AN INDEX FOR ANTICIPATING EXCESSIVE PRECIPITATION WITH ELEVATED THUNDERSTORMS

Alzina Foscato and Patrick Market

Dept. of Soil, Environmental & Atmospheric Sciences
University of Missouri

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• Collaborators
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PRECID Project

Use McCoy’s forecast method to predict where heavy-rain-producing elevated thunderstorms will occur.

Deploy teams to collect observational data from storm environment.

http://weather.missouri.edu/PRECIP or
https://www.facebook.com/PRECIPresearchprogram
McCoy 2014

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

- Created a method to forecast heavy-rainfall producing elevated thunderstorms in this preferred region of elevated convection in US
McCoy’s Conclusions…

• Unique patterns to look for when forecasting heavy-rainfall-producing elevated thunderstorms:
  • Strong signal; strong variability
    • Upper-level jet streak to the northeast of the region
      • Divergence $> 3 \times 10^{-5}$ s$^{-1}$ (lift)
    • Event located within or just south of 850-mb $\theta_e$ advection maximum (convergence max)
      • Signals LLJ from the SSW (moisture; lift; instability)
  • Strong signal; small variability
    • $>30$ K-index values (instability)
    • Precipitable water values $> 1.6”$ (moisture)
    • 2-m $\theta_e$ pattern (confirms elevated convection)
…led us here

- Program for Research on Elevated Convection with Intense Precipitation (PRECIP) highlighted certain composite meteorological fields, which featured
  - significant mean values
  - minimal spread
    - (as quantified by low interquartile ranges)

- Excessive Precipitation with Elevated Convection (EPEC) Index
  - Currently being used for decision support for equipment deployment
What is the EPEC index?

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

- $KINX = K$-index
- $PWAT = \text{Precipitable water}$
- $\text{Div} = \text{Divergence}$

- These variables display strong signal and low variability

- $50^{th}$ percentile minimum values
  - $K$-index $\rightarrow$ 35
  - PWATs $\rightarrow$ 37 mm
  - Divergence $\rightarrow$ $5 \times 100,000\ s^{-1}$
What is the EPEC index?

- Values from McCoy’s (2014) thesis

- Uses 25, 50 and 75 percentile numbers
  - 74 is 25th percentile
  - 86 is 50th percentile
  - 98 is 75th percentile

- Scaled divergence term, as it is many orders of magnitude smaller than KINX or PWAT

- **Employed only on the “cold” side of a $\theta_e$ boundary**
Objectives

• EPEC is designed to help aide in identifying where heavy rainfall with elevated (or surface-based) convection may occur
  • Discriminate surface-based from elevated using 2-m or 950-mb $\theta_e$ field

But...

• Does EPEC demonstrate skill in forecasting where heavy precipitation should occur?
Rankings

• Ranked as 0, 1, 2, 3
  • 0 being a complete miss
  • 1 as being the poorest
  • 2 being a decent event but could be better
  • 3 is “epic”, highlights the correct region

• Ranking these events is the initial approach to this research.
Generate Plots

- Used NAM and GFS to plot total precipitation and plot EPEC.

- Plots were created using total storm precipitation in GARP and plotting the EPEC index over it.

- The total precipitation was taken at 1200 UTC of the event date and EPEC was plotted for the 36 forecast hour.
Ranking of a 0 Northwest Missouri on 22 May 2014 using NAM
Ranking of a 1

Eastern Iowa on 25 June 2015 using GFS
Ranking of a 2 Central Missouri on 03 April 2015 using NAM
Ranking of a 3

Central Oklahoma on 17 July 2014 using GFS
Results

• 21 total events
• PRECIP deployments when ranked were either a 2 or a 3
  • 6 total PRECIP deployments
• Used for Mann-Whitney testing

<table>
<thead>
<tr>
<th>Rankings</th>
<th>Total for GFS</th>
<th>Total for NAM</th>
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<tbody>
<tr>
<td>Ranking of 0</td>
<td>2</td>
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<tr>
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<tr>
<td>Ranking of 2</td>
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<td>11</td>
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<td>Ranking of 3</td>
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<td>2</td>
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Results of Season for GFS

Ranking Results for GFS in 2014-2015

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<th>Ranking of 0</th>
<th>Ranking of 1</th>
<th>Ranking of 2</th>
<th>Ranking of 3</th>
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<tbody>
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</tbody>
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Results of Season for NAM

Ranking Results from NAM in 2014-2015

Number of the ranks

Month

- May
- June
- July
- August
- September

- Ranking of 0
- Ranking of 1
- Ranking of 2
- Ranking of 3
Results Mann-Whitney Test

- Used Mann-Whitney test for statistical difference between the NAM and the GFS

- The results showed no statistical difference between the models and their rankings

- Whenever a deployment was considered, PRECIP normally went with the better performing model that day
WPC Work

0000 UTC (24 hours out) 02 July 2015 from the NAM
Conclusions

• PRECIP deployments when looked back at to rank EPEC were either a 2 or 3

• Help to correctly identify areas of elevated convection with heavy rainfall and flash flooding

• EPEC performs better in the warm season
  • McCoy’s composites: May-September

• Mann-Whitney test revealed no statistically significant difference between EPEC values from NAM and GFS
Future Work

• Statistical analysis using Python
  • Mean absolute error
  • Root mean square error
  • Correlation fields

• To quantify rankings
References
