Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-404-RC2, 2018

Atmospheric Measurement Techniques Discussions

Interactive comment on "An urban microwave link rainfall measurement campaign" *by* Thomas C. van Leth et al.

Anonymous Referee #2

Received and published: 10 January 2018

The authors have put together an experimental campaign in order to explore in depth some aspects of rainfall measurement from microwave links attenuation and understand better the uncertainties, focusing an a relatively short links (2 km) and medium high frequencies (26/38 GHz). The experimental set up is impressive and thorough, with 2 microwaves links –one operating at 38 Ghz and the other one dual frequency 38/26 GHz and dual polarization- sharing the same (2 km long) path ; 5 disdrometers in order to analyze rainfall intensity and microphysical variability along the path and at both ends, and an additional rain gauge ; a near IR scintillometer, cameras and a met station complement the set up and provide additional information on visibility and other atmospheric variables that might influence or help understanding the MWlinks signal fluctuations.

This is an ideal setting to analyze and quantify – at least for the 2 frequencies and the path length that are available here – some of the uncertainties in MWlinks based Quantitative Precipitation Estimation : -variability and time/space scale issues in the k-R relationship -wet antenna attenuation -baseline derivation uncertainty and non-rain induced fluctuations of the signal

-Additionally the MWlink power level is sampled at 20 Hz and with a small quantization error - which could be used to investigate errors due to coarse quantization and to the subsampling of the signal typically provided by Commercial MWLinks network monitoring systems (only providing max and min power every 15 minutes is common).

-Also the dual-frequency and dual-pol capability, together with the 5 disdrometers will allow to go further than the simple k-R based retrieval.

First of all I would like to congratulate the authors for the experiment they have put together and acknowledge the amount of work and time which will be necessary to fully exploit such a data set !

The main objective of the present paper is to present the experimental setting itself and some preliminary results which illustrate -in a rather qualitative manner- some of the issues that could be further explored with the data set : the discrepancy between the rainfall retrieved by the links and the path average rainfall retrieved by the 5 disdrometers, illustrated with 3 rainfall events ; some illustration of measurement during mixed precipitation ; effects of temperature on the signal fluctuations; wet antenna attenuation and its sensitivity to the type of radom material ; effect of dew and fog ; effect of clutter. Altogether an interesting catalog that illustrates the complexity of mwlink based retrieval of precipitation is provided in section 5. However, the reader stands a bit frustrated by a somehow QUALITATIVE OVERVIEW OF VARIOUS CAUSES OF MW SIGNAL FLUCTUATIONS, WITH A LACK OF STATISTICAL AND QUANTITATIVE ASSESSMENT OF THEIR IMPACT ON I) DETECTING/QUANTIFYING ATTENUATION DUE TO RAIN AND II) RETRIEVING RAIN RATE.

I would suggest that Sub-section 5.2, which has the most quantitative results and focus on the main objective of the MWlinks exploitation, i.e. rain retrieval, become a full section and be improved with some more quantitative results.

The other sub-sections in 5 should be lightened (5.3 and Fig9 which is essentially qualitative can be suppressed) and more focused on explaining some of the discrepancies observed in 5.2.

The text itself needs revising ; some expressions or comments are more subjective than scientific – and the authors sometimes overgeneralize their statements e.g. P4 L1 'the power law in the literature are ALL derived at point scale ' P 13 L12 'it is important to take into account that there will always be unexplained anomalies' P2 l 39 :' a relatively straightforward algorithm' P3 L31 'the relations . . .... closely resemble power law' etc. . . see more below.

DETAILed SUGGESTIONS : Title/Introduction :

- The stress on urban in the title is misleading – the paper does not focus on an urban problem or urban hydromet scales specially. A tile like 'A multi-instrument microwave link measurement campaign' would be better. - The introduction also stresses a lot on urban scales which is not that relevant since a single link and not a dense network are studied here. - P1 L33-L35 confusion between the space/time resolution of a single gauge and the problem of gauge network density versus scale of phenomenon. - P2 l8 : modern radar also used propagation variables such as Kdp and not just Z. . .. - P2 L25 : 'therefore further research . . .... microphysical aspects' – Sentence not clear + microphysics is not really the focus of this paper. . .. - P2 L 27 : relevance of urban ? ' in order to help fine tune the existing retrieval algorithm' - The sentence is clumsy and there is nothing about tuning the algorithm in the presented work anyway. . .... L 29 : simulating links from radar data is not at all relevant to what is proposed here and to the local scale (one single 2 km path) studied.

Section 2 – P3 L 29 ' the relations . . .. Resemble power laws' – Paragraph to be revised

– false or approximative statements.

k-R relationship discussion : the discussion on k-R is spread in different parts of the manuscript with no consistency . The paragraph starting on P3 L35 is rather confused. There seem to be a confusion between DSD/rain type variability between rainfall events and k-R variability as a function of the scale considered (point versus path. . .). The concept of 'control volum' is unexplained and unclear. P3 Eq(6) insists on the problem of linearity of the relationship and the problem of point versus path average k-R relationship - but the fact that in this work the path average k-R relationship is effectively derived thanks to 5 disdrometers in not mentioned. . . . Subsection 4.1.2-4.1.3 should be merged and with a more explicit title like 'deriving path averaged k-R relationship'. Also note that k=aRˆb is used in (5 and 6) while a and b in Table 2 are for R=a kˆb most confusing

Section 3 : P4 L25 – please give the same precision for the frequency of the Nokia and RAL links. L24 : 'representative of THE link systems that would be used . . .. ' to be rephrased carefully – not all CMLs are Nokia and you dont use the NOKIA sampling/digitalization. . .. P4 L 31 : 'roughly' – unprecise L32-33 give the exact frequencies.

Section 4 4.1.2/4.1.3 – merge and improve. It seems that you are deriving a path-averaged k-R relationship based on weight values of both k and R derived from the 5 disdrometers with 30s long DSD spectra. Is this the case ? not very clear from the text. This very important point should stressed : most studies do not have access to the path average k-R and have to infer it from ponctual k-R and assumptions on rainfall variability . The differences between the single disdrometer and path averaged k-R should be discussed. P6L29-32 – earlier you mention that the disdrometer are evenly spread – so is this weighing really important ?

THE k-R (and not R-K otherwise do not use a and b as in (5 and 6)) relationships should be given here and the differences between previous studies and IUT discussed

here and not introduced in conclusion. Also here is a good place to discuss point versus path k-R. . .. and your results on this with the 5 disdrometers.

P7 L 19 : the 24h centered window method is not applicable in RT (where you have access only to passed data - - and RT is mentioned in the introduction in the objectives of the work outcomes. . ...

Section 5 :

P7 L 34 what is a 'relatively unambiguous event' ???

P7 L 35 : 'performance . . . for detecting' : this is not done – there is no FAR/Miss study here – only analysis of the rainfall rate itself.

Section 5.2 : As mentioned, this could be enhanced and become the main result section. As suggested by reviewer 1 the analysis in terms of attenuation should be done first and then the retrieved Rain rates can be compared.

One of the major surprise is the discrepancy between the two 38GHz/Hpol links rain retrieval, which is not fully explained by the paper and should be further explored in dB first. -what is the correlation and consistency between the time series of attenuation for the 2 links ? - the variability of the 2 signal in dry/wet periods should be further quantified (variance for instance).

P8 – the analysis should be more objective and vocabulary such as 'visual inspection suggests' L35 ;' the magnitudes are similar' L15 ; 'loss seems almost entirely related to' L28 should be replaced by quantitative indicators.

P9 L1 : 'more spatially heterogeneous and probably convective' – please check and give some indicator of spatial heterogeneity – how is this affecting the path averaged versus punctual k-R on that day ?

P9 L17 to 25 :

The discrepancies between links and between the link and disdro need to be further

understood. What part can be explained by k-R variability ?; what comes from baseline error ? Comparison in DB first (with attenuations dervived from DSD spectra and your Tmatrix code) would help understanding.

Is a possible underestimation of rain rates by the DSD totally eliminated out ? What are the quantitative results of the gauge/DSD comparison for the 3 instruments that are gathered ?

The Conclusion will have to be adjusted when section 5 has been revised.

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