

## ***Interactive comment on* “Prediction of rainfall measurement errors using commercial microwave communication links” by A. Zinevich et al.**

### **Anonymous Referee #1**

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### **1 Recommendation**

This manuscript presents an approach to quantify the uncertainty associated with rain rate estimation from commercial microwave links. This is an important question, relevant for the readers of Atmospheric Measurement Techniques. There are however serious issues (see comments below) that must be addressed before publication in AMT. I recommend to send the manuscript back to the authors for major revision.

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## 2 General comment

1. Many assumptions used to conduct the proposed calculations are not justified enough. It is difficult to judge if they are relevant or not, and this is a serious issue for a scientific article. Here is a list of assumptions which validity should be more rigorously demonstrated:
  - (a) Page 7, eq.13: it is supposed that the interpolation technique employed allows a correct description of the attenuation baseline, so that the noise  $\eta$  is 0 on average.
  - (b) Page 8, eq.15: which terms are neglected and can they be neglected?
  - (c) Page 8, eq.17: idem...
  - (d) Page 12, eq.26: the authors should demonstrate that the assumption of the rain gauge being representative of the (link) path-integrated rain rate is valid?
  - (e) Page 15, l.2: is the assumption of isotropic spatial structure of rainfall field valid?
  - (f) Page 18, l.1-2: on what is based the assumption of constant expected value of rainfall intensity?
2. The proposed analytical expression of the uncertainty affecting microwave link rain rate estimates is evaluated by comparison with point measurements from (nearby) rain gauges and “spatialized” using a climatological variogram. There are sources of errors in the process, so the quantification made is not very reliable and accurate.
3. Only 3 rain events are considered, this is really a very limited sample to draw robust interpretations...

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4. Page 20, l.1-2: there is a confusion between rainfall intensity variability and DSD variability: they are not independent, as the rain rate is a weighted moment of the DSD. If the rain rate is variable, then the DSD is variable. The total concentration and the shape of the DSD can change (while the rain rate may remain constant). This list of sources of error should be rephrase. And also in the abstract.

These issues make difficult to draw strong and robust conclusions from the results presented in this manuscript.

### 3 Specific comments

1. Title: which characteristic of rain fall is investigated? I suppose it is the rain rate or rainfall intensity... This should be clarified in the title.
2. Page 4, l.7:  $A_0$  results from the scattering of the link signal by atmospheric gases, and mostly by water vapor. So the term “dry air” is a bit confusing.
3. Page 5, l.1: the Rayleigh approximation is not valid for the considered range of frequencies. The Mie regime is more appropriate.
4. Page 6, l.7: other factors can influence the attenuation of a link signal: temperature effect on transmission/reception electronics, wind effects on antennas and masts,...
5. Page 6, eq.11:  $\epsilon$  is no defined.
6. Page 6, l.21-22: what does “before and after a rainstorm” exactly mean?
7. Page 6, l.23: Rahimi et al. (2003), Upton et al. (2005) use dual frequency links if I am correct. Commercial links cannot be considered as dual-frequency links (because the frequencies used for the different channels are too close).

8. Page 7, l. 1-2: why a cubic spline can accurately capture the behavior of the attenuation baseline?
9. Page 7, l.15: for (relatively) high frequency (about 38 or 58 GHz) commercial links, are the effects of non-linearity still negligible?
10. Page 8, l. 5-7: this paragraph is not clear to me. Why does the term  $n_q$  appear in the attenuation baseline term? Especially if the attenuation baseline is estimated by interpolation...
11. Page 8, l.13-14:  $n_q$  and  $n_0$  are supposed to be 0 on average, so individual realizations can still be significant.
12. Page 10, section 3: which values have been obtained and how? Are they consistent with literature values?
13. Page 16, l.11-12: 4 points in space is very limited to estimate the experimental variogram at 3 interdistances. How the values at different time steps have been combined?
14. Page 17, eq.41: please provide a detailed description of the derivation.  $e$  is not defined.
15. Page 19, eq.46:  $\hat{\sigma}_{tj}$  is given by eq.44?

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