

***Interactive comment on* “Commercial Microwave Links as a tool for operational rainfall monitoring in Northern Italy” by Giacomo Roversi et al.**

Anonymous Referee #2

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Review of the paper "Commercial Microwave Links as a tool for operational rainfall monitoring in Northern Italy"

The manuscript aims to evaluate the potential of rainfall retrieval from CML network at regional scale in northern Italy to create rainfall maps for operational purposes. The paper describes the unique data set from the region of interest. It should be noted here that the collection of CML data set in large telecommunication network is still a challenge. However, from global perspective other studies already described similar experiments with identical (or wider) scales employing CML data using more advanced methods. Main weakness of the manuscript is therefore related to CML data processing and data analysis which is based on open-source package RAINLINK applied on CML data in northern Italy. I am missing the definition and answering the important re-

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search questions which can provide new insights in CML rainfall retrieval. The overall scientific significance of the manuscript is fair.

Therefore, the manuscript needs major revisions. I see several aspects that can be studied using such data set. The quality of CML product is questionable and it show systematic underestimation. Then one way could be to test/develop other processing methods of CML data to reduce this bias and improve the quality of the product. Other interesting point could be an orographic aspect which is mentioned in the manuscript, but not studied in detail.

General comments:

1. The results show systematic underestimation of QPE derived from CMLs. RAINLINK package contains several strong assumptions (constant WAA of 2.3 dB, constant k-R parameters etc.) which can influence the results significantly. Recent knowledge shows that WAA is complex process with many unknowns (e.g. Leth et al., 2018). The dataset probably contains a certain portion of sensors with low sensitivity (this is reviewer assumption since the CML statistic is not provided) to rainfall where WAA can play dominant role in resulting rainfall retrieval. I would recommend to make at least sensitivity analysis of the results to most significant parameters.

2. Spatial interpolation is based on assumption the path-integrated rainfall is represented as a point measurement. This assumption can be used for rough grid 5x5 km and shorter CMLs. However, it is weak for single link comparison (section 4.1) including single event comparison. Here, spatial-temporal structure of rain together with the layout of given RG and CMLs can play significant role. Then it is impossible to compare single point measurements and CMLs observations.

3. Since rainfall maps are the key product of the presented study, I would expect to show visually CML rainfall maps – event-based or cumulative rainfall compared to reference.

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4. I am missing relevant discussion section in the paper

5. I am not satisfied with the conclusions which do not provide novel information beyond the state of the art in the field of CML rainfall retrieval.

Specific comments:

L. 33-45. I don't agree with this paragraph since the first sentence refer to CMLs. The provide references are partly based on experimental microwave link setup, not CMLs. I wonder we know accurate algorithms for DSD, water content etc. based on CML observation.

L. 70. observation period – since later in the manuscript some analysis are event based I would add into the Supplementary material information and data about precipitation events during observation period. For selected rainfalls and locations used later in section 4.1 some detailed rainfall metrics would be welcome.

L. 90-94 The usage of CMLs with low operating frequencies 6 – 15 GHz is questionable for QPE because of low sensitivity of those devices to rainfall even with longer path lengths. It would be useful to provide statistic evidence of different frequency bands in the data set including calculated theoretical sensitivity to rainfall. Then the effect of constant WAA to the results would be much clearer.

L. 104 Spatial distribution of LC – could you explain why the LC is lower in the main regional cities (Parma and Bologna) than in countryside – Figure 1?

Section 2.1.2 Transmitting power levels I found this paragraph a little bit confusing. I would ask to rephrase it to provide clear information about ATCP processing

L. 193 Interpolation – please explain how path-averaged rainfall depth from each CML is implemented into spatial interpolation. This not very clear from provided description

Section 4.1 Single link verification – see my general comment about point and path-averaged rainfall estimates. This is difficult to understand especially when we don't

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see detailed information about precipitation metrics during observation period. The data also does not correspond with previous statement in Section 2, that in higher altitudes are higher amount of rains.

L. 228 I suggest this statement as weak and confusing "They have been chosen in areas with different terrain and network density and far from the cities, as CMLs in urban areas are already well studied and also the most eligible to be replaced by optic fibres." I don't see why CMLs in cities should work in different way than in country side. Is there evidence that CML in cities are already well studied and in the countryside not? Network development is not relevant for this paper and this sentence is speculation.

Sections 4.1.1.-4.1.2. - Best and Worst Case Example – I do not understand why there is no text information and results interpretation with respect to rainfall intensity and rainfall characteristics. 4.1.2 represents light rain when the sensitivity to rainfall of CMLs is low. WAA is significant here anyway. Also, data provided from NMS system in form Pmin Pmax are limiting factor. This shows clear limits of CML for light rainfalls and Pmin Pmax approach.

Section 4.1.3 – I do not think that this melting layer story fits to this story. First, the data set is presented as spring – summer period. The article is focused on liquid precipitation, this is another story.

L. 320-330 I do not fully agree with those statements about LC. Different LC often means different frequency bands distribution. In the region with high LC one can expect higher frequency bands with higher rainfall sensitivity.

Figures general – I found inconsistency when using brackets for units – none, () or [] in different figures

Figure 7. I do not understand the "bad" results of adjusted radar in comparison to the reference which was used for radar adjustment. The results are comparable to unadjusted radar data. Could you explain that?

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