AOS Cloud-Sensitive Radar Status

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Outline

Cloud Radar Performance Targets

Single-Frequency Cloud Radar Concepts

Simulated Data

Summary

Target and Minimum Radar Capabilities

The project based target performance on the SATM from MCR, reduced to a single frequency.

The targets are written to be **frequency-agnostic**.

Requirements are not finalized until SRR.

Project is studying potential enhancements, including a second frequency, narrow swath, brightness temperature measurements, and LDR.

Target Capabilities

Radar Observable	Altitude	Sensitivity	Uncertainty	Horizontal Resolution (sampling)	Vertical Resolution	Swath
Equivalent Reflectivity Factor (dBZe)	6 to 20 km	-24 dBZe	1.5 dB	2 km (1 km)	500 m	Nadir
	2.5 to 6 km	-20 dBZe			500 m	
	1 to 2.5 km	-15 dBZe			300 m	
	0.5 to 1 km	-5 dBZe			300 m	
Vertical Doppler Velocity (m/s)	6 to 20 km	Reflectivity SNR>0 dB single-shot	0.5 m/s	2 km (1 km)	500 m	Nadir
	2.5 to 6 km				500 m	
	1 to 2.5 km				300 m	
	0.5 to 1 km				300 m	

Minimum Capabilities

Radar Observable	Altitude	Sensitivity	Uncertainty	Horizontal Resolution (sampling)	Vertical Resolution	Swath
Equivalent Reflectivity Factor (dBZe)	6 to 20 km	-20 dBZe	1.5 dB	2.5 km (1.25 km)	500 m	Nadir
	2.5 to 6 km	-13 dBZe			500 m	
	1 to 2.5 km	-8 dBZe			300 m	
	0.5 to 1 km	+2 dBZe			300 m	
Vertical Doppler Velocity (m/s)	6 to 20 km	Reflectivity SNR>0 dB single-shot	0.75 m/s	2.5 km (1.25 km)	500 m	Nadir
	2.5 to 6 km				500 m	
	1 to 2.5 km				300 m	
	0.5 to 1 km				300 m	

Single-Frequency Cloud Radar Concepts

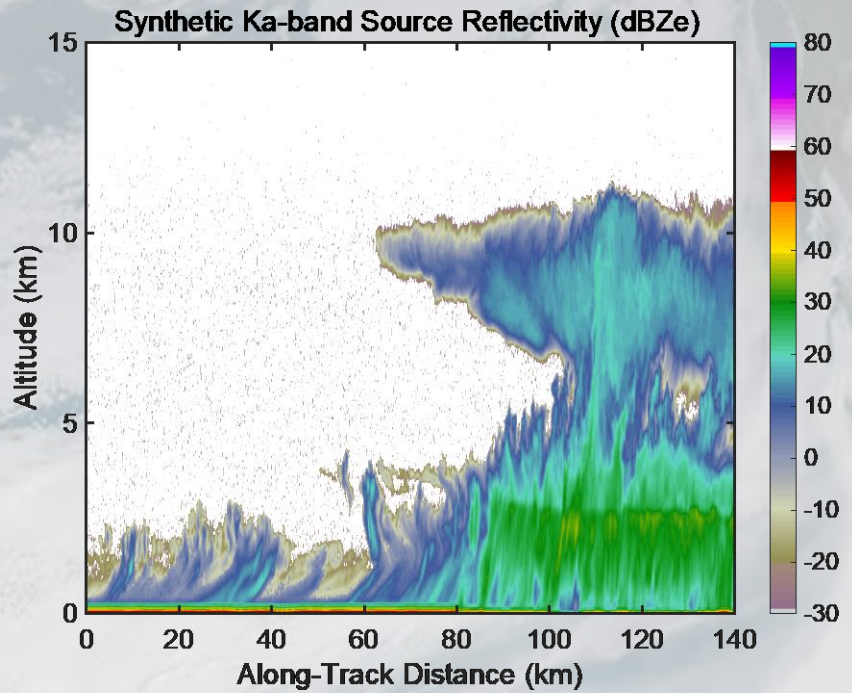
- Displaced Phase Center Antenna (DPCA) W-band Doppler Radar
  - This is the underlying concept of the DORA instrument from the AOS Mission Concept Review (MCR) in May 2022.
  - Two antennas counteract spacecraft movement for high-quality Doppler data.

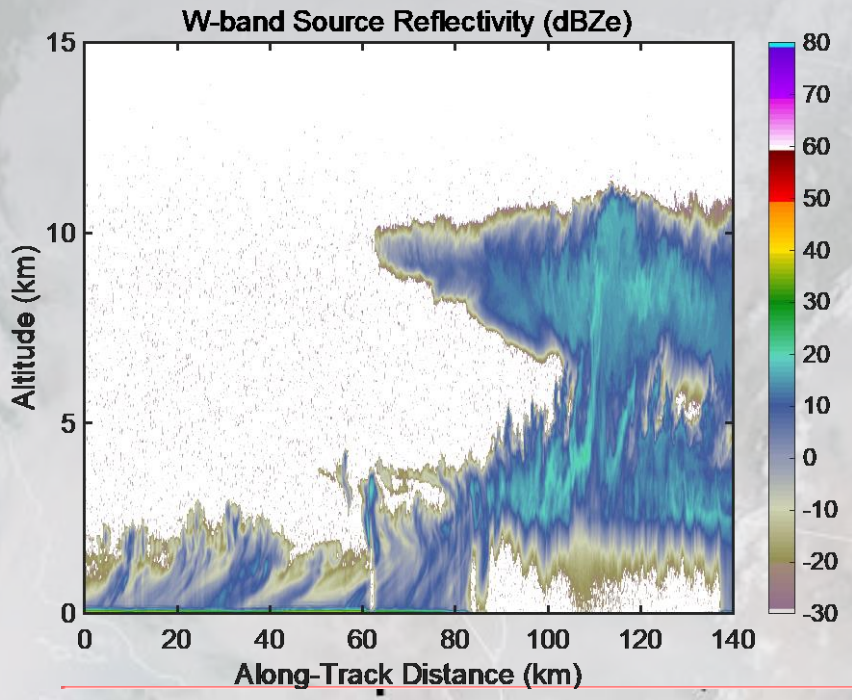
- Large (3-4+ meter) fixed W-band single-aperture Doppler radar.
  - A large aperture is required to mitigate spacecraft spacecraft movement for high-quality Doppler data.

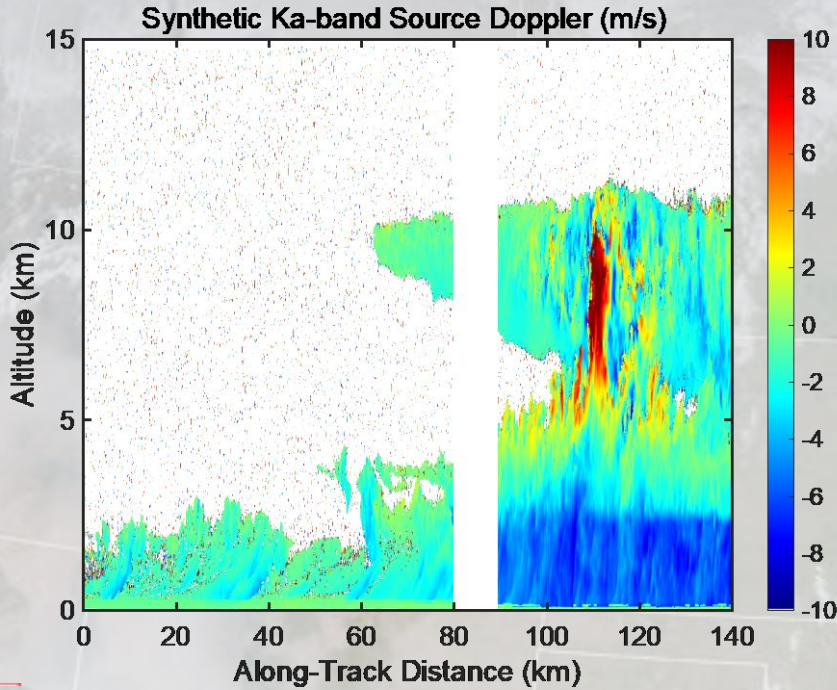
- Large (6-8+ meter) deployable Ka-band single-aperture Doppler radar.
  - At Ka-band, a very large deployable antenna is required for sensitivity and to mitigate spacecraft movement for high-quality Doppler data.

Simulated Data

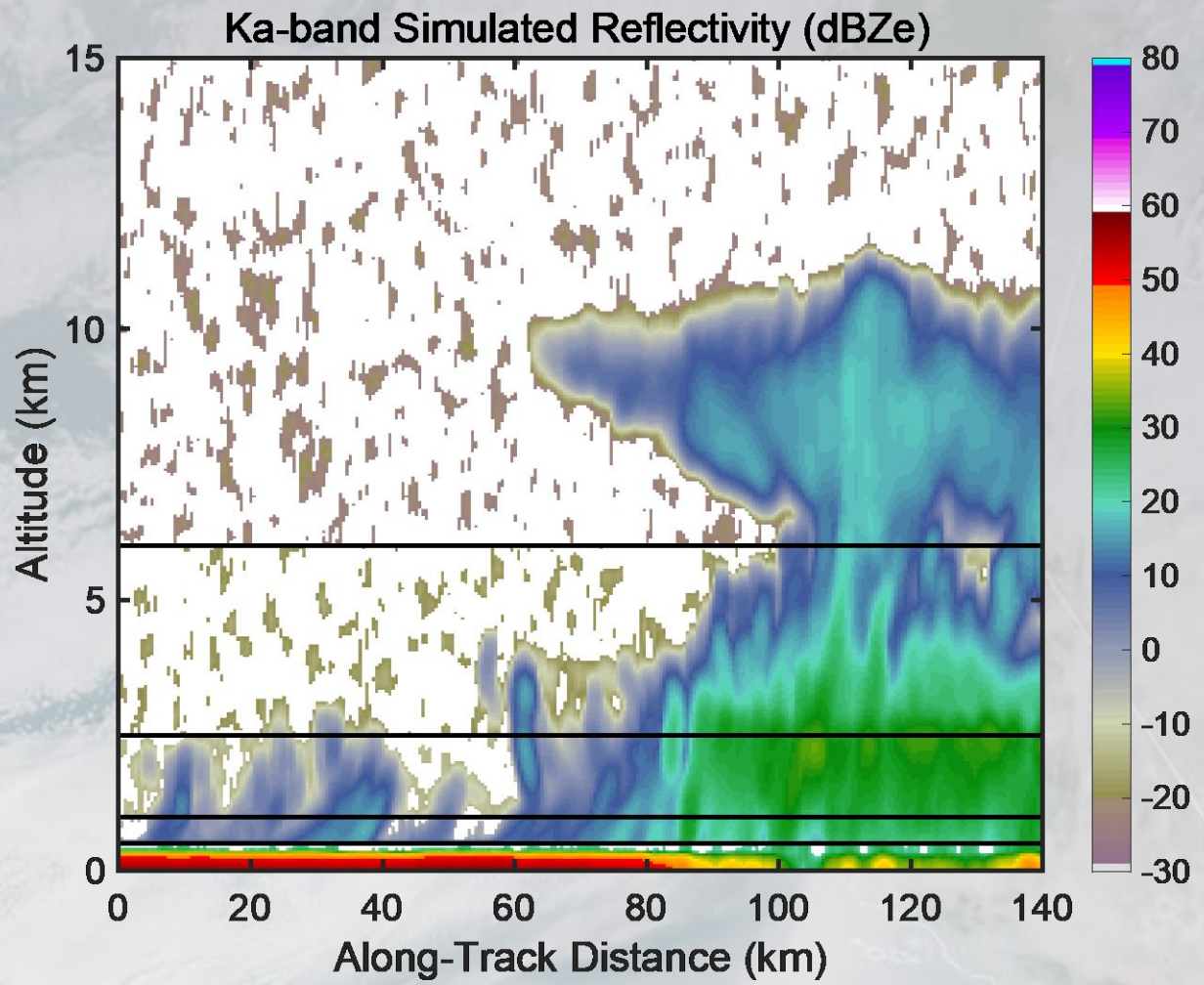
- The next two slides show simulated Ka- and W-band data with target performance.
  - Data derived from the NASA W-band Cloud Radar System (CRS) and the Ka-band High Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) (IMPACTS 2023 Campaign)
- Altitudes associated with performance break-points shown with horizontal lines
- Source data below:

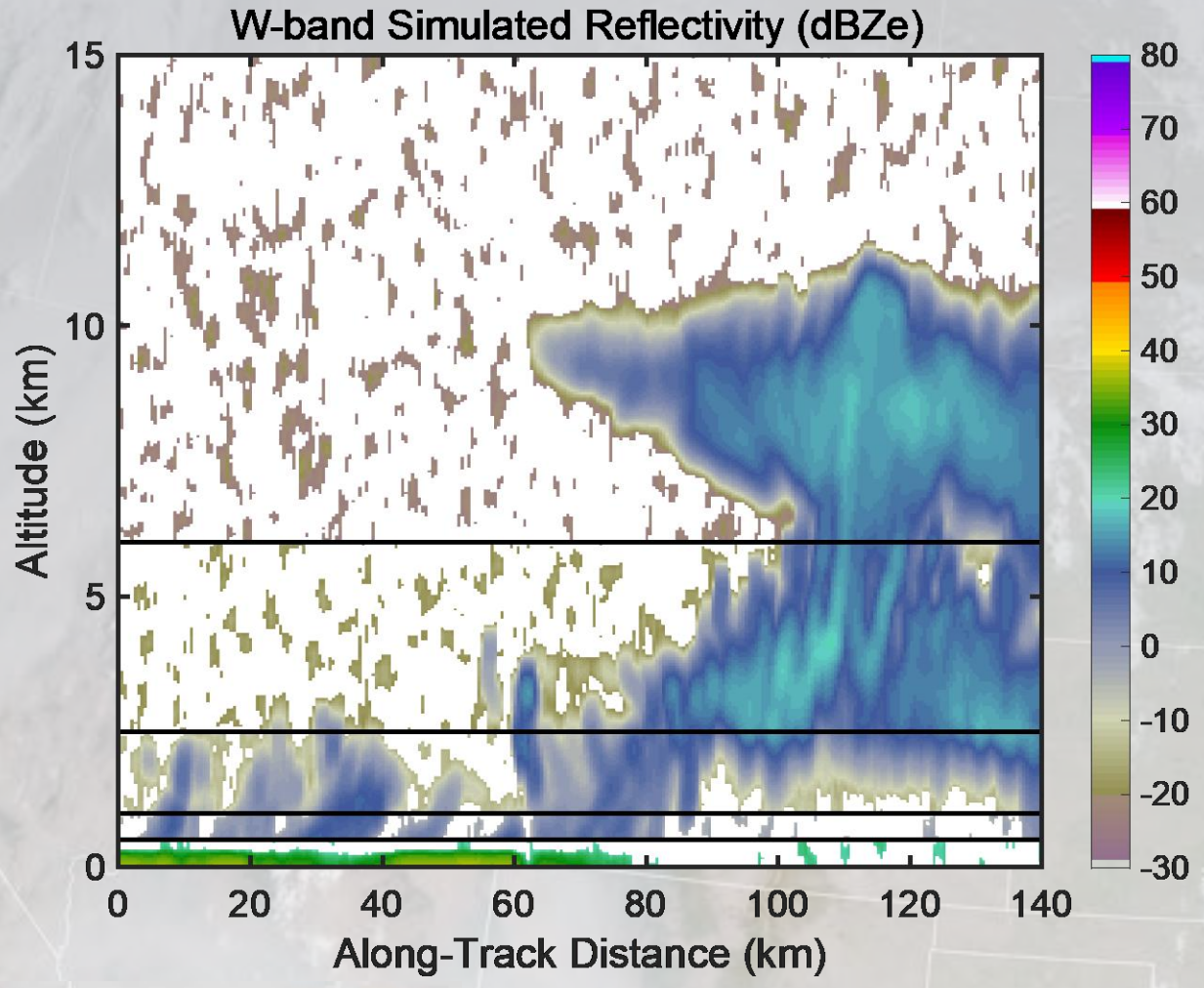




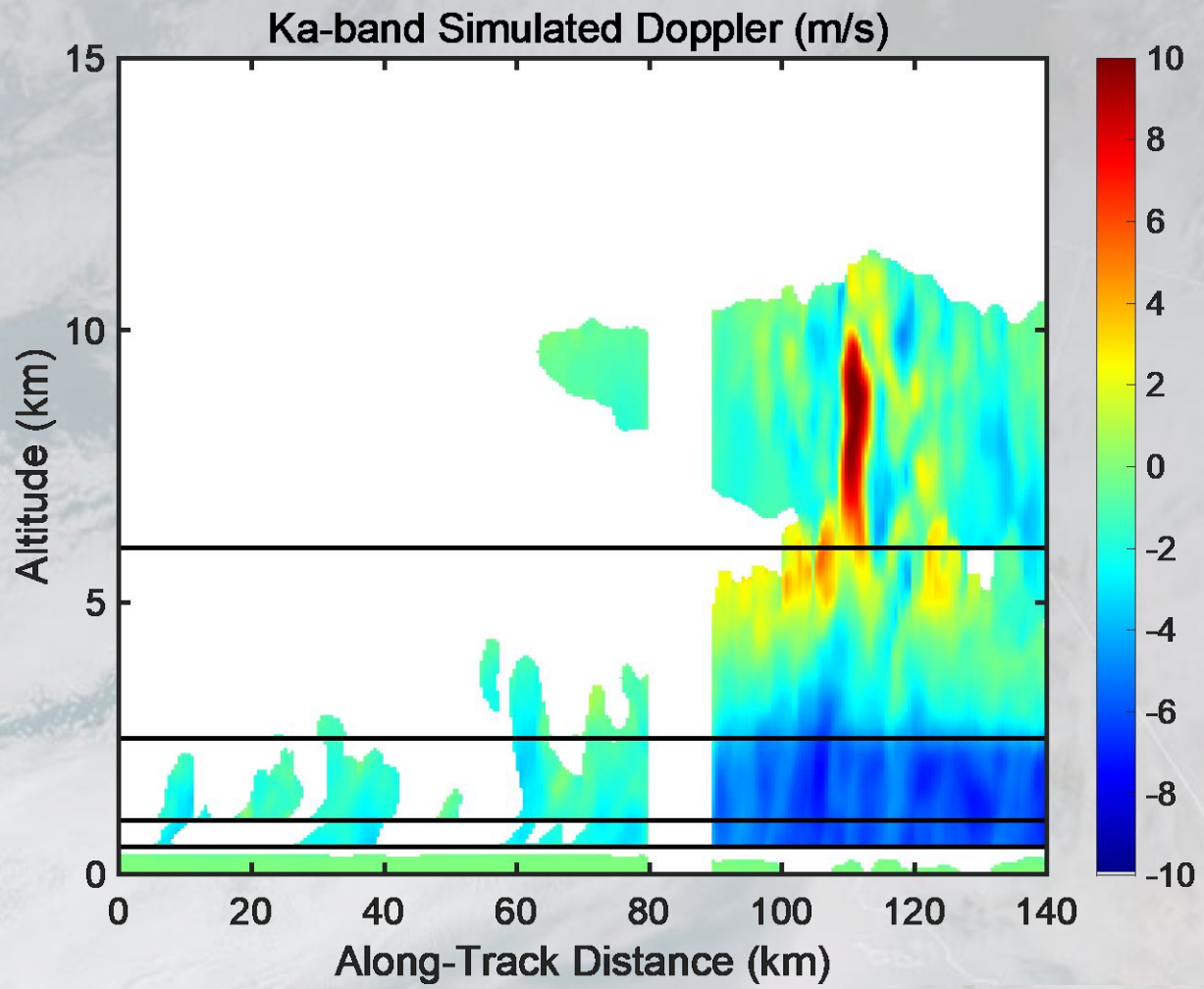


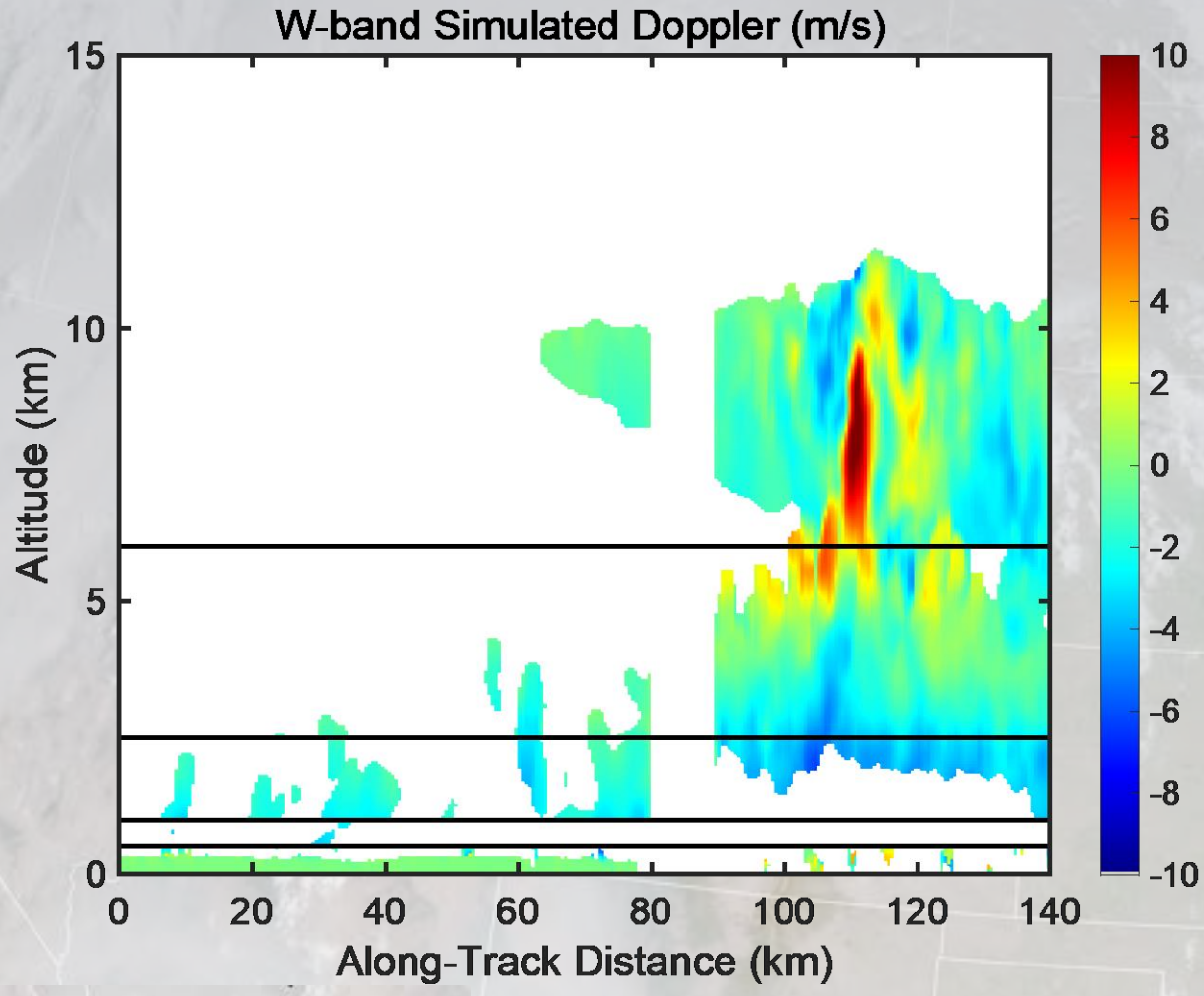
Simulated Data: Ka- vs W-band Reflectivity





Simulated Data: Ka- vs W-band Doppler





Cloud-Sensitive Radar Summary

- Assuming identical performance requirements:
  - Ka-band will have less attenuation, better charaterization of precipitation, less multiple scattering.
  - W-band will enable superior estimates of total liquid water path over oceans using the column integrated hydrometeor attenuation estimate (PIA).
- Detailed investigation of Doppler performance ongoing in the AOS radar working group (GSFC, MSFC, JPL, Aerospace, university).
- Potential enhancements include adding a second frequency, narrow swath, radiometric brightness temperatures, and linear depolarization ratio (LDR).