Extreme Weather in the US: Trends, Drivers, Impacts

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In Brief

- Certain types of extreme weather events are becoming more (less) frequent in the United States
  - In particular, Big Heat, Big Rain and (Big Cold)
  - Also, Big Drought
- The state of knowledge about extreme events is (not surprisingly) related to the state of associated data
- Observing occurrences ("things you count") is different than observing quantities ("things you measure")
  - This is consequential to how we assess extreme events
- Impacts from extreme events depend upon more than physical climate
- Attributing the drivers/influencers/likelihood of extreme events is an emerging discipline

- Mar 2010: NJ RI
- Apr 2010: CT IL MA ME MI NH NJ RI
- May 2010: FL AK
- Jun 2010: DE LA* NC NJ IA MI
- Jul 2010: CT* DE* MA* RI*
- Aug 2010: LA*
- Sep 2010: MN
- Oct 2010: FL
- Dec 2010: FL UT
- Mar 2011: TX
- Apr 2011: IL IN KY MI* NY OH PA TN WV
- Jun 2011: LA TX NM
- Jul 2011: DE* MD* OK TX
- Aug 2011: AZ CO FL LA NM OK TX NH NJ NY VT
- Sep 2011: OR PA
- Nov 2011: RI
- Jan 2012: AK
- Mar 2012: CONUS AL AR CT GA IA IL IN KS KY MA MI MN MO MS NC ND NE NH NJ NY OH OK PA RI SC SD TN VA VT WI WV
- Jun 2012: CO FL UT* WY
- Jul 2012: DE MD VA
- Aug 2012: NV MS
- Sep 2012: CA MN MT ND SD
- Oct 2012: DE
- Nov 2012: NH WV
- Feb 2013: GA
- Apr 2013: ND IA MI
- May 2013: IA
- Jun 2013: NJ UT
- Jul 2013: CT MA RI FL
- Sep 2013: CO OR WA
- Oct 2013: AK
- Jan 2014: CA
- Jun 2014: AK MN
- Jul 2014: AR
- Aug 2014: MT
- Feb 2015: AZ CA OR WA
- Apr 2015: FL
- May 2015: AK CT MA NH CONUS CO OK TX UT
- Jun 2015: CA ID OR UT WA IL IN OH
- Jul 2015: KY
- Sep 2015: CO CT MA ME MI MN RI UT WI
- Oct 2015: WA SC
- Nov 2015: NJ AR MO
- Dec 2015: CONUS AL AR CT DE FL GA IA IL IN KS KY MA MD ME MI MN MO MS NH NJ NY NC OU OK PA RI SC TN VA VT WI WV IA WI

- 1Q 2010: ME VT* MA RI
- Spr 2010: CT* DE* MA* ME MI* NH NJ* NY* RI VT*
- 2Q 2010: CT DE LA MA MD NC NH NJ RI VA VT
- Sum 2010: CT DE GA MD MS NC NJ RI SC TN VA WI
- 3Q 2010: CT DE FL MA
- 4Q 2010: NV UT FL
- CY 2010: ME NH* ND
- Spr 2011: ID IN KY MI MT NY OH OR PA VT WA WV WY AK TX
- 2Q 2011: WA TX IL IN KY MI MT NY OH NM
- Sum 2011: LA NM OK TX NJ TX
- 3Q 2011: NM TX MD NJ NY
- Aut 2011: CT MA ME NH RI VT OH PA
- 4Q 2011: CT* MA* NJ* RI*
- CY 2011: CT IN KY MA NJ NY OH PA VT
- 1Q 2012: CONUS AL AR CT DE GA IA IL IN KS KY MA MD MI MN MO ND NE NH NJ NY OH OK PA RI SD TN VA VT WI WV CT RI
- Spr 2012: CONUS AL AR CO CT DE FL* GA IA IL IN KS KY LA MA MD MI MN MO MS NC NE NJ NY OH OK PA SC SD TN TX VA VT WI WV
- 2Q 2012: CO KS AR UT
- Sum 2012: CO FL NE
- 3Q 2012: AK MS MT NE SD
- Aut 2012: NV
- CY 2012: AR AZ* CO CT DE IA IL IN KS MA MD MI MO NE NH NJ NM NY OK PA RI SD TX VA VT WI WY NE WY
- 1Q 2013: CA
- Spr 2013: IA
- Sum 2013: DE GA SC
- 3Q 2013: CO OR IA
- Aut 2013: WY
- 4Q 2013: CA
- CY 2013: CA
- 1Q 2014: AZ* CA*
- Win 2013-14: CA*
- 2Q 2014: MN
- Sum 2014: AK
- Aut 2014: CA
- CY 2014: AK AZ CA NV
- Win 2014-15: AZ CA NV UT
- 1Q 2015: NY AZ CA NV OR UT WA WY SD
- Spr 2015: FL TX
- 2Q 2015: FL WA TX
- Sum 2015: OR WA
- 3Q 2015: CT ME NH RI
- Aut 2015: CONUS FL SC
- 4Q 2015: CONUS CT DE FL GA IN KS MA MD ME MI MN MS NH NJ NY NC OH PA RI SC TX VA VR WI WV MO NC OK SC TX
- CY 2015: FL MT OR WA OK TX

State records since 2010

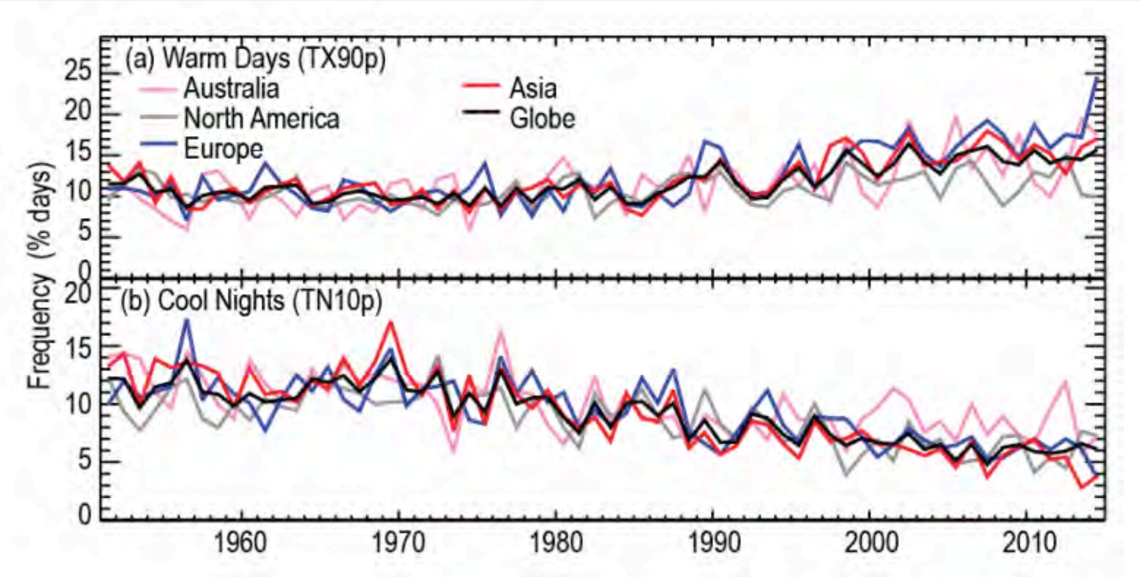
COOLEST
WARMEST
WETTEST
DRIEST

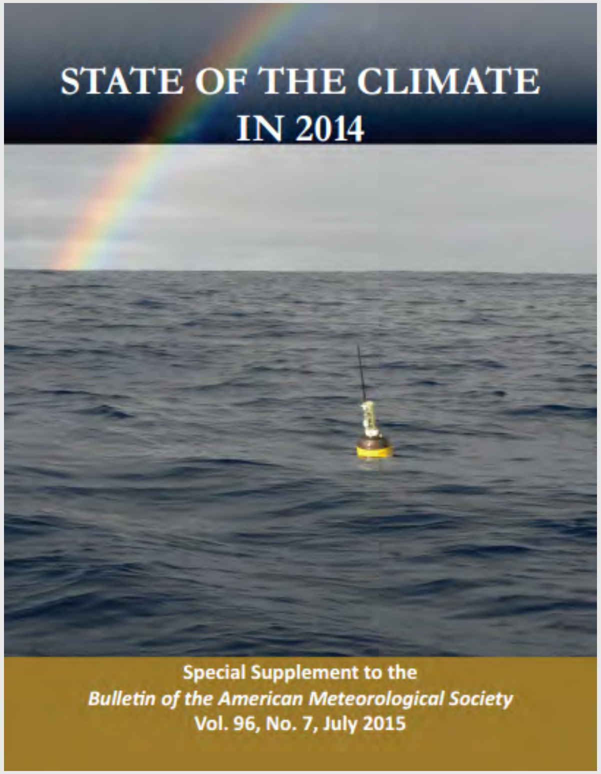
Key to Seasons:
CY: Calendar Year (Jan-Dec)
1Q: 1st quarter (Jan-Feb-Mar)
Spr: Spring (Mar-Apr-May)

* - record was since broken

Climate at a Glance
http://www.ncdc.noaa.gov/cag

It's Not Just the US: State of the Climate



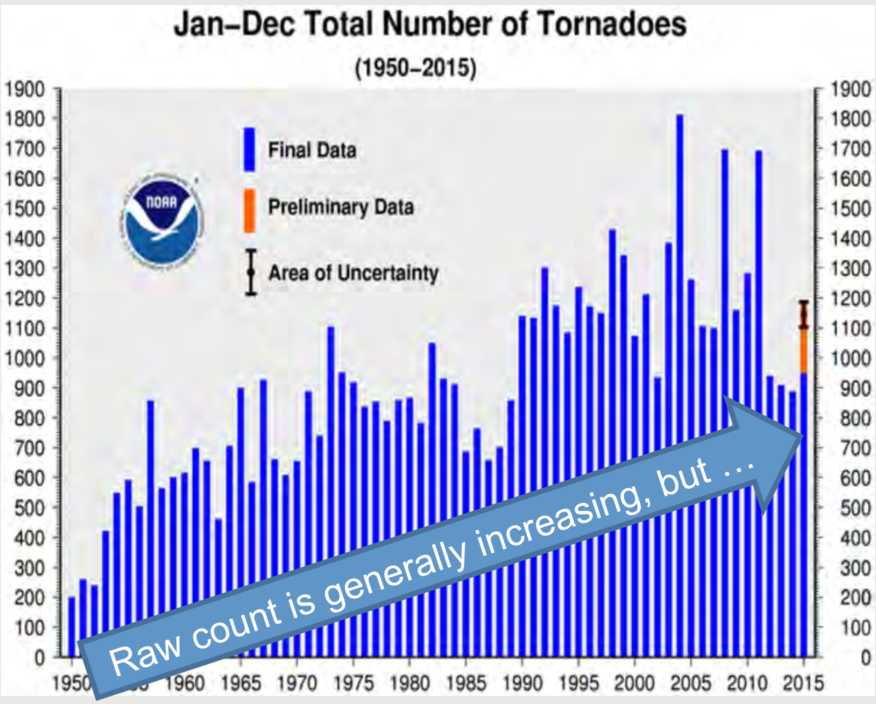


Every continent with robust data shows that, over the long run, extreme highs are increasing, while extreme lows are decreasing.

From Dunn, R.J.H., M.G. Donat, and T.C. Peterson, 2015: Temperature extreme indices [in "State of the Climate in 2014"]. *Bull. Amer. Meteor. Soc.*, **96** (7), S15–S16. © American Meteorological Society. Reproduced with permission.

Counting Things

Late 1980s / Early 1990s: deployment of next-generation radar and concurrent advances in tornado prediction/detection



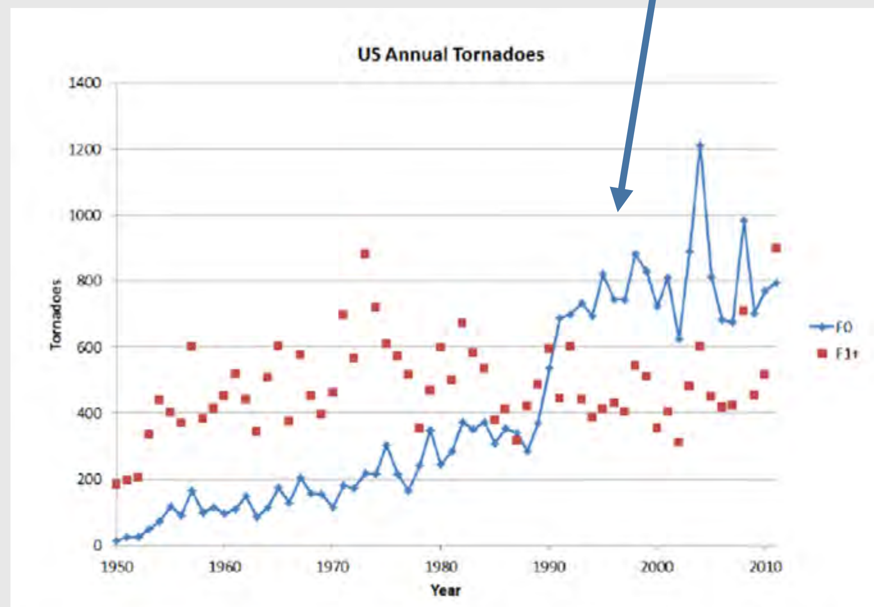
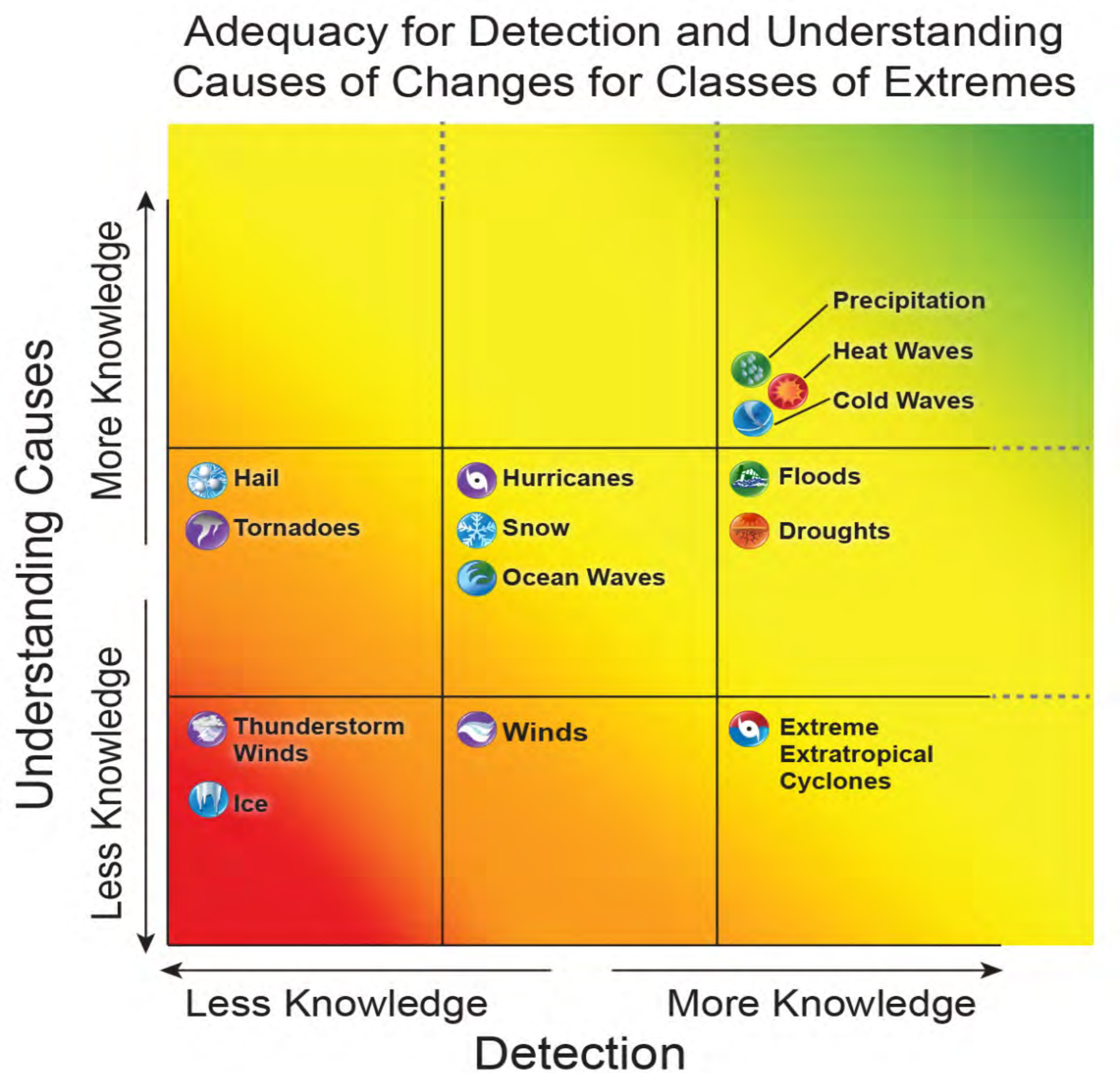


Figure 1. Reported tornadoes in NWS database from 1950-2011. Blue line is F0 tornadoes, red dots are F1 and stronger tornadoes.

- Advances in technology and skill help us observe phenomena today that we used to miss.
- Similar challenges for hurricanes / tropical cyclones, severe local weather (wind, hail) and other "Things you count"

From Kunkel, et al., 2015: Monitoring and Understanding Trends in Extreme Storms: State of Knowledge. *Bull. Amer. Meteor. Soc.*, **94**, 499–514. © American Meteorological Society. Reproduced with permission.

Current State of Scientific Knowledge



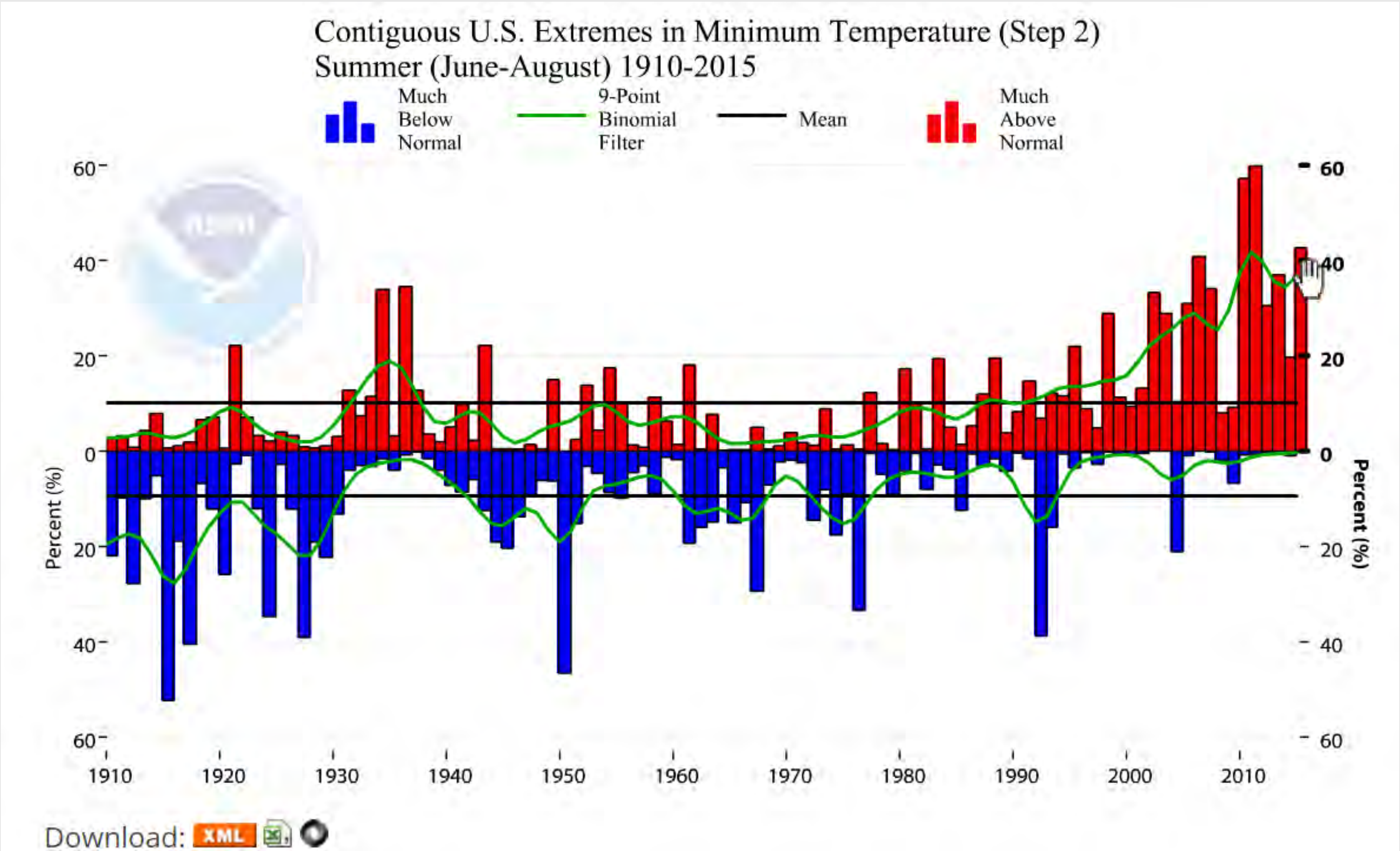
Key phrase

"On Average, …"

Most of the following statements apply to the country as a whole and the calendar as a whole. Specific regions and/or seasons may vary!

Big Heat is Increasing

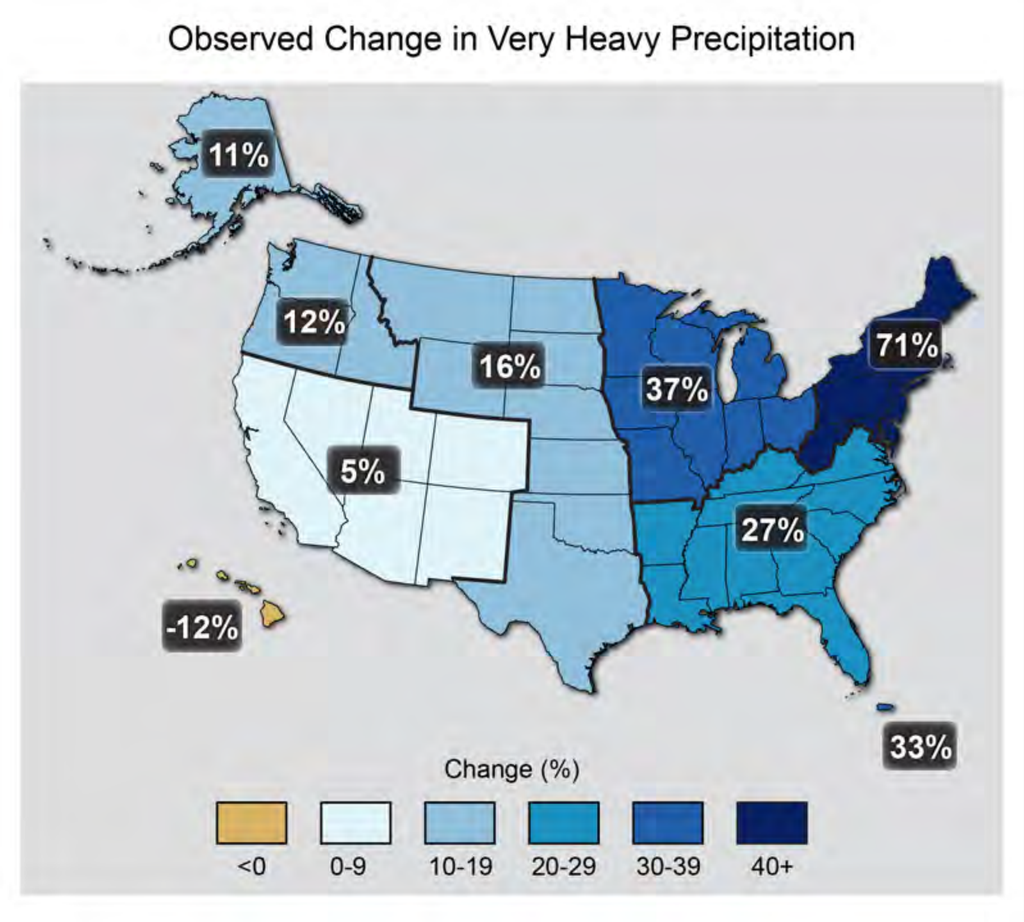
NOAA/NCEI Climate Extremes Index: http://www.ncdc.noaa.gov/extremes/cei



(Big Cold is generally decreasing)

Big Rain is Increasing

- On average, with significant regional patterns, heavy precipitation is increasing in two aspects:
- Large events are now responsible for more of the annual rainfall budget
- Large events are generally getting larger
- This has consequences.

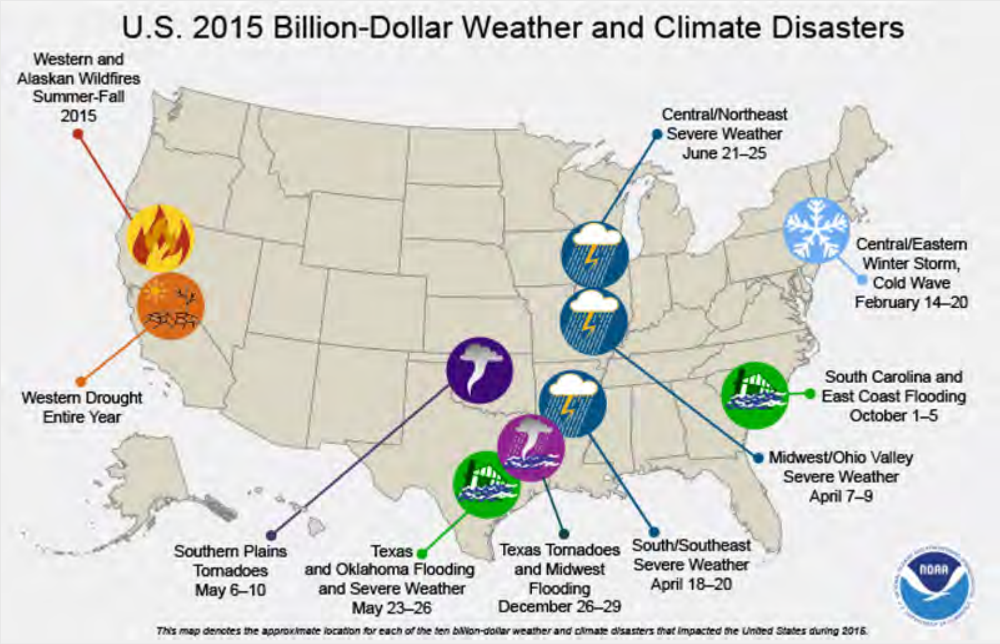


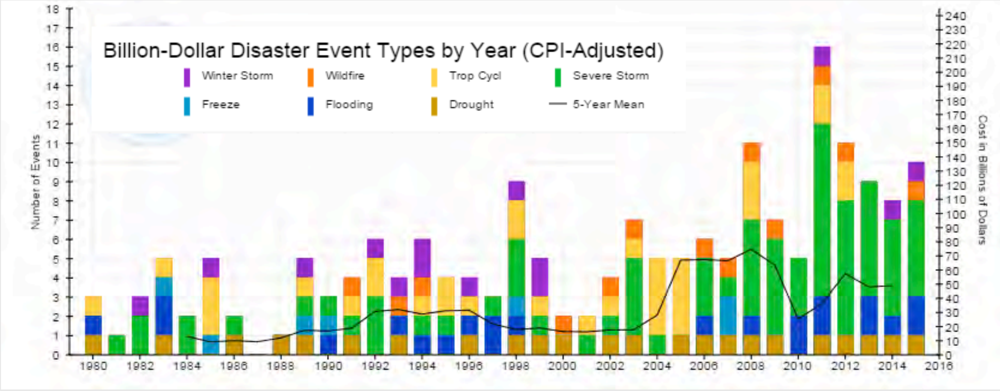
Adapted from National Climate Assessment 2, US Global Change Research Program.

Billion Dollar Disasters

Several factors converge to produce outcomes

- Trends in loss are a combination of:
  - Trends in intensity, number and location of physical (weather and climate) events
  - Trends in where structures and assets are placed (built)
  - Trends in the value of structures and assets

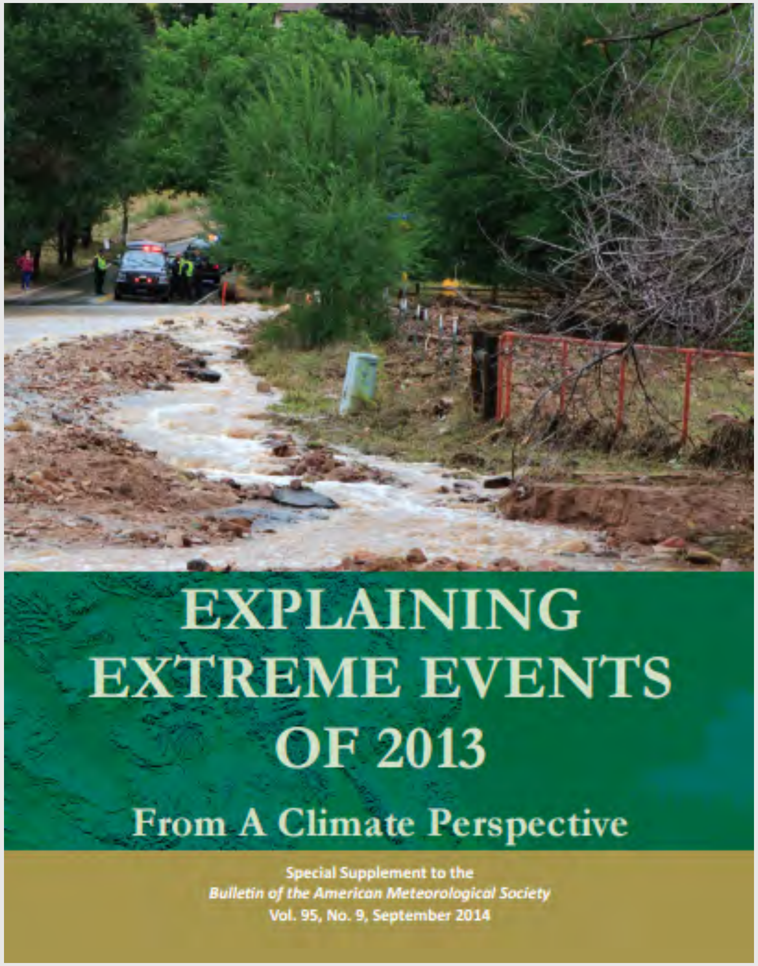




NOAA/NCEI: https://www.ncdc.noaa.gov/billions/

Attribution Science

- Determining the influence of climate change (or variability!) on specific events is not impossible
- It is, however, not easy, nor is it immediate.
- Findings are often statistical/ probabilistic in nature.
- "This event was 8 times more likely in a warming world."



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