Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-341-RC1, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "Atomic oxygen number densities in the MLT region measured by solid electrolyte sensors on WADIS-2" *by* Martin Eberhart et al.

Anonymous Referee #1

Received and published: 12 January 2019

This paper describes further development and testing of a solid-state sensor for oxygen atoms in the mesosphere and lower thermosphere (MLT) region. The paper describes clearly in the introduction the pivotal role of atomic O in the chemistry, dynamics and thermal structure of the MLT. Measurements are currently made by remote sensing of airglow emissions - which are indirect and do not provide very fine vertical or horizontal resolution - or by optical instruments on rocket payloads, which are relatively expensive. The promise of a new type of relatively inexpensive and disposable payload sensor is thus an exciting development.

There are two important objectives described in the present paper: 1) the implemen-

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tation of a molecular beam apparatus with a measured flux of atomic O, in order to provide absolute calibration of each sensor; 2) a rocket experiment where sensors were flown on the fore and aft decks of the payload, along with an optical instrument to measure O independently. The calibration experiment seems to have been carried out with great care, and was successful. The challenge was to determine the nature of the expansion of the O flow through a pinhole into the vacuum chamber. My only comment here is that the potential role of O2(a) is not discussed. This metastable state of O2 is formed in high concentration in a discharge (sometimes up to 20% compared with only a few % of atomic O). Since O2(a) is very long-lived, and has an excitation energy of around 1eV, could this state generate a spurious signal on the sensor?

The rocket experiment seems to have been only partially successful, for reasons that are not clear. The downleg results are more consistent with a semi-empirical model and the optical photometric instrument, and there is somewhat better agreement between sensors (6 altogether, 3 on each deck). So there is no question that the sensors can measure atomic O in the MLT, but the paper ends without a clear idea as to why these individually-calibrated sensors give sometimes very different results. Thus, the reader is left wondering whether the sensors are a reliable method for future studies. I think this point needs to be discussed in some detail. With regard to the first sentence of the Conclusions - "The improved calibration procedure and the optimized sensor orientation in conjunction with a detailed aerodynamic analysis result in quantitative profiles of atomic oxygen number densities in the MLT region with a very high vertical resolution" - I don't really agree with the first part of, though I do agree with the statement about high vertical resolution.

Other points to address:

page 17, figure 11: the photometer reading below 80 km is non-zero, which is unlikely given that this is a night-time flight. Same in figure 12. Some comment is required.

page 18, line 5 - 8: the Fore-1 sensor is very low on the downleg, but is very high on

the upleg. So your explanation of an uneven gold plating seems unlikely

Minor points:

page 1, line 10: small-scale

page 2, line 4: replace "heavily" with "strongly"

page 2, line 7: "as a carrier ..."

page 2, line 16: "the IAP" and "the IRS"

page 2, line 19: "the IAP"

page 2, line 22: "...2009), while ..."

page 3, line 6: "in the form"

page 3, line 13: "had been designed"

page 6, line 4: "an advance on the "

page 11, line 2: state the time of the flight, which is 01:44 UT

page 19, line 11: "Figure 11 end more quickly"

page 19, line 26: "complete recovery of"

page 21, line 13 (and elsewhere): replace "golden" with "gold" or "gold-plated"

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-341, 2018.

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