

Quasi-Idealized Simulations of Bow Echoes

WRF/MM5 Workshop

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EVOLUTION OF BOW ECHO

Proposed by FUJITA, 1979

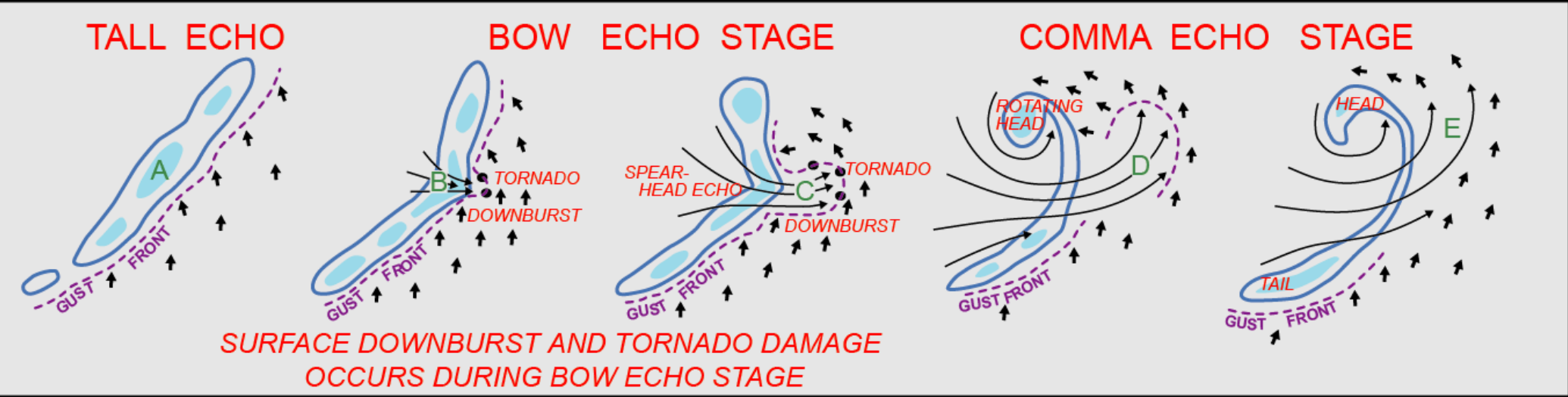
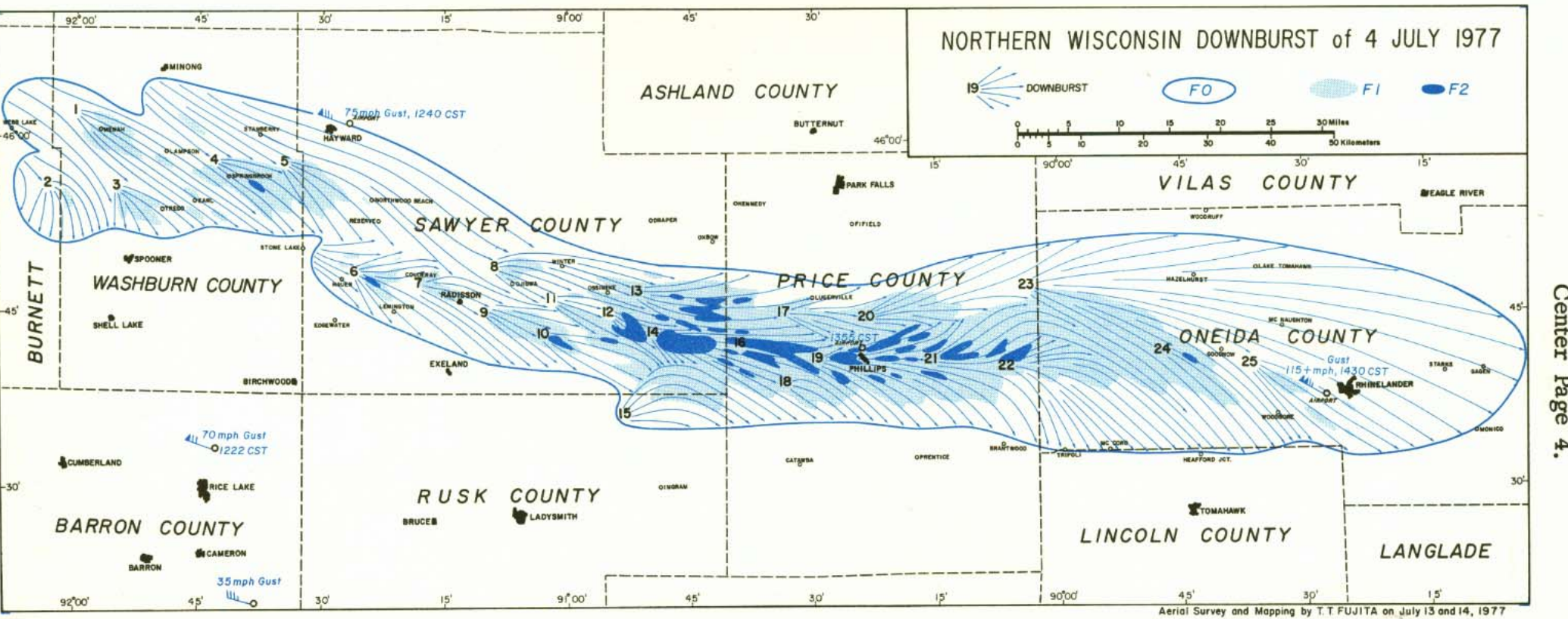


Figure adapted from Fujita (1979)

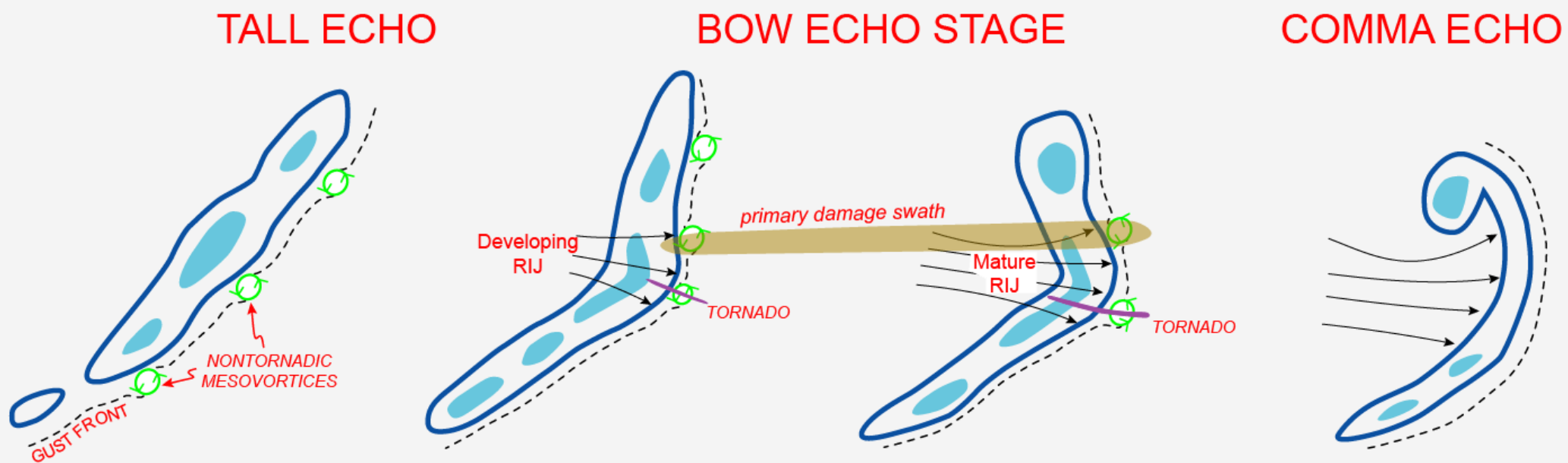
Figure from Fujita (1978)



Results from the Bow Echo and MCV Experiment (BAMEX)

Modified conceptual model of bow echo damage based on 10 June 2003 event

MESOVORTEX DAMAGE WITHIN BOW ECHOES



From Atkins et al. (2005)

Also:

Wakimoto et al. (2005a, b)

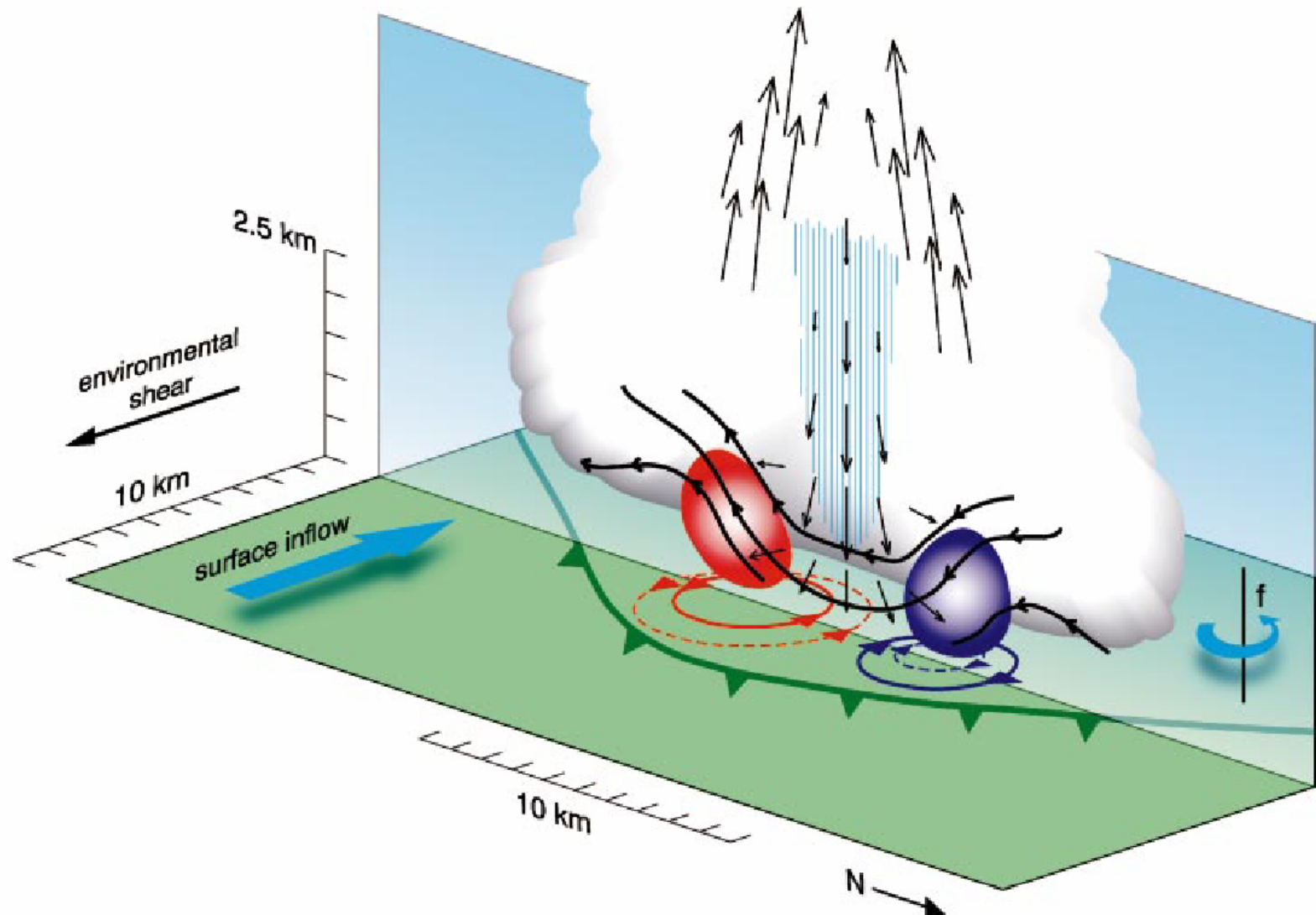
Wheatley et al. (2005)

Mesovortex Genesis

Idealized sounding, warm rain mp, KW cloud model

NOVEMBER 2003

TRAPP AND WEISMAN

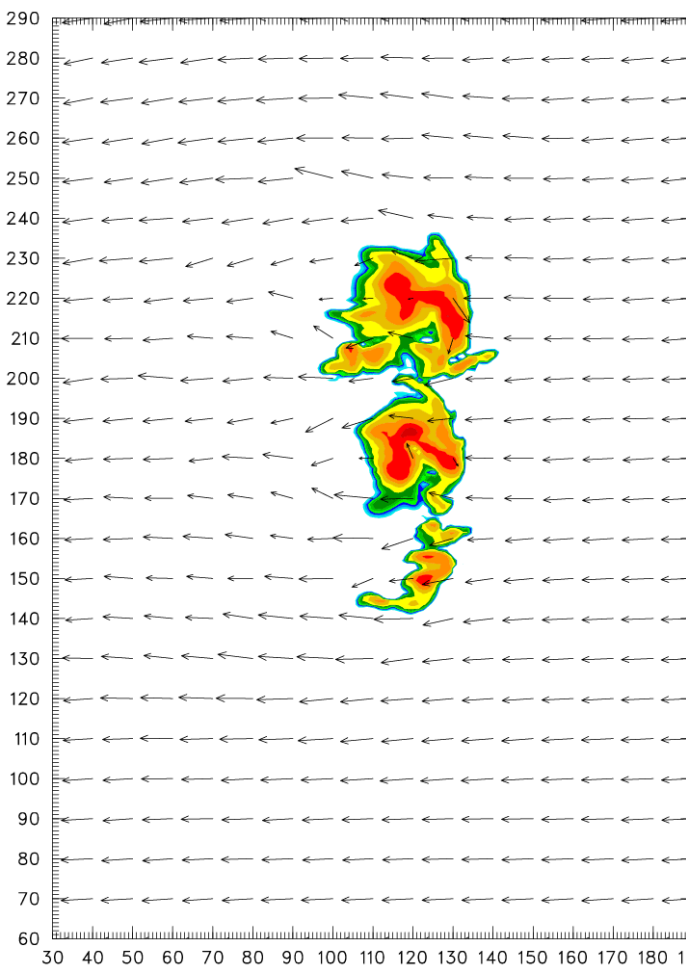


From Trapp and Weisman (2003)

Quasi-idealized Simulation of the 10 June Bow Echo Event during BAMEX using WRF

Control Run Parameters:

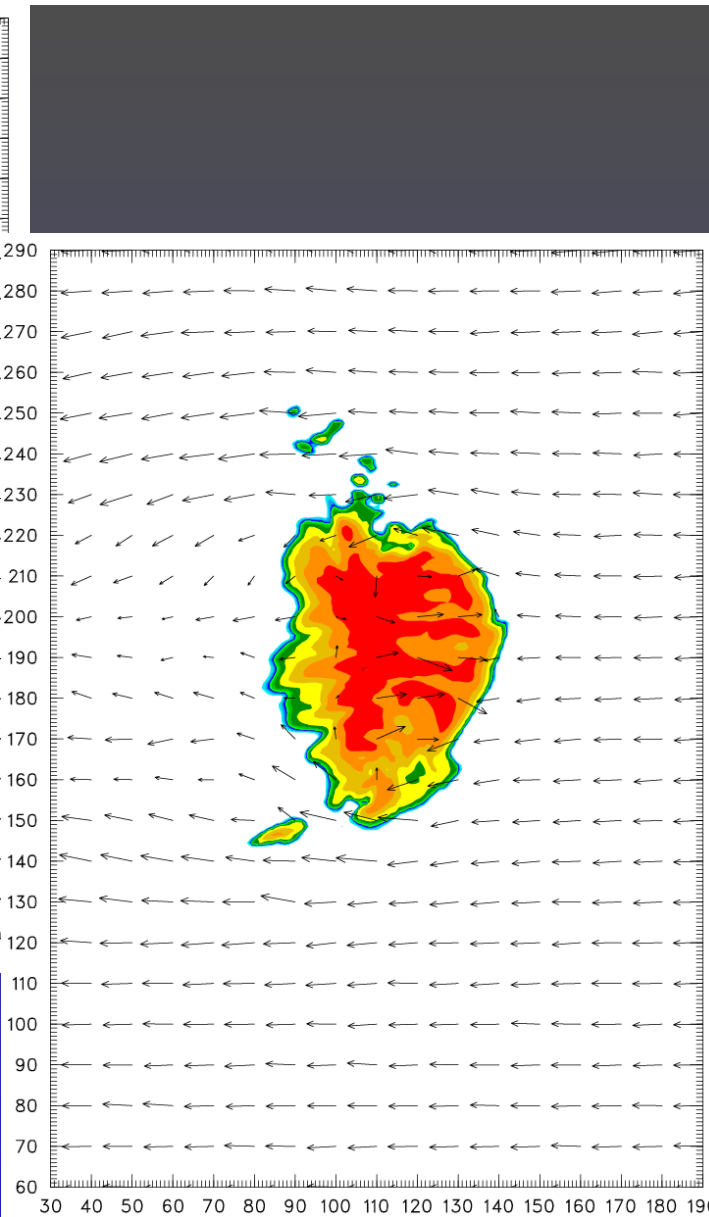
- 400x400x41 domain
- 1 km horizontal resolution
- 18 UTC Springfield, MO sounding (2558 J kg⁻¹, moderate low-level shear)
- Lin et al. mp (qc,qr,qi,qs,qh)
- $f=10^{-4}\text{s}^{-1}$ on perturbations only
- Turbulence – 1.5 order TKE closure
- Convection is initiated with 3 thermal bubbles oriented N-S 40 km apart at center of domain



2hrs

dBZ – 0.1 km

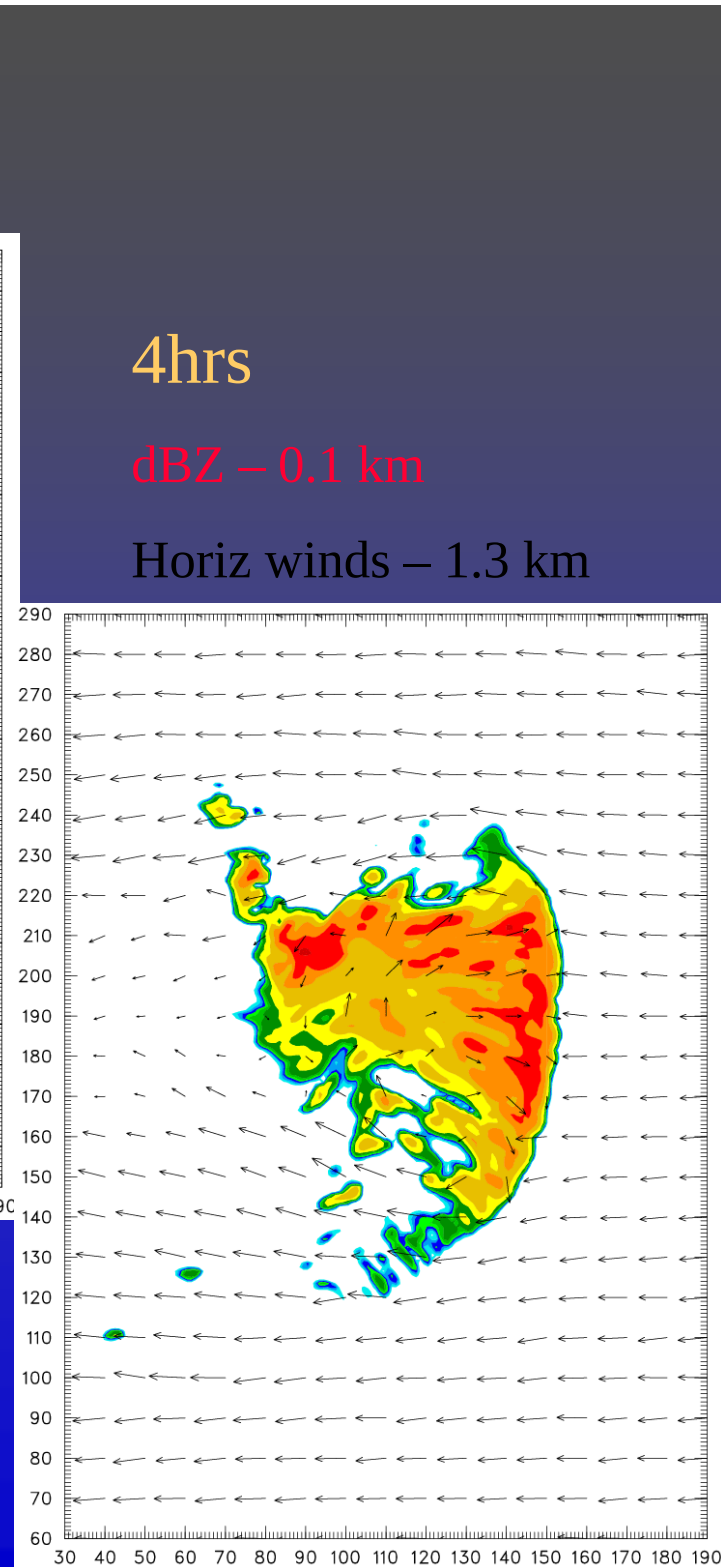
Horiz winds – 1.3 km



3hrs

dBZ – 0.1 km

Horiz winds – 1.3 km



4hrs

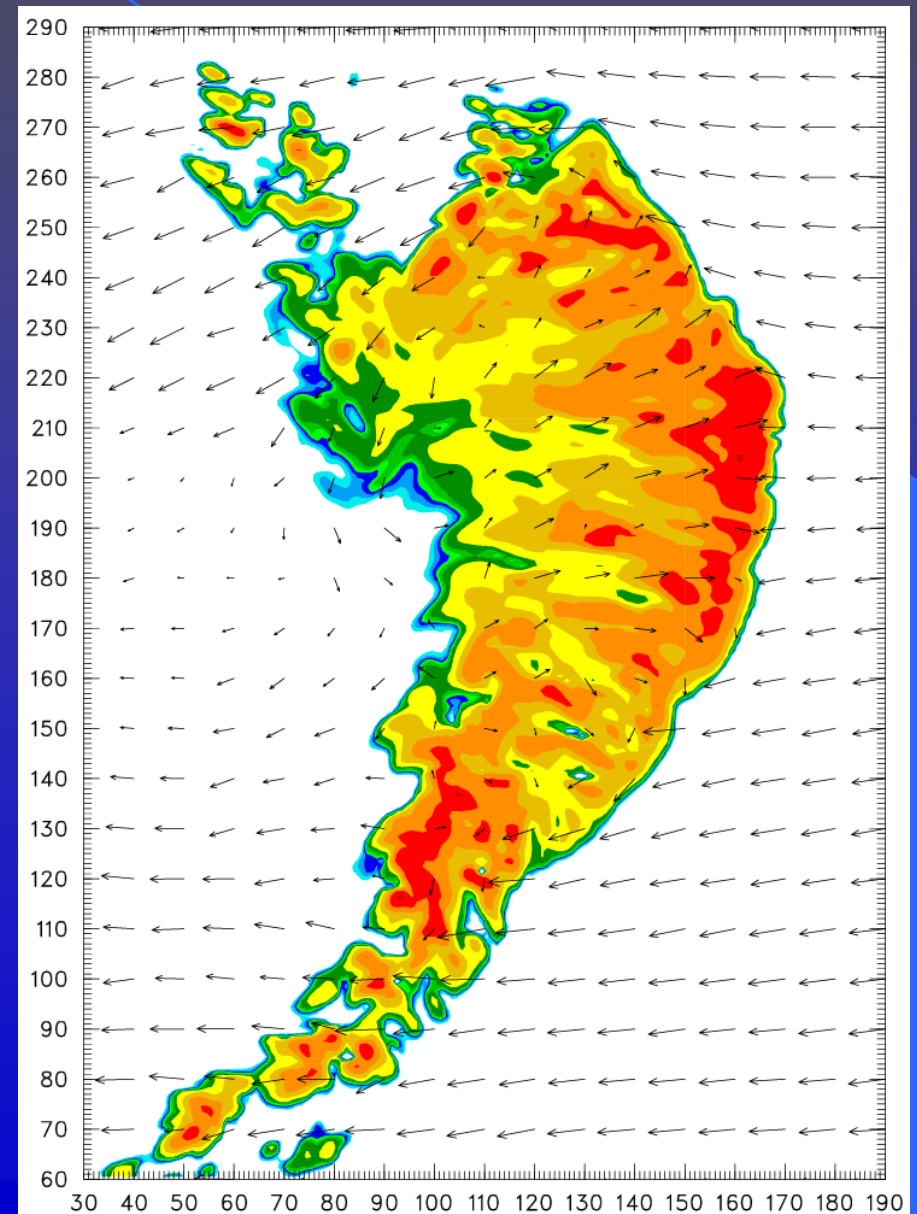
dBZ – 0.1 km

Horiz winds – 1.3 km

6hrs

dBZ – 0.1 km

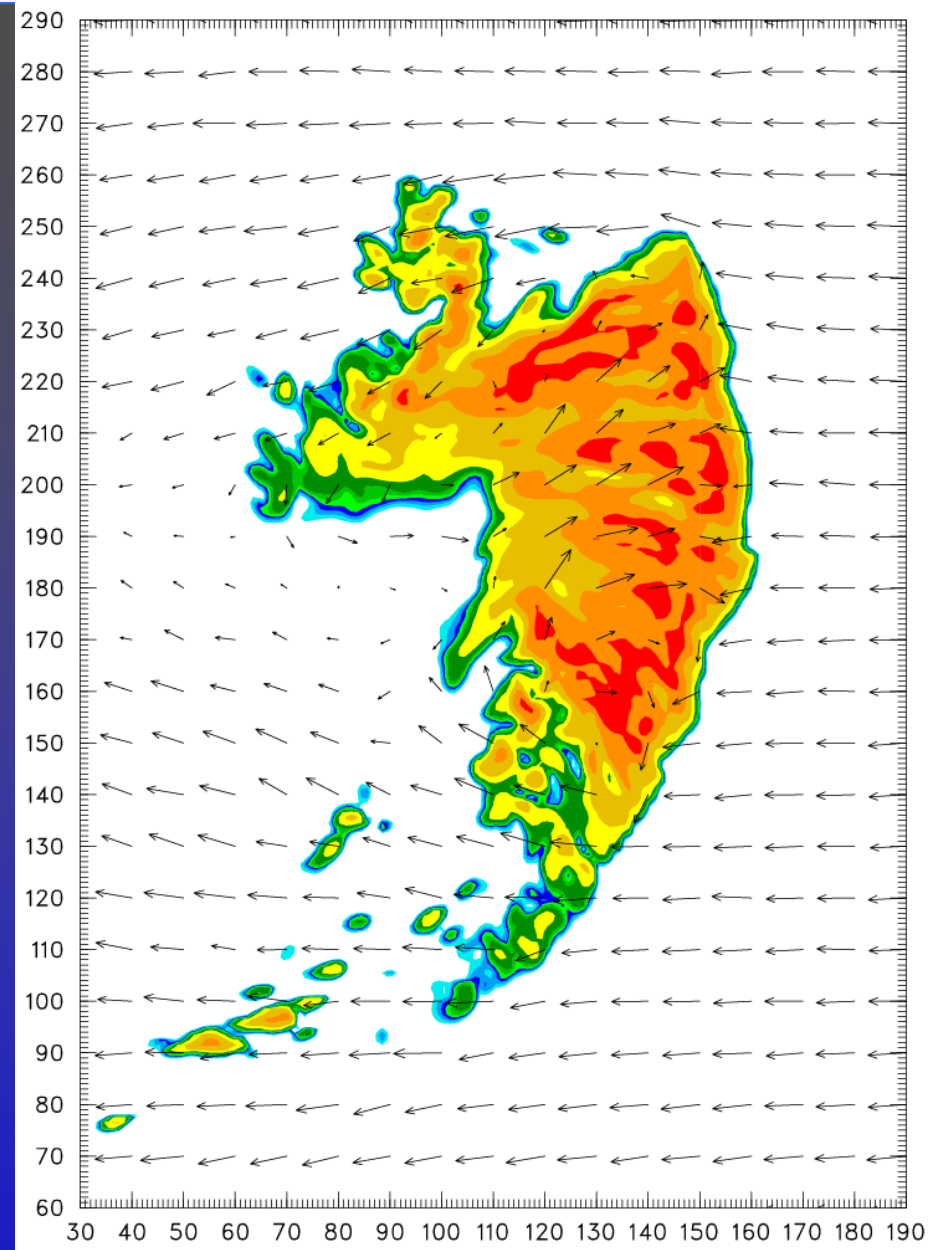
Horiz winds – 1.3 km



5hrs

dBZ – 0.1 km

Horiz winds – 1.3 km

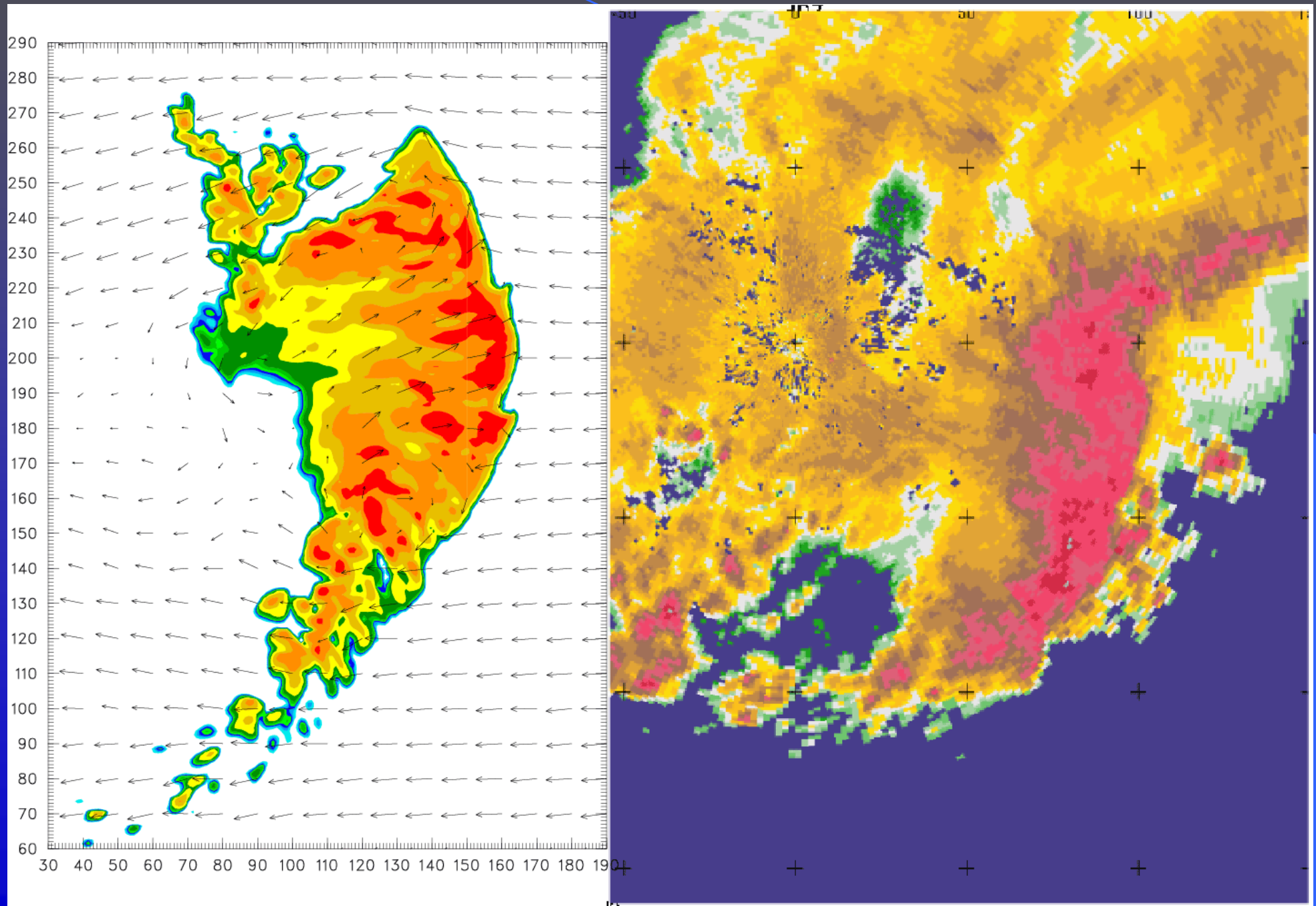


WRF at 5.5 hrs

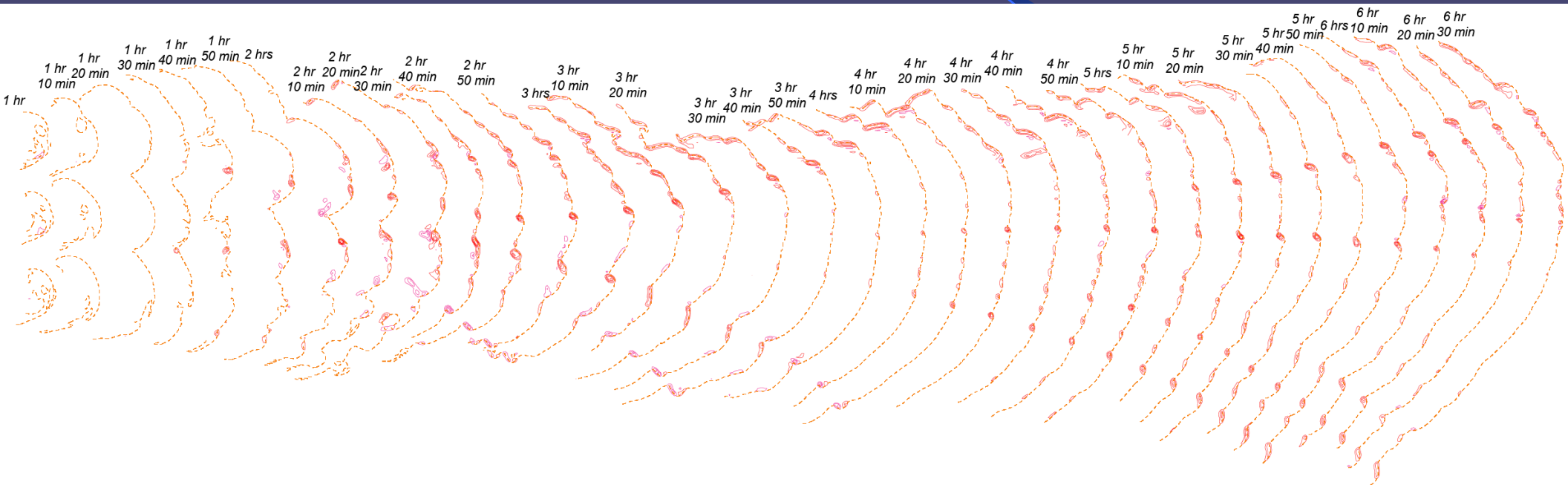
10 June 2003 KLSX (2330 UTC)

dBZ at 0.1 km, horizontal winds at 1.3 km

dBZ data at 0.5 degrees



Cold pool and mesovortex locations every 10 minutes

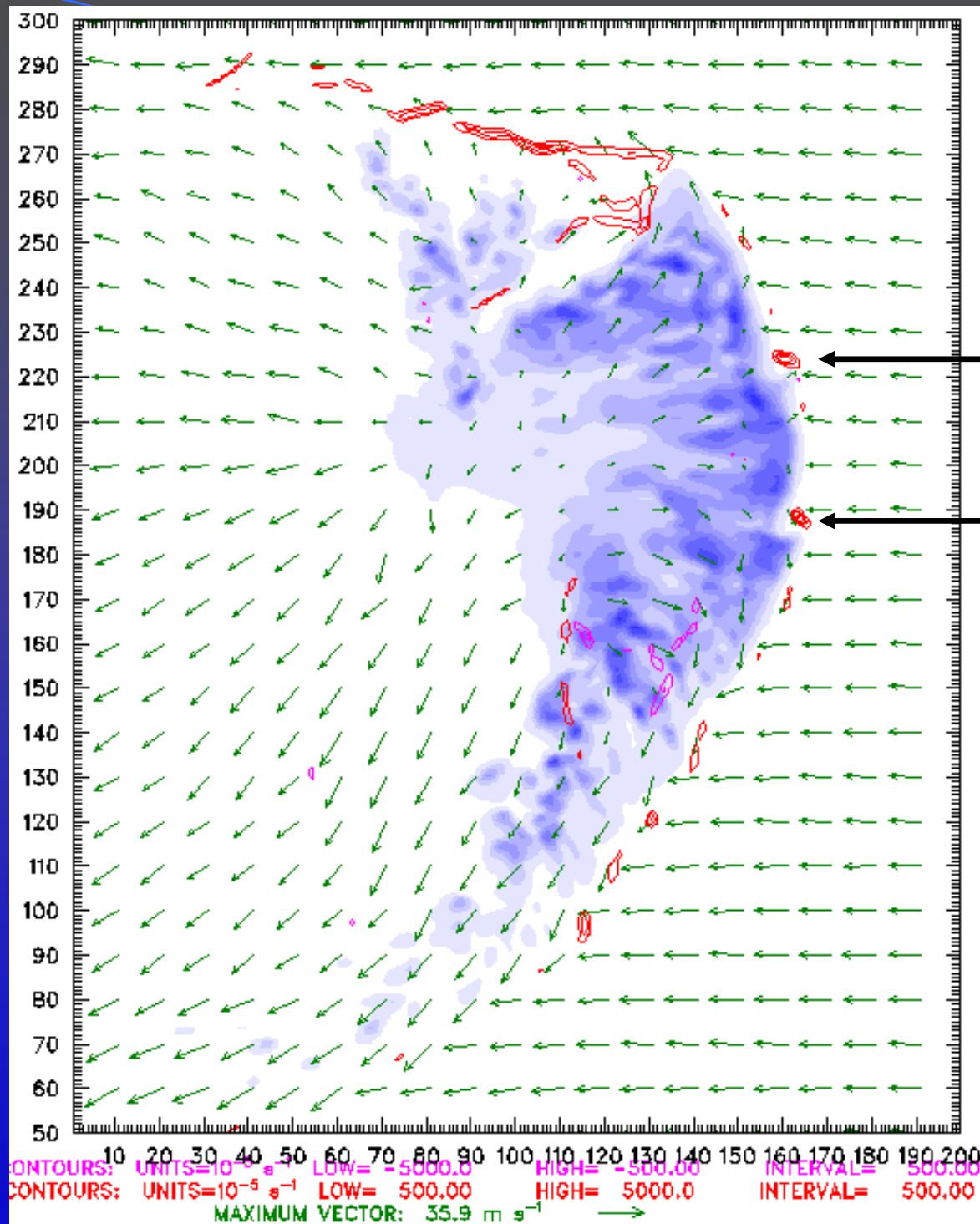


5.5 hrs

$q_r = 0.1$ km

$\zeta = 0.1$ km

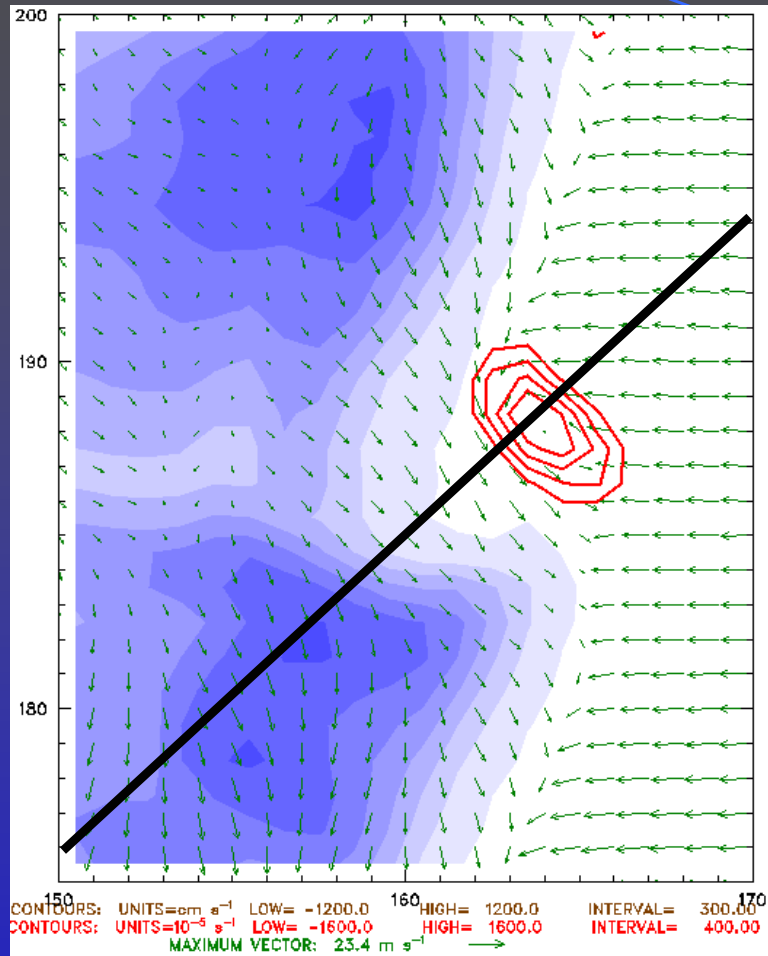
horiz winds $= 0.1$ km



Northern
vortex

Southern
vortex

Southern Mesovortex

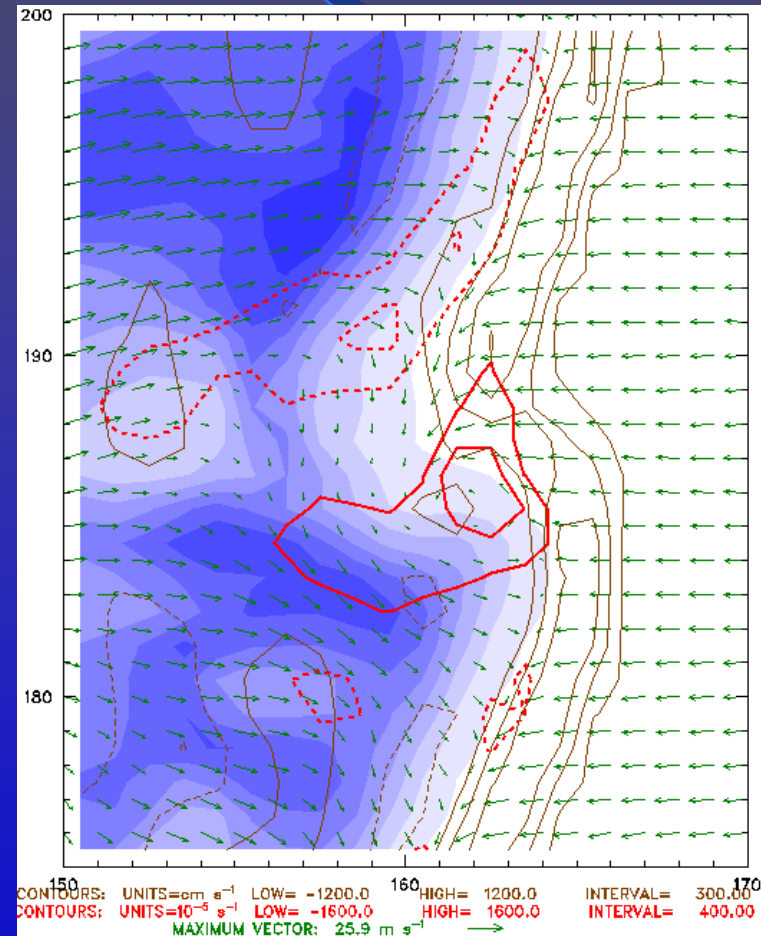


0.1 km

qr ζ horiz winds

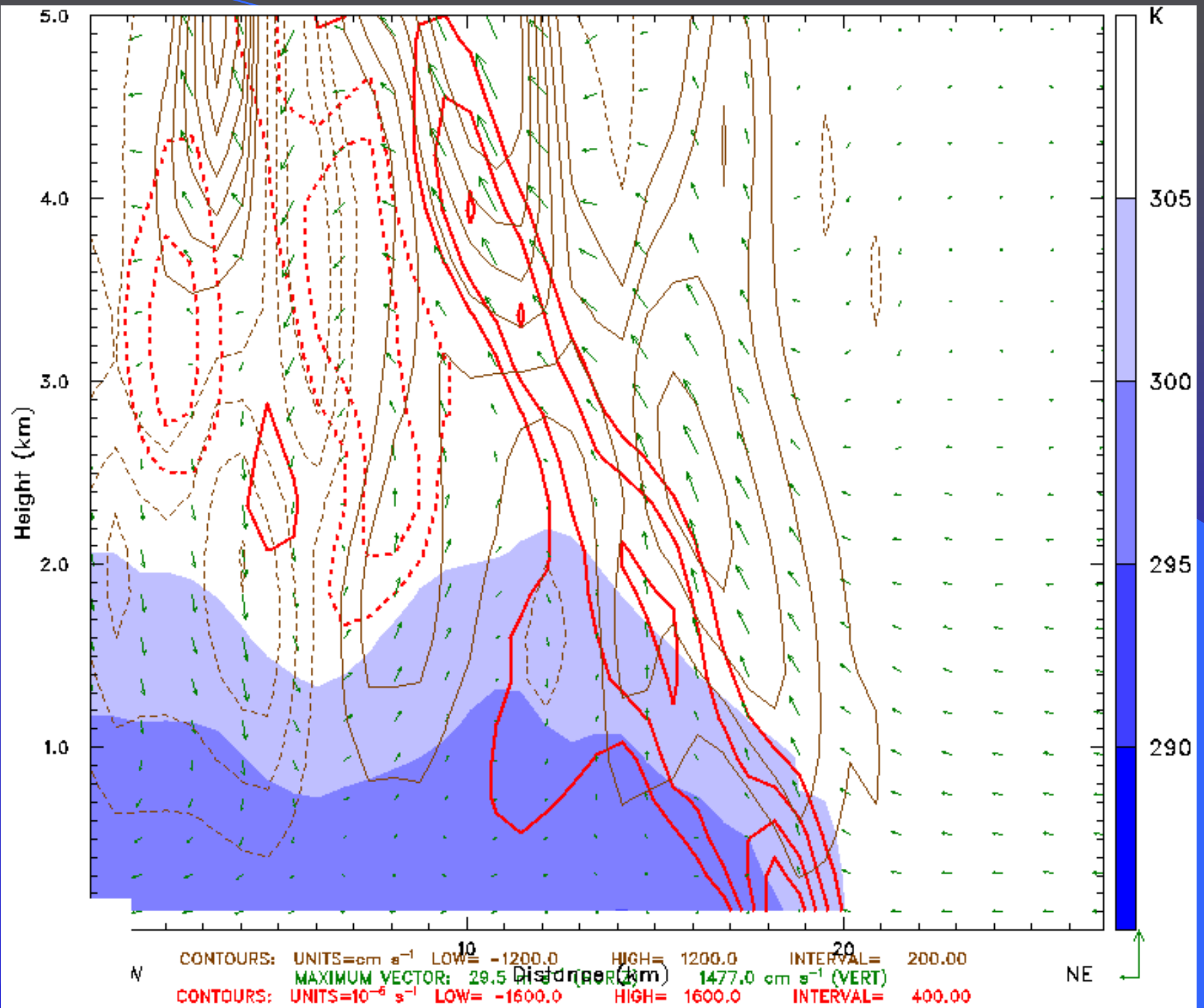
1.1 km

qr ζ horiz winds



Southern Mesovortex

theta
 ζ
Winds
W



Sensitivity Experiments:

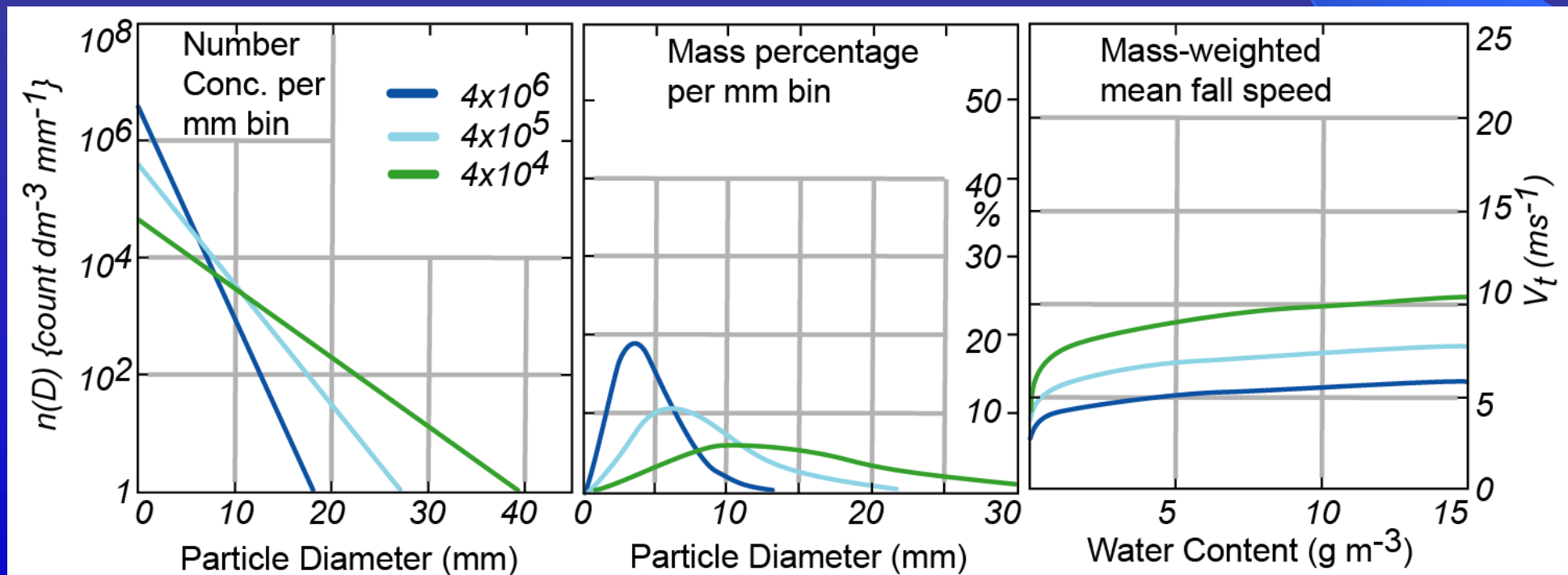
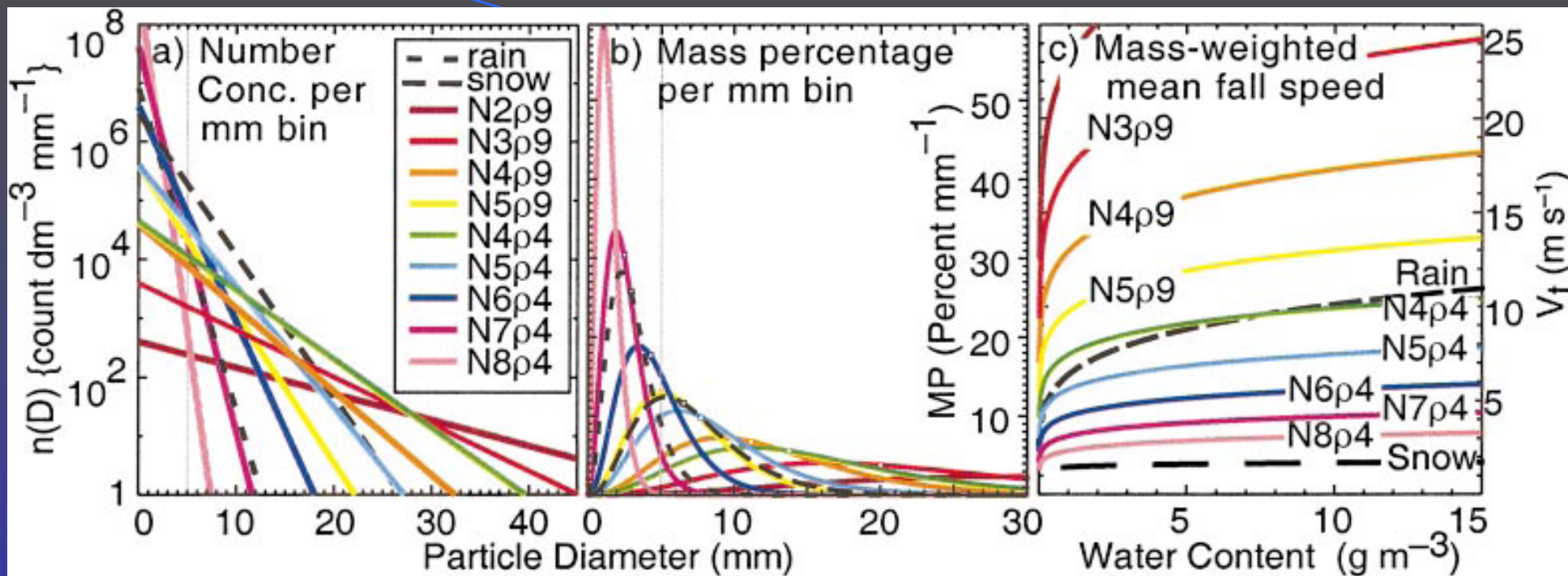
- Microphysics:

- Lin mp hail category y intercept parameter for size distribution

- 4×10^6 (control), 4×10^5 , 4×10^4

- Kessler warm rain mp

Hail Size Distributions (from Gilmore et al. 2004)

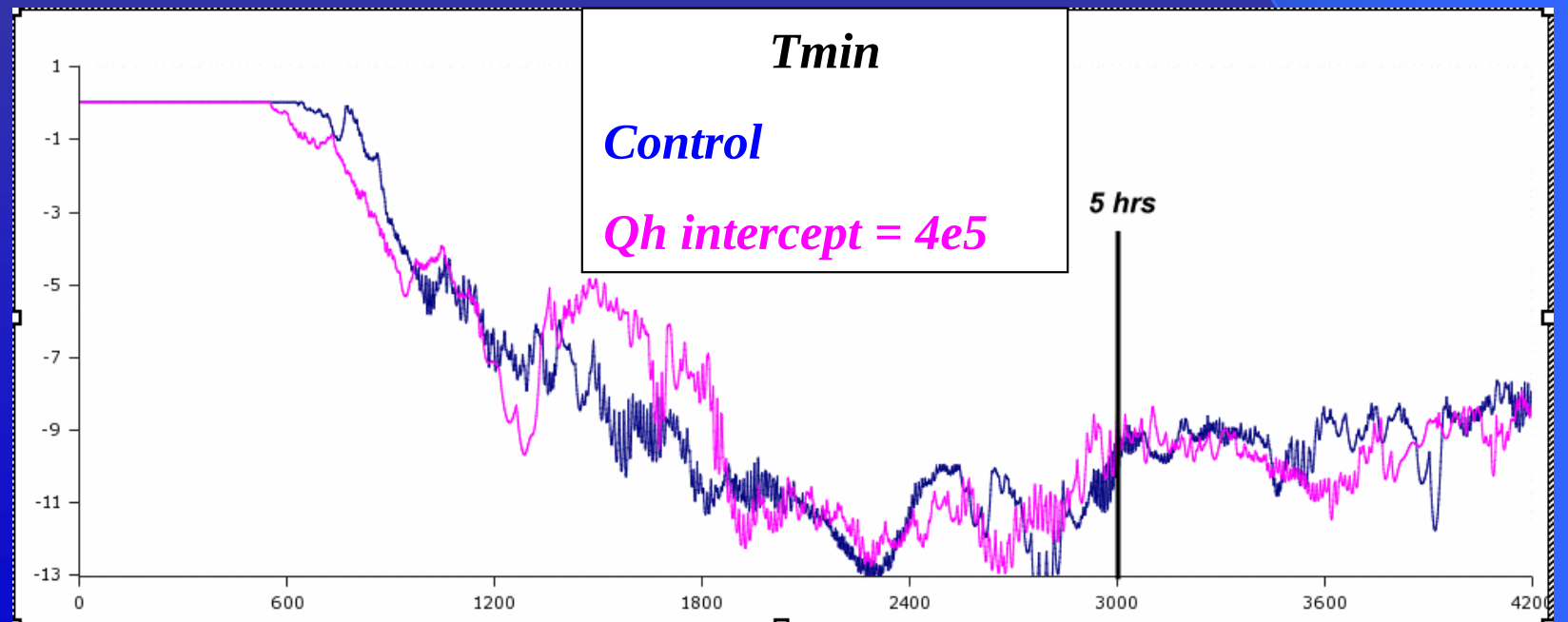
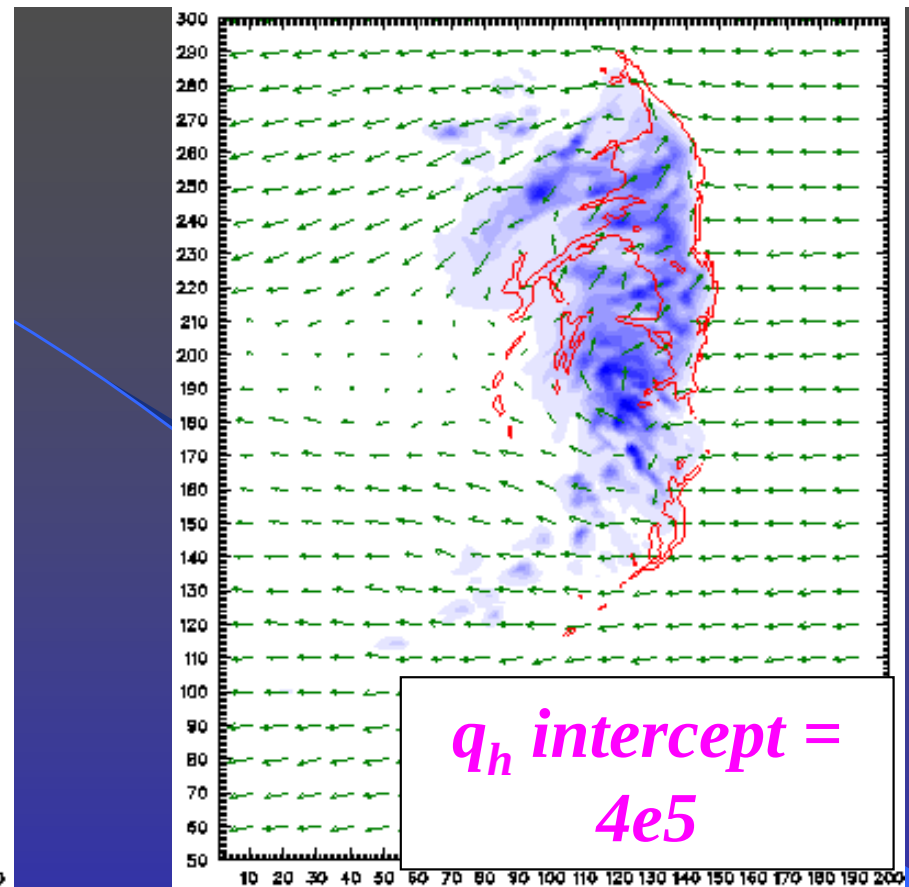
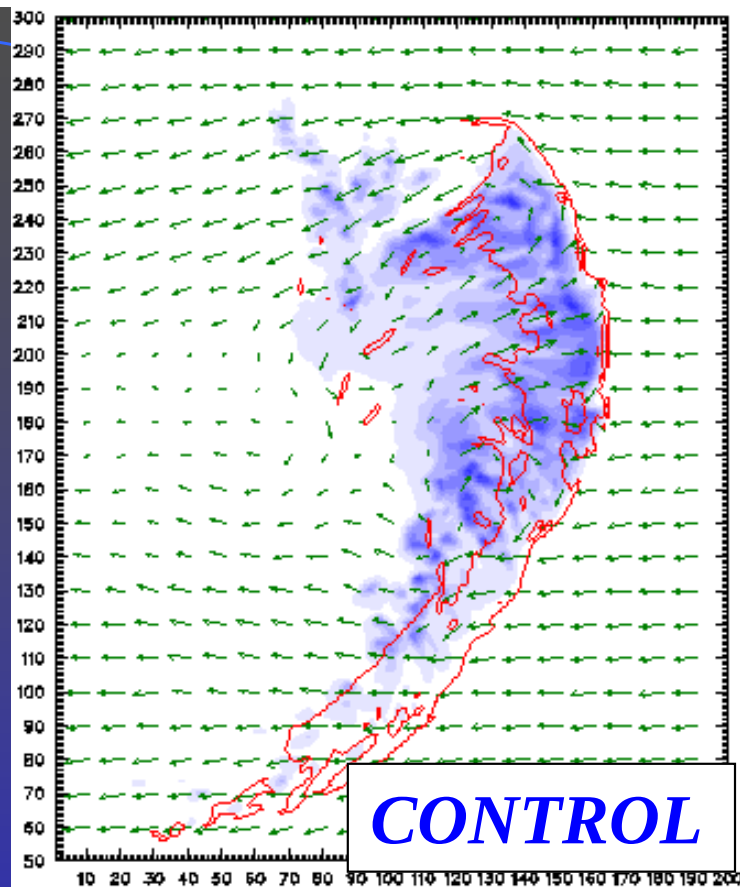


5 hrs

qr – 0.1 km

winds – 1.3
km

-9 K θ' - 0.1
km

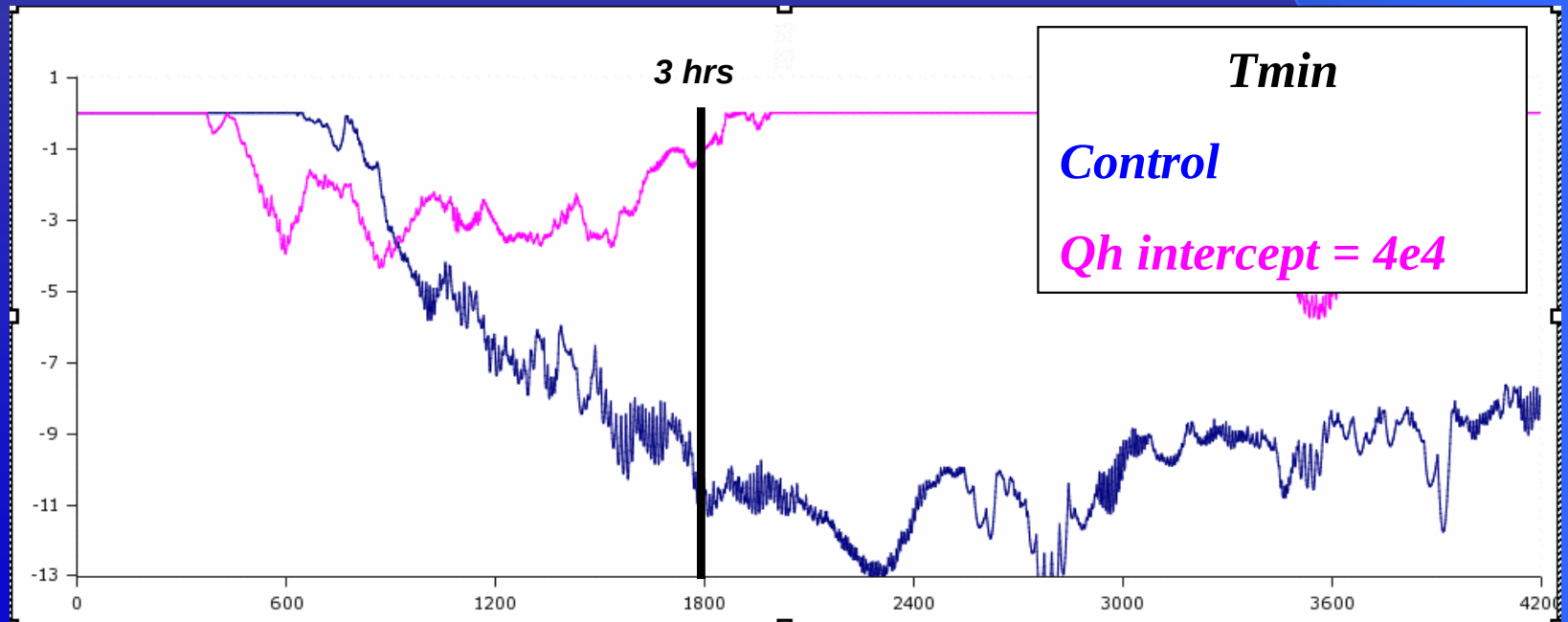
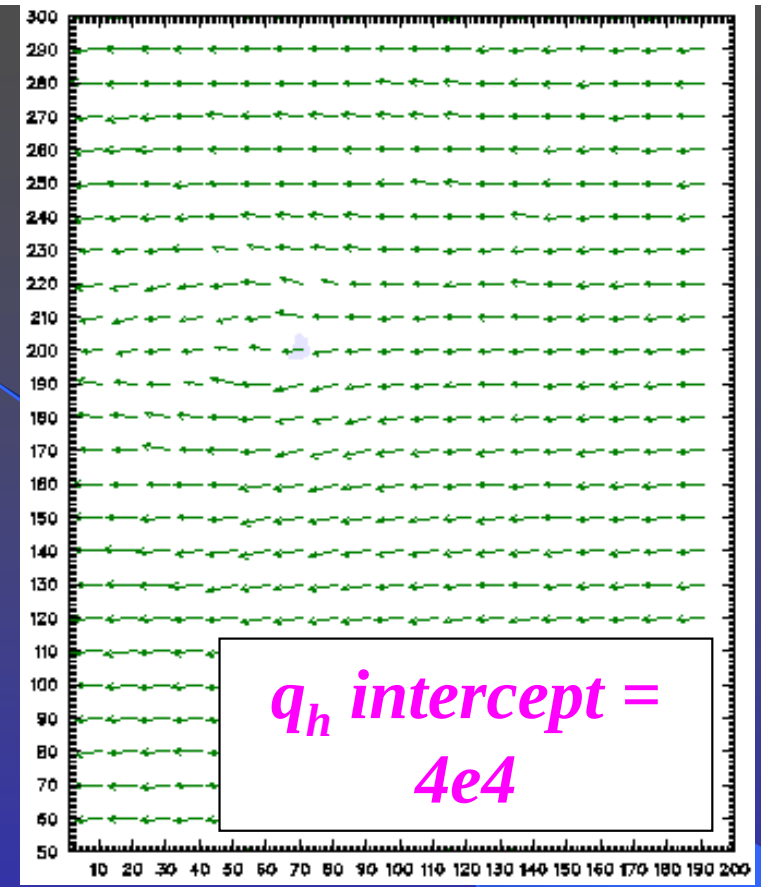
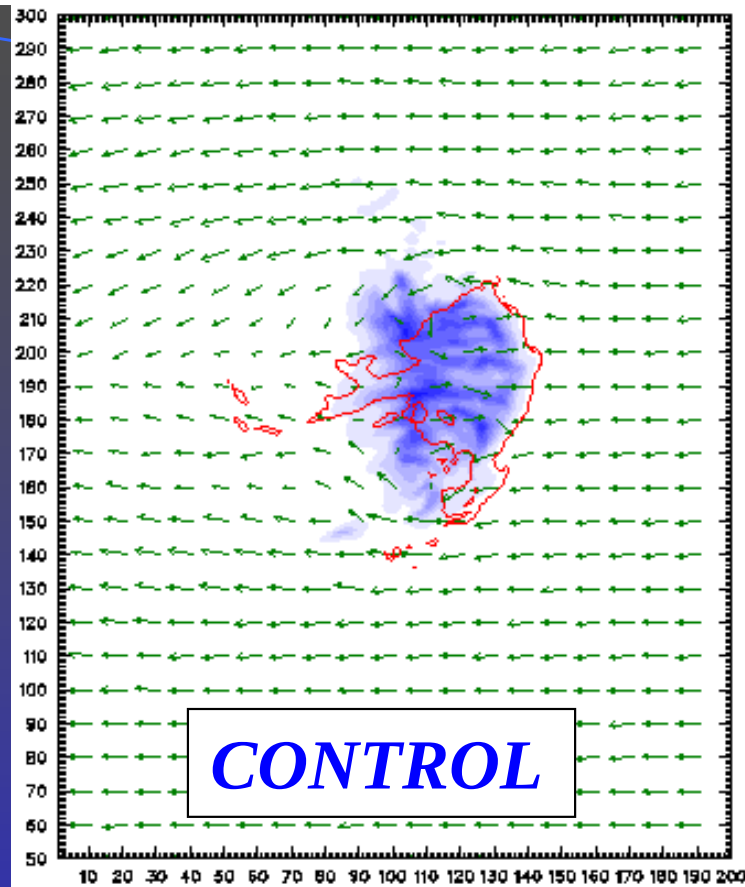


3 hrs

qr – 0.1 km

winds – 1.3 km

-9 K θ' - 0.1 km

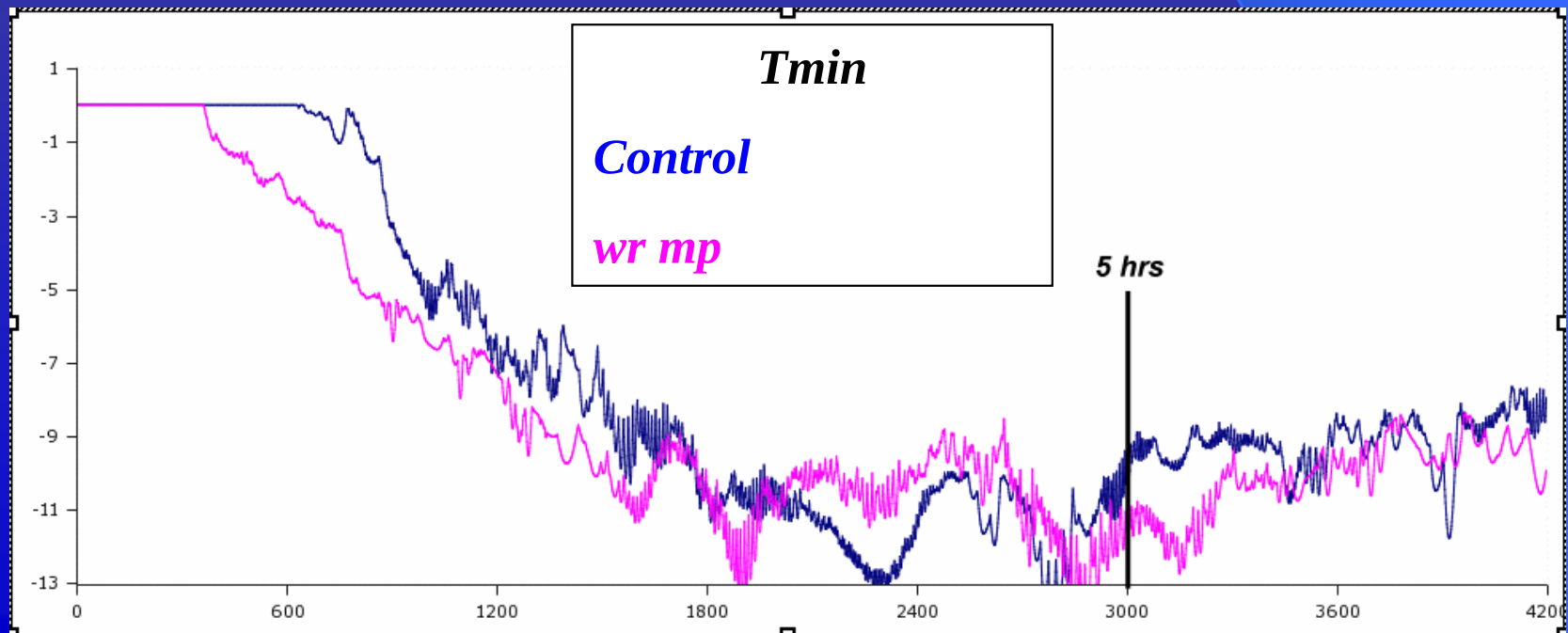
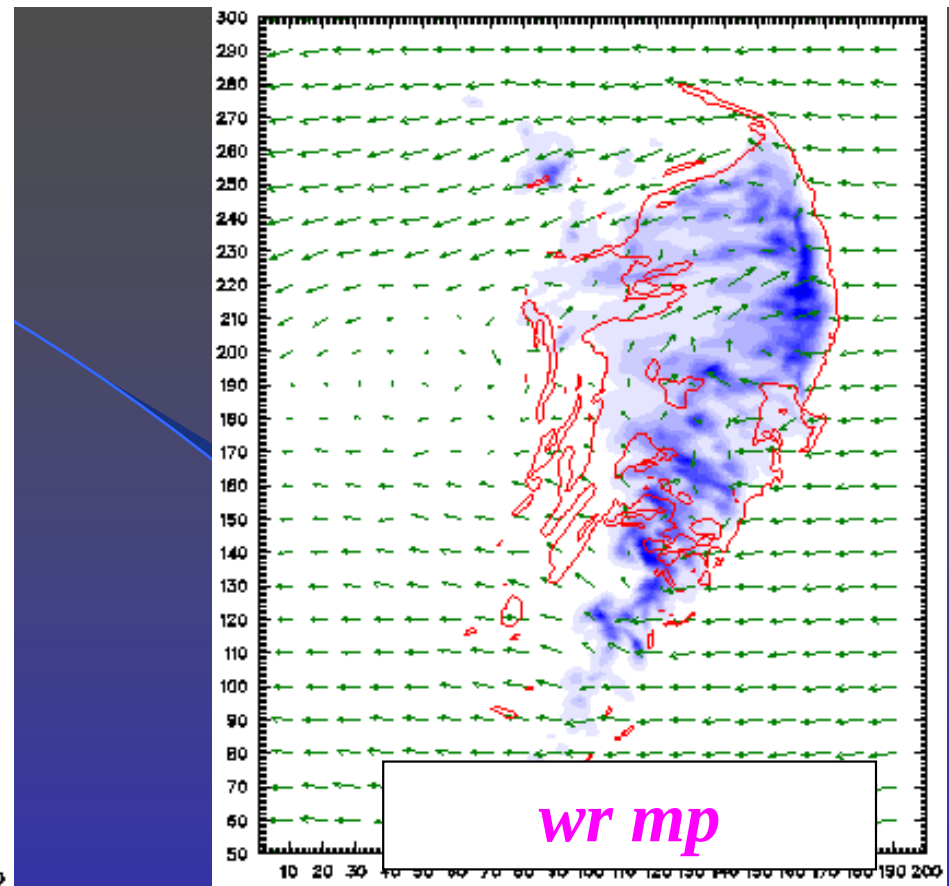
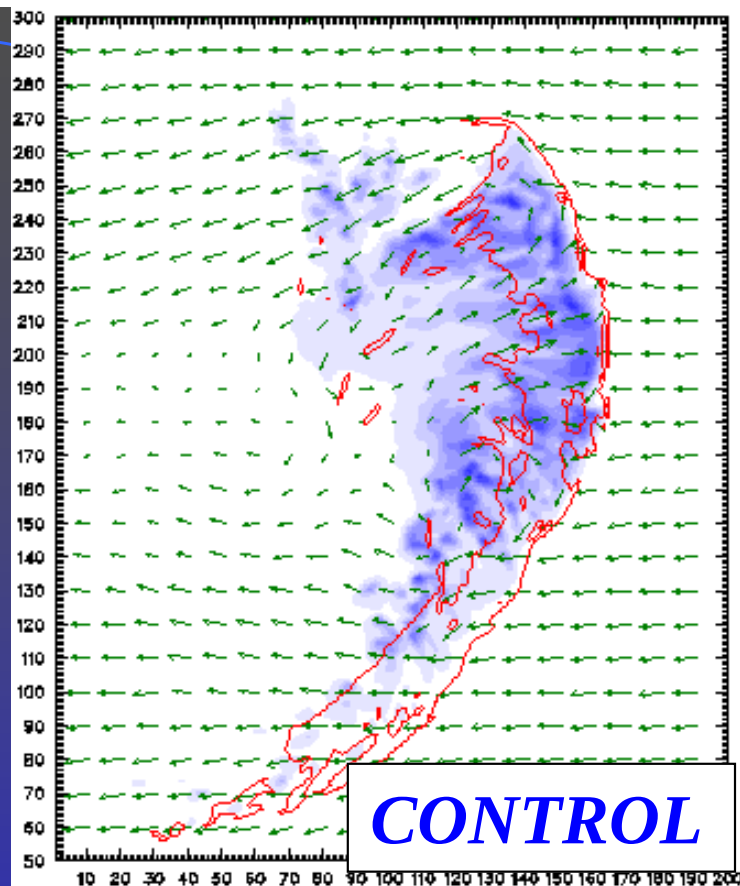


5 hrs

qr – 0.1 km

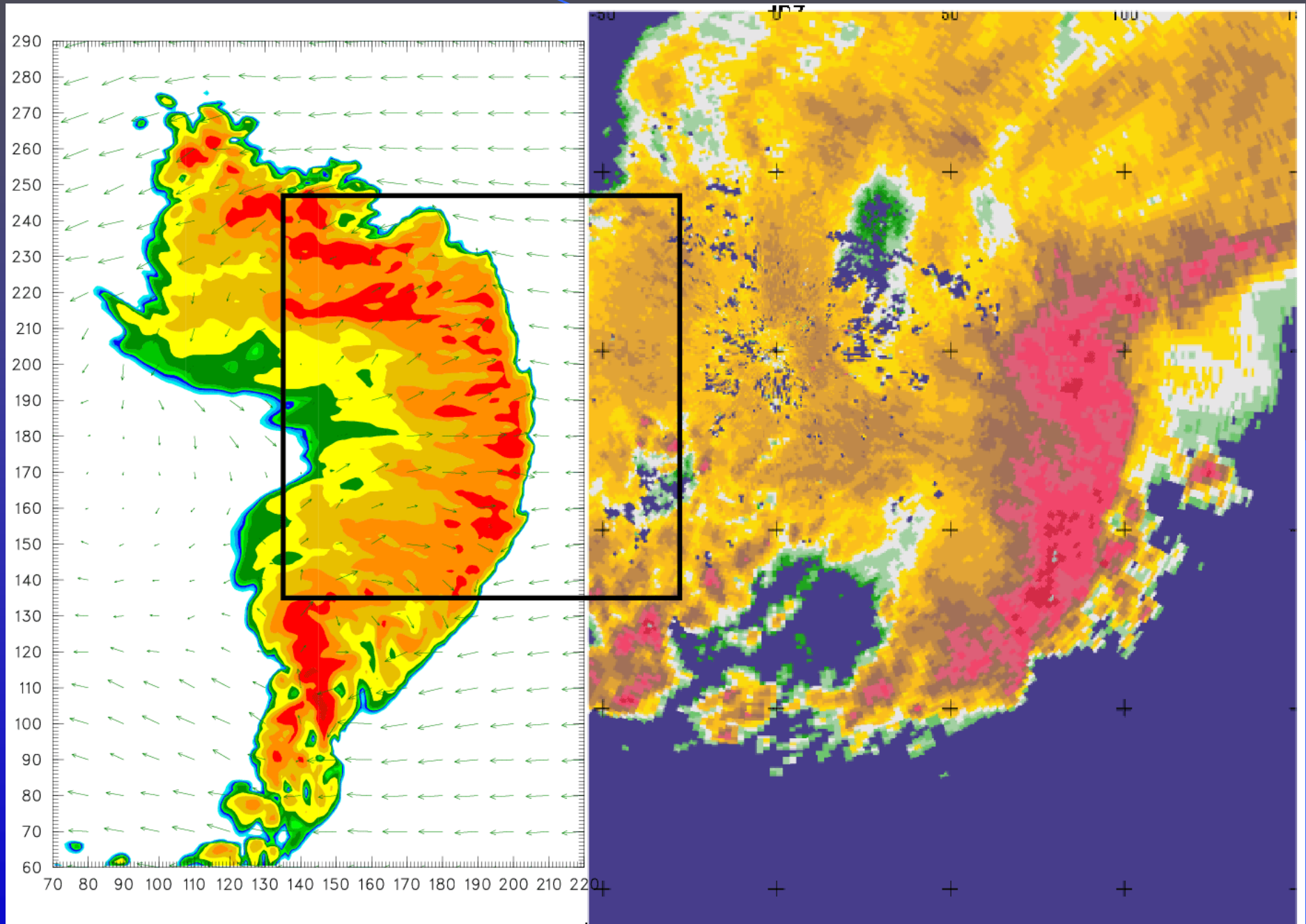
winds – 1.3 km

-9 K θ' – 0.1 km

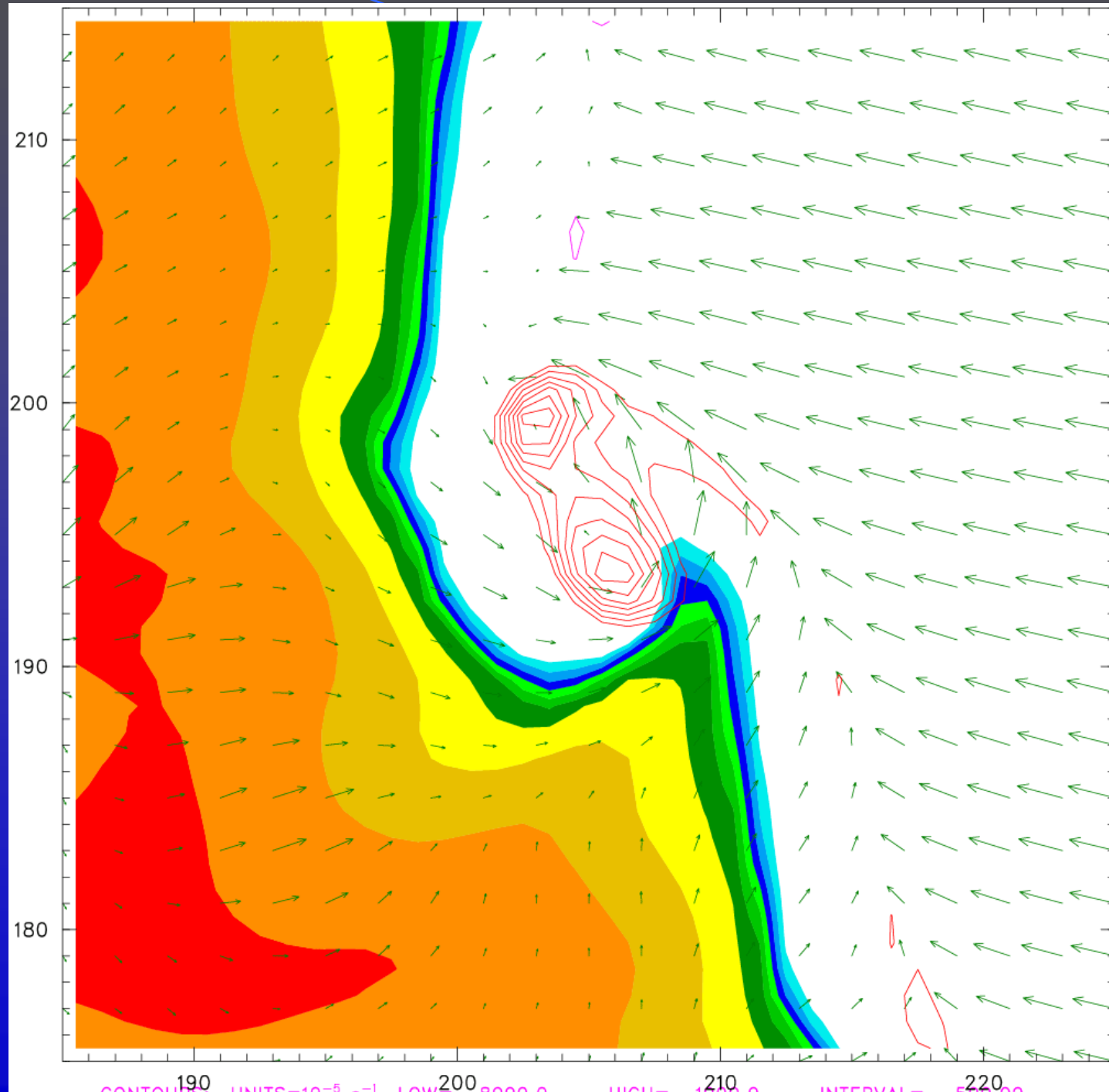


WRF at 5.5 hrs (nested run) 10 June 2003 KLSX (2330 UTC)

dBZ at 0.1 km, horizontal winds at 1.3 km dBZ data at 0.5 degrees



WRF at 5.5 hrs – nested domain – 333 m horizontal resolution



A dramatic landscape photograph featuring a massive, dark, and textured storm cloud that dominates the upper two-thirds of the frame. The cloud has a deep, charcoal-like hue with some lighter, wispy edges where it catches the light. Below the cloud, a flat, green field stretches across the middle ground. In the foreground, a wet asphalt parking lot with white painted lines is visible, reflecting the ambient light. The horizon line is low, showing some distant trees and a few small, illuminated structures. The overall atmosphere is somber and powerful, suggesting an approaching storm.

Questions?