Biogeosciences Discuss.,
doi:10.5194/bg-2016-436-RC2, 2016

Biogeosciences Discussions

Interactive comment on "Initial shifts in nitrogen impact on ecosystem carbon fluxes in an alpine meadow: patterns and causes" *by* Bing Song et al.

Anonymous Referee #2

Received and published: 8 December 2016

Song and co-authors investigate how changes in N deposition affect the net CO2 sink or source strength of an alpine meadow, and study the mechanisms that govern changes in CO2 processes. They measure NEE and ER, soil and microbial respiration and estimate aboveground plant and root respiration in plots across a N addition gradient. I would like to highlight that only a few field experiments have studied this topic using multiple N addition rates, and that these studies are important to understand whether the sink strength of grasslands will saturate at future N deposition rates. Because N deposition is predicted to change during this century and we don't fully understand how it will impact CO2 processes in terrestrial ecosystems, the topic is of global importance and within the scope of Biogeosciences.

My main concerns are related with how the ms is written, how some of the data is interpreted, and with the fact that some conclusions are not justified by the results.

I believe that the ms would benefit if the authors could tighten some paragraphs in the Introduction. In my opinion the second and third paragraph of the introduction lack of direction and intent, and they are somehow repetitive. I think the authors should start this paragraph explaining that the response of NEE to N deposition is likely nonlinear, and that depending on how N affects the main components determining NEE (i.e. GEP and ER), ecosystems will transition from a N limited to a N saturation stage. For instance, some articles showed that GPP and NEP do not respond linearly to changes in N as ecosystems shift to a N saturation stage (e.g. Flescher et al., 2013, DOI: 10.1002/gbc.20026; Gomez et al., 2016, DOI: 10.1111/gcb.13187). Then they could explain how changes in N affect these main components that determine NEP through changes in processes such as plant and root biomass.

The authors added six levels of N. However, ecosystems are receiving natural rates of N deposition. Thus, I think it is important to state in Material and Methods that these experimental N rates are imposed to naturally occurring N deposition. In addition, could the authors explain why they use dry N addition treatments instead of wet?.

Just for clarity, I recommend the authors not to present results from Figure 4 until they have presented all results from Figure 3 (page 9, lines 5-13).

I am not sure I agree with the statement that 'the saturation response of Rabove and the declined response of Rmic in combination contributed to N saturation response of ER and the consequent saturation response of NEE in 2015' (page 10 lines 5-7)'. I think that if ER saturates as N increases, NEE would only saturate if GEP saturates. In addition, this statement should be in Discussion rather than Results.

Page 10, line 8-9. It is not clear to me if increased pH reduction as N increases, reduces Rmic in 2014. In both 2014 and 2015, pH decreases as N increases. Are changes in pH in 2014 affecting Rmic?

Page 10, line 10. I don't think the authors should conclude that decreased Rabove as N increased was attributed to the accumulated standing litter mass and thus less

light condition under high N addition treatments' based on a photo rather than data. In addition, this statement should not be presented in Results but in discussion.

Page 10, line 15. 'Our findings showed that ecosystem C fluxes (NEE, ER, and GEP) had linear responses in the first year but shifted to saturation responses in the second year'. Please rephrase this sentence using specific language. Based on the authors results, these processes are in the limitation stage in 2014; in 2015, they are in the limitation stage at low rates and at rates at or above 20 g N m-2 year-1 they shift to the saturation or declining stage.

The paragraph at the end of page 10, beginning of page 11 is repetitive. The first few sentences (line 15-19) are providing the same information than the last sentences (line 20-23). Please tighten the writing.

The authors state that 'saturated under N addition rate of approximately 8 gN m-2 year-1' (page 11, line 1). I think the authors are fitting thresholds 'by-eye' although there are many statistical methods that can be used to calculate thresholds.

I believe that the presentation of the idea that 'The N saturation responses of ER and thus NEE are mainly caused by the decrease of aboveground plant respiration and soil microbial respiration under high N addition treatments in 2015' (page 11) is not justified by their results. Above 15 g m-2 year-1 NEE reaches a transition threshold and it starts declining. At this stage, further N additions do not seem to be affecting Rmic (Fig. 3), and R above declines just slightly at N rates at 32 g m-2 year-1. I think the authors should consider fitting thresholds using statistical methods; this way the breaking points would be accurate and the trend of each line could be calculated. Perhaps the data that could justify this statement is in Fig. 6c. However, I think that the authors should be cautious drawing this conclusion because Rmic and RE are intrinsically correlated (i.e. Rmic is a component of RE). The authors should calculate the self-correlation coefficient instead of a simple coefficient of determination. Please see Vickers et al., 2009 (http://dx.doi.org/10.1016/j.agrformet.2009.03.009) for more information on this

statistical approach. The same applies to Rabove and Rroot, and RE; Rabove and Rroot are components of RE.

I couldn't find plant growth or standing litter biomass data that supported the statement 'The decrease of aboveground plant respiration under N32 treatment is primarily due to that N addition stimulated plant growth and thus standing litter accumulation after plant senescence' (page 11). Therefore, I am not sure this statement is justified by the authors' results. The same applies to page 14, lines 2-4.

I think that caution should be used when presenting the idea that 'Taken together with our results, it suggests that N saturation of ecosystem C fluxes may happen very quickly.' I agree with the authors that a plausible explanation could be that the net CO2 sink strength of this system saturated after 2 years of treatment. However, another plausible explanation that should be acknowledged is that differences in climate between 2014 and 2015 could explain variations in the response of C fluxes to N addition. For instance, if 2015 was drier than 2014, N demands for plant growth would be met faster.

I am not sure I agree with 'Our estimate on N critical load suggests that ecosystem C cycle would be largely affected under future N deposition scenarios and ecosystem may sequester more C from the atmosphere in the alpine meadow of Qinghai-Tibetan Plateau.' because the authors conducted a 2-year study in which several levels of N were added and to present this idea I believe they would need a long-term study.

Minor comments

Page 2, line 9 – I am not sure that I agree with the statement that 'ecosystem net C sequestration is usually predicted to increase under rising N deposition'. Some articles suggest that net C sequestration will increase and others show that it will decrease. See for instance Naddelhoffer et al. 1999 (doi:10.1038/18205). Please rephrase.

Page 3, line 5 – I am not sure that 'the C cycle gets saturated', I think I would rather

prefer if the authors refer to the specific process that is saturated (e.g. the C sink strength saturates). Please rephrase.

Page 7, line 2 – I think the authors mean 'simultaneous' rather than 'contemporaneous'. Please clarify.

Page 8, line 6 – I think that the authors mean 'monthly mean NEE' rather than 'annual mean NEE'. Please rephrase throughout the ms.

Page 11, line 5 – 'a N addition gradient experiment' rather than 'an N addition experiment'.

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-436, 2016.