

***Interactive comment on “Single-photon laser-induced fluorescence detection of nitric oxide at sub-parts per trillion mixing ratios” by Andrew W. Rollins et al.***

**Anonymous Referee #2**

Received and published: 3 March 2020

General comment:

The manuscript is suitable for publication in the AMT journal. Overall, it is well written and provides important information about the features (supported by theory and observations) of a laser-induced fluorescence system for the direct detection of atmospheric nitric oxide. I recommend a publication after minor revision according to the following comments.

Specific comments:

Line (1-8): Please provide key numbers/values (e.g., wavelength, uncertainty, etc.) in the abstract.

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Line (37): What is the function of dry ice in a CL instrument? Please can you elaborate or provide a reference?

Line (44-45): How do you know it is red-shifted (Measured or from literature)?

Line (63): Why is it important to resolve Doppler broadened in the case of the LIF technique?

Line (66): Is the detection limit at 10 seconds measured or calculated by simply dividing 1 ppt with  $\sqrt{10}$ ? How do you know it follows the square root dependency?

Line (79-82): The sentences “The DFB output. ....an end capped fiber” are not easily understandable. Describe the purpose, why is this performed or what is required to achieve? Please modify it for simplicity.

Line (94): What is the purpose of the reference cell? Why is it necessary to have 500 ppb of NO? This needs a further explanation for a reader.

Line (96): What is the absolute pressure? Is there an orifice involves or just pump is used to achieve a lower pressure inside both cells?

Line (97-101): It is not clear from Figure 1 the location of the fused silica lens and the bandpass filter? What type of signal comes from the reference cell (I assume absorption)? Which of the PMT in Figure 1 is used for the fluorescence signal from the sampling cell? In my opinion, this whole paragraph (Line 91-101 along Figure 1) needs more details for clarification.

Line (104): What is so special about polyether ether ketone based valve? Why is it used? What is an advantage for NO?

Line (106): What is the term “servo controlled”? Please describe the functionality/advantage.

Line (108): How much time is required to achieve stability within 1% of set points? This could be a problem during an ascend/descend (changing altitude) of flight mea-

C2

surements. Did the system manage to keep up with the ascending/descending of the aircraft?

Line (109): What is the zero-air? Is it free of NO?

Line (125-132): Why the comparison between 215 nm and 226 nm. It needs motivation.

Line (213-216): Is it a total signal or background-subtracted signal? Do you see any impact of the cell pressure on the zero-air background? Better to present only NO related signal (total signal - background) in Figure 6.

Line (265-272): How the wavelength is tuned (via temperature or current)? Is the laser thermally controlled or what is the impact of an ambient temperature change on the wavelength/power of the laser?

Line (282): Please also show the standard deviation of the average points in Figure 10.

Line (285-294): I think a lot of hydrocarbons/VOCs have absorption in the UV wavelength region (please check at [http://satellite.mpic.de/spectral\\_atlas/](http://satellite.mpic.de/spectral_atlas/)). This can lead to a potential interference in particular environments (e.g., forest regions). Can you say something about it?

Line (313): Please provide the confidence interval for the uncertainty.

Line (352): Table 1 shows that the weight of the CL instrument was 150 kg. Generally, commercial CL instruments are very lightweight. What is different in this case?

Line (374): How is the PMT in the CL instrument exposed to cosmic rays at higher altitudes?

Line (377): How many background measurements (frequency) and calibrations are required for the LIF instrument in one day?

Line (382): How much difference in the precision in both cases?

Line (403-404): Maybe I missed the point. Where is the relevant demonstration?

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Page 18 (Figure 1): By looking at the layout of the sampling cell, can you say something about dead air pockets near the quartz windows? Are the quartz windows flushed with some dry air? If not, what do you think of dust (build-up on windows with time) related impact on sensitivity or background measurements?

Technical Corrections:

Line (10-15): Please include a reference.

Line (39): "An alternative technique" to "An alternative direct technique".

Line (64): "repitition" to "repetition".

Line (206): Please recheck unit or value "- 90 K".

Line (215): "dependance" to "dependence".

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2020-24, 2020.

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