Propagating Nocturnal Convection within a 7-Day WRF Model Simulation

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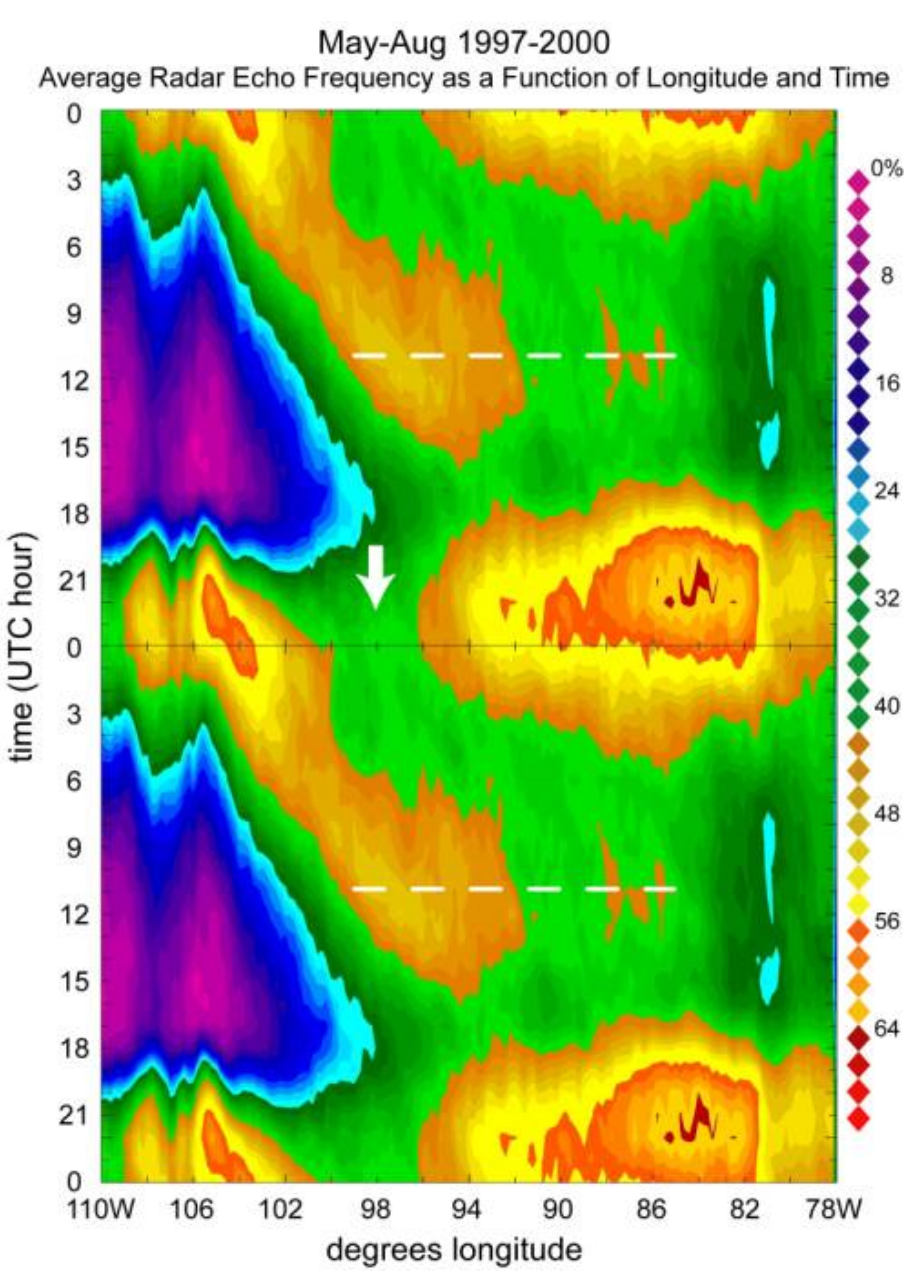
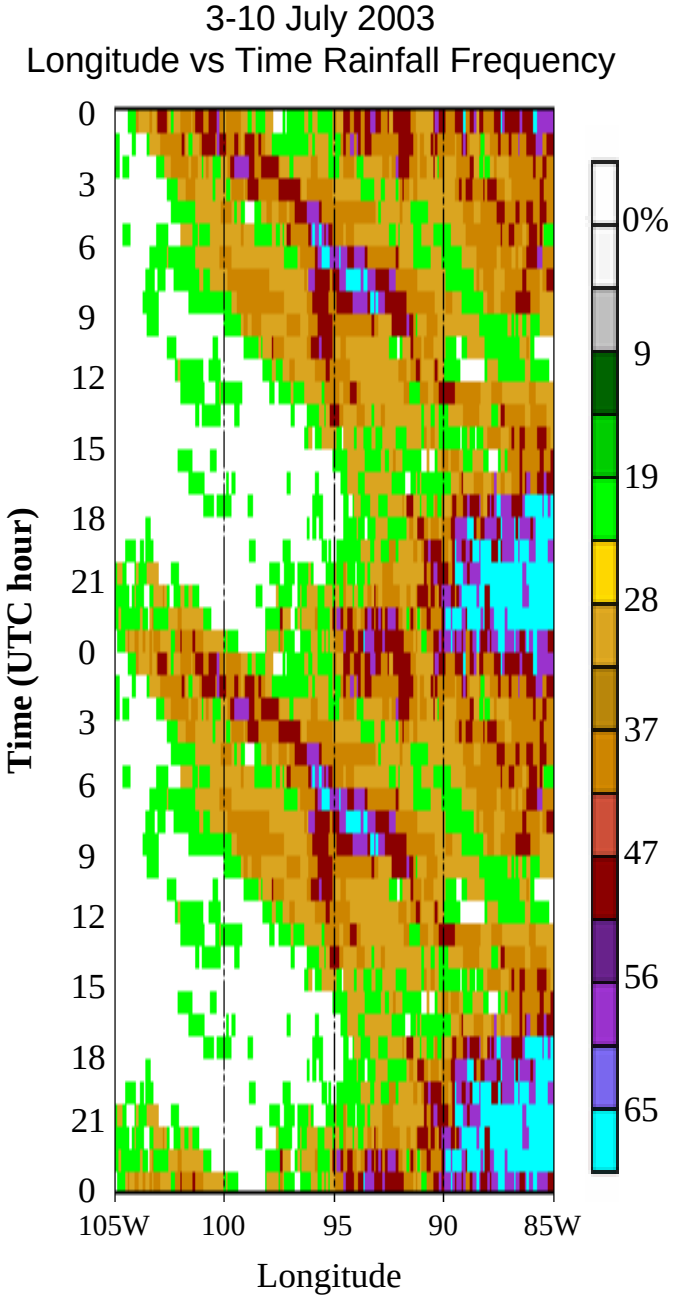
Diurnal Frequency Diagrams of Convection

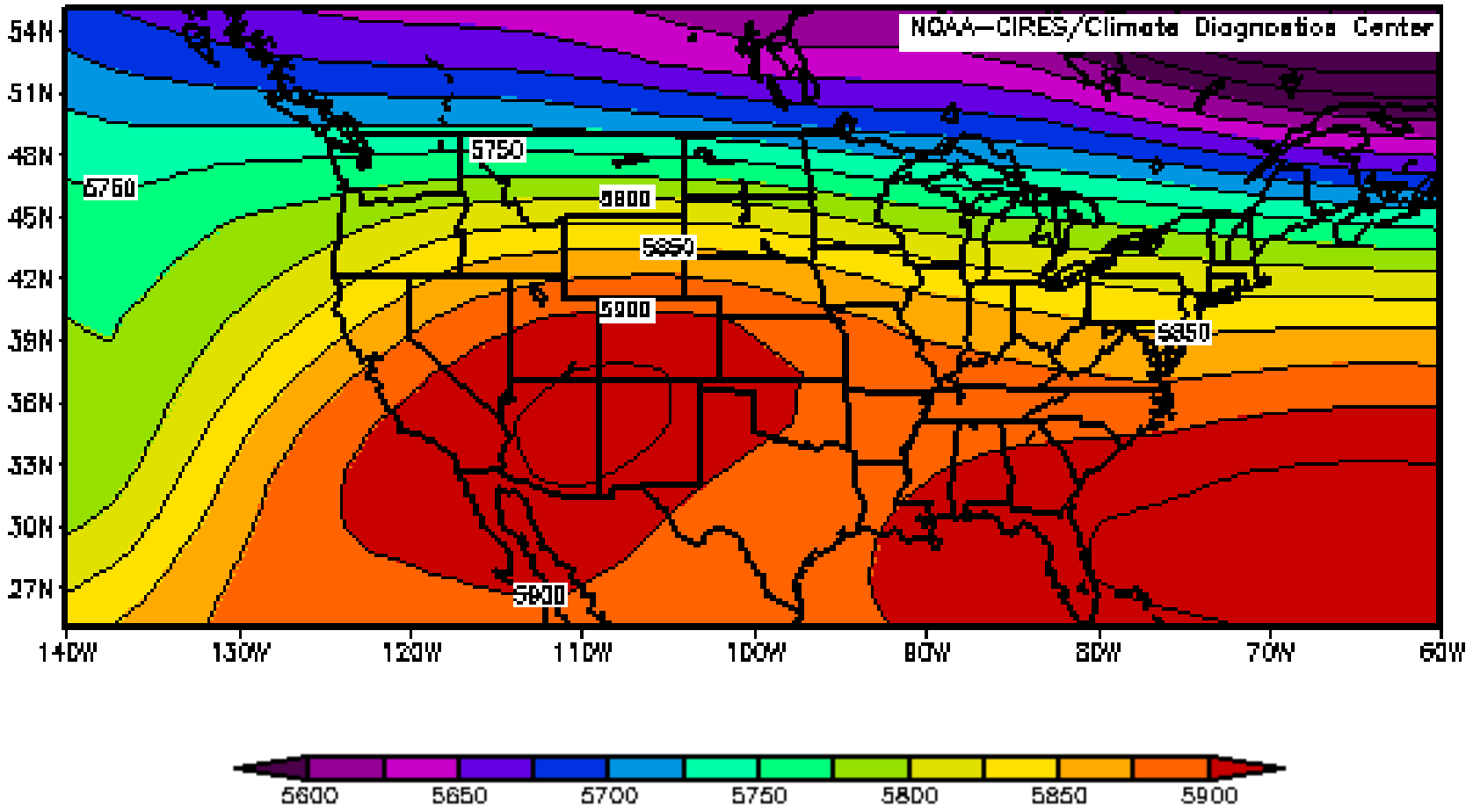




From Carbone et al. (2002; JAS)

July 3-10, 2003

500 hPa Height



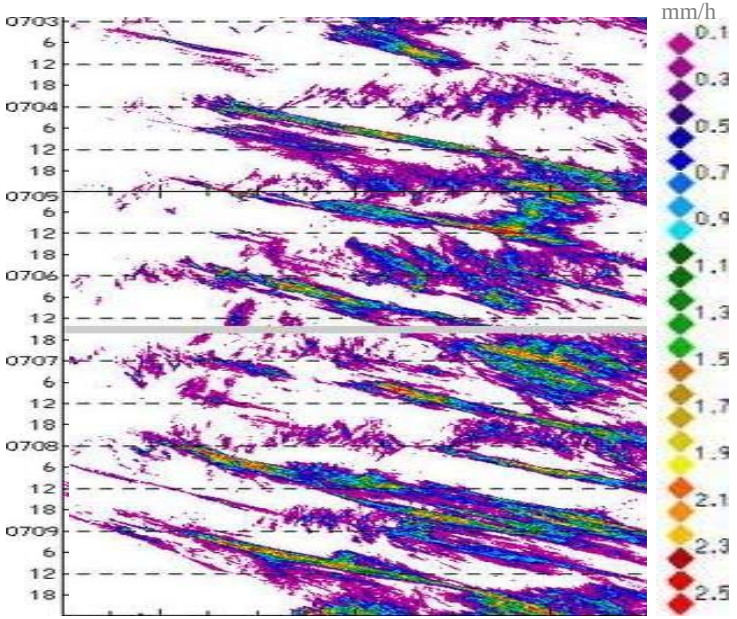
7-Day Simulations Using WRF (00Z 3 July to 00Z 10 July 2003)

- Initial and Boundary Conditions Obtained from ETA Analyses (Δ t = 3h)
- Yosei University PBL Scheme with Noah LSM
- Long and Shortwave Radiation Parameterization
- 4-km Simulation:
  - Central US Regional Domain (625 x 445 x 35)
  - Explicit Convection (No Cumulus Parameterization)
  - Lin et al. (1983) based Microphysical Scheme

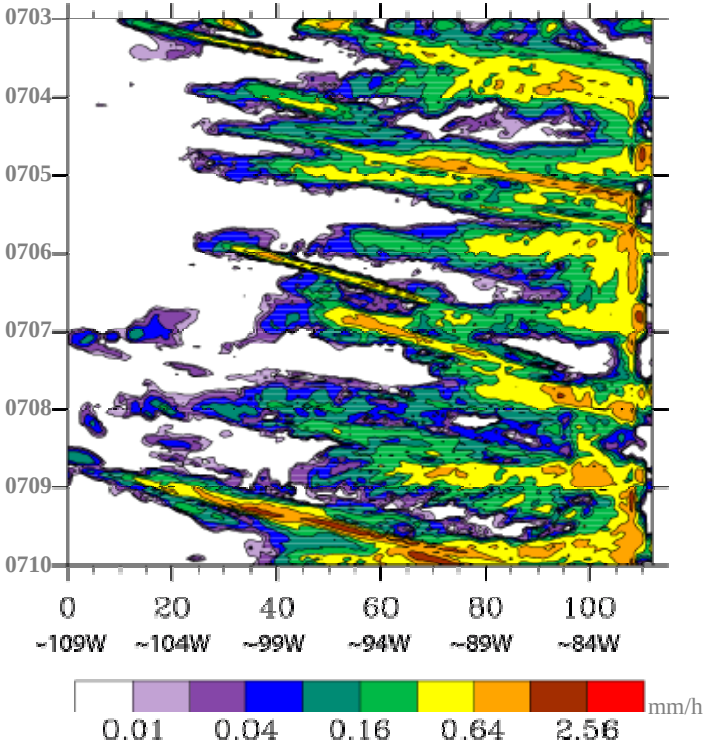
Comparison of Rainfall Characteristics From Observations and Regional Scale Simulations

- Coherent propagating rain streaks (defined as latitudinally averaged RR of 0.5 mm/h for 6 h or 500 km with time width < 6 h) present in both observations and both simulations.
- Abundance of stationary or very slowly propagating afternoon precipitation in 22-km simulation relative to 4-km simulation.
- Excessively heavy and frequent precipitation near eastern domain boundary in 22-km simulation.

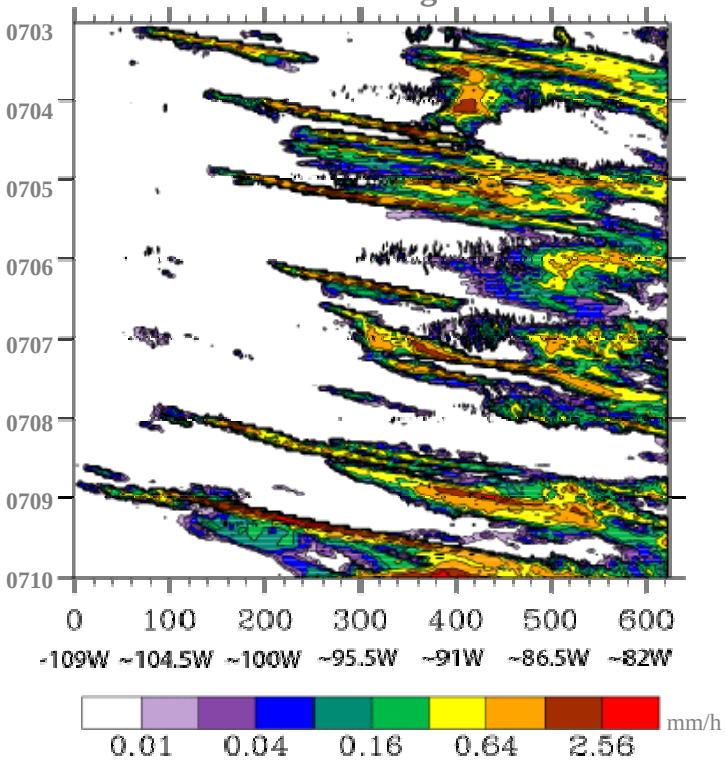
Observed Latitudinally Averaged Rainrate



22-km WRF Y-Averaged Rainrate



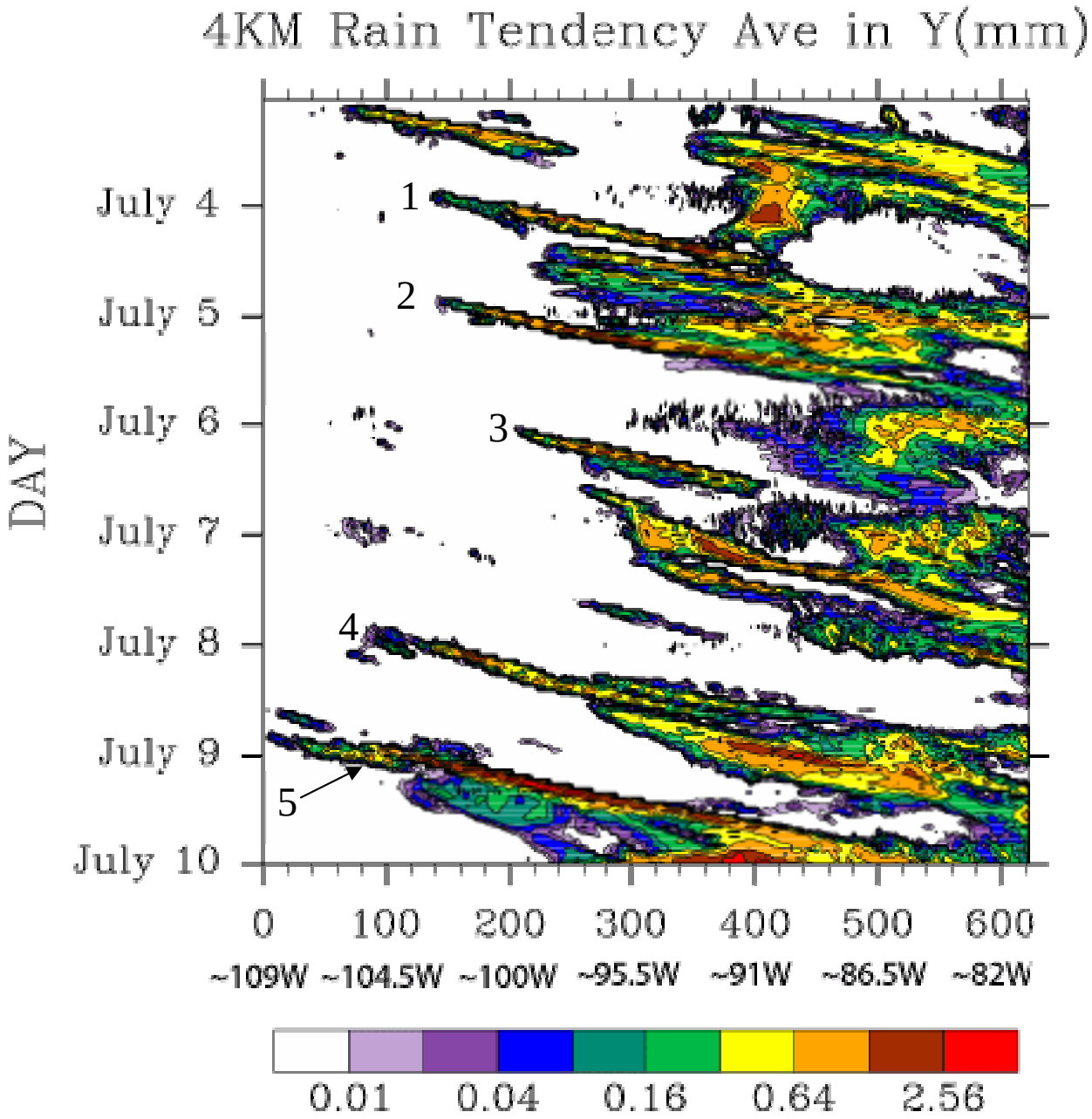
4-km WRF Y-Averaged Rainrate



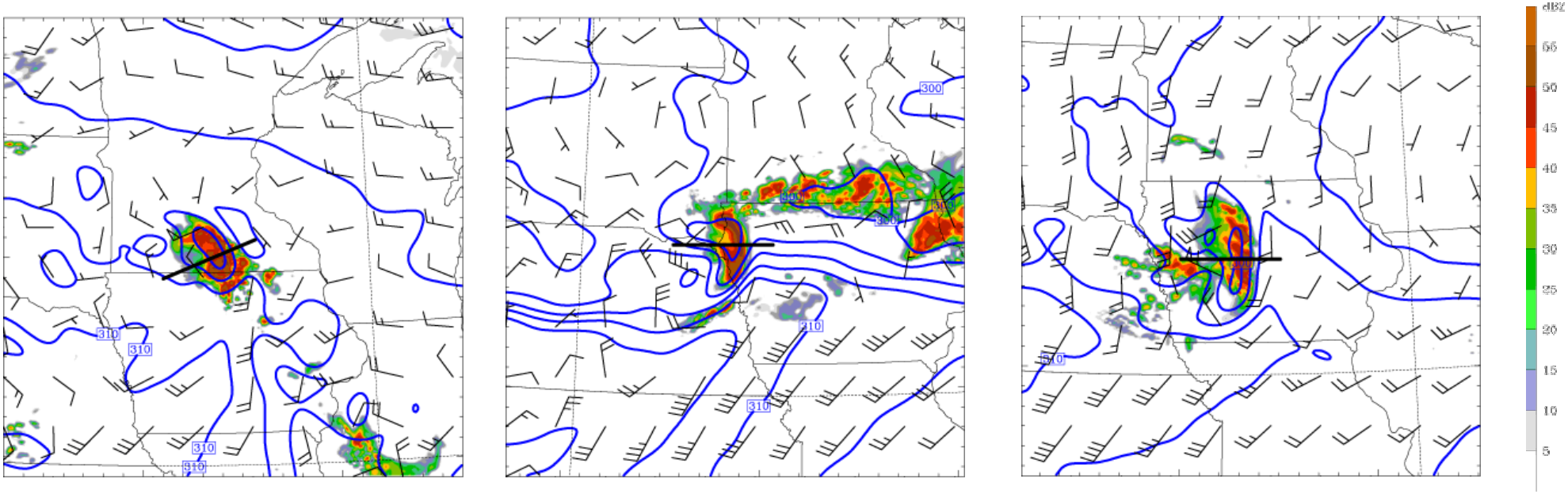
Rain Streak Phase Speed Statistics (3-10 July 2003)

			Distribution				
	Number	**Mean (m/s)**	**5 – 10**	**10 - 15**	**15 - 20**	**20 - 25**	**> 25 m/s**
Observations	14	18.7	2	1	4	6	1
4-km Fully Explicit	13	19.4	0	1	6	6	1

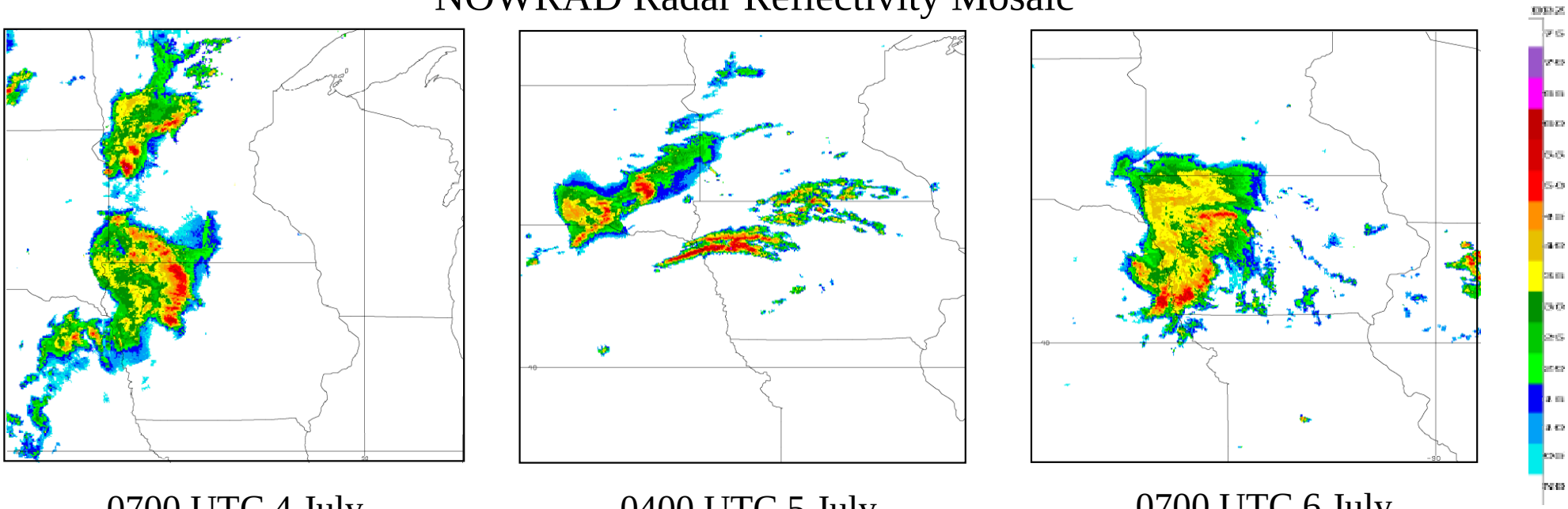
- Coherent propagating rain streaks are defined as latitudinally averaged RR of 0.5 mm/h for 6 h or 500 km with time width < 6 h.


4KM Rain Tendency Ave in Y(mm)
DAY
July 4
July 5
July 6
July 7
July 8
July 9
July 10
1
2
3
4
5
0
100
200
300
400
500
600
~109W
~104.5W
~100W
~95.5W
~91W
~86.5W
~82W
0.01
0.04
0.16
0.64
2.56

Model 900-hPa Potential Temperature, Winds and Reflectivity



NOWRAD Radar Reflectivity Mosaic

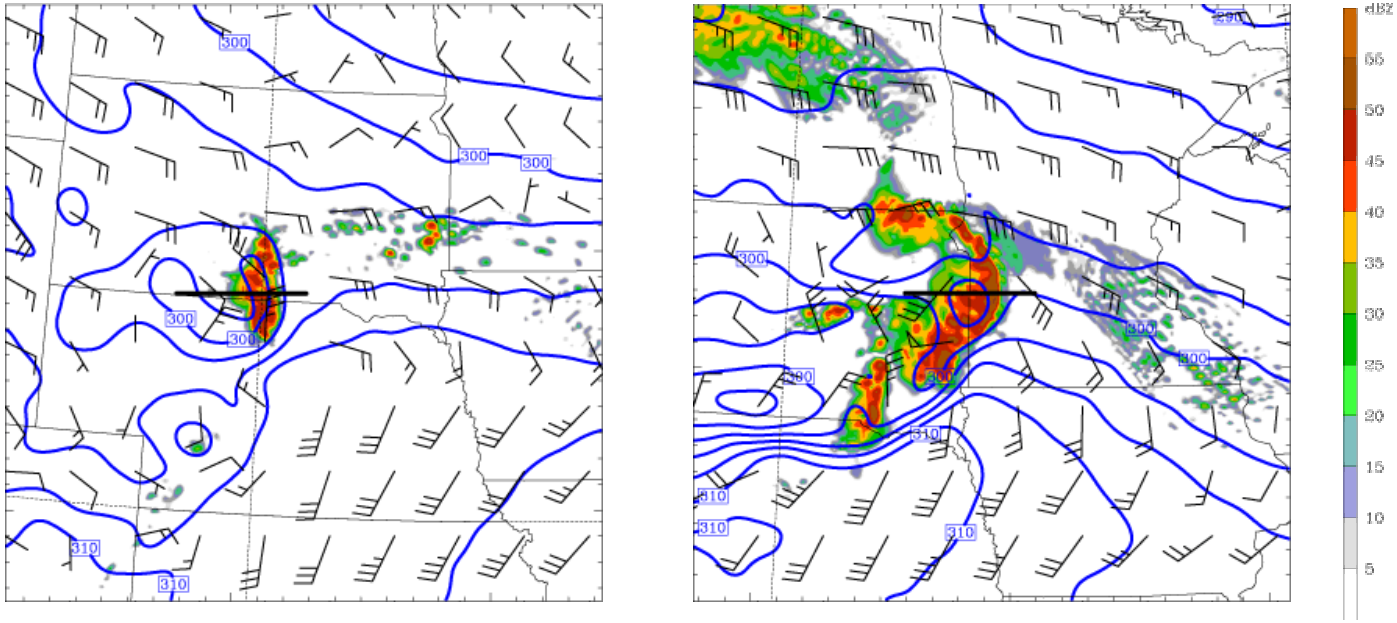


0700 UTC 4 July

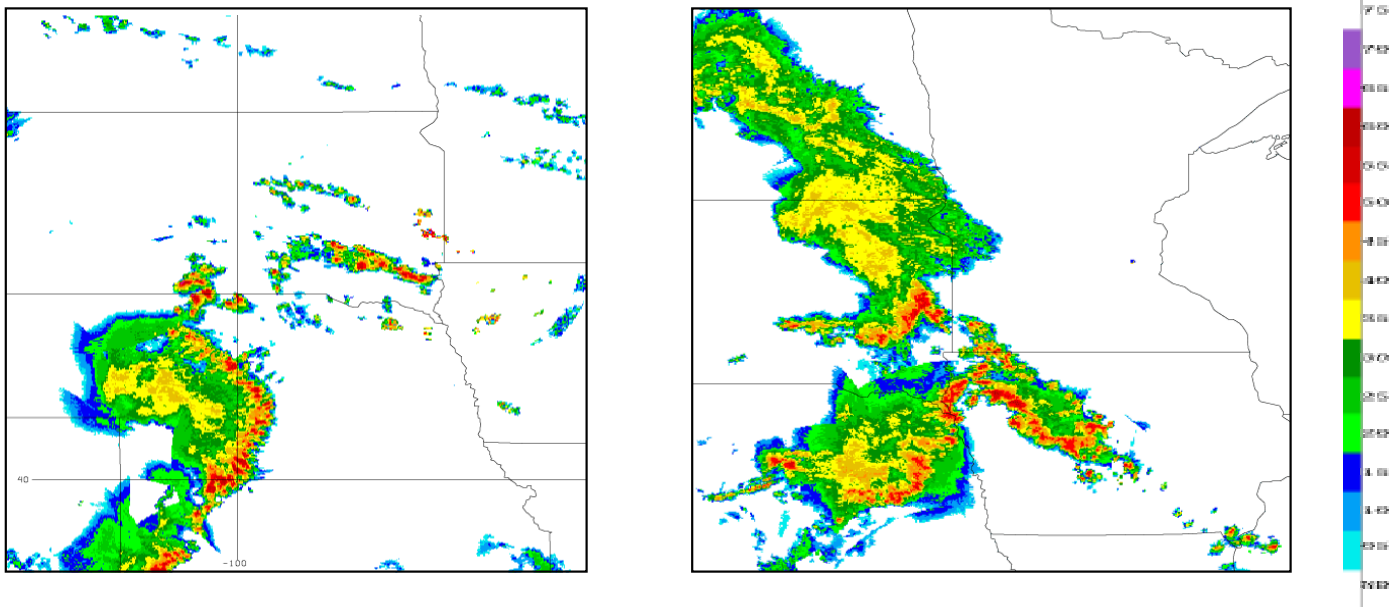
0400 UTC 5 July

0700 UTC 6 July

Model 900-hPa Potential Temperature, Winds and Reflectivity



NOWRAD Radar Reflectivity Mosaic

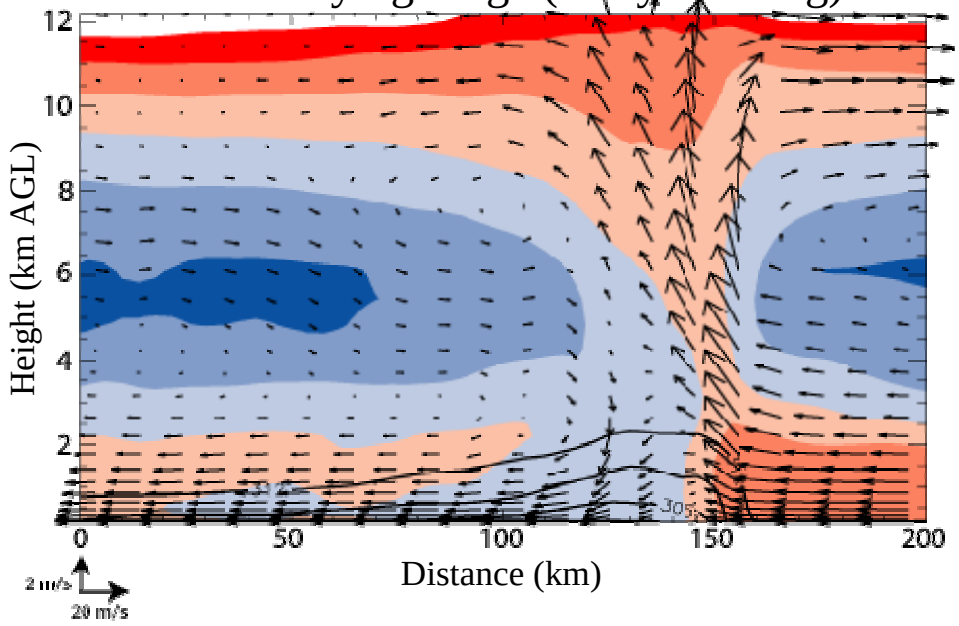


0500 UTC 8 July

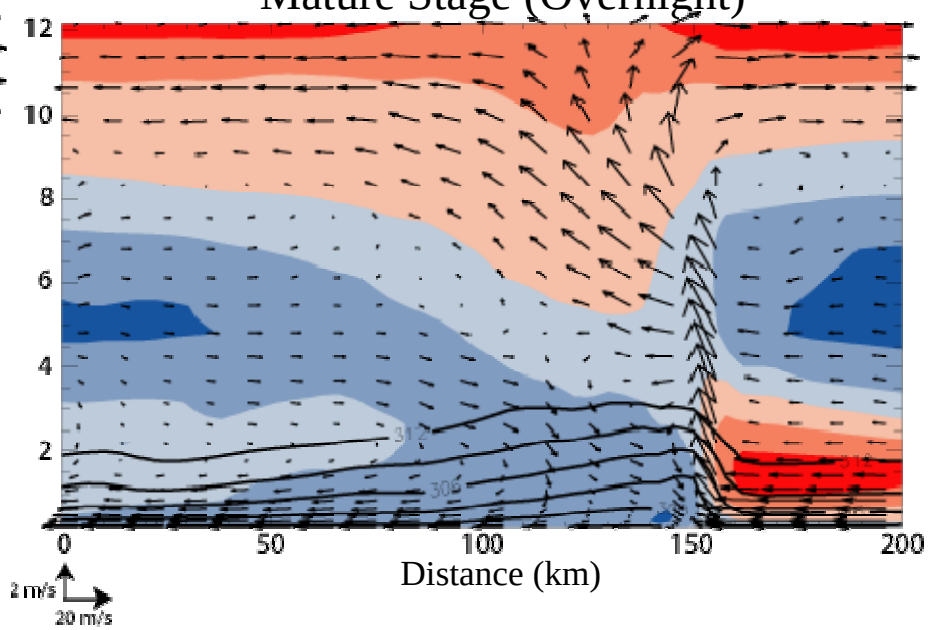
0800 UTC 9 July

Composite System-Relative Flow, Theta (Contours), Theta-e (Colors)

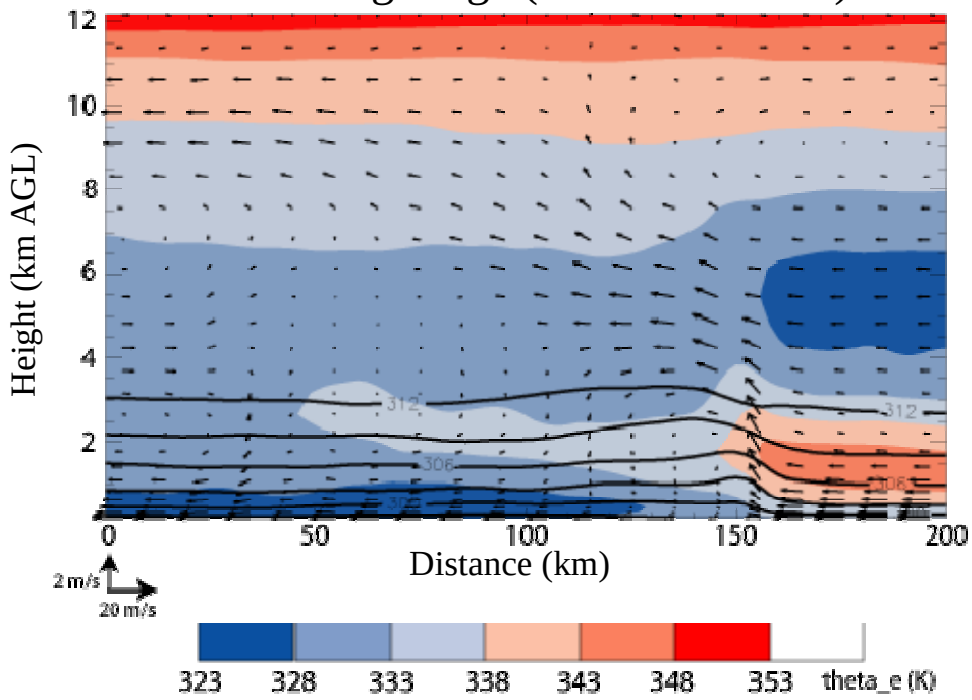
Intensifying Stage (Early Evening)



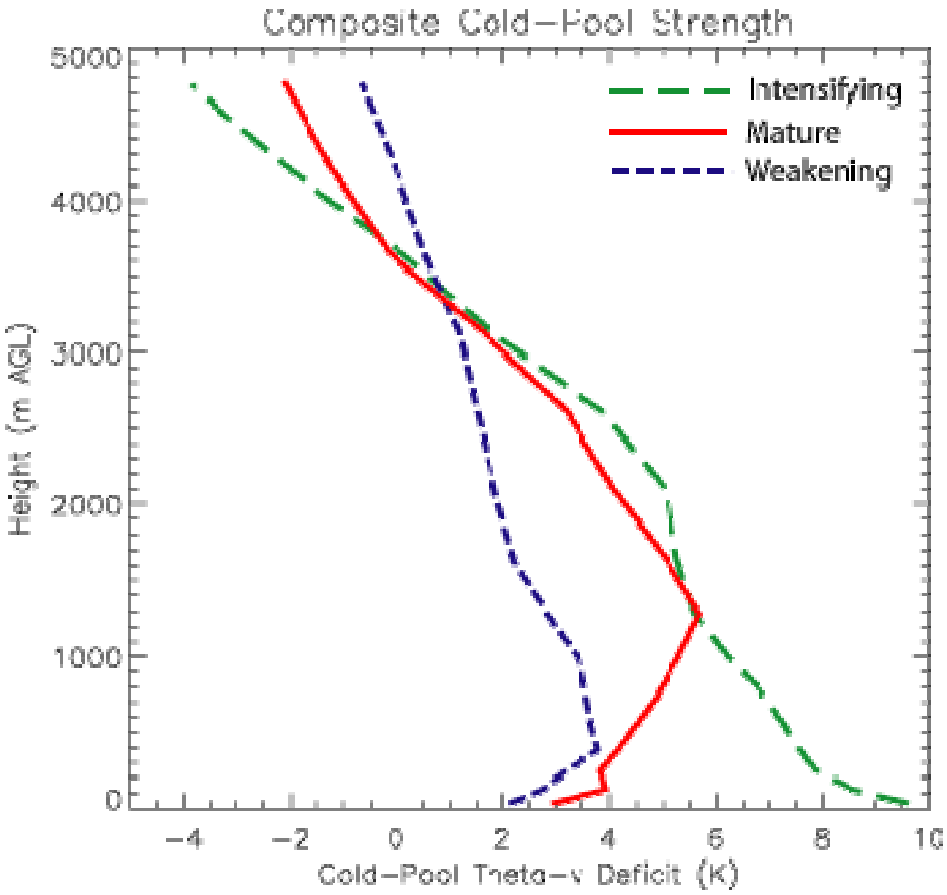
Mature Stage (Overnight)

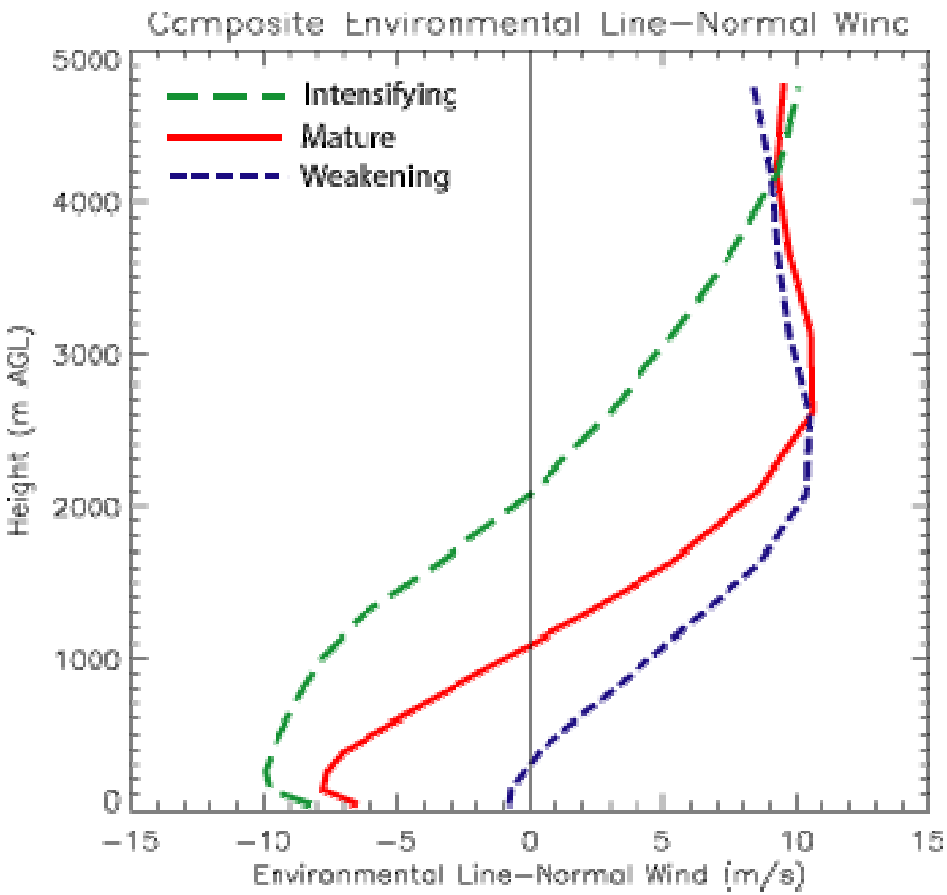


Weakening Stage (Around Sunrise)

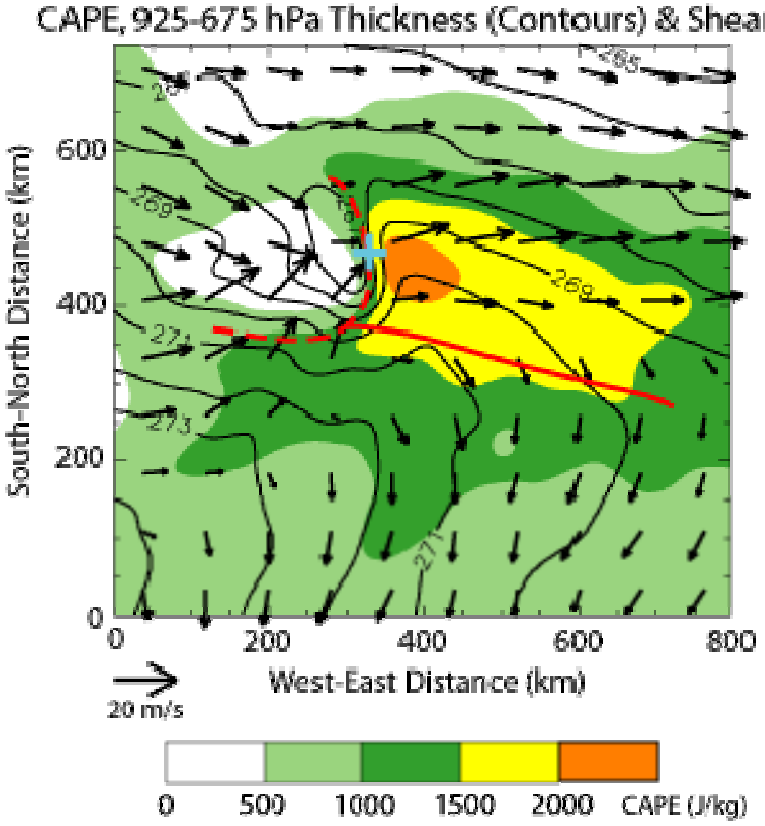


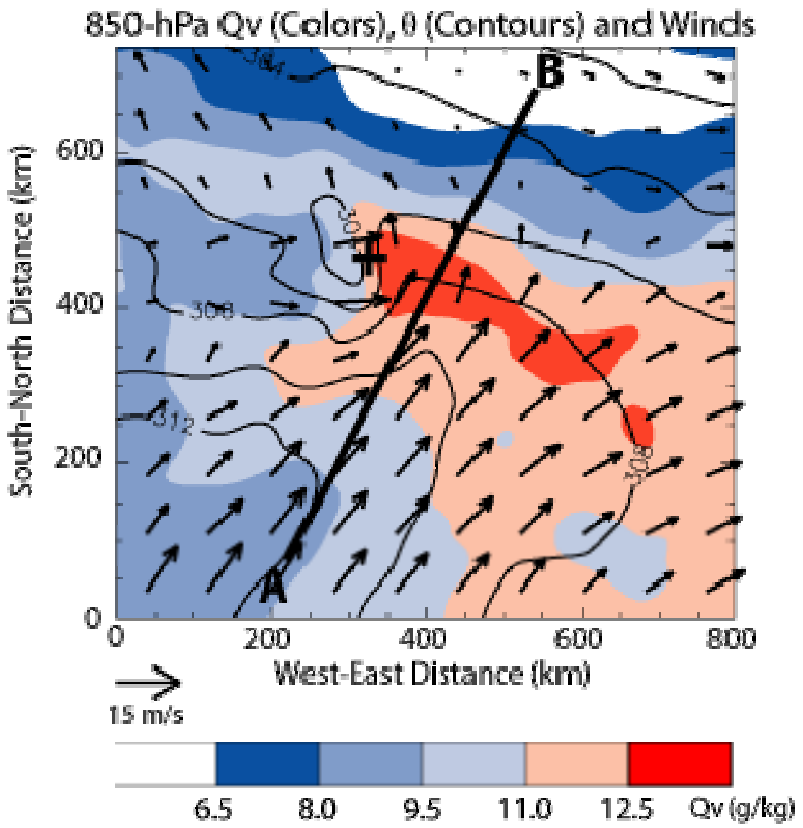
- Five Cases
- 50-km Along-Line Average


Composite Cold-Pool Strength
Intensifying
Mature
Weakening
Height (m AGL)
5000
4000
3000
2000
1000
0
−4
−2
0
2
4
6
8
10
Cold-Pool Theta-v Deficit (K)

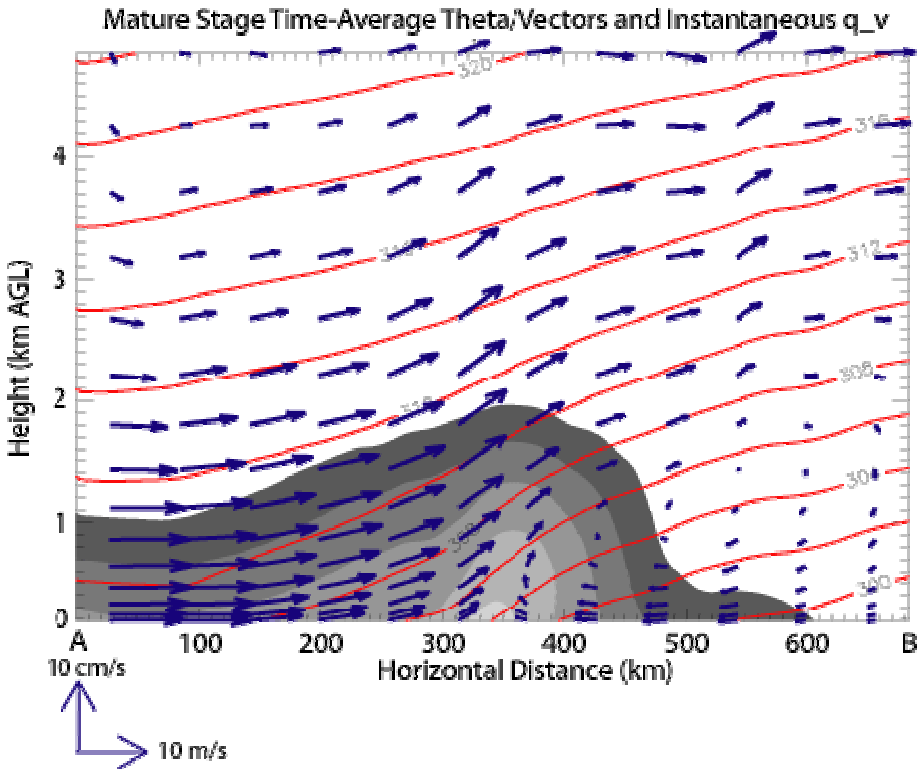

Composite Environmental Line-Normal Wind
Intensifying
Mature
Weakening
Height (m AGL)
5000
4000
3000
2000
1000
0
−15
−10
−5
0
5
10
15
Environmental Line-Normal Wind (m/s)

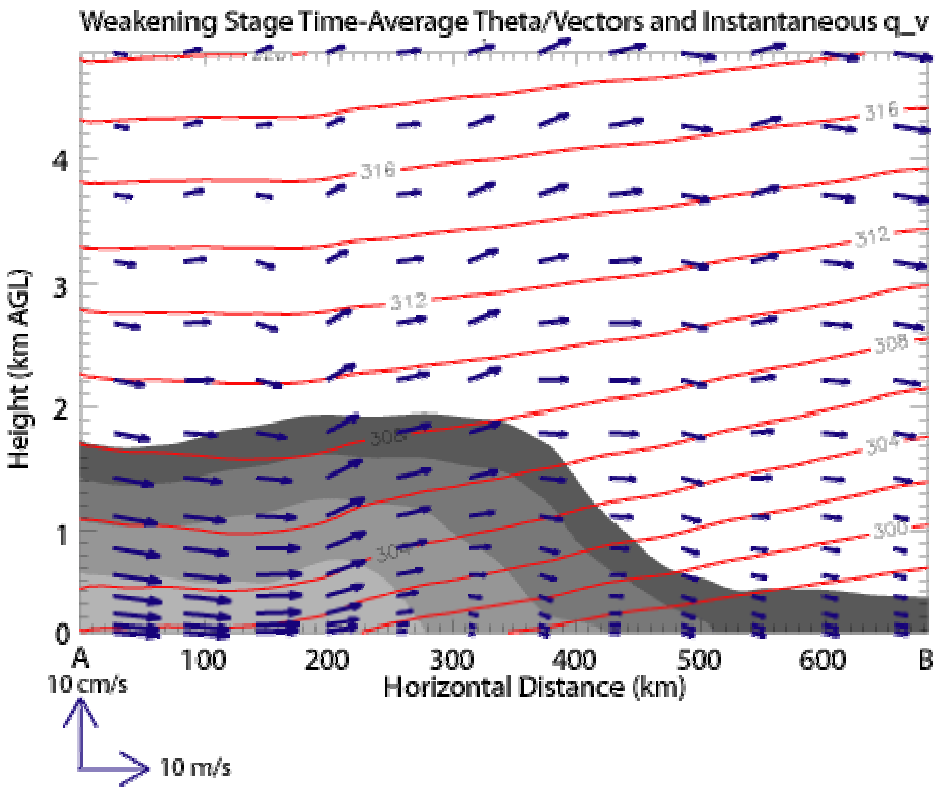
Composites of the Mesoscale Environment for Mature Stage



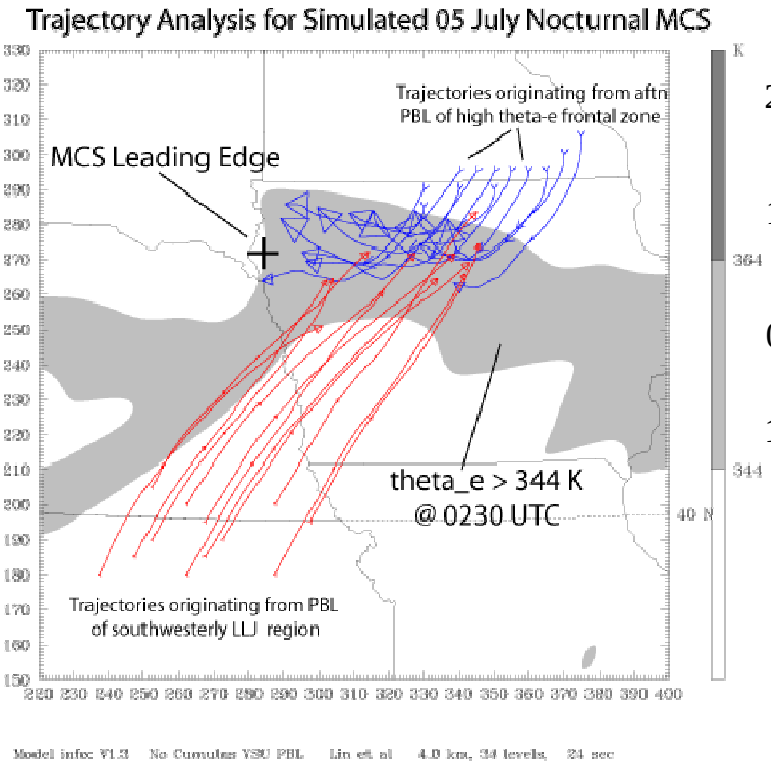


Composite Vertical Cross Sections of the Mesoscale Environment



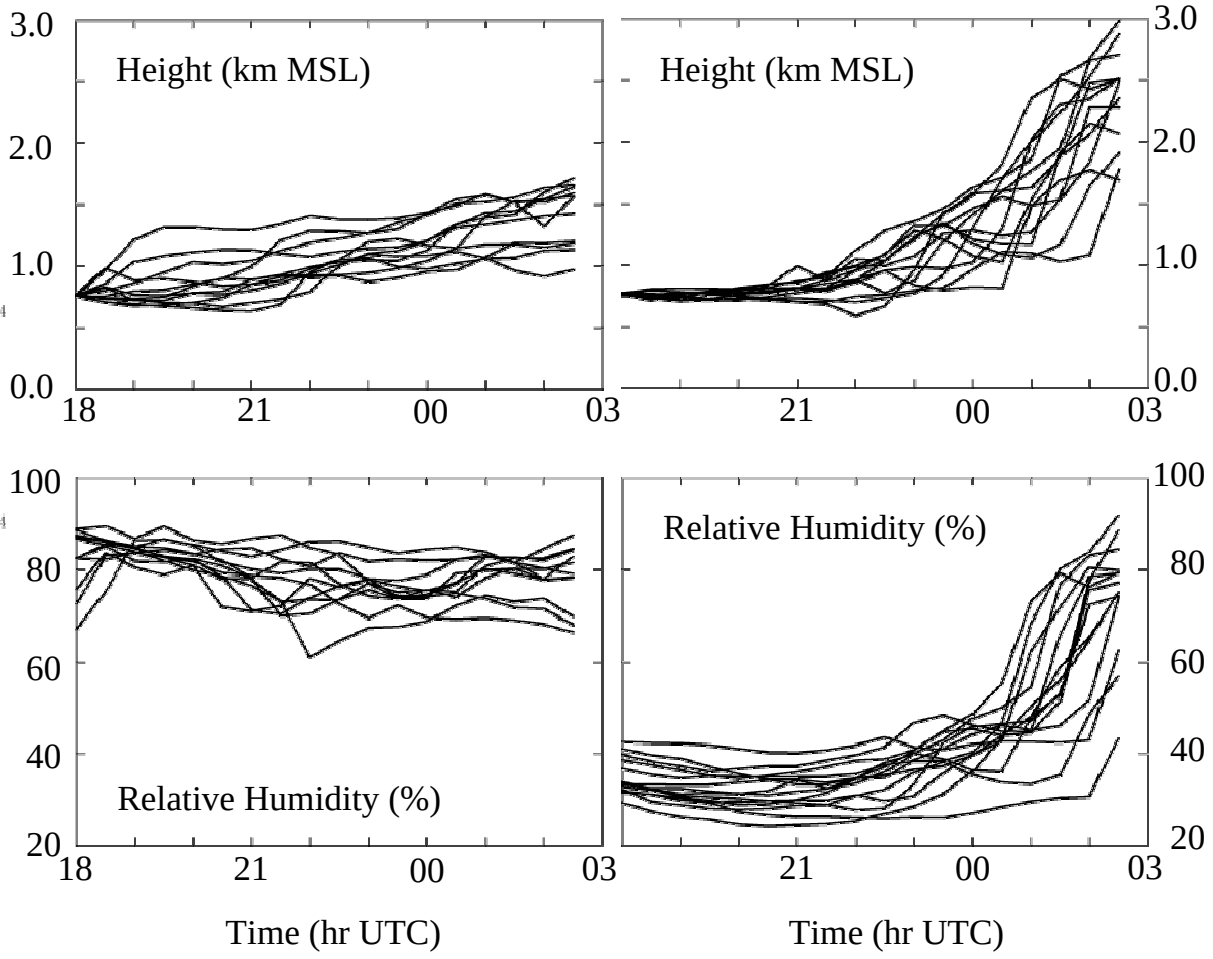


Forward Trajectory Analysis for a Strong Frontal Case Example



Trajectories from NE

Trajectories from SW



Conclusions

- 7-day WRF simulation reproduces statistics of convection
  - Zonal propagation speed
  - Diurnal frequency
- Mesoconvective structure is realistic (except missing stratiform)
- Mature phase nocturnal convection is elevated
  - Propagates within narrow latitudinal corridor defined by lower-tropospheric frontal zone
- Elevated moisture emanates from within frontal zone and from LLJ air being transported northward and being lifted over frontal zone
- Convection typically weakens around sunrise as it moves into less favorable environment
  - lack of strong frontogenetic forcing
  - smaller vertical shear and CAPE

Diurnal Frequency and Composite Mesoscale Environment of Propagating Convection