Close-range Observations of Storm Processes

Rich history of projecting NSSL's field observing expertise into storm environments...

- Tornado Intercept Project (1972-1985)
- SESAME (1979)
- TRIP (1984)
- PRE-STORM (1985)
- COPS-89 (1989)
- SWAMP (1990)
- COPS-91 (1991)
- VORTEX (1994-1995)
- MEaPRS (1998)
- sub-VORTEX (1999)
- IPEX (2000)
- STEPS (2000)
- IHOP (2002)
- BAMEX (2003)
- TELEX (2003-2004)
- *VORTEX2 (2009-2010)*
- *DC3 (2012)*
- *MPEX (2013)*
- *DARPA-TLE (2013-2014)*
- *Plains Elevated Convection at Night (2015)*

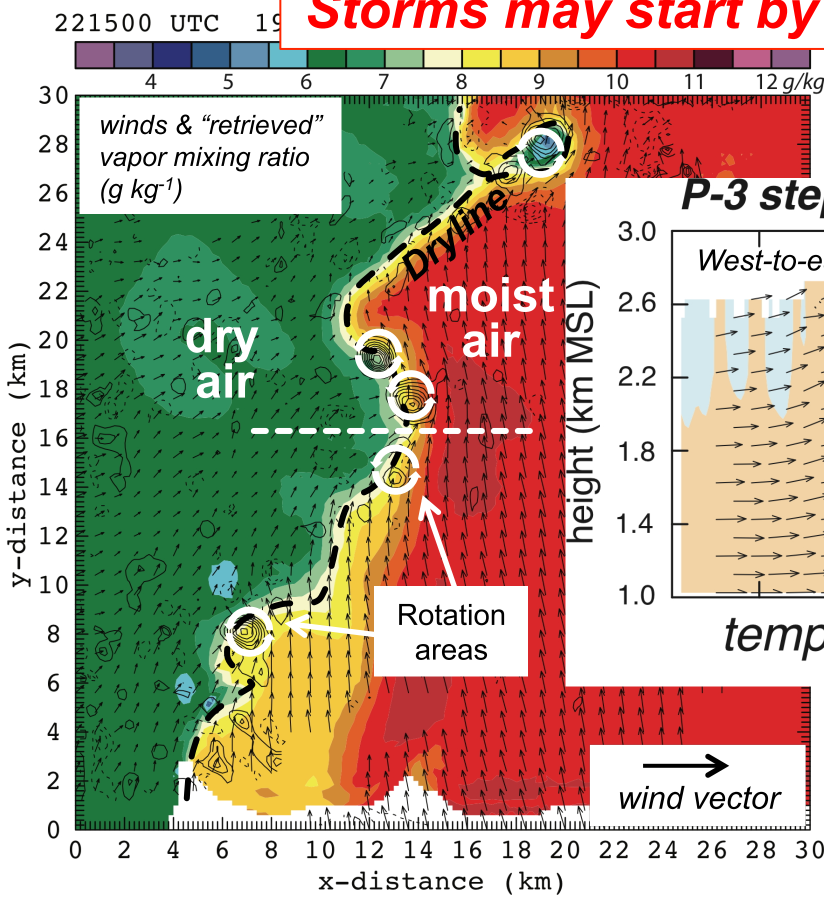
since 2009 program review ↓

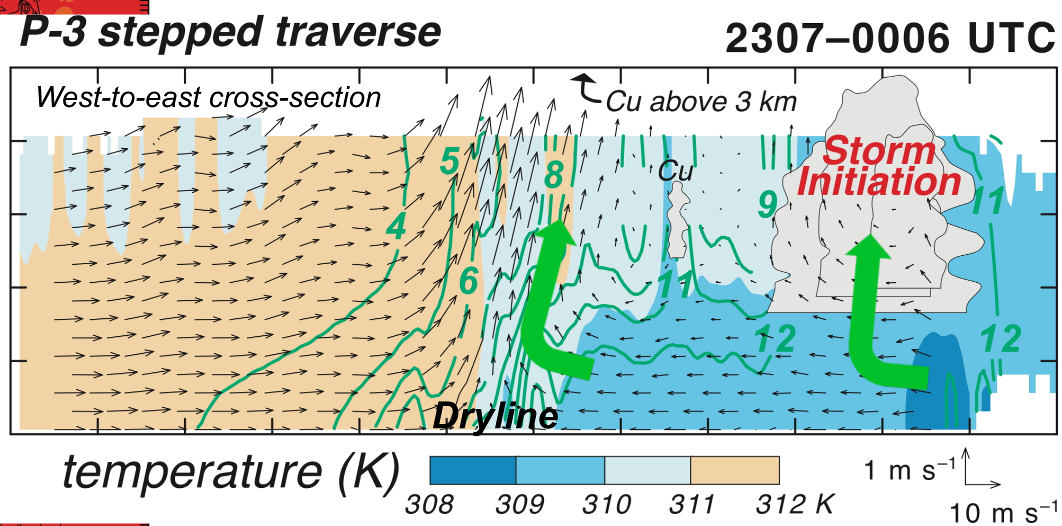
...to study dynamical, cloud & precipitation, and electrification & lightning processes

Storm Initiation

Storms may start by lifting along boundaries

(also called “convection initiation” or CI)





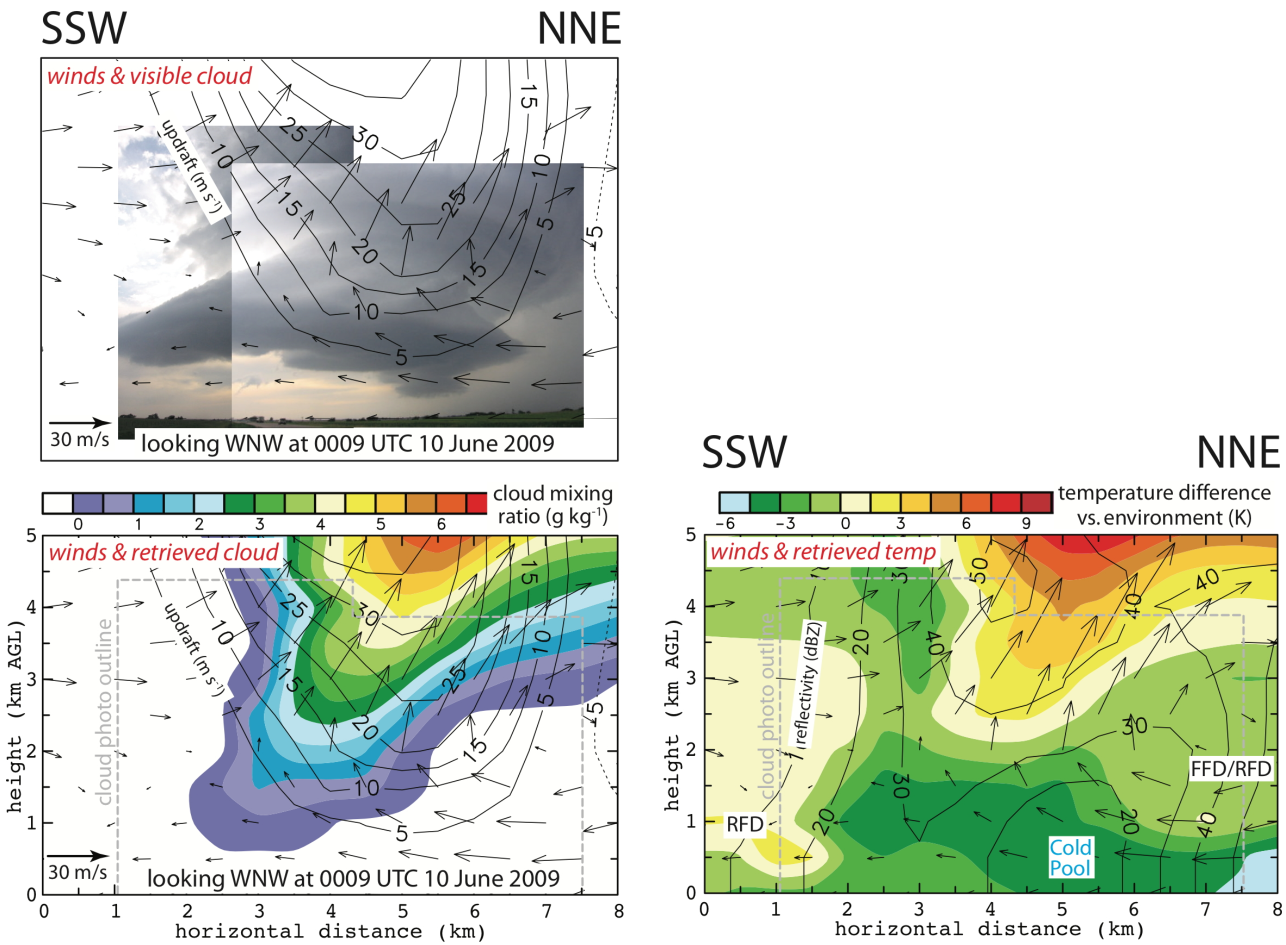
- observational data analysis of winds & temp through dryline
- lifted moisture feeds initiated storms

- NSSL’s observational data analyses include (not limited to):
  - multiple-Doppler radar wind synthesis
  - simple model combining winds & in situ obs to “retrieve” other fields

(Richardson & Ziegler, 2009; Ziegler 2014a)

Mature Supercell Storm Morphology

- cloud photo
- winds & updraft through cloud
- winds from 5 radars (4 mobile + KDDC)

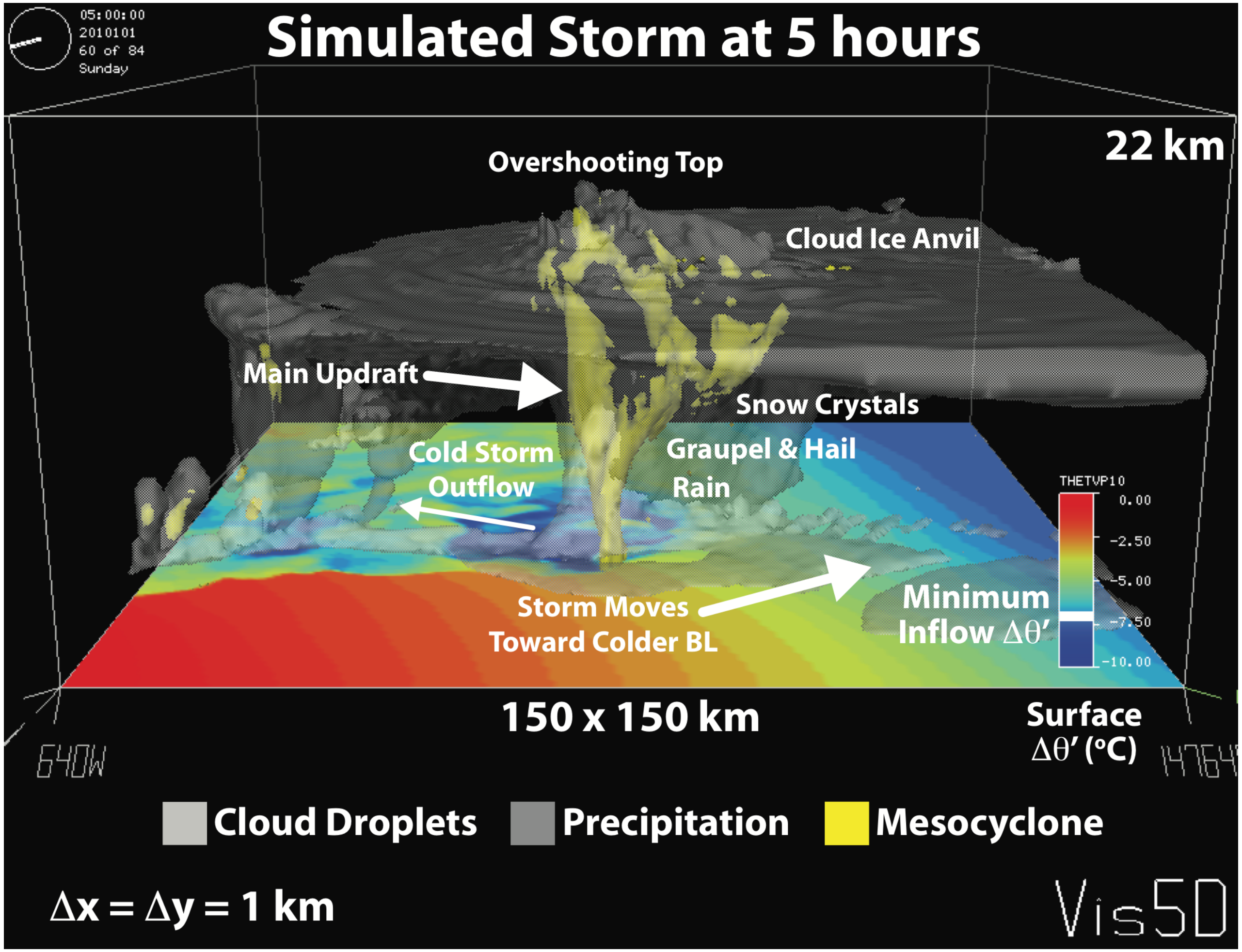


- retrieved cloud
- retrieval shows conditions inside cloud & storm

- retrieved temp & contour reflectivity
- adjacent cold & warm air in downdraft assoc with low-level rotation

(Ziegler et al. 2012, Ziegler 2014a,b)

Mature Supercell Storm Morphology



- simulated supercell storm
- model produces realistic, internally consistent airflow, cloud, & precipitation fields in the simulated storm

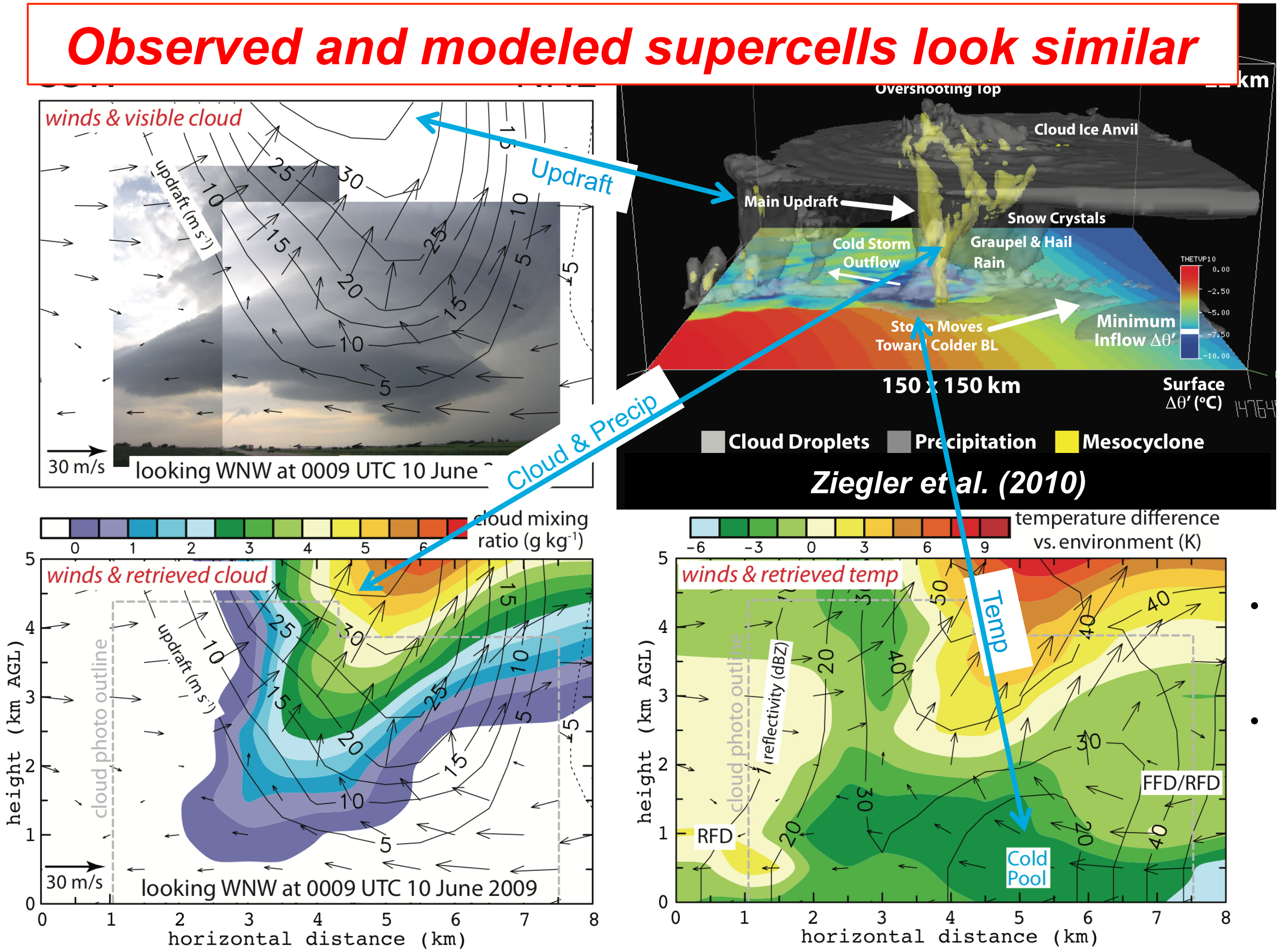
(Ziegler et al. 2010)

Mature Supercell Storm Morphology

Observed and modeled supercells look similar

- cloud photo
- winds & updraft through cloud
- winds from 5 radars (4 mobile + KDDC)

- retrieved cloud
- retrieval shows conditions inside cloud & storm



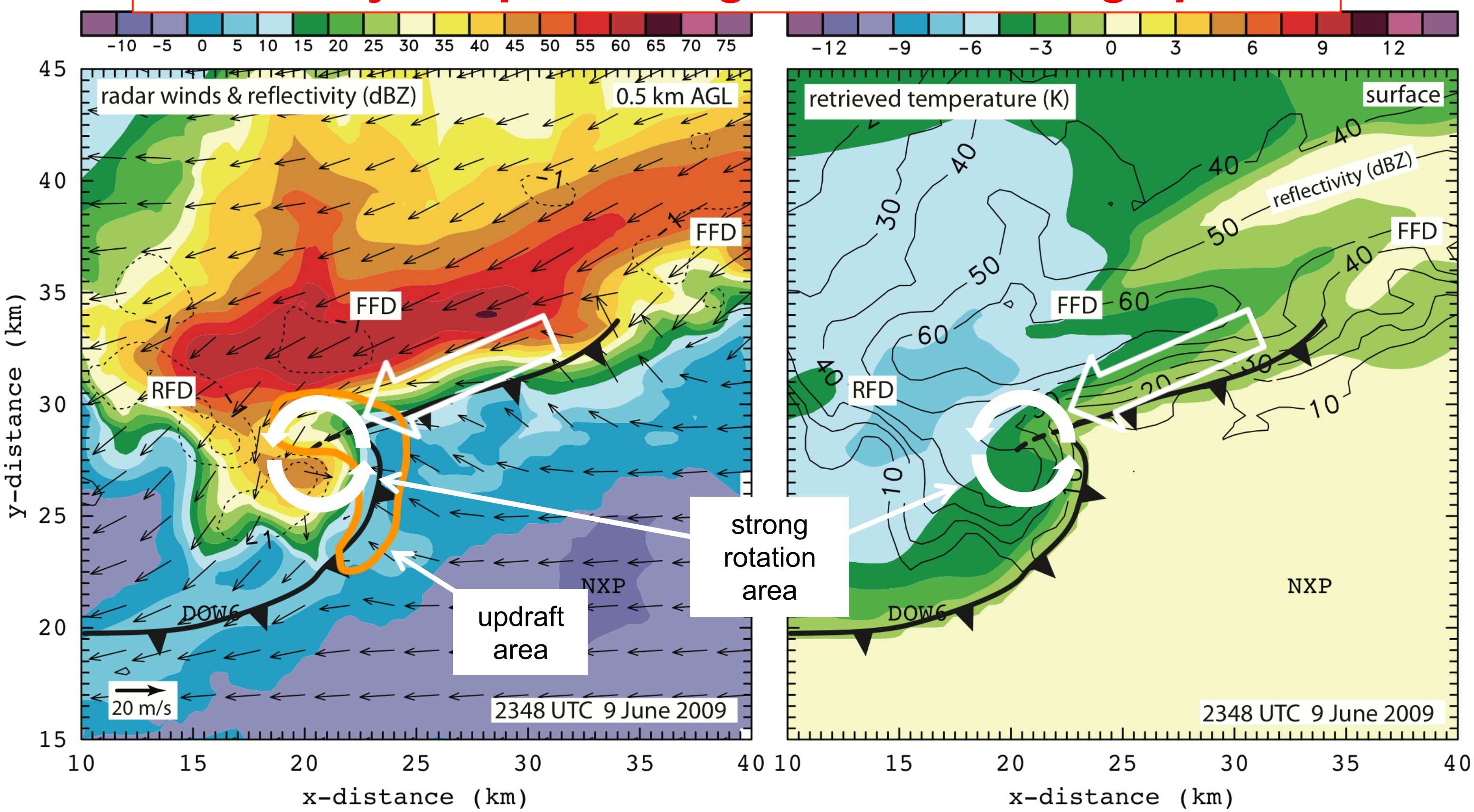
- simulated supercell storm at 5 hr after CI

- retrieved temp & contoured reflectivity
- adjacent cold & warm air in downdraft often accompanies low-level rotation

(Ziegler et al. 2012, Ziegler 2014a,b)

Low-level Supercell Storm Rotation

Forced by temperature gradient entering updraft



- winds & reflectivity at 0.5 km AGL
- strong rotation area at location of radar “hook”

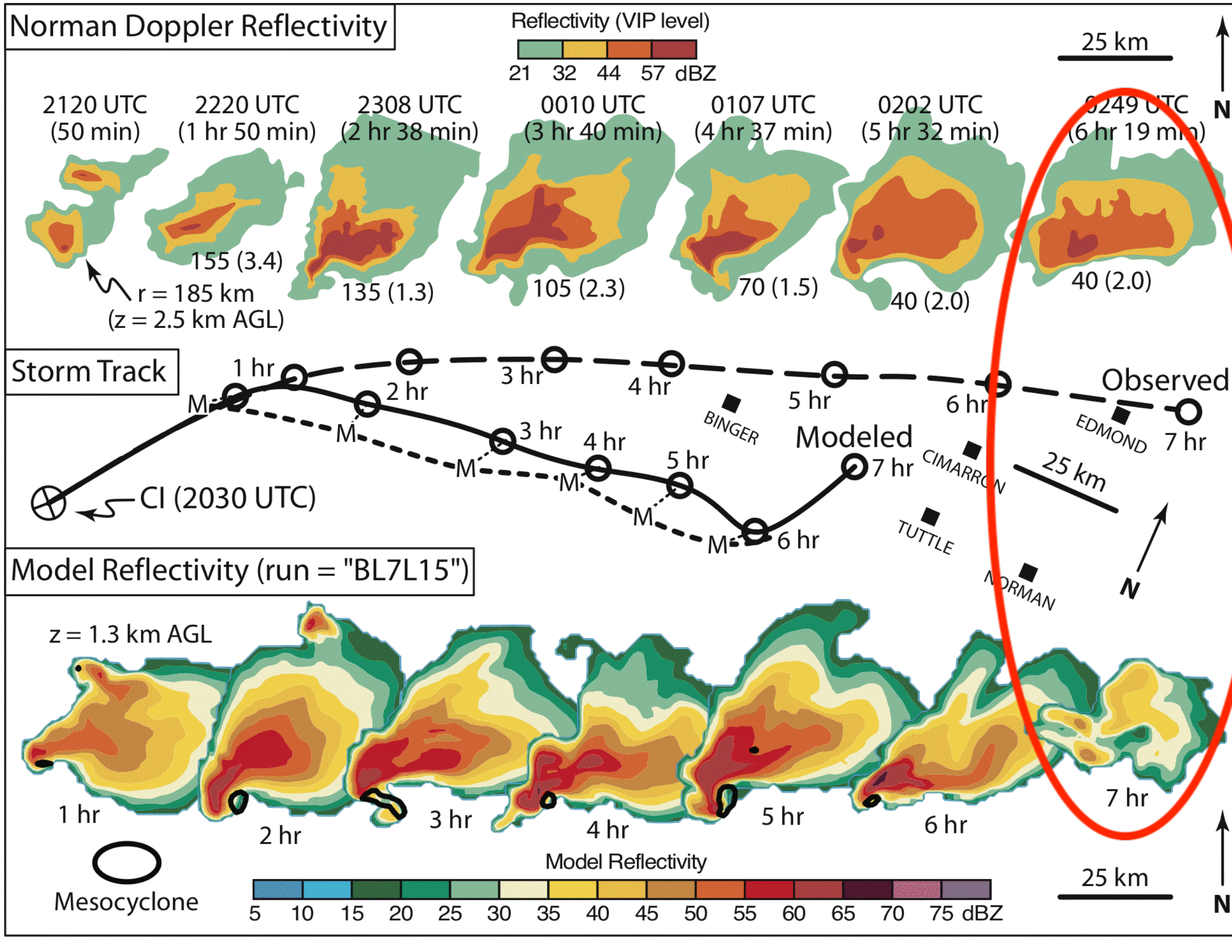
- retrieved temperature at surface
- temp gradient enters LL updraft where rotation develops

Supercell Storm Decay

organizing stage → *mature stage* → *???*

observed storm

simulated storm



Why does storm decay here?

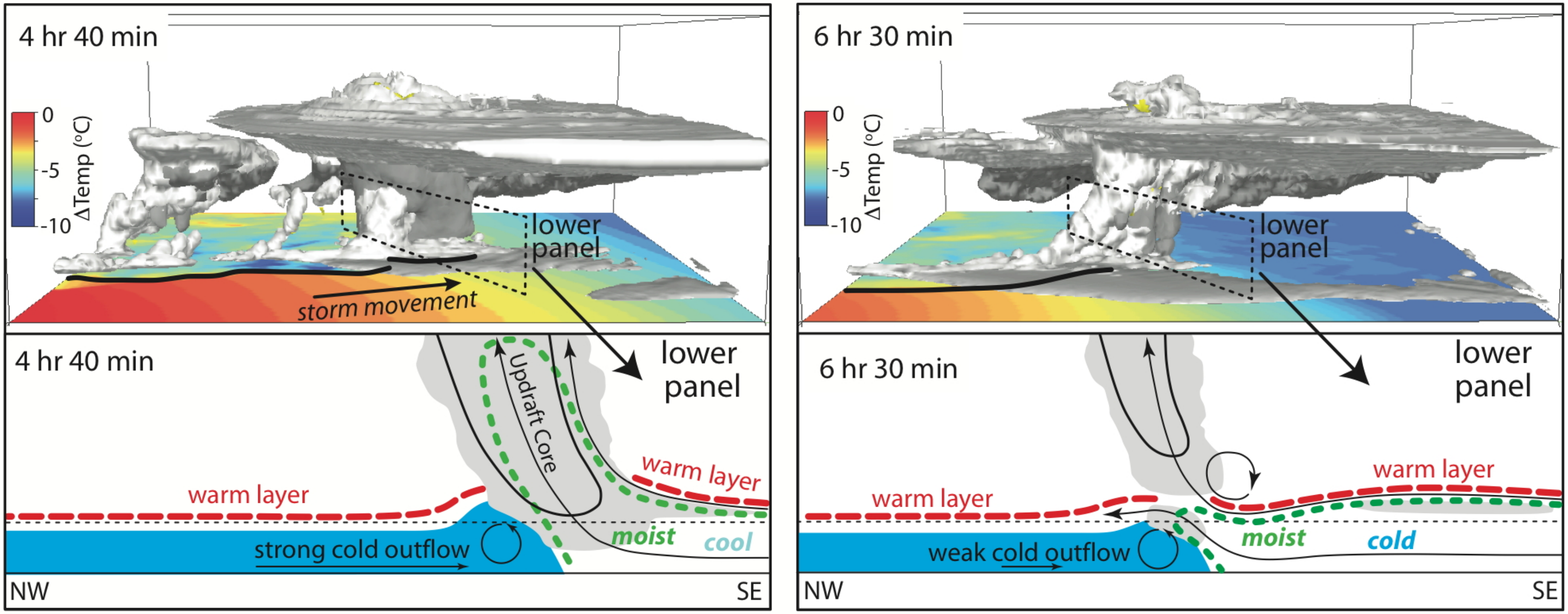
(Ziegler et al. 2010)

Supercell Storm Decay

forced by cut-off of storm inflow from moist BL

Mature Simulated Supercell

Decaying Simulated Supercell



- mature storm moves from warm to cooler air near ground
- updraft & cloud drawing moist near-surface air

- decaying storm moves into cold air near ground
- updraft & cloud weaken as air drawn from above moist layer

Summary

- We use observations & models to look at all aspects of storm lifetimes & processes.
- Some new findings about key forcings of storm lifecycles
  - storm initiation is forced by lifting at boundaries between contrasting airmasses
  - low-level storm rotation is strengthened when a temp gradient enters updrafts
  - a storm decays when it enters a cold near-surface airmass