Analysis of a Parallel Stratiform Mesoscale Convective System during the Midlatitude Continental Convective Clouds Experiment

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Background

- Parker and Johnson (2000) classified mesoscale convective systems (MCSs) into three modes based on the orientation of radar reflectivity features: leading stratiform (LS), trailing stratiform (TS), and parallel stratiform (PS).
- There have been few studies done on PS MCSs (Parker 2007).
- There are uncertainties in the interaction between PS MCSs, their cold pools, and the transition to the TS mode.
  - RKW Theory states that cold pools are necessary in MCS development and evolution (Rotunno et al. 1988; Weisman et al. 1988).
  - Bryan et al. (2004) concluded that the 2D assumptions within RKW Theory are not valid when applied to PS MCSs because of 3D features.
  - Parker (2007) concluded that the development of a cold pool is a major factor in the transition from PS to TS MCS.

Overview

- On 11 May a PS MCS passed over north-central Oklahoma.
- Measurement sources:
  - University of North Dakota Citation II Weather Research Aircraft
  - Oklahoma Mesonet
  - S-Band radars
    - Vance Air Force Base, OK (KVNX)
    - Wichita, KS (KINX)
    - NASA S-Band Transportable Dual Polarimetric Radar (NPOL)

Leg	Altitude [km MSL]	Temperature [°C]
1	7.5	-25
2	6.6	-16
3	5.6	-11
4	4.7	-6
5	3.7	0
6	2.8	8

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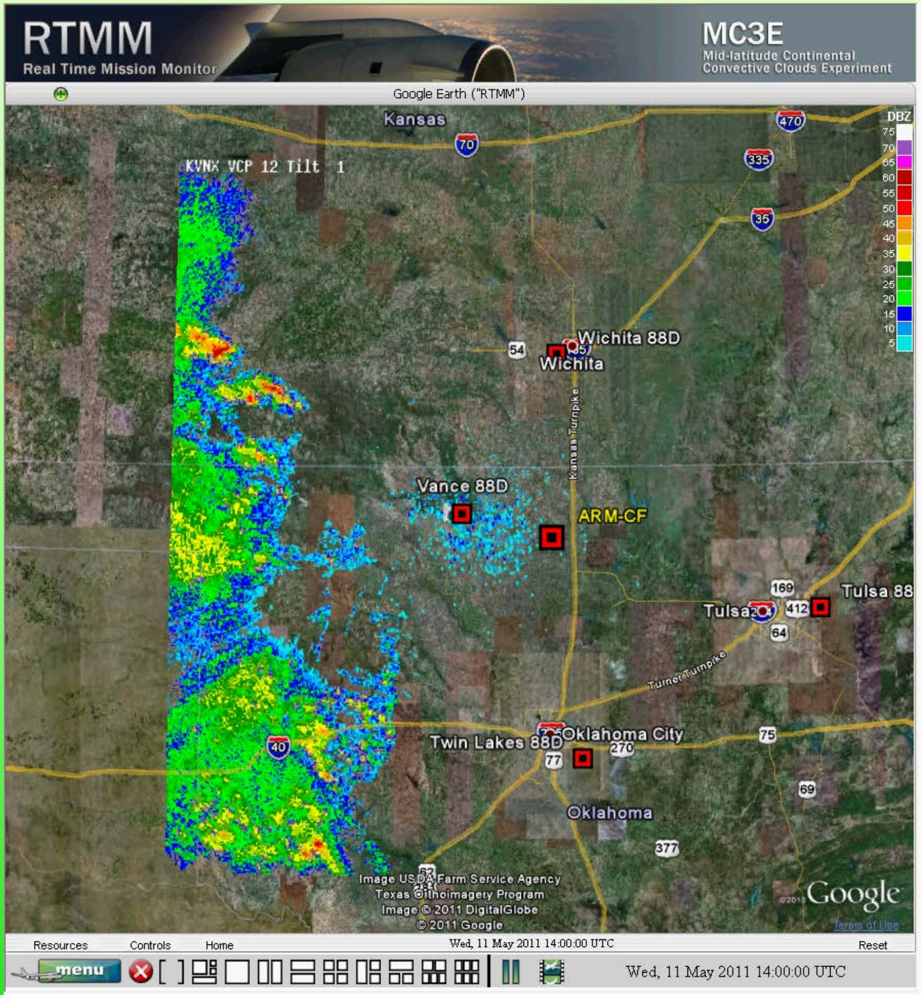
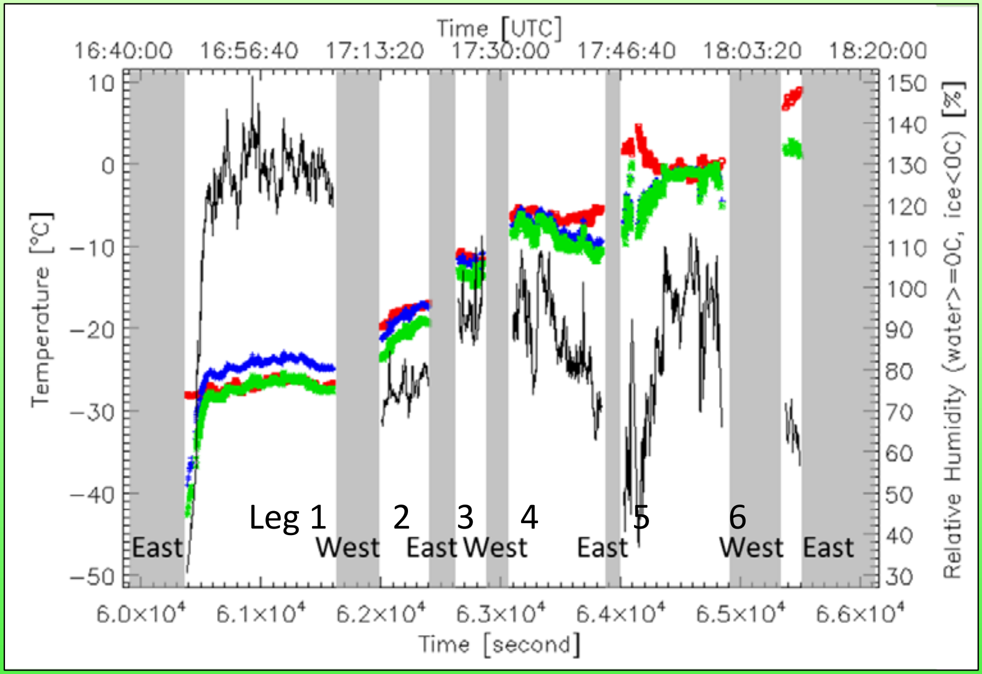


Temperature and Moisture Profile

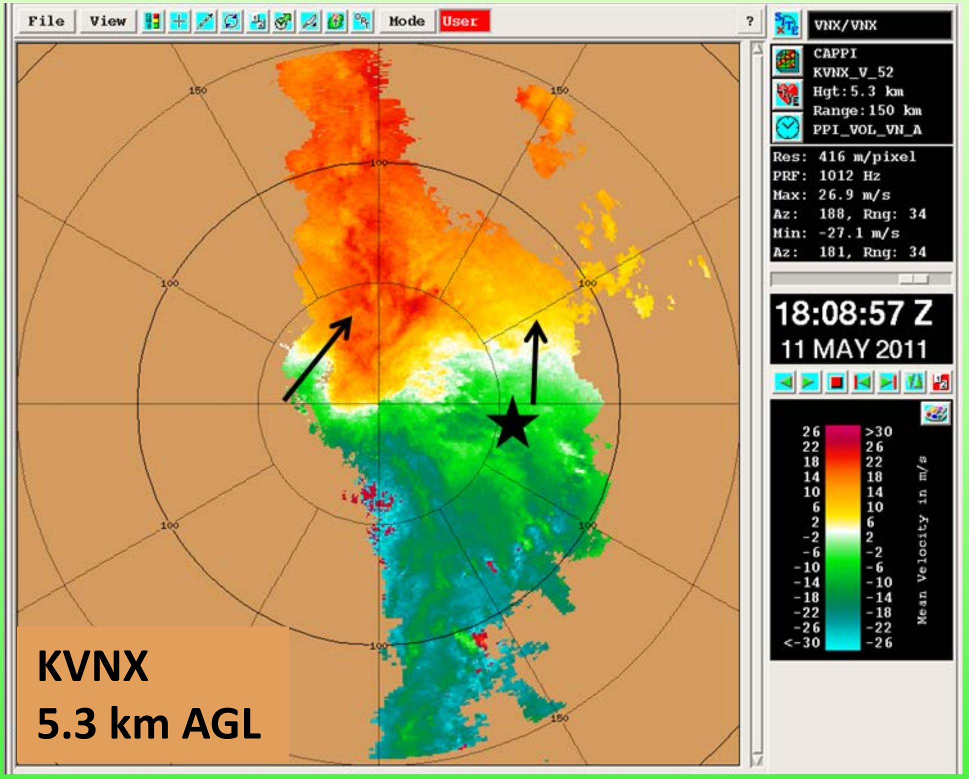
- Supersaturated conditions present in the 1st flight leg (alt ≈ 7.5 km MSL).
- Much variability in the RH across the PS region (Legs 4 and 5).
- Subsaturated conditions present in the 6th flight leg (below the melting layer).



Temperature
Dew Point
Frost Point
Relative Humidity

Kinematic Wind Analysis

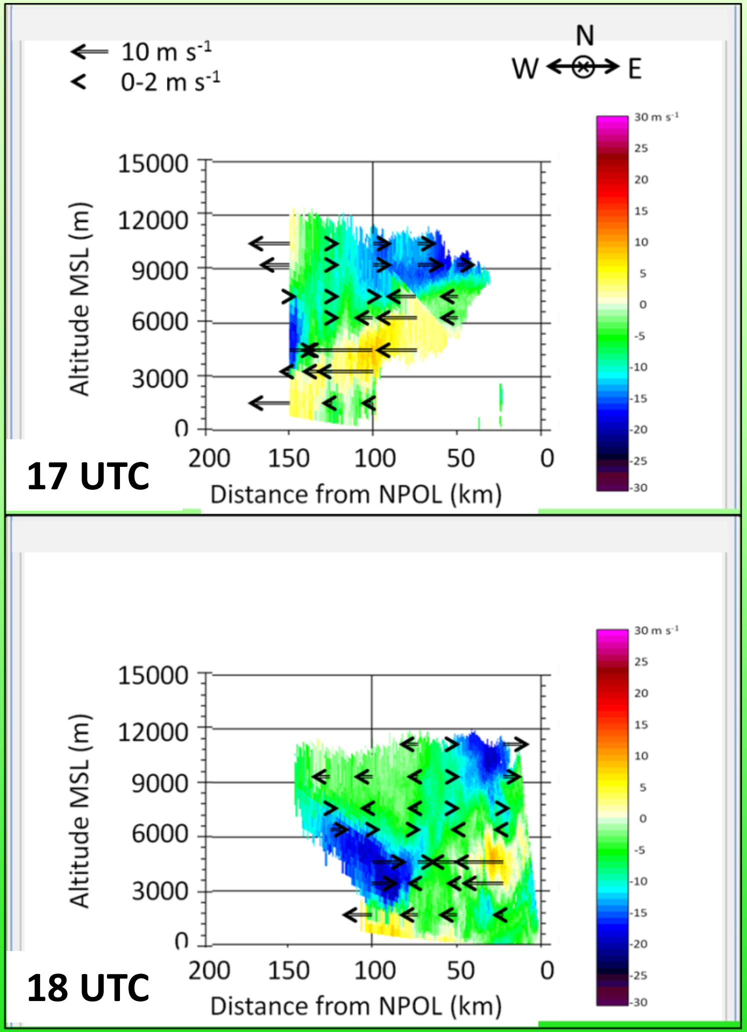
- Radial velocity data from KVNX and KICT were plotted on CAPPIs to analyze the kinematic wind flow.
- Predominately southerly wind flow from 16 to 18 UTC.



★ Location of ARM Southern Great Plains central research facility

Kinematic Wind Analysis

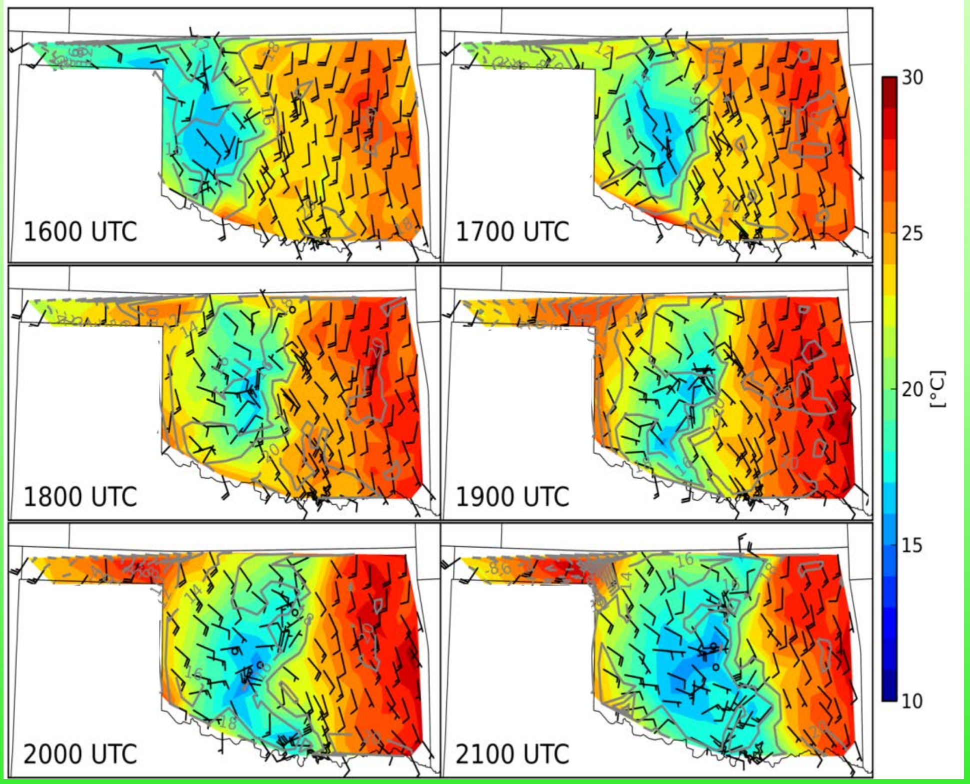
- NPOL 270° azimuth RHI scans show the east-west component of the wind.
- Storm-motion was 22 m s^{-1} towards 22° from north.
- NPOL storm-relative winds show an area of rear-inflow from 3-6 km AGL.



Colors denote ground-relative wind speed.
Arrows denote storm-relative wind speed.

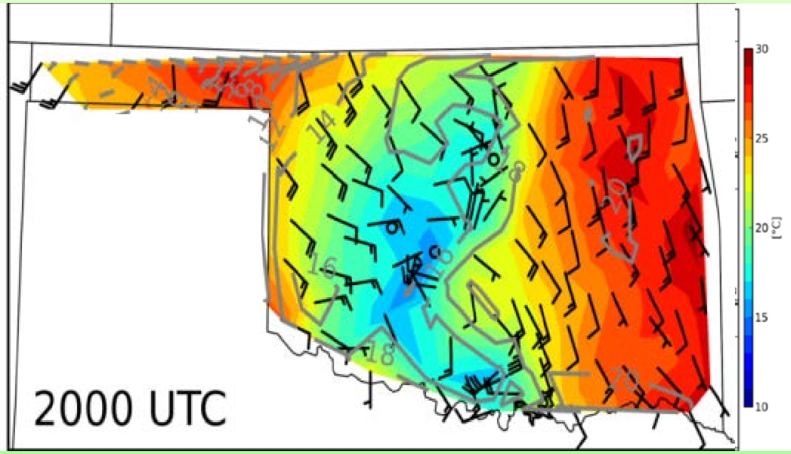
Cold Pool Evolution

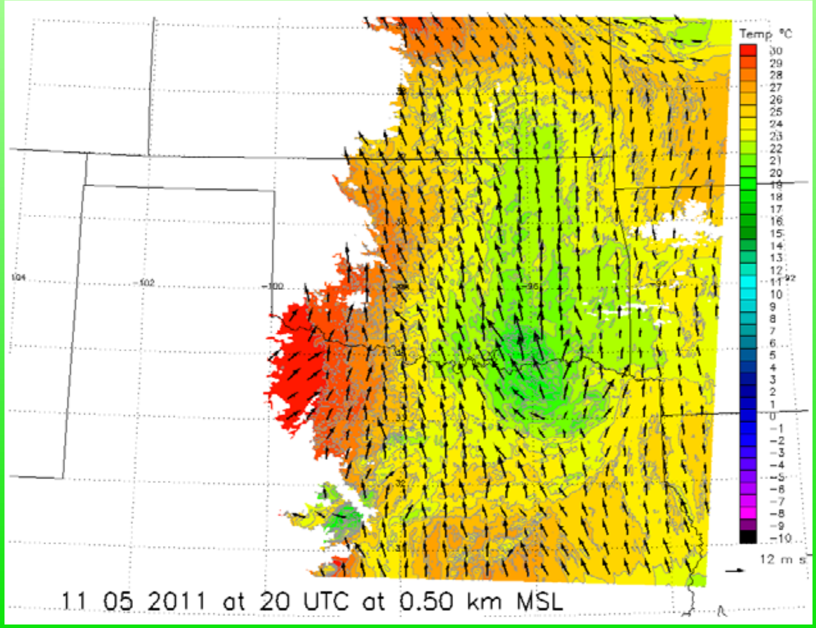
- Oklahoma Mesonet data shows the evolution of the surface cold pool.
- MCS transitioned from PS to TS between 18 and 19 UTC.
- Even after the MCS transitioned to TS mode, there was very little surface outflow extending ahead of the MCS.



Cold Pool Evolution

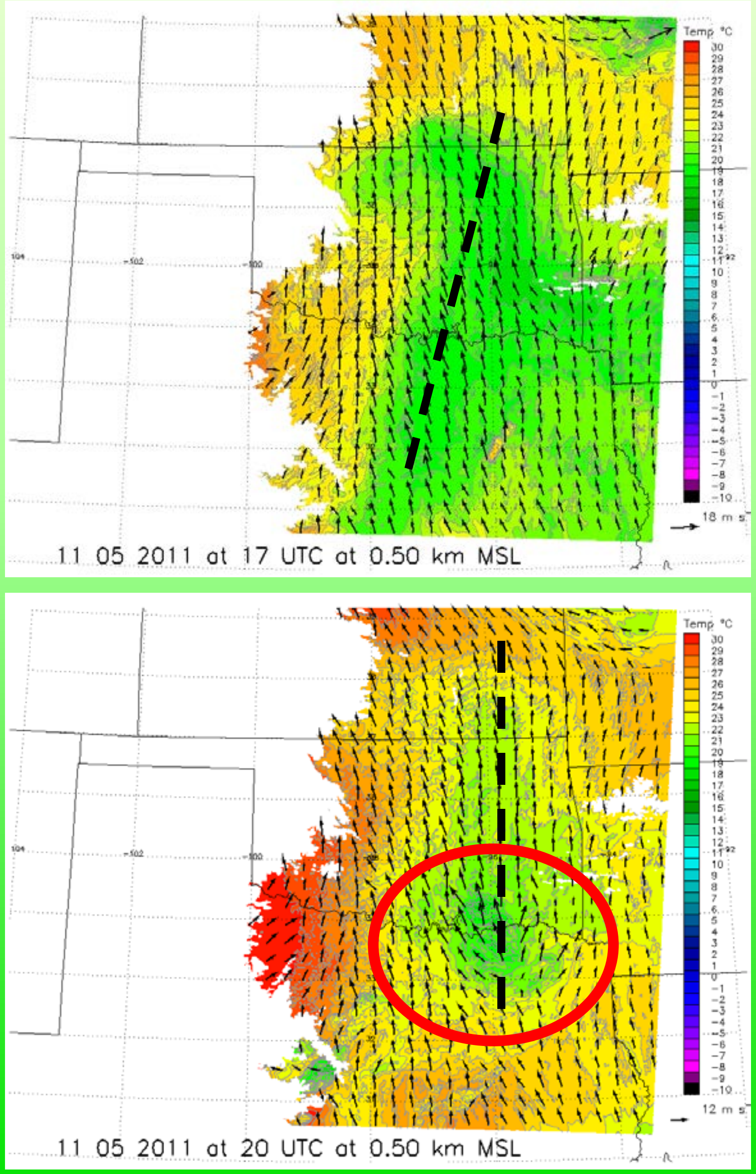
- A mesoscale community WRF model simulation of 11 May 2011 is analyzed to determine the effects of the cold pool upon the MCS.
- Actual and modeled temperature deficits in the center of the cold pool are similar.
- Simulated MCS is displaced eastward compared to the actual MCS from 16-21 UTC.





Cold Pool Evolution

- Cold pool outflow is more pronounced after the transition to TS MCS.



Approximate storm axis

Conclusions

- The pre-storm wind profile was similar to those observed in previous studies of PS MCSs.
- An area of rear-inflow was present – a feature not seen in previous studies.
- Changes in the cold pool coincided with changes in the MCS organization.

Thank you