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Interactive comment on "Complex controls on nitrous oxide flux across a long elevation gradient in the tropical Peruvian Andes" *by* Torsten Diem et al.

Anonymous Referee #3

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Diem et al. report on a remarkably large and comprehensive set of observations and experiments examining N2O fluxes across the Kosnipata tropical elevation gradient in Peru. This was clearly a lot of work. The combination of high temporal resolution chamber observations with WFPS, 15N and litter experiments makes the study particularly compelling. I have four suggestions. First, there a few aspects of the 15N tracer work that require further clarification. Second, I recommend the authors consider scaling their observations to annual values. Third, depending on details of the 15N tracer methods, I suggest the authors consider making use of the N2: N2O flux ratios from the incubations to estimate total N gas losses from these ecosystems if appropriate. Finally, I think the authors could do a better job at contextualizing their work

with reference to other studies and its global implications.

15N tracers: It would appear that the WFPS experiment was not a true "tracer" experiment but is also a N addition experiment and is therefore confounded. For the lower elevation sites, 200 ug N/g soil is not trivial. Are you sure that the background NO3 values are correct? The reported NO3-N values from soil extractions of ∼150 ug/g are approximately 5-10 times higher than those observed in across most high N old-growth tropical forests worldwide. Tracer experiments often add < 0.5 ug/g at 15NO3 of ∼99 atom percent. Further, unless I missed it, there is no description of the isotopic enrichment levels (per mil or atom percent). This needs to be included.

Scaling: Given the seasonal representation of the sampling, I think annual scaling could be justified. When scaled annually, the mean N2O-N emissions (0.27 mg N m-2 day-1) would be ∼ 0.98 kg N ha-1 yr-1 with peak fluxes of ∼2.7 kg N ha-1 yr-1. On average, chamber studies and models find that N2O losses from undisturbed humid tropical soils are ∼1-4 kg N ha-1 yr-1 (See van Lent et al. Biogeosciences 2015 and Werner et al. Global Biogeochemical Cycles 2007). So, these values fit right in.

N2 fluxes: Given the response to the first point above, I suggest considering approximating total N gas losses from these ecosystems. Despite potential artifactual contributions of the incubations (disturbance, N additions) one could calculate rough N2 losses assuming equal N2:N2O ratios at a given WFPS as measured during the chamber work. This could be insightful as there are many chamber-based N2O estimates for tropical forests published but very few for total N gas fluxes because it's difficult to measure. Eyeballing the 15N2 versus 15N2O flux ratios (∼20 to 80) and applying these to the chamber observations would yield N2 fluxes of ∼20 – 216 kg N ha-1 yr-1. The lower-end flux is possible (see Fang et al. PNAS 2015) but the upper end estimate is highly unlikely. Such total N export rates could never persist in a near-equilibrium forest as even the lower end is higher than average N mineralization and annual plant uptake and far exceeds external N inputs in tropical forests (see Brookshire et al. Geophysical Research Letters 2017).

The beauty of the Kosnipata gradient is that it represents a quasi-space-for-climate change substitution. More could be done with this context in the introduction and discussion. Further there are many other papers examining denitrification in tropical landscapes (some of them mentioned here) that would benefit the narrative to include.

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