Drylines and Convection

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Introduction

- Characteristics
- Formation
- Movement
- Role in initiating convection
  - Large-scale along-dryline variability
  - Small-scale along-dryline variability

Characteristics

- Dewpoint difference
  - Change of 3°C at rate of .5°C per hour up to 18°C
- Wind shift
  - Sharp wind shift on west with weak winds to the east
- The zone between two air masses or boundary layers
  - Depth of boundary layers oscillate

Characteristics

- Doppler velocity used to study
  - Low level convergence and upper level divergence
  - Hot air from west overflowed to east
  - Secondary circulation with descent to the east
    - Driven by vertical potential temperature gradient
  - Westward tilt with height of vertical vorticity

Formation

- Negatively tilted longwave trough at 500 mb over western U.S.
- Weak jet at 500 mb across southern CO
- 850 mb southerly winds over Texas from Gulf
- Appearance of strong inversion at 1200Z
- Terrain slope, heat fluxes, and soil moisture affect formation and movement

Movement

- Warm dry air on west side overruns and forms cap
- Dry air creates higher PBL
- Moves by mixing and lowering dewpoint
- Can retrograde at night

Movement

- Move smoothly in morning and jump in afternoon
- Bulges can form
- Evidence of other boundaries forming near dryline with similar characteristics
  - Double dryline possible

Convective Initiation

- Large-scale along-dryline variability
  - Soil Moisture
  - Pressure Gradient Force
  - Cloud Streets
- Small-scale along-dryline variability
  - Horizontal Convective Rolls (HCRs)
  - Misocyclones
- Air Parcels

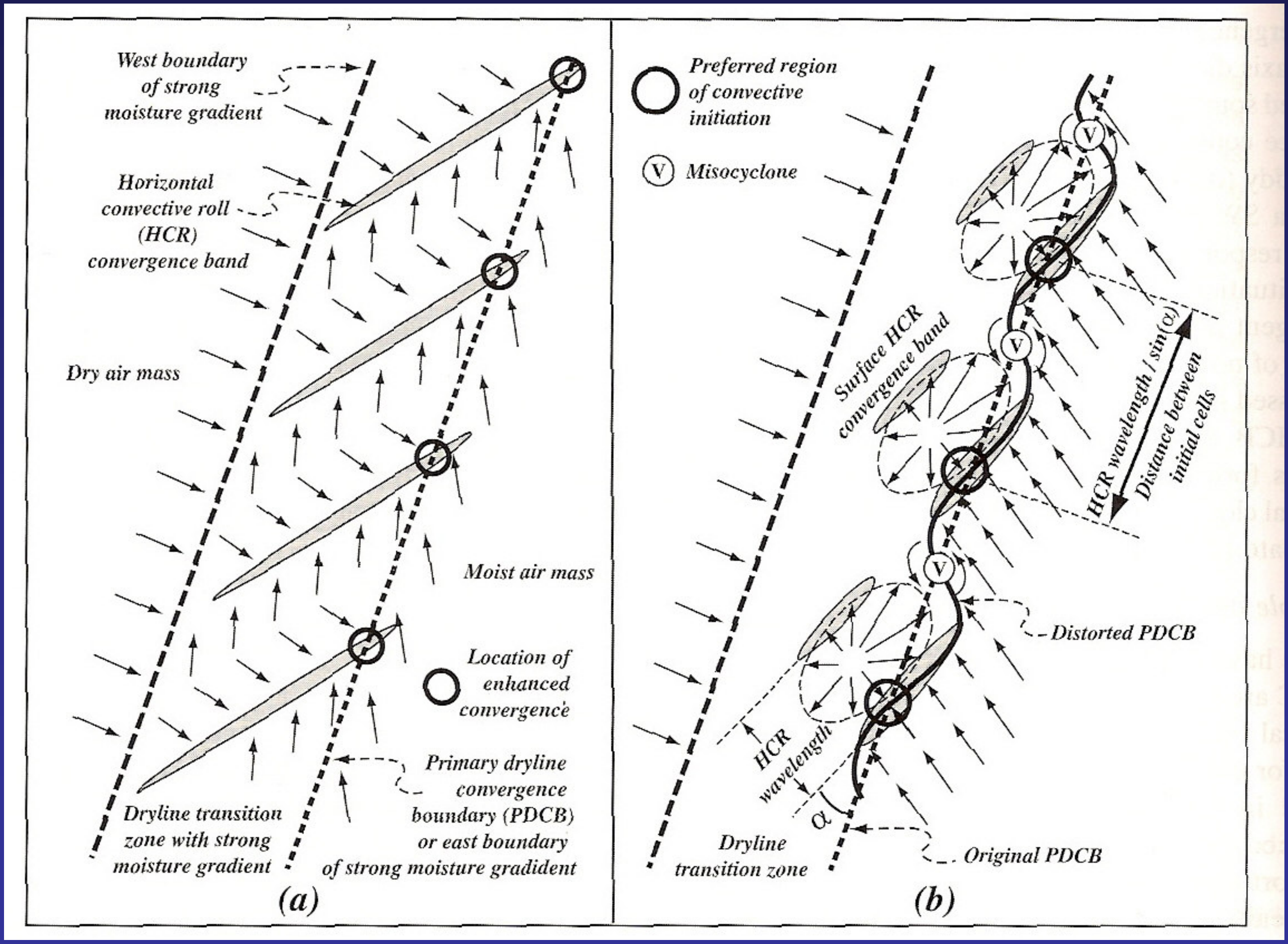
Horizontal Convective Rolls

(HCRs)

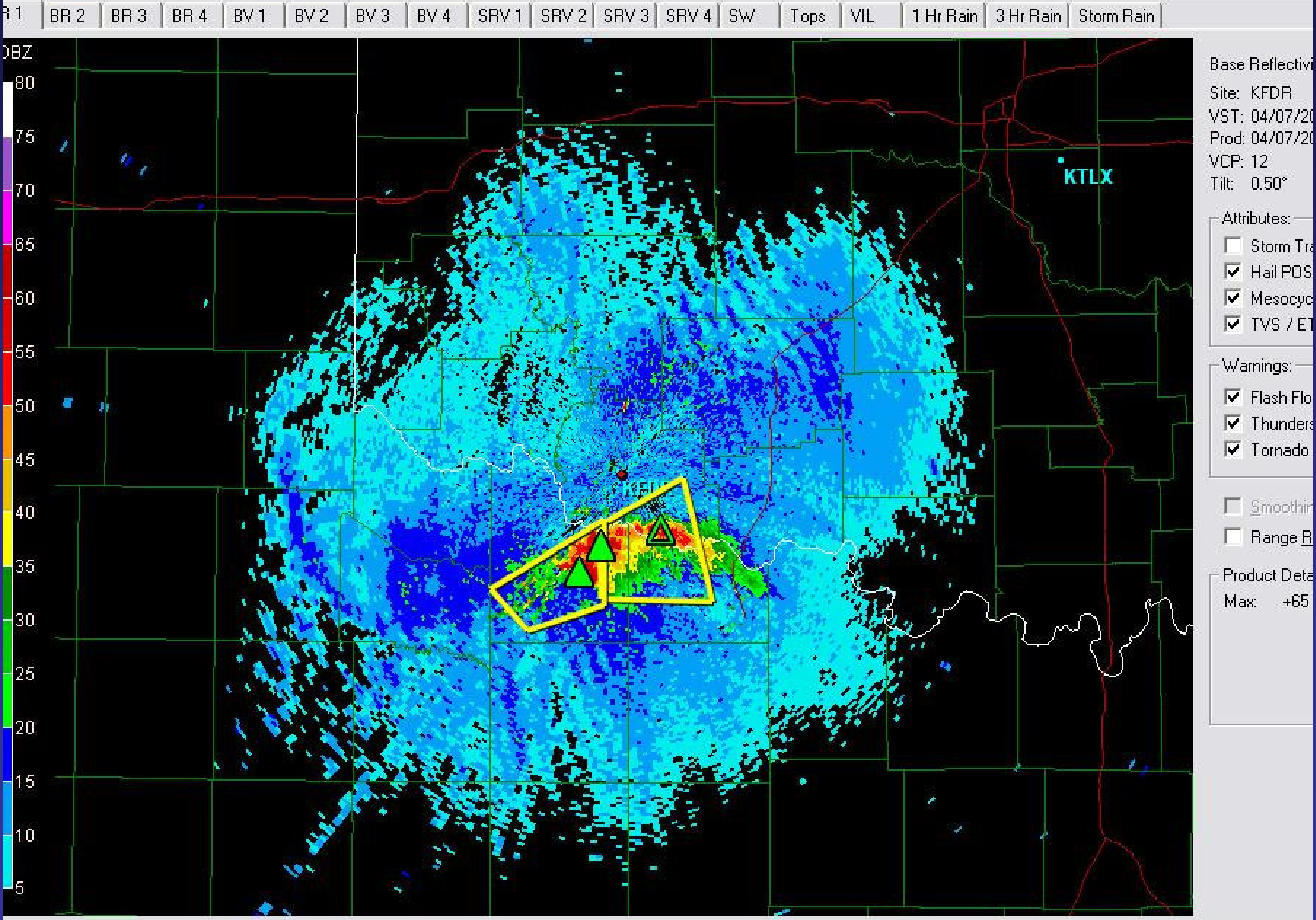
- Tubes of horizontal vorticity
- Generated by convective instability and wind shear
- Aligned with boundary layer shear vector
- Cloud streets, reflectivity fine lines
- Near-Surface Moisture Convergence (modeled)
- Enhanced surface convergence → enhanced upward motion!

HCR Conceptual Model

From Xue and Martin (2006)



HCRs on Radar



Base Reflectivi
Site: KFDR
VST: 04/07/20
Prod: 04/07/20
VCP: 12
Tilt: 0.50°

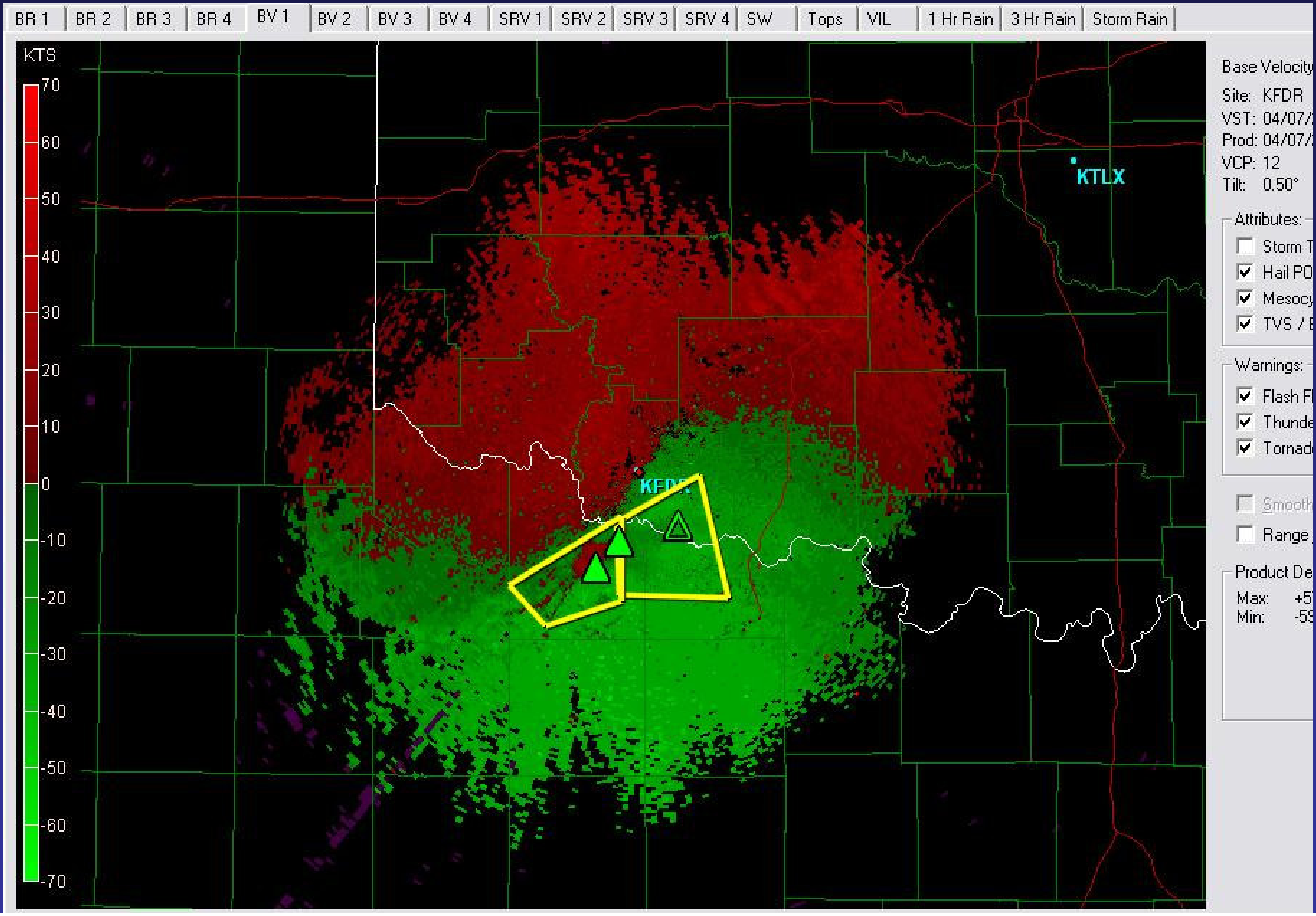
Attributes:
☐ Storm Tra
☑ Hail POS
☑ Mesocyc
☑ TVS / ET

Warnings:
☑ Flash Flo
☑ Thunders
☑ Tornado

☐ Smoothin
☐ Range R

Product Deta
Max: +65

HCRs on Radar (cont.)



Base Velocity

Site: KFDR

VST: 04/07/

Prod: 04/07/

VCP: 12

Tilt: 0.50°

Attributes:

☐ Storm T

☑ Hail PO

☑ Mesocy

☑ TVS / E

Warnings:

☑ Flash F

☑ Thunde

☑ Tornad

☐ Smooth

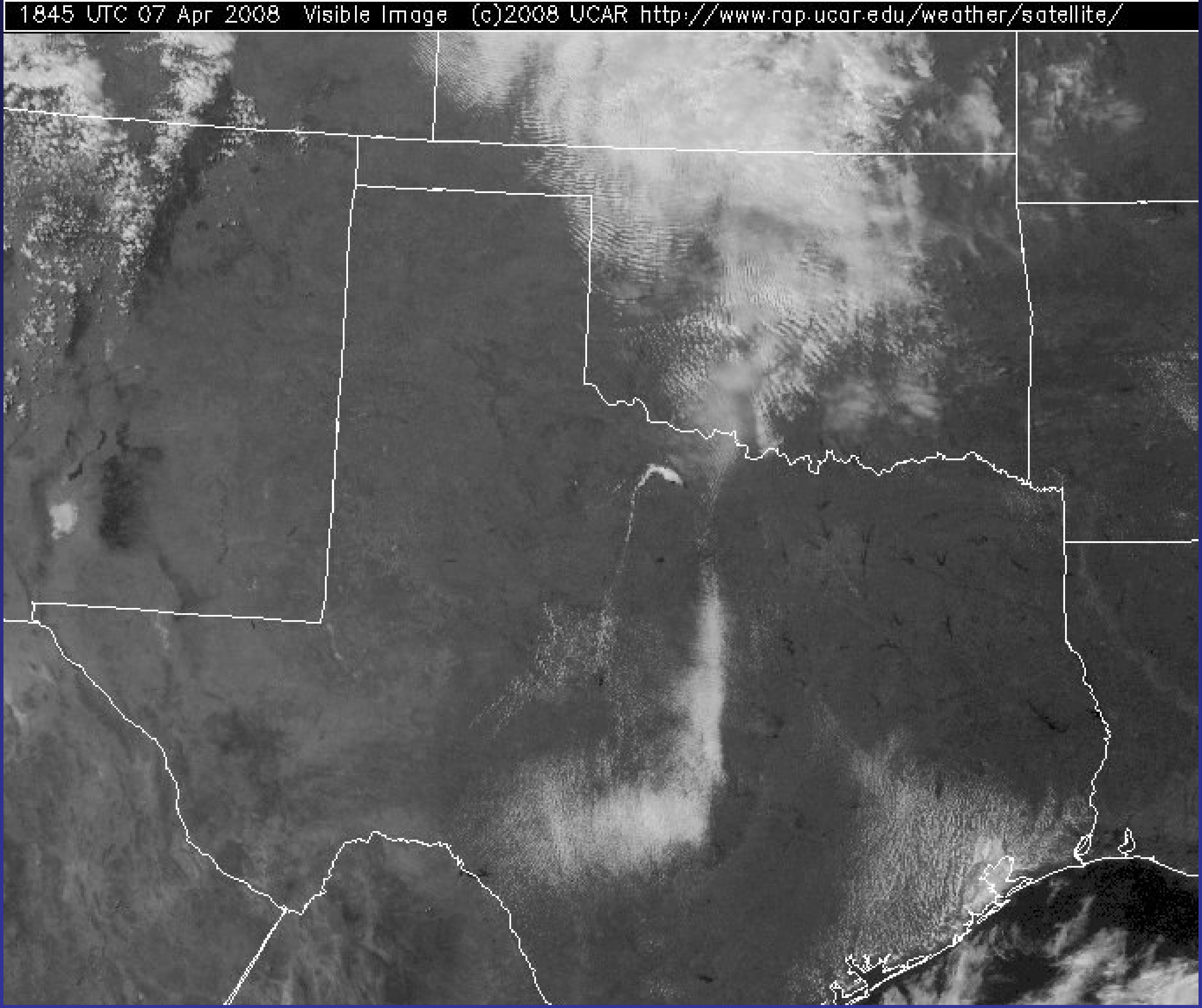
☐ Range

Product De

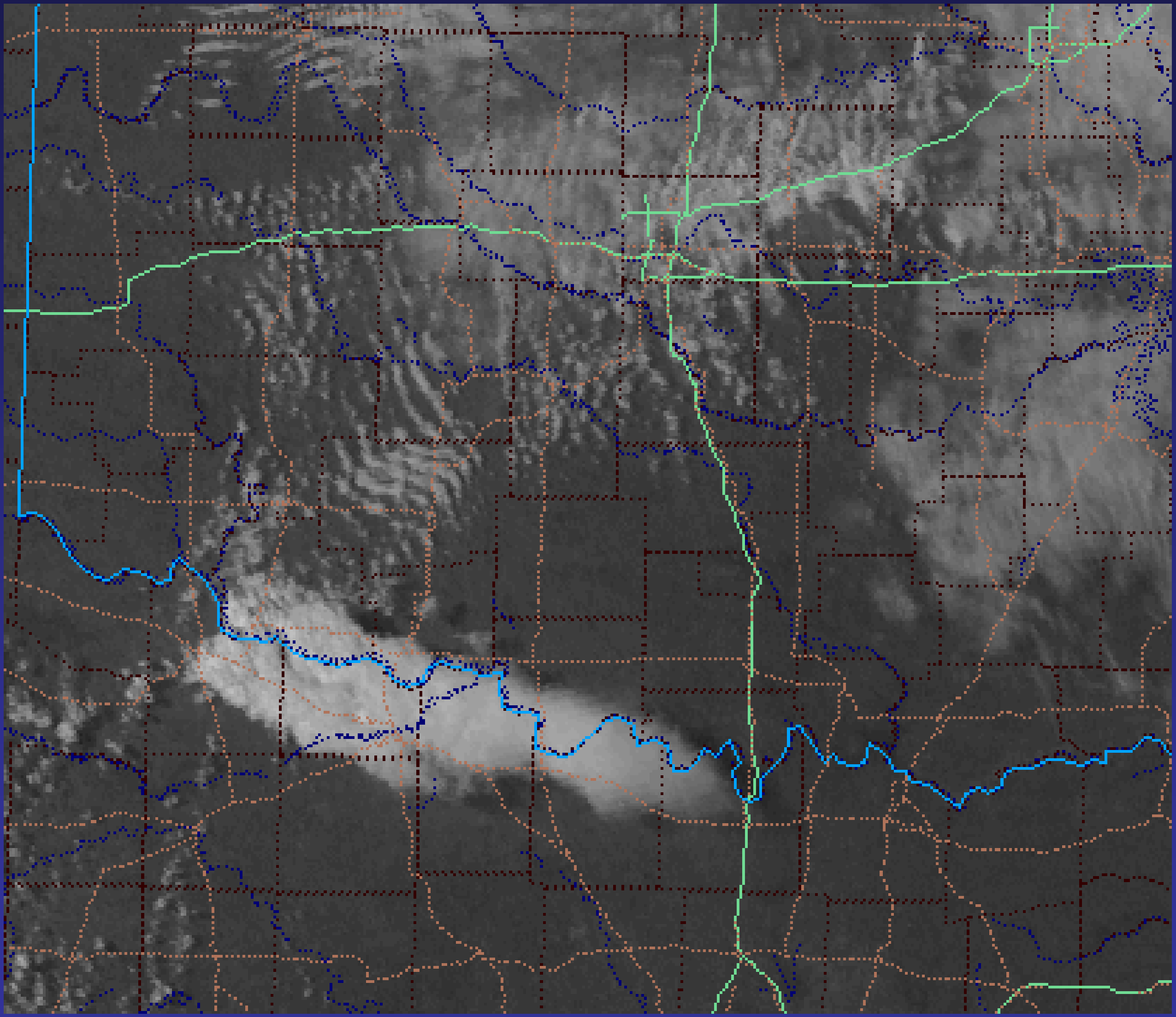
Max: +5

Min: -59

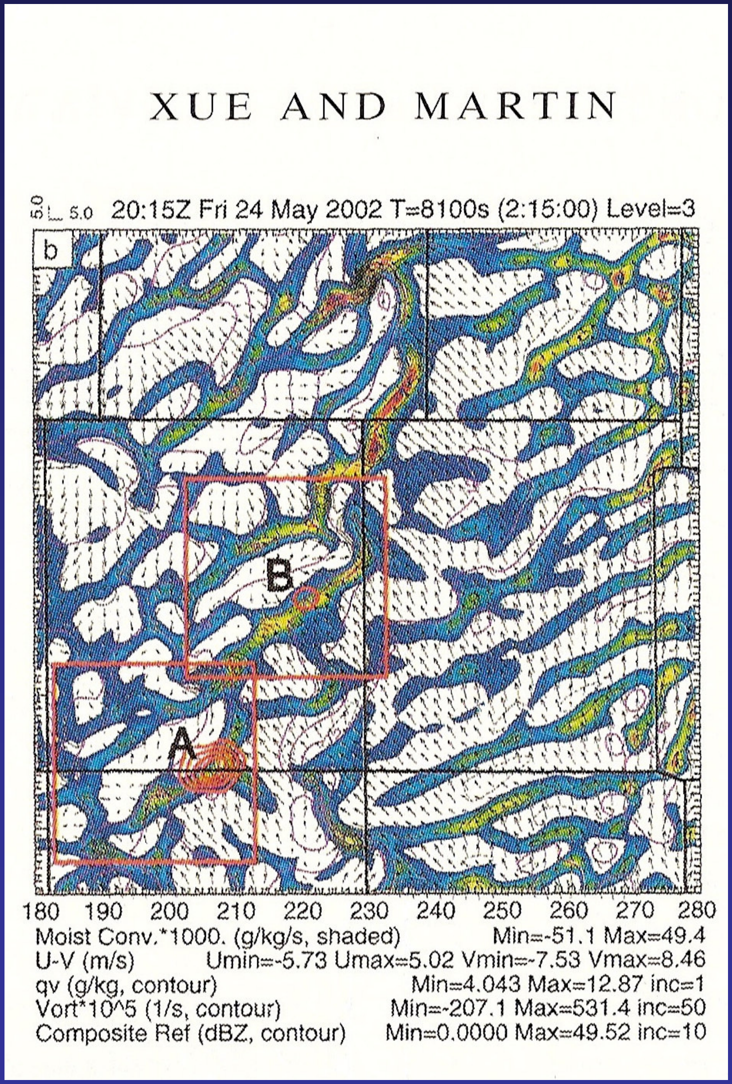
HCRs on Satellite (Cloud Streets)



A Closer Look



Near-Surface Moisture Convergence



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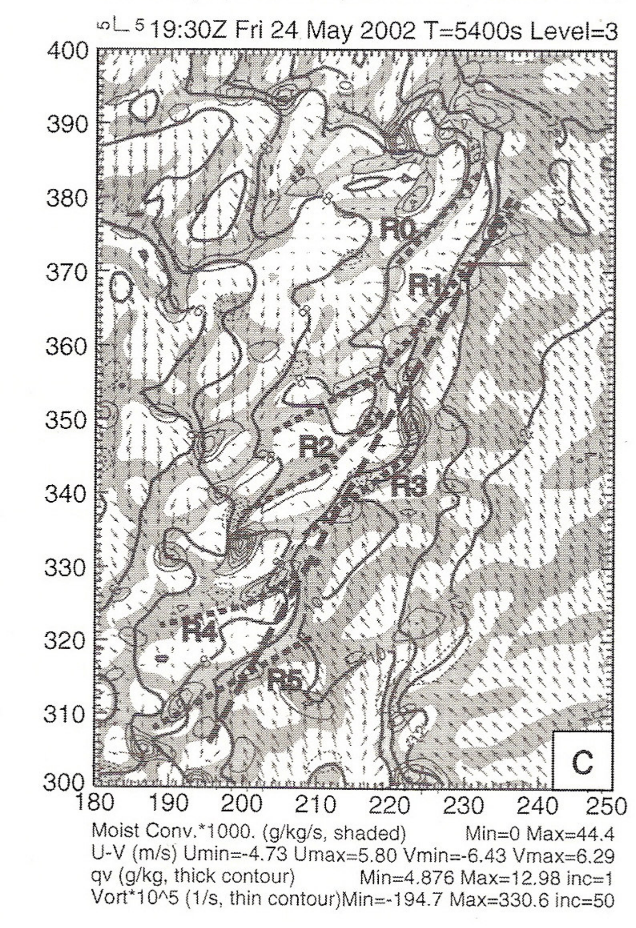
20:15Z Fri 24 May 2002 T=8100s (2:15:00) Level=3

Moist Conv.*1000. (g/kg/s, shaded) Min=-51.1 Max=49.4
U-V (m/s) Umin=-5.73 Umax=5.02 Vmin=-7.53 Vmax=8.46
qv (g/kg, contour) Min=4.043 Max=12.87 inc=1
Vort*10^5 (1/s, contour) Min=-207.1 Max=531.4 inc=50
Composite Ref (dBZ, contour) Min=0.0000 Max=49.52 inc=10



19:30Z Fri 24 May 2002 T=5400s Level=3

Moist Conv.*1000. (g/kg/s, shaded) Min=0 Max=44.4
U-V (m/s) Umin=-4.73 Umax=5.80 Vmin=-6.43 Vmax=6.29
qv (g/kg, thick contour) Min=4.876 Max=12.98 inc=1
Vort*10^5 (1/s, thin contour)Min=-194.7 Max=330.6 inc=50

Misocyclones

- Vertical vorticity tubes < 4km in diameter
- Relationship near HCRs along boundary
  - Aid in bending boundary to wavelike shape
- Control where updrafts can exist due to downward-directed pressure gradient at core
- Can spawn non-supercell tornadoes when established updraft core/storm collocates with misocyclone

Misocyclones

From Murphey et al. (2006)

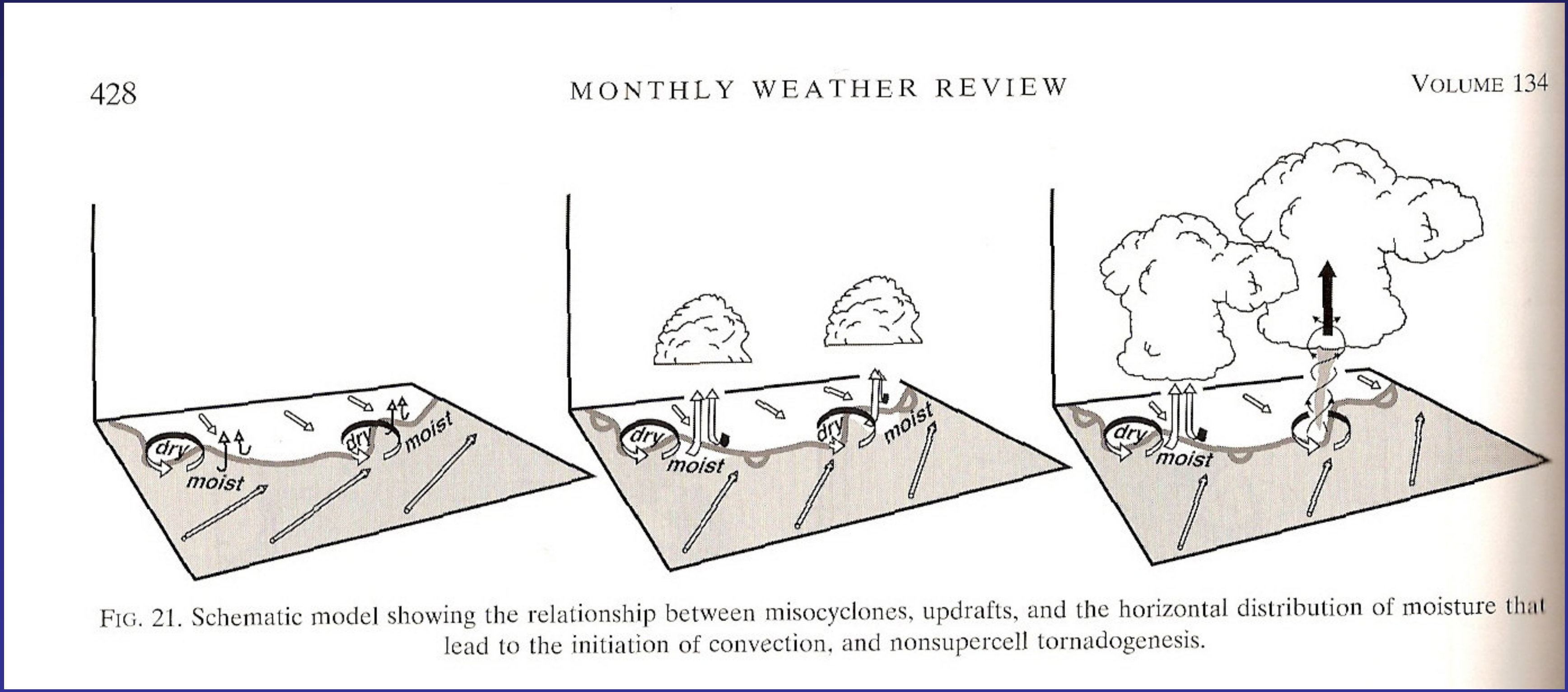


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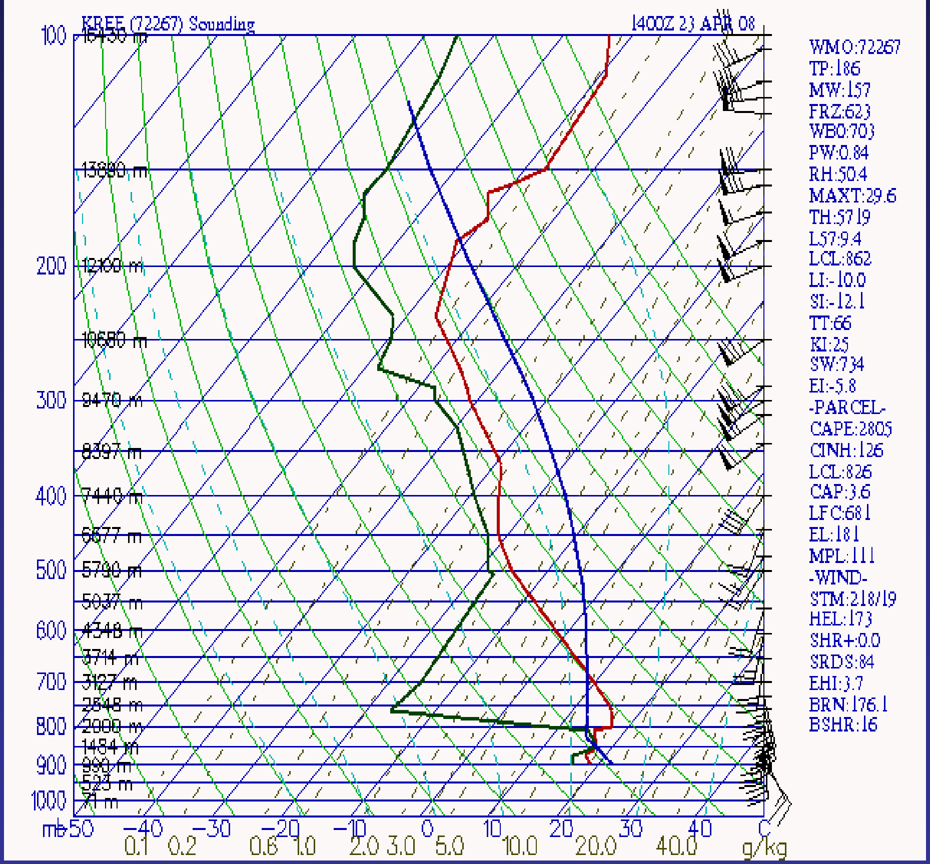
FIG. 21. Schematic model showing the relationship between misocyclones, updrafts, and the horizontal distribution of moisture that lead to the initiation of convection, and nonsupercell tornadogenesis.

Air Parcels

The “So what?” of it all

- Even in the presence of enhanced convergence and vertical motion, convection can still be rejected
  - Parcels need to be forced to their LFC
  - h_{lcl} and h_{lfc}
  - Large-scale subsidence at a ridge
  - Capping
  - CIN, and too much of it



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