. This is because one of the factors that still limits our understanding of ecosystem C and N dynamics is our knowledge of what regulates biogeochemical process rates in situ. While laboratory studies give us insights into the potential controls on biogeochemical processes, laboratory systems are so fundamentally different from field conditions that it is often difficult to directly translate insights gained in the lab to the field. Field applications of pool dilution techniques provide us with an opportunity to bridge this knowledge gap, but are not without potential pitfalls; for example, as outlined by Well and Butterbach-Bahl (2013) Global Change Biol. 19.

What is novel about this paper is that it seeks to push forward our knowledge of trace gas dynamics at this very important methodological frontier. In the work that they have presented here, the authors are able to develop not only more accurate estimates of gross CH4 and N2O fluxes in their study site, but are also able to better-establish the role of different environmental drivers (i.e. the hierarchy of environmental drivers) in modulating rates of CH4 and N2O flux. Interestingly, the authors are able to show how the hierarchy of environmental drivers shifts in response to changes in the 'boundary conditions' of the ecosystem; for example, during the active growing phase of corn, factors such as soil moisture, soil temperature, net N mineralization, and CO2 flux influ-

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enced N_2O fluxes, while this relationship became simplified when corn was senescent (i.e. CO_2 flux alone became the dominant control on production/consumption fluxes of N_2O). Findings like these demonstrate the utility of the pool dilution technique, and also provide important insights for process-based modelling and data assimilation (which are used to upscale data such as these)."

We appreciate the referee's thoughtful synopsis of the importance and novelty of our work.

"While I have no major criticisms of the approach and methods described in this paper, I do have a minor concerns about how the research is framed and the findings are discussed. In its current form, the introduction tends to emphasize the pool dilution technique and its benefits, while not necessarily highlighting the importance of this research for understanding agro-ecosystem functioning. In order to gain a wider readership, I believe it would be in the authors' best interest to expand their introduction to incorporate more information about how their work may further our understanding of trace gas dynamics in corn ecosystems. Given the global importance of corn as a crop and concerns over GHG emissions from corn, 're-balancing' the introduction may help to widen the appeal of this paper. In a similar vein, it would be interesting if the authors highlighted in the discussion how their findings have helped to enhance our understanding of how corn ecosystems function. For instance, the change in the dominant controls on N_2O flux during different stages of maize growth was noteworthy. I was left wondering if this phenomena had been observed before or if this was a new/novel finding? Likewise, the rise in gross methanogenesis with increasing plant biomass tends to imply that methanogenesis in this soil was at least partially C limited and linked to plant activity – an interesting finding because similar pool dilution studies elsewhere suggest that methanogenesis is not always C limited nor linked to plant activity, but may be more strongly influenced by other factors, such as soil anaerobiosis. What might explain the difference in CH_4 production in corn relative to other agro-ecosystems?"

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We appreciate the reviewer's suggestion to better frame the introduction and discussion in terms of how our work furthers understanding of N_2O and CH_4 dynamics in corn ecosystems relative to other agro-ecosystems. We agree that this would broaden the readership of this work and can make the necessary revisions. To answer the referee's specific questions, we are unaware of other studies showing changing controls on N_2O dynamics during different stages of maize growth. With regards methanogenesis, our results do not necessarily contradict other pool dilution studies showing that the abundance of anaerobic soil microsites controls methanogenesis rather than the supply of C or plant activity itself. An increase in plant biomass over the course of the growing season may have increased C supply to directly fuel methanogenesis. Alternatively, the plant C inputs may have primed heterotrophic activity to create more anaerobic soil microsites conducive to methanogenesis. The strong relationship between gross CH_4 production and the methanogenic fraction of C mineralization (an index of the abundance of anaerobic soil microsites) on DAS 11, 24, and 171 (when root respiration likely did not contribute significantly to CO_2 effluxes) supports the latter interpretation.

Interactive comment on Biogeosciences Discuss., 12, 19167, 2015.