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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 #1

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This paper describes the deployment of two different kinds of solid state sensor to measure atomic oxygen from a rocket payload traversing the mesosphere and lower thermosphere. The paper explains well why this measurement is so crucial for understanding both the physics and chemistry of this region of the atmosphere. The construction and calibration of the solid electrolyte sensor (FIPEX) is described in detail in the paper. The results from the upleg and downleg measurements on a single rocket flight are then presented, and compared with a previous measurement by VUV resonance absorption and the MSIS semi-empirical model.

The FIPEX instrument is calibrated using a laboratory atomic O source. This seems to

have been carried out carefully and thoroughly. Further corrections are made for the flow dynamics by using a fluid dynamics code to simulate the effects of the shock front around the payload. The overall impression is that this is an exciting advance in atomic O measurements, offering unprecedented vertical height resolution. The sensors are also presumably reasonably inexpensive, and thus expendable (although each sensor has to be calibrated in the lab). The paper should probably be published, although there are a number of points below which need to be addressed first.

1. The calibration involves a microwave discharge of pure O2, which is then expanded into a vacuum chamber through a pinhole. Have the authors considered two possible problems: a), there will be a large concentration of long-lived O2(1_Delta) produced in the discharge (probably a factor of 5 times higher than O), which will certainly survive expansion into the vacuum chamber; b) O3 will also be produced from the recombination of O and O2, before expansion. Both O2(1_delta) and O3 will very likely affect the signal produced on the platinum and gold-plated electrodes. The effects of these species need to be discussed.

2. On page 19 (line 18), it is stated that the FIPEX O atom densities are perhaps an order of magnitude lower than the MSIS and resonance absorption measurements. That conclusion is supported by other rocket-borne measurements at high latitudes (e.g. Plane et al., JASTP, vol. 118, 151-160; Murray and Plane, ACP, vol. 5, 1027-1038) which show that atomic O tends to peak at over 2e11 cm-3 between 90 and 95 km. The authors speculate that there may be a non-linearity at higher atomic O concentrations than those that were used in the calibrations, which demonstrate clear linearity (Figure 6). However, this is difficult to understand. The highest atomic O concentration in Figure 6 is 2.6e10 cm-3, and there is no evidence of curvature. The curves would have to flatten almost immediately in order to be out by 1 order of magnitude.

3. It is puzzling that the atomic O signal is not smaller at 80 km (Figure 14). This is a night-time flight, so there should be very small concentrations below 82 km. However, this data does not show evidence for the atomic O "shelf", which is seen in the NLTE

data and the rocket flights referenced in point 2 above. Since nose cone separation occurred below 60 km, which is data not shown from 70 km upwards?

4. What causes the large "bite-out" in atomic O around 90 km in the profile measured with one of the forward-facing sensors (black line)? Perhaps it could be due to a short-period gravity wave with a vertical wavelength of about 7 km, but it is not seen in the other sensor (green line), which does not track very well at all. In contrast, the aft sensors track each other very well.

5. Why is the PHLUX profile shifted upwards by 16 km! This is a huge correction, and is not even commented on!

Minor points:

The introduction should include a brief discussion of the other techniques that have been used to measure atomic O (resonance absorption, airglow profiles, etc.).

page 14, line 11: "where", not "were"

page 17, line 8:"As laid out before, the ..."

Figure 6. Explain what the legend refers to (presumably different sensor heads).

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