

Response to Reviewer#2

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Title: Eddy covariance fluxes and vertical concentration gradient measurements of NO and NO₂ over a ponderosa pine ecosystem: observational evidence for within canopy removal of NO_x

We would like to thank reviewer#2 for their constructive and thoughtful comments. Our responses to the comments are shown in bold as below.

Responses to the general comments and suggestions

I miss some details about O₃ flux measurements and especially about soil NO emission. It seems that some dynamic chambers were applied at very few occasions. I find the omission of continuous soil NO emission measurements a major flaw of this study.

→ We added references to prior studies of ozone flux at this site, Fares et al., 2010 and Kurpius and Goldstein 2003. We agree that continuous measurements of soil NO fluxes would have been a great addition to the study. Such measurements were not available and they are more difficult at these very low NO fluxes/concentrations than at sites where such measurements might have been more routine.

Responses to the specific comments and suggestions

p.12439, 1.15: The conversion of NO to NO₂ by reaction of O₃ is also important to mention here.

→ A phrase is added to describe the previously suggested mechanism.

p.12440, 1.15: Other relevant references are:

J. H. Duyzer, J.R. Dorsey, M. W. Gallagher, K. Pilegaard, S. Walton. Oxidised Nitrogen and Ozone Interaction with Forests II: A Multi-layer Model to Describe Above and Below Canopy Exchange and Processing. Quarterly Journal of the Royal Meteorological Society, 130, 1957-1971, 2004.

J. R. Dorsey, J. H. Duyzer, M. W. Gallagher, H. Coe, K. Pilegaard, J. H. Westrate, N. O. Jensen and S. Walton. Oxidised Nitrogen and Ozone Interaction with Forests I: Experimental Observations and Analysis of Exchange with Douglas Fir. Quarterly Journal of the Royal Meteorological Society, 130, 1941-1955, 2004.

→ References added

p.12440, 1.28: I miss a reference for the statement of timescales.

→ We add text to explain that the timescale is based on typical values for J_{NO₂}.

p.12442, 1.3: The NO_x concentration within the canopy might be higher due to soil NO emission.

→ Agree. A sentence is added to describe possible contribution of soil NO emission.

p.12444, 1.6: Since the O₃ fluxes are quite relevant to this study, I wonder why no details (or a reference) is given. Also the O₃ fluxes are not included in the discussion. It might be because the NO concentrations are so small that they do not influence O₃ substantially. However, for completeness, I think this should be addressed.

→ We will add a brief discussion to section 4 to describe NO_x conversion and prior observations of O₃ flux at this site. Consistent with the reviewers estimate that the O₃ fluxes do not affect the issues in this paper substantially, the day time gradients in O₃ are described and shown to be too small to contribute to a gradient in partitioning of NO_x.

p.12444, 1.16: As stated above, I wonder why so little emphasis is put on soil NO emission measurements.

Measurements at only three specific days (and no information on duration nor timing) is very little and clearly not representative. It also seems that these data are not reported except for a mentioning of the minimum value. If the methodology and data are documented somewhere else at least a reference should be given.

→ All the soil NO measurements we were able to make are described in the paper. We will add a few more details to our description of the measurements as suggested by the referee (duration, timing, etc.).

p.12450, 1.8: I miss power spectra of the NO and NO₂ measurements. Sampling at 5Hz might lead to loss of fluxes at high frequencies.

→ The power spectra of NO₂ using this instrument at this site had been shown by Farmer et al. 2006. Fluxes reported by many others at this site show that 1Hz sampling would be more than adequate to capture the fluxes (at the accuracy needed for our scientific questions).

p.12453, 1.9 ff: I find this quite speculative because of the missing information on soil NO emission, The only

information given is on p.12454, l.8, where we are told that the NO emission measured was 3 ppt ms⁻¹ in the morning (what morning?).

→ See comments above.

p.12454, l.23: "Using the lowest measured soil emission rate ..." I wonder whether this is relevant considering the very scarce NO emission measurements.

→ As described above, there was a limited resource for soil NO emission we had during the mission. By taking the lowest emission rate we were able to estimate the lowest limit of the chemical conversion, conservatively. Also as mentioned from the responses above few sentences are included to address this limitation.

p.12455, l.17: It might be relevant here to study the works of Leif Kristensen and coworkers:

Title: First-order chemistry in the surface-flux layer Author(s): Kristensen, L; Andersen, CE; Jorgensen, HE; et al.

Source: JOURNAL OF ATMOSPHERIC CHEMISTRY Volume: 27 Issue: 3 Pages: 249-269 DOI:

10.1023/A:1005800416423 Published: JUL 1997

Title: Fluxes and concentrations of non-conserved scalars in the atmospheric surface layer - Second-order destruction

Author(s): Kristensen, Leif; Kirkegaard, Peter Source: JOURNAL OF ATMOSPHERIC CHEMISTRY Volume: 53

Issue: 3 Pages: 251-263 DOI: 10.1007/s10874-006-9016-z Published: MAR 2006

Title: A Simple Model for the Vertical Transport of Reactive Species in the Convective Atmospheric Boundary Layer

Author(s): Kristensen, Leif; Lenschow, Donald H.; Gurarie, David; et al. Source: BOUNDARY-LAYER

METEOROLOGY Volume: 134 Issue: 2 Pages: 195-221 DOI: 10.1007/s10546-009-9443-x Published: FEB 2010

→ Authors appreciate suggested references to explore chemical interference in vertical transport.

p.12460, l.25-26: This is a bit in contradiction to l.20-21. Maybe it can be made more clear by a changed wording.

→ We do not see the contradiction in those sentences. Line 20-21 described the existence of NO_x loss process(es) other than NO to NO₂ conversion and line 25-26 specifies that would be NO₂ to PN and/or AN formation. We will try to clarify the wording.