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Exploring Rain Scintillation Spectra from Microwave Links for Raindrop Size Distribution Retrieval

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Rainfall has been monitored with microwave links opportunistically for nearly 20 years. So far, most studies have focused on retrieving rainfall rates using the mean received signal, based on the power-law relation between specific attenuation and rainfall rate. However, theories and measurements have indicated that the power spectral density (PSD) of received signal contains extra information about rainfall. The drop size distribution (DSD) and the motion of raindrops both play a role in determining the scintillation spectrum of rain. To evaluate the feasibility of making use of rain spectra for retrieving information about DSDs, measurements from different experimental datasets are investigated. Initial results indicate that some information about rainfall (e.g. rainfall rate) is indeed retained in the spectra measured by a radio link at 26 GHz and a scintillometer at 160 GHz. Furthermore, a simulation of the PSD of the received voltage during rain is made to gain understandings of its behavior. The simulation, based on Ishimaru's work (1978), allows for the customization of various settings (e.g., wavelength, geometry, antenna gain functions) of radio links, as well as the DSD at different locations along the links. It is shown that large raindrops generally have more influence on the PSD of received voltage than smaller raindrops. A theoretical method to retrieve DSD from the PSD of the received voltage is proposed and its performance is assessed by simulation. Results show that the concentration of the tiniest raindrops is hard to retrieve because of their minor impacts on PSD. In the simulation, the concentration of larger raindrops can be relatively reliably retrieved, even when a large variation of DSDs is present along the microwave link.

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