

# D3R Radar Observations from OLYMPEX

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## Characteristics of the D3R

Frequency	Ku-13.91GHz, Ka-35.56GHz
Beamwidth	0.9 degree
Maximum range	39.75 km
Maximum unambiguous Doppler velocity	26.96 m/s (Ku-band)
Minimum detectable signal (Ku/Ka)	-8/-3 dBZ at 15 Km for a single pulse at 150 range resolution
Angular coverage	220-130 degree Azimuth, -0.5-90 degree Elevation
Data Format	NetCDF

## List of Measured and Derived Products

Measured Products	Symbol	Frequency	Comments
Reflectivity	Z	Ka and Ku	Attenuated and corrected
Differential Reflectivity	Z <sub>DR</sub>	Ka and Ku	Attenuated and corrected
Differential Propagation Phase	Φ <sub>dp</sub>	Ka and Ku	
Specific Differential Phase	K <sub>dp</sub>	Ka and Ku	
Co-polar Correlation Coefficient	ρ <sub>co</sub>	Ka and Ku	
Linear Depolarization Ratio	LDR	Ka and Ku	Attenuated and corrected
Cross-polar Correlation Coefficient	ρ <sub>cx</sub>	Ka and Ku	
Radial Velocity	v	Common to both	
Derived Products			
Rainfall Rate	R		Various algorithms
Drop Size Distribution	DSD		Various algorithms

## OLYMPEX: Olympic Mountains Experiment

The NASA dual-frequency, dual-polarization, Doppler radar (D3R) is a Ku- and Ka-band radar developed for the GPM ground validation mission. As part of the OLYMPEX ground validation field campaign, the D3R was deployed collocated with the NASA NPOL radar in Moclips, WA.

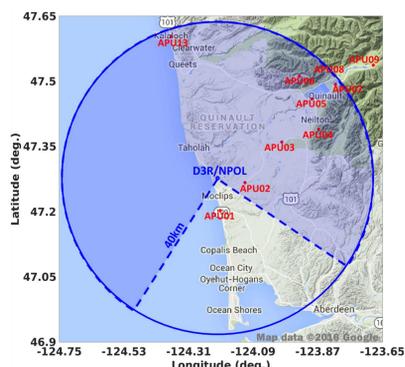
Dates Operated (UTC)	Nov. 3 – Dec. 19, 2015 and Jan. 3 – Jan. 15, 2016
Operations	38 of 53 days had notable precipitation
Azimuth Angles Covered by D3R	220 – 130 degrees
Scan Strategy	Surveillance, RHI sector west, birdbath, RHI sector to east, birdbath
Scans Performed	> 180,000
Data Collected (time-series and NetCDF)	> 85 TB



NPOL (left) and D3R (right) at the radar site in Moclips, WA.



Close-up view of the NASA D3R with the Ku-band (left) and Ka-band (right) antennas.

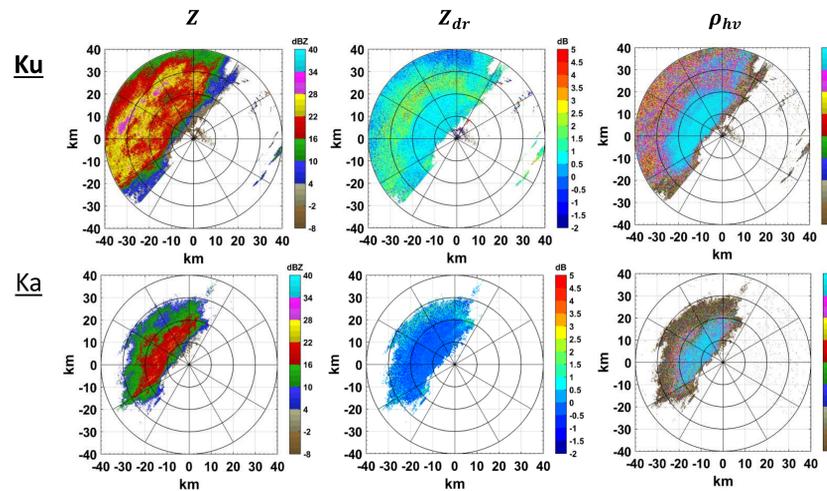


Map showing instrument locations during OLYMPEX. D3R's observation domain is shaded in blue.

## Ku- and Ka-Band Observations

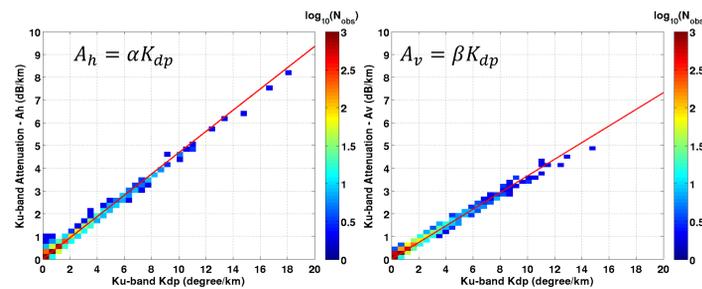
November 23, 2015 21.19 UTC

Note: Clutter Filtering OFF, No attenuation correction

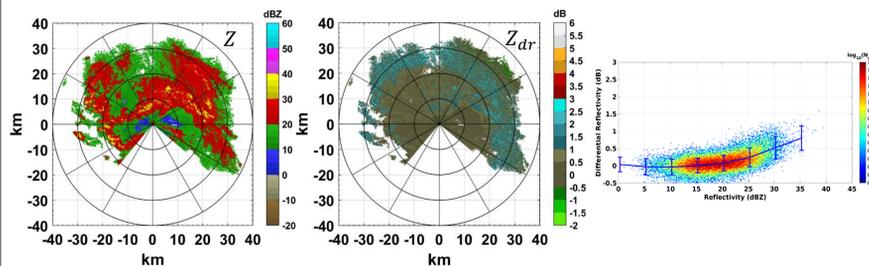


## Preliminary Ku-Band Attenuation Correction Results

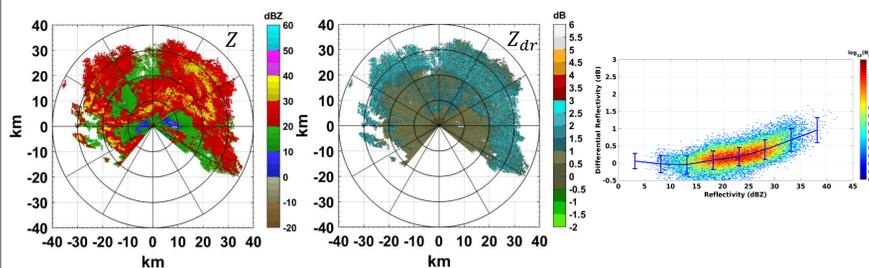
Differential phase based attenuation correction is applied for D3R observations. Preliminary relationships between attenuation and specific differential phase are derived from disdrometer-based simulations.



Ku-band observations November 12, 2015 14:34 UTC (before attenuation correction)



Ku-band observations November 12, 2015 14:34 UTC (after attenuation correction)



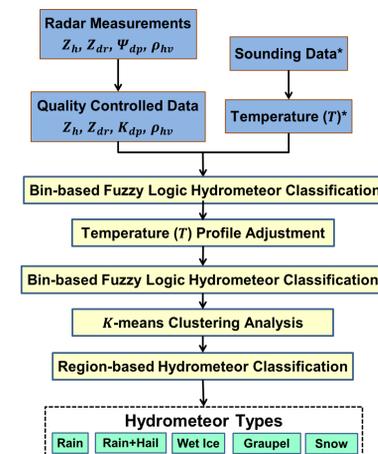
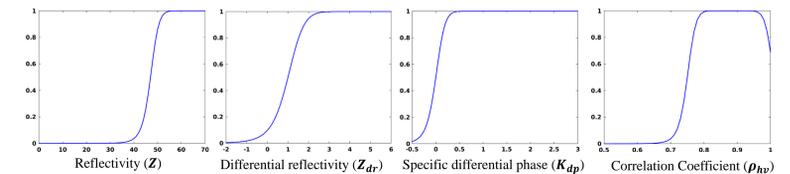
## Ku-Band Hydrometeor Classification

One-dimensional fuzzy-logic membership asymmetric beta functions (MBF) used for each variable.

$$MBF(x) = \begin{cases} \frac{1}{1 + \left(\frac{x-m}{a_l}\right)^{2b}}, & x \leq m \\ \frac{1}{1 + \left(\frac{x-m}{a_r}\right)^{2b}}, & x > m \end{cases}$$

where x is the value of the input variable; m = (max+min)/2 is the midpoint of the function; a<sub>l</sub> and a<sub>r</sub> are the left- and right-side half-widths; b is the slope representing the confidence in the MBFs.

## Example membership function of radar variables for Ku-band rain-hail mixture



\*Optional Input

The NASA D3R Ku-band hydro-class methodology (see figure to left) is based on the technique developed by Bechini and Chandrasekar (2015): Bechini, R., and V. Chandrasekar, 2015: A semi-supervised robust hydrometeor classification method for dual-polarization radar applications. *J. Atmos. Ocean. Technol.*, **32**, 22-47.

## Example Convective Case: December 5, 2015, 02:59 UTC

