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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of Water Vapor using Ground-based Observations from a Prototype ATOMMS Active cm- and mm-Wavelength Occultation Instrument" *by* Dale M. Ward et al.

Anonymous Referee #1

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Comments on:

"Retrieval of water vapor using ground-based observations from a prototype ATOMMS cm- and mm- wavelength occultation instrument ", by D.M.Ward et al., version dated 26 July 2017, submitted to Atmos. Meas. Tech. Discussions.

General comments

1. This paper extends studies in preparation for a new satellite radio occultation technique to profile atmospheric humidity. In order to explore some aspects of the deploy-

ment of this technique between two LEO satellites, the paper describes implementation of the same technique with transmitter and receiver on two mountain tops.

2. It is a well-conceived experiment and the ideas and results are interesting. The paper is generally well written. The results are presented concisely but adequately. The discussions of the results and of the future potential of this technology are careful and persuasive.

3. There is some problem with Figure 2 – the annotation referred to in the text is missing.

4. I recommend publication subject to minor revision to address the points below.

Specific comments

5. p.1, l.24: "precision" and "absolute accuracy". The words "precision" and "precise" are used here and in other places, and it is not clear whether the usage is technical or just general. Also, nowadays, "uncertainty" is usually preferred for "accuracy". So in this case, does "precision" mean "random uncertainty" and does "absolute accuracy" mean "systematic uncertainty"? If so, I suggest to re-write this sentence to clarify this, and to review all other occurrences of "precise" "precision" and "accuracy" throughout.

6. p.1, l.25: "constraining processes". This is too brief to be clear. It is well explained on p.2, l.1.

7. p.1, l.28: "precise". See comment 5 above.

8. p.2, l.32: "precision". See comment 5 above.

9. p.4, l.1: "precise". See comment 5 above.

10. p.4, l.3-4: "... attenuation ... distributed along the path ... In contrast, ...". Although this problem is more acute for passive radiometry, it is also present for RO – the attenuation is also distributed along the path and it is not possible to say where exactly along the path it takes place, even in the full RO retrieval context. So "In contrast"

is too strong.

11. p.4, l.8: “in terms of amplitude rather than intensity”. Does this explain the factor of $\frac{1}{2}$ in eq.(1)? It may be worth pointing this out. Otherwise it looks like a rather unconventional definition of optical depth.

12. p.6, l.12-26. It would be helpful to say something here about another geometric difference: in this experiment, all the attenuation takes places at $\sim$2600 m in height whereas, even in a single LEO-LEO measurement, it takes place over a range of altitudes characteristic of limb-viewing geometry.

13. p.7, l.2-3: “as indicated by the annotations in Fig.2”. The intended annotations in Fig.2 appear to be missing. See comment 3 above. Similarly, “the First Reference period” (p.2, l.8) is not clear and presumably is intended to be an annotation on Fig.2.

14. p.7, l.21 and l.23: 4:30 –> 16:30?

15. p.7, l.29: “as the calibration tone”. Do you mean fCAL, which you call the “calibration signal” on p.4, l.20? It would be helpful to standardise references to fCAL, calibration signal, calibration frequency and calibration tone throughout.

16. p.8, l.1-5. The description of the processing is very compressed and it is not possible for the reader, from this alone, to understand how the processing is done. Can you give a reference to a more complete description?

17. p.8, l.15: “are identified in Fig.2”. See comment 13 above.

18. p.8, l.22 and elsewhere: “the am Atmospheric Model”. This is not clear; is the name of this forward model the “Atmospheric Model”, abbreviated as “am”. Later it is referred to as “AM” sometimes with a version number. Please make all these references consistent.

19. p.9, l.10-11: “12 different solutions”. At this point the 12 solutions have not been mentioned or explained. Please refer forwards to section 5 for this description.

19. p.10, l.4-20. This is a very ingenious solution to the problem – nice piece of work! The only question remaining at this point in the reader’s mind concerns the inherent uncertainties in this method. You discuss this later in section 5, and so I suggest here you refer forward to this discussion.

20. p.12, l.6 and l.26: “AM7.2” and “am”. See comment 18 above.

21. p.18, l.7-13. In addition to these points, it is worth mentioning that GPS RO loses sensitivity to humidity, typically from the mid-troposphere upwards (at a height dependent on absolute humidity and hence temperature) because of the relatively low absorption coefficient of water vapour at GPS frequencies.

22. p.18, l.1 and l.23: “achieves” –> “would achieve”? “offers” –>“would offer”?

23. p.19, l.4-6. It would be more conventional to write this sentence as a simple statement with reference “(Holger Vömel, personal communication)”.

24. p.19-20. In addition to the arguments presented in this Appendix, I think there is an additional one. If the typical scales that need to be measured are $\sim$13m, then any in situ observing system would need to be so close to the axis of the ground-based remote sensing system that it would interfere with the measurement. Otherwise it is not measuring the same path.

25. Fig.2. See comments 3 and 13 above.

Editorial points

26. p.1, l.2. Title: “mm- wavelength” –> “mm-wavelength”?

27. p.3, l.16. “Uncertainty” –> lower case?

28. p.11, l.20. “,” after “seconds”?

29. p.16, l.30: “sought after” –> “sought-after”?

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