Climate Trends in New Hampshire and Its Impact on Storm and Riverine Flood Behavior

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Providence Street – West Warwick, RI at 1030 am Wednesday 3/31/10

Outline

- From a “Practitioner’s Perspective”
- Touch upon some of our major flood events of the past 10 years
  - New Hampshire is not alone
  - Common themes & characteristics
- How may a changing climate be impacting storm behavior in the Northeast?
- What does this all mean?

A few caveats

- I'm not a climate scientist!
  - I'm a practitioner
- I have the benefit of living in this part of the country my entire life
  - It's different now – beyond temps & precip
  - Changes in vegetation, insects, bird life & ***river response***
  - Sea level rise
- The mission: Develop a better understanding of the current regime vs. the old & what that means to how we model our rivers
  - "Accumulation of Ingredients" – not one single "source"
  - Where we are headed: that's the million $$ question!

I've been a little busy these past 7 years!

Job Security in the face of changing flood behavior!!

Record flooding along the Fish and Saint John Rivers – northeast Maine, 4/30/2008

St-Jean-sur-Richelieu, Quebec, Canada, 5/6/11
Photo: AP//Canadian Press, R. Remoirz

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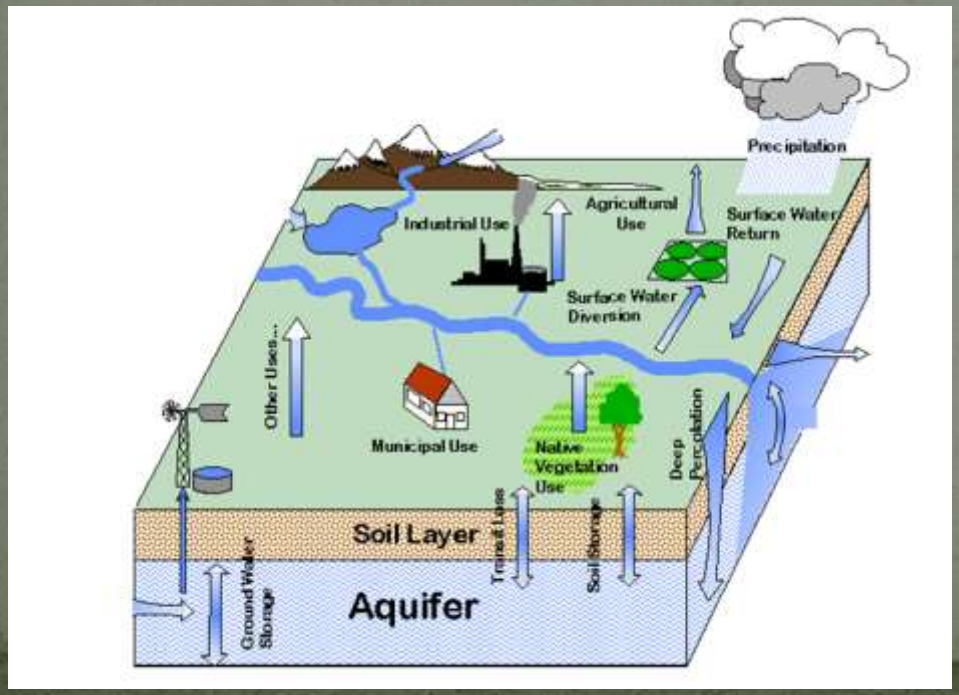
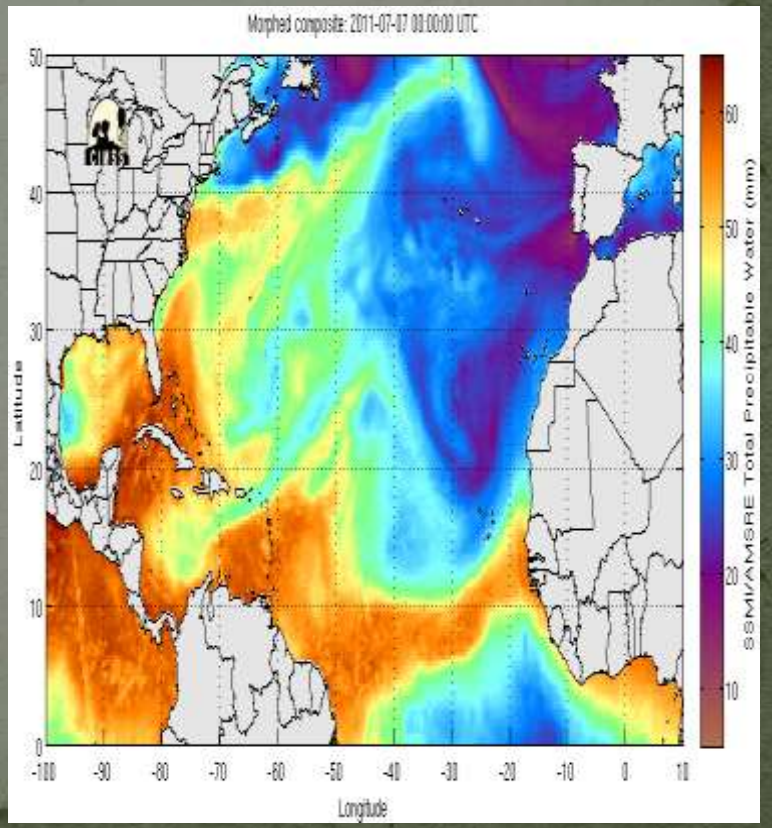
Home washed off its foundation along the Schoharie Creek, Prattsville, NY – Tropical Storm Irene

Is there a common theme to recent ?

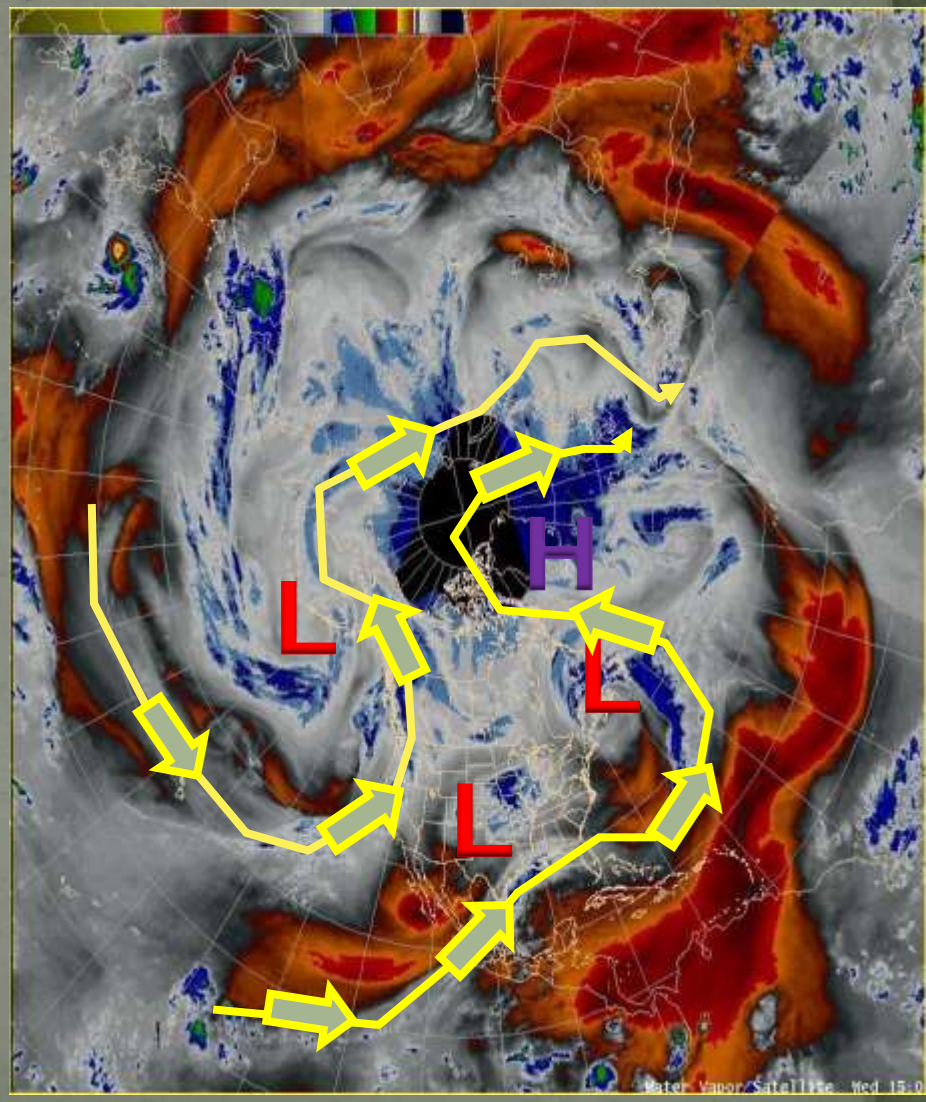
- Several:
  - Slow moving weather systems – a blocked up atmosphere
  - Multiple events in close succession or 1 or 2 slow movers
  - Resulted in saturated antecedent conditions before "main event"
  - Each fed by a "tropical connection"
    - Plumes of deep moisture





Is there a plausible "Climate Hypothesis"?

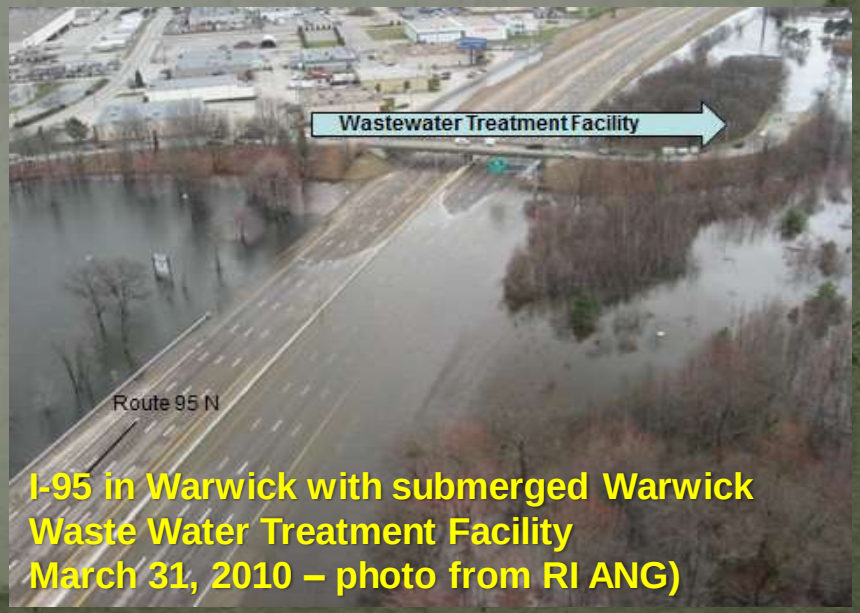
- Modest changes in air & sea temperatures = atmosphere can hold more moisture
  - New England is in close proximity to the ocean and the Gulf & Atlantic moisture streams
  - Affected by dual storm tracks and blocking high pressure over Greenland
  - These ingredients offer us more “opportunities” to latch onto these plumes
- Reduction of sea ice changes upper level wind flow
  - Blocked up pattern induces slower moving storms or back-to-back-to back events



The Changing Climate

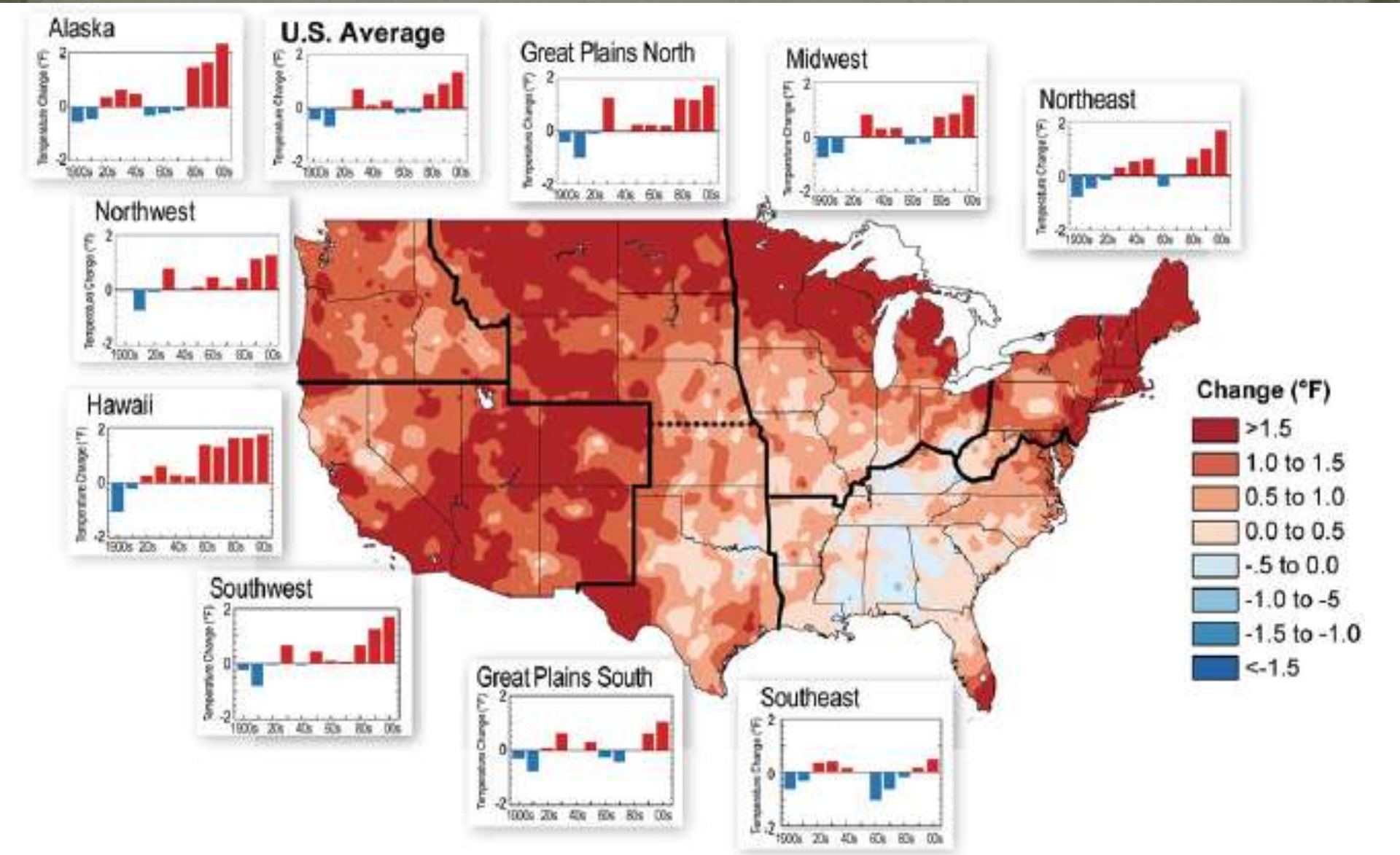
- Common themes across New England:
  - Increasing annual precipitation
  - Increasing frequency of heavy rains
  - Warming annual temperatures
  - Wildly varying seasonal snowfall
- Shift in precipitation frequency (50, 100 yr – 24 hr rain)
- For smaller (<800 sq mi) basins – trend toward increased flood magnitude and/or frequency
  - Most pronounced where significant land use change and/or urbanization has occurred

Moderate flooding – Connecticut River at Portland, CT, April 2007



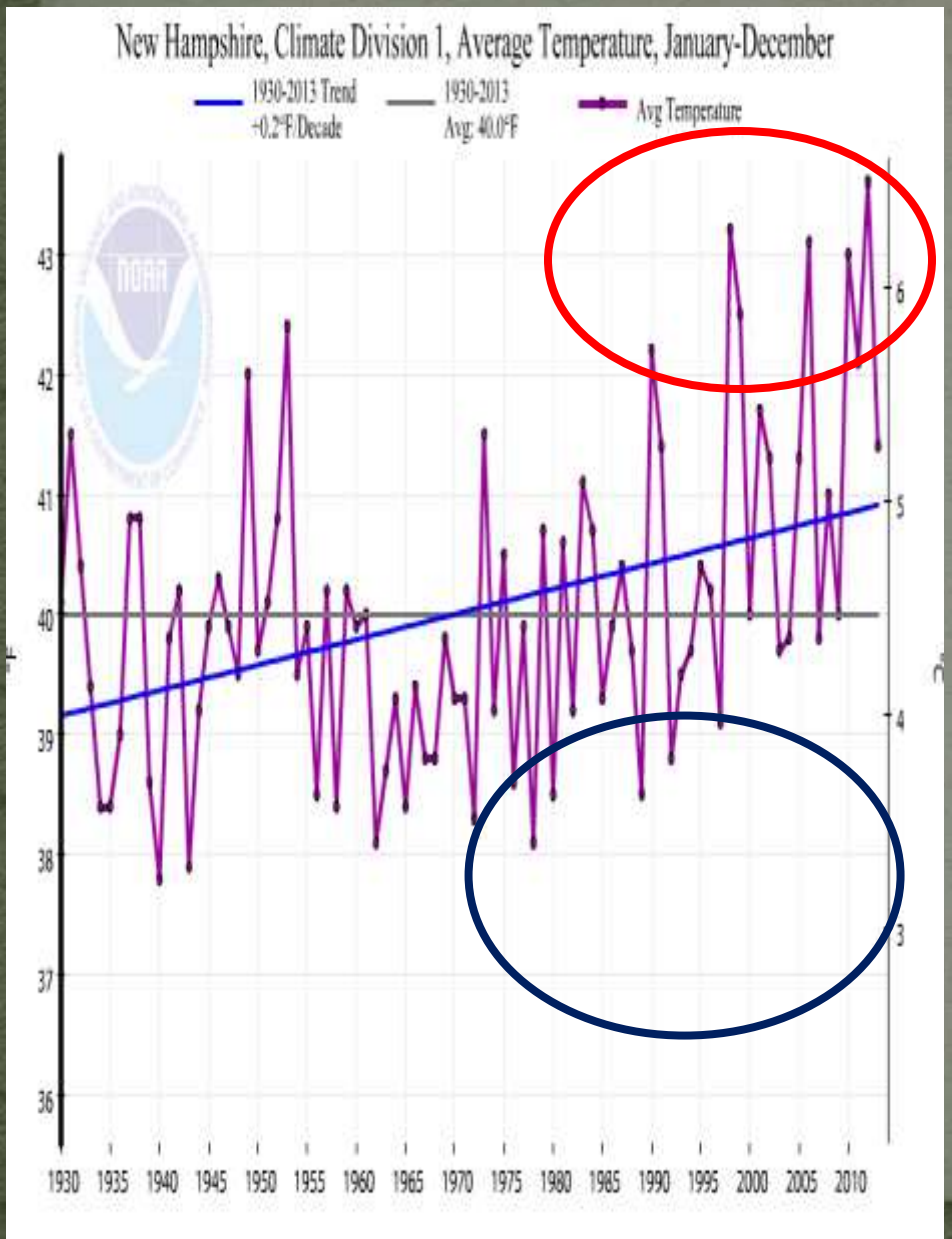
I-95 in Warwick with submerged Warwick Waste Water Treatment Facility March 31, 2010 – photo from RI ANG)

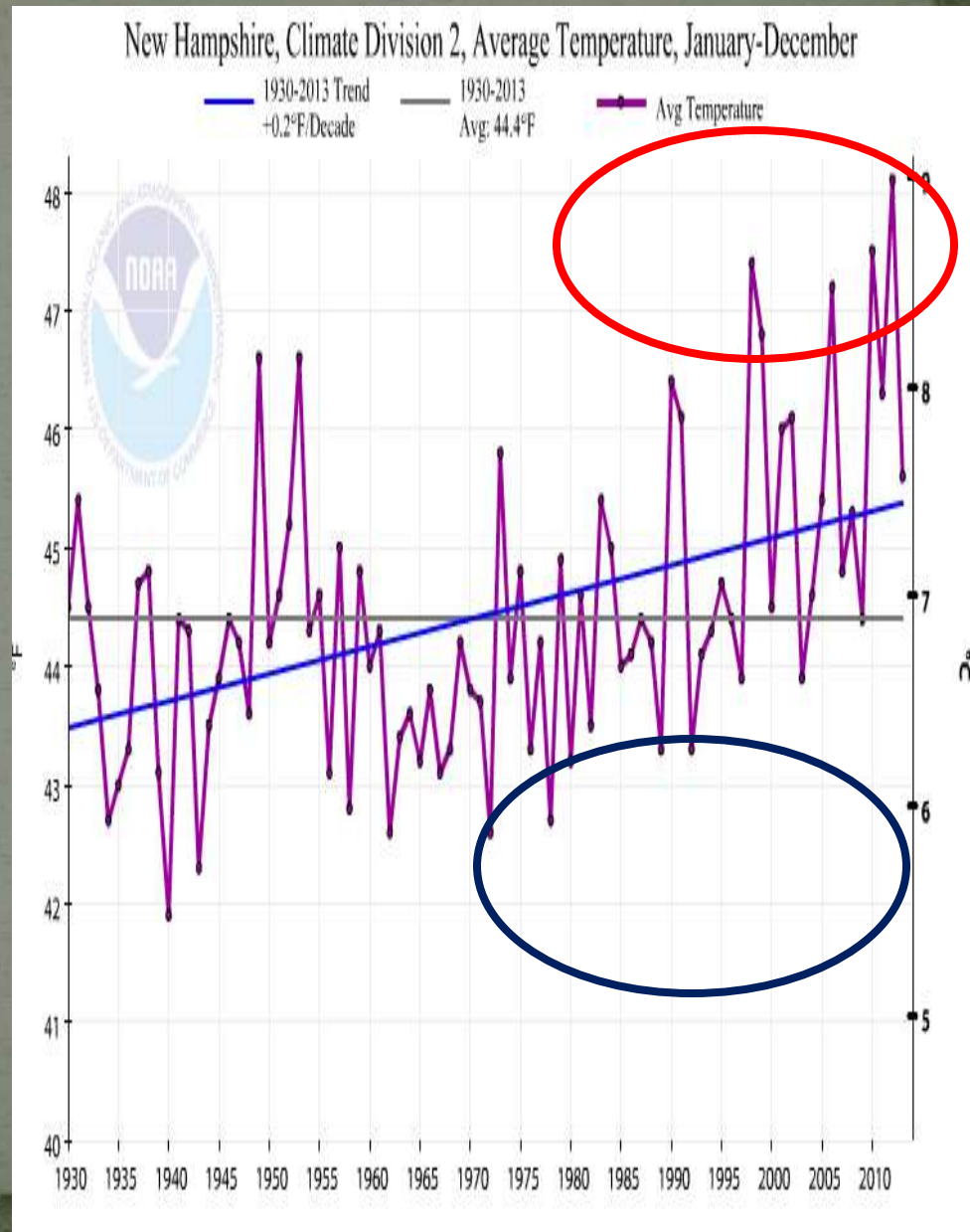
Trends in U.S. Temperature:
Decadal trends and 1991-2011 relative to 1901-1960



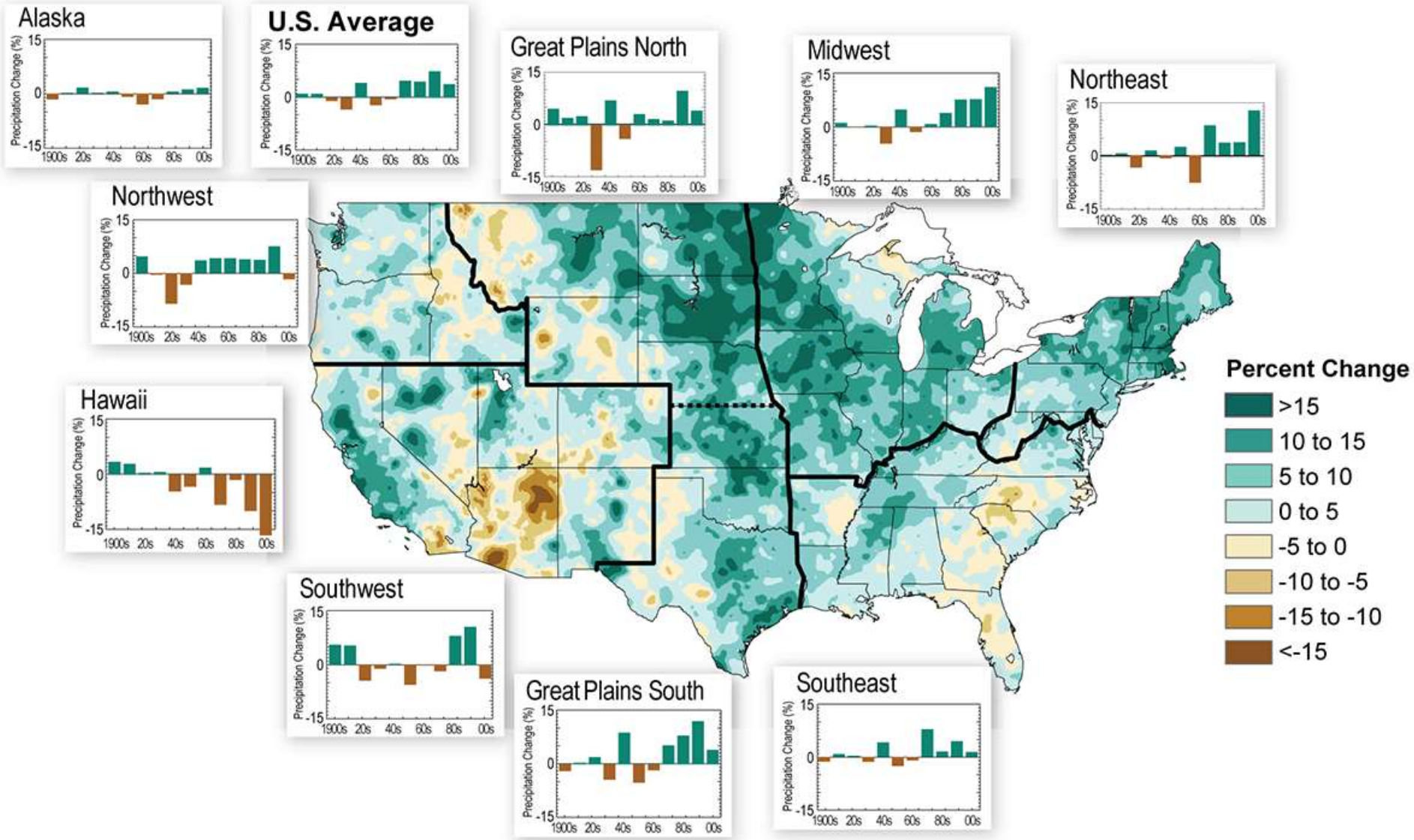
A Look at Temperature and Precipitation Trends

http://www.ncdc.noaa.gov/cag





Trends in U.S. Precipitation:
Decadal trends and 1991-2011 relative to 1901-1960



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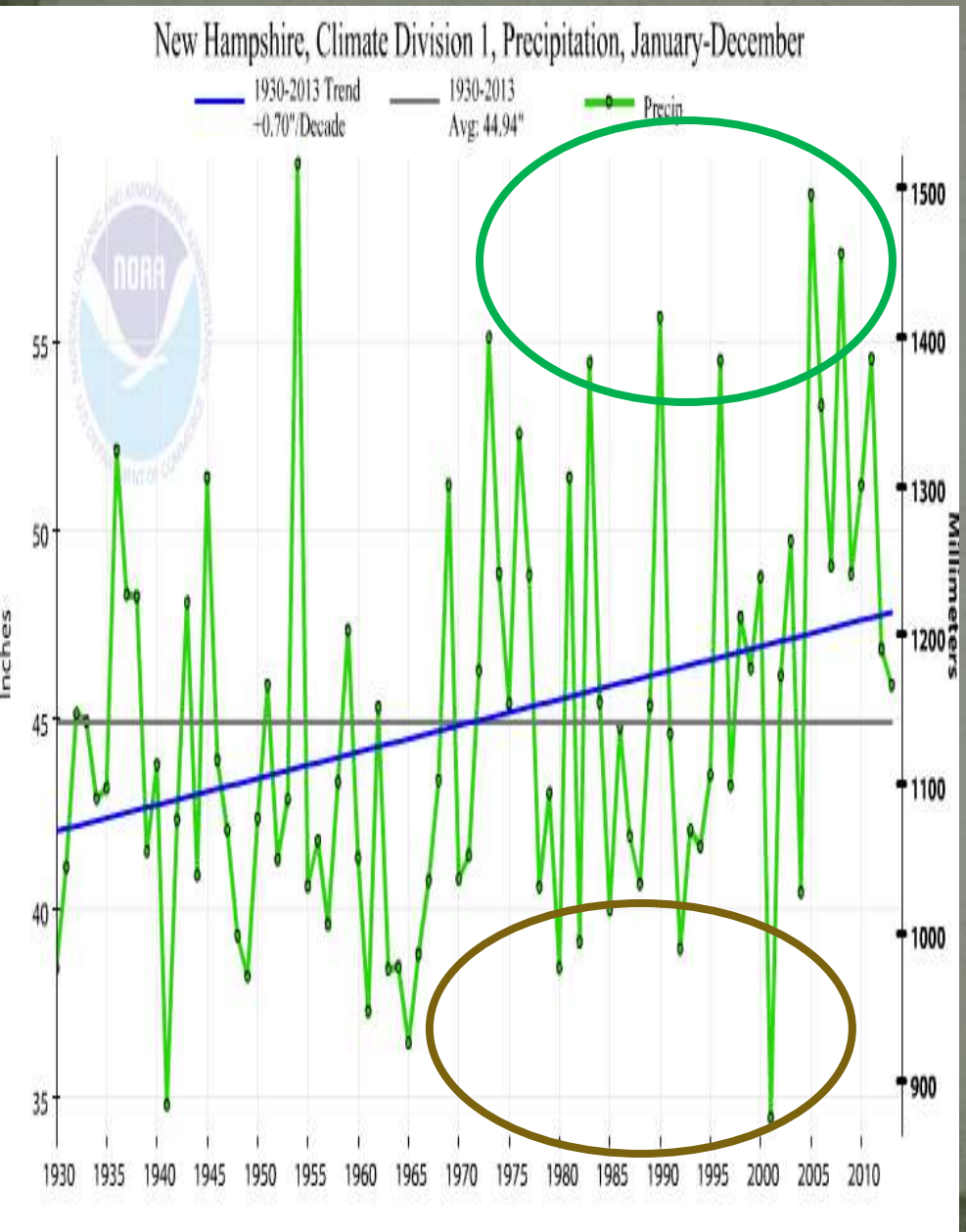
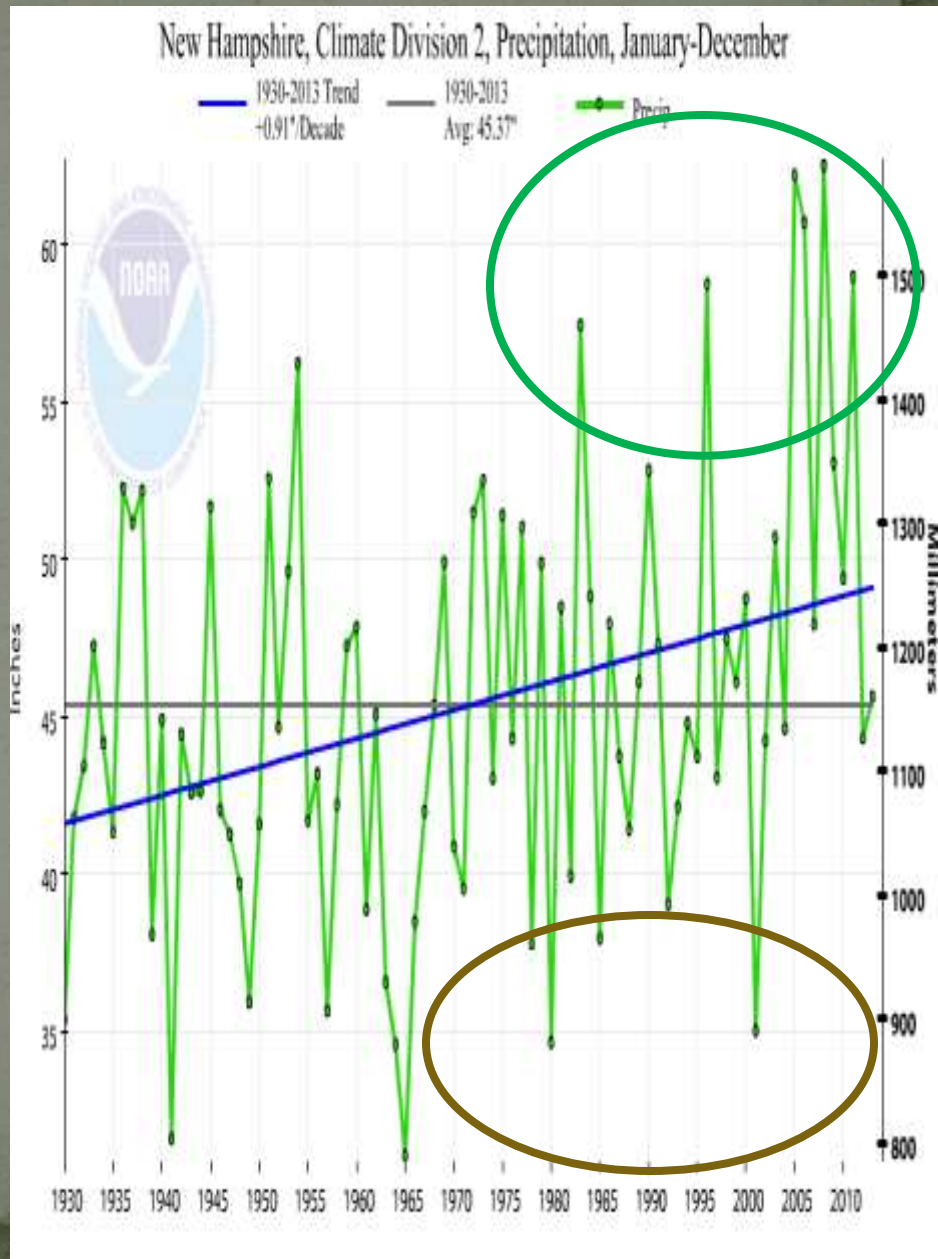
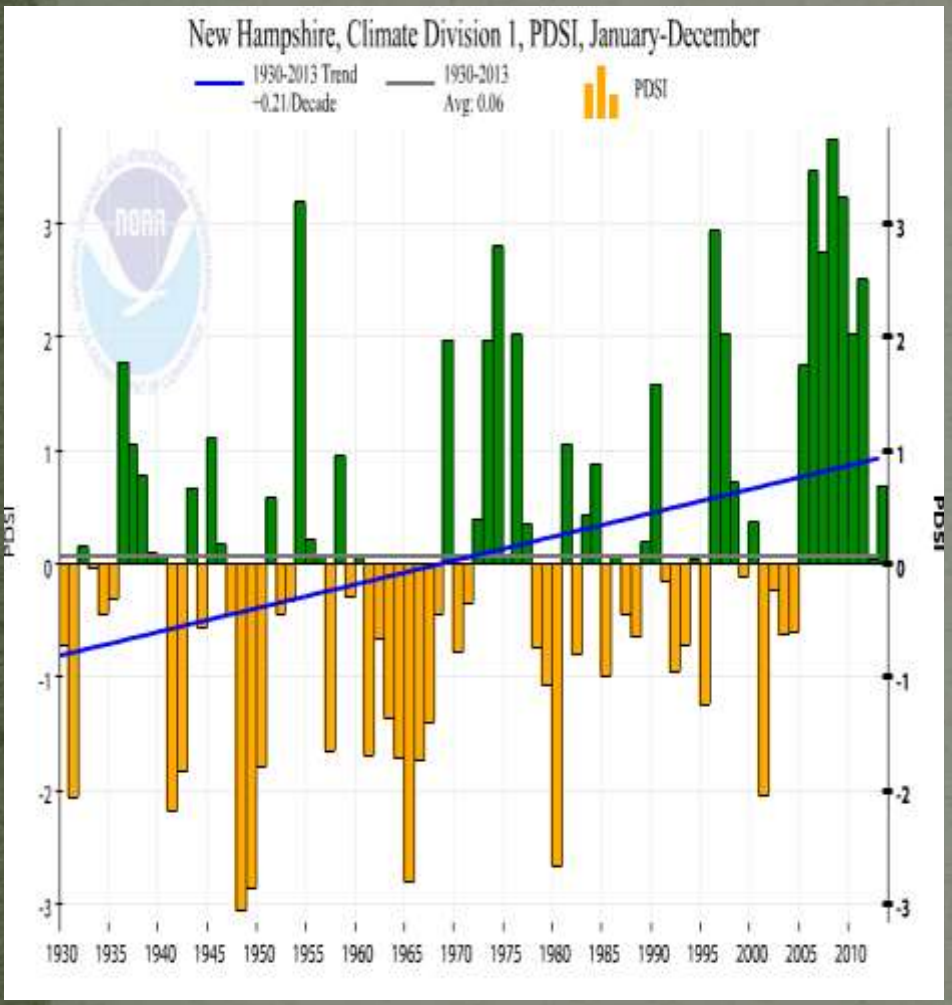
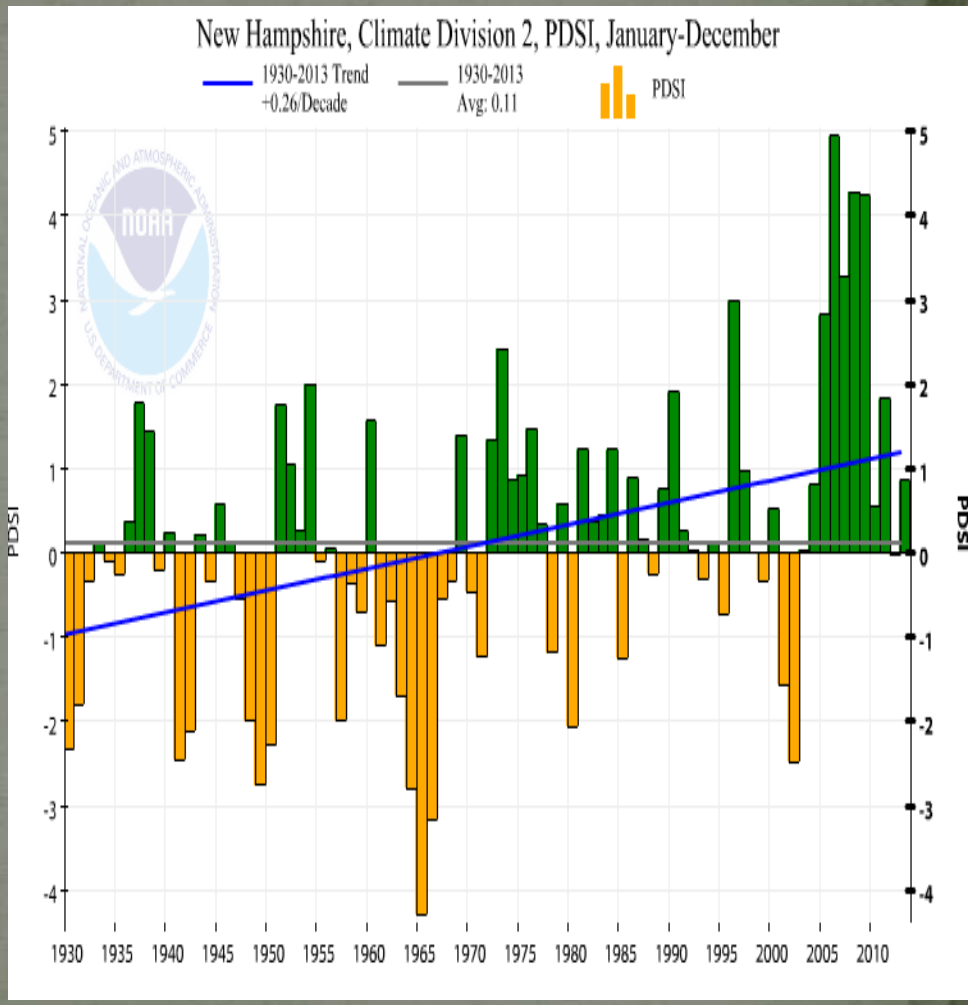




Notice changes in the Palmer Drought Index – per NCDC database

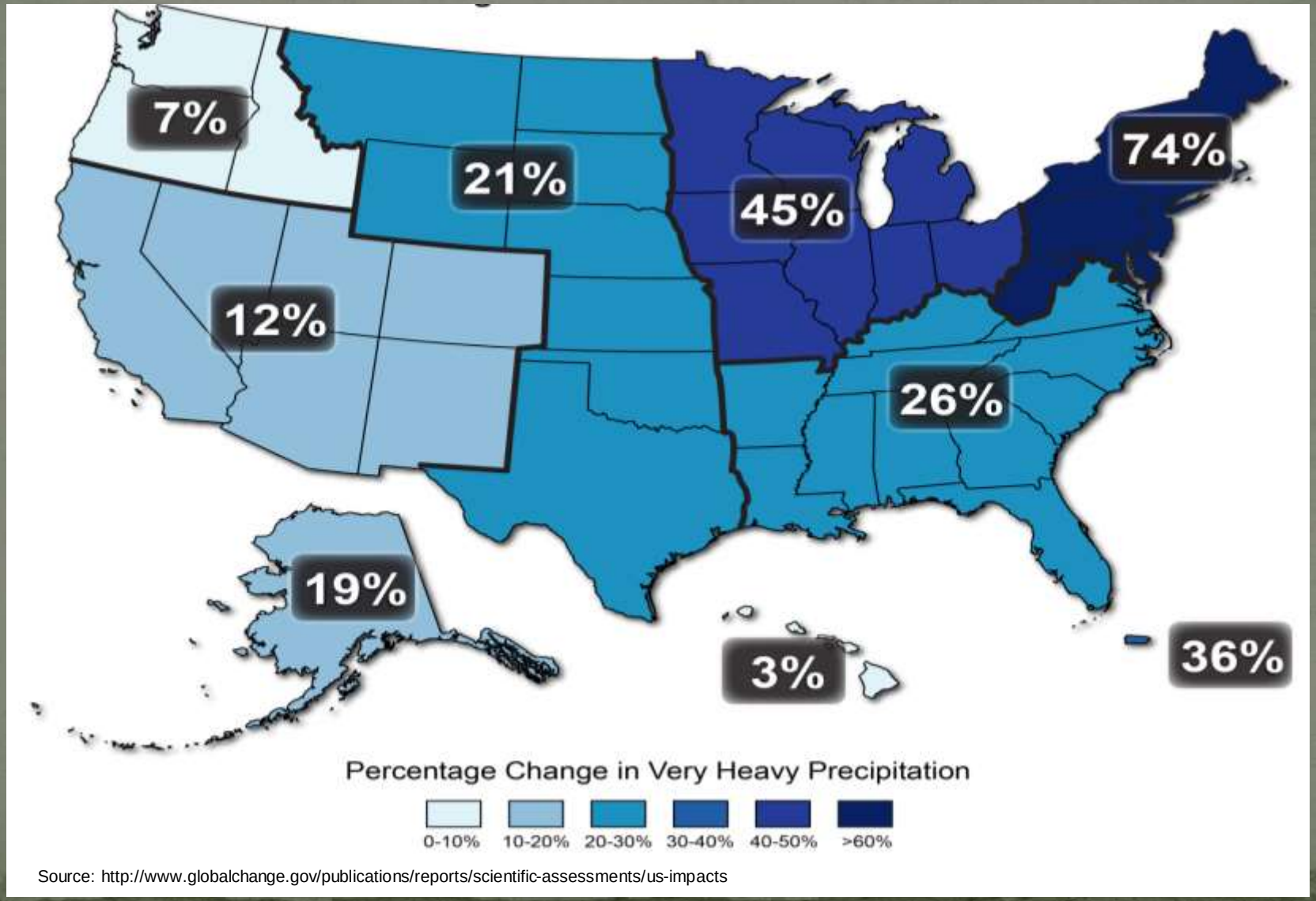




Since the late 60s, similar signature of much shorter, less intense dry periods and longer higher amplitude wet periods

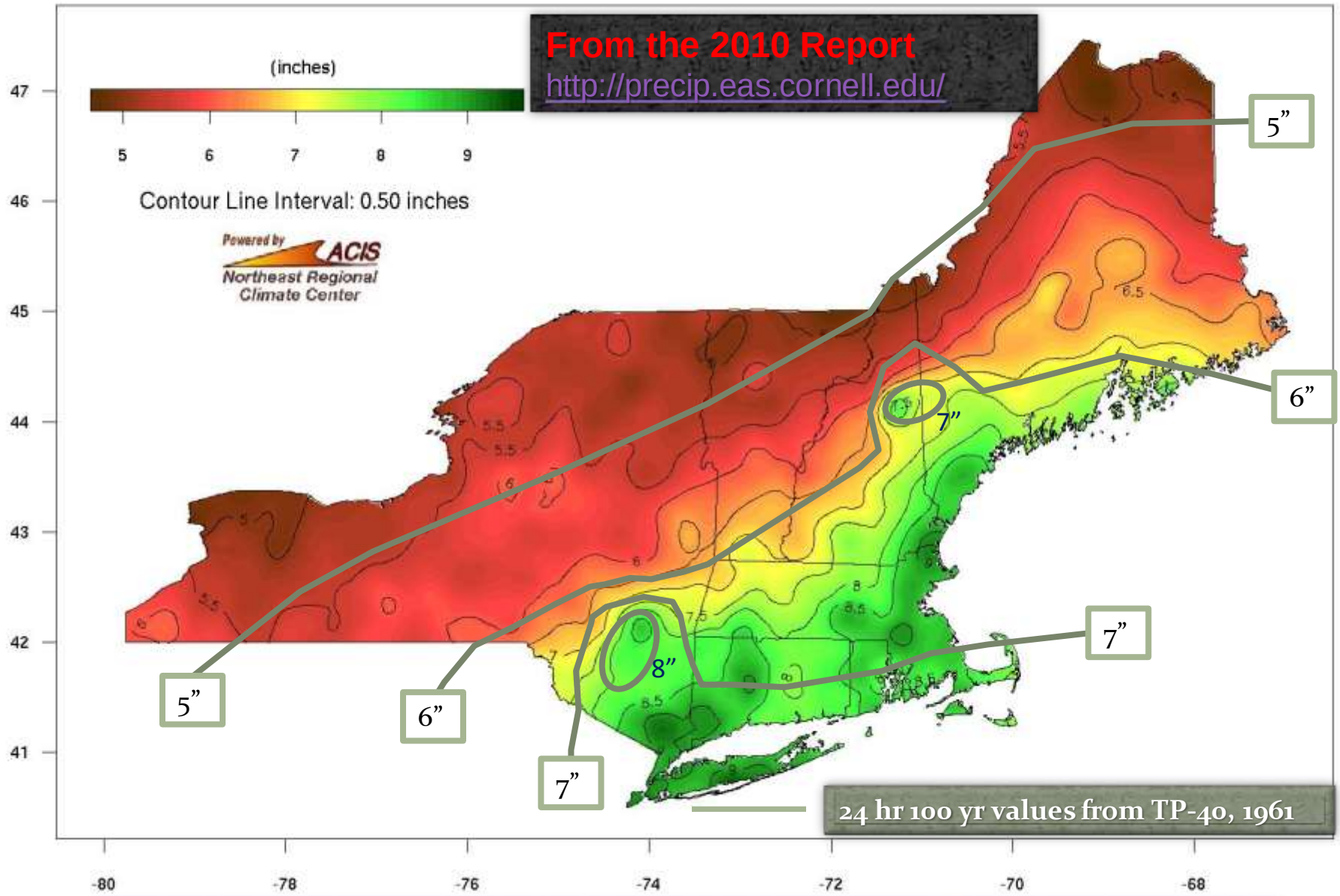
Change in Precipitation Patterns

Intense precipitation events (the heaviest 1%) in the continental U.S. increased by 20% over the past century while total precipitation increased by 7%.



Source: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

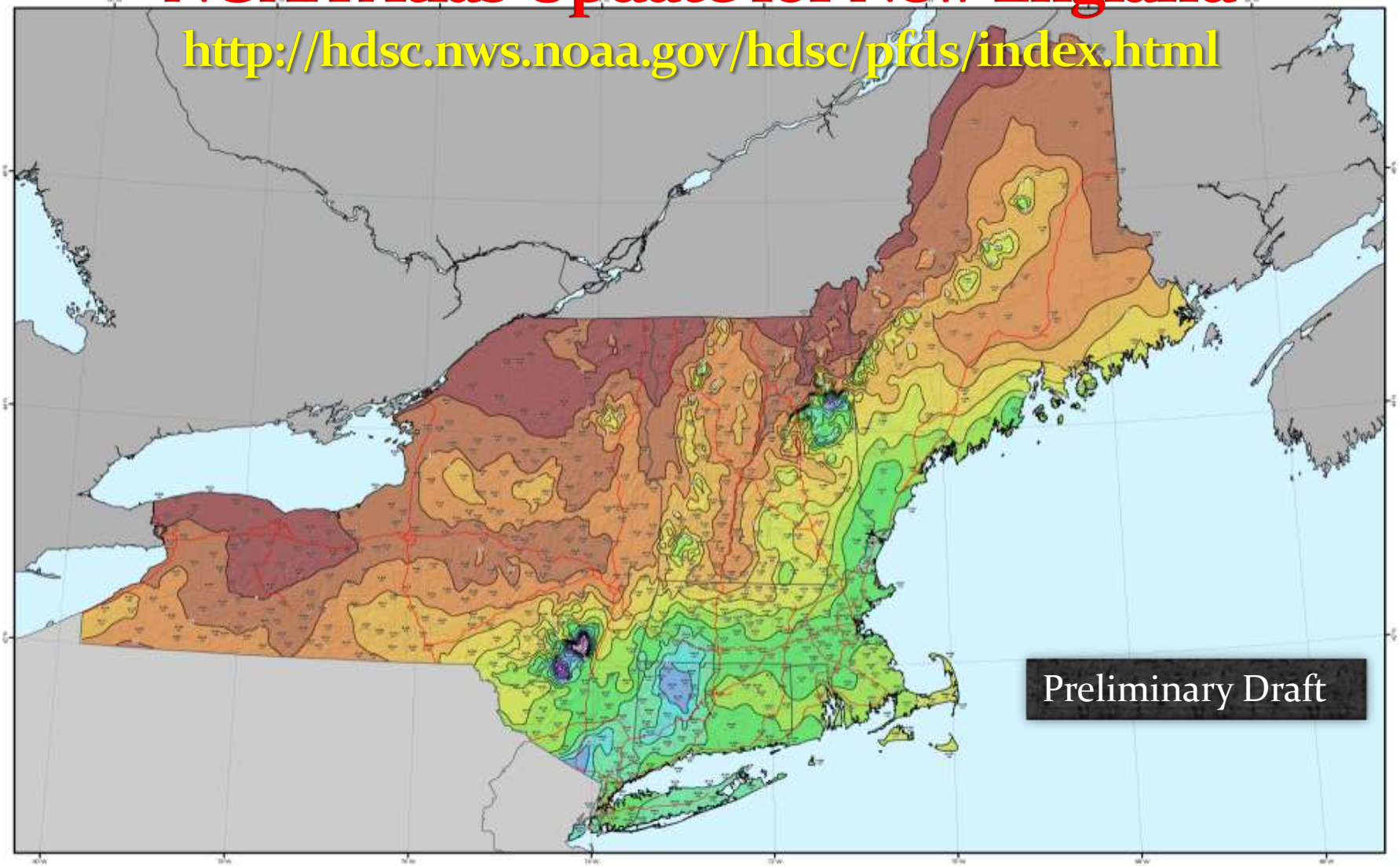
Extreme Precipitation Estimates
24hr 100yr



Southeast ½ of NE experience a 1 to 2 inch upward shift!

NOAA Atlas Update for New England

http://hdsc.nws.noaa.gov/hdsc/pfds/index.html



CONNECTICUT, MAINE, MASSACHUSETTS, NEW HAMPSHIRE, NEW YORK, RHODE ISLAND, VERMONT

NOAA Atlas 14, Volume 10, Version 1
Northeastern States

Prepared by U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
OFFICE OF HYDROLOGIC DEVELOPMENT
HYDROMETEOROLOGICAL DESIGN STUDIES CENTER
September 2014

Isopluvials of 100-year 24-hour precipitation in inches

N

SCALE 1:2,500,000

4.50 - 5.00	7.51 - 8.00	10.51 - 11.00
5.01 - 5.50	8.01 - 8.50	11.01 - 11.50
5.51 - 6.00	8.51 - 9.00	11.51 - 12.00
6.01 - 6.50	9.01 - 9.50	12.01 - 12.50
6.51 - 7.00	9.51 - 10.00	12.51 - 12.97
7.01 - 7.50	10.01 - 10.50	

Trends in Flood Frequency:
From the Practitioner's perspective

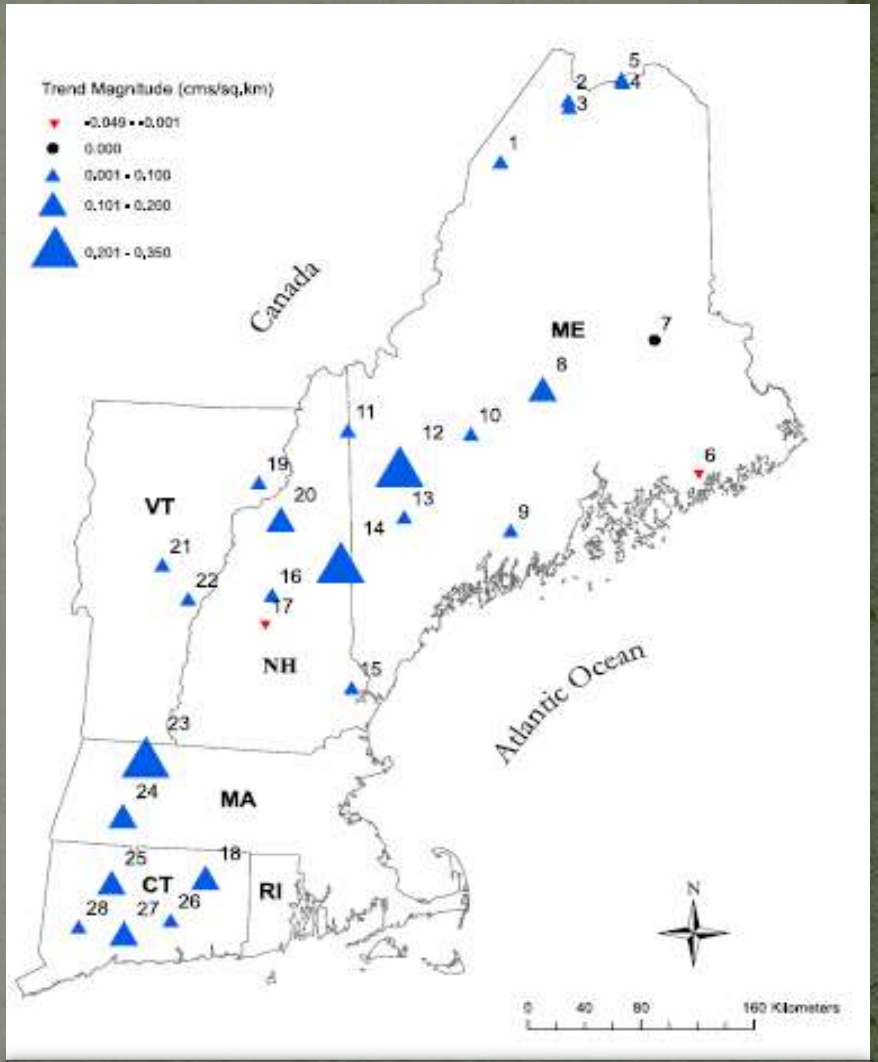
- Small watersheds feeling the effects
  - Changes in frequency/magnitude
  - Part land use/urbanization
    - Compounded by encroachment in the floodplain
  - Part changing climate
- Larger basins with flood control haven't seen as noticeable a shift
  - Most USACE reservoirs are built for 6-8 inch runoff events
  - Greater capacity to handle more rain

Perkins Avenue, Warwick, RI
Tuesday, March 30, 2010


Flooding along the Housatonic River following Lee, Sept 8, 2011.
Photo: A. Driscoll, Connecticut Post

Instantaneous peak flows

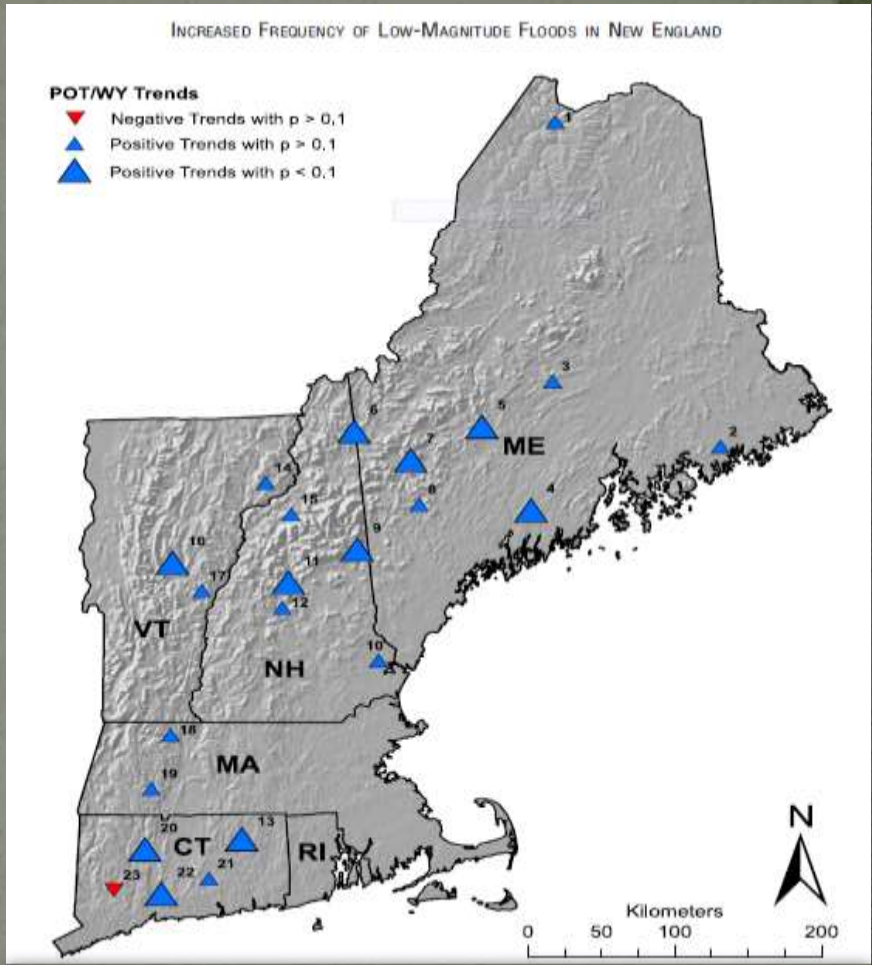
- Mathias Collins – NOAA NFMS – Restoration center
  - 2009 study of 28 watersheds with minimal human influences
  - Results indicate basins in central and western Maine experienced increased peak annual flows
    - Strongest statistical trends noted by the large blue triangles



Spatial distribution of trend directions & magnitudes for based with minimal human influences.
Reference: *M. Collins, Journal of The American Water Resources Association (JAWRA) April 2009.*

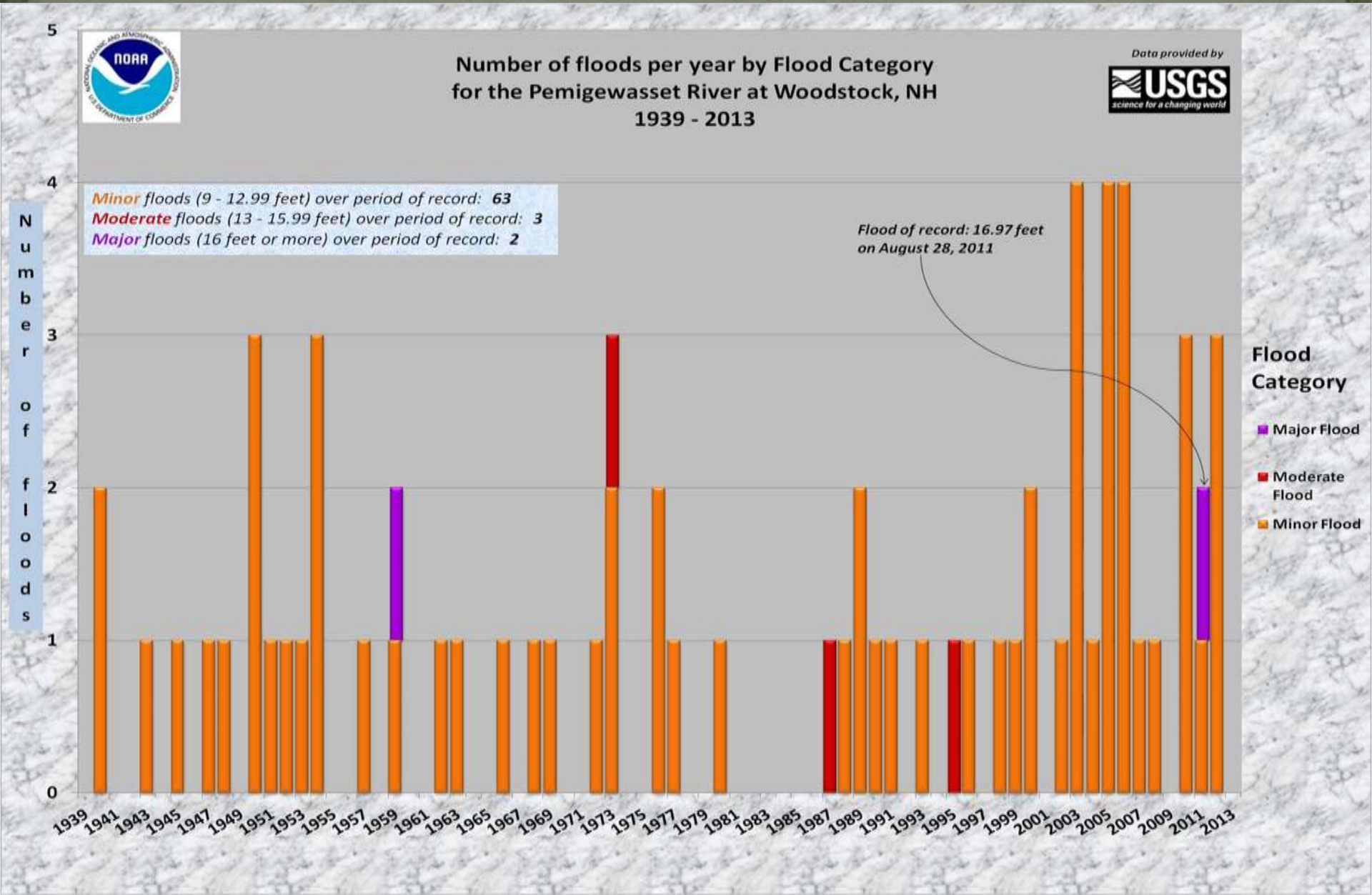
Increased low magnitude floods

- Mathias Collins – NOAA NFMS – Restoration center
  - 2011 study of 23 watersheds with minimal human influences
  - Examined peaks over defined thresholds per water year (direct measure of flood frequency)
  - More frequent flooding at 22 of 23 locations
  - Increasing flood magnitude at 17 of 23 locations



Spatial Distribution of Flood Frequency – as measured by peaks over threshold per water year.
Reference: W. Armstrong, M. *Collins, and N. Snyder Journal of The American Water Resources Association (JAWRA) April 2011.*

Examining Flood Frequency& Magnitude of flood events at NWS forecast points



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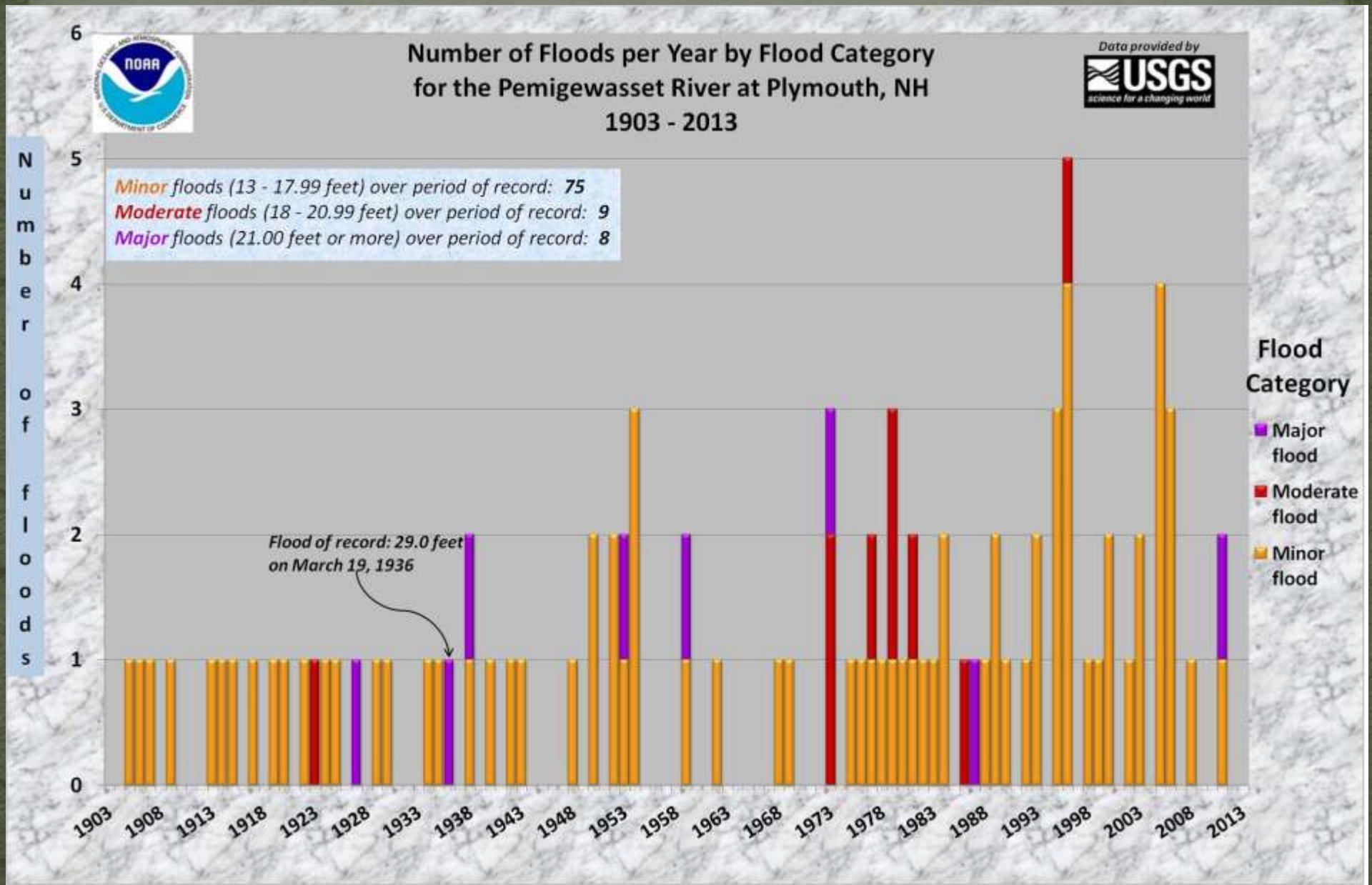

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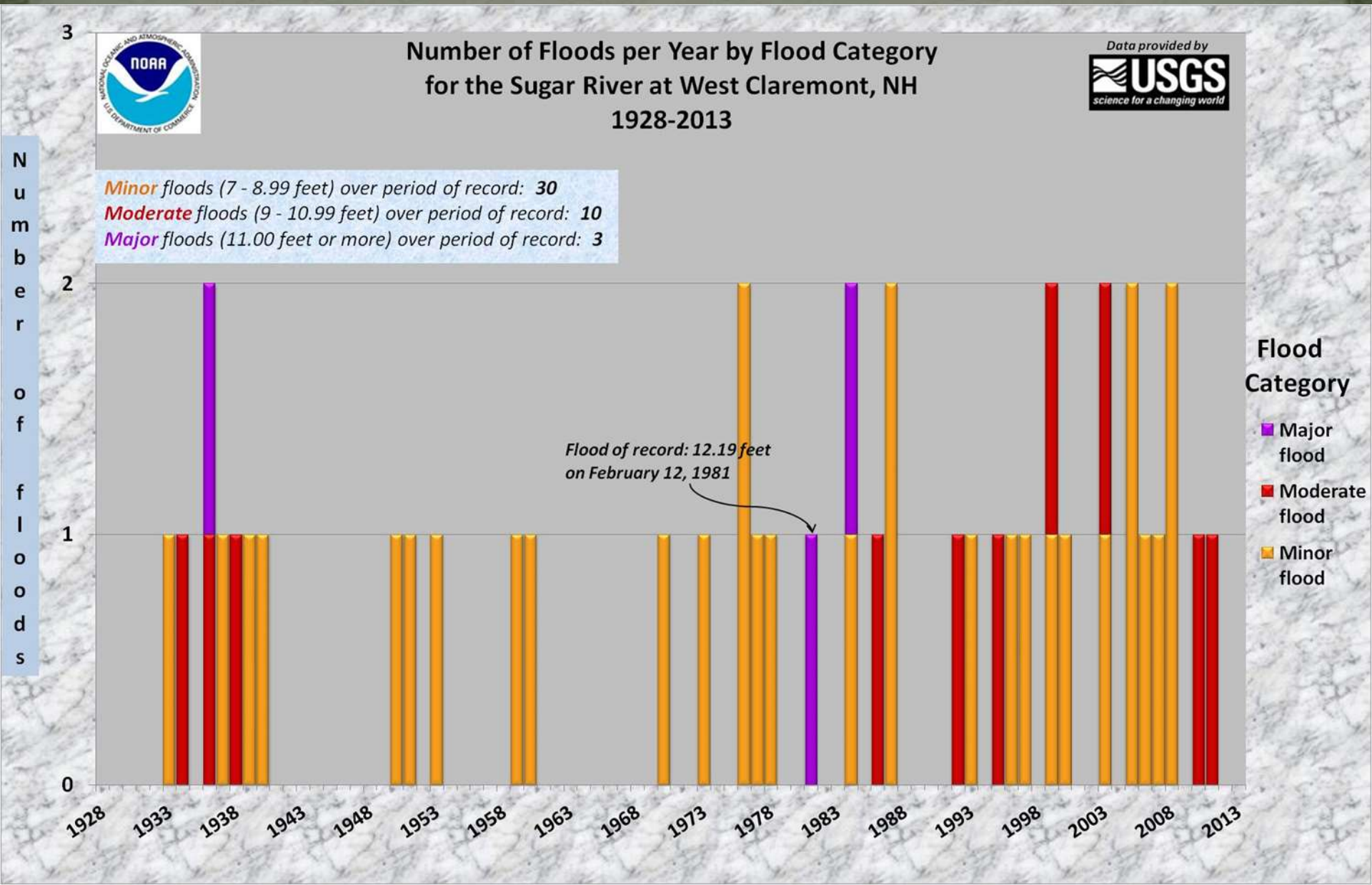
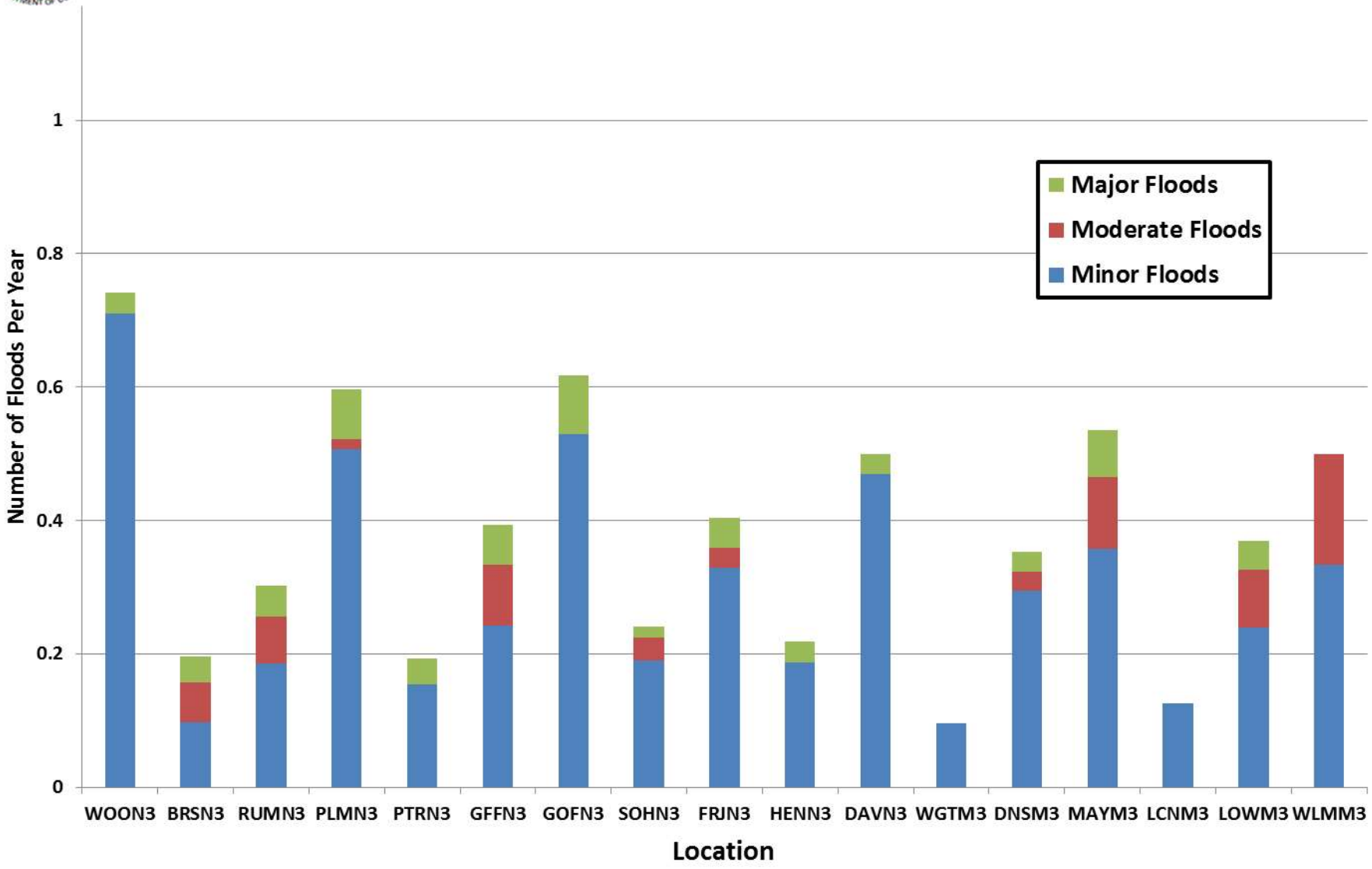


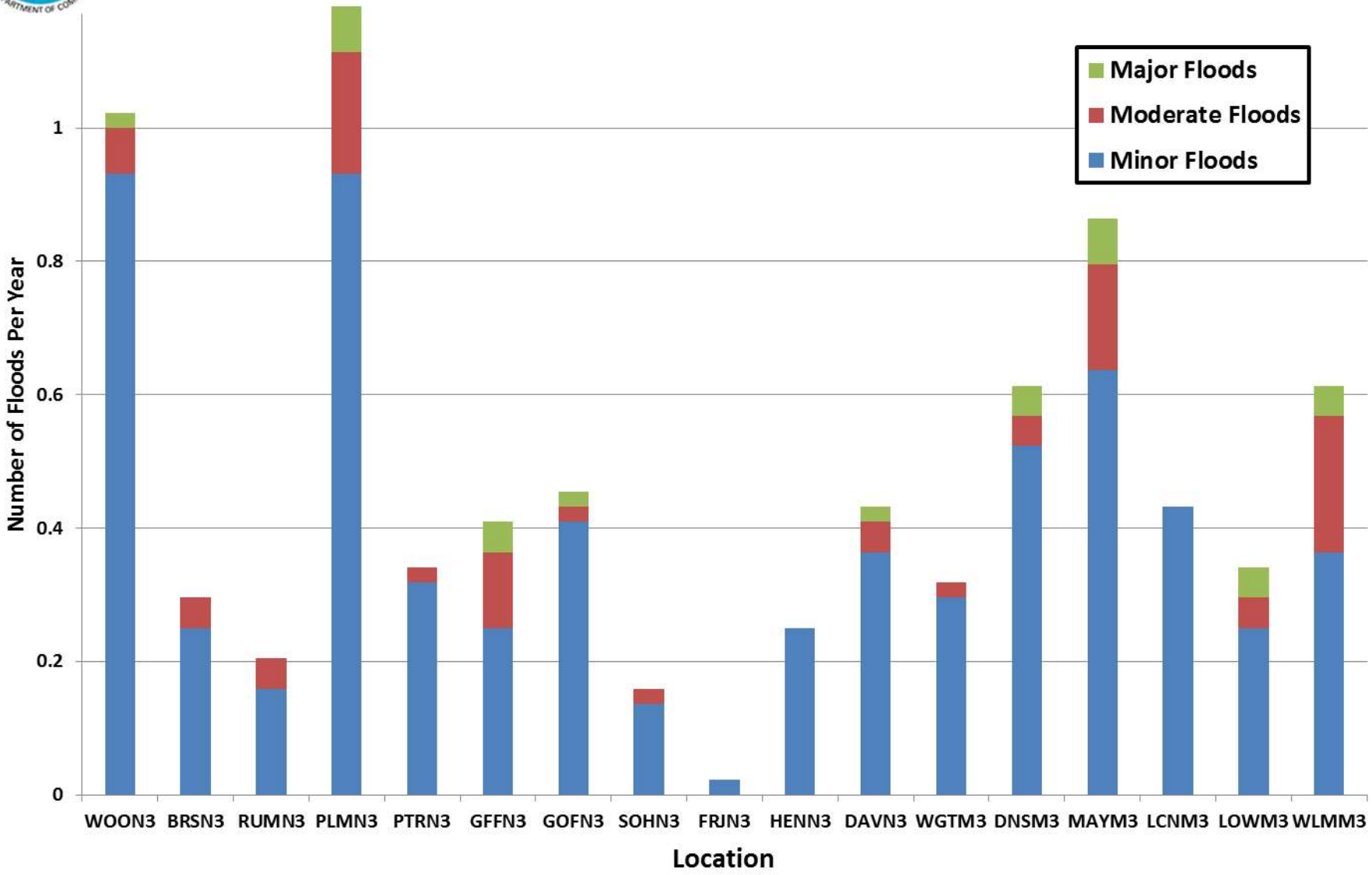
Merrimack River Basin Normalized Number Of Minor, Moderate, & Major Floods Per Year Prior to 1970

Data provided by USGS science for a changing world



Merrimack River Basin Normalized Number Of Minor, Moderate, & Major Floods Per Year from 1970 - 2013

Data provided by USGS science for a changing world

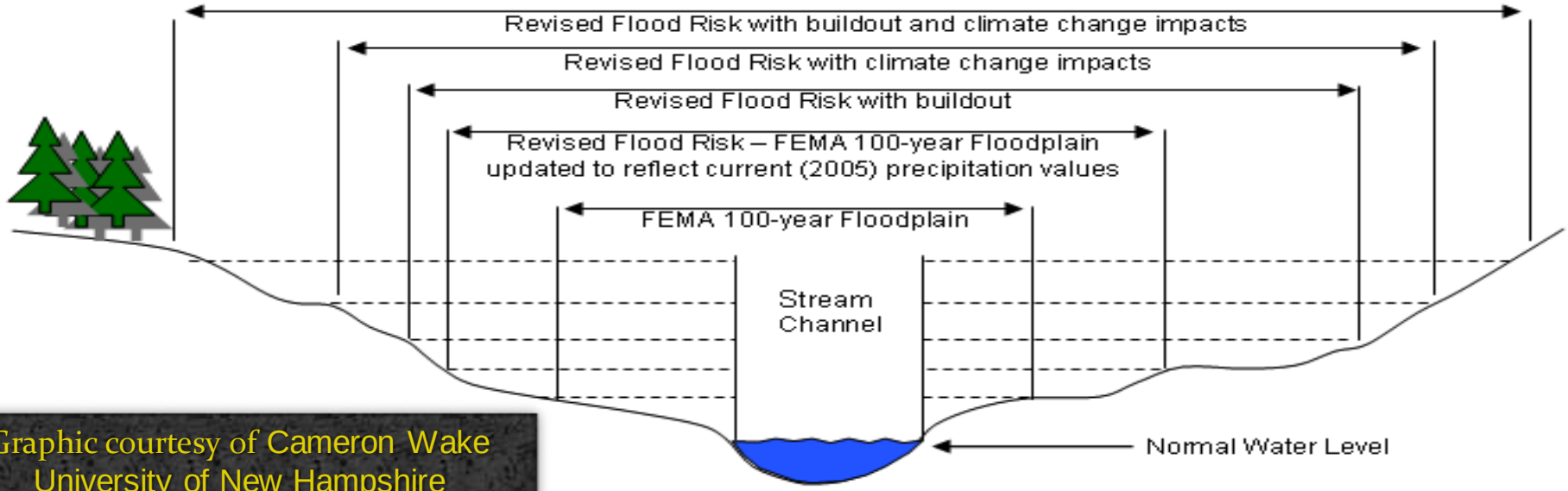


Summary

- The Northeast has become a “hot spot” for record floods & heavy rainfall in the past 10 years
- Noticeable trends include increased yearly rainfall and increased annual temperatures
  - Southeast New Hampshire has experienced a 1.5 to 2.5 inch shift upwards in the 100 yr – 24 hour rainfall
- Smaller watersheds & those with significant urbanization are most vulnerable to increased river & stream flooding

Far reaching implications:
Protect, Adapt or Retreat???

- Floodplain, land use, infrastructure, dam spillway requirements, drainage requirements, non-point source runoff, bridge clearances, "hardening" of critical facilities in the floodplain, property values etc…
- Flood Insurance – work to increase participation
- How much risk are we willing to insure and accept?



Graphic courtesy of Cameron Wake
University of New Hampshire

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