THE PROGRAM FOR RESEARCH ON ELEVATED CONVECTION WITH INTENSE PRECIPITATION (PRECIP): AN OVERVIEW

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  - Ron encouraged our continued study of cold season (ROCS) and warm season (PRECIP) elevated convection

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  - Collaborators
    - Mike Bodner
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    - Dr. Scott Rochette
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- PRECIP Project
  - Developed methods to predict where heavy-rain-producing elevated thunderstorms will occur
  - Deployed teams to collect observational data from storm environment
  - http://weather.missouri.edu/PRECIP or https://www.facebook.com/PRECIPresearchprogram
Introduction

Early work

- Colman (1990) initiated the modern era of elevated convection studies
- Showed the preferred region of elevated convection in US
  - northeast of a surface cyclone
  - north of its attendant warm front
- Moore et al. (2003) created composites
Later work...

- Corfidi et al. (2008)
  - Examined the nature of *altocumulus castellanus*
  - Determined that the “...division between elevated and surface-based [convective] activity is rarely distinct.”

Even later work...

- Parker (2008)
- Marsham et al. (2011)
- Schumacher (2015)
- Nowotarski et al. (2011)
- Billings and Parker (2012)

- PBL CAPE $\Rightarrow$ often still some degree of boundary layer air contributing to the convection
- If some amount of near-surface CAPE is available, even with significant CIN in the profile, then the convection is likely surface-based to some degree
A Hierarchy of Elevated Convection

**Pure:** \( \tau > f^{-1} \)  
**ex:** *wraparound*

Surface influences on mid-level parcels dramatically reduced or eliminated because of their 1) vertical location and/or 2) temporal history

**Hybrid:** \( \tau \sim f^{-1} \)  
**ex:** *north of warm front*

Surface influences on mid-level parcels (if any) mitigated by their arrival over frontal inversion

**Mixed:** \( \tau < f^{-1} \)  
**ex:** *warm sector castellanus*

Surface influences on mid-level parcels unrestricted
Objectives

- Study historical events of EC with HP over Colman (1990) bullseye
- Create method for forecasting heavy-rainfall-producing elevated thunderstorms in this region
- Deploy observational assets to observe events in real time
Scientific Questions

Hypotheses

- Upright convection from the release of elevated PI is the dominant mode in elevated convection that produces heavy precipitation

- Elevated convection cells are more shallow, but longer lasting than convection rooted in the boundary layer

- Elevated PI results primarily from differential temperature advection
Methods

Ideal Deployment Method

- 2 radiosonde sites
  - 2-hourly sampling typical
- Under the umbrella of 1-2 WSR-88D radar(s)
Archived Case Selection Methodology

❑ Event criteria:

✓ Produced over 2” rain in 24 hrs.

✓ Local rainfall maximum within CWA boundary

✓ Used North American Regional Reanalysis (NARR) to evaluate event

Archived Case Composite Method

❑ Composite events within following National Weather Service County Warning Areas (CWAs):
  - Kansas City/Pleasant Hill (EAX)
  - Springfield, MO (SGF)
  - Tulsa (TSA)
  - Wichita (ICT)
  - Topeka (TOP)
Results

Composites – Plan View (McCoy 2014)

250-mb Jet Core > 70 kt

Moisture – PWATs > 1.6” (~40 mm)
Lifting – 250-mb DIV > 3 x 10^{-5} s^{-1}
Instability – K Index > 32
Composites – Cross Section (McCoy 2014)

“The X”

EC from PI  (Market et al. 2015)
EC Threats  *(Kastman et al. 2015)*

- Lightning and rainfall characteristics
  - 8 elevated vs. 8 surface-based thunderstorm cases
  - 2007 through 2010; central CONUS
  - Areas of rainfall greater than 50.8 mm / 24 hours

- Elevated convection cases tend to produce
  - more rainfall
  - more total CG lightning flashes
  - more positive CG lightning flashes
  - than surface based thunderstorms

EPEC Parameter *(Foscato 2016; 2017)*

- Excessive Precipitation with Elevated Convection

\[
EPEC = KINX + PWAT + (\text{Div}_{250} \times 100,000) \quad mm \quad s^{-1}
\]

- Units are neglected

- Originally estimated from mean and interquartile range plots from McCoy (2014)
EPEC Parameter (Foscato 2016; 2017)

Evaluated at WPC during FFaR  
Adopted at SensibleWeather.com

DCIN Parameter (Market et al. 2017)

- Downdraft Convective Inhibition
DCIN Parameter *(Market et al. 2017)*

- Downdraft Convective Inhibition

Convergence Columns *(Difani et al. 2017)*

- Vertical structures within coherent areas of CONV that are derived from Doppler radar radial velocity volume scans

- When associated with $Z_{DR}$ columns, columns of convergence indicative of location of convective updraft
Convergence Columns (*Difani et al. 2017*)

- Convergence at lowest observed height in elevated cases is significantly lower than in surface-based convection.

EC Characteristics (*Wunsch et al. 2017*)

- Elevated cells tend to have
  - higher reflectivities, but
  - lower echo top heights
    - Indicates heavier rainfall rates, a known hazard w/EC

- Elevated cells have stronger convergence and thus stronger updrafts in the first 30-40 minutes of their lifetimes.
Conclusions

- **Synoptic environment**
  - EPEC - Several parameters with low interquartile ranges → higher confidence for EC/FF events
  - X “marks the spot” in cross sections
  - DCIN - Sounding parameter to help define EC

- **Storm-scale**
  - EC → higher reflectivities, but lower echo top heights
  - EC → more rainfall
  - EC → more total CG lightning flashes
  - EC → more positive CG lightning flashes
Thank you!!

Program for Research on Elevated Convection with Intense Precipitation

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