The Importance of Summer Season Fronts in Extreme Precipitation Events

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Overview

• Motivation
• Data
• Seasonal Results
• Regional Results
• Future Work
Motivation

2-Day Precipitation Events Exceeding 5-Year Recurrence Interval

Relative Number of Extreme Events (%) vs. Year
Motivation

• Fronts of extratropical cyclones are the single largest cause of heavy precipitation events in the continental United States.

• Analysis of 935 Cooperative Observer stations

• Dataset of 1-day heavy precipitation events exceeding a 1-in-5-year occurrence.

• Each event attributed to one of seven possible “causes”
Motivation

![Bar chart showing the percent of extreme precipitation events by type: Fronts-ETC (50%), Extratropical Cyclone (Not Front) (20%), Tropical Cyclone (10%), Mesoscale Convective System (5%), North American Monsoon (1%), and Air Mass Convection (0%).]
Motivation

- Fronts cause more than half of all extreme precipitation events*
- Fronts are the dominant cause of the increase

Data

• 935 Cooperative Observer Network Stations
• 1908-2013
• Continental U.S.
• Identified events which exceed a 1-in-5-year occurrence
  – Station ID
  – Year, Month, Day of occurrence
  – Precipitation amount (mm)
  – Type of Event
• 18,242 total events
• 13,061 total events attributed to fronts
Updated Time Series of Frontal Events
Annual Time Series of All Events
Number of Frontal Events per Station
Analysis of Top 5 Events per Station

• Analyzed the top 5 events per station over 104 year period = 20-year return
  – 18,241 total events, of which, 13,061 are attributed to fronts (71.6%)
• Calculated the percentage of these top 5 events that are attributed to frontal events
  – 4,675 total “Top 5” events, of which, 3,141 are attributed to fronts (67.2%)
• Assigned frequency as one of 6 possible frequencies:
  – 0%
  – 20%
  – 40%
  – 60%
  – 80%
  – 100%
Percentage of Top 5 Events per Station
Number of Events per Season

Events by Season - U.S.

- Winter (JFM): 1089
- Spring (AMJ): 4249
- Summer (JAS): 5697
- Fall (OND): 2026
Cold Season Results (Nov-Apr)
Warm Season Results (May-Oct)
Warm Season Results (May-Oct)
Regional Results - Midwest

Number of Events per Decade - MW

Number of Events per Month - MW

Decade

1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s 2010s

Number of Events (per year)

Number of Events

Month

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Number of Events

7% 32 17% 241 534 1136 1000 1064 1034 358 145 68

Regional Results - Midwest

Number of Seasonal Events - MW Region

Decade

1910s 1920s 1930s 1940s 1950s 1960s 1970s 1980s 1990s 2000s 2010s

Number of Events (per year)

Winter Spring Summer Fall
Regional Results - Southeast

Number of Events per Decade - SE

Number of Events per Month - SE
Regional Results - Southeast
Future Work

• Analyze top events for significant regions

• Identify patterns in atmospheric variables

• Derive “typical” dynamic picture for predictability of future events of the similar magnitude
Conclusions

• Summer fronts are the dominant cause of extreme precipitation in the Midwest region

• Summer fronts are also important in the Southeast region

• Of 18,241 total events, 71.6% are attributed to fronts

• Of 4,676 top 5 events for each observing station, 67.2% are attributed to fronts