

Interactive comment on “Laser induced fluorescence based detection of atmospheric nitrogen dioxide and comparison of different techniques during the PARADE 2011 field campaign” by Umar Javed et al.

Anonymous Referee #2

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The manuscript of Umar Javed and colleagues is an interesting study on a new laser induced fluorescence instrument for the measurement of atmospheric nitrogen dioxide. It describes the set-up of this instrument with an emphasis on its calibration system and the analysis of possible cross-sensitivities. An important part of the manuscript focuses on the results of an intercomparison field campaign where different nitrogen dioxide measurement techniques have been compared. Nitrogen dioxide is an important atmospheric trace gas and imposes quite some efforts to perform good measurements with different techniques. This manuscript makes a valuable contribution to improve ni-

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trogen dioxide measurement techniques. I recommend this manuscript for publication; however there are some points that should be addressed before.

Specific comments:

L16: Abstract: I suggest that in the abstract the field campaign PARADE should be mentioned; also the location and time of the field campaign.

L 32: Aircraft emissions as well are directly affecting the free troposphere.

L 96: The wavelength of the laser is given but not the wave length of the fluorescence.

L 103: In this context: What is the definition of zero air?

L 125 / L 144: What is the PMT temperature? Is the PMT actively cooled? What causes the background signal? Would the background decrease, if the PMT was cooled down at temperatures below 0°C by an active cooling unit?

L 223: "... at a lower temperature..." Which temperature?

L 237: Is there an explanation for the change in sensitivity? What is the range of sensitivity change?

L 268: Figure 8 shows the relative precision obtained during different calibrations. But how exactly do you determine the relative precision? Does it include for example only the variability of the sensitivity or the variability of the background, etc.? Please describe in more detail.

L 318: R6 is not a valid chemical reaction (both sides of the reaction arrow should be balanced).

L 337: I agree the short residence time of the sample air inside the instruments minimizes the thermal decomposition of the respective species. But please give at least a few calculated lifetimes against thermal decomposition for the most important interfering gases that illustrate this statement.

L505: I suggest that in the summary the authors underline the main advantage and disadvantage of this measuring system, also in comparison with other measurement techniques. What is the future of Gandalf (besides LOTR)? Are there specific plans to use this instrument during other field campaigns?

L 508: The authors are mentioning that the instrument is capable for measurements throughout the troposphere with a time resolution of 1 s to 1 min. However, the whole preceding discussion has been focused on ground based measurements at a time resolution of 1 min. Also the concentration of NO₂ in the free troposphere is much lower than in the boundary layer. LOD would increase significantly if you reduced the sampling time from 60 s to 1s. Please outline in short what improvements would be necessary to achieve this goal.

Technical Corrections:

L 298: ... about 8 time higher than the cross section of ...

Tables:

Table 3: $\pm \delta$ – explanation in the caption is missing.

Table 4: Uncomplete caption - which ratios?

Figures:

In general the figure captions are often not sufficient in explaining the content of the figures.

Figure 1: The numbers in the caption of this figure have different orientations and do not facilitate the reading. All numbers should have the same conventional orientation (like the numbers “9, 10,...”?. “SF” - This is not quite consistently. All other objects of this figure stand for units of the instrument. “Sampling flow” is the gas stream into the instrument (I assume) and not part of the instrument. So it would be more suitable to write: Inlet orifice or sampling flow line, or. ...

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Figure 4: ... as a function of O₃ concentration in ... Please explain “arb” in the y-axis label. The caption is incomplete; “Box-Model NO₂” is not mentioned.

Figure 5: “also theoretically calculated residence time (7.73s)...” I assume the red line in this figure is meant.

Figure 6: What do you mean by calibration signal? I assume it is the number of counts at the PMT?

L 250 – L 265 / Figure 7: The description in the text and in the figure caption is a little bit confusing and should be clarified. E.g. an ozone analyzer is shown in the figure but not mentioned in the text. In the text blue, red and white arrows are mentioned; in the figure you find additionally orange arrows. In the text only red arrows in L2 are mentioned, but there also white arrows found in L2. I assume that the valves EV3 and EV2 have to point at the position P1(P2) at the same time? Above the Gandalf-box in Figure 7 there are three times written “4100 sscm” in different colors and different orientation. As long as you do not discuss it explicitly in the text, one “4100 ssm” label is enough. Figure caption: “outdoor – operations”? - Better during field campaigns or during the PARADE field campaign.

Figure 8: JD = Julian Days. The formulation of this caption is a little bit unclear. Please improve.

Figure 12 and 13. “Ratios...” – The readability would be improved if you would write in the caption which ratio is meant. Please choose the same y-scale for all figures.

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