

Interactive comment on “Effects of global change during the 21st century on the nitrogen cycle” by D. Fowler et al.

Anonymous Referee #2

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This paper is a comprehensive review of the nitrogen cycle, its future changes and policy implications. It is challenging to address some many topics in a single paper, but the authors manage to incorporate substantial amount of information in the manuscript. I am in favor of its publication. However, there are some important issues that need to be addressed as listed below.

Major issues:

(1) Structure.

This paper is not well structured and balanced which undermines its importance. The introduction is rather short and doesn't give a clear overview of the whole nitrogen cycle. Then it immediate follows by sections describing individual processes, in which

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different structures have been adopted. For example, in the section of marine nitrogen fixation, its influencing factors have been intensive discussed (in several sub-sections) which is not the case in the terrestrial nitrogen fixation section. Overall, I found the figures are easier to understand than the texts. I agree with Referee #1 that substantial editorial work is needed to compile and synthesize work from individual contributors.

(2) Policy implications.

This paper is a contribution to the special issue “Atmospheric composition change: science for policy”. If that's the main purpose, this review can be to shortened to a large extent. Processes of less importance and larger uncertainties can be summarized into a single section without detailed discussions.

(3) Missing processes.

With regard to the exchange of molecular and reactive nitrogen between the atmosphere and terrestrial surfaces, the review should not miss to address recent findings indicating that cryptogamic covers on ground and plant surfaces may account for as much as half of the biological nitrogen fixation on land (Elbert et al. 2012; Porada et al., 2014) and that nitrous acid (HONO) can be reversibly deposited and emitted in large quantities comparable nitrogen oxide (NO) (Su et al. 2011; Kulmala and Petäjä 2011; Oswald et al. 2013; Maljanen et al. 2013; Donaldson et al. 2014; VandenBoer et al. 2015).”

Other comments:

Abstract: p1749 line 3, what is the meaning of “input of reactive nitrogen from human activities”, NO_x emission or nitrogen fixation?

Introduction: p1750 line 13, I would suggest including an introduction to the nitrogen cycle and relevant processes in the beginning.

p1750 line 14, it is better to first explain what's reactive nitrogen for policy makers.

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p1751 line 8-16, this paragraph should appear before the last one “The negative effects of human N . . .”

p1753 line 11, “Biological nitrogen fixation (BNF) is currently estimated to provide a global annual input of approximately . . .”, a reference is missing.

p1756 line 20, Q10 should be defined before use.

p1757 line 20, why not adopt the same structure for terrestrial N fixation

p1761 line 19, “. . . by effects which decrease N₂ fixation.”, such as?

p1761 line 21 “. . . providing a strong negative feedback to increases in atmospheric CO₂”, please explain what’s the negative feedback

p1764 line 16 “plus combustion related emissions . . .”, is combustion related emissions considered as fixation or emissions?

p1771 line 8, “kg”, g should be a subscript

p1771 line 8, please use either parentheses or brackets for NH₃ and NH_{sw}, the meaning of “sw” should be explained.

p1771 line 13 use either “exp” (Eq. 2) or “e” throughout the manuscript.

p1773 line 8 “the global NH₃ emission” should be “that the global ocean NH₃ emission”

p1778 line 23, why discuss denitrification in the nitrification section?

Figure 16, some texts were half-covered

References:

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Elbert, W., Weber, B., Burrows, S., Steinkamp, J., Budel, B., Andreae, M. O., and C1315

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VandenBoer, T. C., Young, C. J., Talukdar, R. K., Markovic, M. Z., Brown, S. S., Roberts, J. M., and Murphy, J. G.: Nocturnal loss and daytime source of nitrous acid through reactive uptake and displacement, *Nature Geosci*, 8, 55-60, 10.1038/ngeo2298, 2015.

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