A 95 GHz Solid State Cloud Radar for Cloud Research from Unmanned Aircraft

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The Microwave Remote Sensing Laboratory (MIRSL) at the University of Massachusetts (UMass) has developed the first compact low power cloud radar designed to operate from high altitude unmanned aircraft. The Compact Millimeter-wave Radar (CMR) has recently flown as part of a suite of cloud and radiation sensors on the NASA Proteus Aircraft during engineering test flights in the Mojave Desert and in a U.S. Department of Energy sponsored cirrus experiment in Oklahoma. After a series of three planned flight series on the manned Proteus aircraft CMR and other sensors flown on the Proteus will be reinstalled on the U.S. Department of Energy Atmospheric Radiation Measurement Unmanned Aerospace Vehicle Program (ARM-UAV) Altus unmanned aircraft.

CMR is specifically designed as a compact low power radar for cloud studies from high altitude aircraft. CMR differs significantly from prior klystron tube transmitter based 95 GHz radar systems operated from the ground and from larger medium altitude aircraft. First, the klystron tube is replaced with a small array of solid state diode amplifiers whose outputs are combined to achieve a final peak output power of approximately 1 W. Use of the solid state transmitter eliminated the need for pressurizing the klystron's high voltage power supply and any other portion of the hardware. Next, frequency modulation (FM) chirp pulse compression is used to reclaim sensitivity lost by the use of such a low peak power transmitter. Here a direct digital synthesizer generates a low frequency version of the output waveform. Received waveform pulse compression is achieved in a stand-alone digital receiver/pulse-pair signal processor that is implemented in relatively low power reconfigurable logic.

Initial data from the 2002 flight series is presented, which verifies CMR's anticipated pulse compression gain, and proves that the radar operated reliably during 50+ hours of flight time. Calibration measurements and inter-comparison of cloud data with previously developed sensors having well established characteristics are also presented.