We thank the reviewer for the helpful comments. Below our reply set in red font color.

This paper presents a modeling study on global nitrogen leaching from natural ecosystems with an ecosystem model LPJ-GUESS. Overall, the paper is well-written and the results are informative. My major concern is on the dependence of results on model representation of nitrogen and carbon cycling process and the inherent model assumptions. Please find my specific comments below.

1. Authors conclude that atmospheric N deposition is the major driver behind nitrogen leaching globally. This is not surprising as atmospheric nitrogen deposition is the dominant N input and linearly linked to soil nitrogen storage in the model. I would suggest add more details on the mathematical formulations in representing atmospheric nitrogen deposition and nitrogen mineralization in the model. Are the results sensitive to the specific formulation of atmospheric nitrogen deposition and mineralization? Discussion on the nitrogen deposition dataset should also be added.

Nitrogen deposition was not predicted in this study, but taken from the dataset of the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP; Lamarque et al., 2013). This data comprises results from an ensemble of simulations with 11 complex atmospheric chemistry models. Therefore, providing details on the mathematical formulation of N deposition is not feasible. For this we refer to the Lamarque et al., (2013) and references therein. The results of the ACCMIP simulations have been thoroughly and favourably evaluated against observations by Lamarque et al. (2013), and can be assumed to represent the best estimate of global N deposition currently available. A sentence stating this has been added to section 2.2.1.

Regarding N mineralization, indeed the results are likely to be sensitive to the mathematical formulations in soil N cycling module. The soil N cycling module in LPJ-GUESS is largely based on the CENTURY model which has been applied many in many studies, and is described in detail in Smith et al. (2014) and Parton et al. (1993). A detailed discussion on the effect of different formulations of mineralization is outside the scope of this paper, also because we deem other aspects of the model more relevant for uncertainty of predicted N leaching (discussed in section 4.4). A thorough comparison of different N cycling models (including LPJ-GUESS) has been published by Zaehle et al. (2014), including discussions on the formulation of N mineralization.

2. Table 1 lists the numerical experiments conducted in this study. I would suggest add some statements on the purpose of these experiment designs in the methodology section 2.3. For example, which combination of experiments is used to disentangle the effects of a specific environmental driver (e.g. N deposition)?

Section 2.3 has been expanded with several sentences.

3. Increase in nitrogen deposition may potentially lead to increased plant carbon uptake and plant productivity, which would feedback to the nitrogen budget and affect leaching process. Is the impact of carbon–nitrogen interactions on N leaching process considered in this study? This aspect of carbon–nitrogen dynamics on N leaching process should at least be discussed. Please also add a table specifying carbon–nitrogen ratios for all natural plant types considered. It would be interesting to examine/discuss how plant growth regulate the simulated N leaching for different PFTs in the model.

LPJ-GUESS is a dynamic global ecosystem model that simulates fully coupled C and N cycling in vegetation and soil. Hence, C-N interactions are considered and indeed an important aspect of this study (cf the effects of N deposition and CO2 on GPP, shown in supplemental figure S19).

Leaf C-N ratios are calculated prognostically based on canopy level photosynthesis and N availability (as described in supplement text S1), while C-N ratios of other pools are fixed. We added a figure of the PFT-mean leaf C:N ratios to the supplemental information (Figure S12)

4. The effects of fire and gaseous loss on N leaching is analyzed in the results section. But the descriptions on the representation of fire in the model is missing. In addition, it seems that the proposed numerical experiments in Table 1 doesn't consider fire?

Description of the fire module is given in supplemental text S1. This section has been expanded.

5. In section 2.2.1, the CRU monthly climate is interpolated to daily values as inputs for the model. More details on this temporal disaggregation are required. Discussions are also needed as the simulated sensitivity of N leaching to precipitation may depend on the daily sequence of precipitation and intensity.

Additional information on the interpolation of the climate data has been added to section 2.2.1. A sentence stating the relevance of rainfall distribution in time for N leaching has been added to section 4.1.2.

6. I would suggest clarify which specific aspect of N leaching is the focus of this study, the mean value or its temporal variation?

A sentence has been added to the introduction: "*Specifically, we focus on temporal changes during the last century in relation to change of environmental drivers, as well as spatial patterns of contemporary N leaching rates.*"

7. How is N status quantified?

This is done based on the N limitation factor, expressing reduction of photosynthesis due to N limitation. This is described in sections 2.1.2 and 2.3.

8. In section 3.2.1, the statement "N deposition, climate and atmospheric CO2 all increased during the 20th century" is confusing as "climate" is a broad concept.

The sentence has been modified.

9. I would suggest using the percentage change (%) as the unit in Figure 10

We assume the reviewer suggests to plot the relative changes as (sim-control)/control. We attempted this but it does not result in a readable graph, because regions where N leaching is very low in the control the relative change takes very high values, often infinity or NaN.

10. The name of the model used in this study can be added in the title.

We prefer to leave the title as it is. The name of the model is mentioned in the abstract.