The 22 May 2014 Duanesburg, NY, Tornadic Supercell

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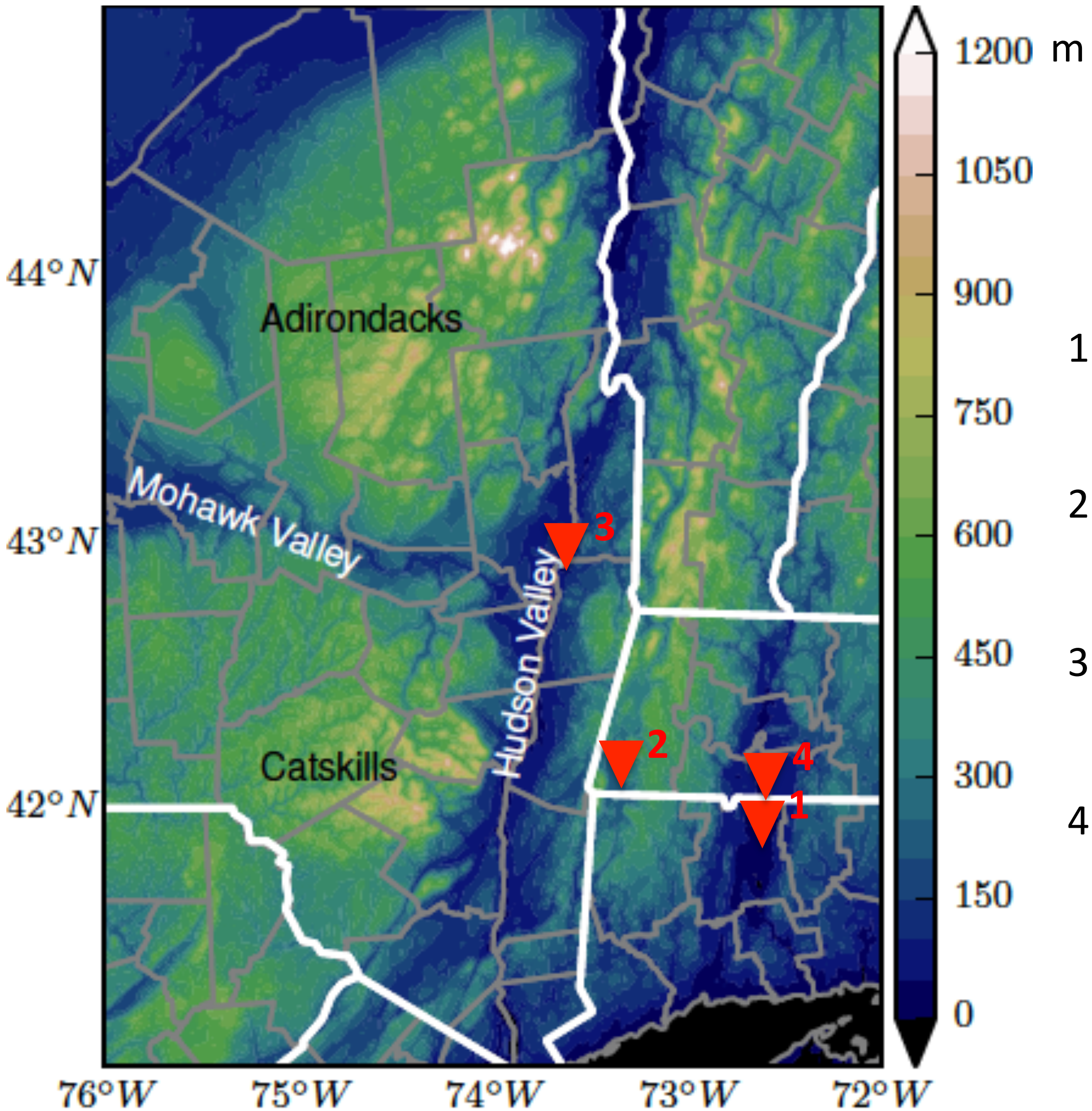


Notable Tornadoes

1) 1979 Windsor Locks, CT
(Riley and Bosart 1987)

2) 1995 Great Barrington, MA
(Bosart et al. 2006)

3) 1998 Mechanicville, NY
(LaPenta et al. 2005)

4) 2011 Springfield, MA
(Banacos et al. 2012)

How may **complex terrain** modulate supercell evolution and the risk of severe weather?

- Channeling of low-level flow may act to
  - Locally increase low-level shear/helicity
  - Advect moist, unstable air into storm inflow

(Riley and Bosart 1987; Braun and Monteverdi 1991; LaPenta et al. 2005; Bosart et al. 2006; Geerts et al. 2009; Peyraud 2013)

- Upslope flow may act to
  - Reduce convective inhibition and increase relative humidity

(Markowski and Dotzek 2011)

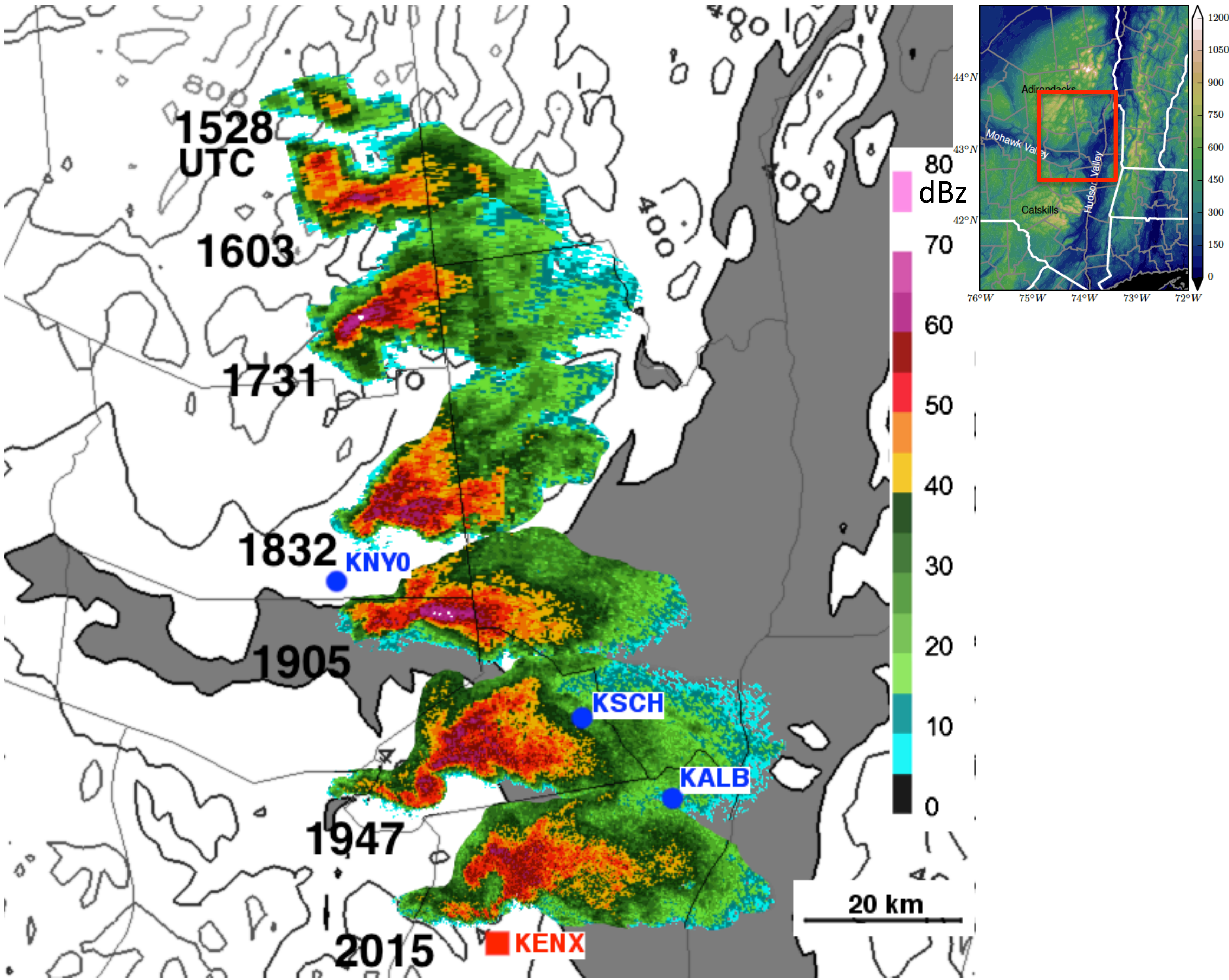
How may **baroclinic boundaries** modulate supercell evolution and the risk of severe weather?

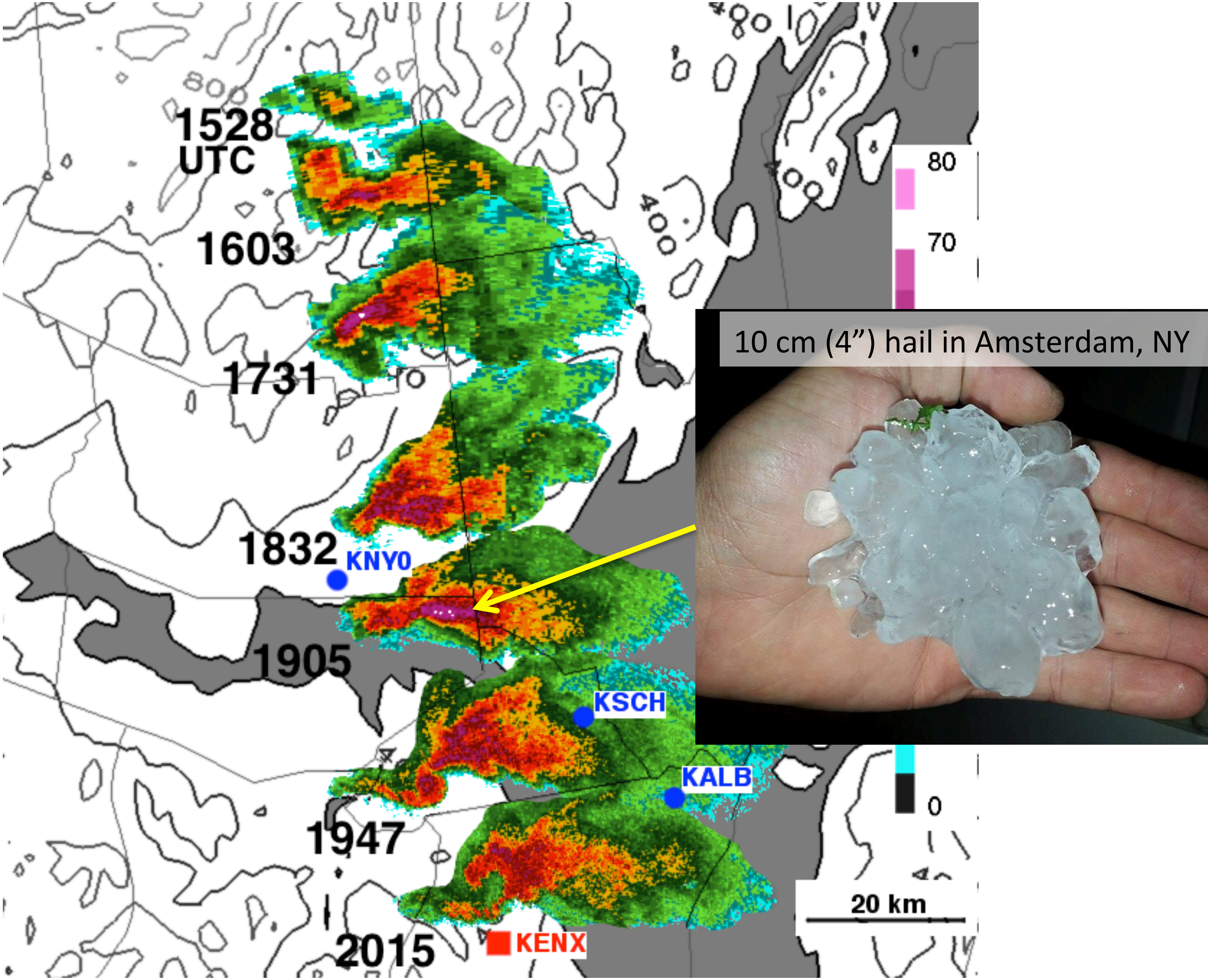
- Maxima in streamwise vorticity along the boundary
    - Increased probability of tornado as supercell crosses to cool side of boundary

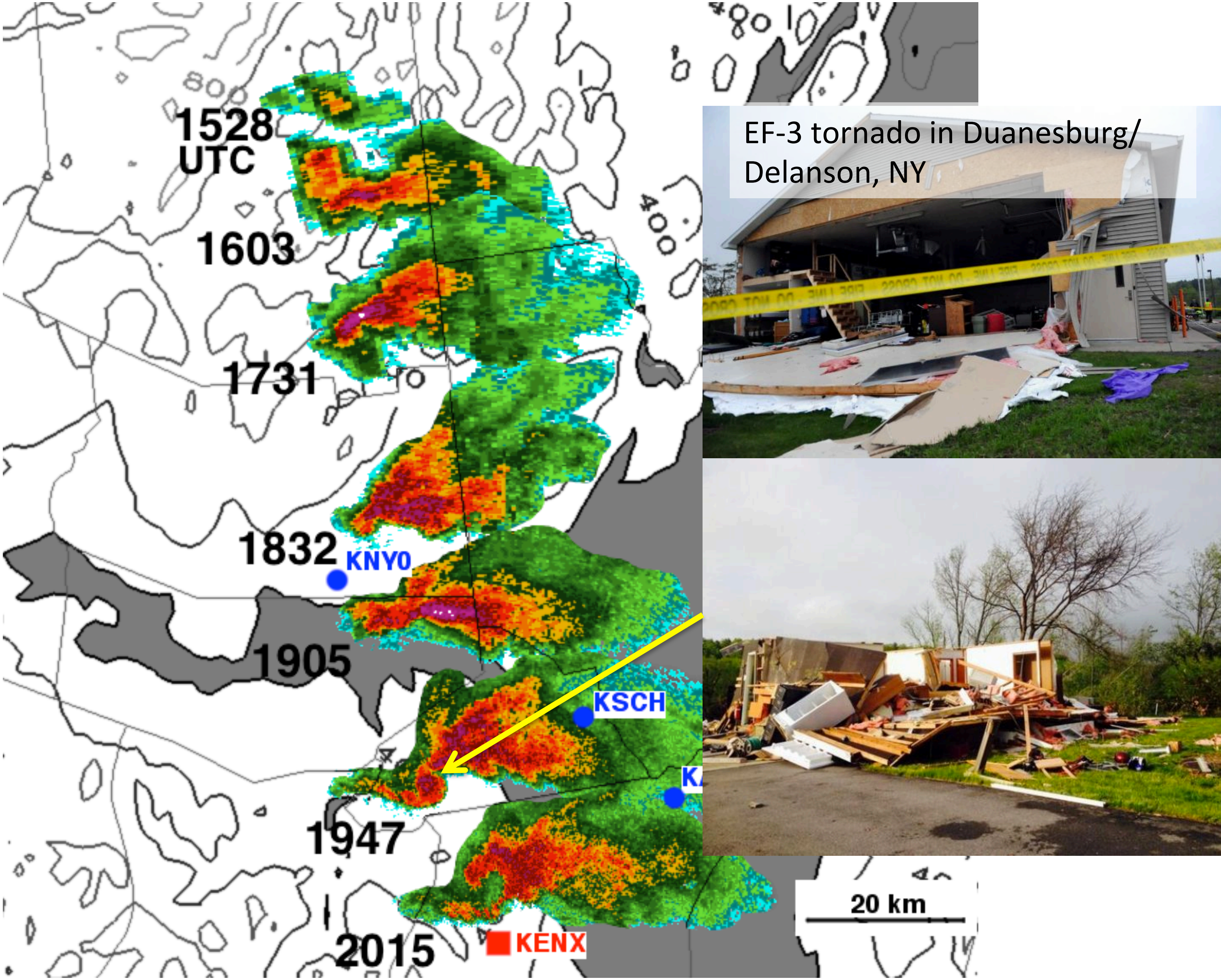
(Markowski et al. 1998; Atkins et al. 1999; Rasmussen et al. 2000)

- Maximum in moisture flux convergence along boundary

(Maddox et al. 1980)

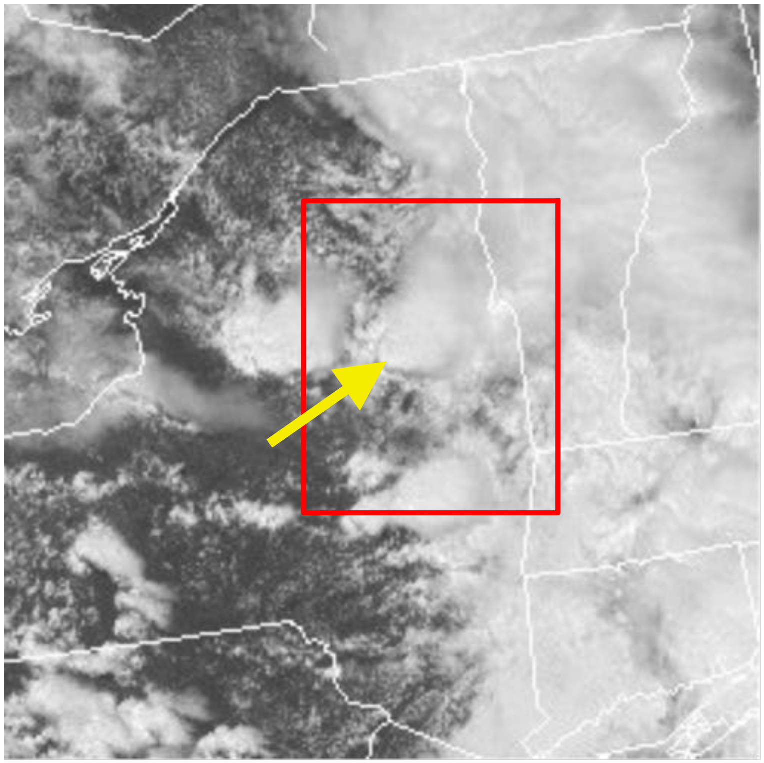

1528
UTC
1603
1731
1832
1905
1947
2015
KNY0
KSCH
KALB
KENX
20 km
80
dBz
70
60
50
40
30
20
10
0
400
800
Adirondacks
Mohawk Valley
Hudson Valley
Catskills
44°N
43°N
42°N
76°W
75°W
74°W
73°W
72°W
1200
1050
900
750
600
450
300
150
0


1528
UTC
1603
1731
1832
1905
1947
2015
KNY0
KSCH
KALB
KENX
800
400
80
70
0
20 km
10 cm (4”) hail in Amsterdam, NY


1528
UTC
1603
1731
1832
KNY0
1905
KSCH
1947
2015
KENX
800
400
20 km
EF-3 tornado in Duanesburg/
Delanson, NY

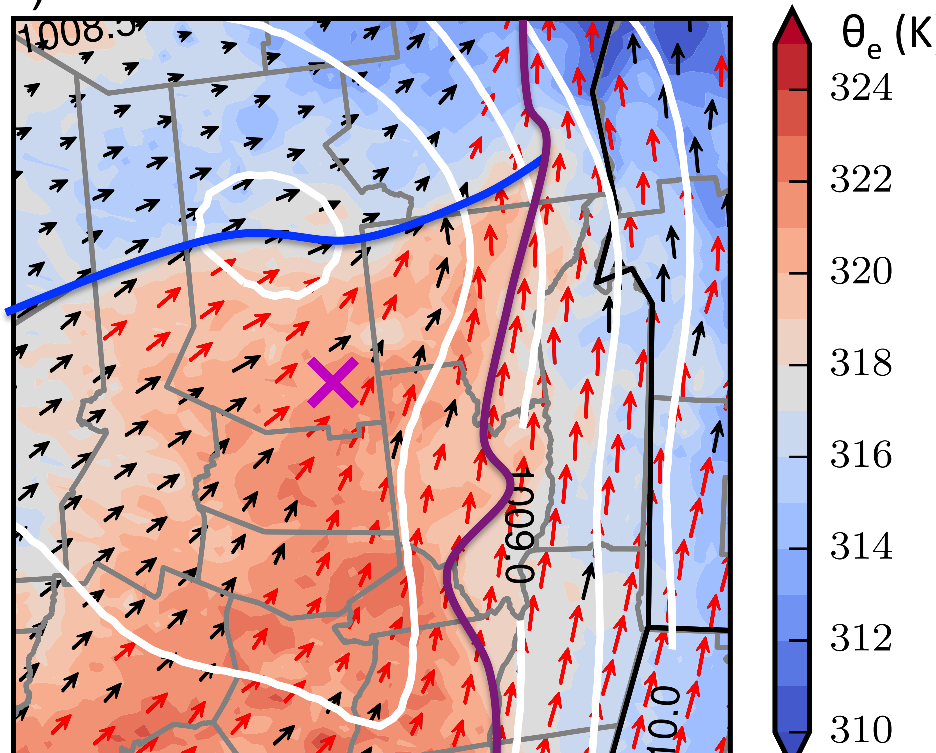
Storm track close to boundaries important for supply of streamwise vorticity

e) 1715 UTC



HRRR analysis

f) 1700 UTC



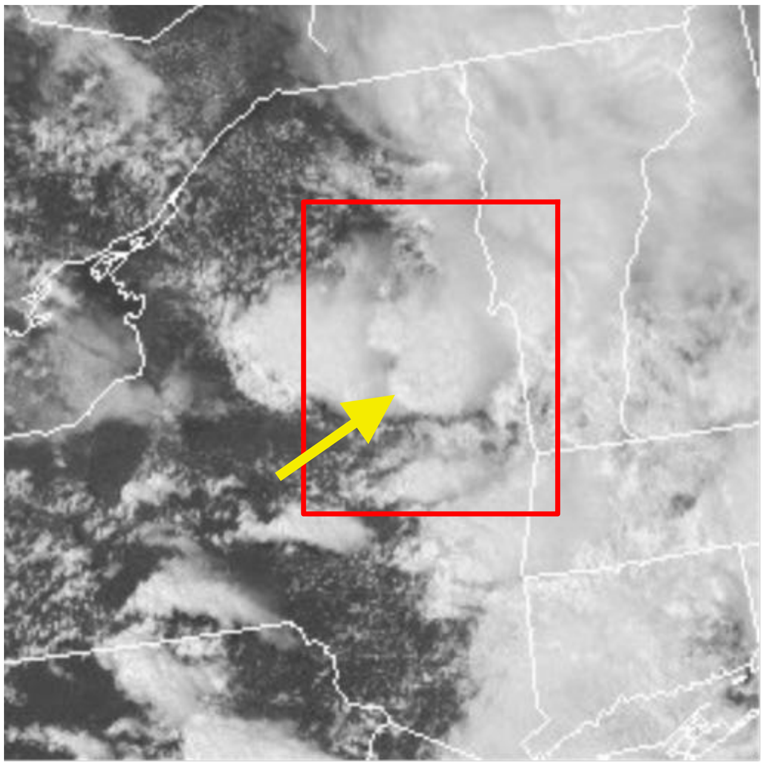
→ 0-1 km storm-relative wind

→ $|\boldsymbol{\omega}_s| > 5 \times 10^{-3}\ s^{-1}$

MSLP (every 0.5 hPa)

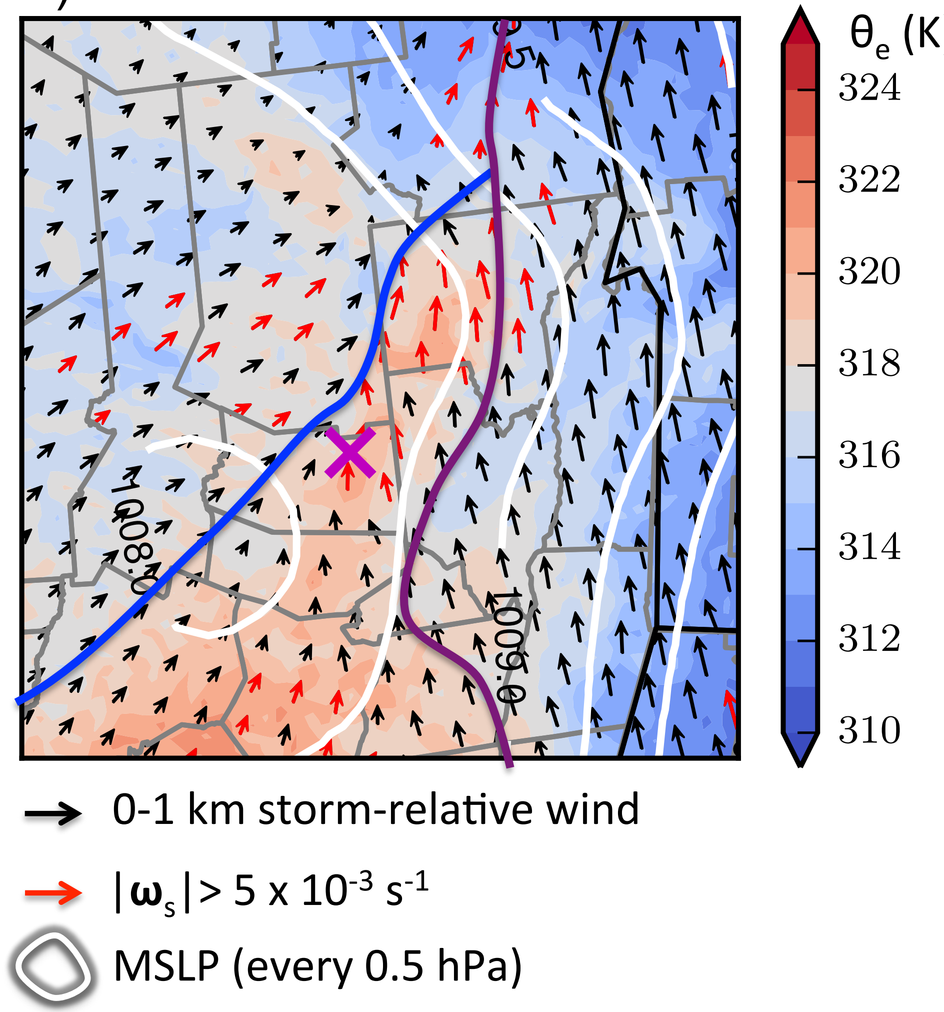
Differential heating and channeling of maritime air up Hudson Valley anchored N-S baroclinic boundary

g) 1815 UTC

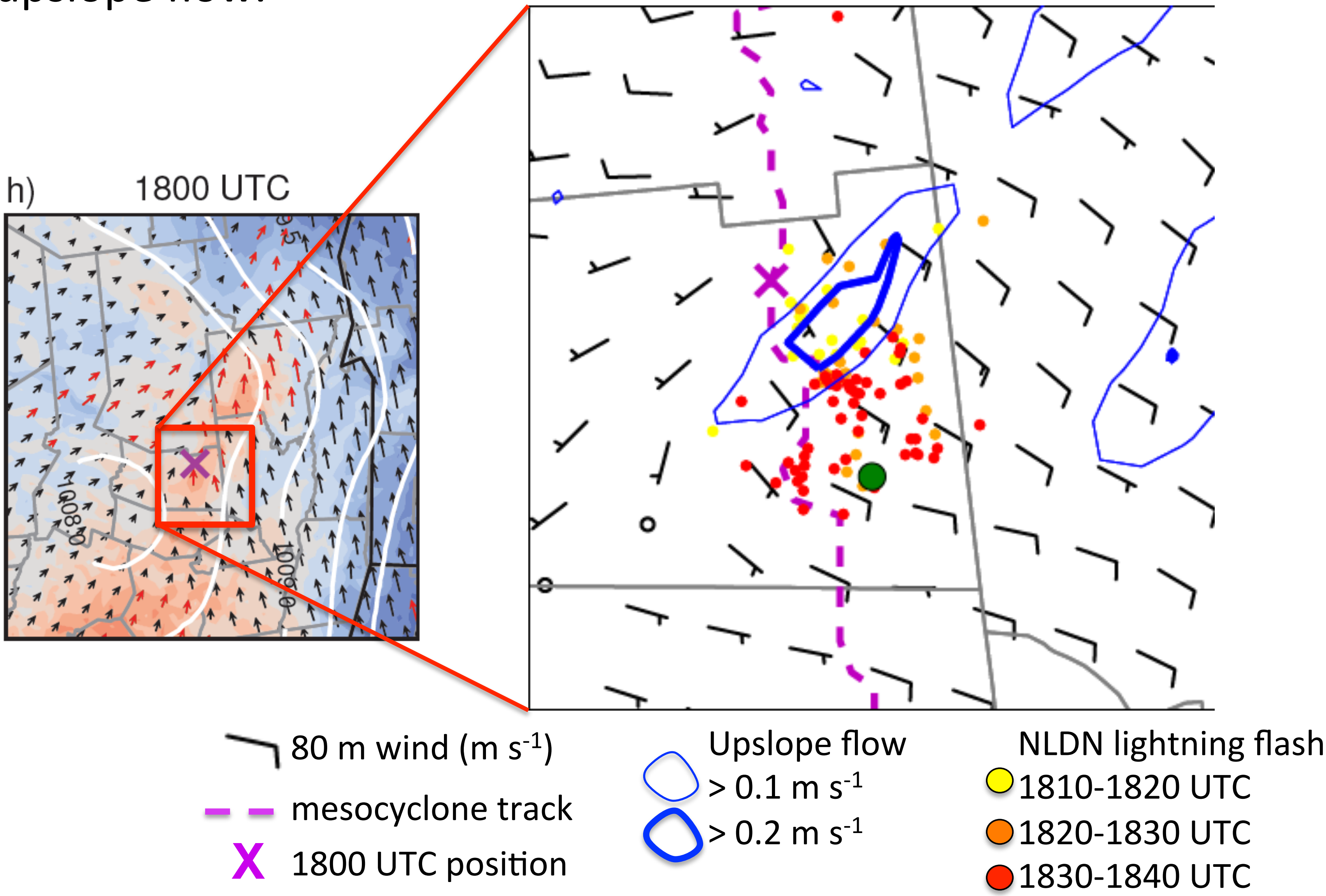


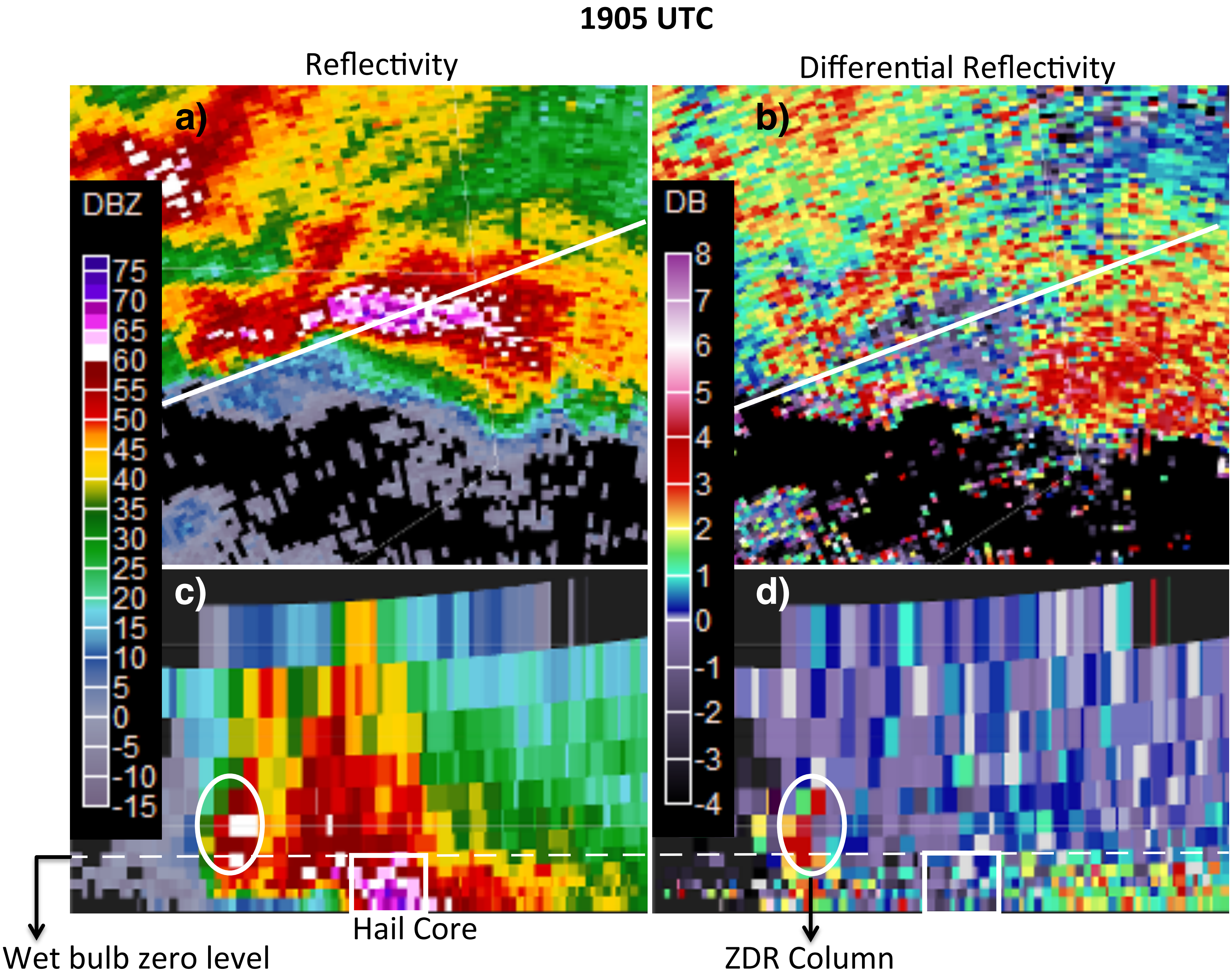
HRRR analysis

h) 1800 UTC



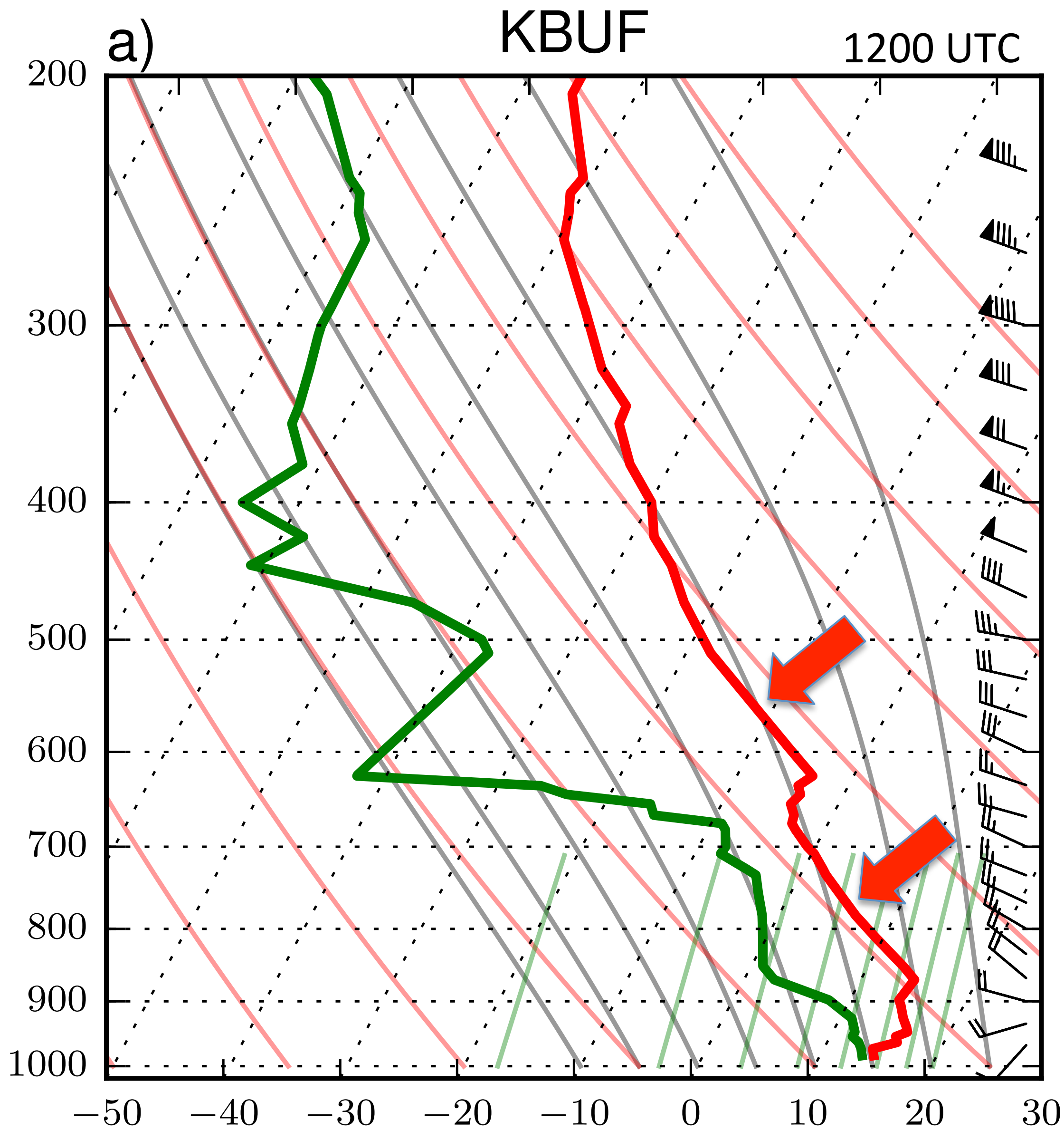
Ageostrophic backing of flow across boundary induced upslope flow along S Adirondacks. Invigoration of supercell upon crossing upslope flow.



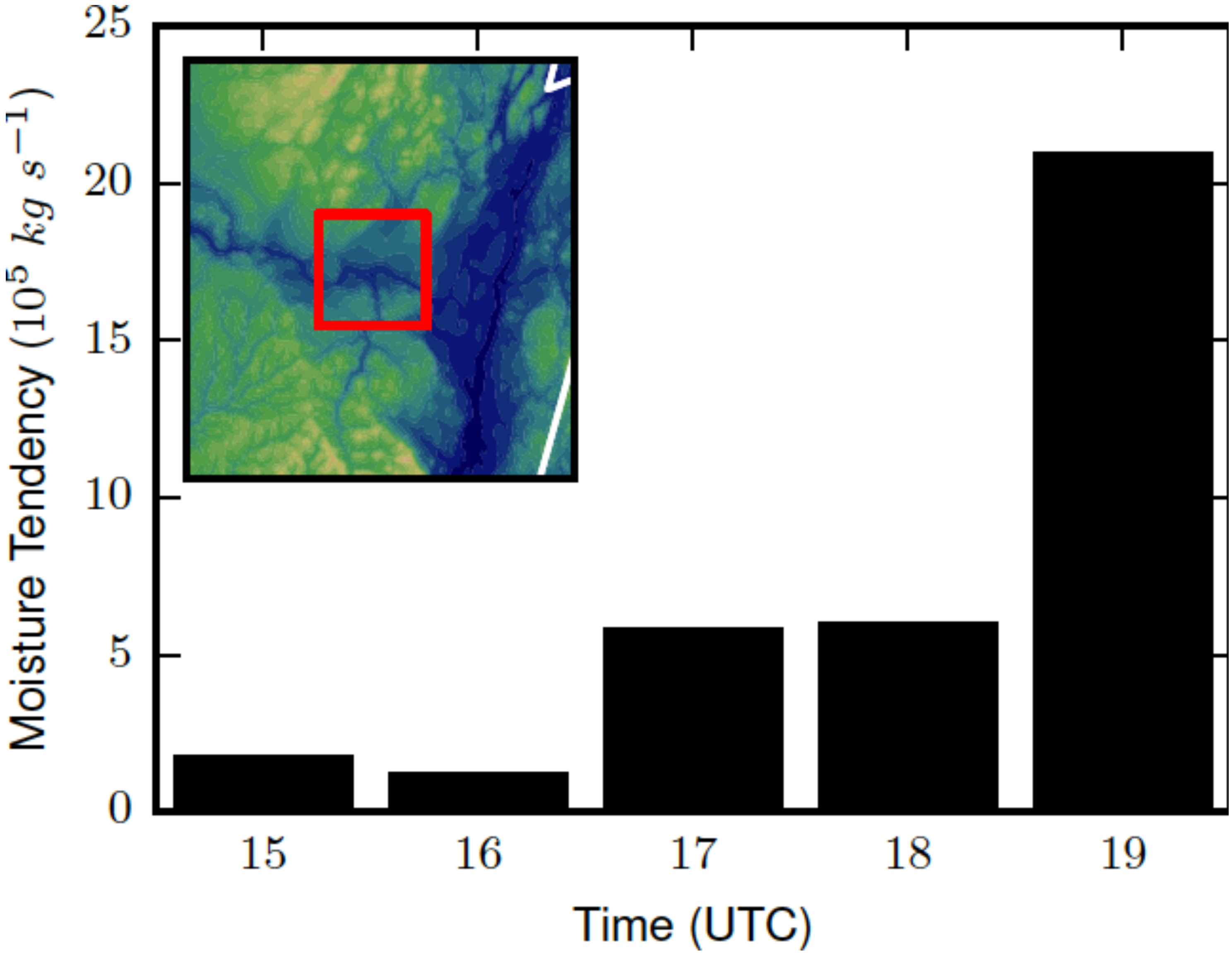


1905 UTC
Reflectivity
Differential Reflectivity
a)
b)
c)
d)
DBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
DB
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
Hail Core
Wet bulb zero level
ZDR Column

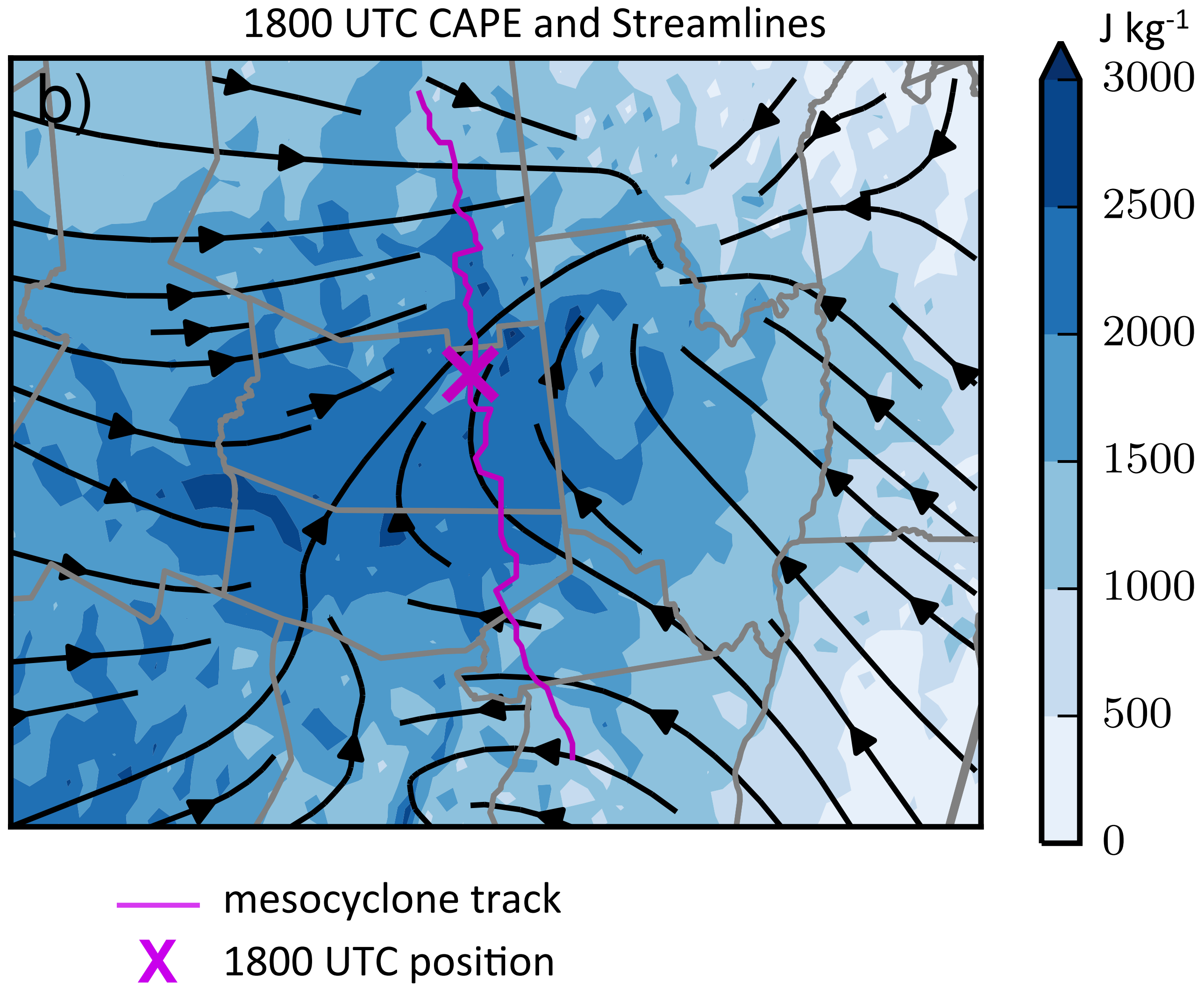
2 elevated mixed layers advected over Mohawk Valley by 1800 UTC



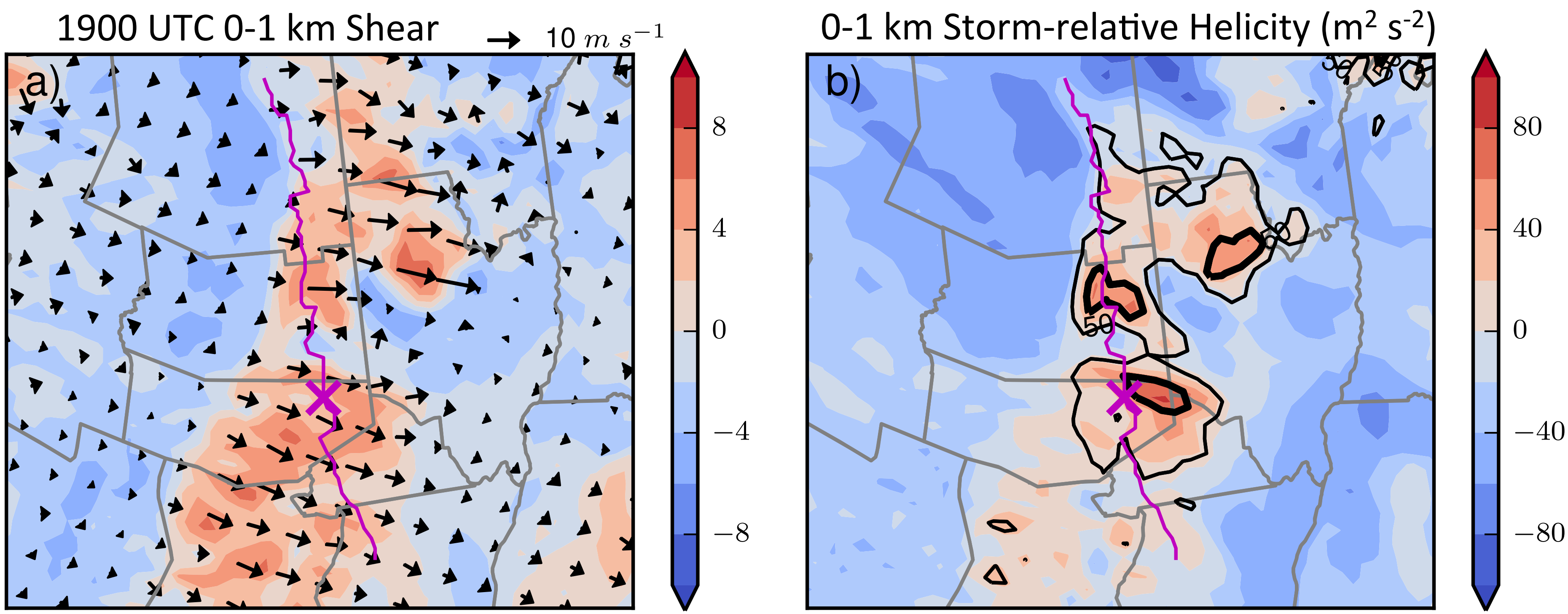
Horizontal moisture flux convergence increased in Mohawk Valley due to backing of flow and convergence along boundary



Surface-based CAPE maximized in the Mohawk Valley due to moisture flux convergence and insolation



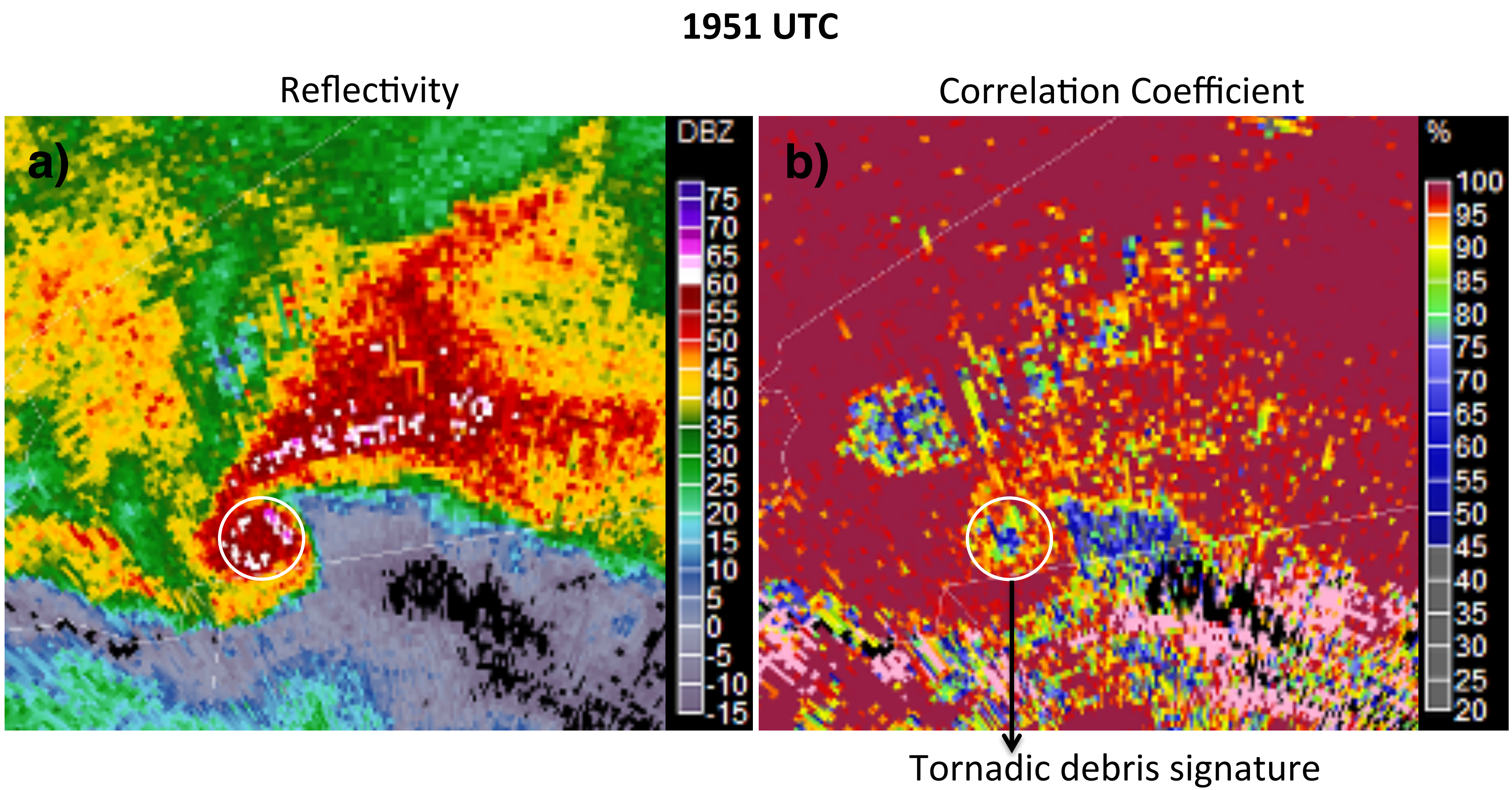
Low-level shear (streamwise vorticity) comparable to other significant tornado events (Thompson et al. 2003, Markowski et al. 2003)



Shading is 1900 – 1600 UTC change in shear/storm-relative helicity

mesocyclone track

X 1900 UTC position


1951 UTC
Reflectivity
Correlation Coefficient
a)
DBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
b)
%
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
Tornadic debris signature

The interaction of the supercell with terrain and baroclinic boundaries seemed to be critical

10 cm (4") Hail

- Upslope may have contributed to first severe hail
- Channeling of low-level moisture into Mohawk Valley combined with EMLs aloft increased instability

EF-3 Tornado

- Low lifting condensation levels on cool side of boundary
- Narrow maxima in low-level wind shear and streamwise vorticity along boundary, esp. cool side

Identifying scenarios and locations where mesoscale inhomogeneities may increase the risk of severe weather remains a challenging problem!

Differential heating caused MSLP differences between KNY0 and KALB/KSCH, leading to ageostrophic flow up Mohawk Valley