Contribution ID: **53** Type: **Poster**

Beyond Cellular Networks: Rainfall Estimation Using Low-Frequency and Short-Distance Commercial Microwave Links

Wednesday, June 25, 2025 3:15 PM (45 minutes)

Commercial Microwave Links (CMLs) have emerged as a promising tool for opportunistic sensing, particularly for rainfall estimation. However, most studies have focused on high-frequency cellular network links, leaving a gap in understanding the viability of CMLs operating at lower frequencies (10 GHz −15 GHz) and over shorter distances (≤2 km). In this study, we analyze data from a private CML distributor and investigate the challenges and limitations that arise in this context.

The data from low-frequency and short-distance links present unique obstacles during preprocessing. Our dataset is influenced by a variety of environmental and infrastructural factors that introduce inconsistencies. Standard methods of opportunistic sensing, which usually rely on established models of attenuation and signal fluctuations, often fail due to the increased susceptibility to non-meteorological signal variations. In our study, we critically examine the nature of the data and assess the suitability of wet/dry classification and rain estimation methods at the lower limits of sensitivity.

We present an overview of the key challenges encountered during preprocessing, including baseline estimation and uptime utilization. Furthermore, we evaluate the performance of existing opportunistic sensing methods on this dataset, demonstrating their limitations and the need for novel approaches tailored to these conditions. Our preliminary findings underscore the importance of refining preprocessing techniques and developing new analytical frameworks to enhance the reliability of rainfall estimation from such data.

This extended abstract outlines our ongoing work and emphasizes the significance of addressing the challenges posed by non-traditional CML datasets. By improving the robustness of data preprocessing and refining methodologies for rain estimation, we aim to expand the applicability of CML-based precipitation monitoring beyond conventional cellular infrastructure. Future work will explore machine learning-based approaches to enhance the accuracy of rain rate retrieval and wet/dry classification from low-frequency, short-distance CMLs.

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Session Classification: Coffee Poster Session Tuesday

Track Classification: Processing methods