

Interactive comment on “Measurement of atomic oxygen in the middle atmosphere using solid electrolyte sensors and catalytic probes” by M. Eberhart et al.

Anonymous Referee #2

Received and published: 25 May 2015

This manuscript describes two different simple in-situ instruments for the detection of atomic (and partly also molecular) oxygen in the middle atmosphere. The manuscript starts with a short motivation describing that atomic oxygen is a major contributor to the middle and upper atmospheric energy budget and then describes the two different sensor types in detail: an electrolyte based sensor called FIPEX and a catalytic sensor called PHLUX. The authors then present the calibration efforts of these instruments in some detail, they present Monte Carlo simulations to determine aerodynamic correction factors for the rocket borne application of the instruments and they finally present flight data from a sounding rocket flight in the summer Arctic. The results are discussed

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with respect to sensor performances and they conclude that qualitatively their observations did agree well with climatology, however, they also notice discrepancies in terms of absolute number densities and offer some speculation for the underlying reason.

While high resolution and high accuracy atomic oxygen measurements in the middle and upper atmosphere are beyond doubt critically important for an understanding of this part of the atmosphere, this manuscript has a number of major deficiencies which need to be addressed before it may be accepted for publication in AMT. My detailed major and minor comments are given below:

Major

1. What strikes me most is that the authors do not show a single error bar for either laboratory or atmospheric measurements in their entire manuscript. However, in order to make this novel and promising technique a competitive one compared to photometric in-situ observations or optical observations from space, this is surely mandatory. This manuscript should definitely not be published unless an estimate of such error bars is provided.
2. In the same direction, I am also wondering why the authors do discuss the similarities and differences between upleg measurements with their instruments on the front deck and downleg instruments in the aft, but why they don't discuss the similarities and differences between the sensors on the same deck. I would assume that a lot can be learned regarding the accuracy of the data from such a comparison.
3. The discussion of the PHLUX data is definitely too short and not appropriate for publication in the peer reviewed literature. I recommend that the authors only briefly mention that there was another set of measurements that requires a much deeper analysis which will be presented in a future paper.
4. When discussing the observations in Figure 14 and 16 it appears necessary that the authors explain more about the geophysical conditions of their launch. I accept

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that this is mainly an instrumental paper but nevertheless several of the features can probably only be understood when the geophysical situation is accounted for. For example: were the sounding rockets launched under conditions of mesospheric ice clouds? These have been speculated to be effective sinks for atomic oxygen which might explain the very sharp ledge seen at ~87 km in Figure 16.

5. In the introduction very little background is given on past in-situ measurements of atomic oxygen even though such measurements have surely been in the scientific focus for many years (albeit admittedly not so much over the past two decades).

Minor comments

- Abstract line 1: atmospheric → middle- and upper atmospheric
- In general the authors should spell out all used acronyms; to give just a few examples of acronyms that are not explained: WADIS, CONE, etc.
- Abstract, line 9: As indicated above I recommend to remove the part on PHLUX until a more conclusive analysis can be reached
- Several references to atmospheric findings are cited such as (Hedin et al., 2009). This is surely a good paper, however, it surely also hasn't been the first on the subject under discussion. I hence recommend to cite such papers as (e.g., Hedin et al....). Note that there are several of these references. Please check carefully and adapt.
- Page 3247, line 6: → the global circulation; wave motions → substitute by "turbulent mixing"
- Page 3247, line 17: You refer to WADIS as a campaign but later you state that a second campaign in the same project is planned (at least it reads like this). Maybe you should better refer to the "WADIS-project".
- Page 3248, lines 19 - 23: spell out instrument acronyms and provide references. To my knowledge all these instruments have heritage.

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- Page 3249, lines 11 - 14: please write proper sentences.
- Page 3250, line 22: What kind of impurities? How can the authors be sure that this is not an issue for their observations.
- Page 3251, line 18: What is a PI controller; please spell out acronyms.
- Page 3252, section 3: see above; I recommend to delete the PHLUX-part of the manuscript until a proper analysis is available.
- Page 3253, line 25: What is the "NISI"-method? Please spell out any acronyms.
- Page 3255, line 10: How do you know that the sensors did not show any sensitivity towards molecular oxygen? I think it is critical that you convince the reader that this statement is correct.
- Page 3257, line 6: Please provide a reference for CONE temperature measurements.
- Page 3257, line 14-15: I guess the observations were rather divided by this factor, right? Also, how were the Monte Carlo results shown in Figure 10 interpolated to altitudes not directly covered by the calculations?
- Page 3259, line 16: Figure 13 only shows upleg data.
- Section 6.2: Isn't it possible to correct the O₂-estimates for contamination by O? You have in fact measured both! Please comment and explain.
- Figure 4: please label the other instruments as well and provide references. For the white sketch on top of the photo: please indicate which of the sensors are FIPEX and which are PHLUX-instruments.
- Figure 6: Please provide proper explanations what is shown here. I believe that the x-axis shows atomic oxygen partial pressure in mbar, correct? Please indicate this in the figure caption. Then: why do all calibration curves have different slopes? Is this on purpose? Why? I suspect that the labels denote different sensors. Please clarify this

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in the figure caption. Most important: add error bars! Also: how were the calibration curves applied to the data? Were they fitted by a polynomial? What did you do?

- Figure 9: Mention angle of attack.

- Figures 11 and 12: Add error bars!

- Figure 14: This plot is far too busy. I suggest to break it down in front and aft sensors, show them separately and first discuss the various sensors among each other before differences between up- and downleg are discussed.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 3245, 2015.