RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

Exploring New Jersey's Climate Variability & Change

Presentation at the Great Swamp Watershed Association

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Professor, Department of Geography
& New Jersey State Climatologist
Rutgers University

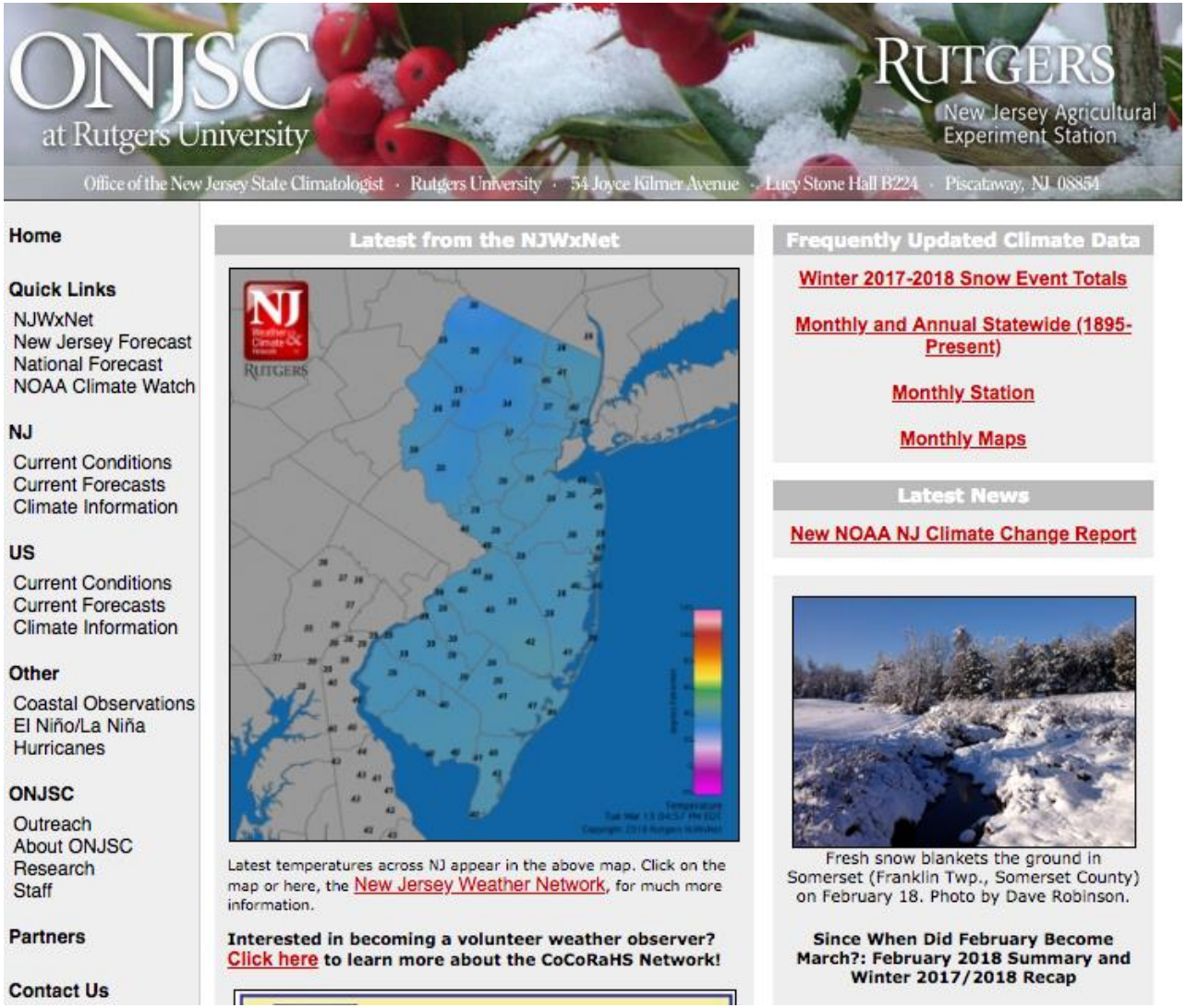
March 27, 2018

Butler, NJ 7 March 2018
(AP Photo: J. Cortez)

Greetings from the Office of the NJ State Climatologist

Helping decision makers

Locals trusting locals



Overview

1. New Jersey's weather and climate
2. Climate change, past, present…..future?
3. Impacts and potential actions

Sea Girt, NJ
1 March 2018
(J. Amberg)

Climate or Weather???

Weather refers to the short-term phenomena

Climate refers to the long-term patterns

Better yet!

Climate is your personality…..

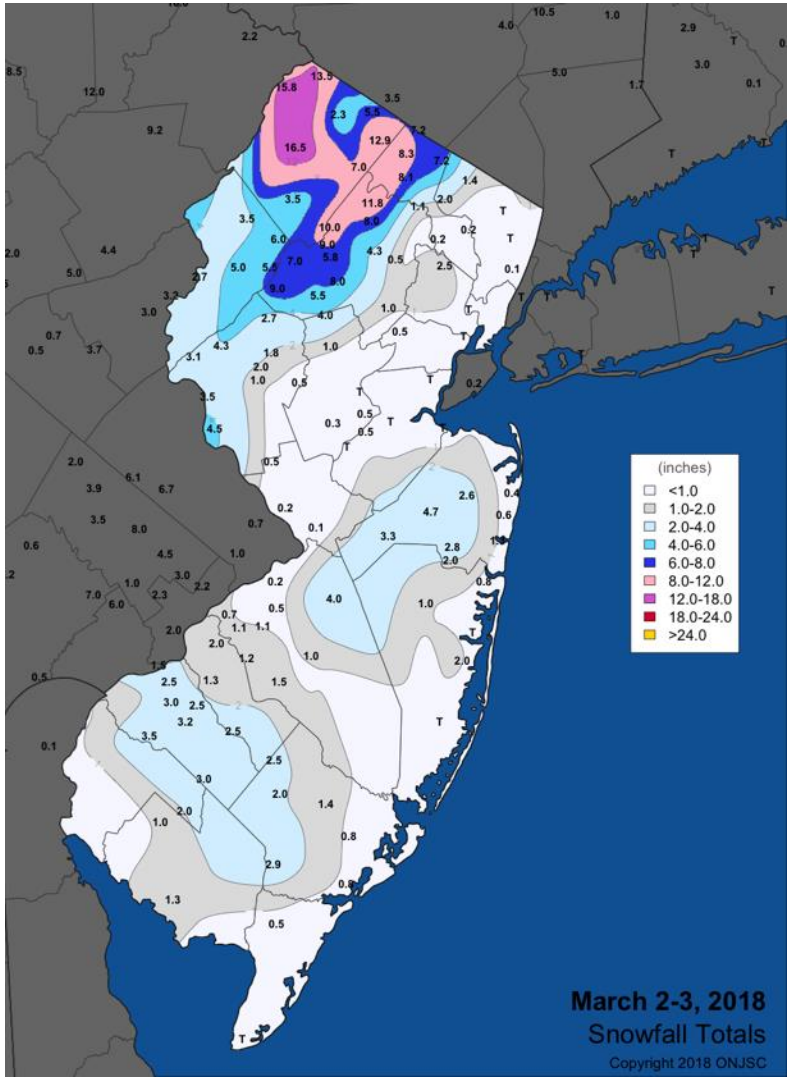
Weather is your mood……

Somerset, NJ
Afternoon of March 7

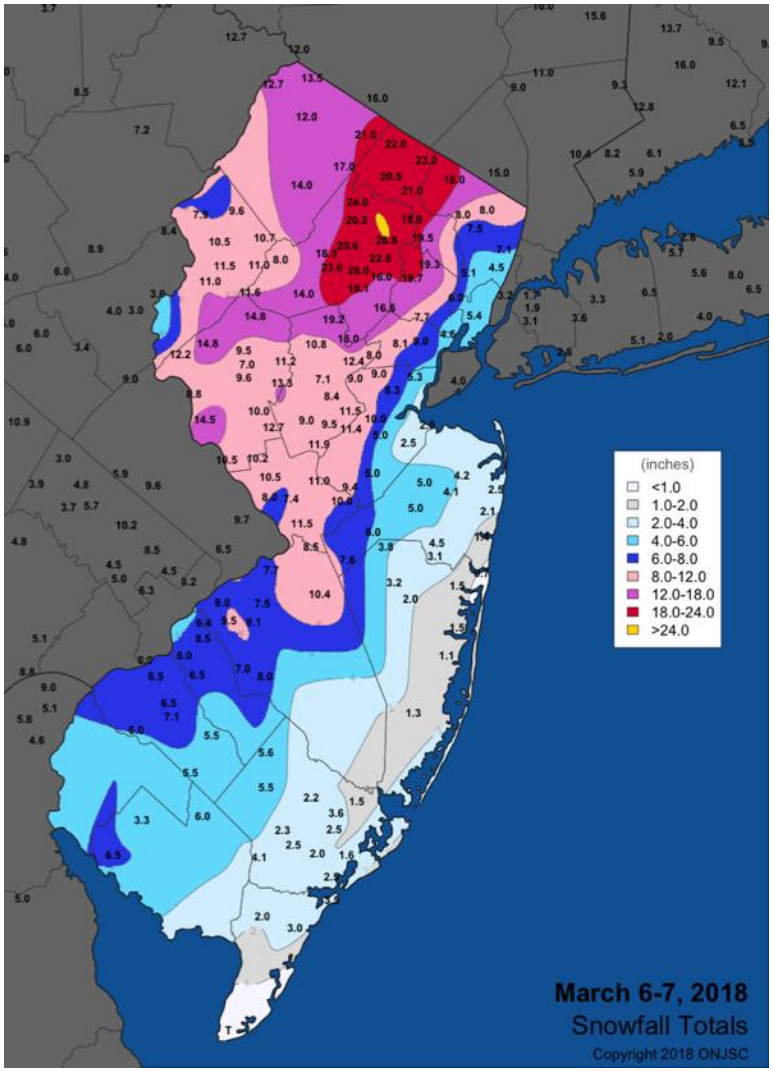
Yup, a tree “visited” the backyard during the storm.
Small dogwood was cleared off before branches broke
Photo AM 8 March

Somerset, NJ
Trees and branches, broken and down everywhere
Photo 8 March 7:30 AM

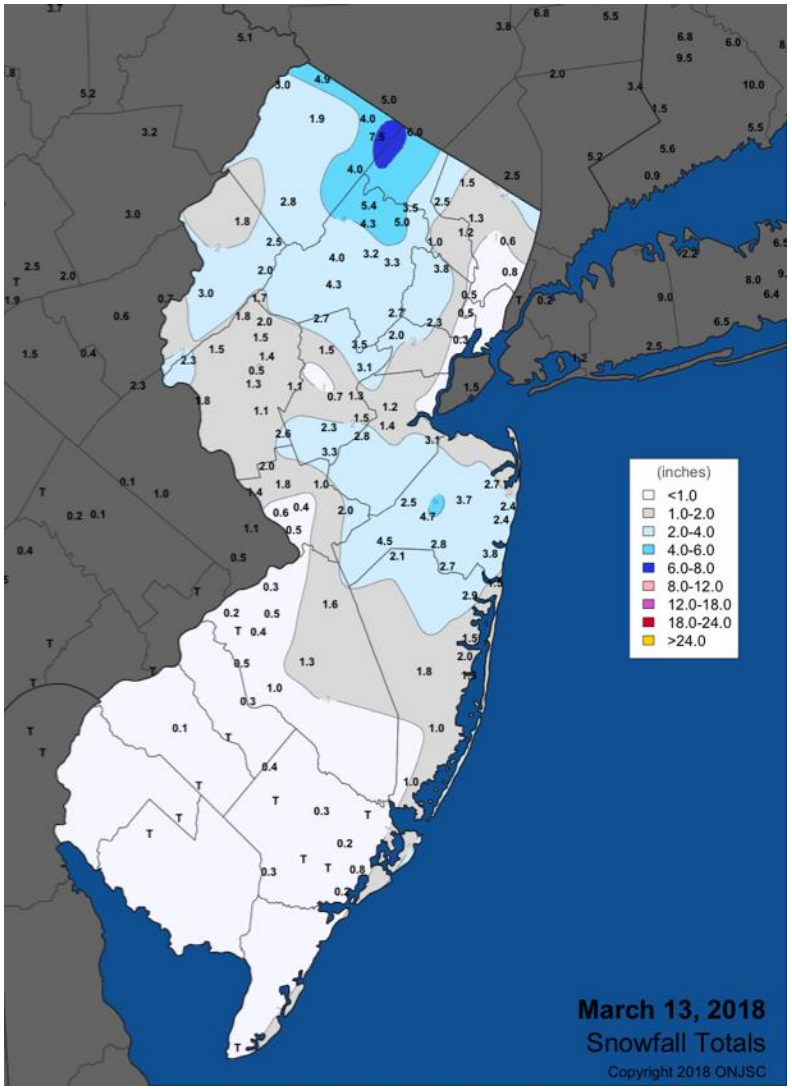
Location, location, location……
Photo taken 8 March 7:30AM….turned 180 deg from the previous photo



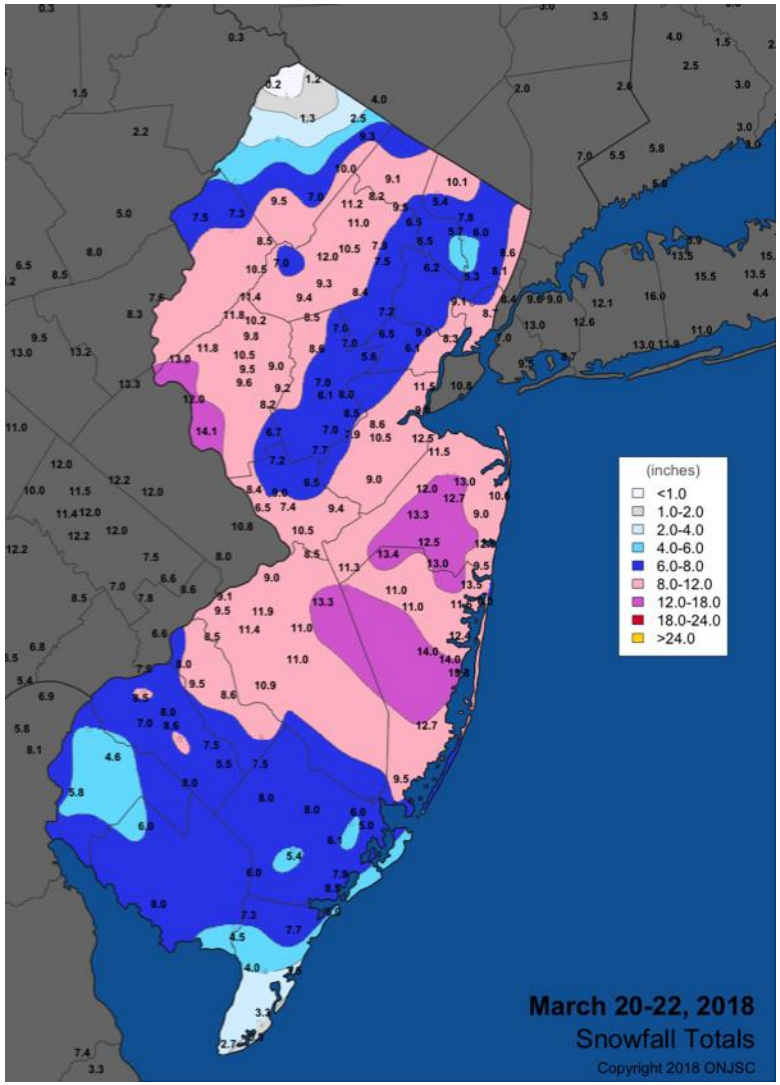
March 2-3



March 6-7

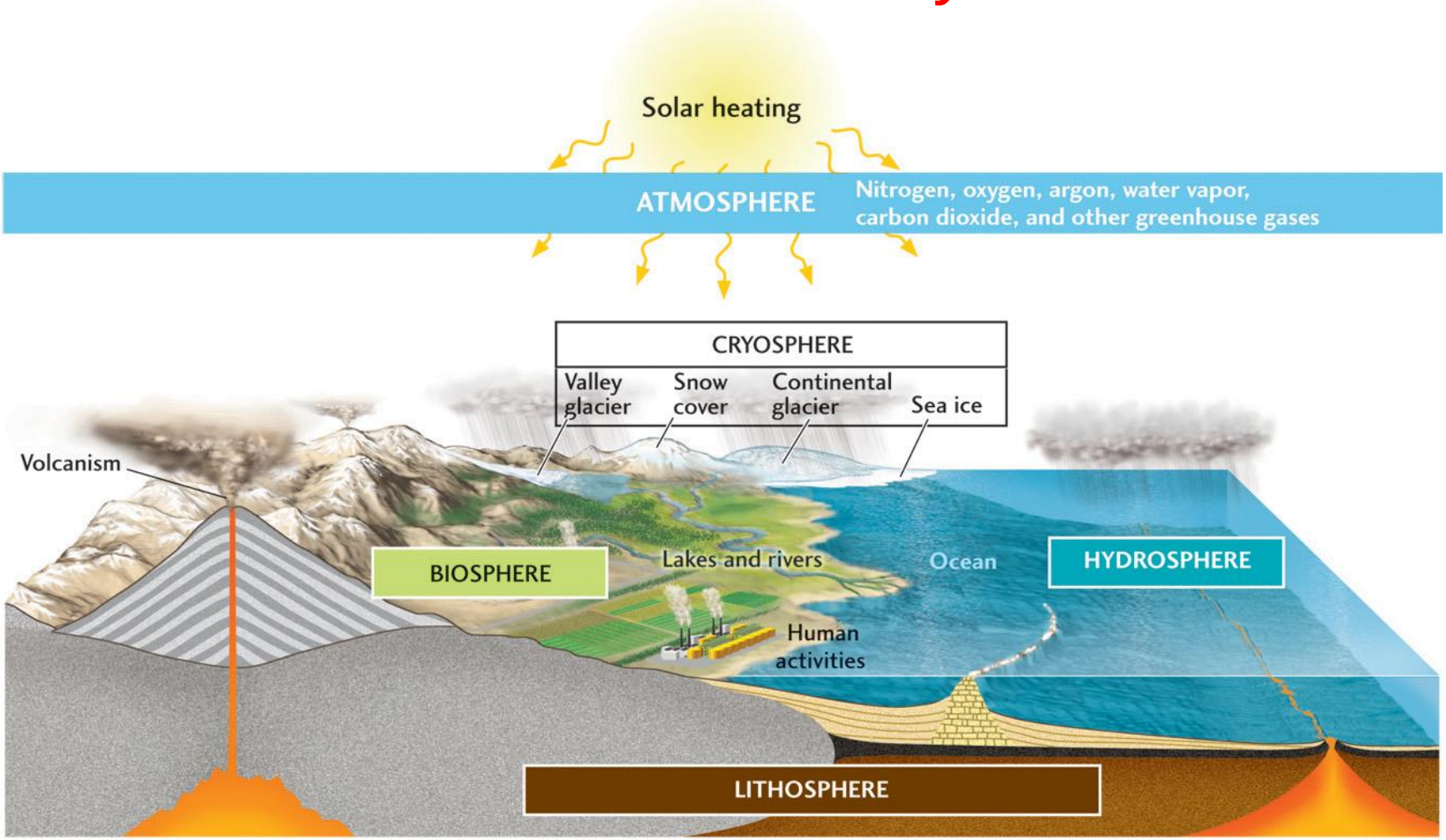


March 13

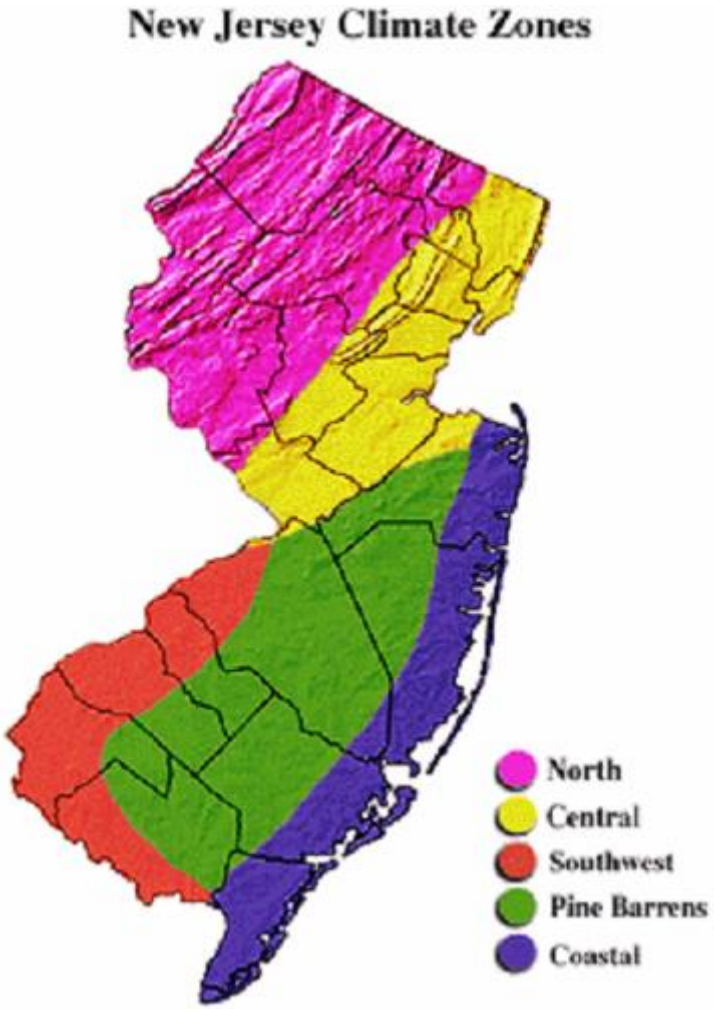


March 20-22

The Earth's Climate System

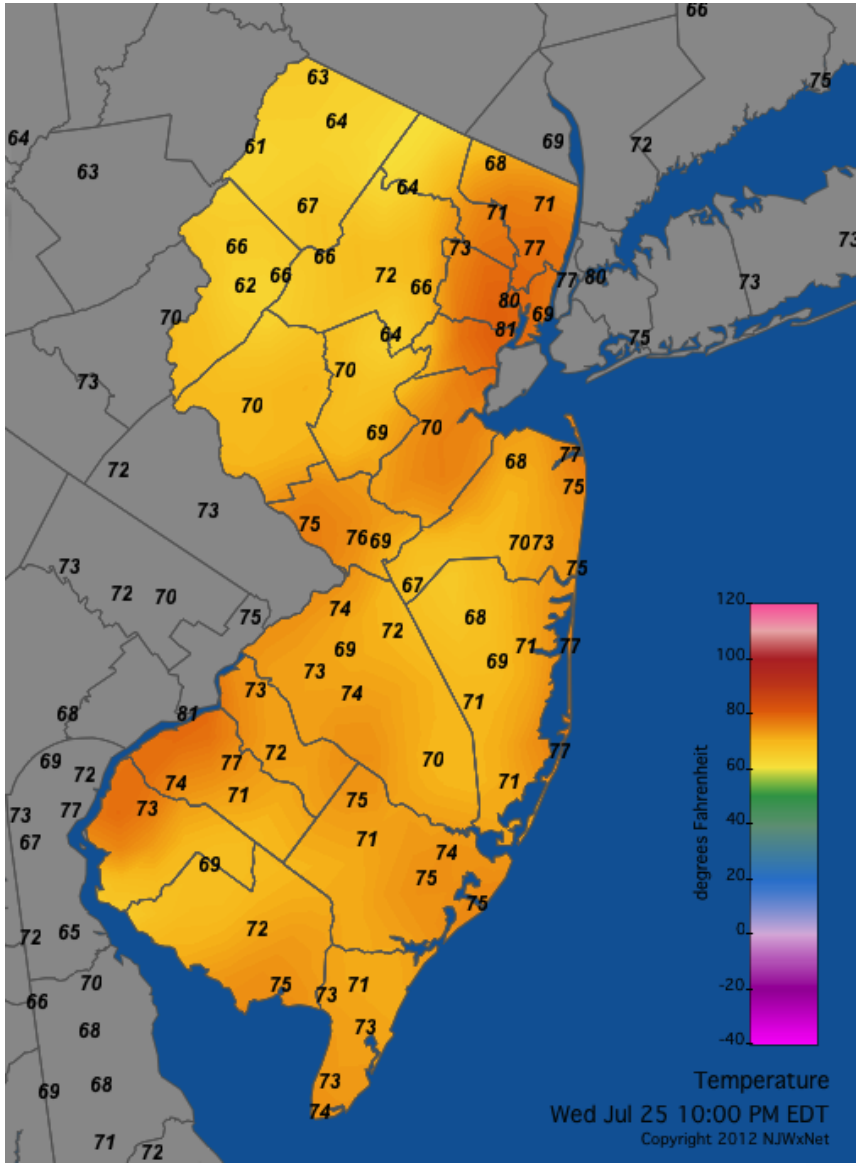


Diversity: local controls on NJ's weather and climate

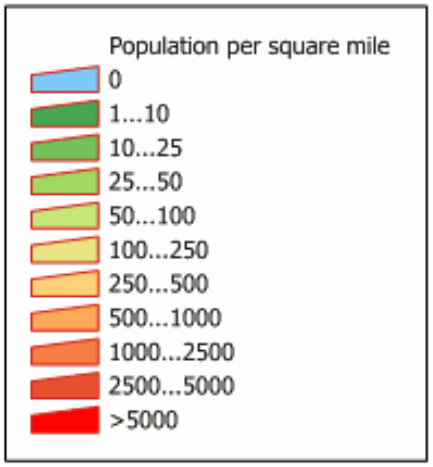


Ludlum 1983

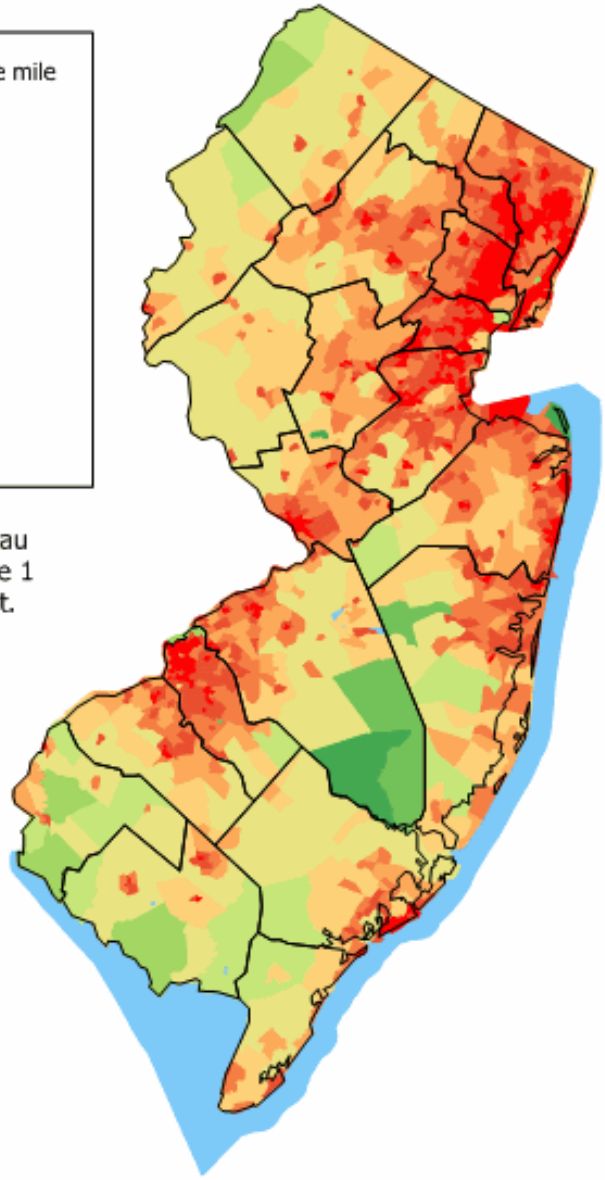
- Altitude
- Latitude
- Surface Conditions
- Land-Water Contrasts



10 PM 25 July 2012



Source: U.S. Census Bureau
Census 2000 Summary file 1
population by census tract.



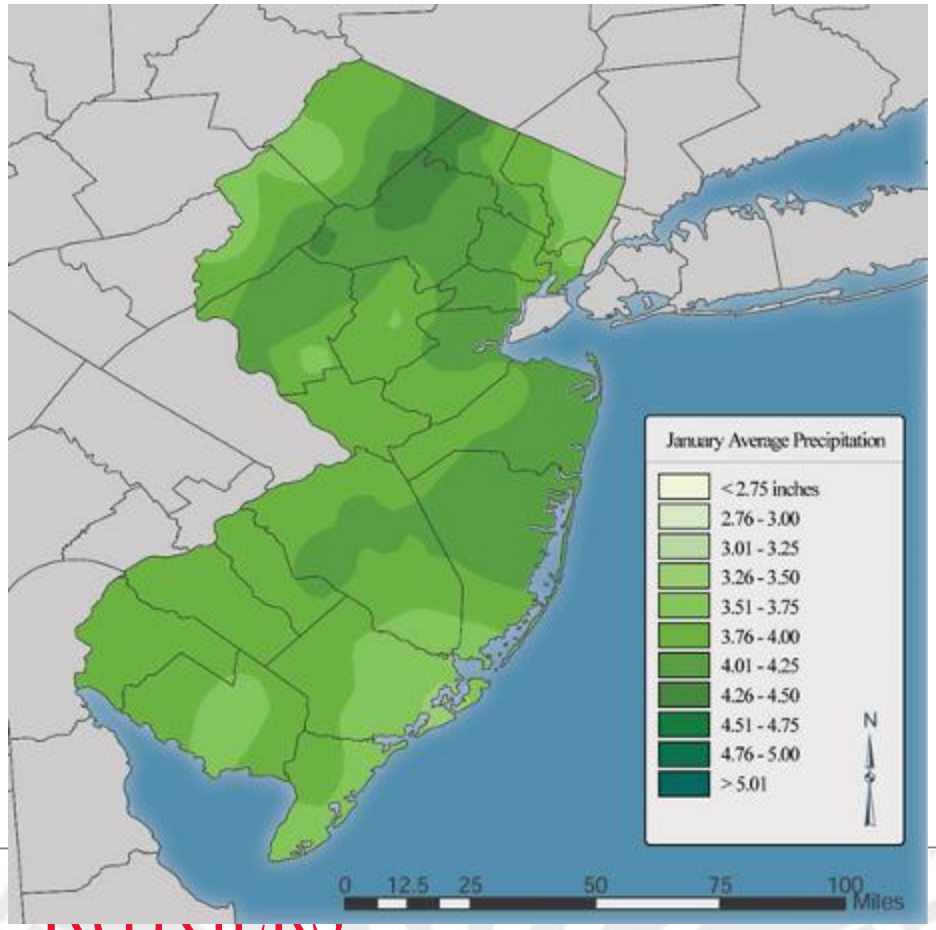
https://en.wikipedia.org/wiki/New_Jersey

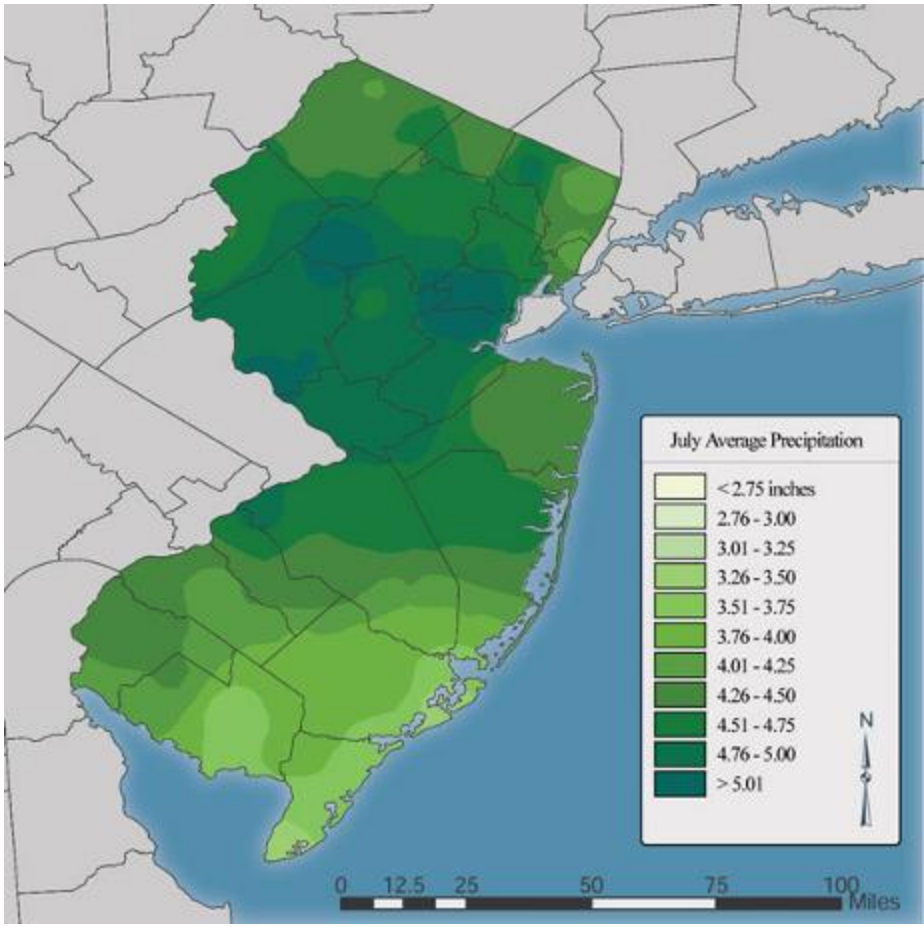
Land cover matters!

Trenton

Great Swamp

A precipitation rich state……





……most often

Sometimes too much…

Fairfield: 11 March 2011

Sometimes too much…

Boonton

Kinnelon

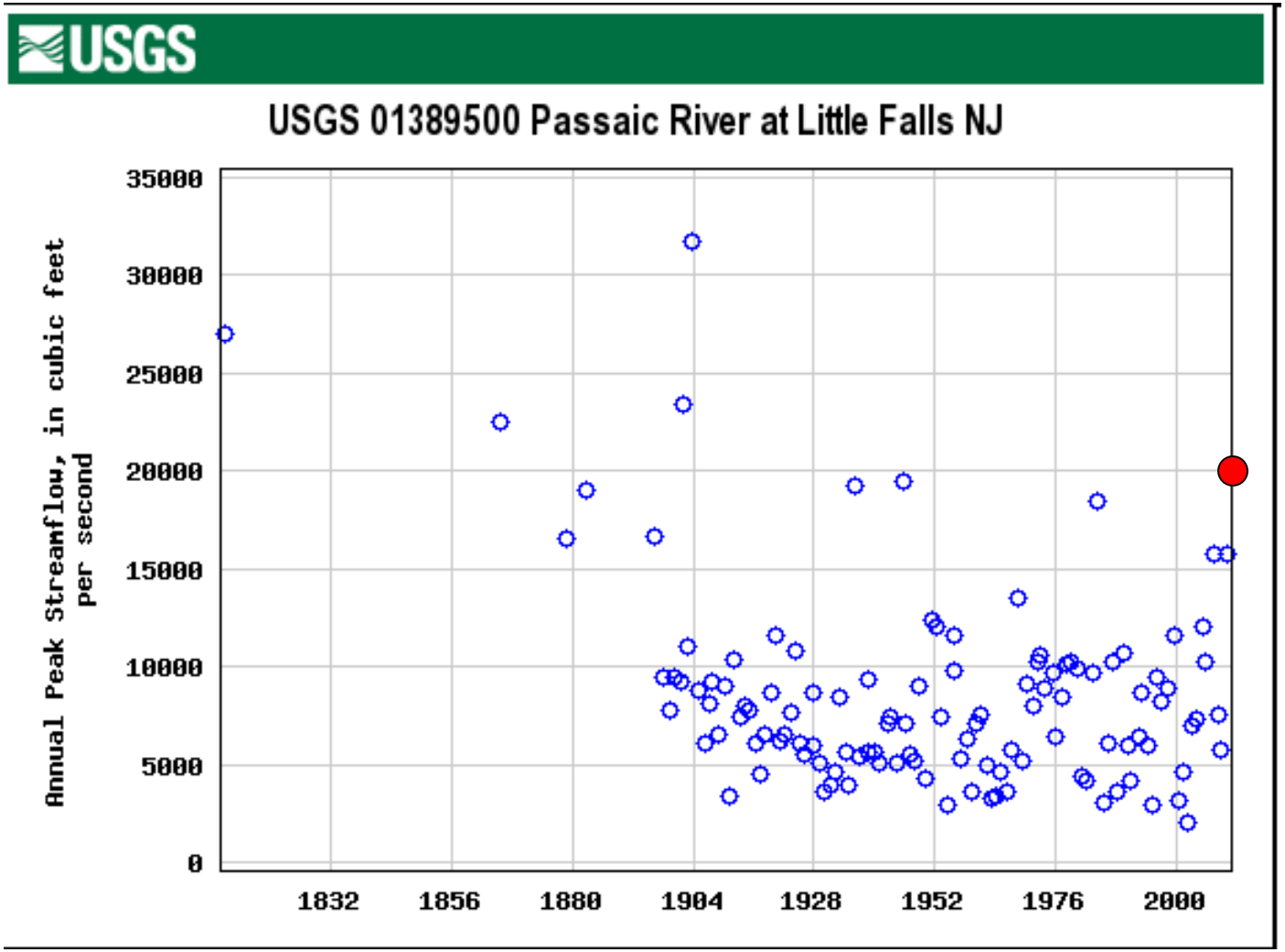
Irene: August 2011

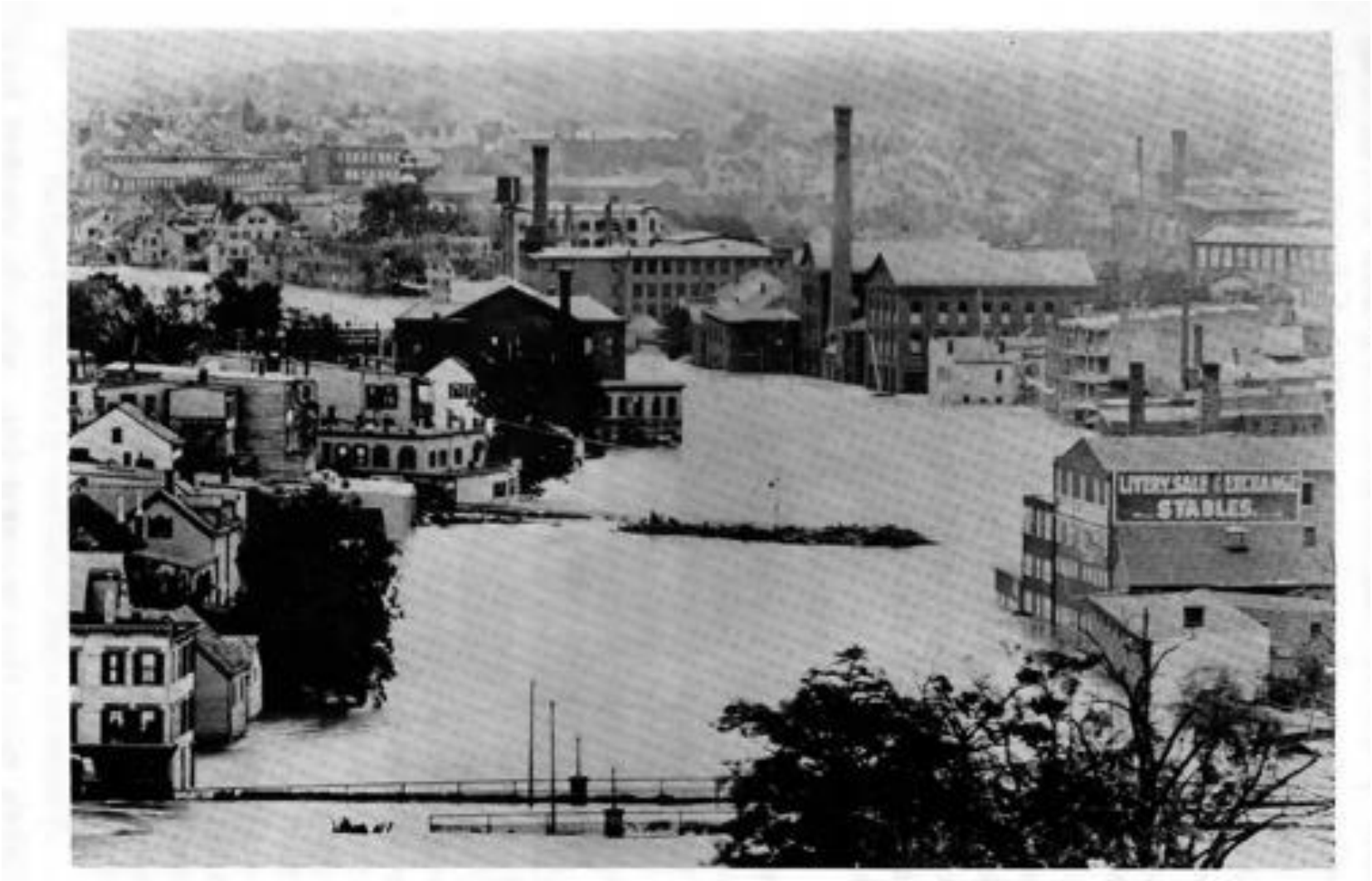
Sometimes too little……

Wanaque Reservoir: February 1981

Understanding NJ Weather & Climate Variations….

Peak Annual Flow of the Passaic at Little Falls





Paterson: October 1903 (Army Corps of Engineers)

Location unknown: April 1984

Little Falls: March 2007 (Army Corps of Engineers)

Wayne: April 2010 (Army Corps of Engineers)

Passaic Basin

March 2011

Irene
29 August 2011

Lincoln Park

Paterson

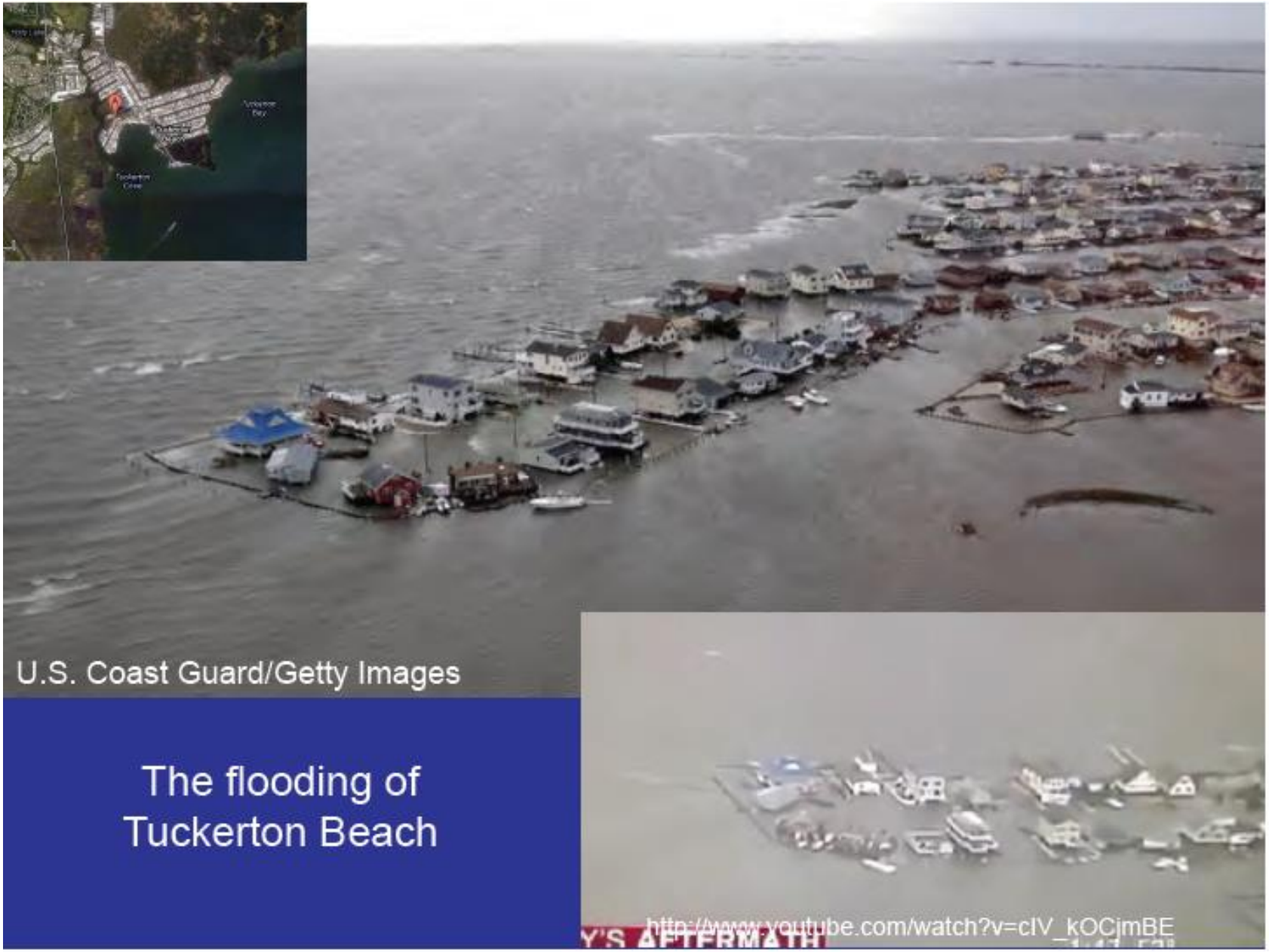
Paterson

Kinnelon

29 October 2011 snowstorm

Sandy 29 October 2012

Hoboken. New Jersey



The flooding of Tuckerton Beach

Overview

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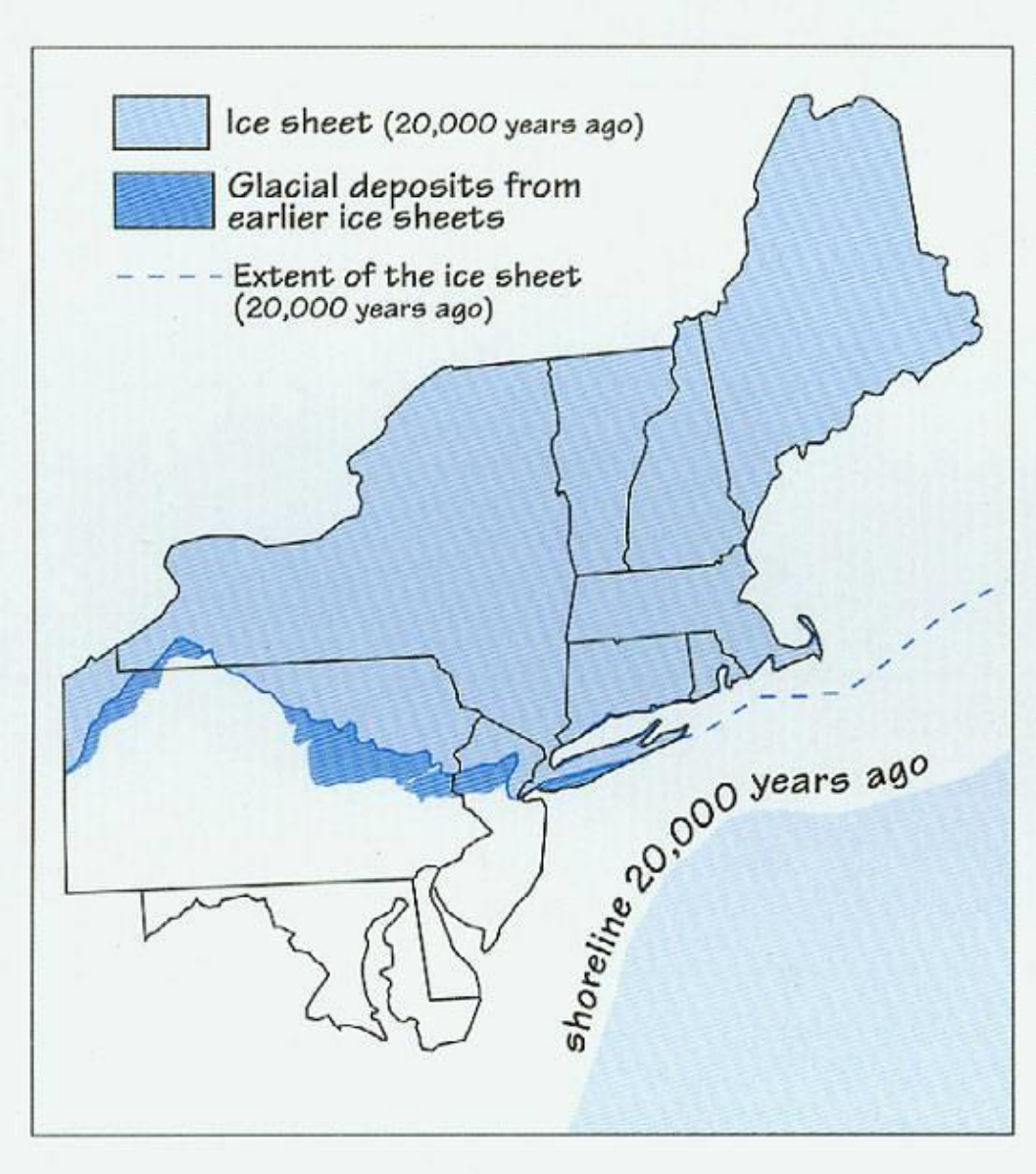
3. Impacts and potential actions

High Point, NJ
23 February 2018
(N. Stefano)



http://ferromonte.org/history1.htm

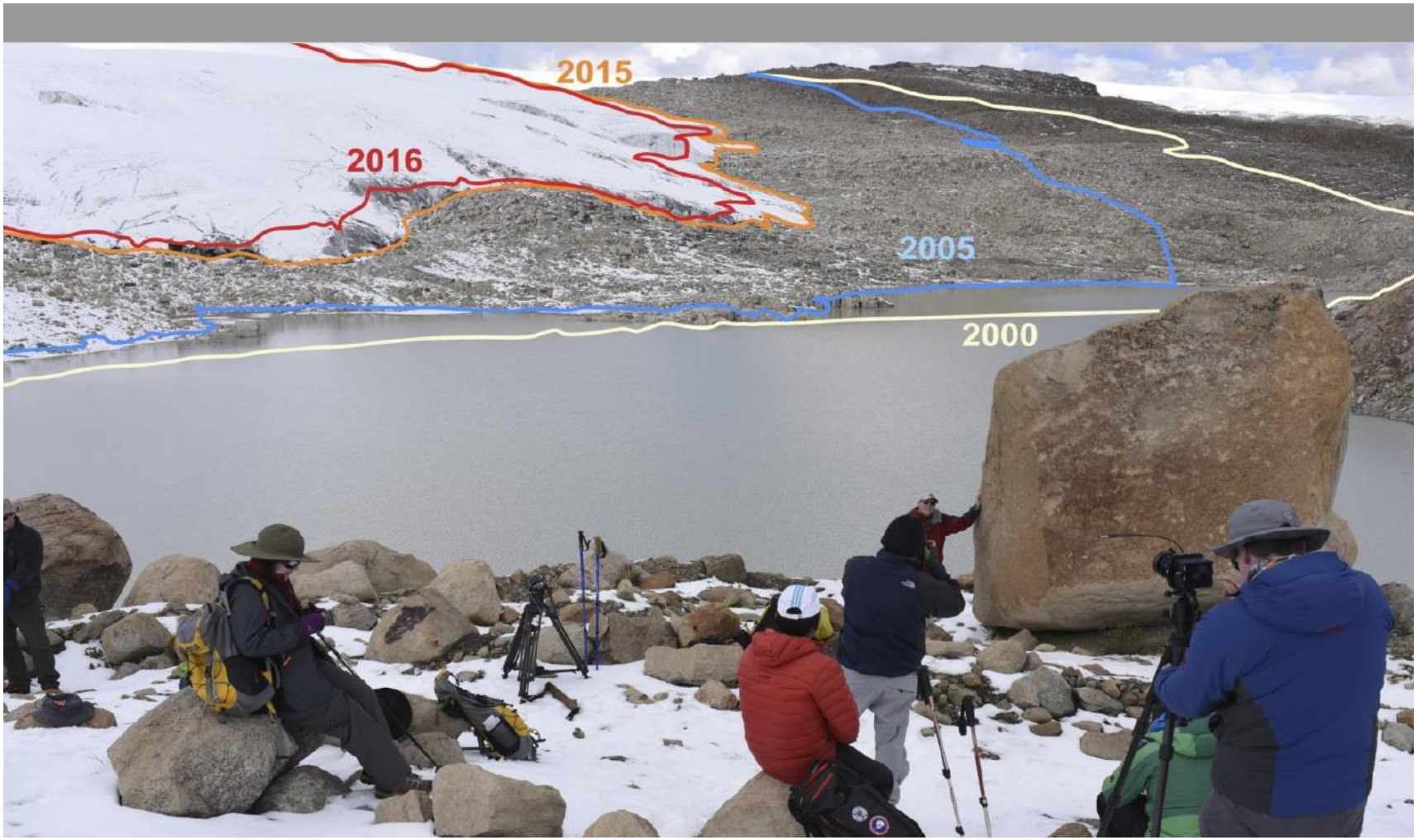
Climate regimes have changed dramatically on many time scales in the past

Tripod Rock: Pyramid Mountain Park
Morris County, NJ

Peruvian Glacier Terminus

Courtesy of L. Thompson

Peruvian Terminus Retreat

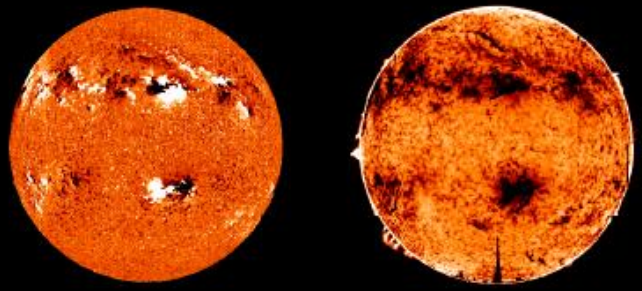


Courtesy of L. Thompson

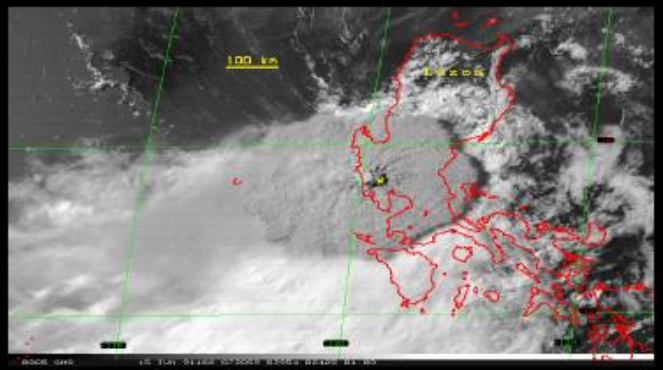
Natural mechanisms influence climate

Natural mechanisms

Changes in solar output →

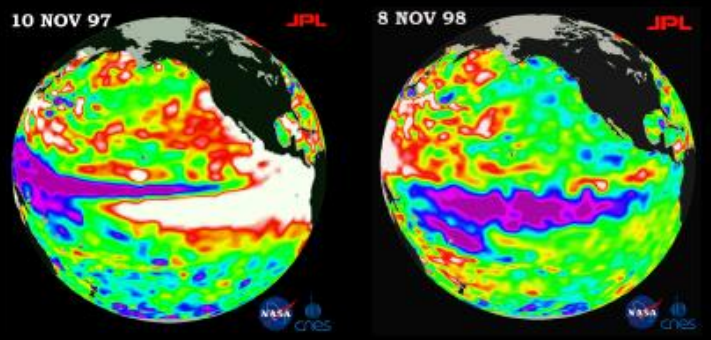


Changes in the amount of volcanic aerosols in the atmosphere →



Internal variability of the coupled atmosphere-ocean system (e.g., ENSO, monsoon systems, NAO)

→



Is climate presently changing in NJ & elsewhere?

Preponderance of evidence suggests climate change is occurring and humans are responsible for a significant portion of recent changes

1. Theory
2. Observations
3. Models

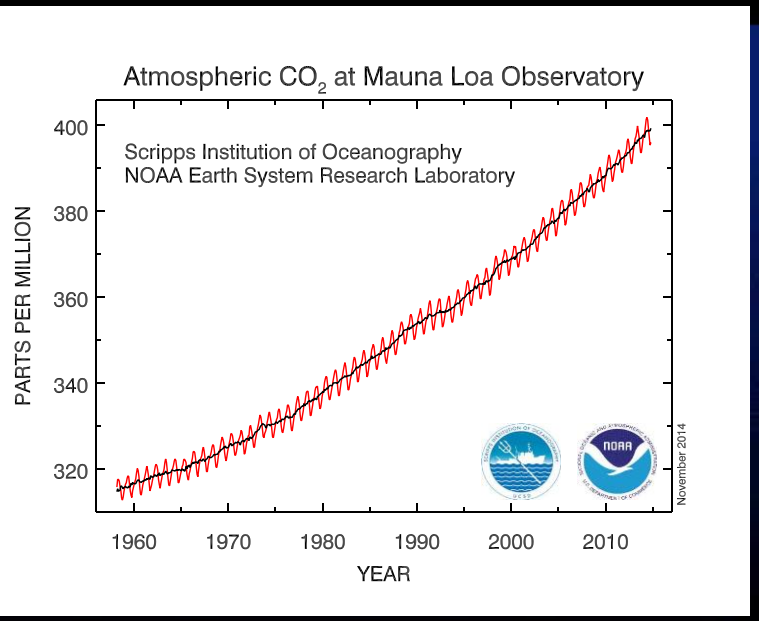
Human factors also influence climate

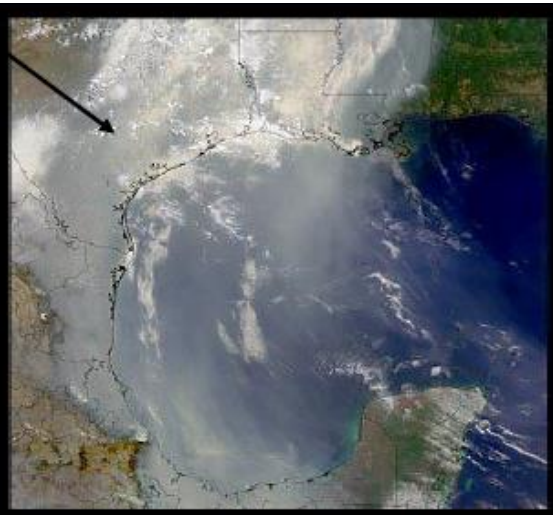
Non-natural mechanisms

Changes in the concentrations of atmospheric greenhouse gases →

Changes in aerosols and particles from burning fossil fuels and biomass
- **coal (sulfate aerosols) – cooling**
- **biomass (black carbon) – warming**

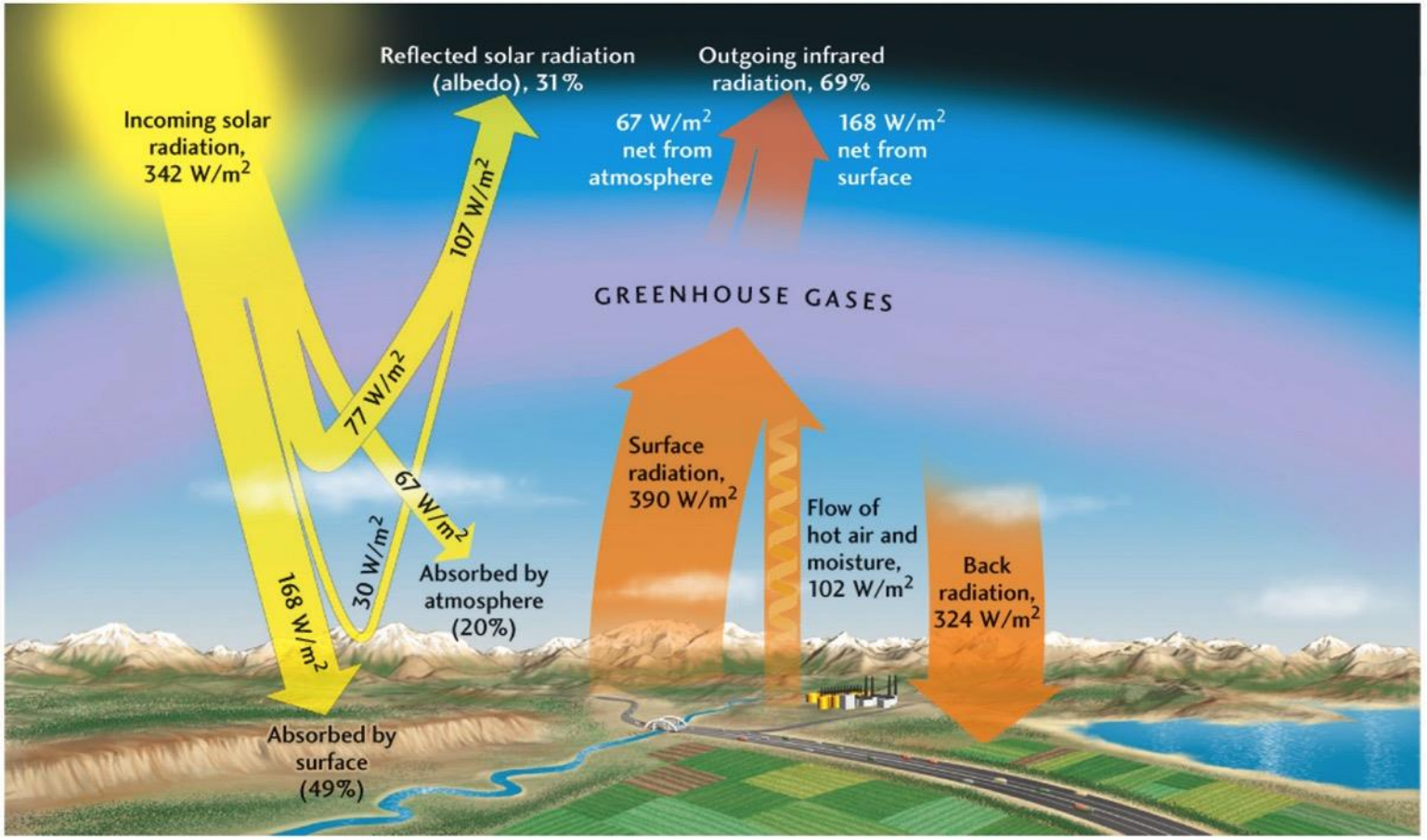
Changes in the reflectivity (albedo) of Earth's surface and the hydrologic cycle





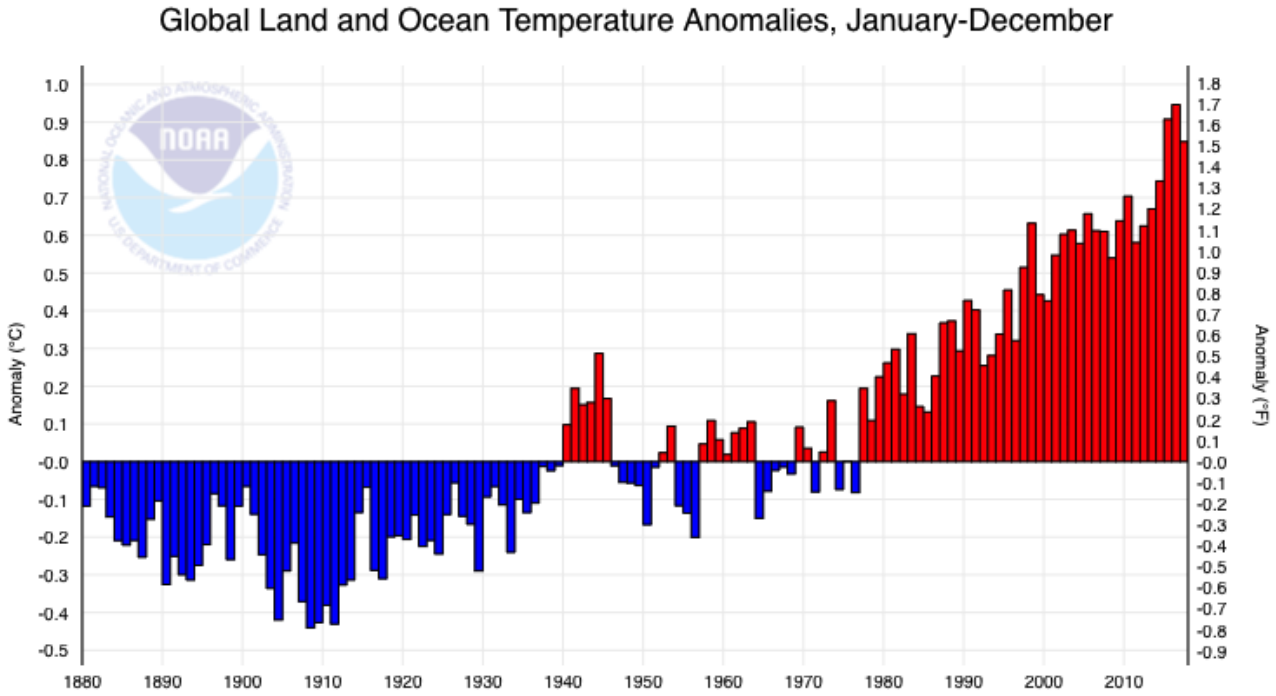
Smoke from fires in Guatemala and Mexico (May 14, 1998)

Greenhouse Effect



- The Earth reflects radiation not absorbed by the atmosphere & surface (lost heat).
- Strong ***greenhouse gases*** delay the exit of absorbed radiation back to the space (enhancing atmosphere & surface temperatures).

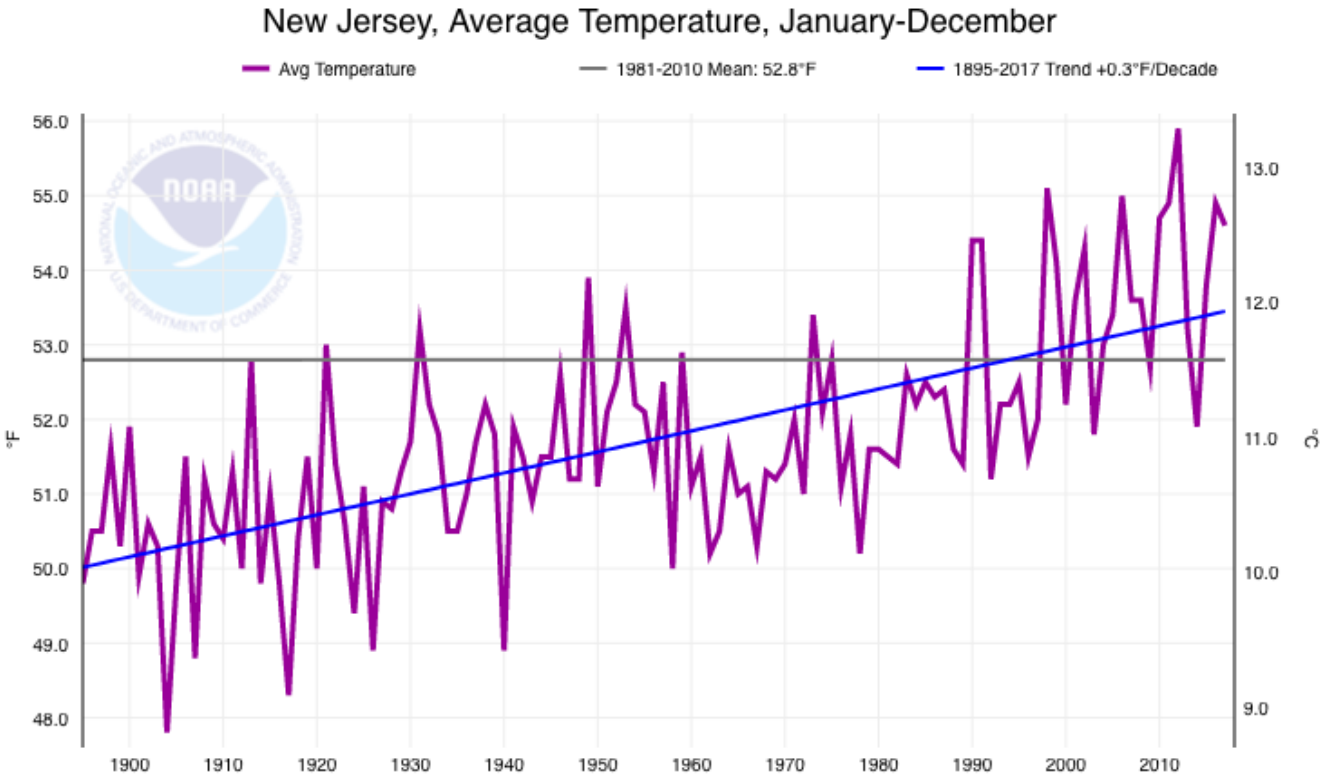
Global surface air temperatures over ocean and land: 1880-2017



NOAA

- Evidence of current global warming
  - 9 of 10 warmest years on record occurred since 2005 (since 1880)
  - Global temperature increasing at 0.13 ° C per decade
  - Ocean temperatures increasing to depths of 9800 feet
  - Sea level rise
  - Temperatures in Arctic increasing at twice global rate

New Jersey annual temperature; 1895-2017



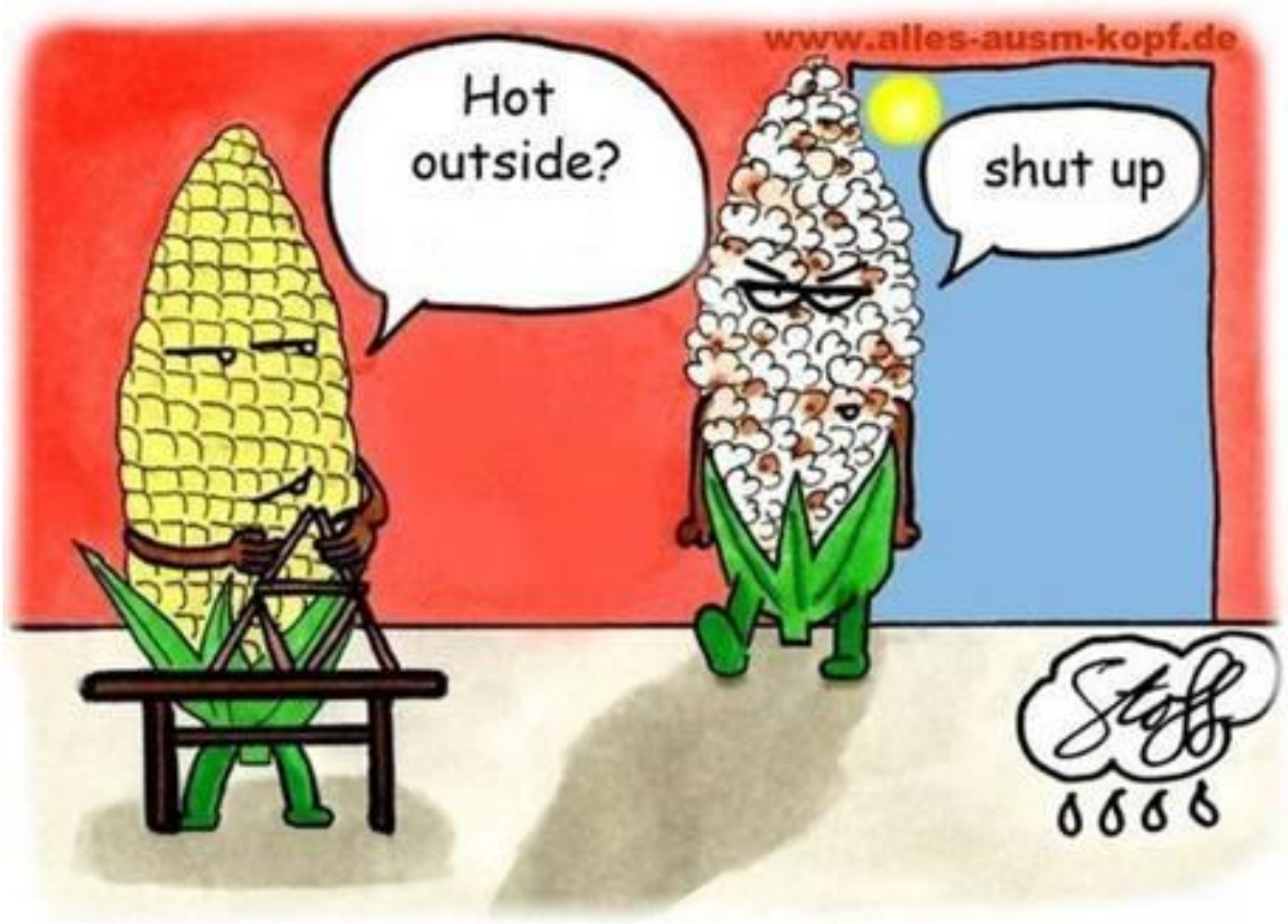
Long-term upward trend of 2.2°F per 100 years

More rapid warming since 1980

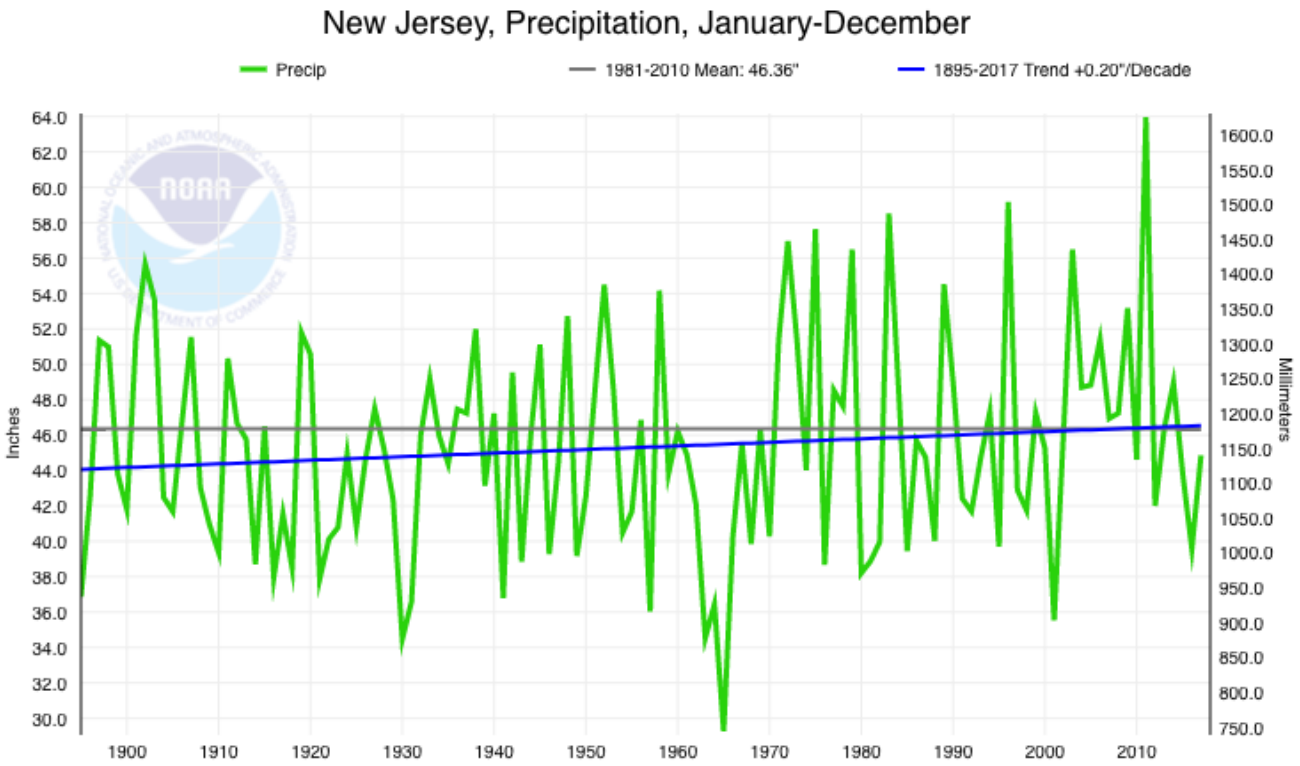
The three warmest years have occurred since 1998

2012 was the warmest year on record

data source: National Centers for Environmental Information


www.alles-ausm-kopf.de
Hot outside?
shut up

New Jersey annual precipitation: 1895-2017



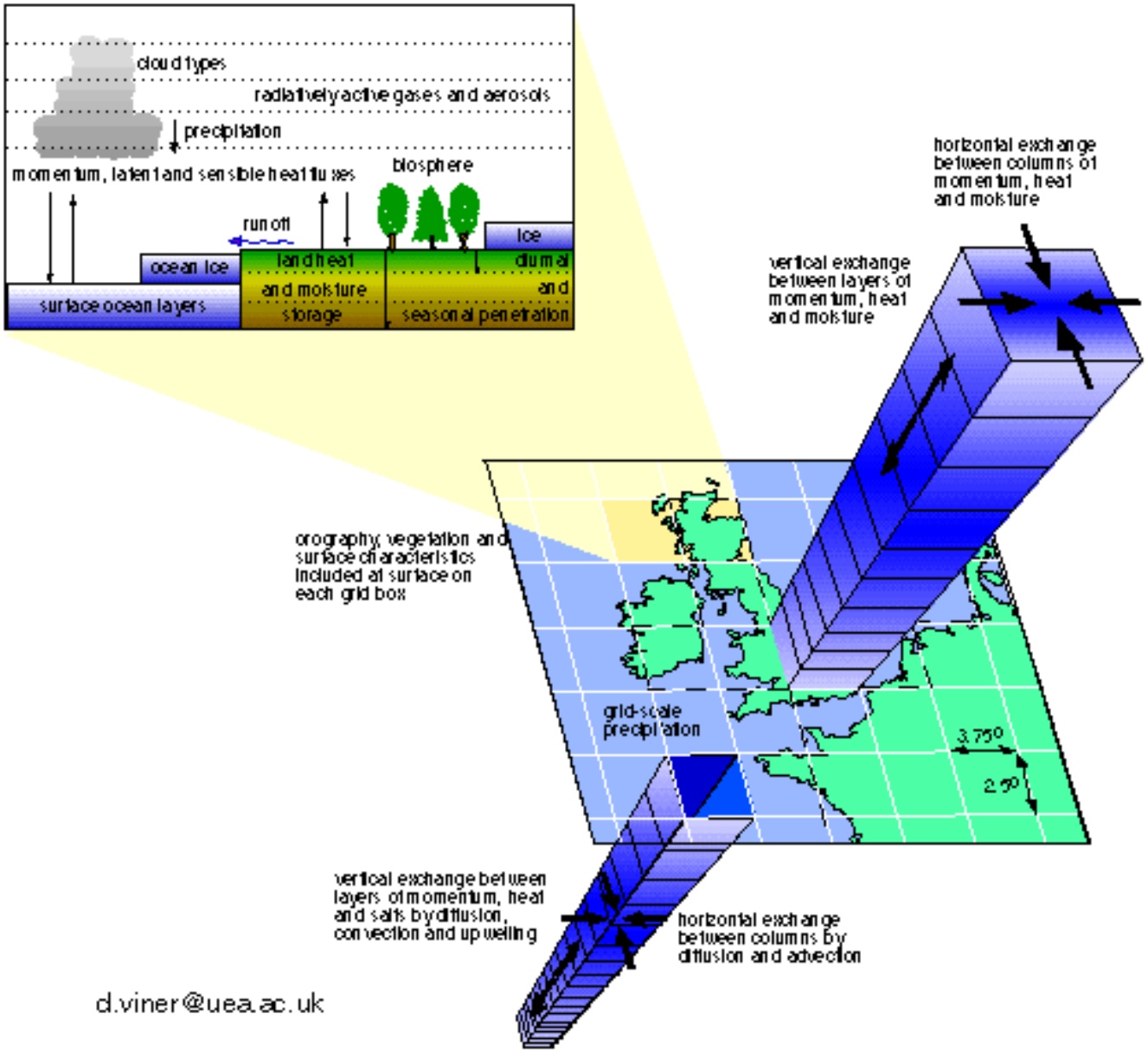
Long-term upward trend of 4.1" per 100 years

Large decadal variability (early 1960s drought, wet 1970s, very wet in last decade)

Most of the upward trend comes from changes in spring and fall

data source: National Centers for Environmental Information

Coupled Climate Model Schematic



d.viner@uea.ac.uk

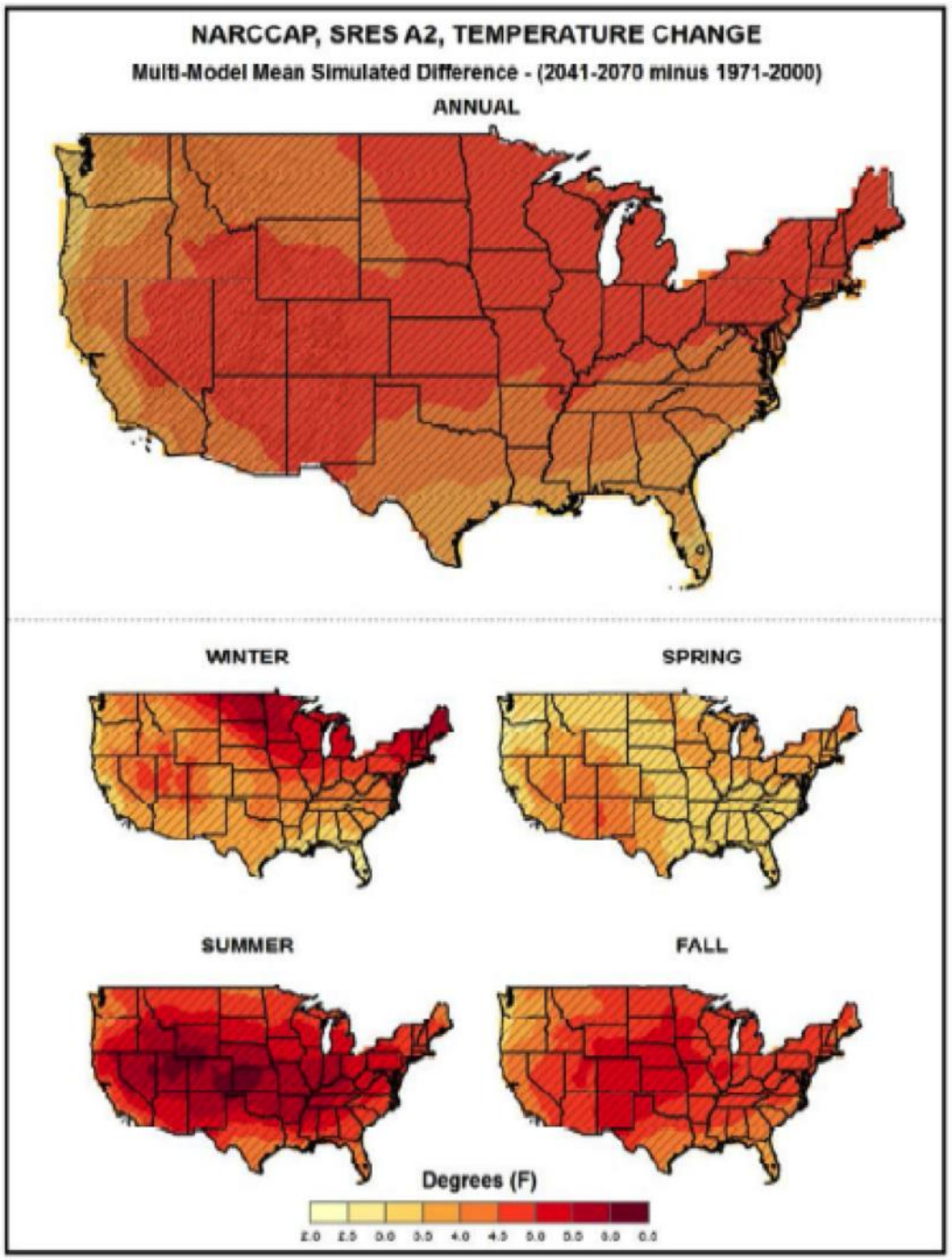
New Jersey's future climate

- Rising temperatures
- Steady or increasing precipitation
- Increasing variability and extremes
  - storms, flood, drought, heat…….
- Rising sea level

Changing Annual and Seasonal Temperatures

2041-2070 minus 1971-2000

North American Regional Climate Change Assessment Program



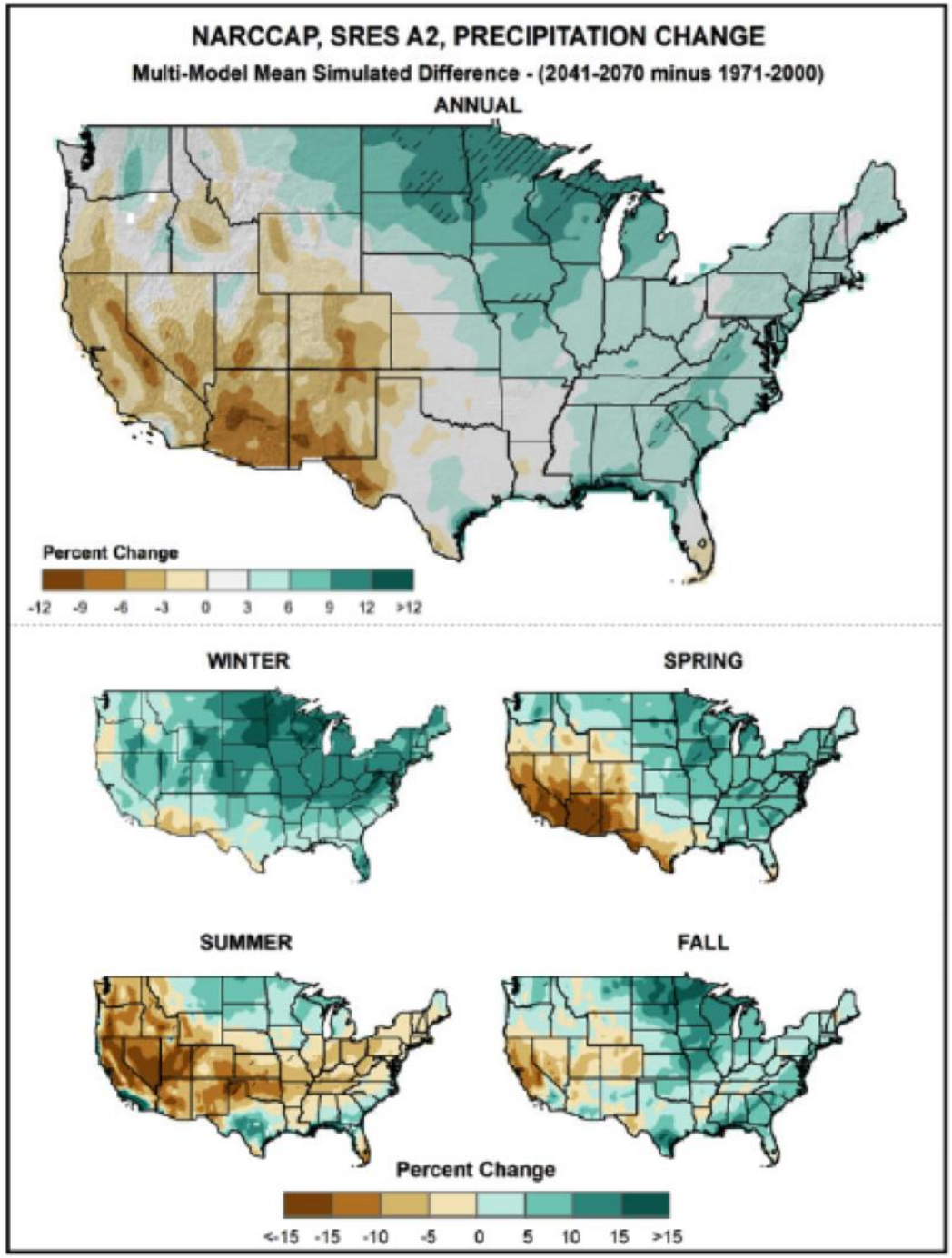
Kunkel et al. NOAA Tech. Report NESDIS 142-9, 2013

Changing Annual and Seasonal Precipitation

2041-2070 minus 1971-2000

North American Regional Climate Change Assessment Program

Kunkel et al. NOAA Tech. Report NESDIS 142-9, 2013



New Jersey sea level rise projections

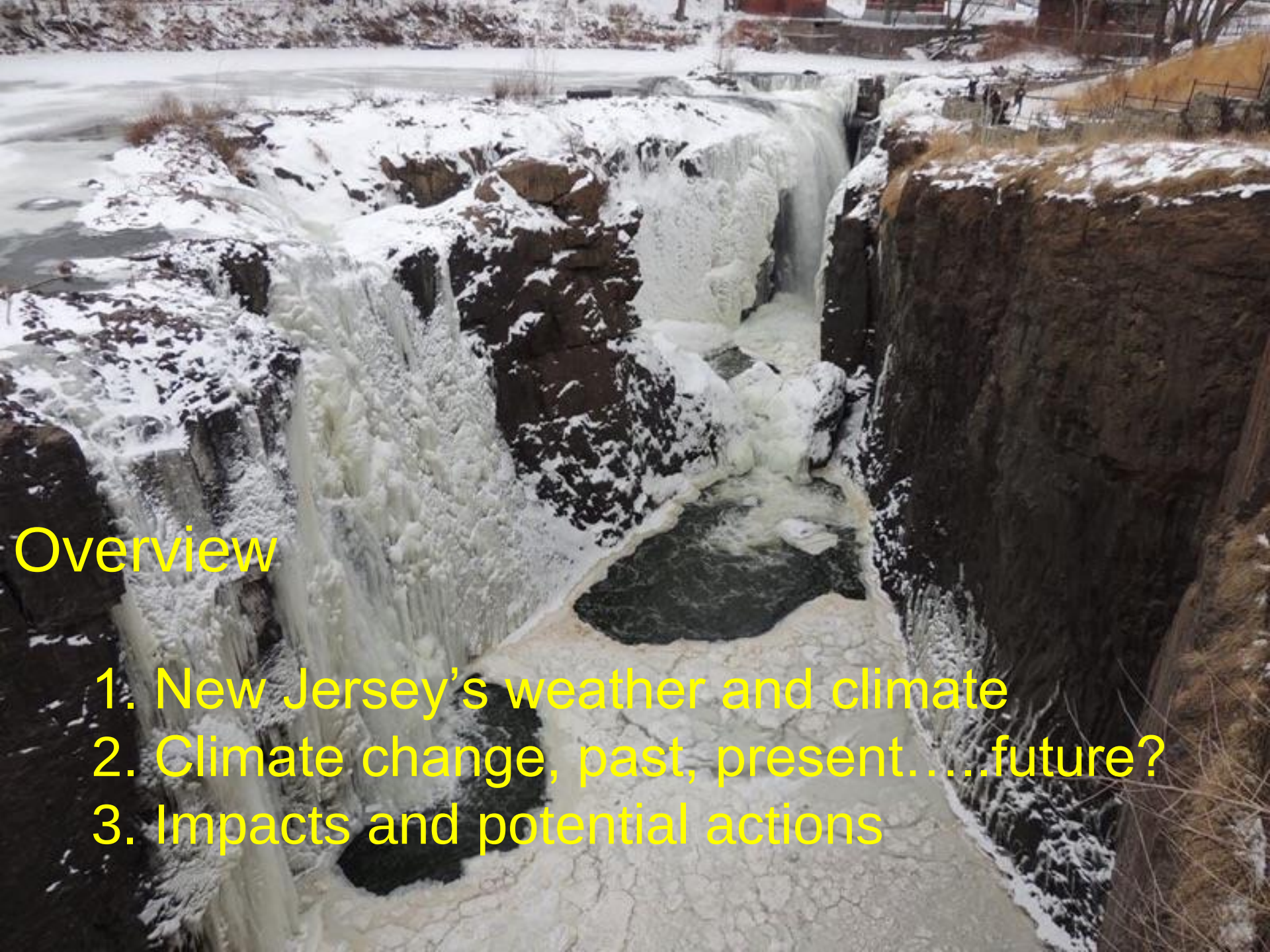
1 foot
(likely by ~2040)

3 feet
(likely by 2090s)

6 feet
(~5% chance by 2100)

Seaside Heights

Maps available from http://slrviewer.rutgers.edu/ and http://sealevel.climatecentral.org/



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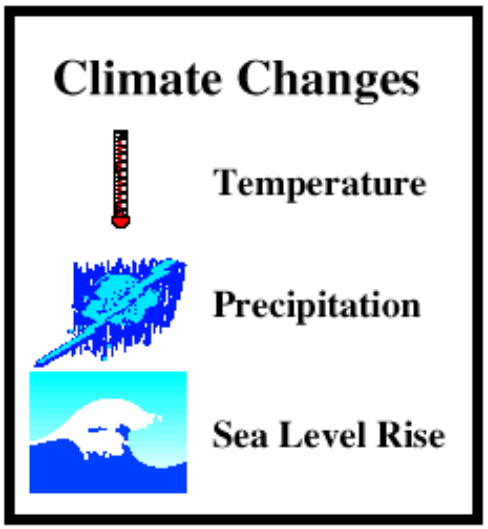
Potential climate change impacts



Health Impacts
Weather-related Mortality
Infectious Diseases
Air Quality-Respiratory Illnesses

Agriculture Impacts
Crop yields
Irrigation demands

Forest Impacts
Change in forest composition
Shift geographic range of forests
Forest Health and Productivity

Water Resource Impacts
Changes in water supply
Water quality
Increased Competition for water

Impacts on Coastal Areas
Erosion of beaches
Inundate coastal lands
Costs to defend coastal communities

Species and Natural Areas
Shift in ecological zones
Loss of habitat and species

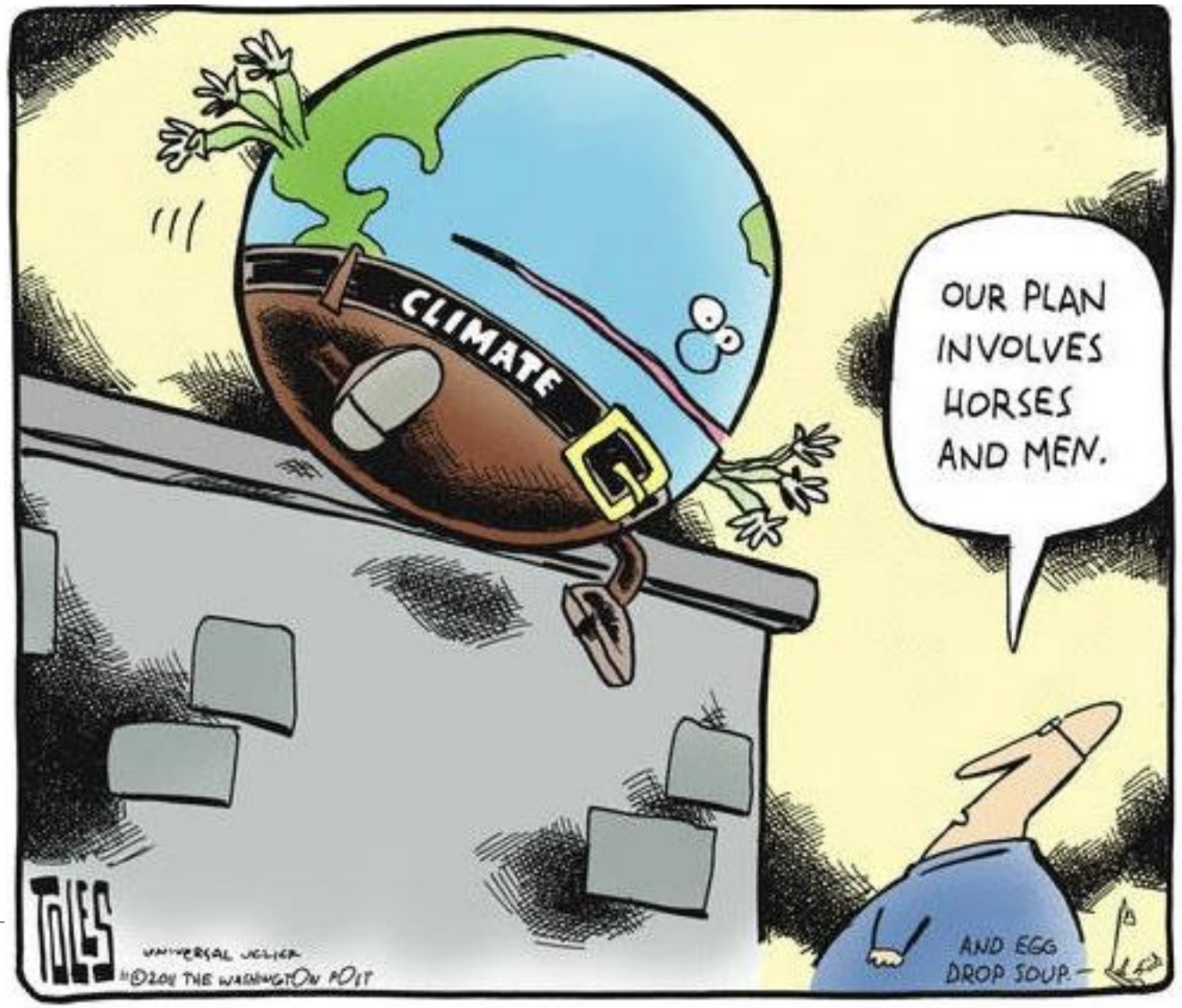
EPA

United States Environmental Protection Agency

A dilemma

Passaic flooding: March 2011

Is there something we should be doing about this climate dilemma?



Challenges Requiring Attention

- Knowledge: Develop a better understanding of the details of future climate change.
- Mitigation: Reduce emissions of carbon dioxide and other greenhouse gases.
- Adaptation: Increase the resilience of society to climate change.
- Activism/Leadership: Raise public awareness of the challenges posed by climate change and the need to mitigate and adapt. Participate…..vote.

Summing up:

Be it weather moodiness or long-term climate personality changes, a dull moment is rare to find in New Jersey and beyond.

There is abundant evidence that the atmosphere, oceans and continents are primed to produce even more action, more variability, and more change in the decades ahead on local to global scales.

Continued vigilance is required to monitor, understand and predict the future behavior of the climate system.

The climate change train has left the station, however time remains for mitigative and adaptive actions to slow the locomotive.

Keeping an eye on conditions

Rutgers New Jersey Weather Network

https://njweather.org

NJWxNet stations measure:

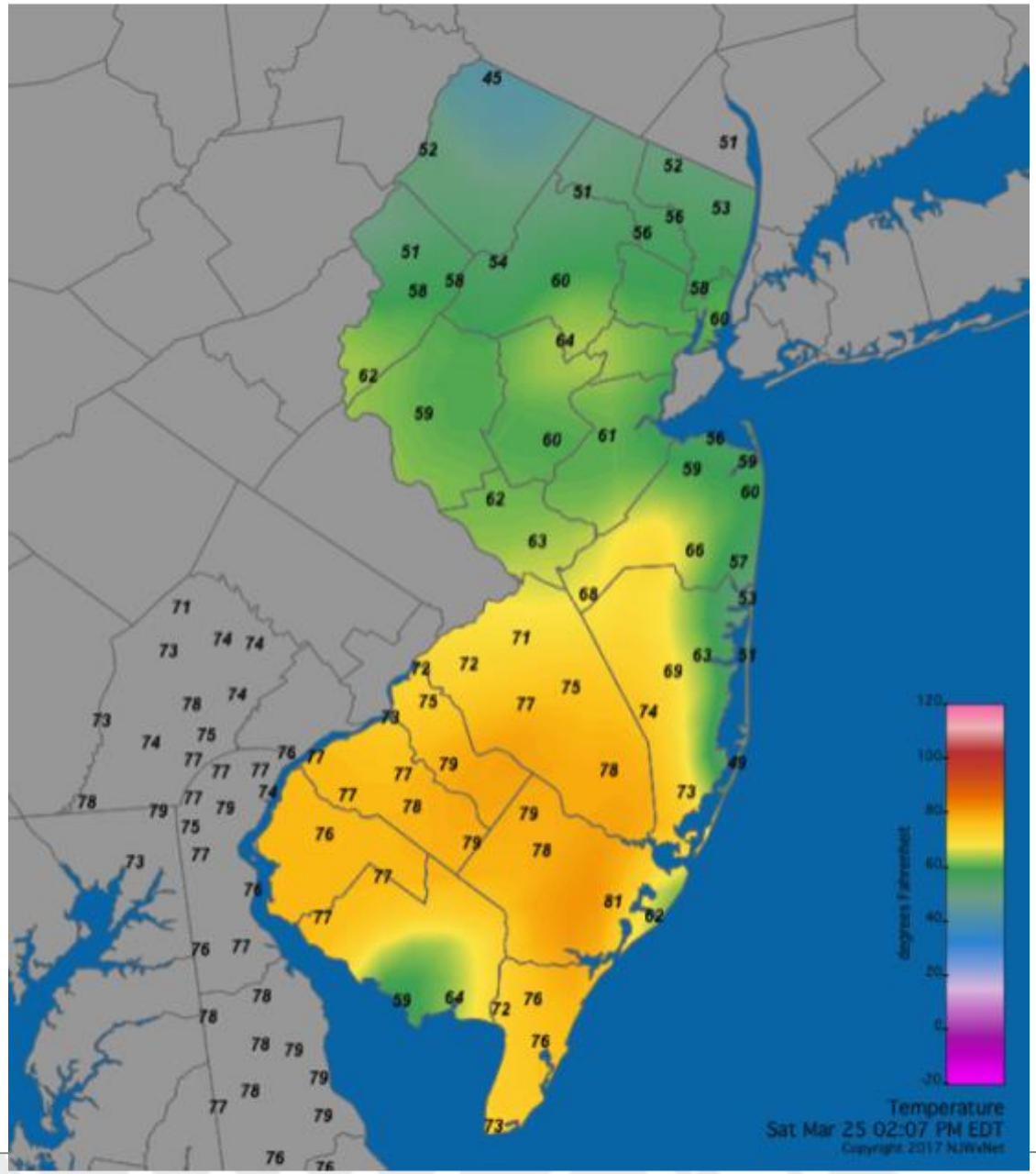
- Air temperature
- Wind speed and direction
- Dew point/Relative humidity
- Precipitation
- Barometric pressure
- Solar radiation
- Soil temperature
- Soil moisture
- Snow depth

Solar power

Cellular communications

Ability for expansion built into station design

Basking Ridge:
Lord Sterling Park

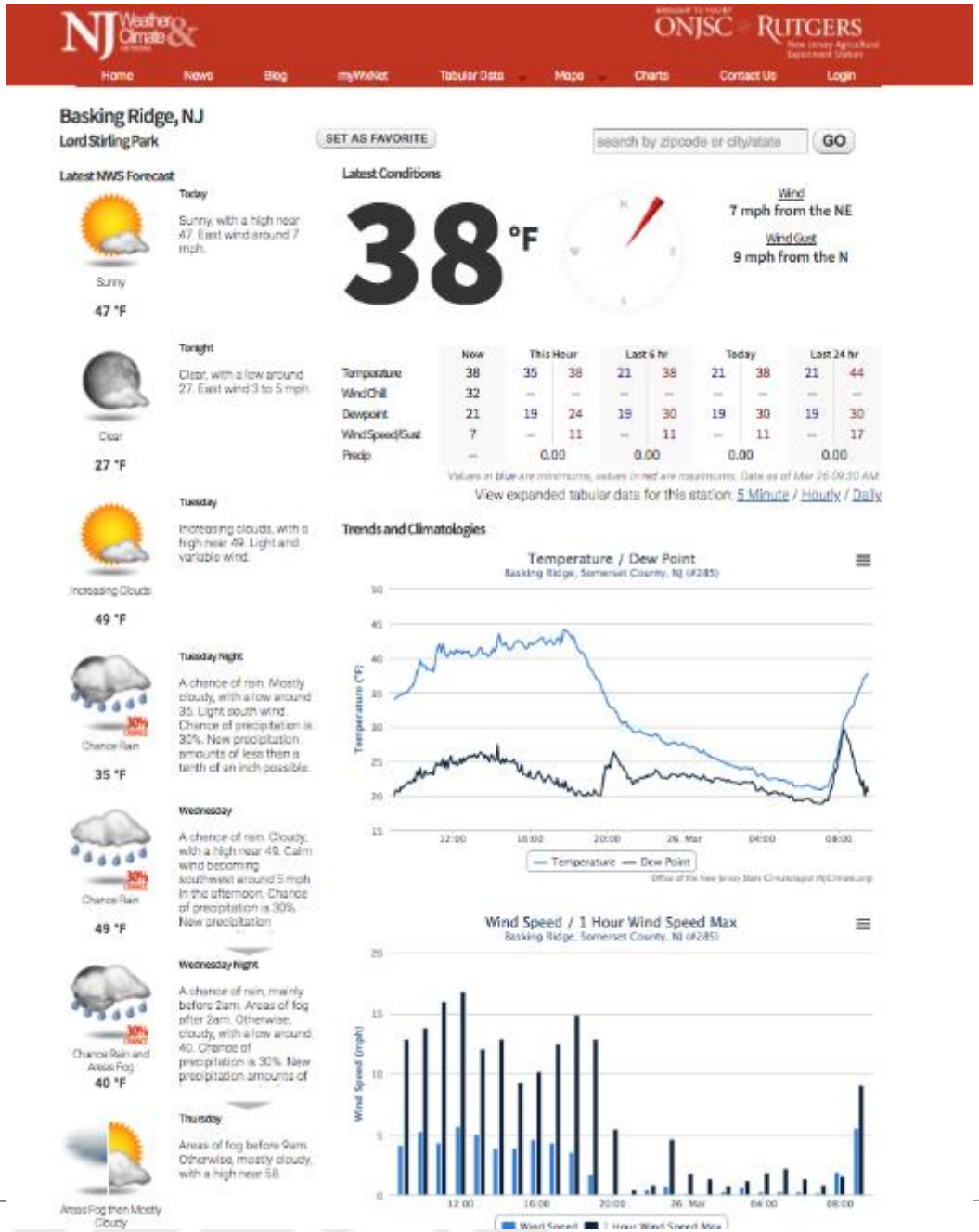


Maps every
5 minutes

Statewide
temperature
range from
41° to 81°

March 25, 2017
2 PM

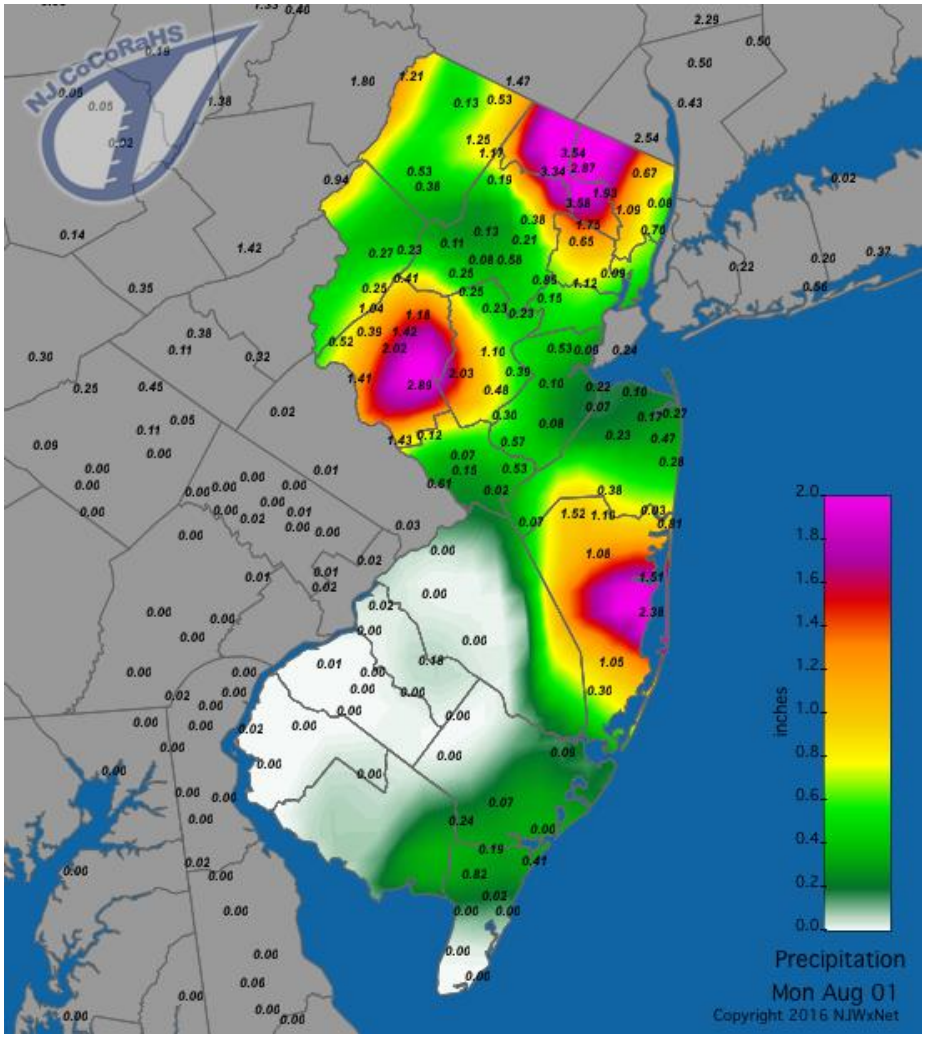
Station-specific web pages



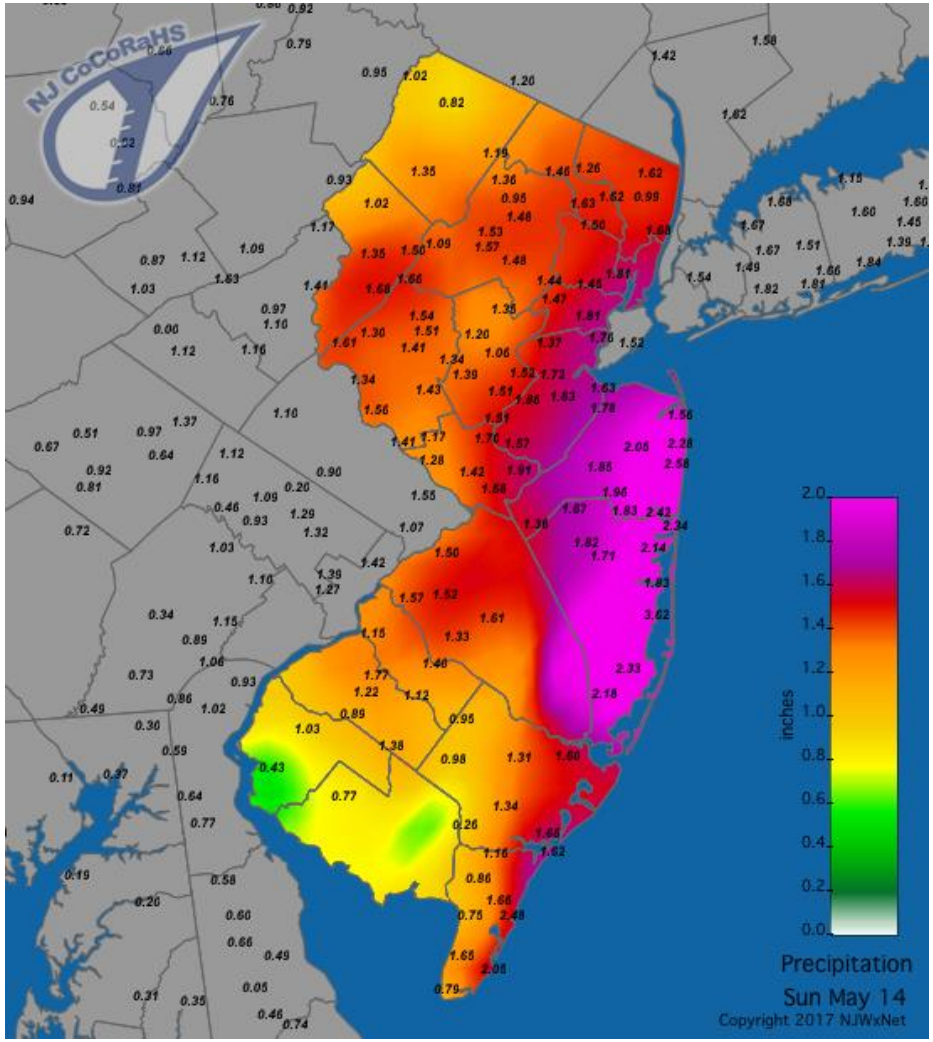
Become a citizen scientist observer!!

Daily observations by trained volunteers of all ages

Community Collaborative Rain, Hail and Snow Network:



7AM 31 July– 7AM 1 Aug 2016



7AM 13 May – 7AM 14 May 2017

Thanks

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njclimate.org