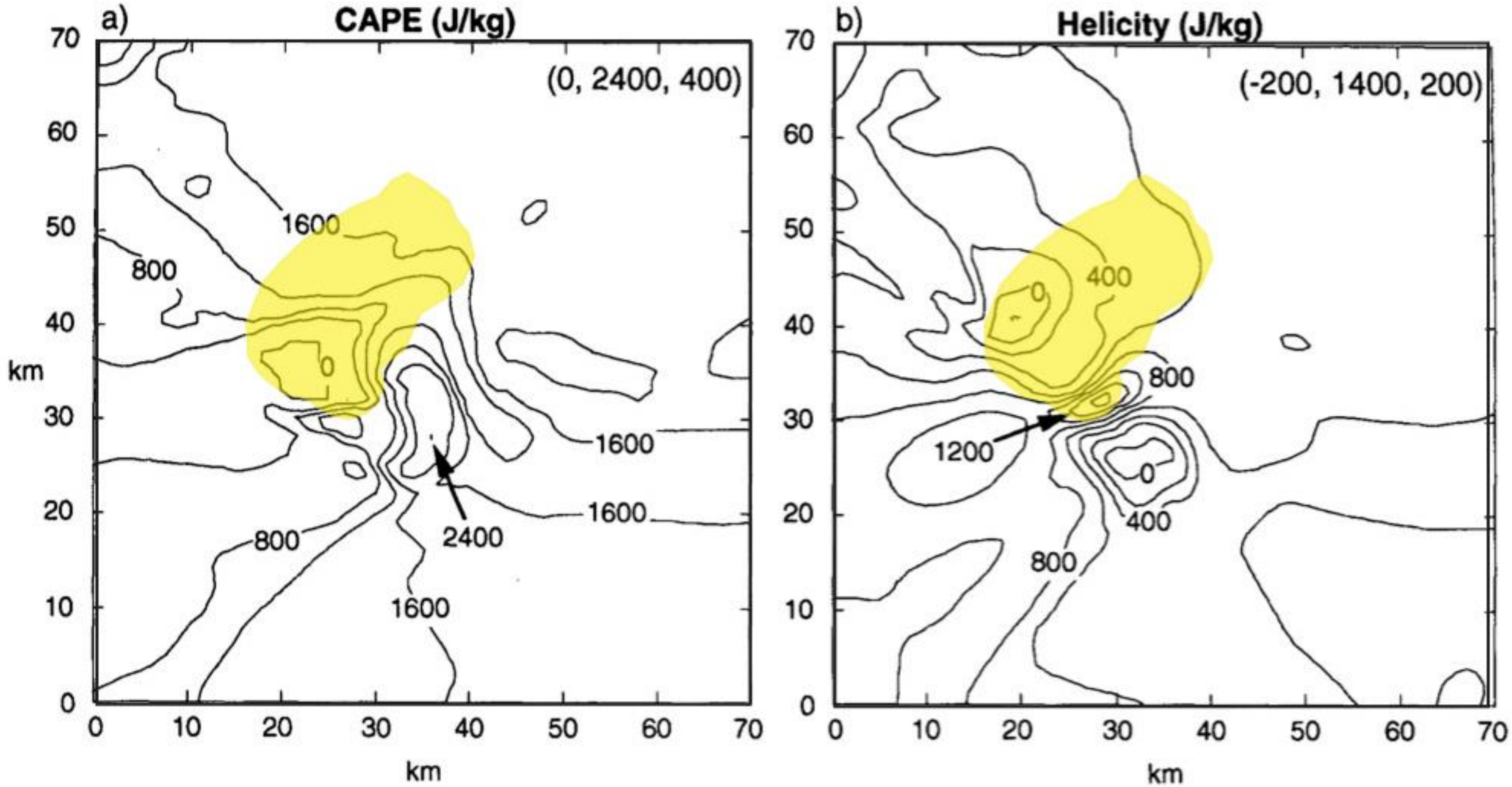
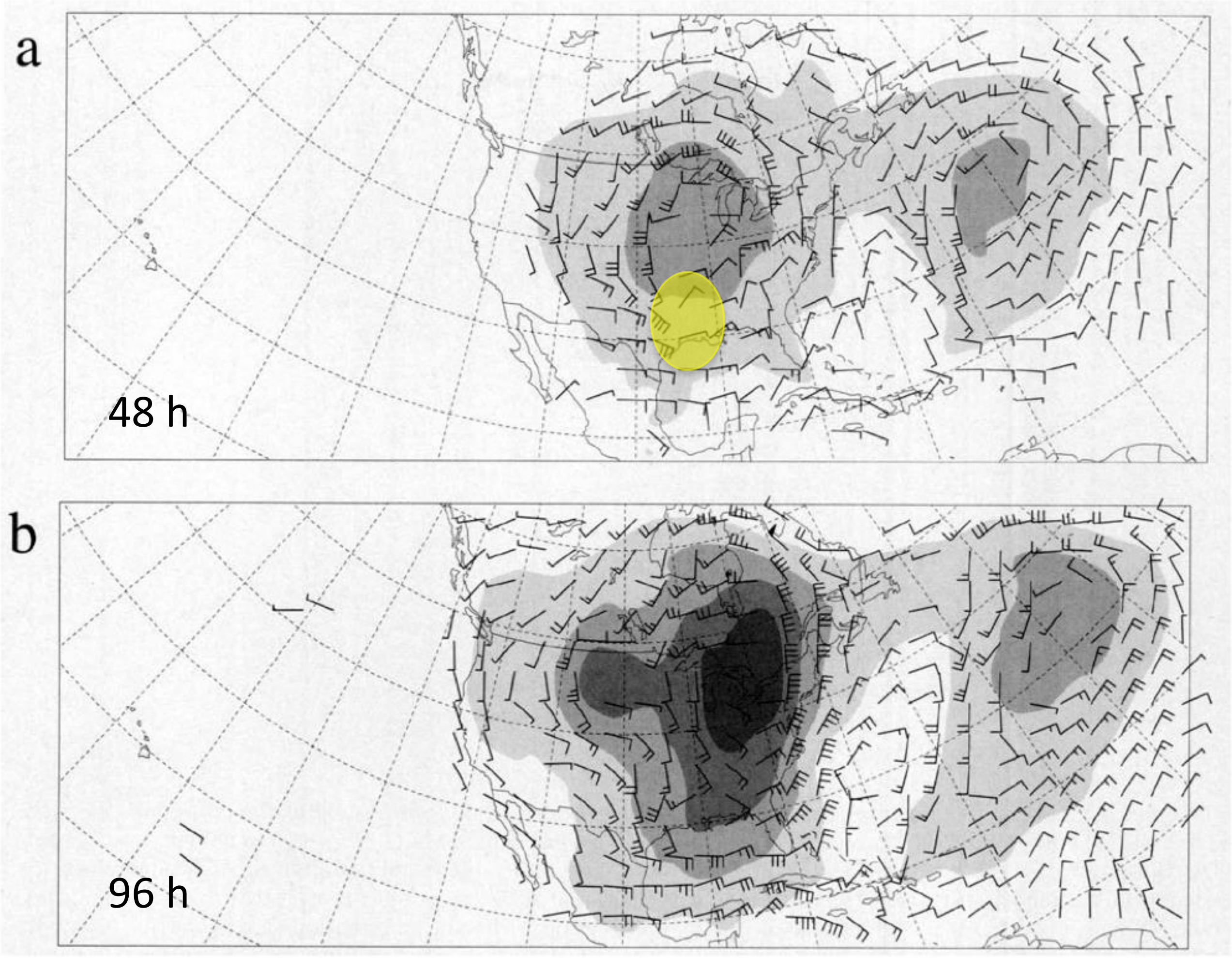
Ability of Models to Reproduce Upscale Feedback of Deep Convection

David J. Stensrud
NOAA/National Severe Storms Laboratory



From Brooks et al. (1994 WAF)

200 hPa Wind and Geopotential Height Differences
Run with deep convection – run without deep convection



From Stensrud (1996 JAS)

Figures from my final paper in Toby Carlson's Advanced Synoptic class. Vertical circulations diagnosed from Sawyer-Eliassen secondary circulation equations (Shapiro 1981). Circulation associated with deep convection would assist in formation of tropopause fold.

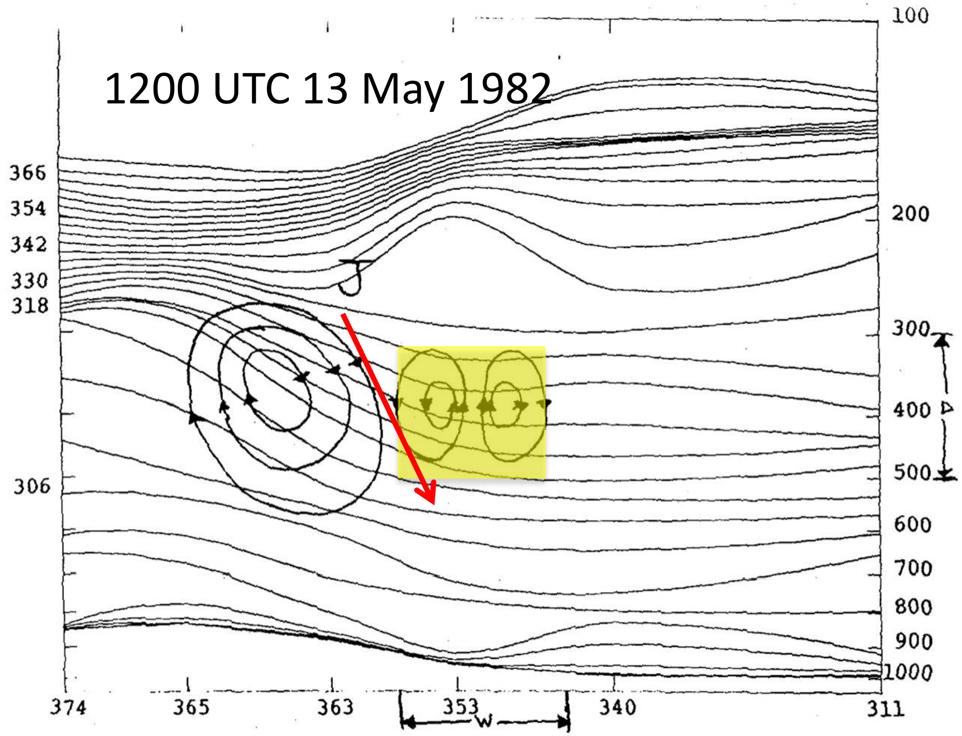


Fig. 10. Cross-section from Athens, Georgia, to Winslow, Arizona, from 1200 UTC 13 May 1982. *Isentropes every 3 C.* J denotes location of jet core, and solid lines with arrows denote transverse ageostrophic circulations. *Hypothesized circulations due to* diabatic heating are located in the region indicated by W and D. W is the estimated horizontal width of the anvil region; D is the estimated depth of the anvil. Location of the cross-section is from A-A' in Fig. 2 (d).

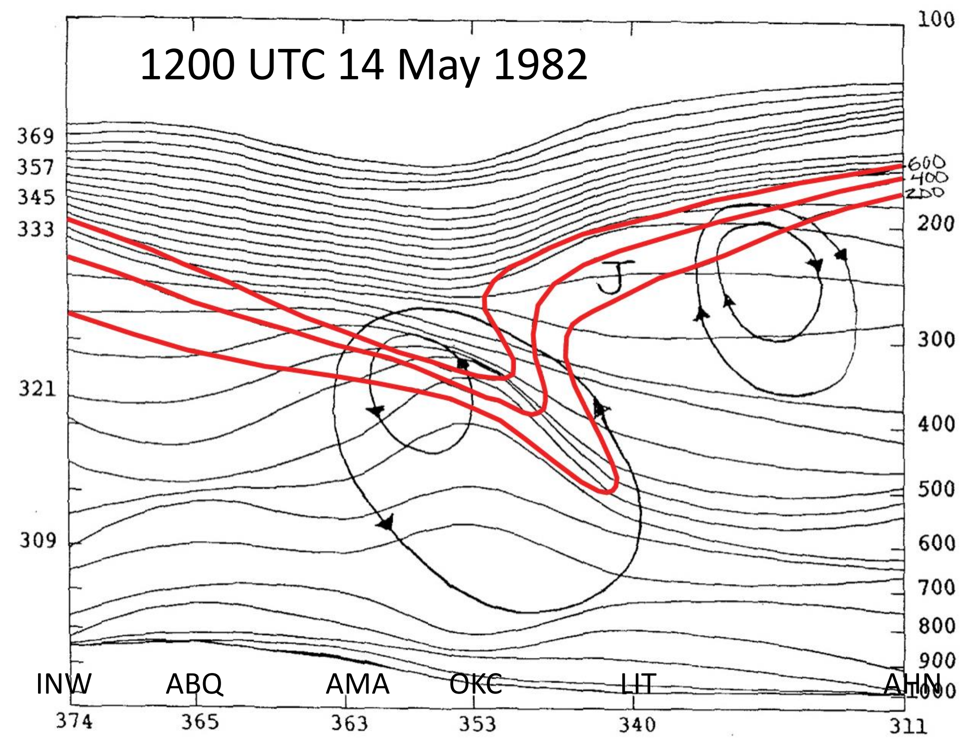
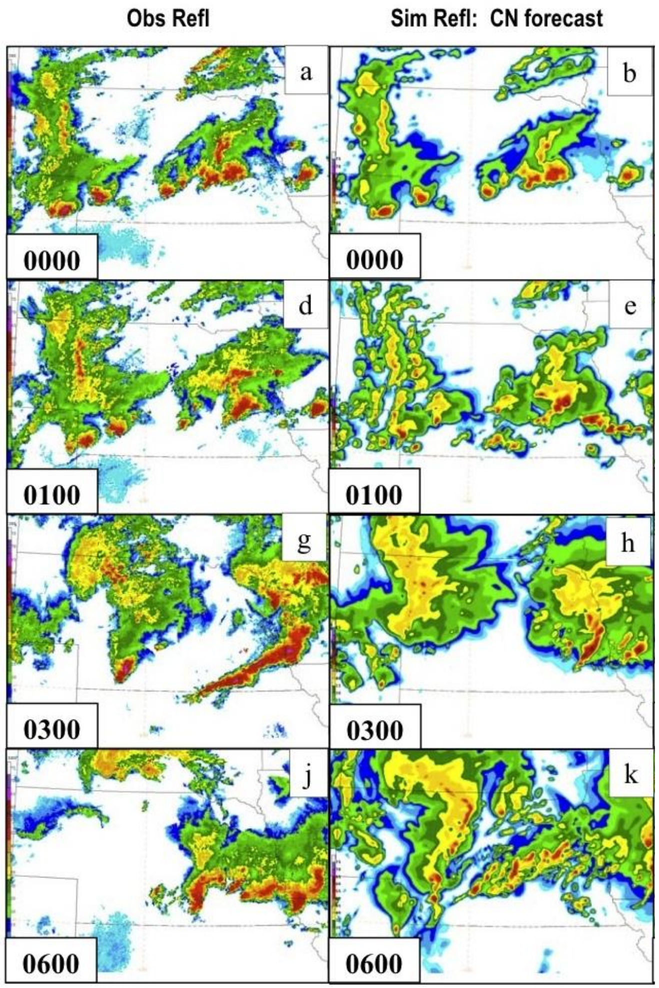


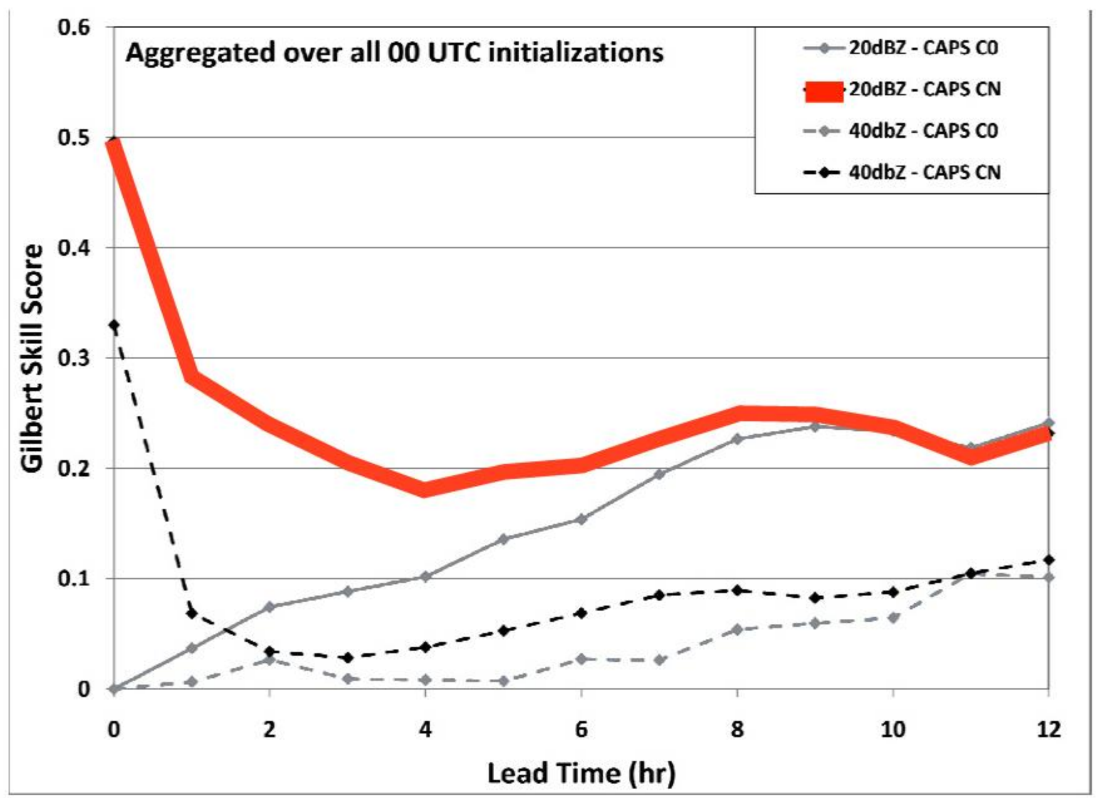
Fig. 3. Cross-section from Athens, Georgia, to Winslow, Arizona, from 1200 UTC 14 May 1982. Isentropes every 3 C. J denotes location of jet core. Dark solid lines show contours of potential vorticity (1×10^{-5} K mb^{-1} s^{-1}), and solid lines with arrows denote diagnosed transverse ageostrophic circulations. Location of cross-section is from A to A' in Fig. 2 (d).

Challenges in Convective-scale NWP



4-km forecasts initialized using radar observations yield improved short-range forecasts of convective activity (Kain et al. 2010).

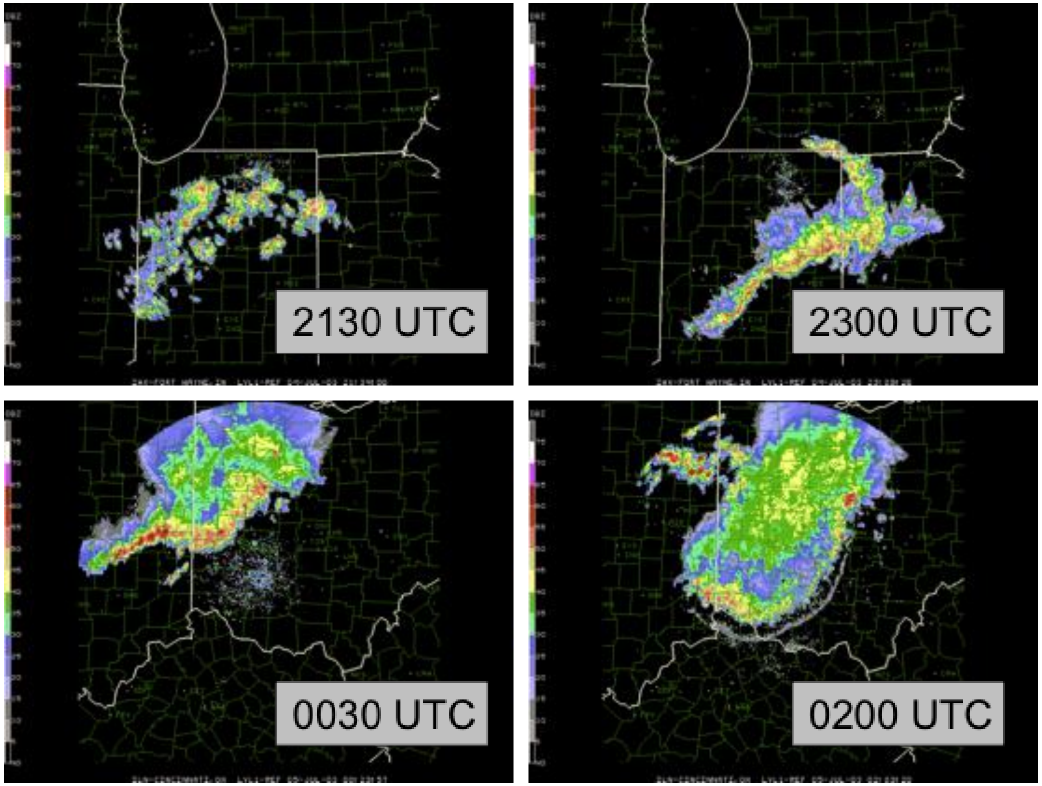
Particularly helpful for looking at convective mode and evolution.



Center for Analysis and Prediction of Storms
University of Oklahoma

Courtesy Jack Kain

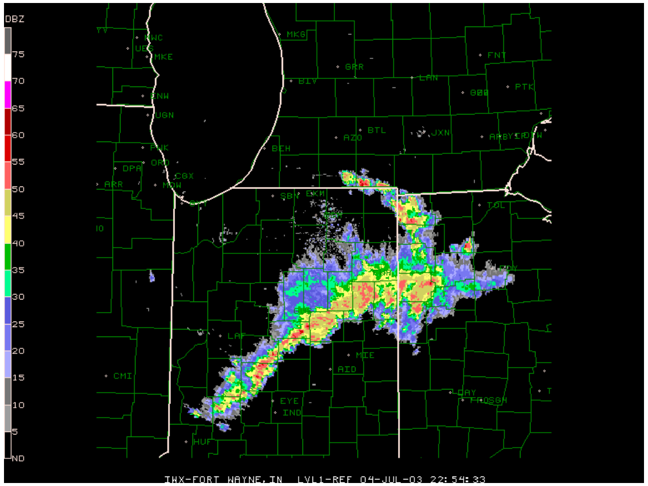
4-5 July 2003 MCS damaging-wind and flooding event

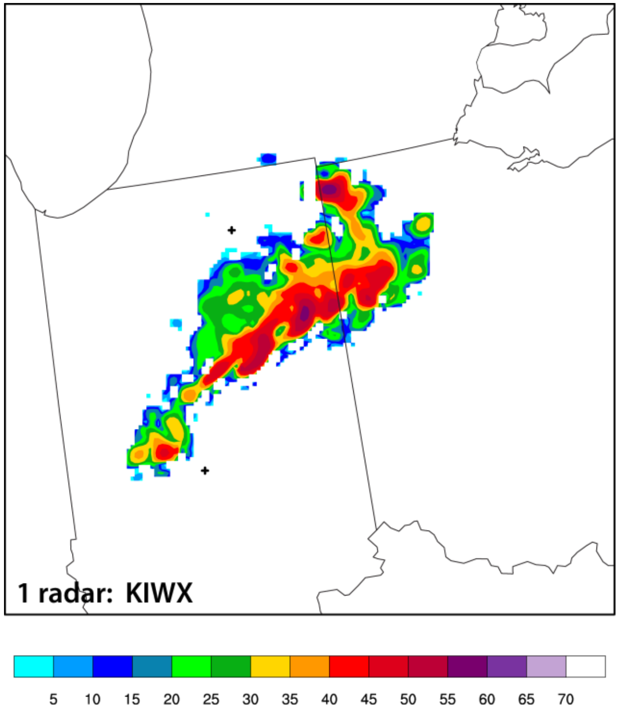


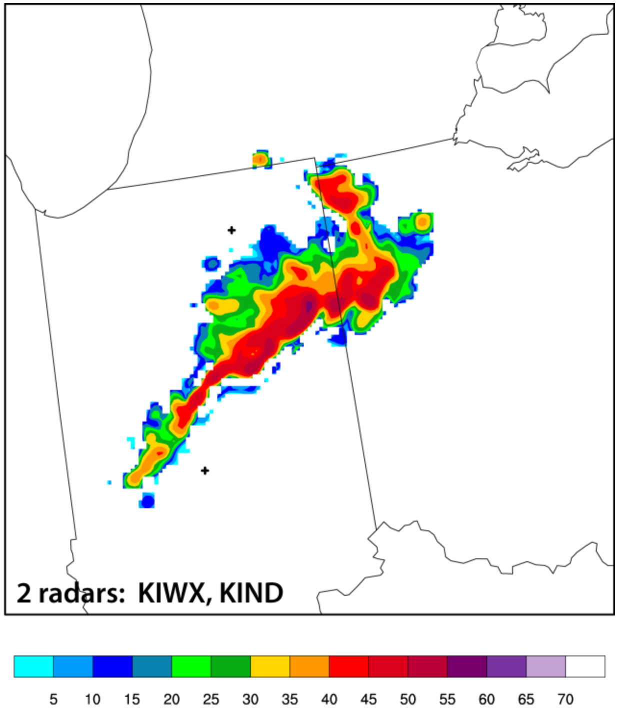
- Observed during BAMEX
- Produced 100+ wind reports across Indiana and Ohio
- Contributed to record flooding across north-central Indiana
- Not captured in NWP models of the day

Courtesy Dustan Wheatley

Ensemble Analyses valid 2300 UTC 4 July



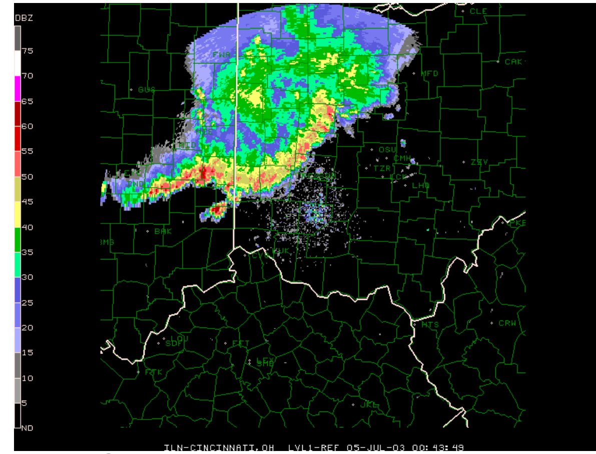




3 km dx, 51 levels, WRF/DART, 45 members, 88D observations

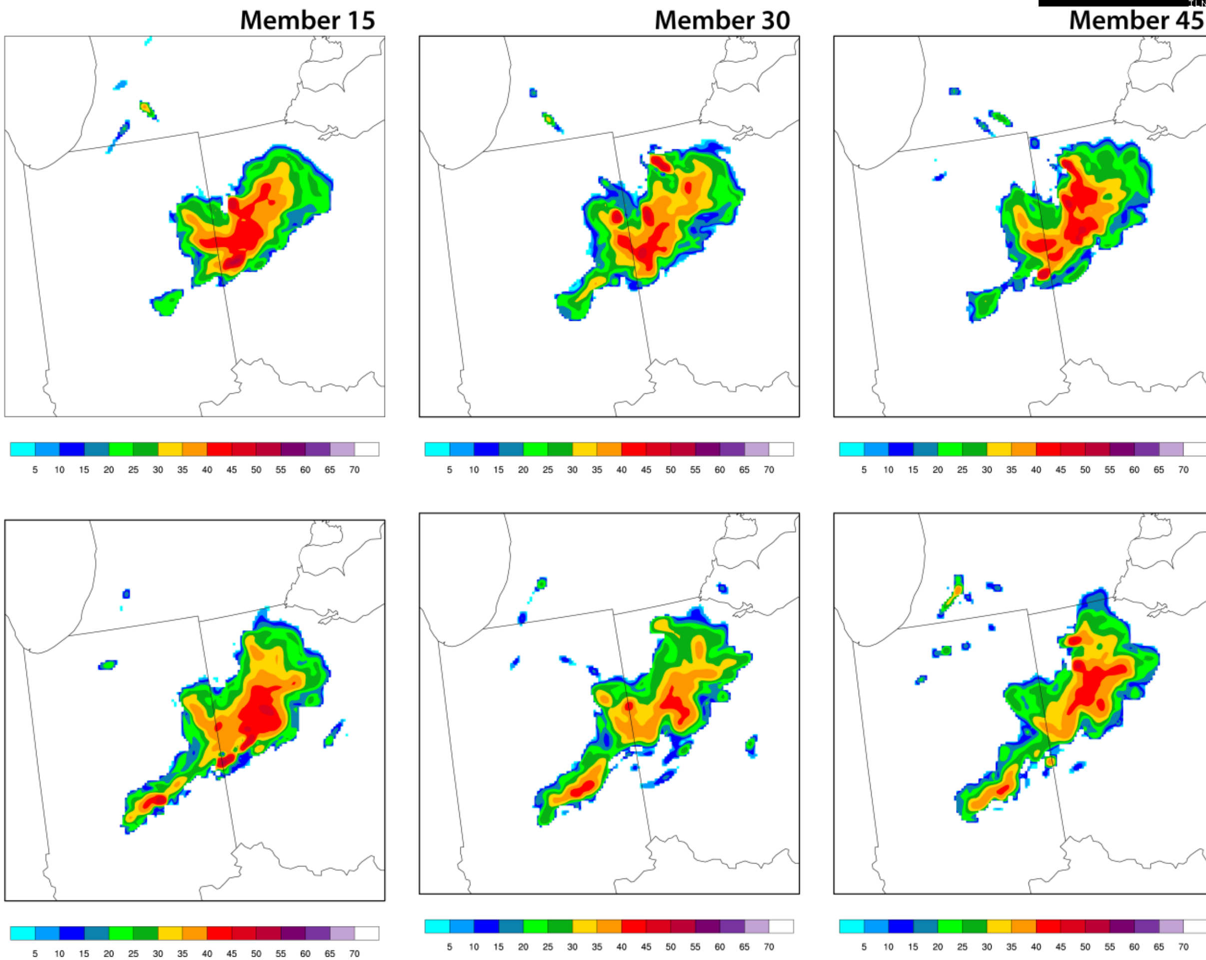
Courtesy Dustan Wheatley

Ensemble 90-min forecasts
Valid 0030 UTC 5 July



1 radar:

2 radars:

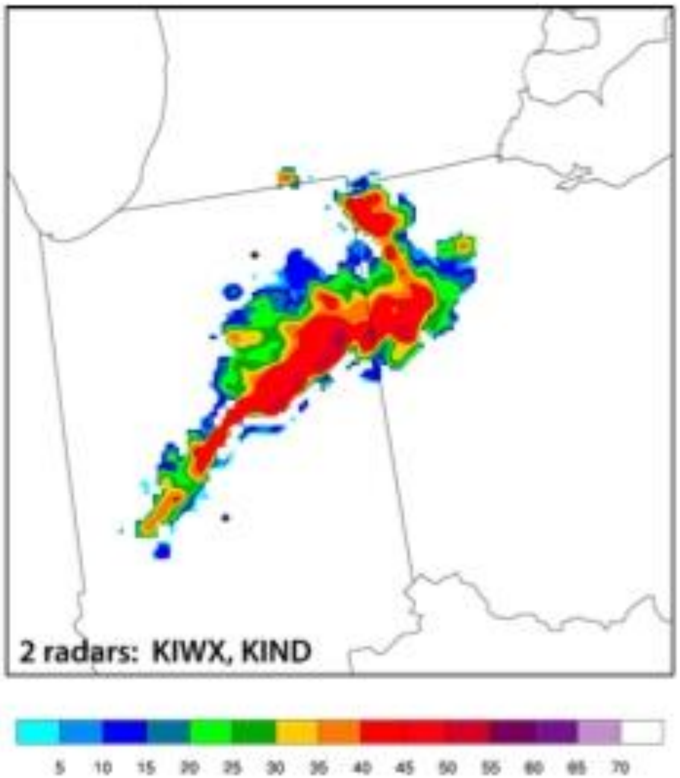


Courtesy
Dustan Wheatley

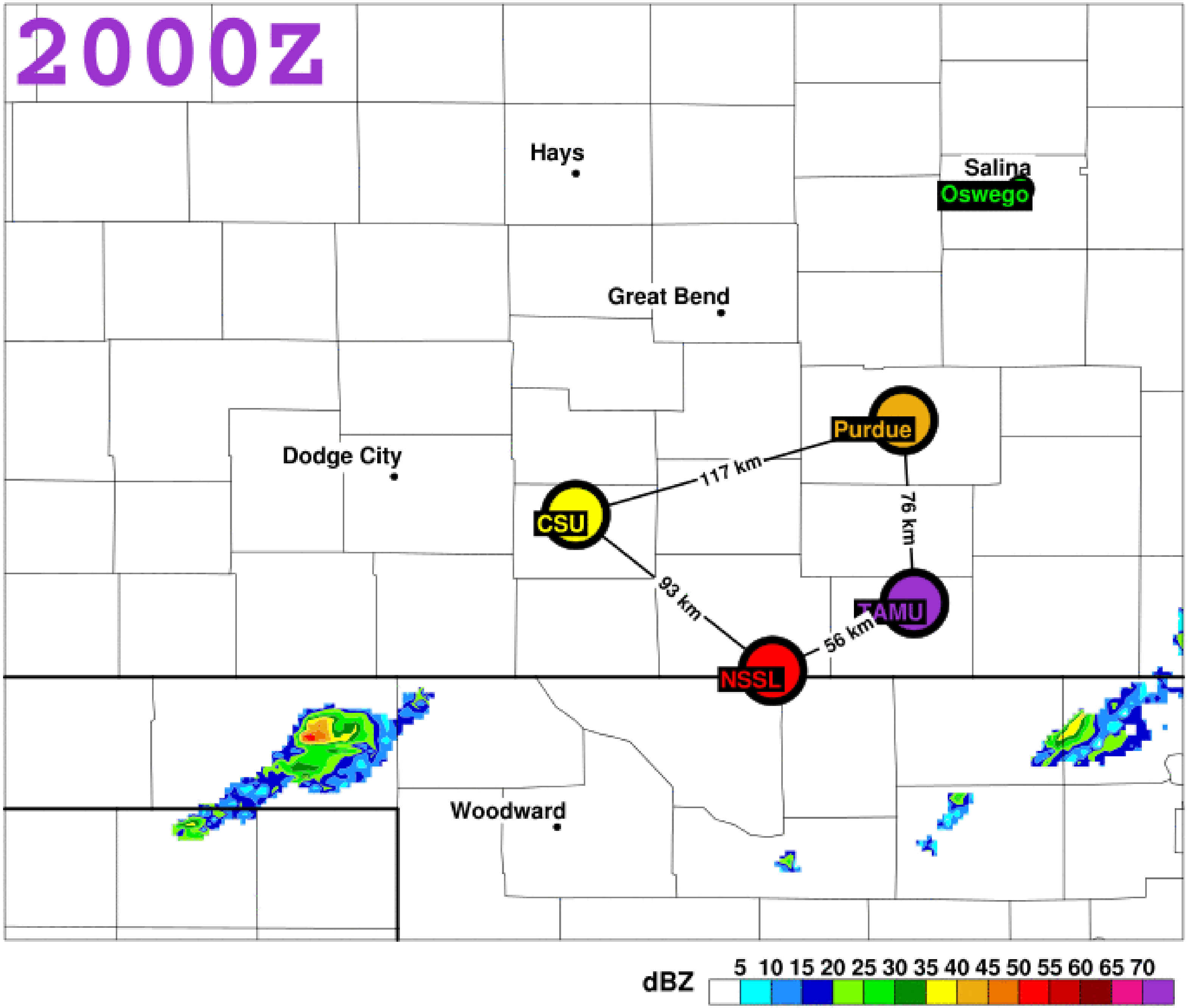
Research Thoughts

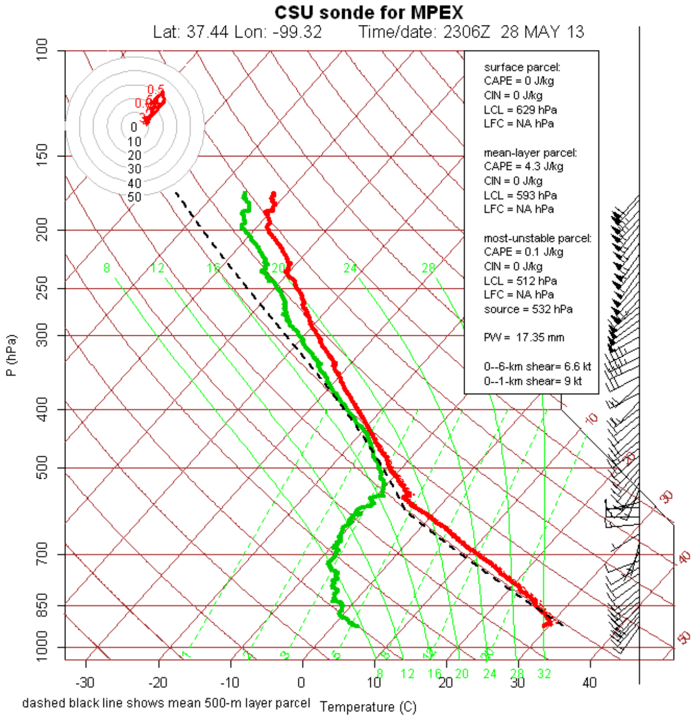
- Current results suggest challenges in predicting organized convection in models, even though analyses appear quite good from radar and surface perspectives.
  - Nearing predictability limit
  - Model error
  - Initial condition error
    - Effects of convective feedbacks?
    - Use 60 minutes worth of data to create storms, yet often they have been in existence for hours.
    - How well do we predict their upscale influence on their nearby environment?

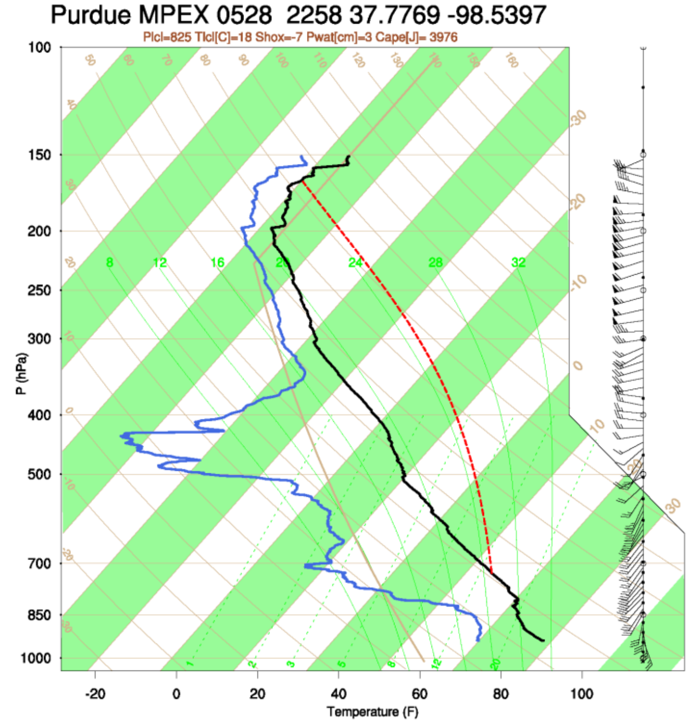
- Use WRF/DART to assimilate radar observations and compare ensemble soundings with MPEX soundings that surround storms/MCSs

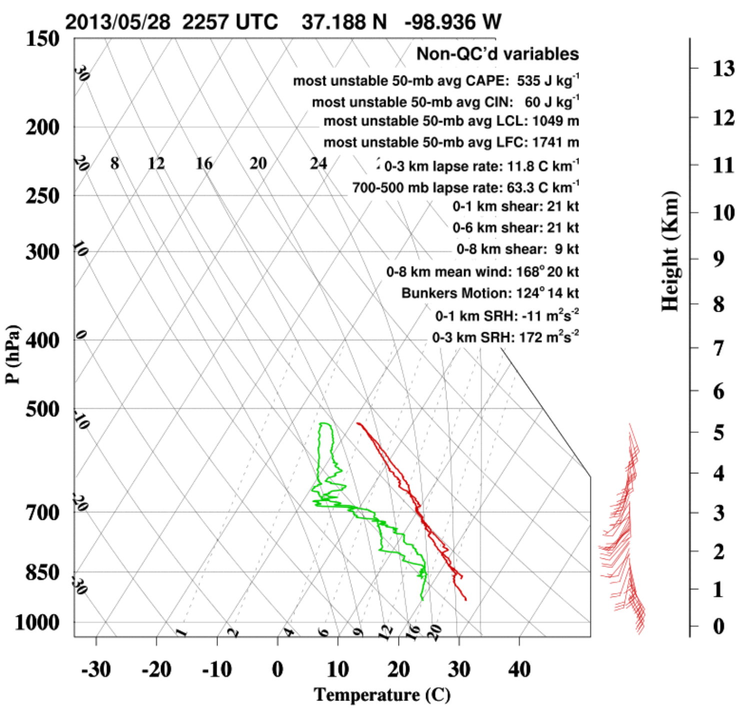


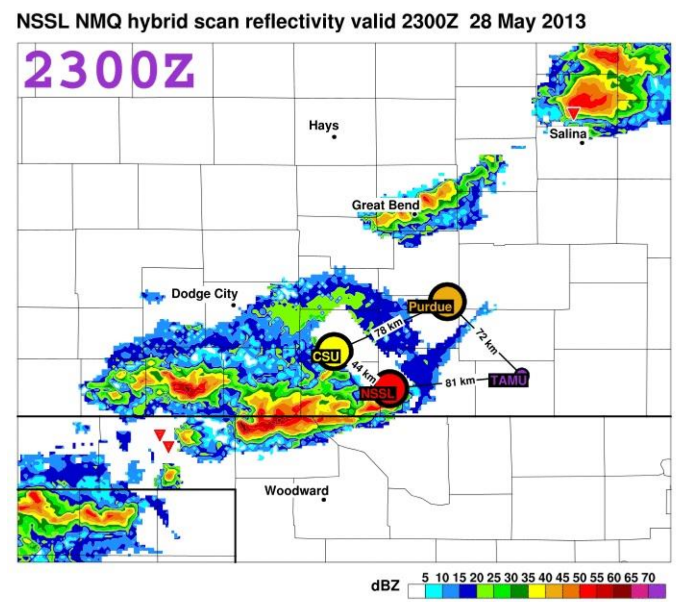
NSSL NMQ hybrid scan reflectivity valid 2000Z 28 May 2013

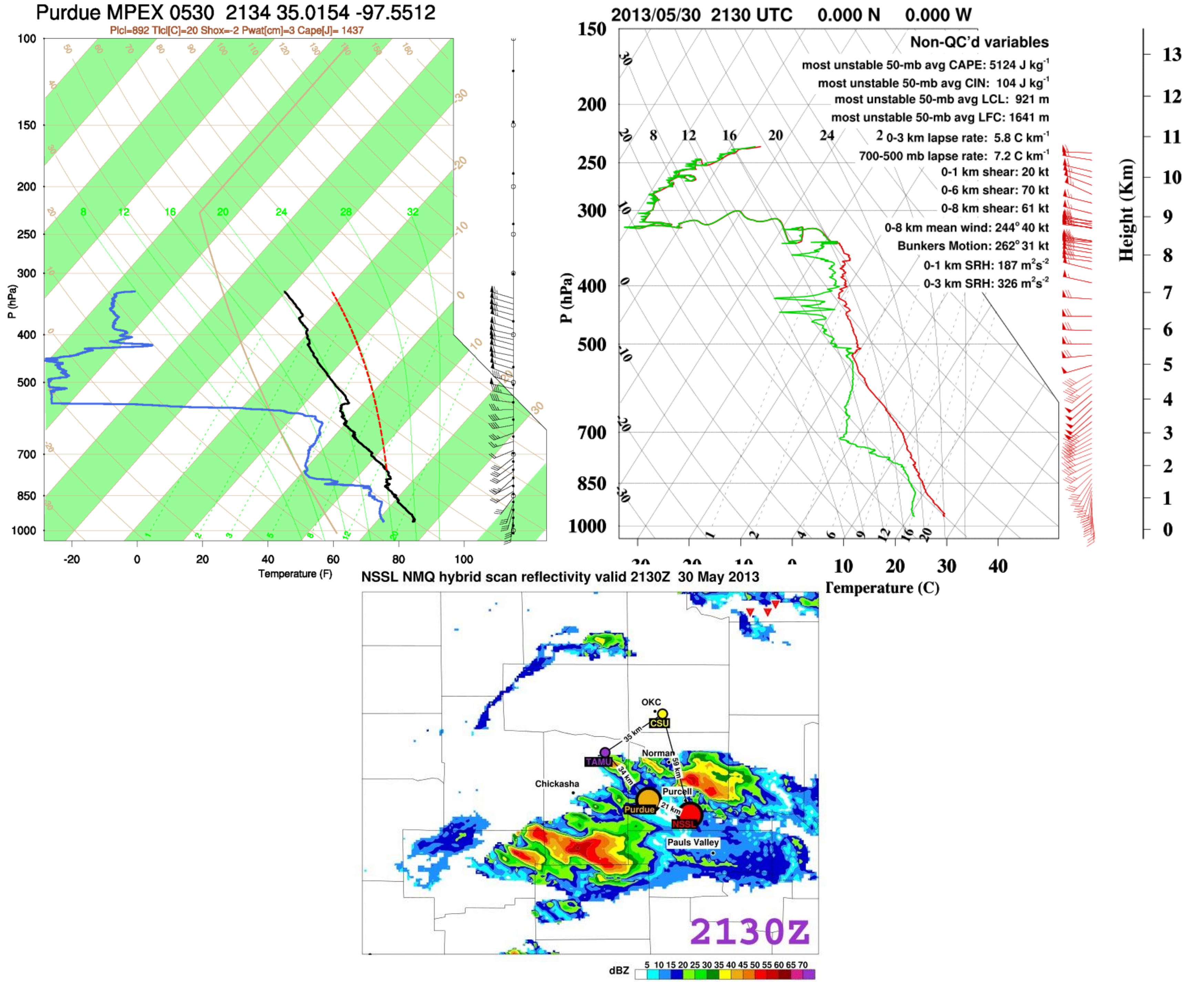



CSU sonde for MPEX
Lat: 37.44 Lon: -99.32 Time/date: 2306Z 28 MAY 13
surface parcel:
CAPE = 0 J/kg
CIN = 0 J/kg
LCL = 629 hPa
LFC = NA hPa
mean-layer parcel:
CAPE = 4.3 J/kg
CIN = 0 J/kg
LCL = 593 hPa
LFC = NA hPa
most-unstable parcel:
CAPE = 0.1 J/kg
CIN = 0 J/kg
LCL = 512 hPa
LFC = NA hPa
source = 532 hPa
PW = 17.35 mm
0--6-km shear= 6.6 kt
0--1-km shear= 9 kt
P (hPa)
Temperature (C)
dashed black line shows mean 500-m layer parcel


Purdue MPEX 0528 2258 37.7769 -98.5397
Plcl=825 Tlcl[C]=18 Shox=-7 Pwat[cm]=3 Cape[J]= 3976
P (hPa)
Temperature (F)


2013/05/28 2257 UTC 37.188 N -98.936 W
Non-QC'd variables
most unstable 50-mb avg CAPE: 535 J kg-1
most unstable 50-mb avg CIN: 60 J kg-1
most unstable 50-mb avg LCL: 1049 m
most unstable 50-mb avg LFC: 1741 m
0-3 km lapse rate: 11.8 C km-1
700-500 mb lapse rate: 63.3 C km-1
0-1 km shear: 21 kt
0-6 km shear: 21 kt
0-8 km shear: 9 kt
0-8 km mean wind: 168° 20 kt
Bunkers Motion: 124° 14 kt
0-1 km SRH: -11 m2s-2
0-3 km SRH: 172 m2s-2
P (hPa)
Height (Km)
Temperature (C)


NSSL NMQ hybrid scan reflectivity valid 2300Z 28 May 2013
2300Z
Hays
Salina
Great Bend
Dodge City
Purdue
CSU
NSSL
TAMU
78 km
72 km
44 km
81 km
Woodward
dBZ
5 10 15 20 25 30 35 40 45 50 55 60 65 70



Purdue MPEX 0530 2134 35.0154 -97.5512
Plcl=892 Tlcl[C]=20 Shox=-2 Pwat[cm]=3 Cape[J]= 1437
P (hPa)
Temperature (F)
2013/05/30 2130 UTC 0.000 N 0.000 W
Non-QC'd variables
most unstable 50-mb avg CAPE: 5124 J kg-1
most unstable 50-mb avg CIN: 104 J kg-1
most unstable 50-mb avg LCL: 921 m
most unstable 50-mb avg LFC: 1641 m
0-3 km lapse rate: 5.8 C km-1
700-500 mb lapse rate: 7.2 C km-1
0-1 km shear: 20 kt
0-6 km shear: 70 kt
0-8 km shear: 61 kt
0-8 km mean wind: 244° 40 kt
Bunkers Motion: 262° 31 kt
0-1 km SRH: 187 m2s-2
0-3 km SRH: 326 m2s-2
P (hPa)
Height (Km)
Temperature (C)
NSSL NMQ hybrid scan reflectivity valid 2130Z 30 May 2013
OKC
CSU
35 km
TAMU
Norman
59 km
34 km
Chickasha
Purcell
Purdue
21 km
NSSL
Pauls Valley
2130z
dBZ
5 10 15 20 25 30 35 40 45 50 55 60 65 70

Questions?