Modeling 5G Interference on a Weather Radiometer

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Organizations such as NOAA and NASA develop and operate satellite radiometers to obtain various meteorological data for weather and climate forecasting. For example, to estimate water vapor concentrations in the atmosphere, weak signals resulting from natural radiation and molecular resonances in the 23.6-24 GHz band require the radiometer to be extremely sensitive, potentially making it vulnerable to interference from other radio emissions. In particular, the recent ITU regulation and 3GPP standardization of 5G cellular systems in the adjacent 24 GHz band (24.25-27.5 GHz) has raised concerns that comparatively much stronger 5G signals may cause harmful interference to the radiometer measurements. Some reports suggest that such interference could set the quality of meteorological predictions back by 3-4 decades. On the other hand, limiting the power of the 5G signals too much to avoid interference could reduce the utility of the 24 GHz band for mobile telecommunications.

To better understand how 5G operation affects radiometers, we are developing a system model that integrates four ingredients: 1) antenna and radio front-end characterization of the Joint Polar Satellite System-Advanced Technology Microwave Sounder (JPSS ATMS), a multichannel satellite radiometer operated by NOAA, where the first channel of the JPSS ATMS measures at a center frequency of 23.8 GHz (Lambrigsten, NASA ATMS L1b ATBD, 2014; Weng et al., *IEEE GRSS Lett.*, vol. 10, no. 4, 2013; NOAA-21 ATMS Spectral Response Function (SRF) Dataset, Jul. 2023), 2) a block diagram model for the Dicke radiometer in the JPSS ATMS sounder based upon (Goldstein, *IEEE Proc. IRE*, vol. 43, no. 11, 1955), 3) interference from a single 1 W 5G user equipment (UE) modeled as bandlimited Gaussian noise with free-space path loss at 3GPP center frequencies and bandwidths in the 24 GHz (n258) band (3GPP TS 38.104 V17.10.0, Jun. 2023), and 4) ITU frequency-dependent rejection (FDR) (ITU-R Rec. SM.337-6, Oct. 2008) and interference protection criteria (IPC) (ITU-R Rec. RS.2017-0, Aug. 2012) for the radiometer.

Specifically, comparing the received 5G UE interference power and the ITU IPC for the radiometer (Fig. 1a), we see that the radio front-end needs to provide at least 12 dB of FDR. The calculated FDR for the radiometer for various UE center frequencies and bandwidths in the 3GPP 24 GHz band (Fig. 1b) suggest that this IPC can be met with significant margin. Basestation interference, as well as aggregate interference from both UEs and basestations, is the subject of ongoing work. We are also studying the spectrum at each stage of the Dicke radiometer model to identify opportunities for interference detection.

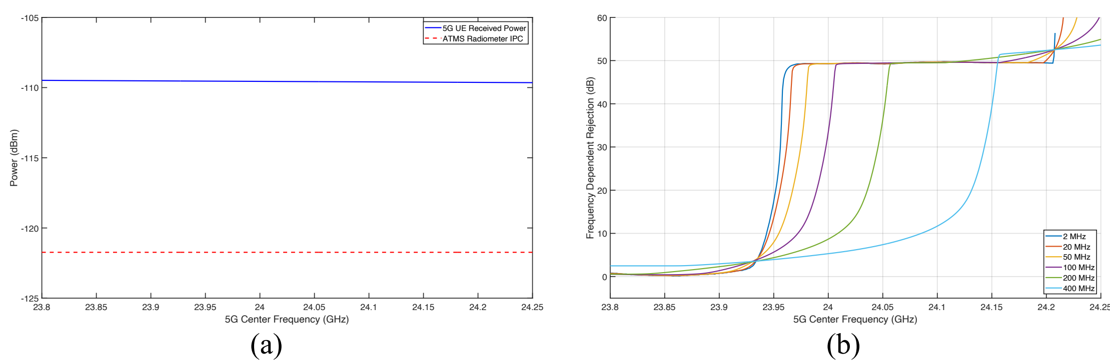

Figure 1. (a) Comparing interference power received from a terrestrial 1W 5G UE to the NOAA-21 JPSS ATMS radiometer IPC. (b) Calculated FDR of the NOAA-21 JPSS ATMS ATMS radiometer front-end for a 1W 5G UE operating at different 3GPP center frequencies and bandwidths.

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