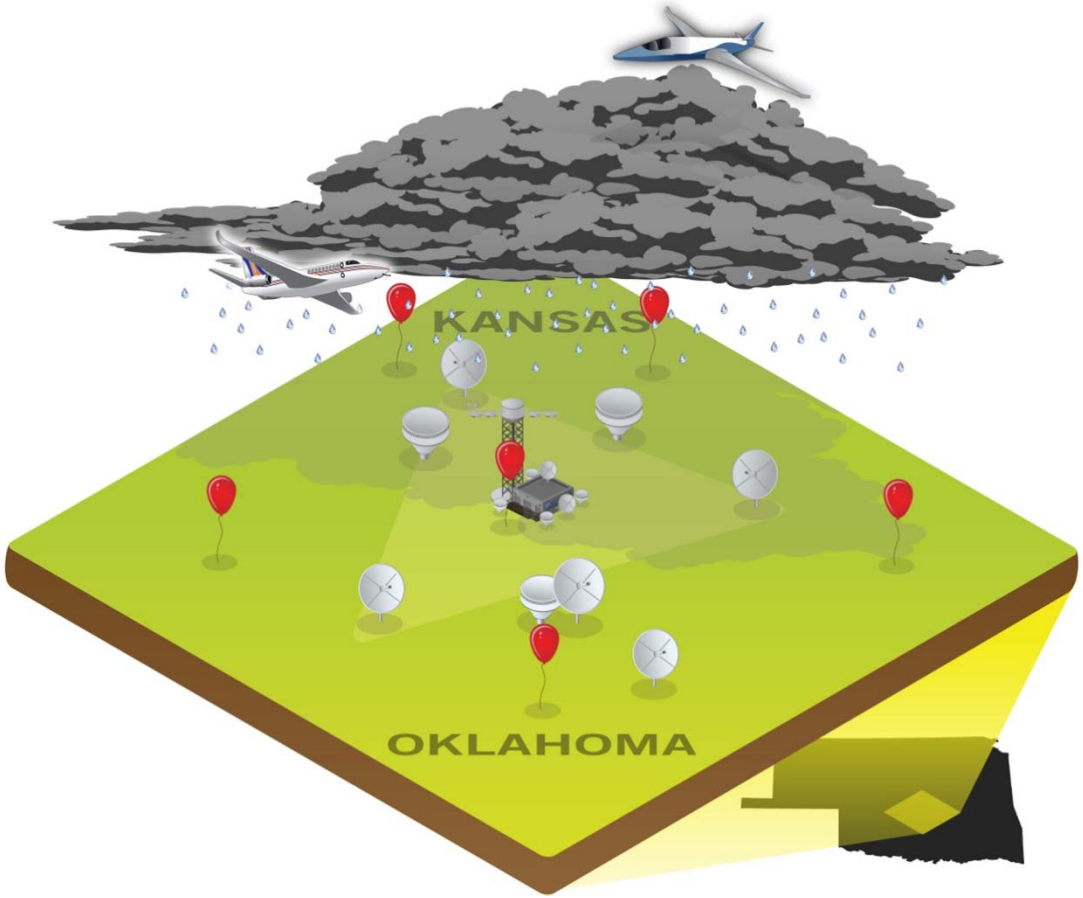
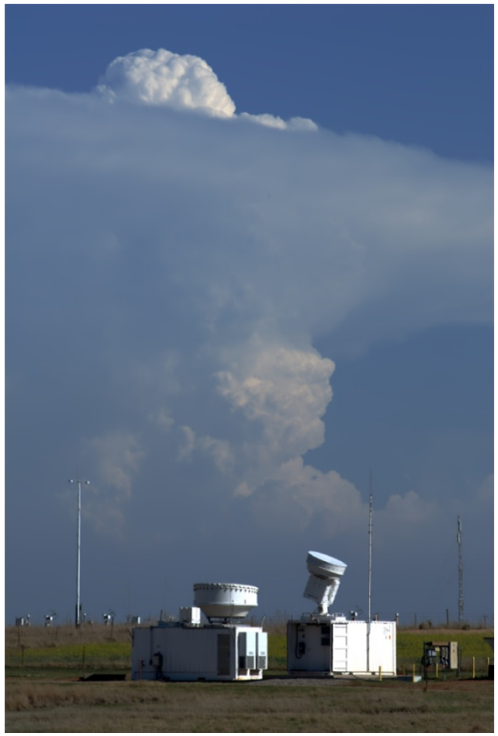
The Midlatitude Continental Convective Clouds Experiment (MC3E): An Overview of Field Campaign Observations





Michael P. Jensen
Brookhaven National Laboratory

12 September 2011
ASR Cloud Lifecycle Working Group Meeting, Annapolis, MD

Quick Overview of MC3E

Who? DOE Atmospheric Radiation Measurement Program
NASA Global Precipitation Measurement Ground Validation

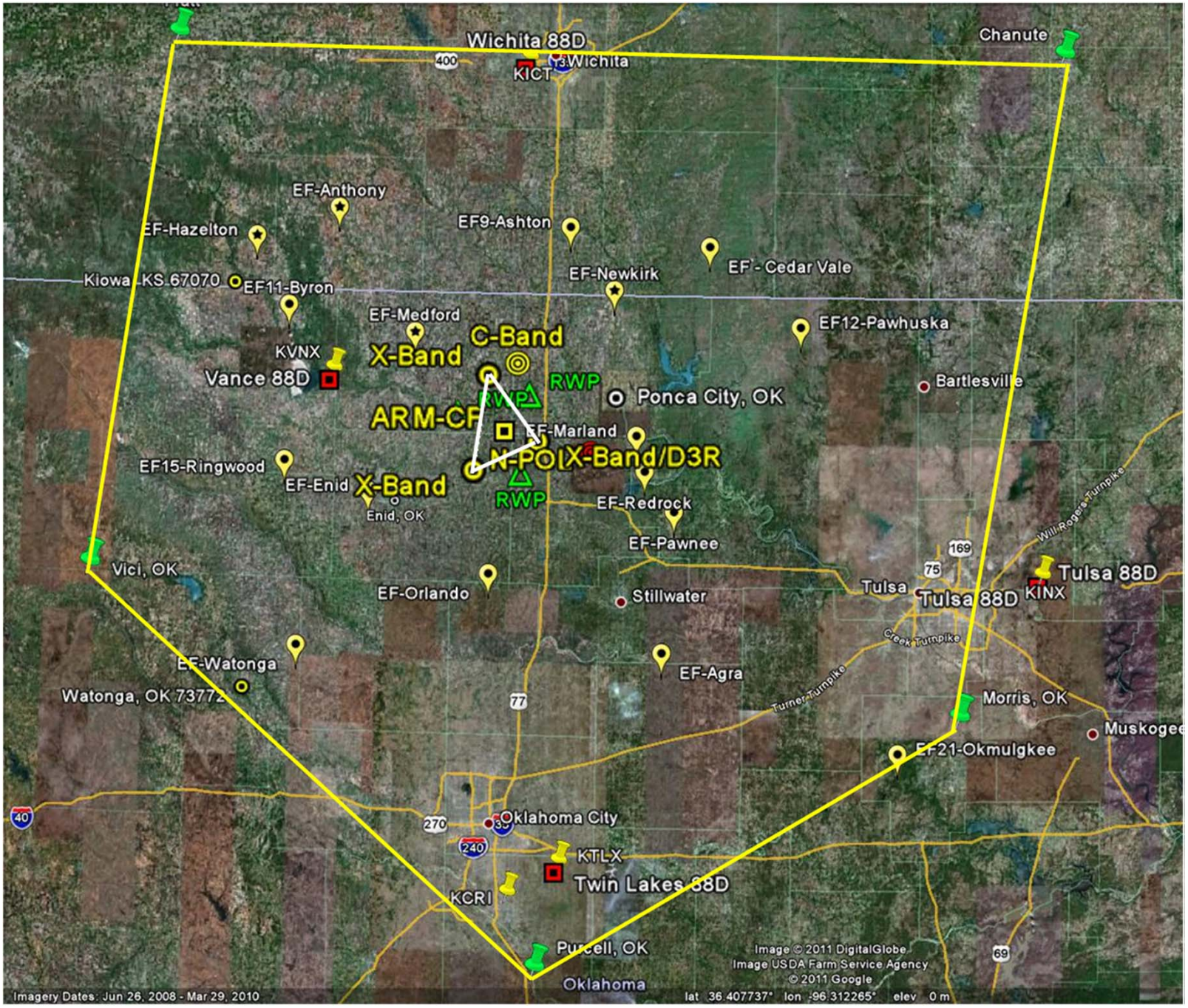
What? Ground-, Aircraft-, Satellite-based observations of convective cloud systems

Where? Centered at the ARM Southern Great Plains site in Lamont, OK
Extended facilities from Southern Kansas to south of OKC

When? April 22 – June 6 2011

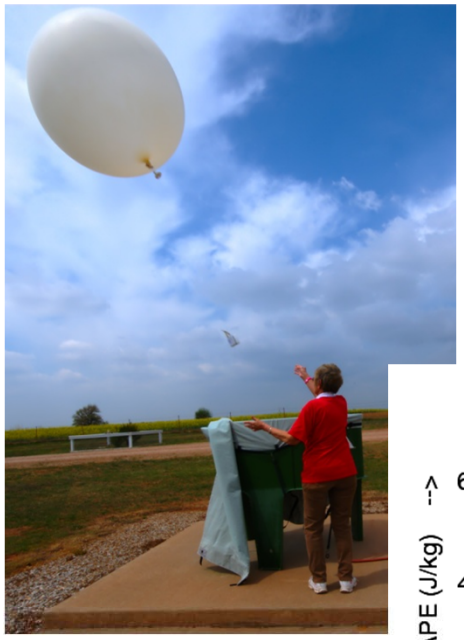
Why? 1) Advance the understanding of the different components of convective parameterization

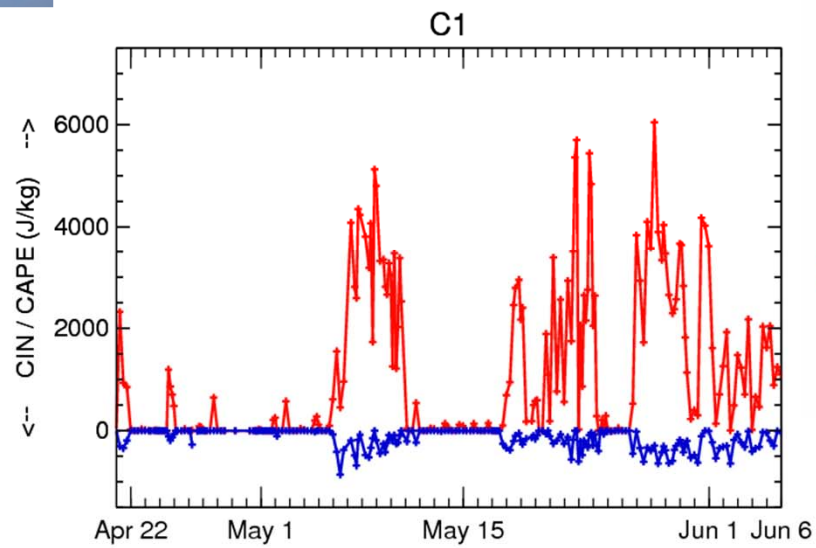
2) Improve the fidelity of satellite estimates of precipitation over land.

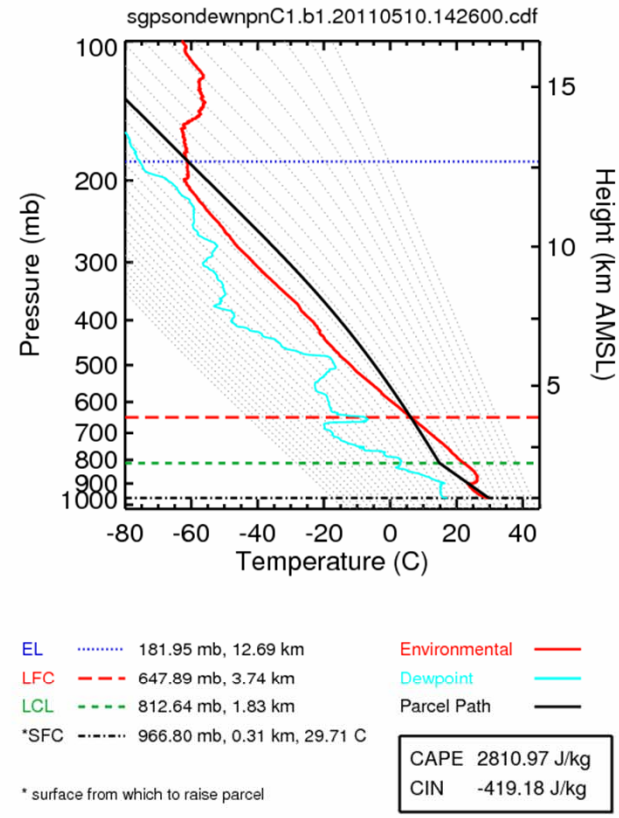

Wichita 88D
KICT
Wichita
Chanute
EF-Anthony
EF-Hazelton
EF9-Ashton
EF - Cedar Vale
Kiowa, KS 67070
EF11-Byron
EF-Newkirk
EF-Medford
EF12-Pawhuska
C-Band
X-Band
KVNX
Vance 88D
RWP
Ponca City, OK
Bartlesville
ARM-CF
EF-Marland
N-POL
X-Band/D3R
EF15-Ringwood
EF-Enid
X-Band
Enid, OK
RWP
EF-Redrock
EF-Pawnee
Vici, OK
EF-Orlando
Stillwater
Tulsa
Tulsa 88D
KINX
Tulsa 88D
EF-Watonga
Watonga, OK 73772
EF-Agra
Morris, OK
Muskogee
EF21-Okmulgkee
Oklahoma City
KTLX
Twin Lakes 88D
KCRI
Purcell, OK
Oklahoma
Image © 2011 DigitalGlobe
Image USDA Farm Service Agency
© 2011 Google
Imagery Dates: Jun 26, 2008 - Mar 29, 2010
lat 36.407737° lon -96.312265° elev 0 m

MC3E sounding operations

- More than 25 staff launched 4-8 sondes/dat at 6 sites
- More than 1200 radiosondes over 6 week period
- Variational Analysis Product – S. Xie (LLNL)

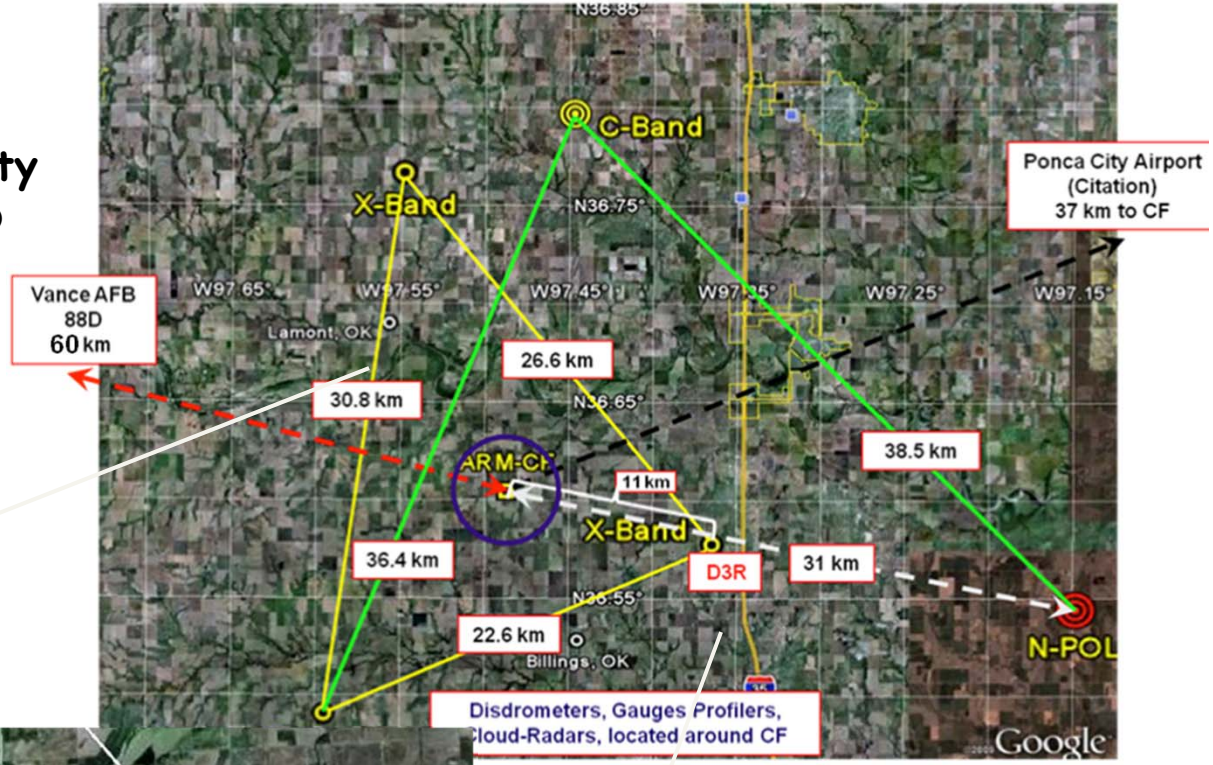


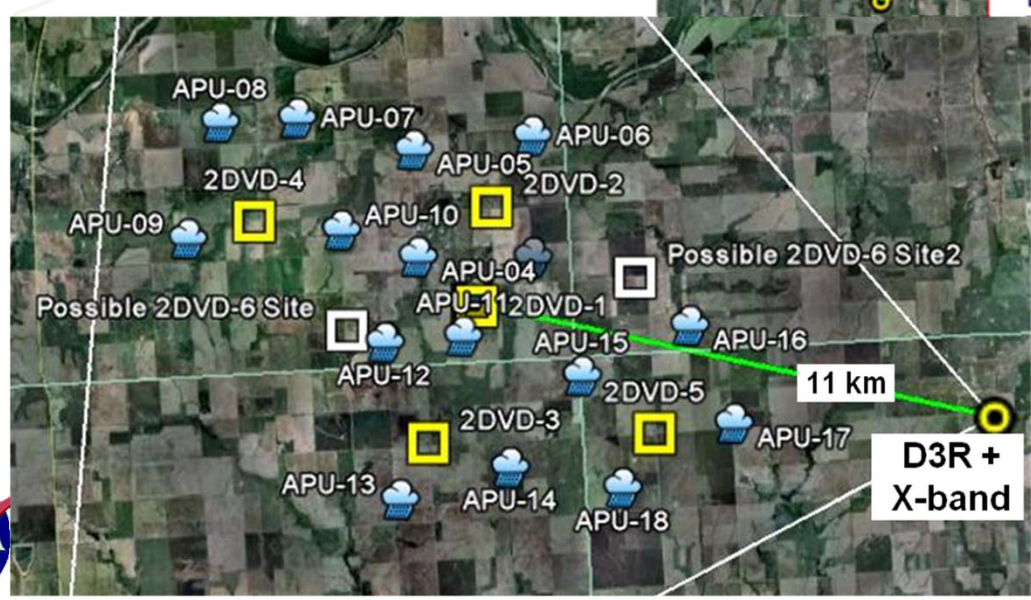




MC3E Sampling: Ground

- Multi-Freq./ Doppler / polarimetric/ profiling radars
  - Sub-pixel DSD/rain variability
  - 3-D (solid/liquid/mixed) HID
  - Cloud water.....(maybe)
  - Kinematics
- Network embedded in sounding array
  - CRM Forcing
  - Budgets

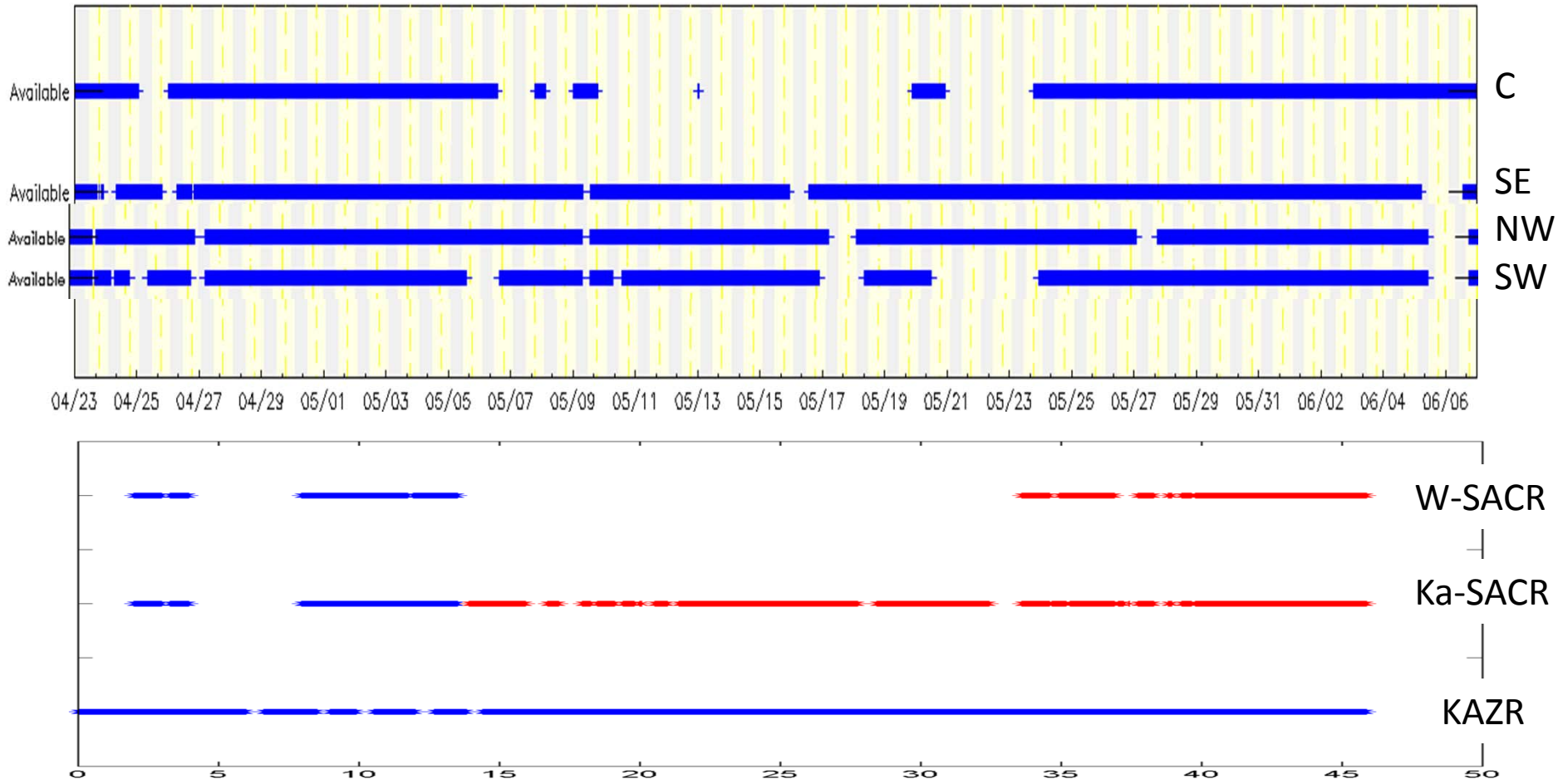




NASA Disdrometer network

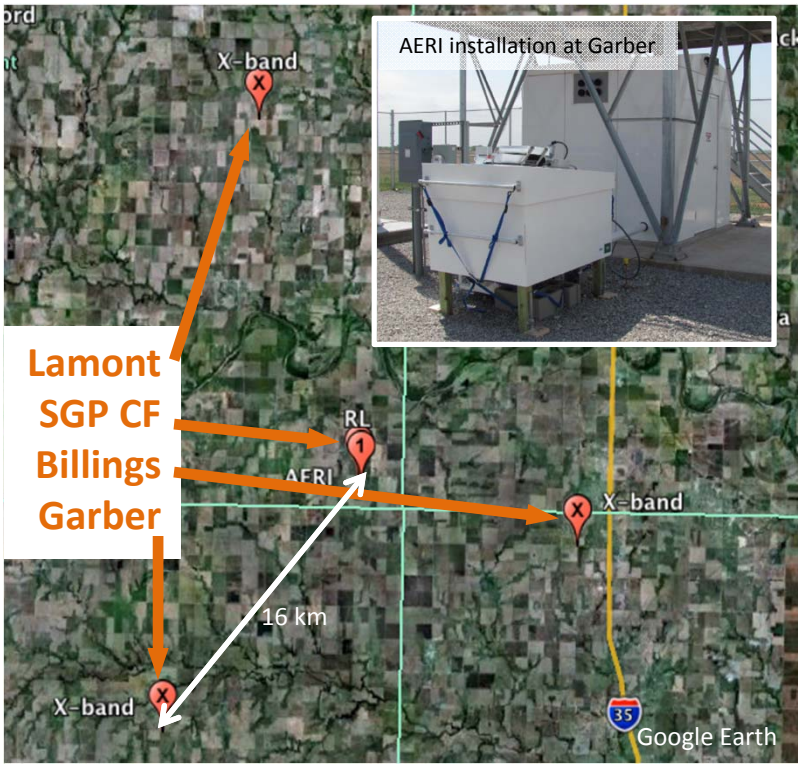
- 5 2DVD 3rd Generation, compact
- 16 Parsivel (Autonomous)
- 1-3 Joss (915 Profiler collocated)
- 20-40 Rain gauges collocated

ARM Radar Systems During MC3E

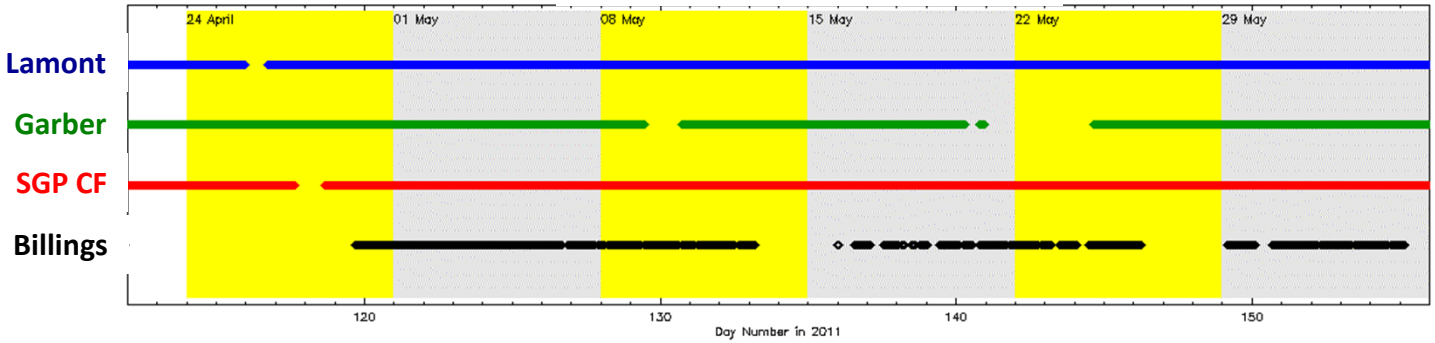


Inner Domain Thermodynamic Profiling during MC3E

- Objective: to characterize "small-scale" horizontal gradients in temperature and water vapor in pre-convective and convective environments
- Approach: deploy ground-based infrared spectrometers (i.e., AERIs) at each of the ARM X-band radar locations; retrieve T/q profiles from radiance observations
- Status as of Sep 2011:
  - Data collection was reasonably complete
  - Analysis of calibration underway
  - Initial retrievals will be performed in coming months



AERI Data Availability during MC3E



Contact:
Dave Turner
dave.turner@noaa.gov

GPM Airborne Assets during MC3E

GPM Core Satellite "Simulator"

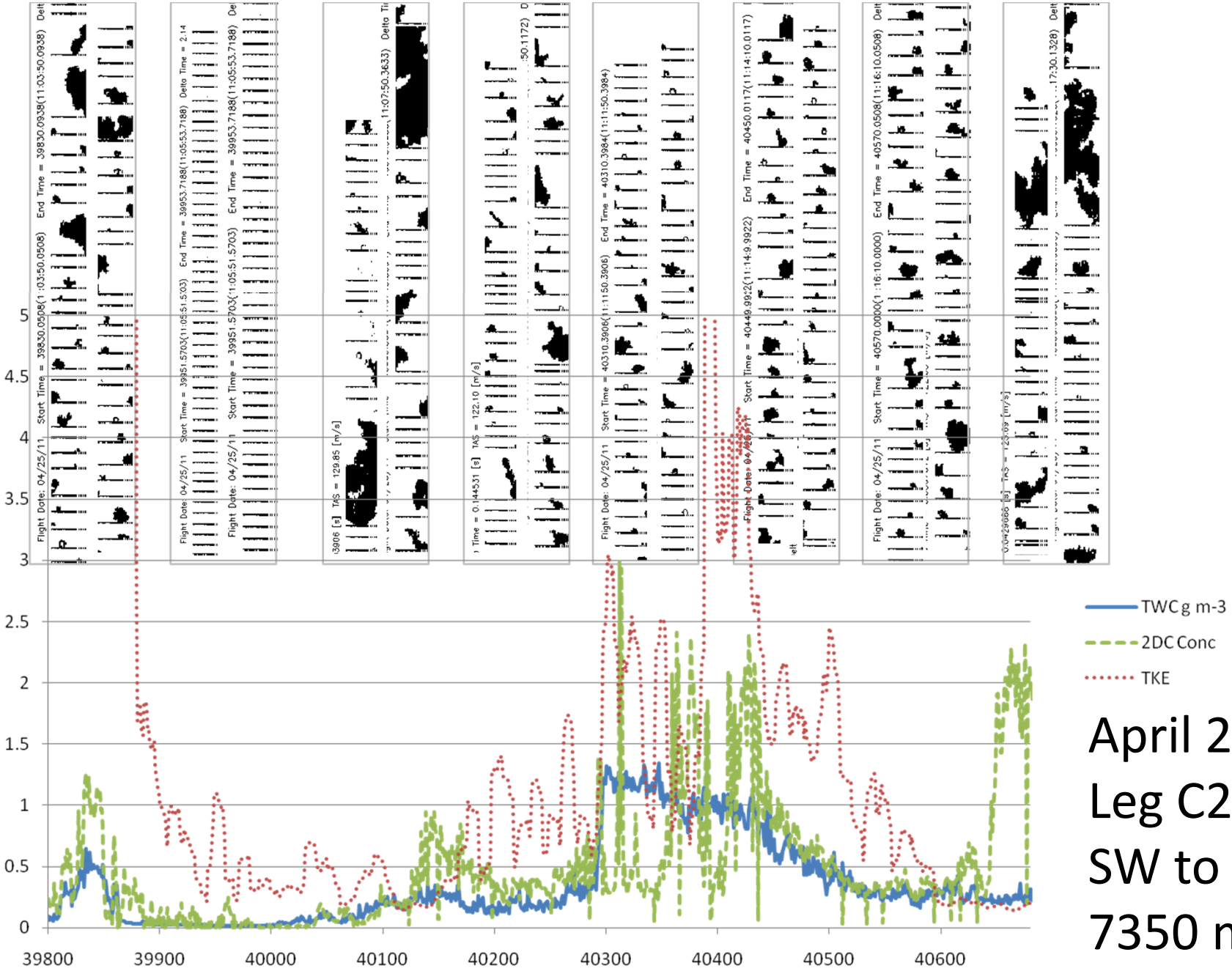
- NASA ER-2: Satellite simulator
- 86 flight hours
- Base: Albuquerque (Kirtland) AFB , NM

Instrument	Characteristics
AMPR (Radiometer, H +V)	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(Radiometer, H+V)	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 Radar	13.91/13.35 GHz, 35.56/33.72 GHz
Transmit peak power	30 W (Ku), 10 W (Ka)
3 dB beamwidth	2.9º Ku, 1.2º Ka
MDS (dBZ_e, 60 m res., 3.3 μs chirp pulse, 10 km range)	0.0, -5.0 dBZ_e

In Situ MIcrophysics

- UND Citation
- Microphysics
- 50 flight hours
- Base: Ponca City, OK

Instrument	Measurement
King	Cloud liquid water
PMS 2D-C/CIP	Cloud particle spectra
HVPS	Precipitation particle spectra
CPI	Cloud particle images
CDP	Cloud droplet spectra
Nevzorov	Total water content
Rosemount icing probe	Supercooled liquid water
CN/UHSAS	Aerosol



April 25
Leg C2
SW to NE;
7350 m,
-25 °C

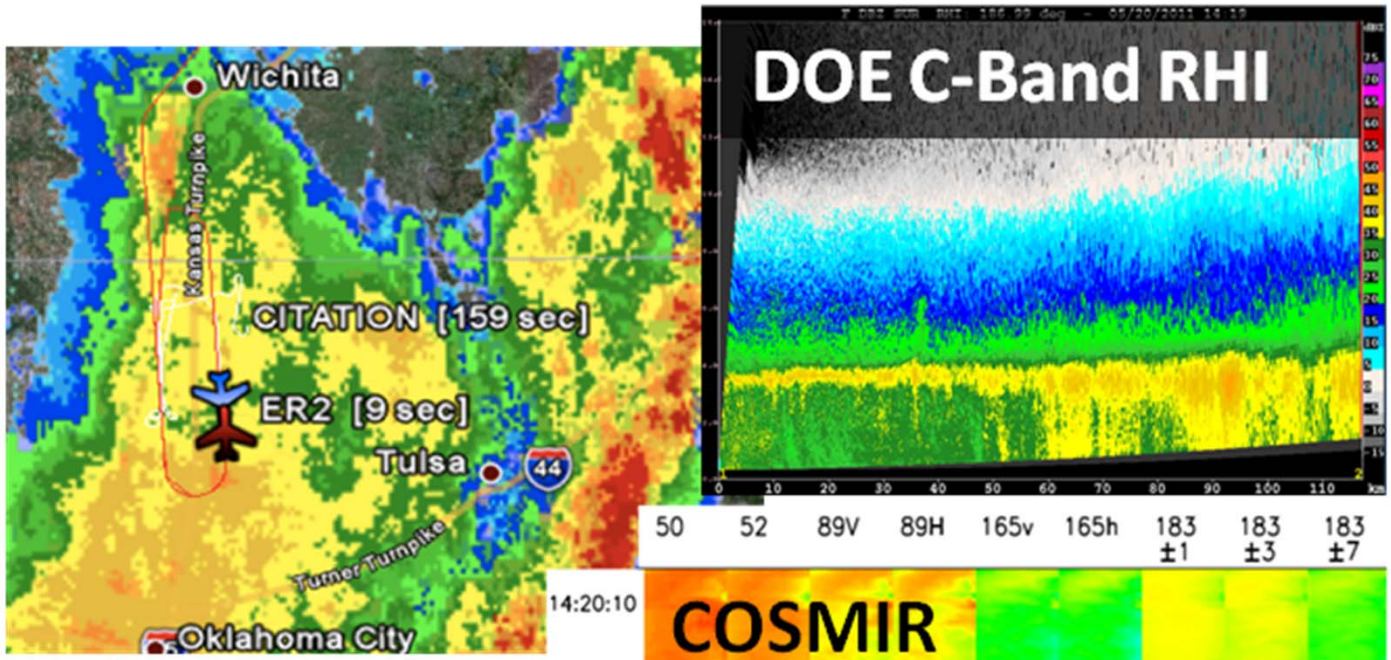
Summary of conditions sampled during MC3E

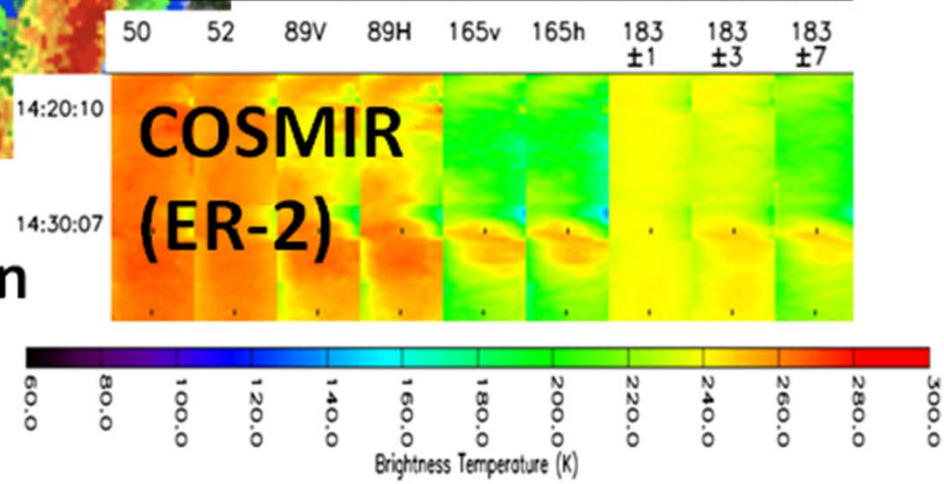
Category	Description	# days sampled	Days
1	Convective Line / Cell events	8	**4**/22,25; **5**/11,18,20,23,24,31
2	Widespread Stratiform Rain	3	4/27, 5/1, 5/10
3	Elevated Weak (Overnight) Convection	3	**4**/23, 24; **5**/18
4	Boundary Layer Clouds	10	**4**/26; **5**/5,13-15,19,27-29;**6**/1
5	Mid- or Upper-level clouds	7	**5**/2,3,8,9,25,26; **6**/2
6	Clear	14	

- Coordinated aircraft missions focused on categories 1 & 2
- Dedicated boundary layer cloud flight by UND Citation 5/27 & 5/30
- Enhanced sounding operations focused on categories 1-3

Coordinated Aircraft sampling

May 20MCS Precipitation (ER-2/Citation)



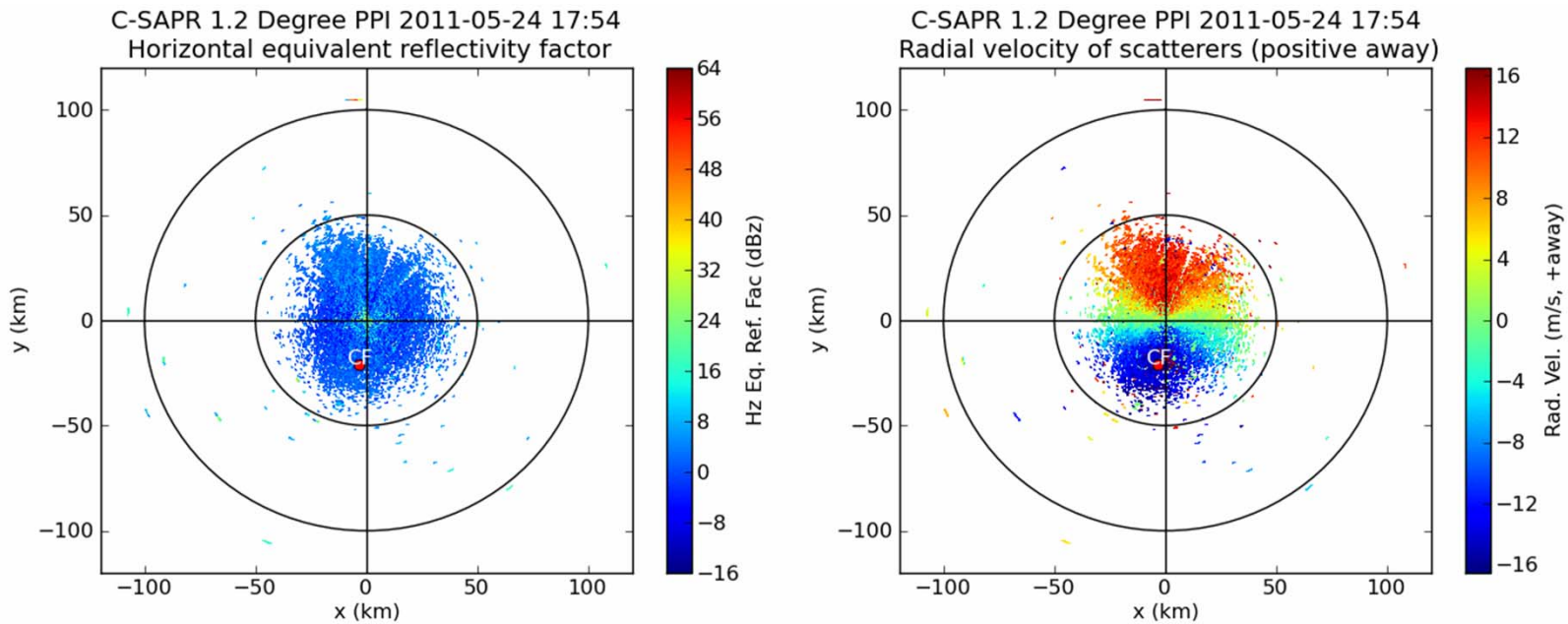


ER-2 and Citation stacked over SGP in MCS stratiform "Dream Scenario"

CoSMIR TB's indicate ice scattering

ARM C-band radar observations during MC3E

24 May 2011 - Strong convective line with severe weather



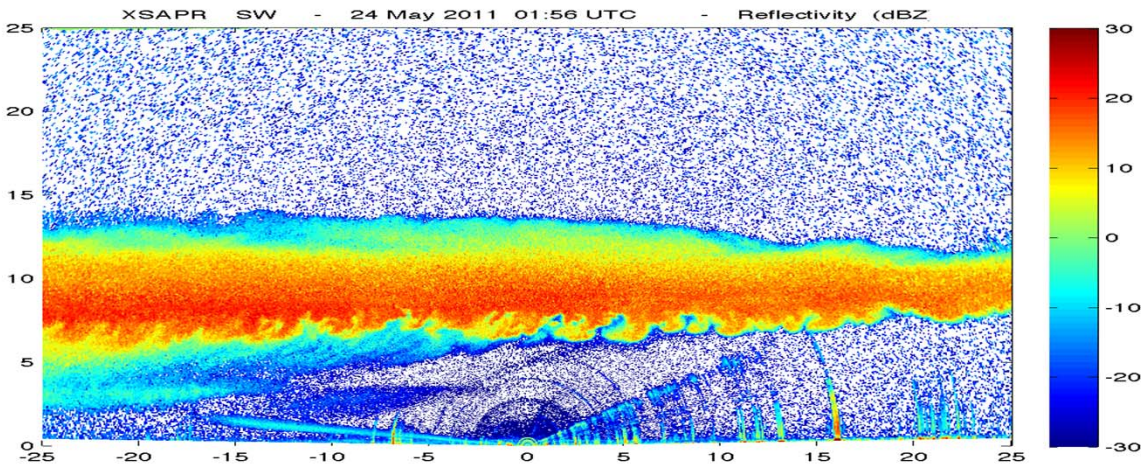
- Provide large-scale surveillance of precipitation and dedicated (RHI) cross-sections over the SGP Central Facility

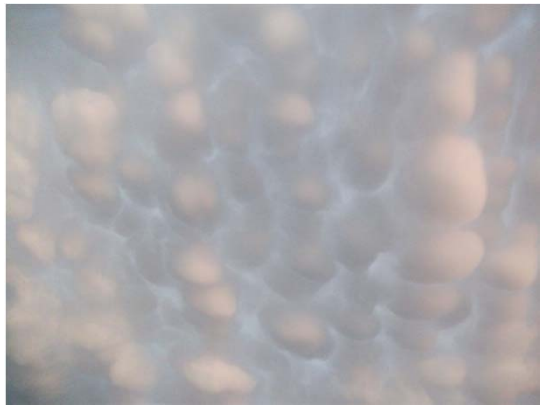
- On 05/24 SGP CF was in a regions of “High Risk of Severe Weather” for the entire day

- Animation includes ER-2 and UND Citation flight tracks

ARM X-band radar observations during MC3E

24 May 2011 - Mammatus clouds observed over SGP CF





- X-band radar systems have provided better than expected observations of clouds

- Several excellent cases for multi-Doppler analysis of atmospheric motions

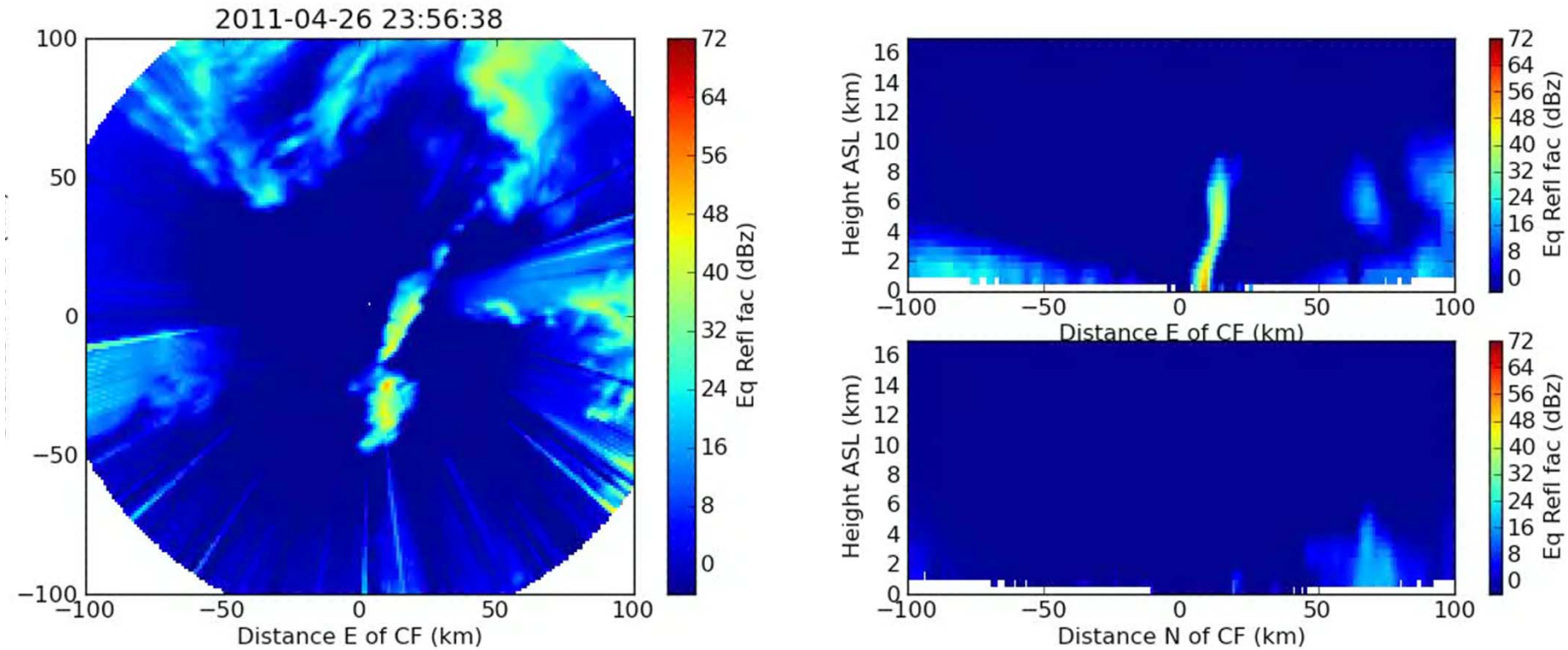
- One example of cloud observing capabilities of the X-band radar systems was on 24 May an excellent case of anvil base mammatus clouds were observed over the SGP CF during an (RHI) cross section scan.

Precip. Radar Analysis - Targeted cases

S. Collis (ANL), S. Giangrande (BNL)

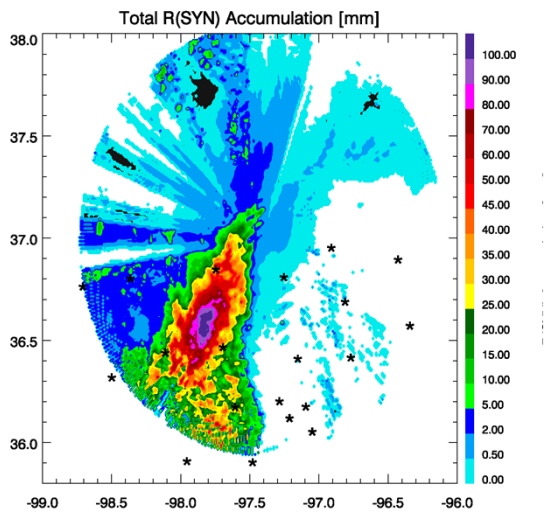
Event	Times	Status
April 24th	08-09UTC	Mostly processed, some errors
April 25th	07-13UTC	Mostly processed, some errors
April 27th	07-15UTC	Data fetched
May 1st	12-19UTC	Mostly processed, many errors
May 20th	04-15UTC	Fully processed
May 23rd	21-24UTC	Mostly processed, some errors
May 24th	00-02UTC	Data fetched
May 31st	07-10UTC	Not started

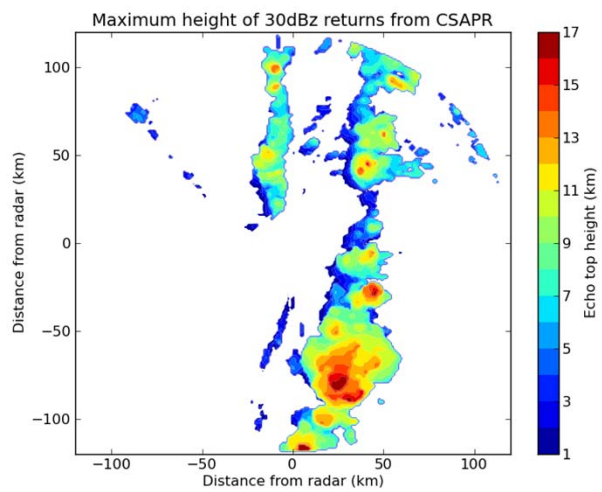
May 20th, A bit of everything



Evaluation VAPS for MC3E

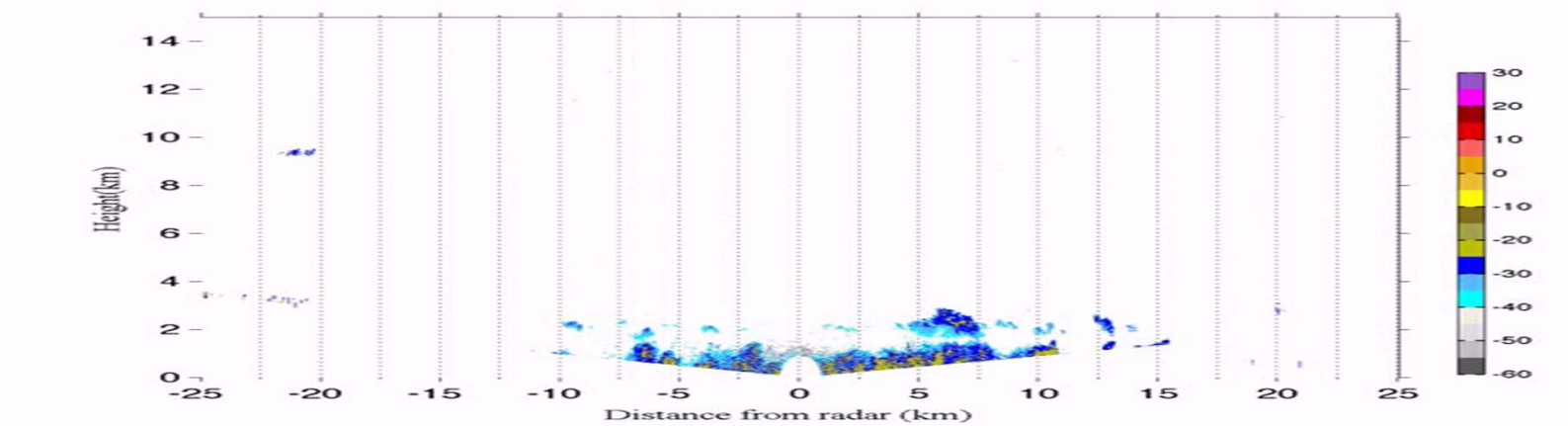
VAP	Domain	Times
Mapped Moments	240x240x17km, 100x100x17km	Whole experiment
QPE	240x240km	Whole Experiment
Vertical Velocities	100X100X17km	Select cases, lets collaborate!
Texture Maps	240X240km	Whole Experiment





ARM W-/Ka-band cloud radar observations during MC3E

5/27 May 2011 - Shallow convective cloud lifecycle



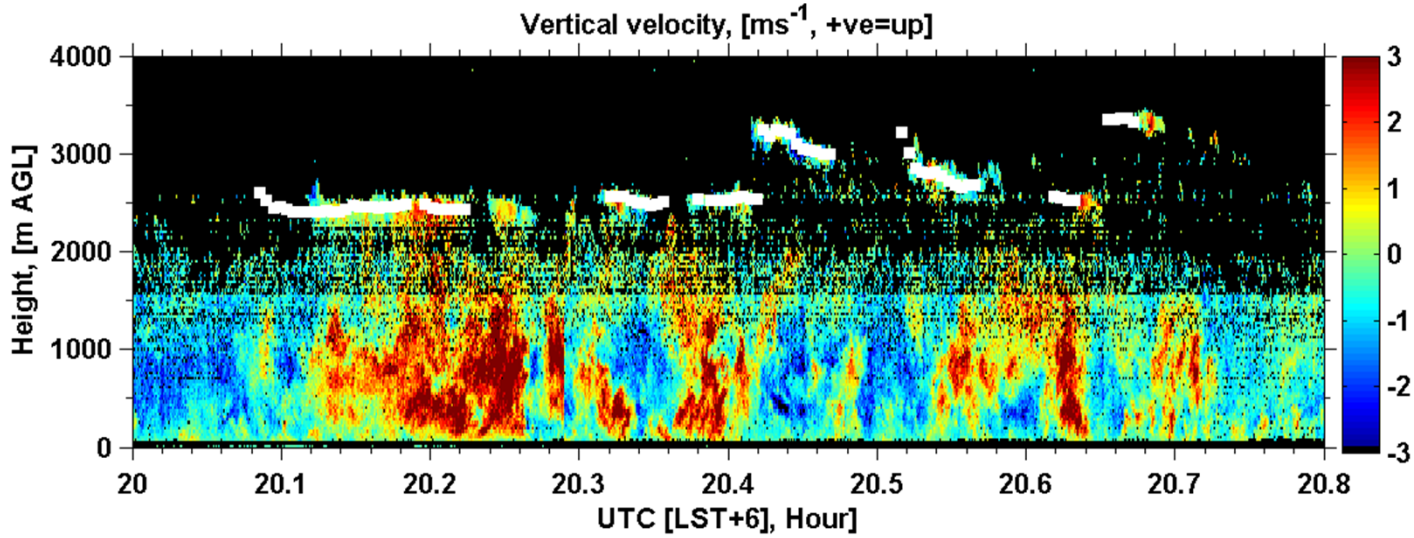
- Along wind scanning by radar allows observation of lifecycle of clouds

- First dataset of the complete lifecycle of shallow convective clouds observed by scanning ARM cloud radar

- Additional scanning observations of fair-weather cloud systems with coordinated in situ flights by the UND Citation

Doppler lidar observations during MC3E

05 May 2011 – Mid-level cloud case



- Doppler lidar provides important information on sub-cloud vertical motions

- Good correlation between sub-cloud upward motion and presence of clouds

- Strategic positioning adjacent to reconfigured 915 MHz profiler for complete sampling of boundary layer through deep convective cloud conditions