Precipitation and Temperature Extremes in the U.S.: Trends and Causes

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October 26, 2015
October 3, South Carolina
Oct. 24, Texas
Extreme Precipitation Analysis

• Definition
  – Events exceeding a threshold amount for a specified average recurrence interval and duration: 2-day, 1-in-5yr, 1-day, 1-in-1yr
  – Amount of precipitation exceeding 99\textsuperscript{th} %ile
  – Fixed threshold: 2 inches

• Periods: 1901-2012/2015, 1951-2014
Number of 2-day, 1-in-5yr: U.S.
Number of 2-day, 1-in-5yr: U.S.
Daily 2 inch Precipitation Trends

Observed Number of Extreme Precipitation Events

Number of Events with Precipitation Greater Than 2 Inches

5-year Period


Contiguous U.S.
Global Extreme Precipitation Trends

1 Year, 1 Day, 1951–2014

Map showing global precipitation trends with different colors representing upward and downward trends, and gray dots indicating significance levels (p ≤ 0.05 and 0.05 < p ≤ 0.10).
Heat and Cold Waves
Observed Extreme Temperature Episodes

- 4-day, 1-in-10yr hot spells
- 5-day, 1-in-5yr hot spells
- Days with Tmin < 0F
- Days with Tmin > 75F
- Record hot and cold temperatures
  - Daily records
  - Monthly temperature records
U.S. Hot Spells (4-day, 1-in-10yr)
U.S. Hot Spells (4-day, 1-in-10yr)
U.S. Cold Spells (5-day, 1-in-5yr)
Extreme Temperature Episodes

- Record hot and cold temperatures
  - Daily records
  - Monthly temperature records
5-day, 1-in-5yr cold spells trend, 1951-2014
Causes of U.S. extreme precip trends

- Have there been secular changes in the frequency, intensity, and other characteristics of the meteorological phenomena producing heavy precipitation?
- Are the recent increases primarily a result of increases in atmospheric water vapor concentrations?
Causes

• Have there been secular changes in the frequency, intensity, and other characteristics of the meteorological phenomena producing heavy precipitation?
Meteorological Types

• Extratropical Cyclones
  – Frontal (at least ~300 km away from center of surface or upper low)
  – ETC (near surface or upper low center)

• Tropical Cyclones

• Mesoscale Convective Systems

• Air Mass Convection

• North American Monsoon

• Upslope
>18,000 precip events were categorized for the period of 1908-2009
The U.S. upward trend in extreme precipitation is associated with an increase in the number of events associated with fronts and tropical cyclones. There is no trend in the number associated with the other meteorological types.

There is not any trend in the number of landfalling tropical cyclones. More extreme precipitation events per tropical cyclone. Does this mean higher water vapor is the cause?

We have not investigated (yet) whether there are more fronts or the fronts have characteristics more conducive to extreme precipitation.
Conclusions

• 2015 preliminary extremes assessment
  – Above average extreme precipitation
  – Near average extreme heat and cold
• Recent above average occurrence of extreme precipitation events continues long-term trend
• Cold temperature extreme decreases
• Hot temperature extreme increases for nighttime minima
NAM, MCC, Air Mass, Upslope

Number of Events/Station/yr vs Year

- Monsoon
- Air Mass
- MCC
- Upslope
99%ile precipitation change: 1958-2012