

## ***Interactive comment on “Measurement report: Leaf-scale gas exchange of atmospheric reactive trace species (NO<sub>2</sub>, NO, O<sub>3</sub>) at a northern hardwood forest in Michigan” by Wei Wang et al.***

### **Anonymous Referee #2**

Received and published: 20 April 2020

The study by Wang et al. investigates the existence of an NO<sub>2</sub> compensation point for a mixed hardwood forest by using branch enclosures in the field. Foliar deposition of NO, NO<sub>2</sub> and O<sub>3</sub> were measured by applying different concentrations of these compounds in cleaned air to the enclosures to measure foliar uptake/emission. The enclosures were installed at mature trees of several dominant tree species. This study is very valuable as there are very few studies on NO<sub>2</sub> deposition to trees and esp. to mature trees under field conditions. The topic is very important to understand NO<sub>x</sub> cycling and to finally come up with a more profound understanding of in-canopy NO<sub>x</sub> retention. This in turn is of utmost importance to adequately model NO<sub>x</sub> fluxes from forest canopies. The measurements and data analysis are sound and the manuscript is well written.

C1

Therefore, I suggest publication after addressing the minor comments given below.

L45: Maybe rather state “the air layers above the forest” instead of “free troposphere” as the air will first encounter the roughness sublayer or at nighttime the stable nocturnal boundary layer, then the mixed layer (daytime) or residual layer (nighttime) before reaching the free troposphere.

L96: folia => foliar

L132: To be able to judge potential surface effects and light absorption behavior (cutoff wavelength) of the enclosure please provide information about the material the bags were made of.

L140: Which material were the lines made of?

L147 and Fig. 2: Was there any special reasoning for putting the activated charcoal in front of the Purafil NO<sub>x</sub> scrubber? Different to NO<sub>2</sub>, NO is not well captured by charcoal, and therefore normally the Purafil is put in front of the charcoal as it not only adsorbs NO<sub>2</sub>, but also oxidizes NO to NO<sub>2</sub> which is finally captured by the Purafil and the charcoal. At low ambient NO it might make no difference, but for higher NO this setup normally works better.

L163: Leaf wetness measurements are mentioned here but not presented or discussed in the manuscript. Could you please add these results? Alternatively, at least mention why they were not used.

L168: 1 min zero air measurement plus 2.5 min NO and 2.5 min NO<sub>2</sub> results in a 6 min cycle? Please clarify.

L171: To have higher NO<sub>2</sub> absorption and less HONO photolysis the light emissions of the diode should be > 390 nm. The 365 nm is close to the HONO absorption band at 368 nm (Stutz et al., 2000). Nevertheless, even at the peak absorption of HONO the absorption cross section of HONO is about a factor of 1.5 smaller and under environmental conditions the HONO to NO<sub>2</sub> ratio is normally below 10 % (some cases up to

C2

30 %). Therefore, the HONO interference in ambient air should be small. Due to the high surface to Volume ratio of the chambers, the HONO to NO<sub>2</sub> ratio could be higher and might depend on the chamber material. So please also provide information on the chamber material (see above comment).

L300: "Unknown measurement issue for water concentration". As stated in the paper in line 315 the chamber air was not condensing according to the calculated dew points. Could the reason be instead evaporation of surface water films that form at a RH > 50 % due to the deliquescence of deposited salts and other processes (e.g. Burkhardt and Eiden, 1994), Burkhardt and Hunsche, 2013).

L317: Liquid surface films can be formed by processes other than condensation (see esp. Burkhardt and Hunsche, 2013). Furthermore, a recent laboratory chamber study investigated the influence of liquid films (at RH below condensation) on deposition of Peroxyacetyl nitrate and O<sub>3</sub> to plants ((Sun et al., 2016) in detail.

L353: As mentioned in the above comments there are processes other than pure condensation that lead to the formation of liquid films. What about the surface wetness measurements? Do they show any changes at RH between 50 and 100 % that could be associated to enhanced O<sub>3</sub> uptake?

L361: As the reactions will not stop at the chamber outlet please provide the total residence time from within the chamber (1.5 min) to the analyzer as well?

L365: A very good description of the relevant loss processes for O<sub>3</sub> is provided by a recent review (Clifton et al., 2020).

L464: Please revisit this statement in the light of the above comments that liquid films can form at RH > 50 % and therefore contribute to enhanced O<sub>3</sub> surface deposition (esp. Sun et al., 2016).

#### References:

Burkhardt, J. and Eiden, R.: Thin water films on coniferous needles, *Atmos. Environ.*,  
C3

doi:10.1016/1352-2310(94)90469-3, 1994.

Burkhardt, J. and Hunsche, M.: "Breath figures" on leaf surfaces—formation and effects of microscopic leaf wetness, *Front. Plant Sci.*, doi:10.3389/fpls.2013.00422, 2013.

Clifton, O. E., Fiore, A. M., Massman, W. J., Baublitz, C. B., Coyle, M., Emberson, L., Fares, S., Farmer, D. K., Gentine, P., Gerosa, G., Guenther, A. B., Helmig, D., Lombardozzi, D. L., Munger, J. W., Patton, E. G., Pusede, S. E., Schwede, D. B., Silva, S. J., Sörgel, M., Steiner, A. L. and Tai, A. P. K.: Dry Deposition of Ozone Over Land: Processes, Measurement, and Modeling, *Rev. Geophys.*, doi:10.1029/2019RG000670, 2020.

Stutz, J., Kim, E. S. and Platt, U.: UV-visible absorption cross sections of nitrous acid, *J. Geophys. Res.* VOL. 105, NO. D11, PAGES , JUNE 16, 2000, 105 (No. D, 14585–14592, 2000.

Sun, S., Moravek, A., Trebs, I., Kesselmeier, J. and Sörgel, M.: Investigation of the influence of liquid surface films on O<sub>3</sub> and PAN deposition to plant leaves coated with organic/inorganic solution, *J. Geophys. Res.*, 121(23), doi:10.1002/2016JD025519, 2016.

---

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2020-149>, 2020.