



The Mid-latitude Convective Clouds Experiment (MC3E)



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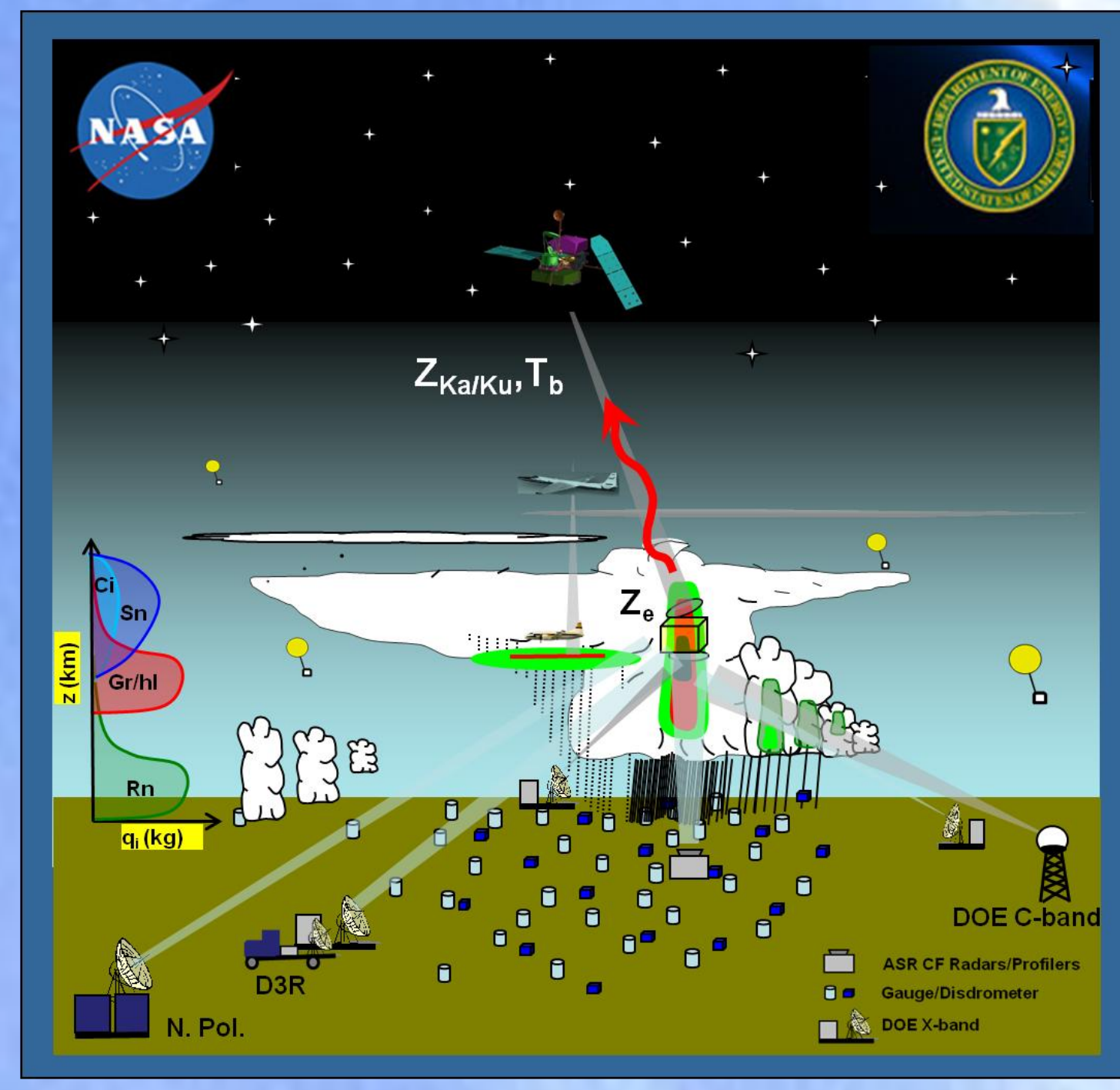
Represents a collaborative effort between the DOE ASR Program and the NASA Global Precipitation Measurement (GPM) mission

Overarching Science:

A complete characterization of convective cloud systems in order to:

- 1) Advance the understanding of the different components of convective parameterization
 - Focus: Convective initiation and up/downdraft coupling to precipitation and cloud microphysics.
- 2) Improve the fidelity of satellite estimates of precipitation over land.
 - Focus: Observation and quantification of dominant column microphysical processes impacting satellite-based passive/active microwave retrievals

Measurement Approach



- Air/ground-based study of precipitation in the column and land-surface state using networks of NASA and DOE radars, radiometers, soundings, disdrometers, rain gauges, and other ASR Facility surface meteorological assets.
- Coupled CRM/LSM simulations driven and validated by observations

MC3E Airborne Instrumentation



NASA ER-2 Radiometer and Radars

AMPR (Passive)	H+V	Characteristics
polarizations		
Frequencies		10.7, 19.35, 37.1, 85.5 GHz
Resolution @ 20 km range		0.6 km (85.5 GHz), 1.5 km (37.1 GHz), 2.8 km (10.7-19.35 GHz)
CoSMIR (Passive)	H+V	
polarizations		
Frequencies		37, 89, 165.5, 183.3+/-1, 183.3+/-3, 183.3+/-8 GHz
Resolution @ 20 km range		1.4 km footprint at nadir
HIWRAP Ka-Ku band (Active)		
Frequency (inner/outer beam)		13.91/13.35 GHz, 35.56/33.72 GHz
Transmit peak power		30 W (Ku), 10 W (Ka)
3 dB beamwidth		2.9° Ku, 1.2° Ka
MDS (dBZ _e , 60 m res., 3.3 μs chirp pulse, 10 km range)		0.0, -5.0 dBZ _e
CRS W-band (Active)		
Frequency		94.15 GHz (dual-polarized)
Transmit peak power		1700 W
3 dB beamwidth		0.6° x 0.8°
MDS (dBZ _e , 0.5 μs pulse; 1 km range)		-35 dBZ _e

UND Citation

Instruments	Measurement
FSSP/King	Cloud liquid water
PMS or DMT (TBD: 2D-C/P, CIP/PIP etc.)	Cloud and precipitation particle spectra
SPEC Inc. HVPS	Large hydrometeor spectra
SPEC Inc. 2D-S	Cloud particle spectra
CDP and/or SID	Cloud particle spectra
CVI	Total water content
Rosemount icing probe	Supercooled liquid water

Note- UND Citation instrument manifest may be modified and/or supplemented as needed

Sampling focused on ice and mixed phase microphysics under view of Ka/Ku-band radar and multi-frequency radiometers

Campaign Measurement Objectives:

NASA GPM

1. Coordinated airborne “satellite simulator” and in-situ platform
 - a. High-altitude Ka/Ku-band radar + multi-frequency radiometer overflying in-situ ice microphysics aircraft
 - b. Pre/post storm land surface properties (e.g., emission, backscatter cross-section)
2. Unified 3-D Mapping of *hydrometeor distribution/type*
 - a. Sub pixel-scale DSD and rain rate variability (0.5 – 5 km)
 - b. Combined dual-frequency (Ka-Ku band) and dual-polarimetric hydrometeor size/rate /type retrievals
3. Data to support satellite *simulator model testing (CRM/LSM/RT)*
 - a. Collection of high quality sounding-based forcing data sets
 - b. Microphysical and kinematic validation datasets.
 - c. Land surface states affecting variability in emission.

DOE ASR

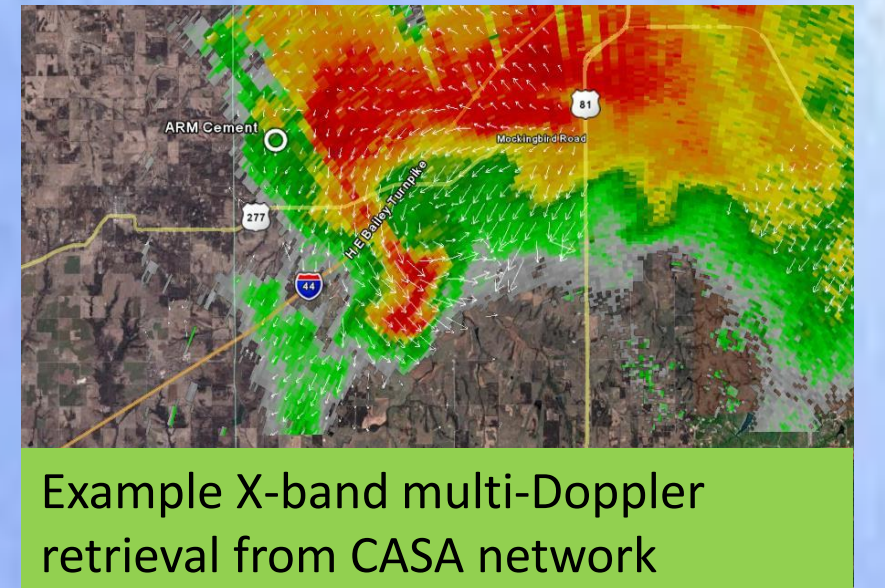
- 1) Determine Pre-convective environment, large-scale fording and feedbacks
- 2) Observations of convective initiation,
- 3) Quantify updraft / downdraft dynamics,
- 4) Diagnose Condensate transport / detrainment / entrainment
- 5) Characterize precipitation and cloud microphysics,
- 6) Assess influences on radiation

MC3E Ground Instrumentation Sampler

NASA NPOL S-band Dual Pol. Radar

Component	Specification
Frequency	2.7 – 2.9 GHz
Polarization	H, V, STSR
Variables	Z, ZDR, Φ _{DP} , KDP, ρ _{co} , ρ _{cv} , LDR, Vr
Transmitter	Magnetron, solid state pulse modulator
Transmit peak power	850 kW (425 kW / channel in STSR)
Pulse width	0.8 – 2.0 μs
PRF	250 – 2000
Antenna	8.5 m prime focal parabolic, no radome
Gain	46 dB
Pointing accuracy	0.1°
Beamwidth	0.9°
Rotation rate	18° / s maximum
First sidelobe	< -28 dB
X-pol isolation (on axis)	< -38 dB

DOE ASR X-SAPR, C-SAPR Radars

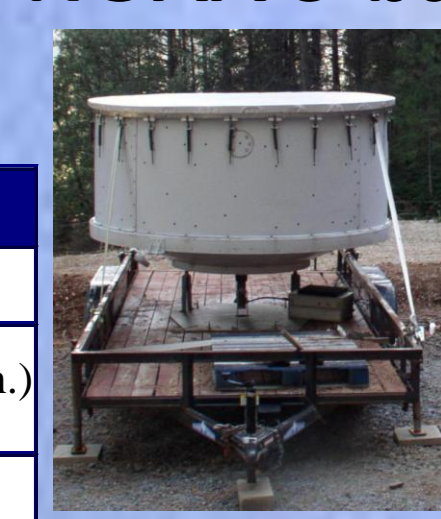
- 3 X-band scanning dual-polarimetric Doppler radars
 - 1 C-band scanning dual-polarimetric Doppler radar
- 
- ASR CF 3-D wind and precipitation sampling
 - Funded by ARRA

NASA Ka-Ku Deployable Dual-Polarimetric Doppler Radar (D3R)



- Maximum operating range 30 km (-15 dBZ at 10 km MDS)
- Solid state transmitter; 13.91 GHz and 35.56 GHz
- Variables: Z, ZDR, F_{DP}, KDP, r_{co}, r_{cv}, LDR, v
- STSR or alternating (full covariance matrix) pulse schemes
- Scanning, dual-aperture, aligned antennas, beamwidth < 1°

NOAA S-band Profiler

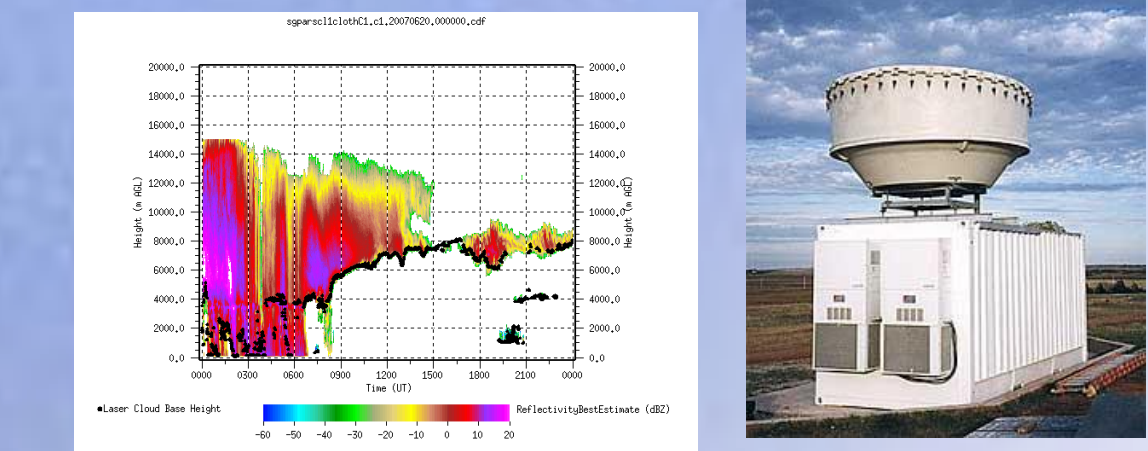


Parameter	Value
Frequency (GHz)	2.875
Antenna diameter (m)	2.4
Average transmit power (W)	500
Peak power (W)	500
Beamwidth (deg)	2.5
Range resolution (m)	45-50 (105, 420)
Time resolution (s)	30
Doppler resolution (m/s)	0.1
Forecast sensitivity (dBZ at 10 km)	-10

DOE ASR Scanning Ka/W band radar.

Radar Specification	Ka-SACR	W-SACR
RF output frequency	35.29 GHz	93.93 GHz
Peak transmit power from EIRP	2.2 kW typical (2 kW min.)	1.7 kW typical (1.4 kW min.)
Transmitter duty cycle	5% max.	1% max.
Pulse widths (selectable)	50-13000 ns	50-2000 ns
Transmit polarization	H-pol linear	H-pol linear
Receiver polarizations	Simultaneous Co- and Cross-polarization linear	Simultaneous Co- and Cross-polarization linear
Antenna Diameter	1.82 m (72")	9 m (36") under-illuminated for beam-matching
Antenna Beamwidth	33 degrees	29 degrees
Cross-polarization isolation	-27 dB typical	-27 dB typical

To operate in tandem with DOE 915 MHz DOE MMCR (Ka-band radar)



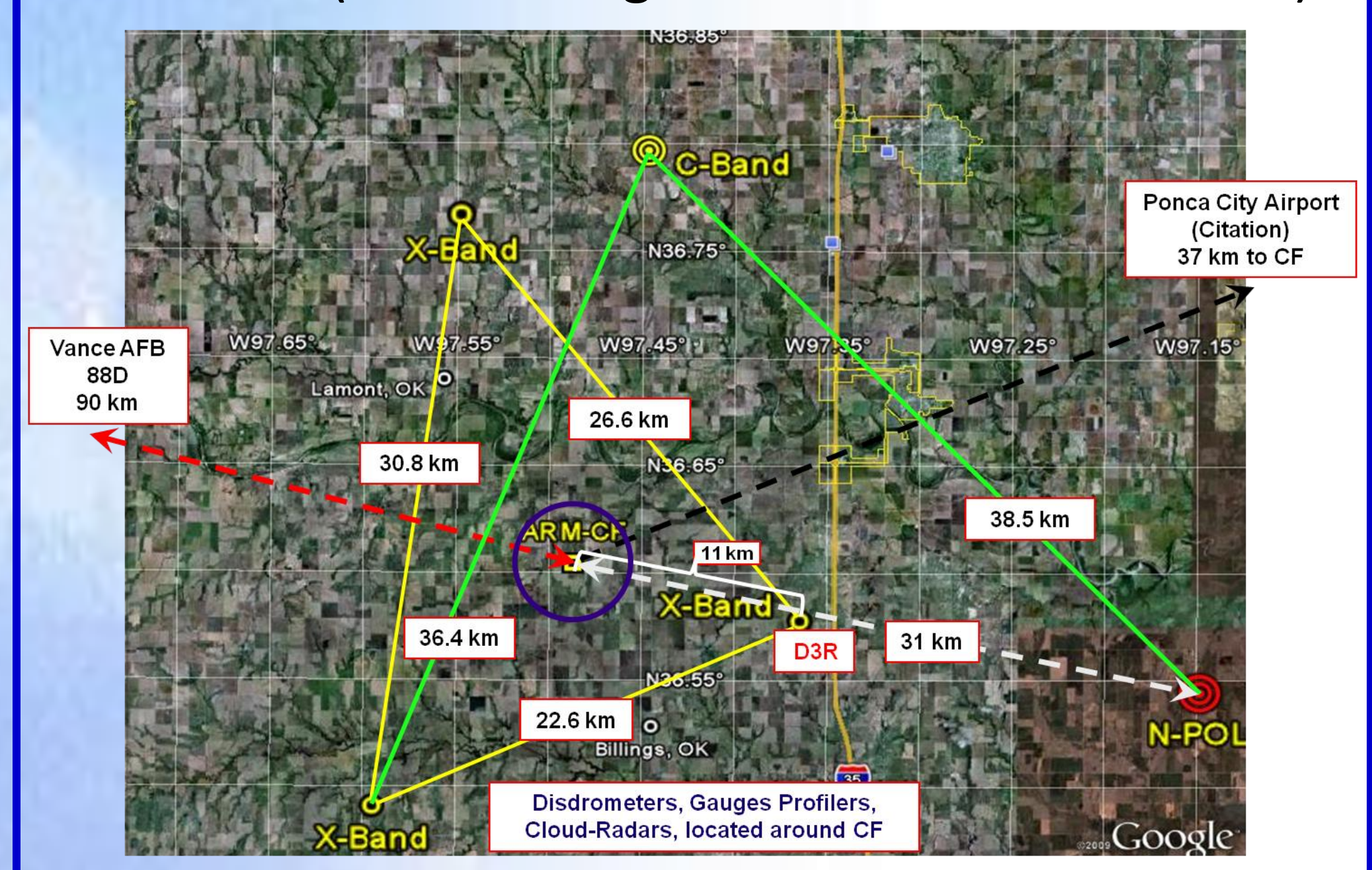
NASA Disdrometer Facility



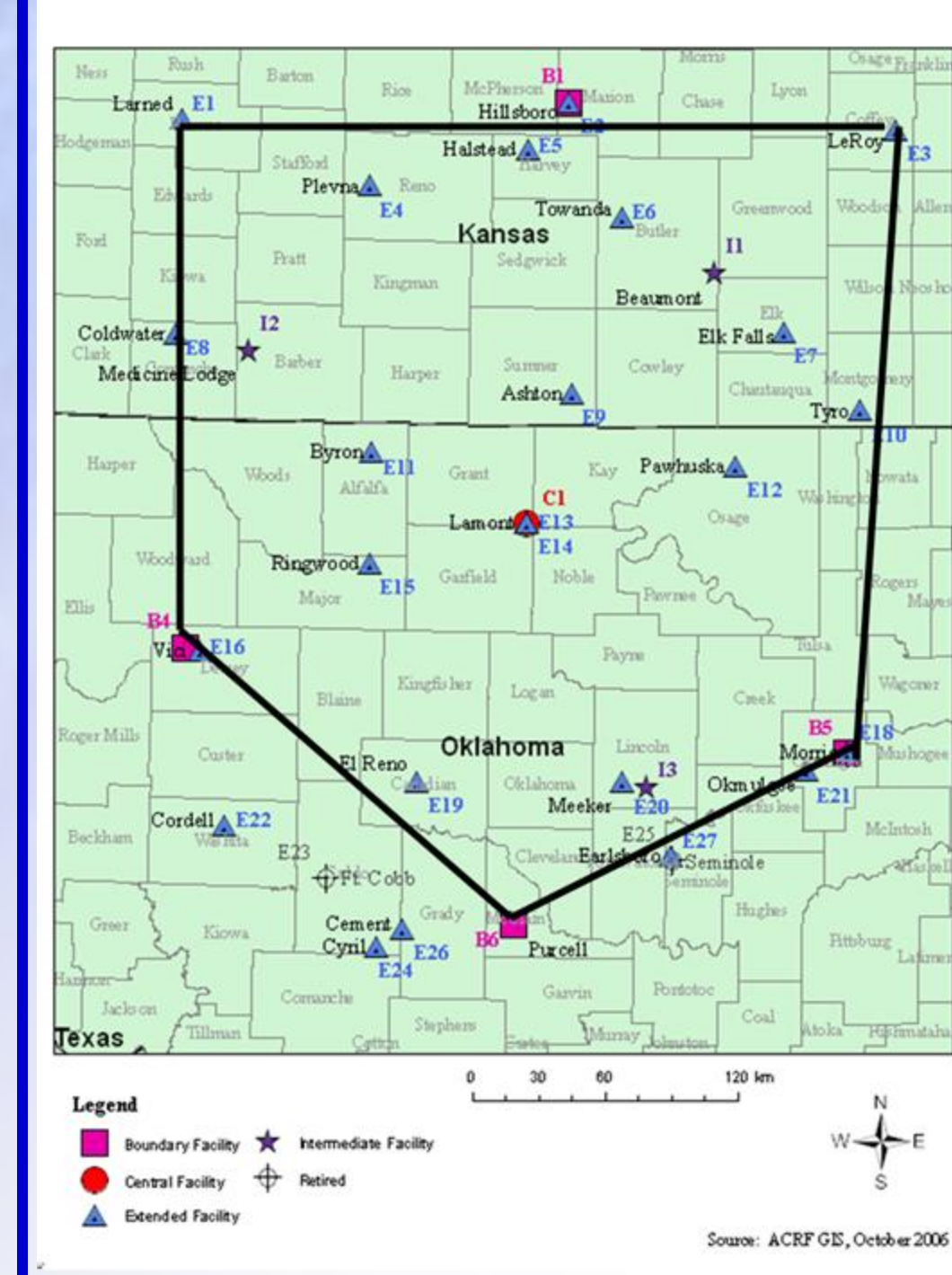
- 16 Parsivel disdrometers
- 5 3rd-generation 2DVDs
- 20 Rain gauges

MC3E Observational Network

Centered on ASR Central Facility in northern Oklahoma (also leverage ASR extended facilities)

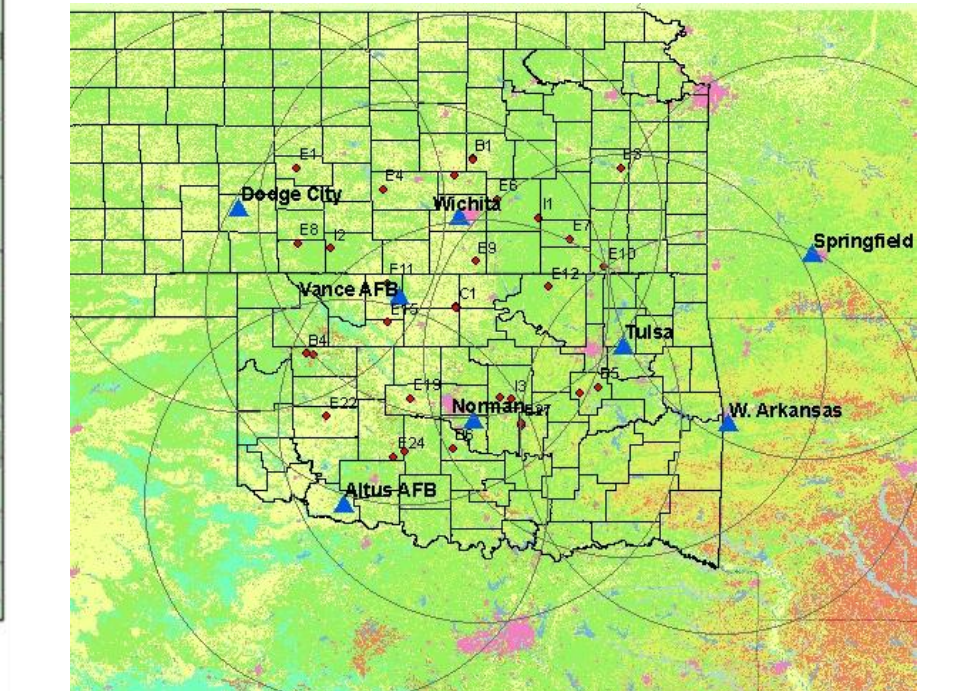


Distribution of multi-frequency radar platforms about central facility



6-station sounding array for model forcing and environment studies

NEXRAD coverage



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