

Response to Editor's comments – manuscript BG-2020-364

Forest-atmosphere exchange of reactive nitrogen in a low polluted area – Part I: Measuring temporal dynamics

We sincerely thank the editor for her comments to the revised version. We rephrased the corresponding lines according to the provided suggestions and clarified the remaining minor points.

Comments range from R1.1 to R1.111. Line numbers in the answers, where new information was added to the manuscript, refer to the last revised version. The text which is enclosed by “...” and highlighted in red is implemented in the manuscript.

Response to Editor's comments:

Comments to the manuscript:

Comment R1.1: *Title: Using “remote region (area)” instead of “low polluted area” would sound much better to my opinion.*

Response to R1.1: We replaced “low polluted area” by “remote region”.

Comment R1.2: *Line 5: ...at a mixed forest exposed to air pollution levels.*

Response to R1.2: We removed the adjective “low-polluted” and added “exposed to low air pollution levels” to end of the sentence.

Comment R1.3: *Line 15: ...high solar radiation...*

Response to R1.3: We replaced “incident” by “solar”.

Comment R1.4: *Line 19: No significant influence of temperature, humidity, friction velocity, or wind speed on ΣN_r dry deposition sums were found.*

➔ *This is somewhat in contrast to what was mentioned in other places of the paper. These variables determine the deposition velocity, and, hence, at the end also total deposition. Maybe reformulate or delete.*

Response to R1.4: We rephrased the sentence to “No significant influence of temperature, humidity, friction velocity, or wind speed on ΣN_r fluxes when using the Mean-Diurnal-Variation (MDV) approach for filling gaps of up to five days was found.”

Comment R1.5: *Line 21: ...half-hourly value...*

Response to R1.5: Added “y”.

Comment R1.6: *Line 25: ...to a remote forest ecosystem.*

Response to R1.6: Replaced “of” by “to” and added “remote”

Comment R1.7: Line 37: nitric oxide (NO)

Response to R1.7: Corrected.

Comment R1.8: *Line 39...aerodynamic gradient method (AGM), please change throughout.*

Response to R1.8: We changed it in lines 39, 71, and 72.

Comment R1.9: Lines 79-80: *These few long-term micrometeorological measurements of Nr species above forests were made more than 20 years ago and no recent reports on long-term flux measurements of Nr are currently available.*

Response to R1.9: We rephrased the lines according to your suggestions.

Comment R1.10: Lines 83-84: *As stated above, the outstanding benefit of TRUNC is*

Response to R1.10: We replaced “true” by “**outstanding**”.

Comment R1.11: Line 85-86: *I would combine this sentence with the scientific objectives mentioned in lines 100-104: please reformulate / list points (1), (2), (3) as scientific objectives.*

Response to R1.11: We deleted the sentence in line 85 and rephrased lines 100-104 as follows:

“Our study is the first one presenting long-term eddy-covariance flux measurements of ΣN_r above a remote forest. Based on the successful implementation of the TRANC methodology, our objectives are:

1. A discussion of observed concentration and flux patterns of ΣN_r in the context of different temporal scales
2. An investigation of the influence of micrometeorology on deposition velocities
3. An assessment of annual N deposition using both gap-filling for the dry deposition eddy flux data and complementary wet deposition estimates from local samplers.”

Comment R1.12: Lines 105-108: *Please delete these lines as they are not required here and can be misleading. I would just mention one sentence that a follow up paper will deal with...*

Response to R1.12: We agreed and deleted the lines 105 to 110 since the content of the follow-up paper may be modified during its review process and added the following sentence to the text: “A follow-up paper will investigate the usage of the acquired dataset in a modeling framework to estimate annual N budgets.”

Comment R1.13: Line 196: *Additionally, fast-response measurements.... (delete..., too).*

Response to R1.13: We added the word “**Additionally**” at the beginning of the sentence and deleted the word “too”.

Comment R1.14: Line 251: *... and associated descriptions are based on...*

Response to R1.14: Corrected.

Comment R1.15: Line 293: *... replace “or nitrogen aerosols” with “or related aerosol compounds”...*

Response to R1.15: Done.

Comment R1.16: Lines 305-306: *Please delete: “Further details about the implementation of these resistances in surface-atmosphere models can be found in van Zanten et al. (2010).”*

Response to R1.16: The sentence was deleted.

Comment R1.17: Line 312: *replace “A breakdown...” by “The contribution of individual nitrogen compounds to the total ΣN_r concentration pattern is shown in Fig. 2, which....”*

Response to R1.17: We rephrased the sentence according to your suggestion.

Comment R1.18: Line 315: *NOx also showed a... (delete “too”)*

Response to R1.18: Added “**also**” and deleted “too”.

Comment R1.19: Line 318: *The ΣN_r concentration was 3.1....*

Response to R1.19: Added “**The**”.

Comment R1.20: Line 321: *...in the annual pattern was reasonable...*

Response to R1.20: Replaced “good” by “**reasonable**”.

Comment R1.21: Line 322: ...with measurement height *was* observed.

Response to R1.21: Replaced “could be” by “*was*”.

Comment R1.22: Line 323-324: At 50 m the NH₃ concentration exceeded that at 30 m by 0.1 μg N m⁻³.

Response to R1.22: We rephrased the sentence.

Comment R1.23: Line 339: I propose to use the expression diurnal cycles instead of daily cycles throughout the MS.

Response to R1.23: We changed the expression throughout the manuscript (lines 373, caption of Fig. 5, 374, 377, 378, 380, 383, 384, 423, caption of Fig. 7, and 693).

Comment R1.24: Line 325: The seasonal variations of the half-hourly ΣNr concentrations are represented by box-and-whisker plots including monthly medians in Fig. S3. (delete: Figure S3 shows monthly box plots of the concentrations.)

Response to R1.24: We rephrased line 325 and deleted the subsequent sentence.

Comment R1.25: Line 327: Medians *ranged* between...

Response to R1.25: Replaced “were” by “*ranged*”.

Comment R1.26: Figure 2 caption: ...Missing NH₃ *values* from the DELTA measurements.... Numbers above the bars *indicate* the relative coverage of TRANC measurements during each exposure period.

Response to R1.26: We replaced “measurements” by “*values*” and added the word “*indicate*”.

Comment R1.27: NH₃ also featured seasonal variations with....

Response to R1.27: Replaced “showed” by “*featured*” and “changes” by “*variations*”.

Comment R1.28: Line 353: As shown in Fig. 2, ΣNr...

Response to R1.28: Replaced “seen by” by “*shown in*”.

Comment R1.29: I would split the first results section in two parts:

3.1 Measured concentrations of individual reactive nitrogen compounds
Including Figures 1-3 and S1-S4

3.2 Measured exchange fluxes of total reactive nitrogen
Starting on page 14 (break at line 355)

Response to R1.29: We changed the header of 3.1 to “*Measured concentrations of ΣNr and individual Nr compounds*” and titled section 3.2 beginning at line 355 “*Measured exchange fluxes and deposition velocities of ΣNr*”.

Comment R1.30: Line 355-356: ...on *a* monthly timescale....

Response to R1.30: Added “*a*”.

Comment R1.31: Line 359: on *a* half-hourly basis..., On *a* monthly basis...

Response to R1.31: Added “*a*”.

Comment R1.31: Line 360: According to Langford et al. (2015), *the limit of detection (LOD) is calculated by multiplying the random flux error (95% confidence limit) with 1.96.*

Response to R1.31: Corrected the position of “*1.96*” within the sentence.

Comment R1.31: Line 364: *This indicates* that emission fluxes....

Response to R1.31: Replaced “it shows” by “this indicates”.

Comment R1.32: Line 365: In general, median deposition was within the same range for the entire campaign with only small seasonal differences.

Response to R1.32: Replaced “on the same level” by “within the same range” and added “only”.

Comment R1.33: Line 367-368: Median deposition was significantly increased from June 2016 till September 2016 than for the same period in 2017 and IQR and whisker also covered a wider range in 2016.

Response to R1.33: Replaced “stronger” by “increased”, the dot by “and”, “too” by “in 2016”, and added “also”.

Comment R1.34: Line 374: Fig. 5 shows averaged daily cycles of measured ΣN_r fluxes for every month.

Response to R1.34: Added “of measured ΣN_r fluxes”.

Comment R1.35: Figure 5: Mean diurnal cycle of ΣN_r fluxes ($\text{ng N m}^{-2} \text{s}^{-1}$) based on half-hourly measurements for every month from June 2016 to June 2018. The shaded....

Response to R1.35: We rephrased the caption according to your suggestion.

Comment R1.36: Line 374-375: In general, the ΣN_r diurnal cycle exhibited low deposition or fluxes close to zero during nighttime/evening and increasing deposition during daytime. Deposition fluxes were...

Response to R1.36: Replaced “neutral exchange” by “fluxes close to zero” and “rates” by “fluxes”.

Comment R1.37: Line 378: ...with near-zero or small negative fluxes...

Response to R1.37: Replaced “neutral” by “near-zero”.

Comment R1.38: Line 379: ... months were comparable.

Response to R1.38: Replaced “uniform” by “comparable”

Comment R1.39: Line 381-382: ...was close to zero one year later.

Response to R1.39: Replace “neutral a” by “zero one”

Comment R1.40: Line 386: Again, the average standard error...

Response to R1.40: Added “the”.

Comment R1.41: Line 390: The meaning of “From May to September, the curve was approximately bell-shaped.” is unclear. Please clarify.

Response to R1.41: Rephrased to: “From May to September, a continuous increase in v_d was observed from 6:00 a.m. until noon. A decrease in v_d followed in the late afternoon (15:00 to 18:00 LT).”

Comment R1.42: 3.3 Controlling factors...

Response to R1.42: We changed the numbering of the section title.

Comment R1.43: Line 396 “leading to a constantly low v_d during the day (Fig. S10).” From Fig. S10 it is evident that v_d even strongly decreases during midday, this should be mentioned (and explained in the discussion).

Response to R1.43: We agree that it should be mentioned. We added the following sentence to line 396: “During that time, a strong decrease in v_d was found with near-zero or even small negative values around 12:00 LT.” The following lines were added to the discussion (line 614). “Stomatal uptake of N_r compounds was possible during periods of photosynthetic activity, leading to high values of v_d during the summer month (Fig. S9). Fig. S10 reveals that a certain degree of ΣN_r uptake still occurred in winter, but deposition decreased strongly during midday, and even periods of emission were observed. These

emissions may be due to the decomposition of leaves, leading to a release NH_3 in late autumn/early winter (Hansen et al., 2013), or from snow-covered soils (see Sec. 4.1)."

Comment R1.44: Line 399: and *the* concentration of ΣNr , especially changes in the concentration of the individual nitrogen compounds...

Response to R1.44: Added "the" and replaced "sub components" by "individual nitrogen compounds".

Comment R1.45: Line 410: For visualizing the impact of *the* concentration on v_d (Fig. 6),...

Response to R1.45: Added "the".

Comment R1.46: Line 412: ...increments of *the* ΣNr concentration...

Response to R1.46: Added "the".

Comment R1.47: Line 413: ...on *the* ΣNr concentration...

Response to R1.47: Added "the".

Comment R1.48: Line 414: It demonstrates that *the* ΣNr concentration...

Response to R1.48: Added "the".

Comment R1.49: Line 419: ... v_d was more influenced by micrometeorological variables than by the ΣNr concentration.

Response to R1.49: Replaced "had a higher affinity" and "parameters than to" by "was more influenced by" and "variables than by", respectively.

Comment R1.50: Line 425-426: Combine 2 sentences, they should read as: "During winter (December, January, and February), v_d was almost equal and even lower during the day, which resulted in a lower deposition of ΣNr ."

Response to R1.50: Done.

Comment R1.51: Line 426-428: The sentence should read as:

The different shapes of the diurnal variations of v_d could be induced by micrometeorological variables, which change the composition of available ΣNr compounds during the day (Seinfeld and Pandis, 2006) and promote photosynthesis (e.g. stomatal uptake or release of NO_2 and NH_3).

Seinfeld and Pandis, 2006 is for sure not the appropriate literature here, please choose other more specific references (as in the discussion section).

Response to R1.51: We rephrased the sentence according to your suggestion and we cited Munger et al. (1996), Horii et al. (2004,2006), Wyers and Duyzer, (1997), and van Oss et al. (1998) instead of Seinfeld and Pandis" (2006) in this sentence. We further added Thoene et al. (1996) and Wyers and Erisman (1998) to line 428.

Comment R1.52: Figure 7. Mean diurnal cycle of v_d from May to September for low and high temperature (a), relative humidity (b), and concentration (c). Median....

Response to R1.52: We replaced "daily" by "diurnal" and changed the sentence position of v_d .

Comment R1.53: Line 435: ... lower relative humidity....

Response to R1.53: Replaced "less" by "lower".

Comment R1.54: Line 437: During dawn/nighttime, deposition velocities exhibited no significant difference between the applied thresholds.... I can see a difference for the dry/wet leaf surface. Please double check this statement.

Response to R1.54: “In the presence of dry leaf surfaces, v_d was higher by approximately 0.2 cm s^{-1} compared to wet leaf surfaces during the night”. The sentence was added to line 437.

Comment R1.55: Line 439: ...compared to the May to September *period*.

Response to R1.55: Replaced “time frame” by “*period*”.

Comment R1.56: Section 3.3 should be changed to:

3.4 Dependence of ΣNr dry deposition sums on micrometeorological variables

Response to R1.56: We changed the section title.

Comment R1.57: Figure 8. ... represented by box-and-whisker plots...

Response to R1.57: Replaced “depicted as” by “*represented by*” and added “*-and-whisker*”.

Comment R1.58: Eq. (3) (Pastorello et al., 2020) please refer to the discussion section here.

Response to R1.58: Replaced the reference by section reference.

Comment R1.59: Line 450: median deposition~~s~~ of ~~the~~ ΣNr fluxes with....

Response to R1.59: Corrected.

Comment R1.60: Line 451: median deposition~~s~~ ... -> please correct all instances

Response to R1.60: Done.

Comment R1.61: Figure 9. Annual ΣNr dry deposition *shown* as bar graphs

Response to R1.61: Done.

Comment R1.62: Line 459: ... dry deposition~~s~~ sums...

Response to R1.62: Done.

Comment R1.63: Introduce new section after Line 466:

3.5 Wet and total nitrogen deposition

Response to R1.63: Done.

Comment R1.64: Line 473: In the second year, *the* contribution of dry deposition...

Response to R1.64: Added “*the*”.

Comment R1.65: Line 476-477: Which was probably related to high NH_3 concentrations... For sure it was, you measured them, please refer to the corresponding Figure here.

Response to R1.65: Added references to Figs. 2 and S2.

Comment R1.66: Line 509: Thus, their influence on NO_x measurements *was most likely* small.

Response to R1.66: Replaced “appeared to be” by “*was most likely*”.

Comment R1.67: Line 515-516: DELTA measurements further suggested that the ΣNr concentration pattern was mainly influenced by gaseous Nr .

Response to R1.67: Changed the order and wording according to your suggestion.

Comment R1.68: Line 521-522: Due to the reaction of NH_3 with HNO_3 and sulphuric acid particulate NH_4^+ is formed, available as NH_4NO_3 or $(\text{NH}_4)_2\text{SO}_4$.

→ I would change the order of compounds here:

Explanation:

In chemical systems composed of NH₃, HNO₃ and H₂SO₄, the formation of non-volatile (NH₄)₂SO₄ is preferred. Only when NH₃ is available in excess of H₂SO₄ and when favourable meteorological conditions (low to moderate T and/or high RH) prevail, neutralization of HNO₃ vapor with NH₃ occurs (Trebs et al., 2005).

Trebs, I., Metzger, S., Meixner, F.X. et al., 2005. The NH₄⁺-NO₃⁻-Cl⁻-SO₄²⁻-H₂O aerosol system and its gas phase precursors at a pasture site in the Amazon Basin: How relevant are mineral cations and soluble organic acids? *Journal of Geophysical Research-Atmospheres*, 110(D07303); doi:10.1029/2004JD005478.

Response to R1.68: We thank the editor for her literature recommendation. We decided to change the order of compounds.

Comment R1.69: Line 523: ... fine mode and *associated with aerodynamic diameters*....

Response to R1.69: Replaced "assigned" by "*associated*" and added "*aerodynamic*".

Comment R1.70: Line 537: ..., but *were* probably

Response to R1.70: Added "*were*".

Comment R1.71: Line 553-554: ...for instance *by bidirectional exchange of NH₃ leading to both periods of net emission and deposition* of ΣNr.

Response to R1.71: Rephrased the sentence according to your suggestion.

Comment R1.72: Line 567: Also, the SO₂ concentration was much larger...

Response to R1.72: Corrected.

Comment R1.73: Line 577: ...resulting in a high v_d, *which is due to efficient turbulent mixing*. Hence, *even* at low concentrations...

Response to R1.73: Replaced "allowed by turbulence" by "*due to efficient turbulent mixing*" and added "*even*".

Comment R1.74: Line 578-579: In conclusion, particulate NH₄⁺ was mainly responsible for the large ΣNr deposition due to its excess over aerosol NO₃⁻.

Response to R1.74: Rephrased the sentence according to your suggestion.

Comment R1.75: I propose that the section on ΣNr emission and the influence of snow can be shortened. The English writing of this section must be improved (Lines 590-609).

Response to R1.75: Agreed. We shortened the discussion on the decomposition and snow cover, e.g. removed descriptions to referred publications.

Comment R1.76: Line 616: I think it is anyway highly unlikely that the concentration drives the deposition velocity.

Response to R1.76: We deleted the sentence in line 616 since it is written in the previous sentence that v_d was independent of the ΣN_r concentration.

Comment R1.77: *However*, the impact of increasing concentrations on....

Response to R1.77: Replaced "still" by "*however*" and added "*s*" to concentration

Comment R1.78: Line 624: ... was *nearly zero* and emission...

Response to R1.78: Replaced "almost neutral" by "*nearly zero*".

Comment R1.79: Line 631: ... contribution of individual~~ly~~ compounds do show a seasonal cycle. Since the ΣNr compounds differ *entiate* in their v_d,...

Response to R1.79: Corrected.

Comment R1.80: Line 635: ...than *of* NO₂, but... than *of* NO₂ for woodland.

Response to R1.80: Added “*of*”.

Comment R1.81: ...and 2.2 cm s⁻¹ ~~for NH₃~~ (see Schrader...

Response to R1.81: Corrected.

Comment R1.82: Lines 637-643: Rewrite to:

However, variations in the composition of ΣNr may correlate with micrometeorological parameters. For example, the formation of HNO₃ is correlated with Rg. The solar radiation responsible for the stomatal opening also promotes the formation hydroxyl radicals, which react with NO₂ to form HNO₃ (Seinfeld and Pandis, 2006). Tair influences the diurnal pattern of NH₄NO₃, which may also volatilize close to the surface due to the depletion of its precursors and in case the temperature gradient is large enough (Wyers and Duyzer, 1997; Van Oss et al., 1998). Thus, part of the NH₄⁺ and NO₃⁻ in the aerosol phase may be converted to NH₃ and HNO₃, which deposits faster to surfaces than aerosols.

Response to R1.82: We implemented your suggestions to these lines and cited additional literature.

Comment R1.83: Line 646: In conclusion, *the* variability...

Response to R1.83: Added “*the*”.

Comment R1.84: Line 648-649: Delete: ~~Definitely, ΣNr concentration had no influence on its deposition velocities.~~

Response to R1.84: Deleted.

Comment R1.85: Line 656: ...measured half-hourly values...

Response to R1.85: Added “*ly*” and “*values*”.

Comment R1.86: Line 657: ... low-quality half-hourly values were effectively...

Response to R1.86: Added “*ly*” and “*values*” and replaced “could be” by “*were*”.

Comment R1.87: Line 660: Was there any footprint analysis performed or required due to fetch limitations? Could you comment on that? Maybe refer to previous publications.

Response to R1.87: We conducted a footprint analysis using the footprint estimation tool of Kljun et al. (2015) implemented in the software TOVI (LICOR Biosciences, 2020). Fig. 1 shows the footprint of the measurement site of stable and unstable conditions with isolines representing a given percentage of the flux contribution exemplarily for the year 2016.

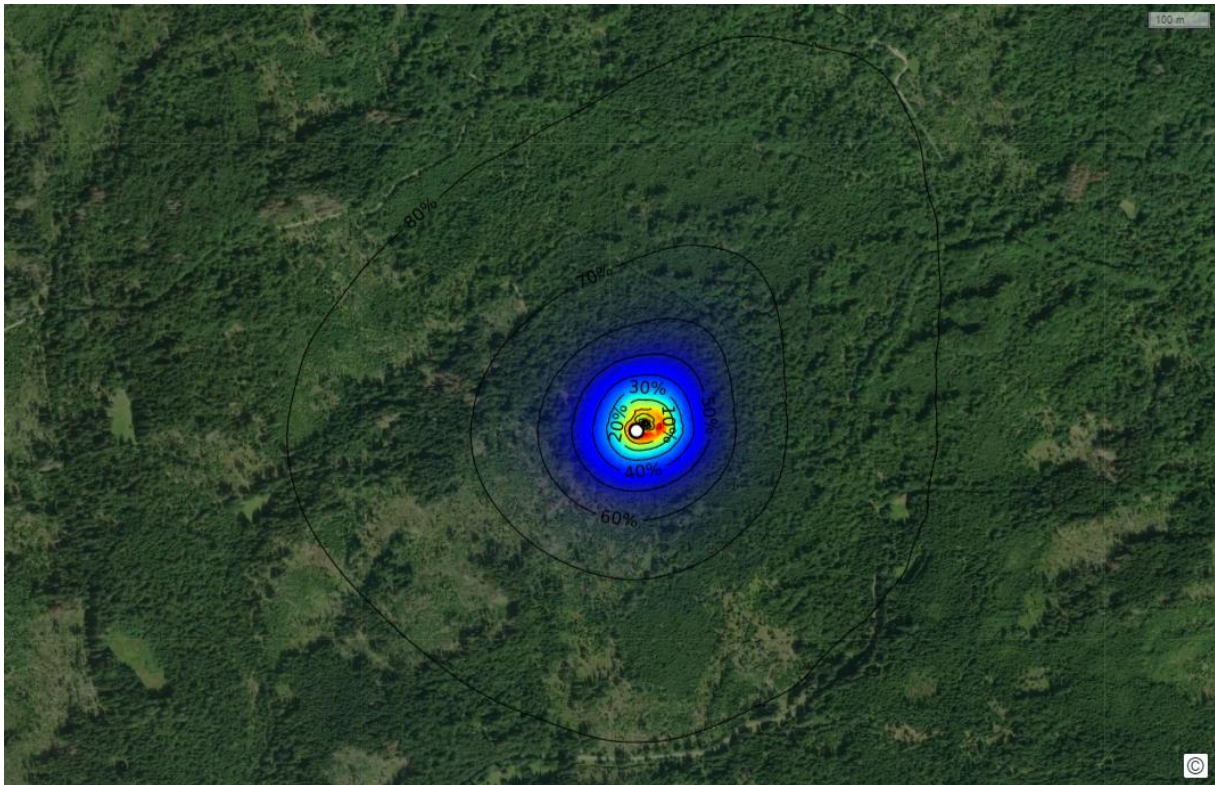


Figure 1: 2D-footprint of the measurement site of stable and unstable conditions exemplarily shown for the year 2016. Isolines represent a given percentage (10% to 80%) of the flux contribution. The heat map illustrates from which direction most of the fluxes originated.

The 2D-footprint analysis showed that the 70% isoline of the flux had an extension of approximately 300 m. In southwest direction of the tower (approx. distance 100 to 300 m), tree density and height were lower than to the Northeast of the tower. Due to the high surface roughness, the flux footprint is limited in its size but the footprint represents the typical forest structure of the Bavarian Forest National Park. Thus, we did not filter half-hourly fluxes from certain wind direction sectors.

We added the text given in this response to line 660.

Comment R1.88: Line 669: *of turbulent motions...*

Response to R1.88: Added “s”.

Comment R1.89: Line 675: *As shown in Fig. 8...*

Response to R1.89: Replaced “seen” by “shown” and replaced “within the error range of the dry deposition sum” by “small compared to estimated dry deposition after 2 years”.

Comment R1.90: Line 679: *...a certain half-hourly value was...*

Response to R1.90: Added “ly and “value”.

Comment R1.91: Line 688: *...estimated dry deposition_s for...*

Response to R1.91: Deleted “s” and rephrased the sentence as follows: “The difference in the annual dry deposition estimates was likely related to the large deposition occurring in February 2018”.

Comment R1.92: Line 693: *...has a distinct diurnal cycle.*

Response to R1.92: Corrected.

Comment R1.93: Lines 701-702: *Please delete: The comparison of TRANC measurements with nitrogen throughfall measurements will be shown the second part of this study.*

Response to R1.93: The sentence was deleted.

Comment R1.94: Line 705: ...total N depositions was...

Response to R1.94: Corrected.

Comment R1.95: Lines 708-709: It suggests that the forest is currently not in a critical state in relation atmospheric N input.

→ I think this statement is incorrect. The N input was 10 and 12 kg N ha⁻¹ a⁻¹, which is within the range of the critical load.

According to the OECD, the critical load is defined as:

Critical Load is the quantitative estimate of the level of exposure of natural systems to pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur.

According to my understanding, the forest is just at the limit of receiving too much Nitrogen from the atmosphere. This implies that N inputs should not increase in the next years.

Response to R1.95: We agree and corrected the statement as follows: “is currently close to the limit of receiving too much nitrogen from the atmosphere assuming that the critical load of the forest site is at the upper end of the reported ranges.”

Comment R1.96: Line 713: ...above a protected *temperate* mixed forest, *that is located in a remote area*.

Response to R1.96: Added “temperate” and “, that is located in a remote area”.

Comment R1.97: Line 721: ...throughout the year.

Response to R1.97: Corrected.

Comment R1.98: Line 726: ...periods of high solar radiation...

Response to R1.98: Replaced “the timeframe” by “periods” and “global” by “solar”.

Comment R1.99: Line 727: seasonal changes in the concentrations of the ΣN_r compounds,..

→ Before is was written that ΣN_r does not influence v_d...

Please double check.

Response to R1.99: We meant here the contributions of the individually measured N_r compounds. We corrected the sentence.

Comment R1.100: Line 728: From May to September, ~~deposition velocity~~ v_d was....

Response to R1.100: Deleted.

~~**Comment R1.101:** Line 732-733: Still, a comparison of measured and modeled deposition velocities of ΣN_r with the latter being determined by inferential modeling with regard to micrometeorological controls, could hint on deficits in deposition modeling.~~

→ This sentence does not make sense, please delete.

Response to R1.101: We deleted the sentence.

Comment R1.102: Line 735: No significant influence of micrometeorological parameters on estimated dry depositions sums was found.

→ This sentence does not make sense and is in contrast to what was written before. (micrometeorology influences v_d and therefore also the total N deposition)

Response to R1.102: We agree and rephrased the sentence as follows: “No significant influence of micrometeorological parameters on ΣN_r fluxes when using the Mean-Diurnal-Variation approach for filling short-term gaps (up to five days) was found.”

Comment R1.103: Line 736-737: Using gap-filling approaches based on inferential modeling for long-term gaps, is an option which we investigate in the companion paper.

→ Please delete, note relevant here.

Response to R1.103: We deleted the sentence.

Comment R1.104: Please add information to the conclusion that dry deposition contributed 1/3 to the total N deposition.

Response to R.104: We added the following sentence to line 739. “Thus, dry deposition contributed approximately 1/3 to the total N deposition.”

Comments to the supplement

Comment R1.105: A1 Description *of* wet deposition measurements

Response to R.105: Replaced “to” by “of”.

Comment R1.106: Figure S3: ...shown as box-and-whisker plots...

Response to R.106: Replaced “depicted” by “shown” and added “-and-whisker plots”

Comment R1.107: Figure S4. Mean diurnal cycle of ΣN_r concentrations ($\mu\text{g N m}^{-3}$) based on half-hourly measurements for every month from June 2016 to June 2018.

Response to R.107: Replaced “daily” by “diurnal”, “on half-hourly basis” by “based on half-hourly measurements”, and corrected the order accordingly.

Comment R1.108: Figure S5: ... presented by box-and-whisker plots...

Comment R1.108: Replaced “depicted as” by “presented by” and added “-and-whisker plots”

Comment R1.109: Figure S6. Mean diurnal cycle of $vd(\Sigma N_r)$ (cm s^{-1}) based on half-hourly measurements for every month from June 2016 to June 2018.

Response to R1.109: Replaced “daily” by “diurnal”, “on half-hourly basis” by “based on half-hourly measurements”, and corrected the order accordingly.

Comment R1.110: Figure S11. Diurnal cycles...

Response to R1.110: Replaced “patterns” by “cycles”.

Comment R1.111: Figure S13.Wind direction corresponds to values measured in three-hourly intervals.

Response to R1.111: Replaced “at 3-h time stamps” by “in three-hourly intervals”

References

Hansen, K., Sorensen, L. L., Hertel, O., Geels, C., Skjoth, C. A., Jensen, B., and Boegh, E.: Ammonia emissions from deciduous forest after leaf fall, *Biogeosciences*, 10, 4577–4589, <https://doi.org/10.5194/bg-10-4577-2013>, 2013.

Horii, C. V., Munger, J.W., Wofsy, S. C., Zahniser, M., Nelson, D., and McManus, J. B.: Fluxes of nitrogen oxides over a temperate deciduous forest, *Journal of Geophysical Research: Atmospheres*, 109, <https://doi.org/10.1029/2003JD004326>, 2004.

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