RenaissanceRe
Risk Sciences

Severe Convective Storms

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Outline

- Severe Convective Storms (SCS)
  - Climatology
  - SCS Hazard Trends vs Variability
  - SCS Losses
- Iowa Derecho

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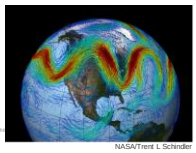
Severe Convective Storms (SCS)

- Atmospheric Convection is the "overturning" of the atmosphere, producing:
  - Tornadoes
  - Hail
  - Straight Line Winds
  - Heavy Rain
- Predominant modes of SCS activity driven by jet stream amplification (bending and strengthening of upper-level flow)
  - Driving cold air southward
  - Dropping surface pressure, forcing warm moist air from Gulf of Mexico towards surface low pressure
  - Attendant vertical wind shear sustains long lived and intense convection



NASA/Trent L Schindler

Dan Craggs

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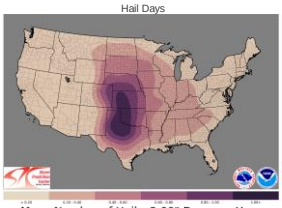
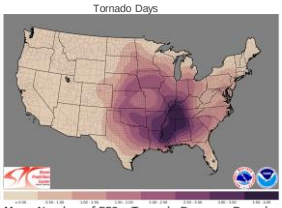
Significant Hazard Climatologies

Hail Days



Mean Number of Hail >2.00" Days per Year
Within 25 Miles of a Point
1986 - 2015

Tornado Days



Mean Number of EF2+ Tornado Days per Decade
Within 25 Miles of a Point
1986 - 2015

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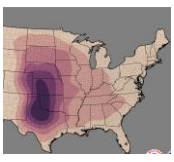
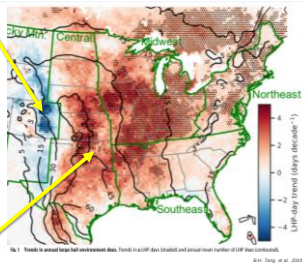
Trends in Large Hail Potential Days

Decrease in number of hail days



Increase in number of hail days



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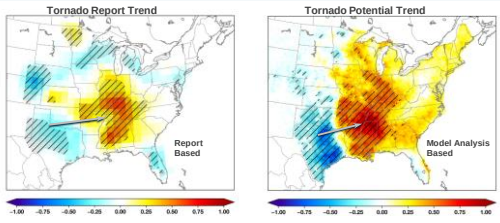
Shifts in Tornadoes and Tornado Potential



Gensini and Brooks, 2018

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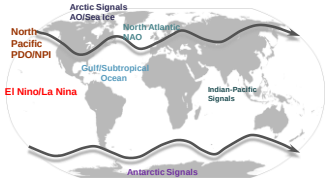
Large Scale: Jet Stream

- Jet streams are the dominant atmospheric force on mid-latitude weather systems
- Jet wave patterns often modified by global climate signals
- ENSO, AO/NAO, and PDO are significant climatic modulators of North American weather



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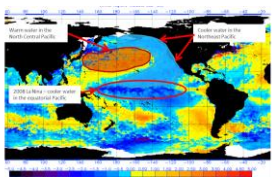
Pacific Decadal Oscillation (PDO)

- Anomalous sea surface temperatures in North Pacific
- Cold or warm phases last about 20 to 30 years.
- ENSO events typically persist for 6 – 18 months
- Negative PDO and La Niña bring stronger northwesterly winds to the Northwest US coast as well as cold Pacific coastal ocean temperatures.

Negative (cold) PDO and La Niña illustrated in sea surface temperature anomaly field on March 6, 2008



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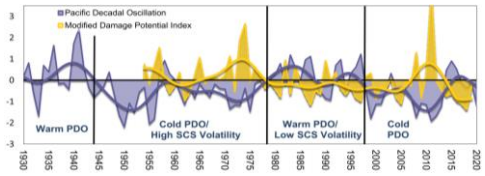
Tornado Variability

- Climate factors & SCS correlate
- No long-term trend in tornado counts, but enhanced SCS activity between 2007 and 2012 suggested from radar & tornado data
- **Evidence for a cycle tied to PDO, with year-to-year variations tied to ENSO**



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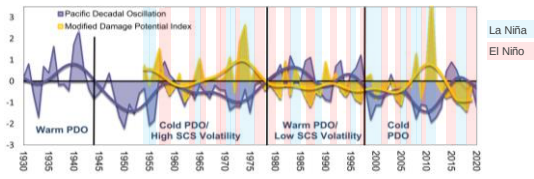

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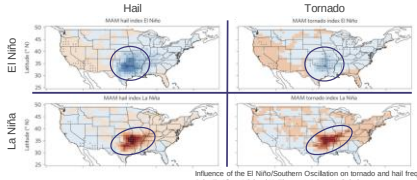
ENSO: Spring Impacts on Hail and Tornado Anomalies



Influence of the El Niño/Southern Oscillation on tornado and hail frequency in the United States
John T. Allen, Michael K. Tippett & Adam H. Sobel
Nature Geoscience 8, 278–283 (2015) doi:10.1038/ngeo2385

- El Niño is related to significantly **reduced** hail and tornado potential in the Central U.S.
- La Niña is related to significantly **increased** hail and tornado potential in the Central U.S.

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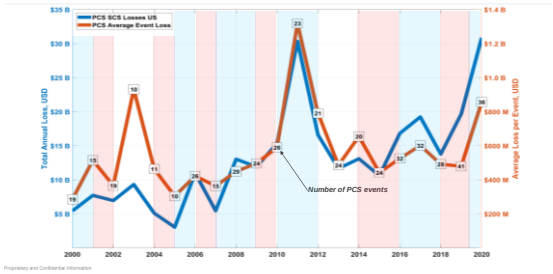
USA PCS SCS Insured Losses



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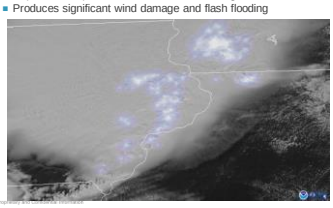
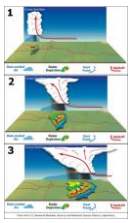
Derecho (Mesoscale Convective System)

- Large, convective system producing a damage swath over 240 miles from winds of at least 58 mph
  - Often travel hundreds of miles over several hours to a couple of days.
- Propagate analogously to an ocean wave in concert with a cold front or along a stationary front
- 'Squall' line expands with broad and intense gust front
- Produces significant wind damage and flash flooding





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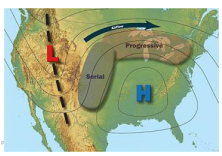
NOAA SPC website/Dennis Cain

Derechos

- Summer-time occurrence associated with strong high pressure over Southeast US.
- Complex in structure and behaves analogously to tropical cyclones:
  - Self-perpetuating
  - Upscale growth
  - Develop large-scale, distinct circulations
- Difficult to forecast in advance
  - Sensitive to subtle atmospheric characteristics
  - Intensity is, generally, unresolved by global, coarse models



NOAA SPC website/Dennis Cain

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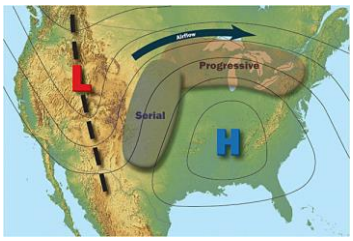
Serial vs Progressive Derecho



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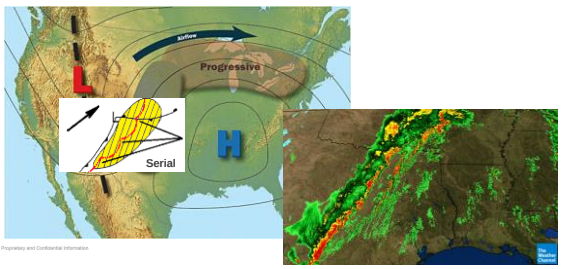
Serial vs Progressive Derecho



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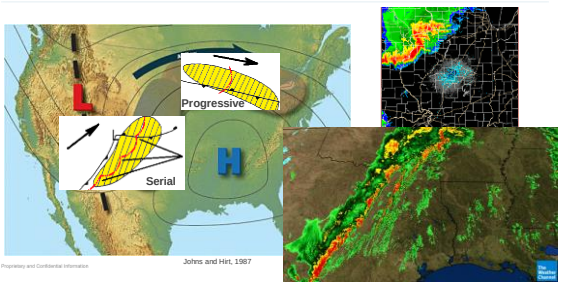
Serial vs Progressive Derecho



Johns and Hirt, 1987

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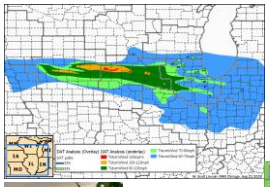
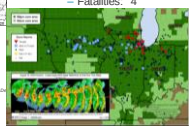
2020 Iowa Derecho (Progressive)



August 10-11, 2020

- PCS: **$8 Billion** *insured total*,
  - **$5.2 Billion** *Iowa*
  - **$1+ Billion** *Minnesota, Illinois each*
- USDA Crop: **$271 Million**
- Duration: 14 hours
- Track length: 770 mi
- Peak wind gust:
  - Measured: 126 mph (Atkins, IA)
  - Estimated: 140 mph (Cedar Rapids, IA)
- Largest hail: 2" (Freeport, IL)
- Fatalities: 4



Des Moines, IA NWSFO

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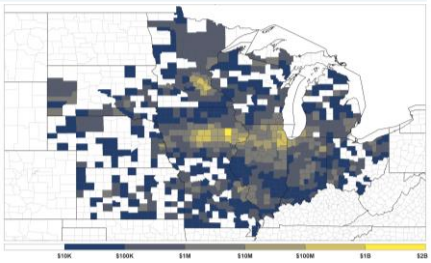
PCS Total Estimated Loss Event 2046

- Linn County, IA
  - Cedar Rapids
  - $1.7 Billion
- Polk County, IA
  - Des Moines
  - $500 Million



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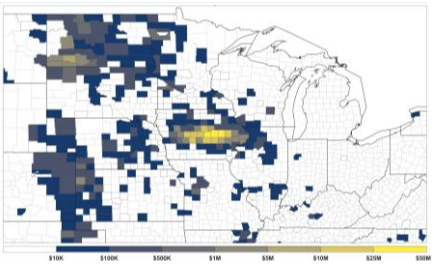
USDA Cause of Loss Indemnities, Aug 2020 SCS

- Benton County
  - $41 million
- Marshall County
  - $40 million
- Tama County
  - $32 million



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2012 Derecho vs. 2020 Derecho (Impact)

June 29-30, 2012
- PCS: **$2.3 Billion** *insured total* (2020 $),
  - **$850 Million** *Ohio*
- 18 *hrs* / 800 *mi*
- Peak wind gust:
  - 91 *mph* (Fort Wayne, IN)

August 10-11, 2020
- PCS: **$8 Billion** *insured total*,
  - **$5.2 Billion** *Iowa*
  - **$1+ Billion** *Minnesota, Illinois each*
- 14 *hrs* / 770 *mi*
- Peak wind gust:
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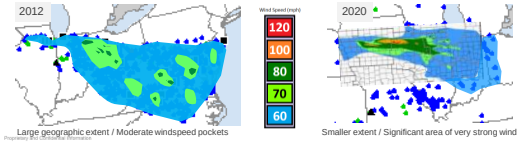

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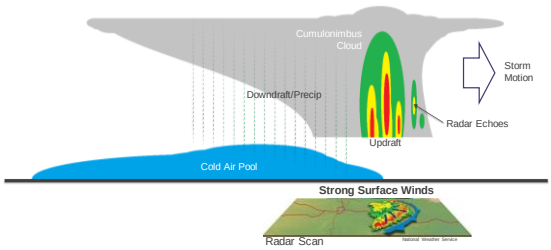
MCS Cross Section



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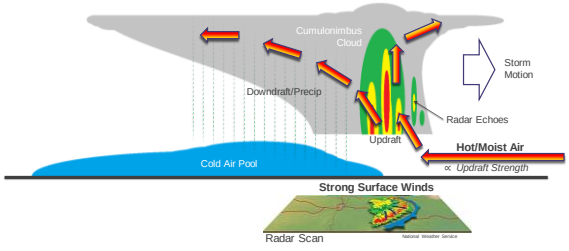

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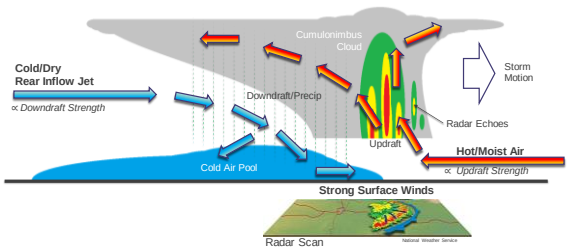
MCS Cross Section



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2012 Derecho vs. 2020 Derecho (Forecasts)

- June 29, 2012, 1300 *UTC*

- **SPC text:** *MULTIPLE STORMS … MAY DEVELOP AND GROW … INTO … BOW ECHOES WITH A RISK FOR DAMAGING WINDS AND LARGE HAIL …*

- August 10, 2020, 1300 *UTC*

- **SPC text:** *TRENDS…SUGGEST…A BOW ECHO WITH RISK OF DAMAGING WINDS. WIDESPREAD WIND THREAT MAY ENSUE.*

26

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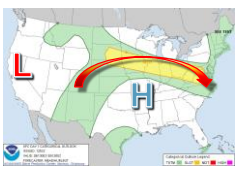

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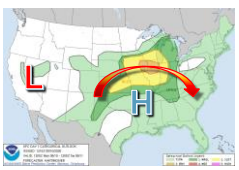

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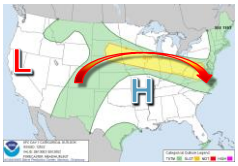

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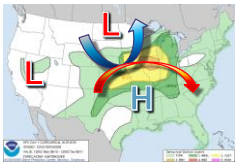

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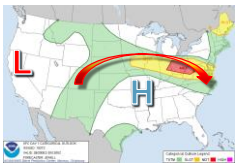
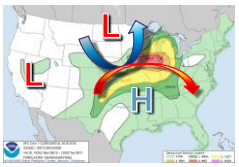
2012 Derecho vs. 2020 Derecho (Forecast Updates)

- June 29, 2012, 1630 *UTC*



- **SPC Text:** *MCS CONTINUES TO GROW... WINDS MEASURED AT 91 MPH. EXTREMELY UNSTABLE AIR MASS...THE SYSTEM MAY CONTINUE TO THE COAST.*

- August 10, 2020, 2000 *UTC*



- **SPC Text:** *POTENTIAL EXISTS FOR A DERECHO WITH INTENSE SEVERE GUSTS AND WIDESPREAD WIND DAMAGE ACROSS CENTRAL TO EASTERN IA, NORTHERN IL AND FAR SOUTHERN WI.*

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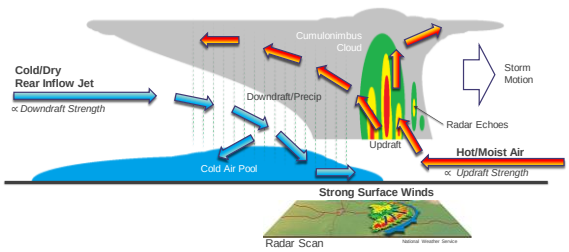
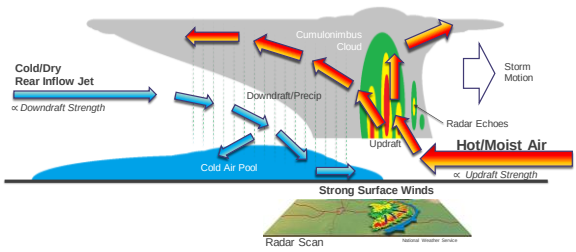
MCS Cross Section (2012 Derecho)



30

MCS Cross Section (2020 Derecho)



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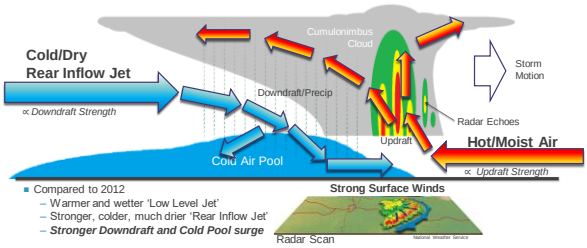
MCS Cross Section (2020 Derecho)



- Compared to 2012
  - Warmer and wetter 'Low Level Jet'
  - Stronger, colder, much drier 'Rear Inflow Jet'
  - ***Stronger Downdraft and Cold Pool surge***

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Thank you!

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