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A Wing Pod-based Millimeter Wave Cloud Radar on HIAPER

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One of the attractive features of a millimeter wave radar system is its ability to detect micron-sized particles that constitute clouds with lower than 0.1 g m^{-3} liquid or ice water content. Scanning or vertically-pointing ground-based millimeter wavelength radars are used to study stratocumulus (Vali et al. 1998; Kollias and Albrecht 2000) and fair-weather cumulus (Kollias et al. 2001). Airborne millimeter wavelength radars have been used for atmospheric remote sensing since the early 1990s (Pazmany et al. 1995). Airborne millimeter wavelength radar systems, such as the University of Wyoming King Air Cloud Radar (WCR) and the NASA ER-2 Cloud Radar System (CRS), have added mobility to observe clouds in remote regions and over oceans.

Scientific requirements of millimeter wavelength radar are mainly driven by climate and cloud initiation studies. Survey results from the cloud radar user community indicated a common preference for a narrow beam W-band radar with polarimetric and Doppler capabilities for airborne remote sensing of clouds. For detecting small amounts of liquid and ice, it is desired to have -30 dBZ sensitivity at a 10 km range. Additional desired capabilities included a second wavelength and/or dual-Doppler winds. Modern radar technology offers various options (e.g., dual-polarization and dual-wavelength). Even though a basic fixed beam Doppler radar system with a sensitivity of -30 dBZ at 10 km is capable of satisfying cloud detection requirements, the above-mentioned additional options, namely dual-wavelength, and dual-polarization, significantly extend the measurement capabilities to further reduce any uncertainty in radar-based retrievals of cloud properties.

This paper describes a novel, airborne pod-based millimeter wave radar, preliminary radar measurements and corresponding derived scientific products. Since some of the primary engineering requirements of this millimeter wave radar are that it should be deployable on an airborne platform, occupy minimum cabin space and maximize scan coverage, a pod-based configuration was adopted. Currently, the radar system is capable of collecting observations between zenith and nadir in a fixed scanning mode. Measurements are corrected for aircraft attitude changes. The near-nadir and zenith pointing observations minimize the cross-track Doppler contamination in the radial velocity measurements. An extensive engineering monitoring mechanism is built into the recording system status such as temperature, pressure, various electronic components' status and receiver characteristics. Status parameters are used for real-time system stability estimates and correcting radar system parameters. The pod based radar system is mounted on a modified Gulfstream V aircraft, which is operated and maintained by the National Center for Atmospheric Research (NCAR) on behalf of the National Science Foundation (NSF). The aircraft is called the High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER) (Laursen et al., 2006). It is also instrumented with high spectral resolution lidar (HSRL) and an array of *in situ* and remote sensors for atmospheric research.

As part of the instrument suite for HIAPER, the NSF funded the development of the HIAPER Cloud Radar (HCR). The HCR is an airborne, millimeter-wavelength, dual-polarization, Doppler radar that serves the atmospheric science community by providing cloud remote sensing capabilities for the NSF/NCAR G-V (HIAPER) aircraft. An optimal radar configuration that is capable of maximizing the accuracy of both qualitative and quantitative estimated cloud microphysical and dynamical properties is the most attractive option to the research community. The Technical specifications of cloud radar are optimized for realizing the desired scientific performance for the pod-based configuration. The radar was both ground and flight tested and preliminary measurements of Doppler and polarization measurements were collected. HCR observed sensitivity as low as -37 dBZ at 1 km range and resolved linear depolarization ratio (LDR) signature better than -29 dB during its latest test flights.

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