High Spectral Resolution V-band Digital Correlating Spectrometer for Climate Monitoring - RF Front End Characterization and Brightness Temperature Spectra Estimation

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Long term direct thermal measurement of the earth's middle and lower tropospheric temperature on a global basis along with the determination of a diurnal temperature climatology is needed to 1) correct historic satellite mid-tropospheric temperature data, 2) estimate the impact of atmospheric greenhouse warming in response to anthropogenic CO2 emissions, 3) inter-calibrate the international fleet of weather satellites, and 4) monitor naturally occurring atmospheric temperature trends. Quantifying anticipated temperature trends on a timely basis requires the globally averaged mid-tropospheric temperature to be observed with a satellite temperature sounding instrument of very high stability and traceability. Stable on-orbit reference instruments are needed to also prevent instrumental drift or deterioration from obscuring trends occurring over several decades. With increased anticipated anthropogenic emission resulting from the imminent deployment of 5G communications electronics and related consumer and defense applications at V-band, radio frequency interference (RFI) detection and mitigation also becomes indispensable for accurate temperature retrievals. A high spectral resolution digital correlating spectrometer capable of observing the lower wing of the 5 mm oxygen absorption spectra from 50 to 58 GHz with extremely stable down conversion to precisely characterize spectral variations within a sounding channel and perform real-time RFI detection and mitigation is thus critically needed for climate monitoring.

The RF front-end laboratory characterization of such an instrument, the V-band Ultra-stable Climate Monitoring Microwave Radiometer (VU-CliMMR), being developed at the University of Colorado (CU) Center for Environmental Technology (CET), is presented. The calibration setup built specifically for two point calibration of the spectrometer and the brightness temperature spectra across 50-58 GHz measured by the calibrated spectrometer with the V-band horn pointed towards zenith on a clear day is also discussed.