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## ***Interactive comment on “N<sub>2</sub>O, NO, N<sub>2</sub>, and CO<sub>2</sub> emissions from tropical savanna and grassland of Northern Australia: an incubation experiment with intact soil cores” by C. Werner et al.***

### **Anonymous Referee #2**

Received and published: 11 July 2014

Soil to atmosphere fluxes of nitrogen gases are important but very poorly quantified in most ecosystems. These fluxes are important to the fertility of ecosystems and to the chemistry of the atmosphere but are very difficult to quantify due to high variability and methodological challenges. It is particularly hard to measure fluxes of dinitrogen (N<sub>2</sub>) from soils to the atmosphere due to the high atmospheric background levels of this gas. In this study, gas fluxes were measured in tropical savanna and grassland ecosystems in Australia that have highly dynamic soil moisture conditions. State-of-the-art field and laboratory methods were used to quantify fluxes of N<sub>2</sub>, nitric oxide (NO), nitrous oxide (N<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>). The results are novel and interesting, showing that N<sub>2</sub> and NO fluxes are more important than expected and that soils in these ecosystems

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frequently function as a small sink for N<sub>2</sub>O.

The experimental design is a bit problematic with only one replicate native savanna and one grassland site. Moreover, these appears to be an unbalanced design with a transect with three locations at the savanna site and not at the grassland site. This is especially a concern given the marked differences in soil texture between the sites, i.e. the grassland site has lower sand and higher clay content. There should be some discussion of just how representative these sites are of savanna and grassland sites in the region.

There also should be some discussion of just how much nitrogen gas flux is actually occurring at these sites. Some analysis of just how many days of high water content and high gas flux and how many “pulse events” actually occur at these sites and how these interact to control the annual flux of these gases would greatly increase the relevance of the paper and allow the reader to evaluate just how robust the conclusions about the relative importance of the difference gases are.

The paper needs a thorough edit for English grammar and usage. A few examples from the very beginning of the paper are listed below. The entire paper needs to be edited.   • Page 8401, Lines 23 – 25. This sentence is poorly worded and unclear.   • Page 8401, line 26. “constraint” should be “constrained”   • Page 8401, lines 14 – 16. Burn more frequently than ?   • Page 8402, line 18. “these” is an unreferenced modifier.

Some more specific comments:

- Page 8403, lines 15 – 30. You’ve already discussed the idea that seasonal variation in moisture and fire and important in savannah ecosystems. Rather than repeating that here, maybe focus more on how this variation influences biogeochemical processes.

- Page 8404, lines 4 – 6. Maybe say a bit more about why measurements of N<sub>2</sub> fluxes are rare and why they might be important. Maybe move some of the text from page 8409, lines 17 – 24 up here.

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- Page 8405, lines 7 – 13. The English grammar and usage are very rough here.
- Page 8405, lines 22 – 24. The vegetation has been described earlier, probably only need to describe it once.
- Page 8406, line 10. Maybe include the scientific name for buffalo.
- Page 8410, lines 10 – 15. It is not clear to me just when the N<sub>2</sub> flux measurements were made relative to the other measurements. Had the cores been help for many days and multiple water and temperature treatments before the N<sub>2</sub> flux measurements were made?
- Page 8417, lines 14 – 17. You might want to take a look at the recent review of N<sub>2</sub>O consumption measurements; Schlesinger, W. H. 2013. An estimate of the global sink for nitrous oxide in soils. *Global Change Biology* 19:2929-2931.
- Page 8417, line 23. It looks like there is a big difference in soil texture between the savanna and grassland sites. How might this have affected the results? I note that there is some discussion of the importance of clay content on page 8419. Also this might be a good place to mention that there is really only one replicate of each site type. There should be some discussion of just how representative of savanna and pasture systems these locations are. This is especially important for the grassland, where these is only one sampling location.
- Page 8421, lines 22 – 28. Given the strong control of N<sub>2</sub> flux by soil moisture it would be important to add some discussion of how common high soil moisture levels are in this system. Just how many days of 75% WFPS do we get in these systems? How might this affect the very interesting conclusion that N<sub>2</sub> is the dominant gaseous product in these systems? This discussion and the subsequent discussion of pulse events raises interest in some estimates of annual emissions. Just how much nitrogen are you suggesting is leaving these systems as gas? How do these estimates compare with inputs from the atmosphere and fertilizer?

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- Page 8424, point #5. This conclusion is weak due to the fact that there was only one pasture site. This conclusion should be “toned down” some.

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