

A proposal for a

A ARM-GPM Midlatitude Continental Convective Clouds Experiment (MC³E)

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When? May – June 2009

Location? ARM SGP

ARM Key Science question #4: How do radiative processes interact with dynamical and hydrological processes to produce cloud feedbacks that regulate climate change?

Goal: Improve climate models!!

Elements Convective Parameterization

- 1) Pre-convective environment
- 2) Convective Initiation
- 3) Updraft/Downdraft Dynamics
- 4) Condensate Transport/Detrainment
- 5) Precipitation/Cloud microphysics
- 6) Influence on environment
- 7) Influence on Radiation
- 8) Large-scale forcing

Big Question: Given PBL (T,q) and vertical profiles, can the precipitation at the ground be predicted?

Surface Remote Sensing (Radar) based approach

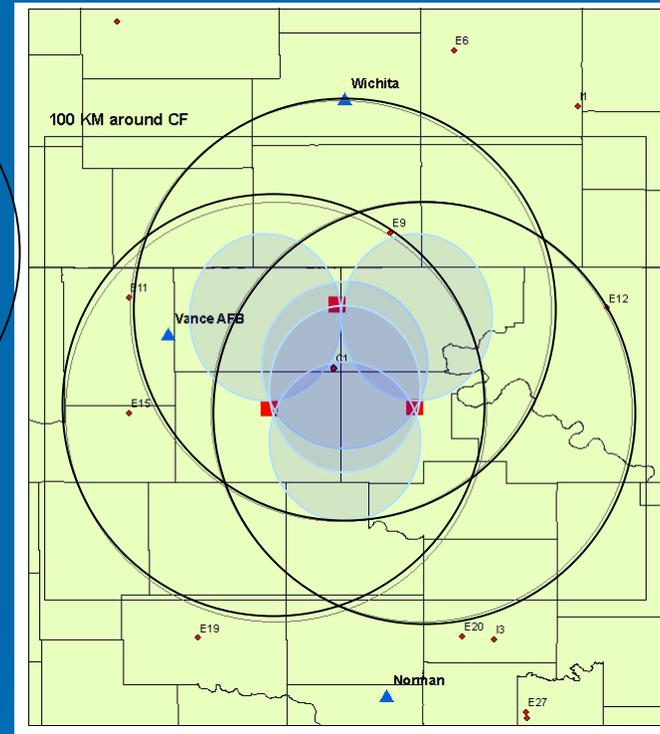
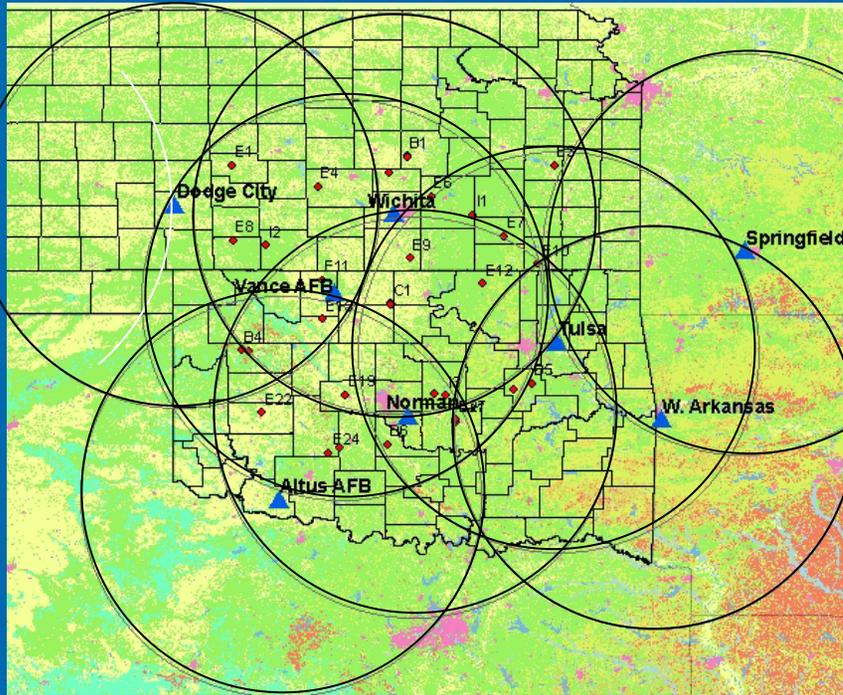
A combination of:

1. ARM-funded IOP measurements
2. GPM-funded IOP measurements
3. Routine non-ARM data resources
4. ARM external datasets
5. Routine ARM observations
6. Externally funded IOP measurements (NSF?)

To measure several quantities important for the consideration of convective parameterization and cloud-resolving model simulations

Centerpiece: Radar Remote Sensing

Multi-scale and Multi-frequency



NEXRAD Network

Area I : Cloud/Precipitation

Tri-Doppler and Profiling

Updraft/Downdrafts and Cloud μ -physics

X-band network (proposed)

Area II: Dual Doppler

Convergence/Divergence

Cloud/Precip. Morphology

GPM Objectives

- Collection of cloud μ -structure, μ -physics, PSD, R, aerosol in mid-lat land environment
- GV instrument precip. errors
- Evaluate GPM GV core instrumentation
- Sfc. fluxes of radiative, sensible and latent heat
- Large-scale forcing datasets (for CRMs)
- Testing of fidelity of CRM simulations
- CRM space-time integrating capability for QPE
- Physically-based GPM PMW algorithm over land
- GPM DPR precipitation retrieval algorithm

History

- Precip IOP suggested by Jim Mather at Fall 2005 CPWG meeting
- Proposal endorsed by CPWG and CMWG during 2006
- NASA-GPM expresses interest if postponed to 2010 (Feb '07)
- ARM-GPM collaboration discussions (Jul '07, Nov '07)
- Pre-proposal submitted to ACRF (May '08)
- Pre-proposal withdrawn (June '08) for resubmission in '09
- MC3E 2011 included in GPM Ground Validation Plan (July '08)
- First MC3E planning meeting (Friday)
- Pre-proposal to be re-submitted to ACRF (Feb '09)

Challenges

- i) coordinate the ground radar resources to accomplish our scientific objectives and identify other critical measurements (e.g., radiometers) that we need to constrain our multiparametric radar observations.
- ii) GPM and ARM funded modelers participation
- iii) without being risky, be innovative in our use of the unique resources to address critical needs of the modeling community
- iv) have a strong aircraft campaign but do not limit ourselves to validation efforts; Also focus on the physics and lifecycle of continental convection

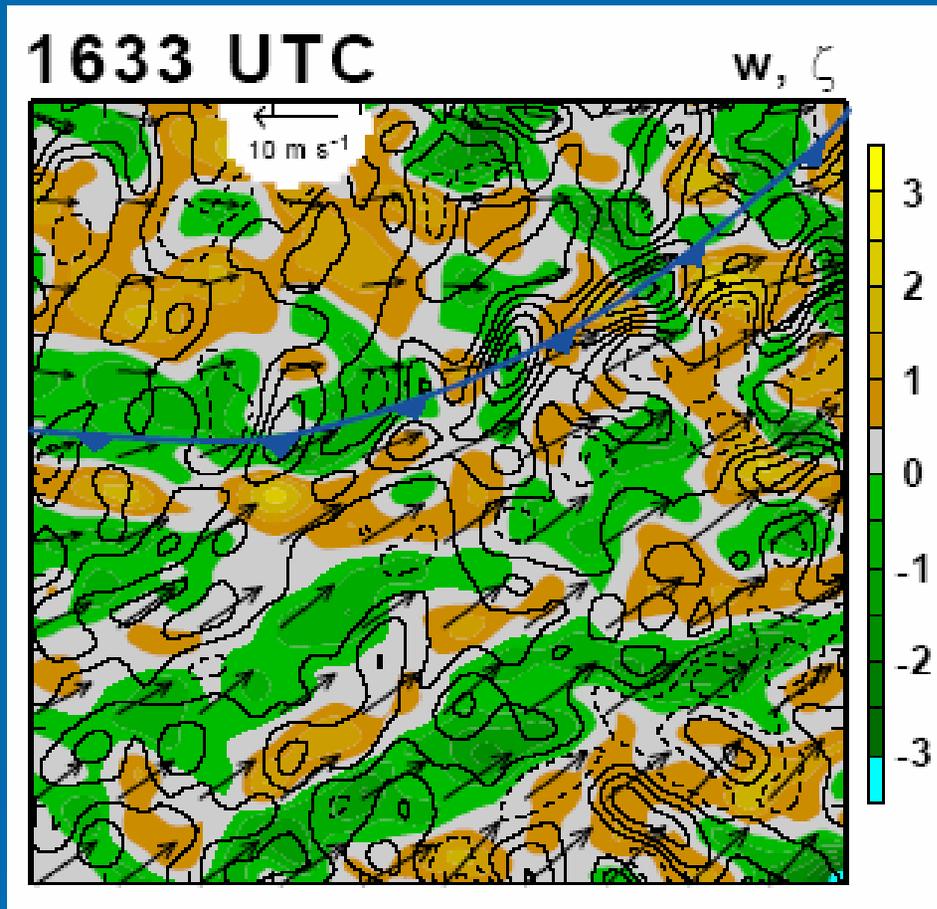


Fig. 5. Horizontal cross section of vertical vorticity (contoured at $1 \times 10^{-3} \text{ s}^{-1}$) at 1 km and near-ground winds (ms^{-1} ; dashed contours are negative) overlaid upon the vertical velocity (w ; color shading) at 1 km at 1633 UTC. The distance between tick marks on the domain borders is 4 km. (from Stonitsch J., and P. Markowski)

Radar measurements of Atmospheric Refractivity (i.e. RH variations)

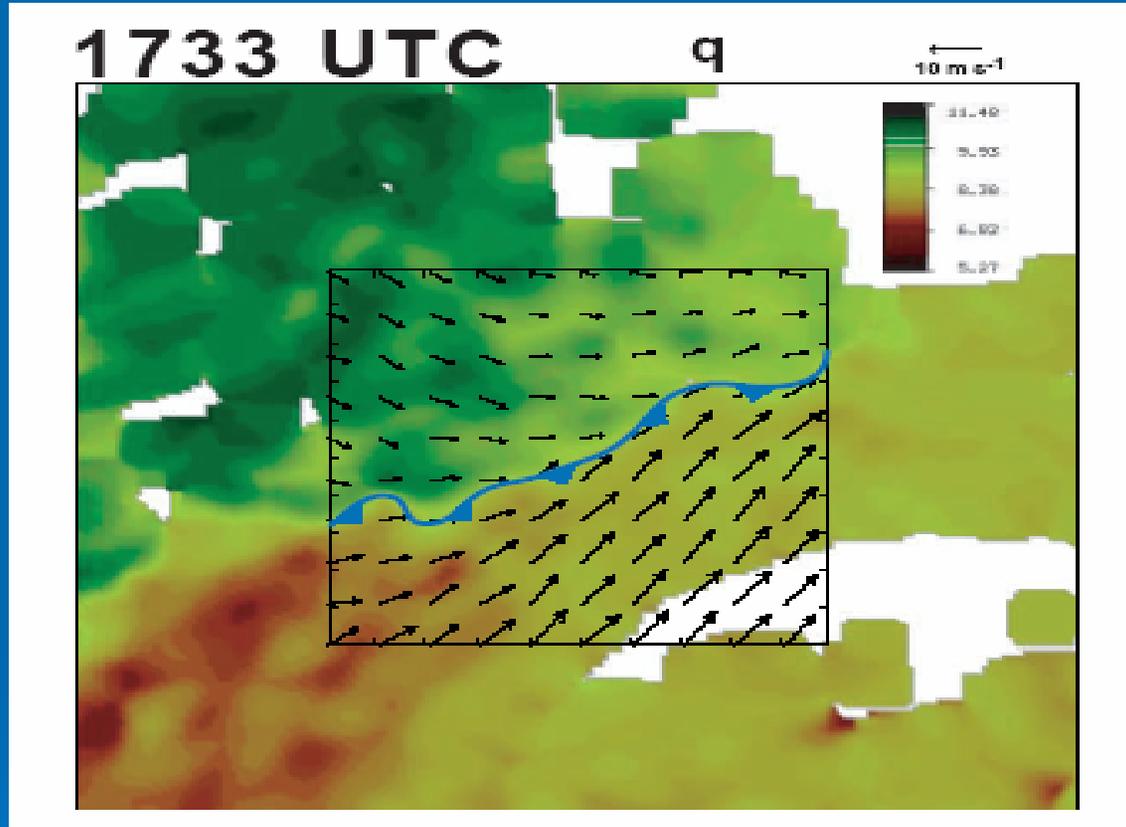


Fig. 3. Surface wind vectors and refractivity-derived specific humidity (q ; color shading) at 1733 UTC. Dimensions of the interior box are $20 \times 20 \text{ km}^2$, while the color moisture field spans $40 \times 40 \text{ km}^2$. (from Stonitsch J., and P. Markowski)

Candidate instruments and what they provide(1)

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|-------------------------------------|-------------------------------------|
| 1) Pre-convective environment | 2) Convective Initiation |
| 3) Updraft/Downdraft Dynamics | 4) Condensate Transport/Detrainment |
| 5) Precipitation/Cloud microphysics | 6) Influence on environment |
| 7) Influence on Radiation | 8) large-scale forcing |

Instrument	Quantities Observed	Conv. Param Elements
Scanning [X-band] radars (3, ARM/guest)	Cloud/Precip properties, Refractivity, Updraft/downdraft structure	1,2,3,4,5,6
Phased-array radar	Cloud/precip properties	2, 4, 5
Ka/Ku DPR (GPM)	Cloud/precip properties, Refractivity (i.e. RH variations)	1,2,4,5,6
Increased radiosondes (ARM)	Vertical profiles of atmospheric thermo	1, 6, 8

Candidate instruments and what they provide (2)

- 1) Pre-convective environment
- 2) Convective Initiation
- 3) Updraft/Downdraft Dynamics
- 4) Condensate Transport/Detrainment
- 5) Precipitation/Cloud microphysics
- 6) Influence on environment
- 7) Influence on Radiation

Instrument	Quantities Observed	Conv. Param Elements
Nexrad WSR-88D (non-ARM)	Large-scale precip.	4,5,8
OK Mesonet (external ARM)	Sfc. met	1,6,8
Disdrometers (ARM, GPM)	Precip properties	5
In-situ microphysics (GPM)	PSD, IN, aerosol	
Aircraft W/Ka/Ku radar, PMW radiometers (GPM)	Cloud and precip. properties	
MMCR (ARM)	Cloud properties	2,3,4,5

Our priorities

- X-band radar network (CASA?)
 - Multi-Doppler updrafts/downdrafts
 - Radar refractivity
 - Will CASA be at SGP or do we need to look elsewhere?
 - Sounding network
 - For forcing dataset
 - Or is ECMWF output sufficient?
 - Scanning precip. radar
 - S-Pol (too costly without NSF participation)
 - C-Pol
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Questions?

- Focus IOP operations at SGP CF or CASA IP1 network?
 - Status of CASA radar network for 2011?
 - Do we need sounding network?
 - What are synergies with NASA GPM?
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