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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Development and testing of the Active Temperature, Ozone and Moisture Microwave Spectrometer (ATOMMS) cm and mm wavelength occultation instrument" *by* E. R. Kursinski et al.

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Review of the paper:

Development and testing of the Active Temperature, Ozone and Moisture Microwave Spectrometer (ATOMMS) cm and mm wavelength occultation instrument

The content is very interesting since the authors present true measured data of ATOMMS instrument gathered during fixed ground to ground test, but some issued



related to the uncertainty and the reliability of the measurements and the estimation procedure of some atmospheric parameters should be better addressed.

I recommend the publication after revision related to the following general and specific comments

General comments

1) The 22 GHz measurements along the 5,5 km path are obviously worse than those at 183 GHz along 800m. Many instrumental questions, as well as they are stated correctly by the authors in sec. 3.3, leave some open doubts in the measurement interpretations together to some big atmospheric questions like scintillation and turbulence effects (see. "Impact of tropospheric scintillation in the Ku/K bands on the communications between two LEO satellites in a radio occultation" by E. Martini et al., on Geoscience and Remote Sensing, IEEE Transactions on , Volume: 44 Issue: 8) that authors should be accounting for in measurement interpretation.

2) There are many calibration and instrumental open issues that are clearly stated by the authors along the papers besides problems of comparison among complete different measurement instruments and methods, especially for the 22 GHz experiment cases. Therefore some statements about better or worst reliability of the propagation models seem to be too much risky. I suggest to give some more details on the reliability of the amplitude ATOMMS measurements.

3) Can you give some more technical parameters of the transmitter and the receiver (i.e. some antenna parameters, beamwidth, transmitting and receiving gain, transmitter power, kind of frequency generator and amplifier)?

4) How much is the sensitivity and the resolution of the receiver for both 183 and 22 GHz bands? How much is the amplitude measurement accuracy?

5 )183-187;200 GHz experiment. You have one amplitude measurement sample for each second (so about 1Hz of noise band), 27 amplitude measurements for a complete

amplitude spectrum in 27 sec and a repetition time of 224 sec.

You compute a single absorption line fit each 224 sec and, correctly, Fig. 7 shows about 18 markers per hour. Do you account for the amplitude measurement accuracy in the fitting procedure?

6) for the 180-200 GHz experiment you use the partial pressure e for the water vapour while for the 22 GHz you use the specific humidity q. I suggest to uniform the measurement units.

7) the ïĄť197cloud estimation in sec. 4.3 is completely unreliable due to the huge uncertainty and approximation of ïĄť197rain computation besides the uncertainty in ïĄť197measurements. Too much errors source are present in the proposed procedure for the estimation of ïĄť197cloud: the dimension and the position of the volume radar cells with respect the propagation path, ground clutter, the very know conversion error of the Marshall palmer among R Z and K (why 300 and 1.4 ??). Therefore the section 4.3 without at least a rough error quantification is not acceptable.

8) for the same reasons reported in the previous comment also quantitative results of LWC is sec 4.5 are unreliable.

9) Authors use amplitude ratio as base measurement parameter. I suggest to try to consider also the normalized amplitude ratio parameter (i.e. the sensitivity approach as analyzed in "Normalized Differential Spectral Attenuation (NDSA) measurements between two LEO satellites: performance analysis in the Ku/K bands" by F.Cuccoli et al. on Geoscience and Remote Sensing, IEEE Transactions on , Volume: 46 Issue: 8). This should offer a more "cleaned" and low-sensible parameter to be used in estimating the water vapour content along propagation paths.

Specific comments

1) Pag. 4671, line 6, eq. (3)

What do you really mean with e, T and P in F(e,T,P)? the optical depth should be



function of the whole temperature and pressure profiles along the propagation path. Therefore e, T and P should be like e(r), T(r) and P(r) with r the position along the path. Please clarify this aspect.

2) Pag. 4671, line 25

In order to well understand the multipath effects, are they due to ground reflection? Or atmospheric multipath?

3) Pag. 4672, line 1-2 "By holding the geometry fixed, the multipath effect remains constant and common to all measurements. . .". Are you sure about this? The 2 frequencies are separated (in sec. 2.2 you have about 200 GHz as ref and 183-187 GHz the others) so the propagation multipath can be different in space and change in time. This comment is connected to the previous one.

4) Pag 4673, line 20, eq(9)

Do you use A symbol both for the signal amplitude at a single frequency as in eq (1) and for the amplitude ratio? I understand A(f,e,P,T) the signal amplitude received but A(f1;f2;e,P,T) is A(f1,e,P,T)/ A(f2,e,P,T)?? and A(f:emax-enorm, P,T) is amplitude ratio / amplitude ratio ?? It is confusing. I suggest to use different symbols for the amplitude ratio (ïĄĎA ??) and the quantity of eq.(9)

5) Pag. 4675, line 10-14 "For various. . ... . . ... 182-205 Ghz." Are you sure about the position of this sentence? Wireless and cell phone make really disturb in 183-200 GHz Range??

6) Pag. 4675, line 14-18 "We also note. . .. ..intervals". I suggest to move this part at the beginning of section 2.2 at line 11 of pag 4673.

8) pag 4675, line 25 For me it's not clear how the red curve of Fig. 5 is computed. However the RMS error in true amplitude ratio measurements should be a combination among instrumental errors (i.e. noise at the receiver) and those due to parameter sensitivity in estimation methods like those of Fig 5. If you can try to better explain

these questions.

9) pag 4678, line 14

You assume T and P constant along the 5.4 km path. Is this approximation too much strong? Fig. 12 shows 10° temperature variation. Is this compatible with your assumption?

10) pag. 4679 line 7 I don't understand the reasons to assess that AM is better than MPM. You say that this happens because looking FIG. 10 the differences in water vapour estimations between AM 23.5 and AM 22.6 are lower than those MPM. But looking table 1 the greater differences are between AM coefficients (0.0346 and 0.0285) instead of MPM (0.0312 0.0287). Moreover reading the following lines (11-19 lines, pag 4679, about calibrations issues the question about which model is better remains unclear. Please clarify this aspect.

11) pag 4681, line 7. The azimuth resolution in meter is non correct. Or you give the azimuth radar angular resolution (i.e. the antenna beam width) or you give the radar range distance where you have 500 m of tangent distance.

12) pag. 4681, line 15-22 and fig 14. If I understood well, the radar data you show is the reflectivity of the radar cells that intersect the vertical plane that contains the 5.4 km path at 0.88 (left) and 1.28 (right) elevation degrees. Why 65 data point? How do they correlated to the 500 m azimuth resolution (see previous comment)? Which is the radar distance?

13) pag 4686, line 1 I'm not agree that "....provides a strong validation...." . Without any discussion about the measurement uncertainty and the conversion errors, I suggest to use something like " there is a qualitative similarity among the different estimation procedures". (see general comment #7)

14) Fig. 7. can you add the some error bars corresponding to the black markers? This request is referred to the general comment #2 and #3.



15 ) Fig. 15 – Which Z map do you use? Which Z-R relationship?

Technical corrections

1) pag 4676, line 2, 3, 11 16

Convert ft in m

2) Fig. 10. caption: shows instead of show

3) pag 4681, line 18-22 The sentence "While... surface" is not syntactically correct.

4) Fig. 14 and 15. Add axis meaning and units

5) pag 4685, Please define Q197 and Qvis in the text.

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