Analysis of a Severe MCS and Nocturnal Tornadogenesis sampled by PECAN on 5-6 July 2015

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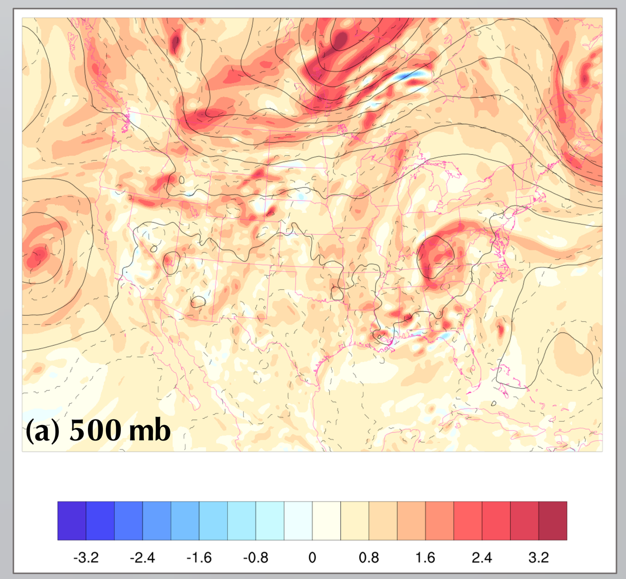
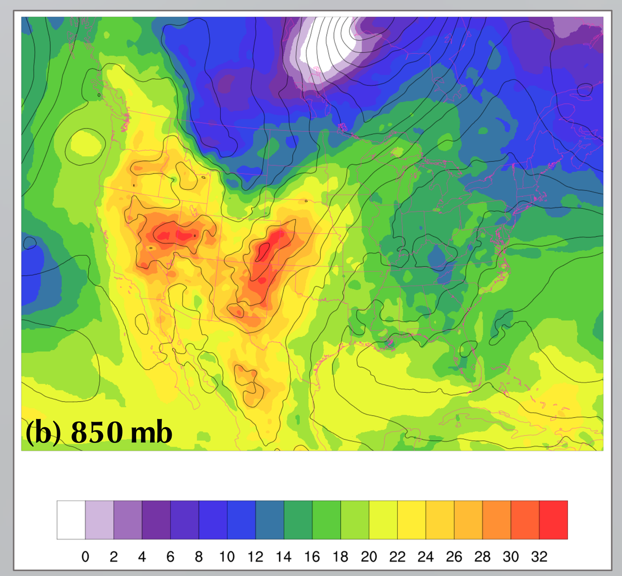
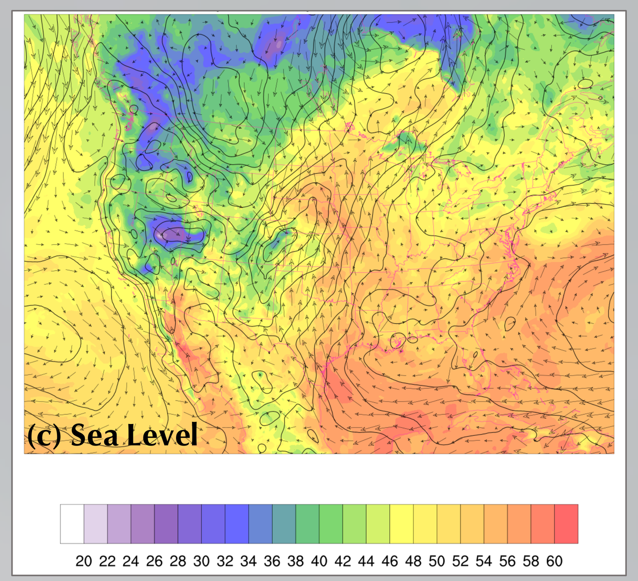
Synoptic and Project Overview
Southeast SD, July 5-6, 2015







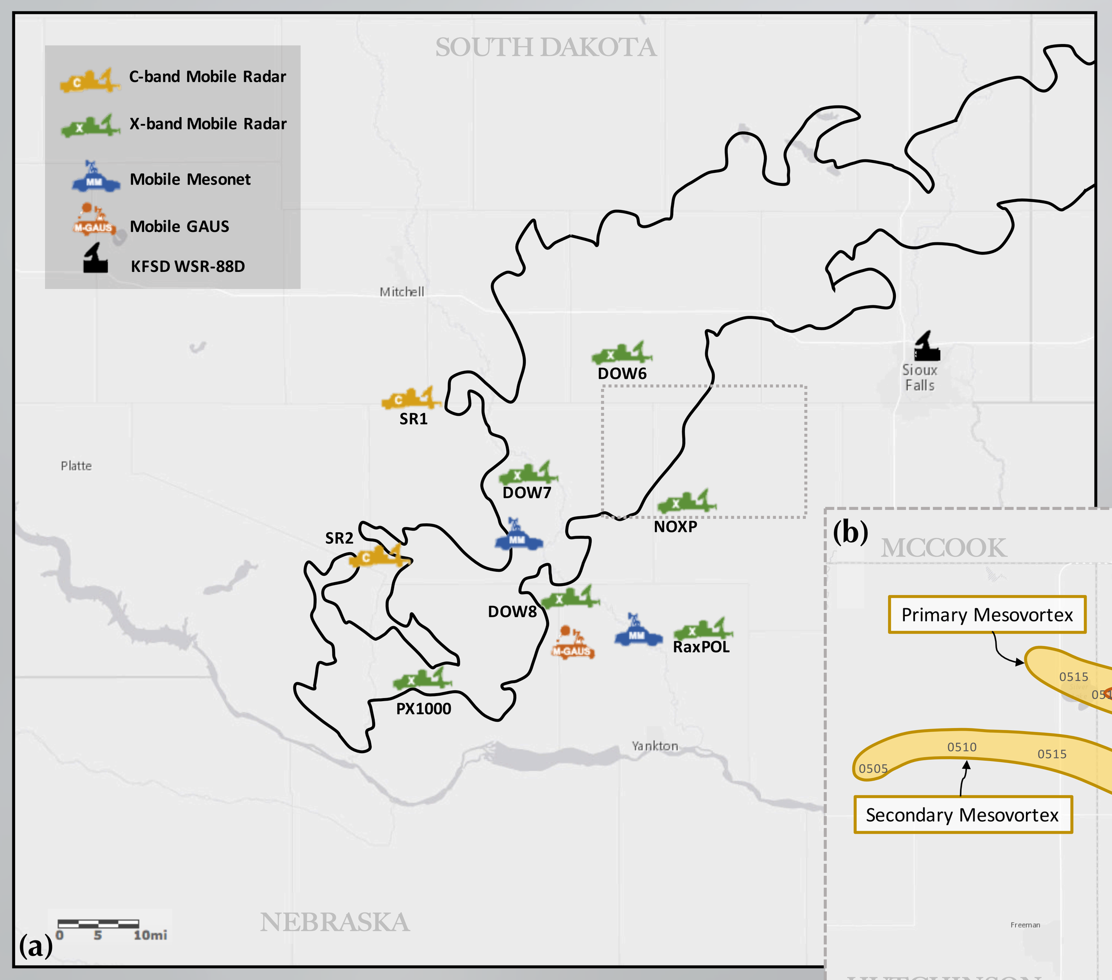
(a) 500 mb plot of vorticity (10^{-4} s^{-1}, fill), geopotential height (solid contours), and temperature (dashed contours).
(b) 850 mb plot of temperature (ºC, fill) and geopotential height (solid contours).
(c) Sea level plot of dewpoint (ºF, fill), sea-level pressure (solid contours), and 10-m wind (arrows).
Note: All plots are valid at 0000 UTC July 6 2015.

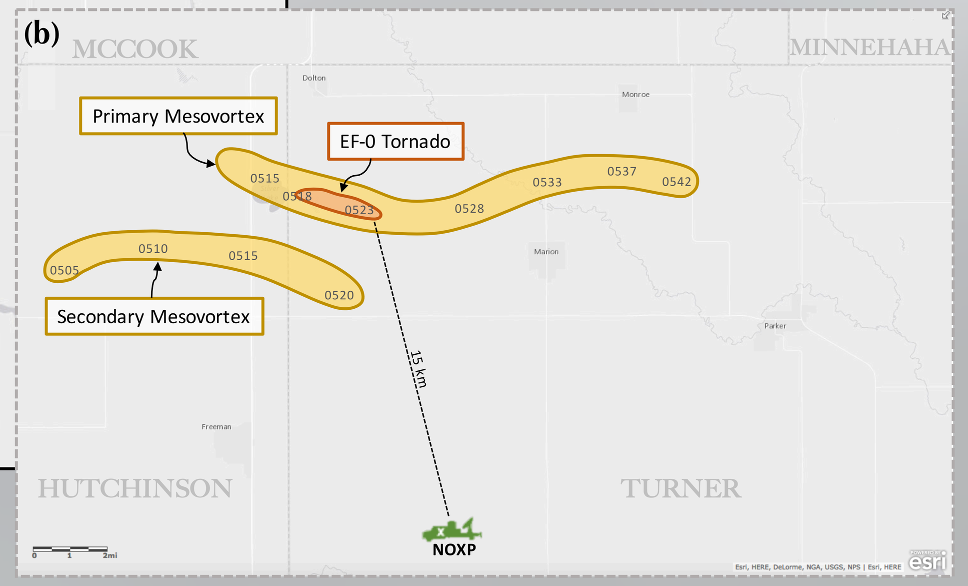
Nocturnal mesoscale convective complexes (MCSs) commonly traverse the Great Plains in the boreal summer. In addition to heavy rainfall, MCSs may produce severe weather, including up to 20% of reported tornadoes (Trapp et al. 2005). While these tornadoes are typically weaker than their supercellular counterparts, **they often present a greater forecasting challenge due to their typically transient lifetimes**. Nocturnal tornadoes in particular pose an enhanced societal threat with respect to daytime tornadoes and thus require larger forecast lead times (Ashley et al. 2008).

To this end, an armada of mobile radars, mesonets, lidars, and aircraft assembled in the Great Plains from June-July 2015 in association with the Plains Elevated Convection At Night (PECAN) field project. Along with fixed radar and lidar sites, these platforms were deployed to collect data on multiple nocturnal atmospheric phenomena, including low-level jets, convective initiation, bores, and MCSs. On the night of July 5-6 2015, the group captured a **severe MCS in southeastern SD that produced several severe wind reports and an EF-0 tornado**.

This study will examine high-resolution simulations of this event using the NSSL Experimental Warn-on-Forecast (WoF) System for ensembles (NEWS-e). Ensemble Kalman Filter (EnKF) techniques are used to assimilate data from both conventional and mobile platforms on the convective scale (e.g. Snyder and Zhang 2003). Recent studies have led to **mixed conclusions regarding the development of low-level mesovortices in quasi-linear convective systems** (QLCSs; e.g. Trapp and Weisman 2003, Wakimoto et al. 2006, Wheatley et al. 2008, Atkins et al. 2009), which are often associated with the most damaging surface winds. This study will **determine meteorological processes influencing the development of a mesovortex and associated tornado and discuss these influences in the context of previous conceptual models**.

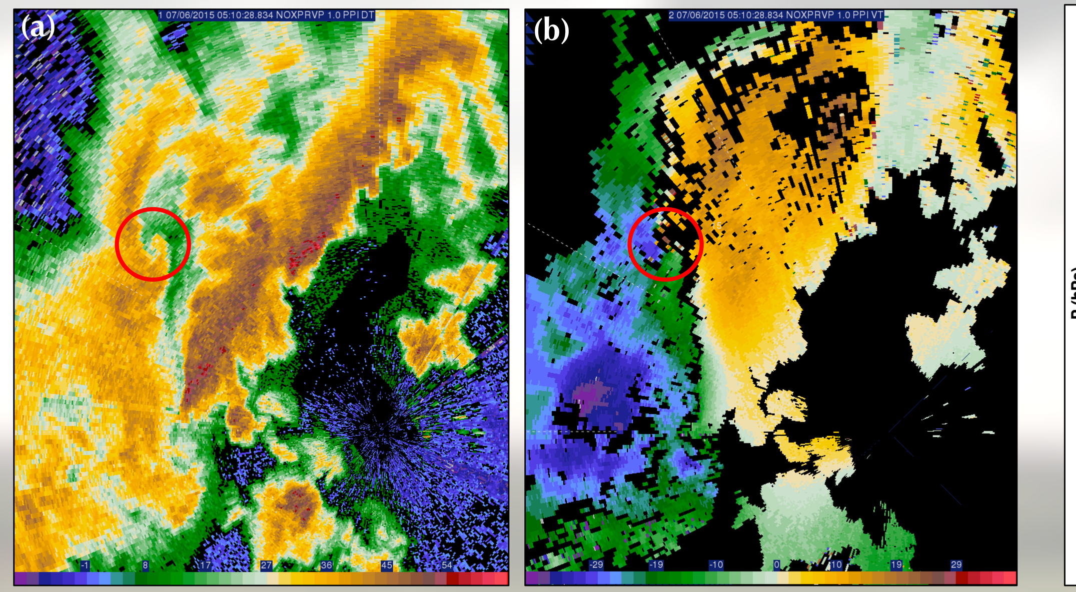
PECAN Deployment Strategy
IOP 20 – "The Megagon"



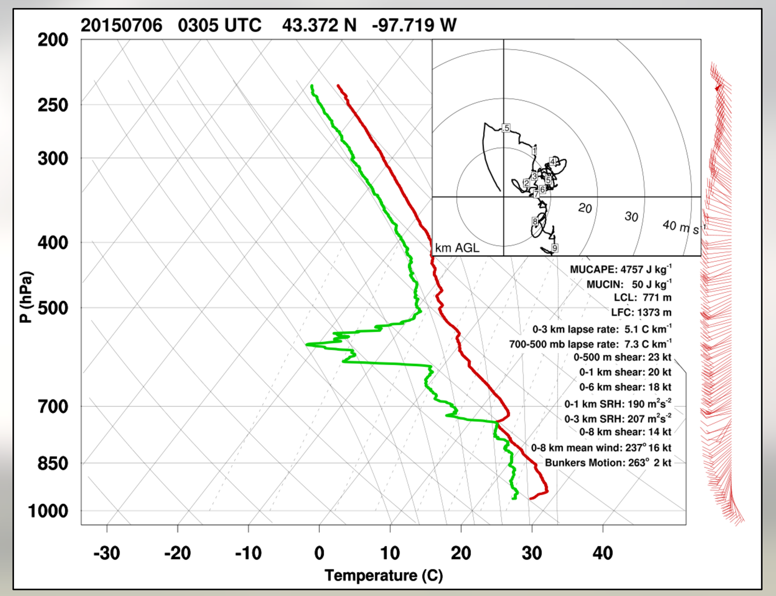


(a) Locations of selected PECAN assets and the 40 dBZ reflectivity contour (based on MRMS data) at 0515 UTC on 6 July 2015 in southeastern SD.
(b) Zoomed-in view of the area of interest, where the EF-0 tornado and two mesovortices formed from 0505 – 0542 UTC.

At 0100 UTC on 6 July 2015, PECAN assets mobilized to get into position for an MCS deployment. Eight mobile radars moved into a hexagon with two center points to optimize multi-Doppler scanning strategies. While this "megagon" assembled in southeastern SD, mobile mesonets began transecting a strong bow echo that had formed a few counties west. Simultaneously, collocated mobile sounding units located near the center of the mobile radar array began launching radiosondes at 20-minute intervals. These sampling techniques continued for the next several hours as the bow echo developed into a more extensive MCS, merged with another storm complex in eastern SD, and moved directly over the radar array.

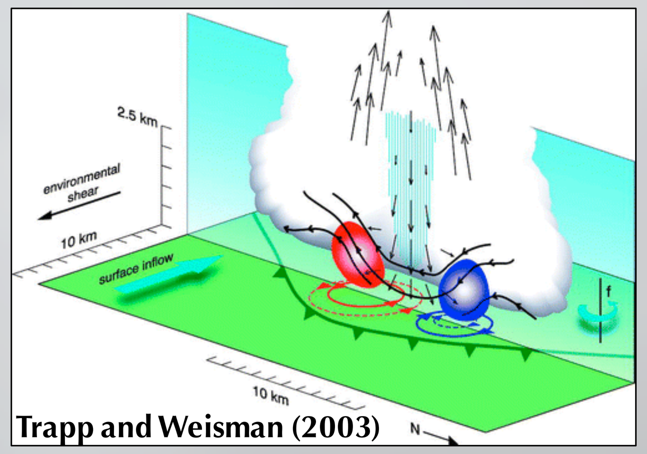


Edited NOXP (a) reflectivity and (b) velocity at 0510 UTC 6 July 2015. This 1.0º scan intercepted the circled mesovortex at 300 m AGL a few minutes prior to tornadogenesis.

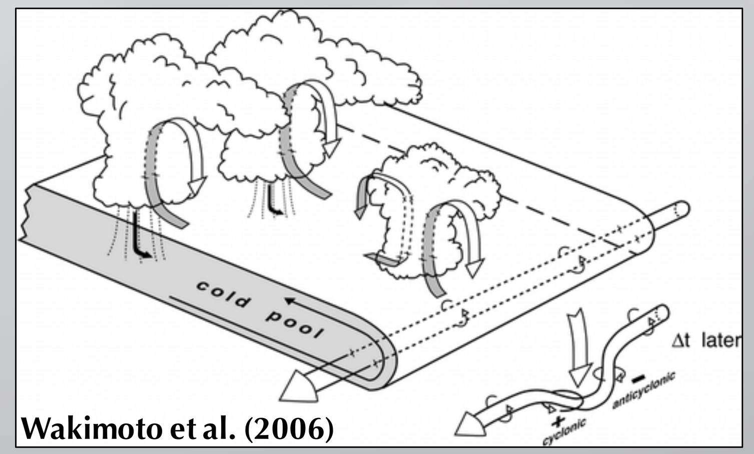


Profile of MG2 radiosonde data from a launch at 0305 UTC 6 July 2015.

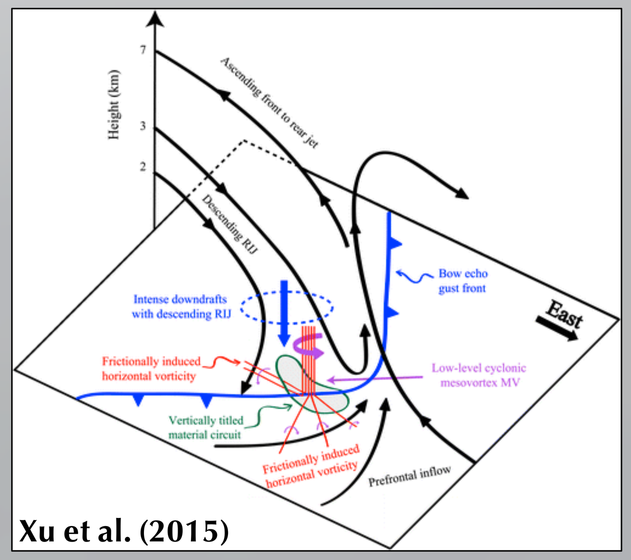
Comparison to Theoretical Models
Mesovortex-genesis



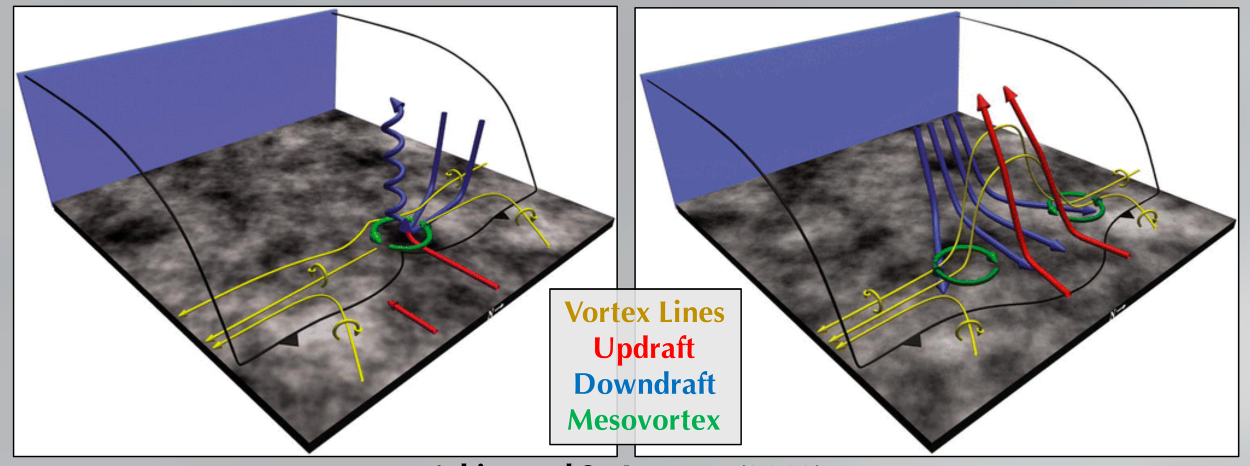
Trapp and Weisman (2003)



Wakimoto et al. (2006)

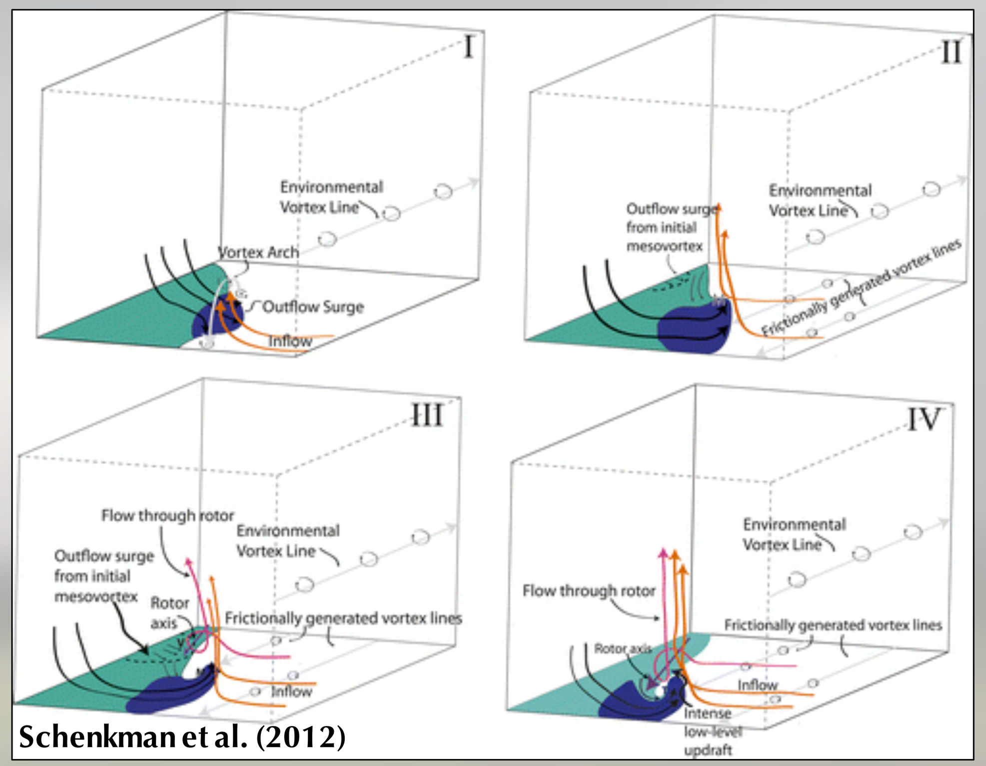


Xu et al. (2015)



Atkins and St. Laurent (2009)

Tornadogenesis



Schenkman et al. (2012)

Ongoing Research Questions:

- What resolution is necessary to resolve the mesovortex and the tornado-like vortex?
- What processes led to mesovortex-genesis in this case?
- How similar are processes leading to supercellular vs. QLCS mesovortex-genesis?
- How important is friction in the development of significant low-level rotation?

Photo by *Kelly DeLay*