Characterization of Autoemission Reflection at High Frequencies for Precise Radiometer Calibration

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The close coupling of antenna horns and pyramidal calibration loads on passive microwave radiometers is standard practice for operational spaceborne calibration. However, various radiometer front end architectures can allow radiation leakage (autoemission) out of the horn which can produce local oscillator standing waves along with upper and lower sideband signals reflected back into the radiometer. Calibration loads are designed to minimize such reflections but this effect still has a measureable effect with error amplitudes that are important for radiometric studies of long term trends in climate. Front end RF isolators and low noise amplifiers (LNAs) can be unavailable or expensive at frequencies above ~90 GHz, in which case there is little protection against autoemission. This study investigates the standing waves resulting from a pyramidal microwave calibration target due to autoemission from a 183 GHz radiometer. The radiometer measures 7 channels using a double side band (DSB) architecture with RF offsets from the LO ranging from 0.55 GHz to 16 GHz. A calibration target is stepped in distance while brightness temperatures are continuously sampled. By detrending gain variations, and coherently averaging the brightness, standing waveforms are obtained. A Fourier transform is subsequently used to analyze the data in the spatial frequency domain. Contributing sources of the autoemission are identified as due to local oscillator (LO) reflections and the reflected RF passband noise from one of the two sidebands of the DSB radiometer. The standard deviation of the standing wave is statistically calculated and compared for a number of measurement cases. Two pyramidal targets are investigated at 4 alignment positions, including over the tip, valley, and combinations of the two. Standing wave results from a 55 GHz radiometer with similar processing techniques were presented at NRSM in 2012 and are compared to results from this study. Results from reflections from a flat aluminum plate are studied. From Fourier analysis, the highest autoemission returns over the targets were typically found to be at the frequency corresponding to twice the lower sideband frequency.