Dual-frequency Dual-polarized Doppler Radar (D3R)

http://pmm.nasa.gov/science/ground-validation/D3R

A Dual-frequency Dual-polarized Doppler Radar (D3R) was developed with funding from NASA's Global Precipitation Measurement (GPM) Project. The D3R is a fully polarimetric, scanning weather radar system operating at the nominal frequencies of 13.91 GHz and 35.56 GHz covering a maximum range of 30 km. The frequencies chosen allow close compatibility with the GPM Dual-frequency Precipitation Radar system, which was selected for flight on the GPM core spacecraft scheduled for launch in July 2013.

The D3R is part of GPM Ground Validation activities. These activities support GPM pre-launch algorithm development and contribute to post-launch precipitation product validation. Pre-launch, the D3R provides independent estimation of hydrometeor classification and drop size distribution retrievals. The radar thus offers an insight into the microphysical processes that dominate the retrieval (and associated measurement error) of precipitation types and rates from satellite data. While the GPM DPR radar presents a global picture of precipitation through observations at Ku- and Ka-band, the ground-based D3R yields detailed, fine-scale local statistics of the microphysical interpretation.

The D3R takes advantage of several innovative technologies to achieve its design goals as a relatively compact, transportable system. Chief among these are the use of solid state power amplifiers and a novel waveform composed of three consecutive, frequency modulated, frequency separated pulses. Using these methods, blind ranges and range sidelobes are minimized, and the radar meets its sensitivity requirement of -10 dBZ at 15 km (clear air, single pulse, with 150 m range resolution).

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View an animation of the D3R radar.

A government-industry-academic consortium developed the D3R. NASA's Goddard Space Flight Center has overall management and lead engineering responsibility for the radar. Remote Sensing Solutions, Inc. is responsible for the solid-state transceivers and intermediate frequency electronics; Orbital Systesm, Ltd.. developed the radar pedestal and positioner. Colorado State University (CSU) developed the data product and archive software, and has a wide range of responsibilities related to the radar electronics (including the digital receiver and waveform generation), electronic integration, and test. The D3R was field tested alongside of CSU's S band CHILL radar. D3R's first deployment was the Mid-Latitude Continental Convective Clouds Experiment (MC3E) field campaign, which took place in April and May 2011.

D3R Documents

- D3R Specifications
- D3R Engineering Overview
- D3R Design & Implementation
- D3R System Requirements

D3R Radar Parameters

System	
Frequency	Ku: 13.91GHz ± 25 MHz Ka: 35.56GHz ± 25MHz
Minimum detectable signal (Ku, Ka)	-10dBZ at 15 km for a single pulse at 150m range resolution
Minimum operational range	450 m
Operational range resolution	150 m (nominal)
Maximum range	30 km
Angular coverage	0-360° Az, -0.5-90° El (full hemisphere)
Antenna	
Parabolic reflector (diameter)	6ft/72in (Ku), 28in (Ka)
Gain	44.5 dB (Ku, Ka)
HPBW	~1° (Ku, Ka)
Polarization	Dual linear simultaneous and alternate (H and V) (Ku, Ka)
Maximum sidelobe level	~ -25 dB (Ku, Ka)
Cross-polarization isolation	< -32 dB (on axis)
Ka-Ku beam alignment	Within 0.2°
Scan capability	0-24°/s Az, 0-12°/s El
Scan types	PPI sector, RHI, Surveillance, Vertical pointing
Transmitter/Receiver	
Transmitter architecture	Solid state power amplifier modules
Peak power/Duty cycle	160 W (Ku), 40 W (Ka) per H and V channel, Max duty cycle 30%
Receiver noise figure	4.6 (Ku), 5.5 (Ka)
Receiver dynamic range	³ 90 dB (Ku, Ka)
Clutter suppression	GMAP
Data Products	
Standard products	Equivalent reflectivity factor Zh (Ku, Ka), Doppler velocity (unambiguous: 25 m/s)
Dual-polarization products (Ku, Ka) (LDR only in alternate transmit mode)	Differential reflectivity Zdr Differential propagation phase _dp Copolar correlation coefficient _hv Linear depolarization ratios LDRh, LDRv
Data format	NetCDF