A Direct Up-Conversion G-band Radar Prototype for Atmospheric Measurements

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***Abstract*— A 240 GHz radar is being built as a part of a multifrequency, compact, low-cost atmospheric radar prototype, called CloudCube. CloudCube instrument consists of three-frequency radar (Ka/W/G-band) modules and uses a radar architecture where the baseband signal is directly upconverted to the RF band without any addition of intermediate frequencies or further multiplication scheme. This architecture, combined with pulse compression techniques, provides a simple and effective solution while achieving the required performance and robustness of an airborne or space flight radar instrument. We present the CloudCube's G-band channel breadboard radar concept and the first-light outdoor observations over clear sky and rain.**

Keywords*— *Meteorological radar, millimeter wave radar, millimeter wave circuits

I. Introduction

Low-cost orbital radars, compatible with small satellite platforms, are crucial to enable new Earth observing systems capable of providing time evolution observations of atmospheric processes at high resolution to improve the weather and climate models. With RainCube [1] — a Ka-band precipitation radar in a 6U CubeSat — the Jet Propulsion Laboratory demonstrated that disruptive innovation in the areas of deployable antennas, pulse compression, and frequency-modulated waveform generation using offset I/Q up conversion make it possible to build very compact Ka-band radars for CubeSats. Building off the RainCube's technical success, we are developing a new atmospheric multifrequency radar, named CloudCube. CloudCube is intended to be the first, compact, low-cost, pulsed-compression radar that combines three frequency channels Ka-, W- and G-band (35/94/239 GHz) for vertical profiling of clouds, convection and precipitation structures and dynamics from space. Pulse-compression techniques allow the transmission of long-duration, low-power signals that achieve the same total pulse energy as traditional higher-power pulse radar systems. Pulse-compression radars can be built using solid-state technology enabling a compact and high energy efficient radar, providing high quality observations comparable to the current high-power pulsed millimeter-wave cloud and precipitation radars.

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II. Radar Breadboard and Results

CloudCube's G-band breadboard includes several in-house designed components such as the InP LNAs and the 240 GHz high-power handling frequency tripler, as well as the G-band fundamental mixer. For transmit power, a solid-state source based on GaAs Schottky diode frequency-triplers is used [2].

Figure 1 shows the radar's first-light measurements- a range spectra in the presence of rain and no-rain. The radar is operated on a FMCW (Frequency-Modulated Continuous-Wave). The results of Figure 1 demonstrate that CloudCube's first G-band breadboard can successfully capture volumetric scattering targets up to ranges of 2 km.

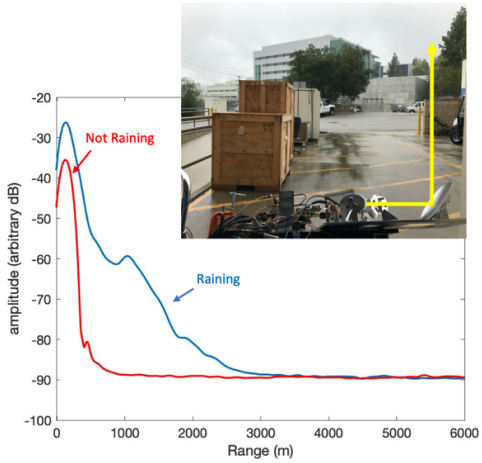

Fig. 3. Range-compressed spectra of the radar in the presence of rain (blue) and without rain (red). Top-right, CloudCube's G-band radar breadboard positioned 60° off zenith outdoors.

References

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