

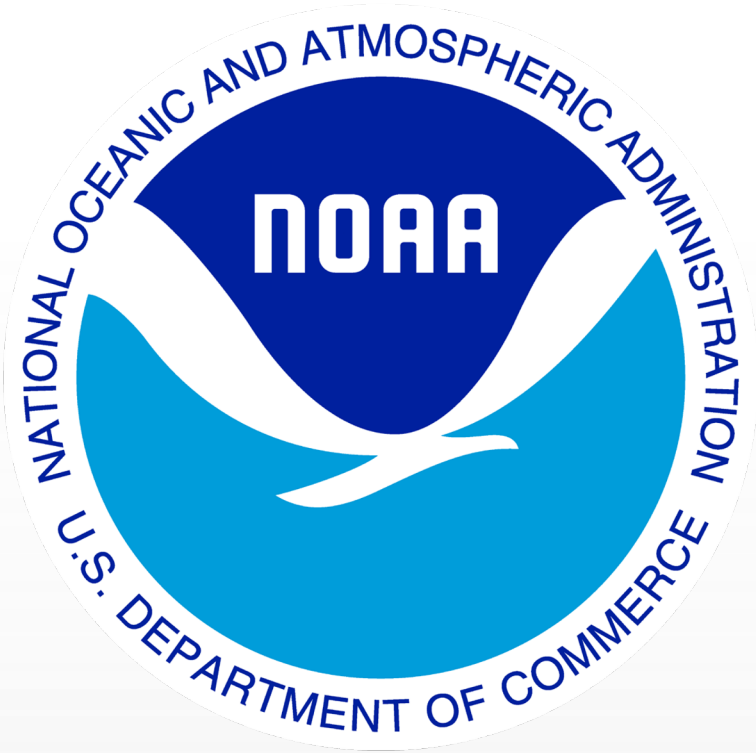
Climate Science, Risk Quantification, & Building Resiliency

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April 22, 2020



What work do I do?

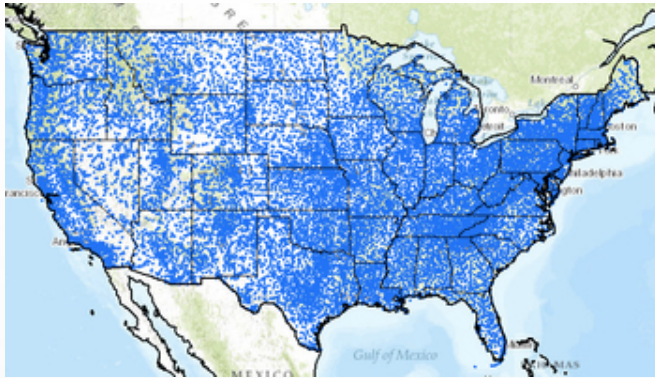


Geophysical Fluid Dynamics Laboratory (GFDL)
Princeton University Forrestal Campus



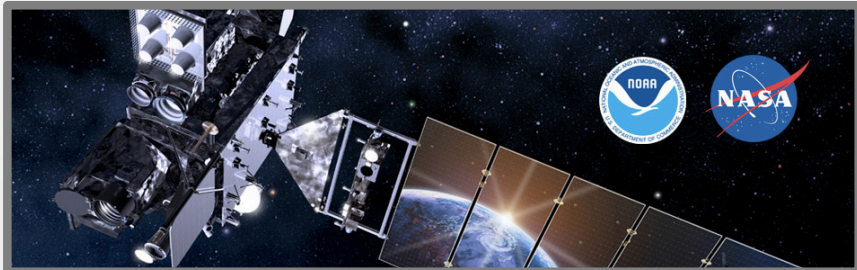
How do we monitor weather and climate?

Observed Climate

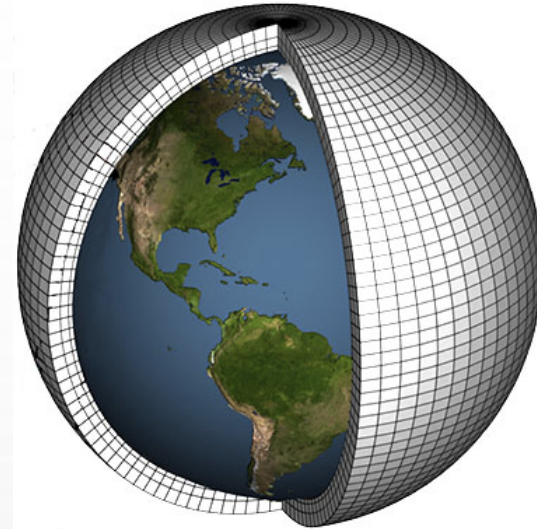


NY Millbrook 3 W

Institute of Ecosystem Studies (Environmental Monitoring Station)
41.8 N 73.7W 440'
November 1, 2004



Modeled Changes

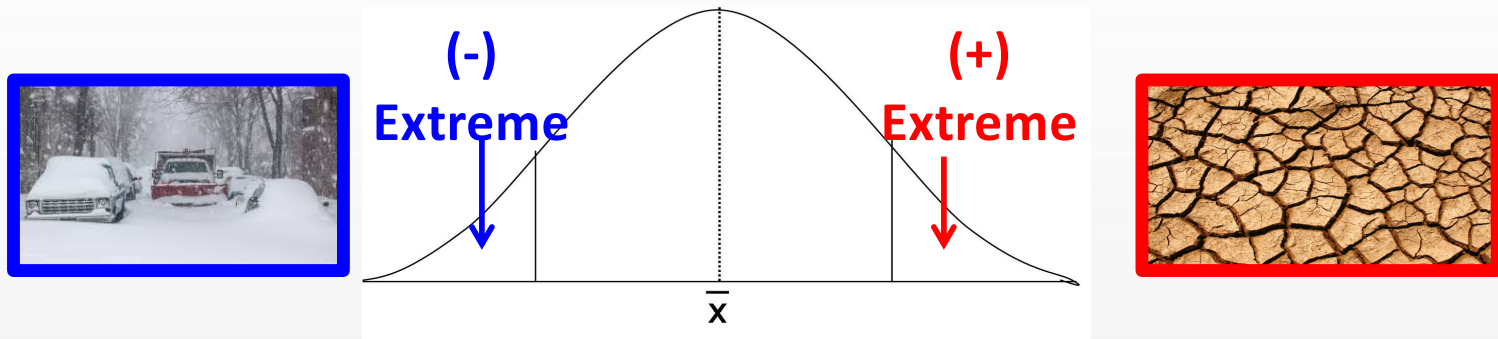


Can create model “experiments” with different worlds:

- What is the climate without changes to greenhouse gases? Aerosols? Solar cycles?
- What does it look like in the future given various pathways (e.g. farming, greenhouse gases, aerosols, wildfire)?

Defining Weather Extremes

- A weather event that causes harm to lives and property
- In statistics, an “extreme events” refers to low probability events in the “tail” of a distribution of events



- Difficulty of quantifying extreme risks: by definition, they do not happen often. We must rely on the limited historical observations and/or use models to generate large data sets to understand their probabilities & causes

We use climate data to answer:

- How has the climate been changing in the past?
- For a specific climate extreme “X”:
 - What is the probability of the event?
 - Is the probability or type of event changing?
 - Why is it changing (or not)?
 - What is the probability going to be in the future?
- What causes uncertainty in our quantification of risk in the past, present, future?
- How might we be able to use this information to protect lives and property?

Extreme Event Risks in NY & Northeast Region

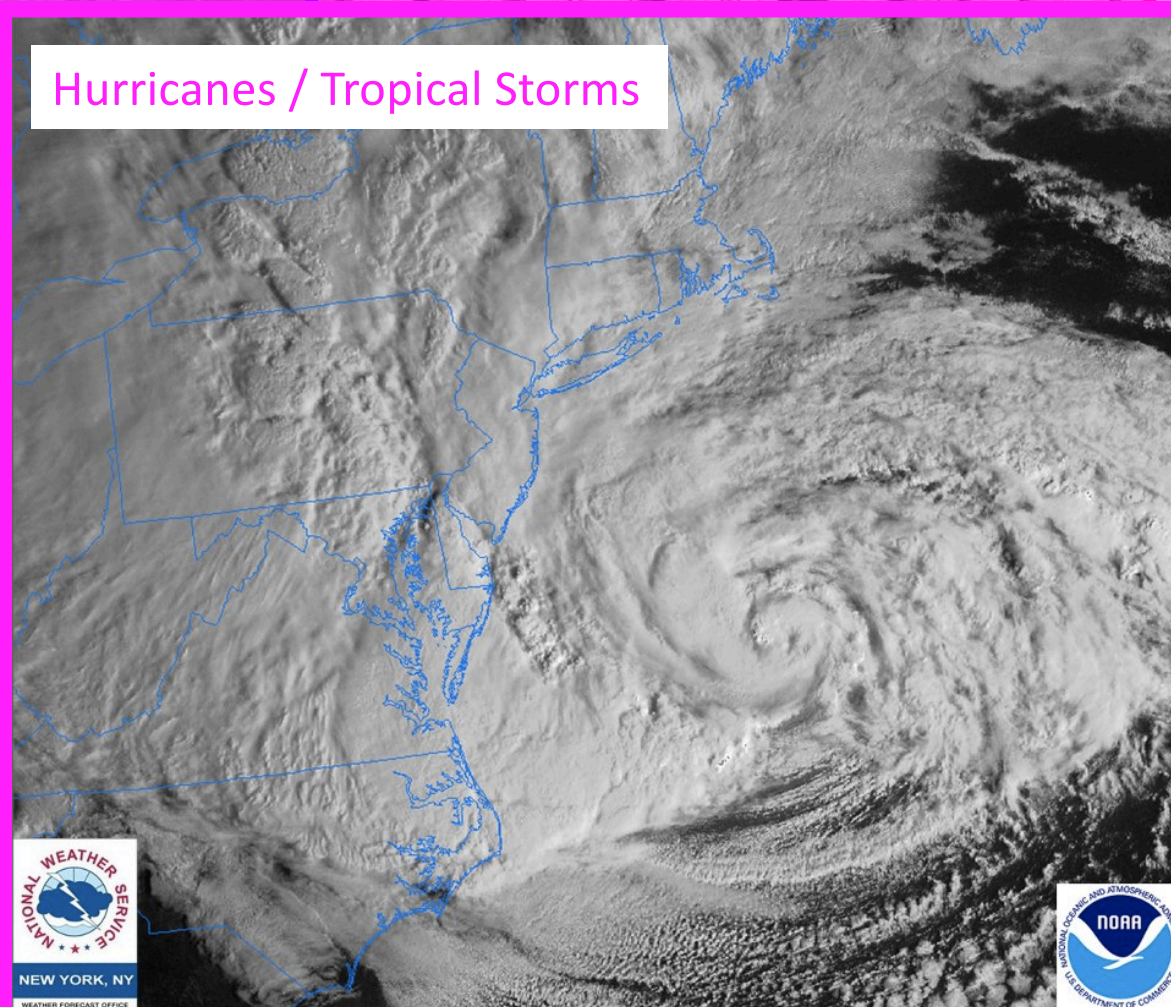


Winter Storms



Heat Waves

Hurricanes / Tropical Storms

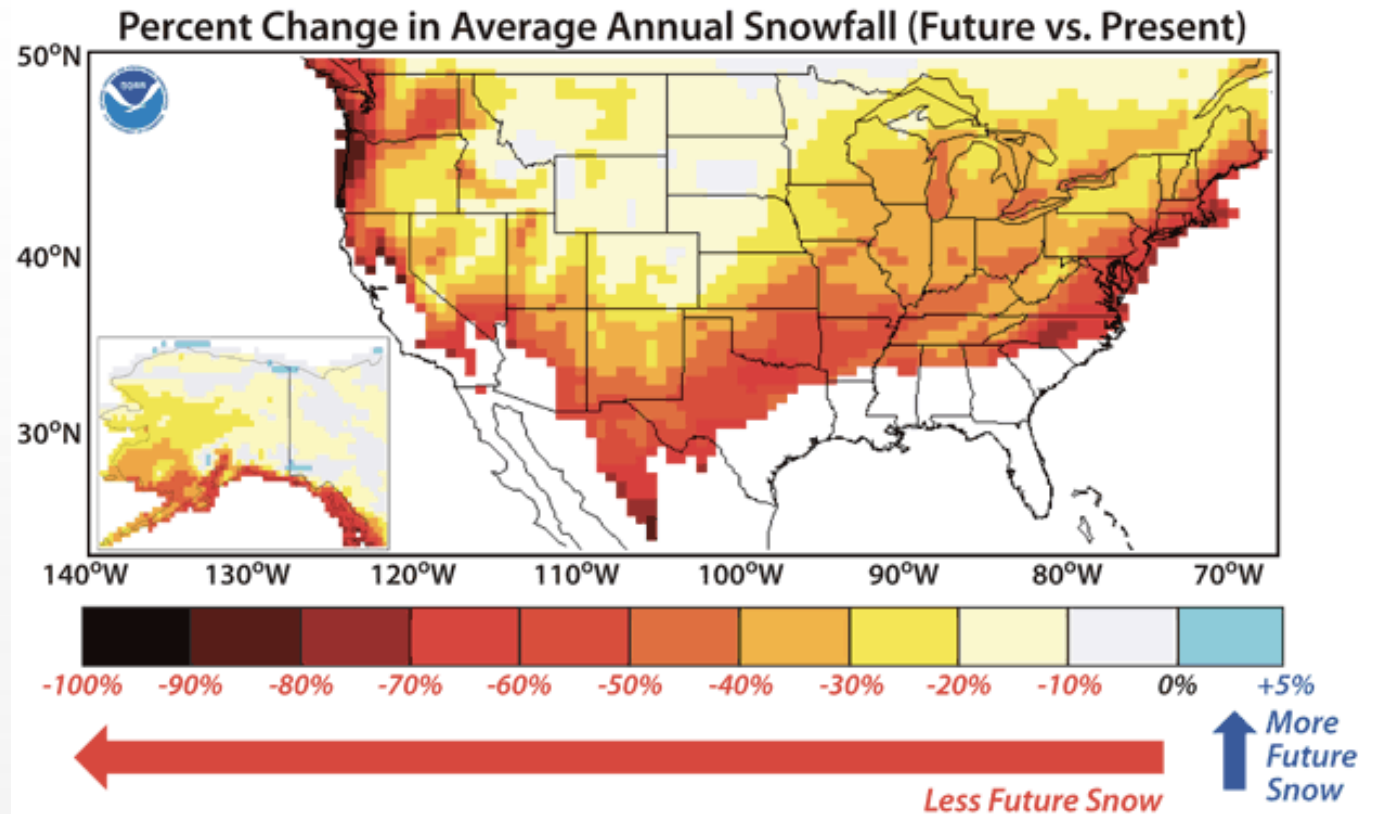
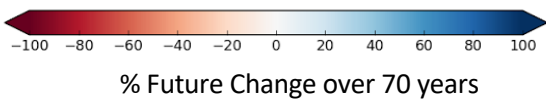
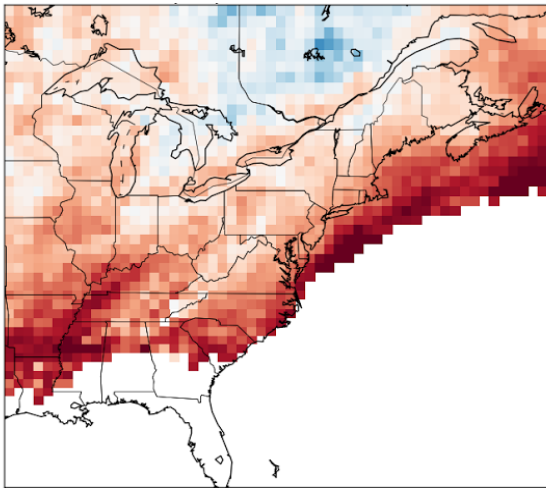


Coastal & River Flooding



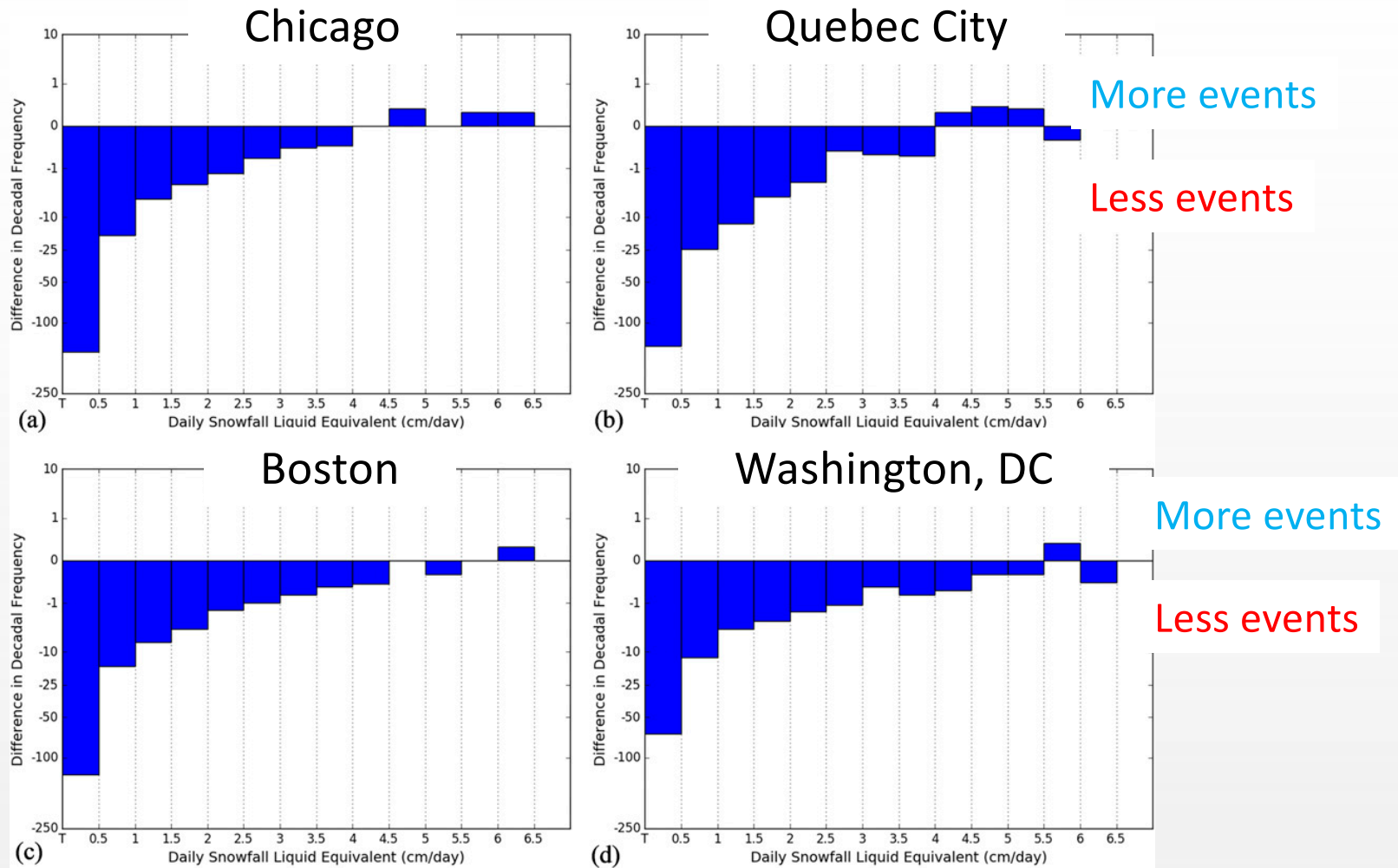
Changes in winter storms & snowfall

East Coast High Wind/Snow Events



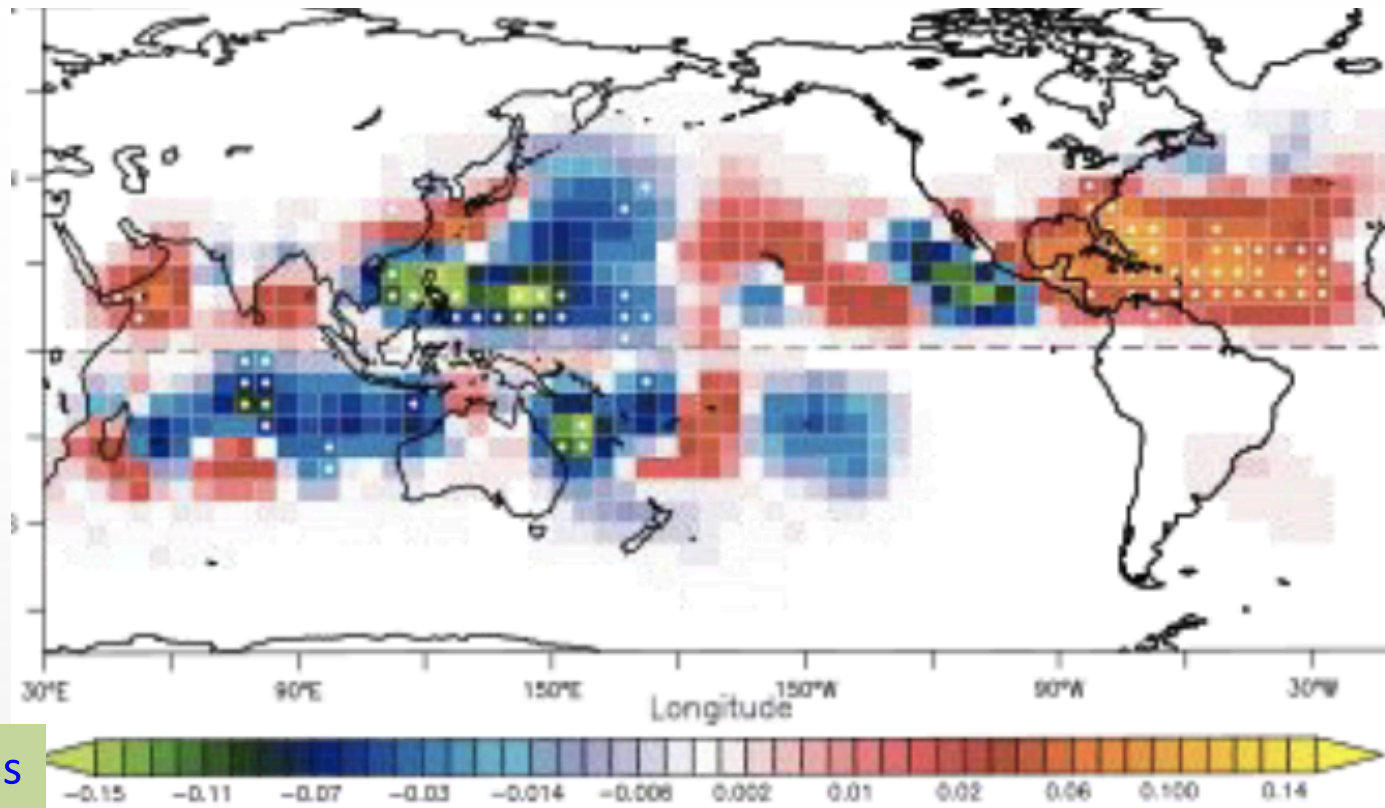
Summary: fewer storms in NY, less snow on average

Uncertainty: Potential simultaneous increase in the most extreme snowfall & decline in lower values



Tropical Cyclones

**Hurricanes are tropical cyclones with winds >74 mph



Fewer storms

More storms

- More tropical cyclones observed over 1980-2018 in the Atlantic (map above), but model simulations suggest less hurricanes by the end of the century
- Uncertainty: aerosols may have a countering effect to greenhouse gases (reducing aerosols—air pollution—may increase storm activity in the Atlantic). The frequency and strength of future tropical cyclones in the Atlantic requires further research

Source: Murakami et al., Proc. Natl. Acad. Sci., In Press



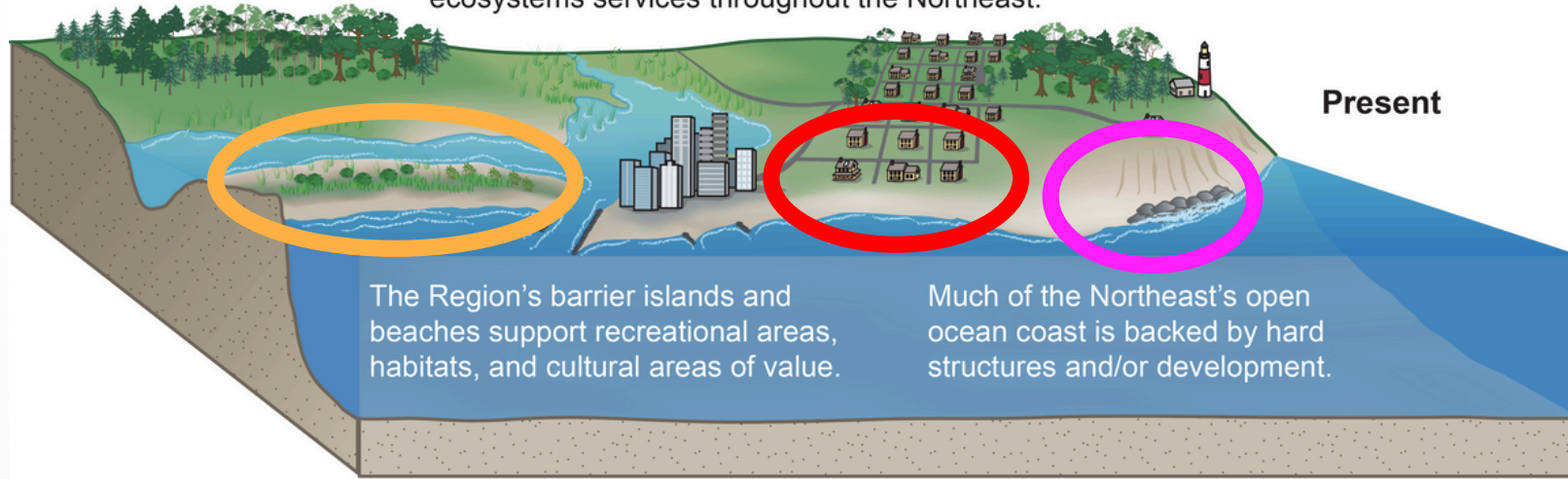
Sea level rise

- Sea level in the region has increased by ~1' since 1900
- Global sea level increases due to two factors:
 - Thermal expansion of water
 - Melting of glaciers and ice sheets
- Even if storms stay the same, storm surge risk increases without changes to coastal communities due to rising sea level
- By 2060, scenarios suggest for NYC:
 - ~1' rise (intermediate low) to ~3-5' (extreme)
 - That is the difference between a dry & underwater lower Manhattan, Coney Island



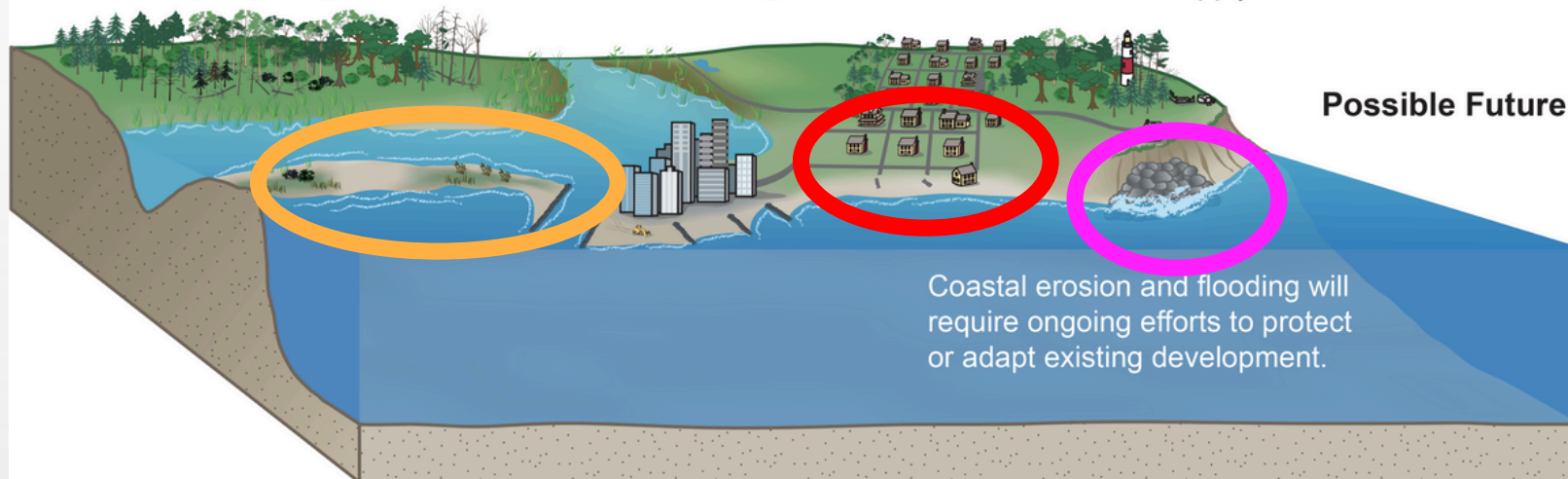
Coastal Adaptations / Changes

Coastal marshes, uplands, forests, and estuaries provide critical habitat and ecosystems services throughout the Northeast.



Forests, uplands, and marshes will either adapt to changing conditions by migrating landward or will become submerged.

Bluffs will erode, and barrier islands and beaches will migrate landward, erode, or narrow, particularly where sediment supply is limited.

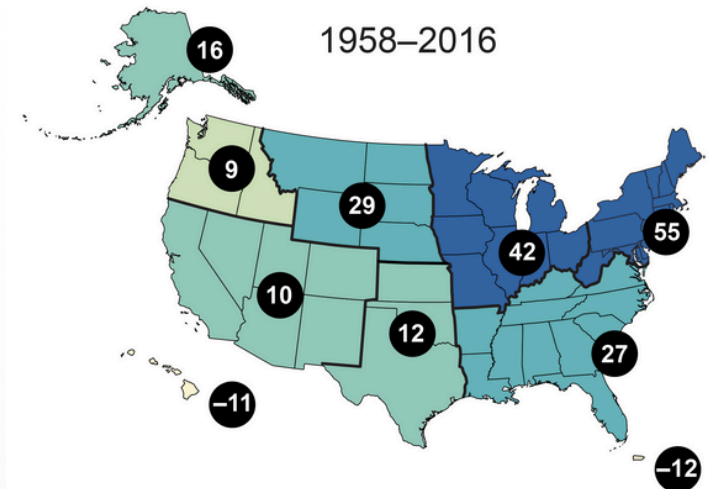


Source: National Climate Assessment, From Figure 18.7 (Source: U.S. Geological Survey)



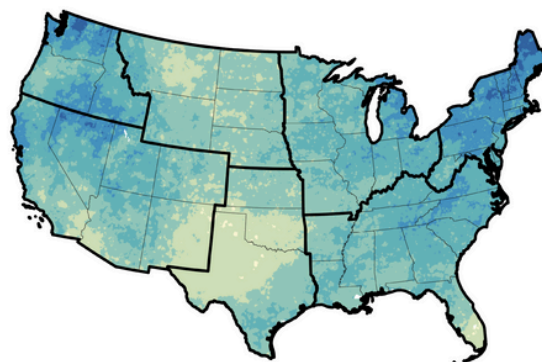
Extreme precipitation

- Historically, the NE has seen the greatest rise in extreme precipitation in the U.S.
- This trend is expected to continue
- Extreme precipitation can:
 - Cause flooding
 - Damage crops
 - Lead to water quality issues

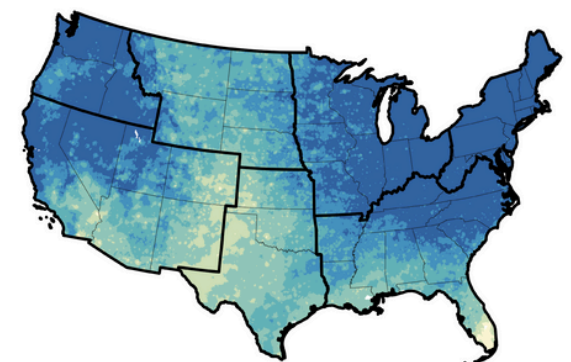


Projected Change in Total Annual Precipitation
Falling in the Heaviest 1% of Events by Late 21st Century

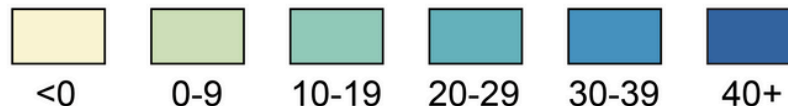
Lower Scenario (RCP4.5)



Higher Scenario (RCP8.5)



Change (%)



Heat Waves

- By 2050, average annual temperatures in the Northeast are expected to increase by 4.0°F (2.2°C) under the lower scenario (RCP4.5) and 5.1°F (2.8°C) under the higher scenario (RCP8.5) relative to the near present (1975–2005)
- In the Northeast we can expect approximately 650 more excess deaths per year caused by extreme heat by 2050 under either a lower or higher scenario (RCP4.5 or RCP8.5) and 960 (under RCP4.5) to 2,300 (under RCP8.5) more excess deaths per year by 2090

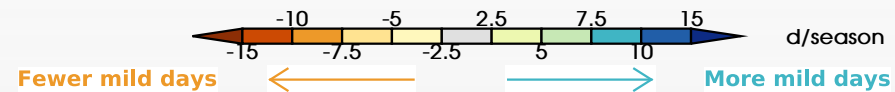
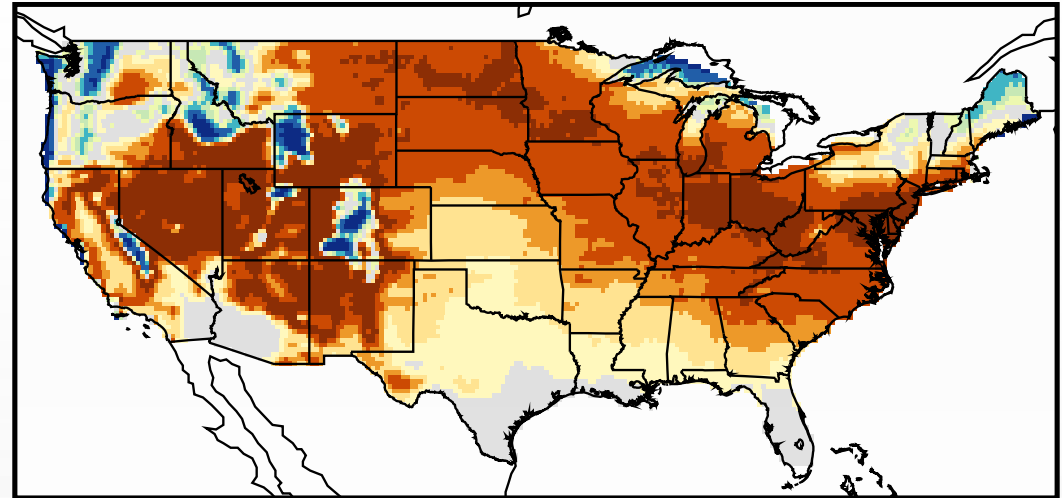
Change in “Mild Weather” Days

2081-2100 vs. 1986-2005, middle of the road scenario

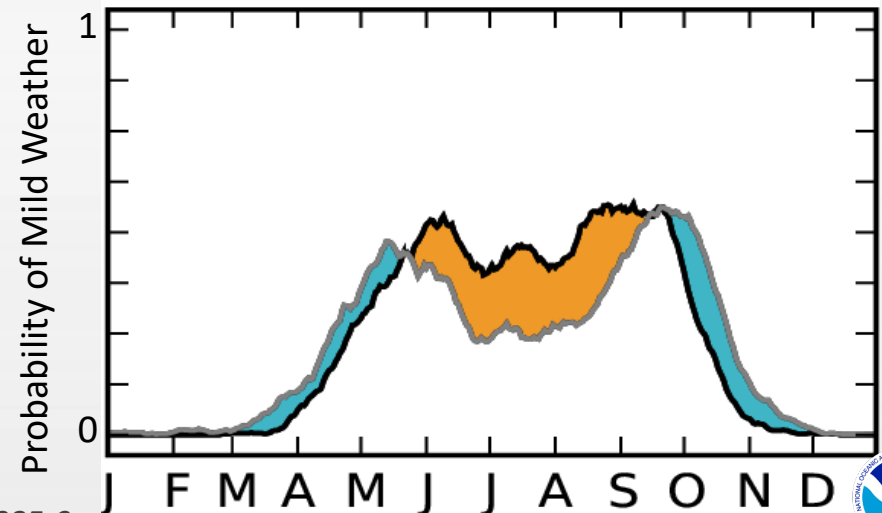
- Definition of a Mild Weather Day:
 - Daily maximum temperature between 64-86°F
 - Virtually no precipitation
 - Daily average dewpoint less than 68°F
- New York historically had **44** mild weather days during the summer, by the end of the century, we lose **17** (lost probability highlighted in orange to the right)

Summer

US mean: -9 days



New York City



Understanding Risk to Reduce Impacts

- **Risk Assessment** (before or after an event happens):
 - What is the likelihood of an event today?
 - What causes an event?
 - How are risks changing? Is the risk today different than the past? What do we expect in the future?
- **Risk Management** (reducing negative impacts):
 - Is an event predictable? How far in advance (weeks, months, seasons)?
 - How can we apply our knowledge of changing risks and prediction skill to inform risk management solutions via operations or data?
 - Can we provide better data for decision makers?



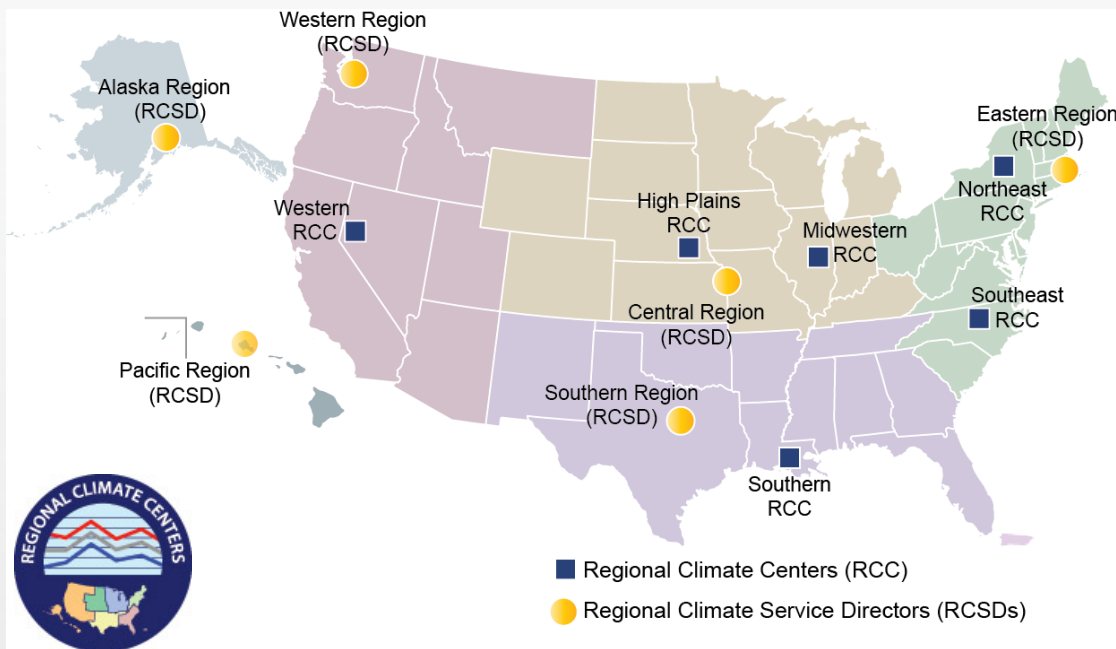
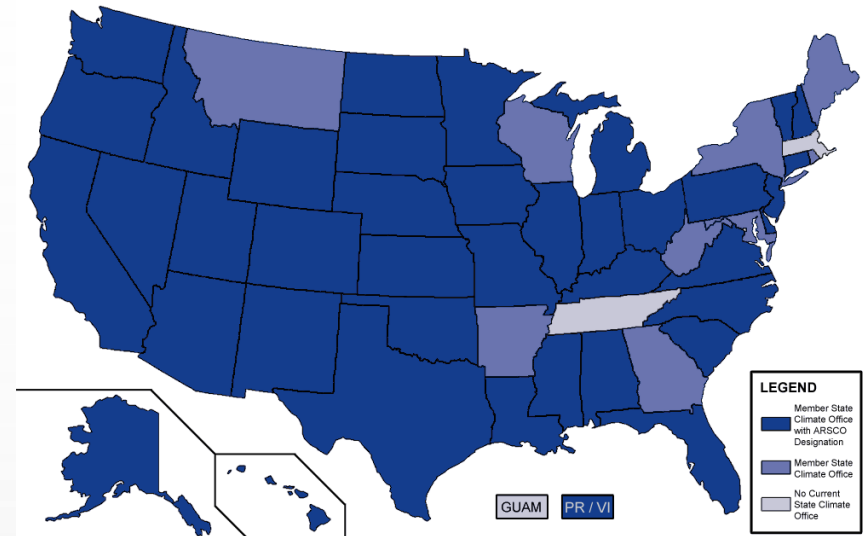
WHERE TO GO FOR FURTHER MATERIALS

Local Climate Knowledge & Services

NOAA's Regional Climate Services & State Climatologists

- Regional Climate Centers:
<https://www.ncdc.noaa.gov/customer-support/partnerships/regional-climate-centers>
- Regional Climate Services Directors:
<https://www.ncdc.noaa.gov/rcsd>

- State Climatologists: <http://stateclimate.org/>



National Resources

<https://www.ncdc.noaa.gov/billions/>

ABOUT CHAPTERS DOWNLOADS

FOURTH NATIONAL CLIMATE ASSESSMENT

Volume II: Impacts, Risks, and Adaptation in the United States

The National Climate Assessment (NCA) assesses the science of climate change and variability and its impacts across the United States, now and the future.

SUMMARY FINDINGS REPORT CH... OVERVIEW DOWNLOADS

Volume I presents an assessment of the physical science underlying this report: science2017.globalchange.gov

The US National Climate Assessment

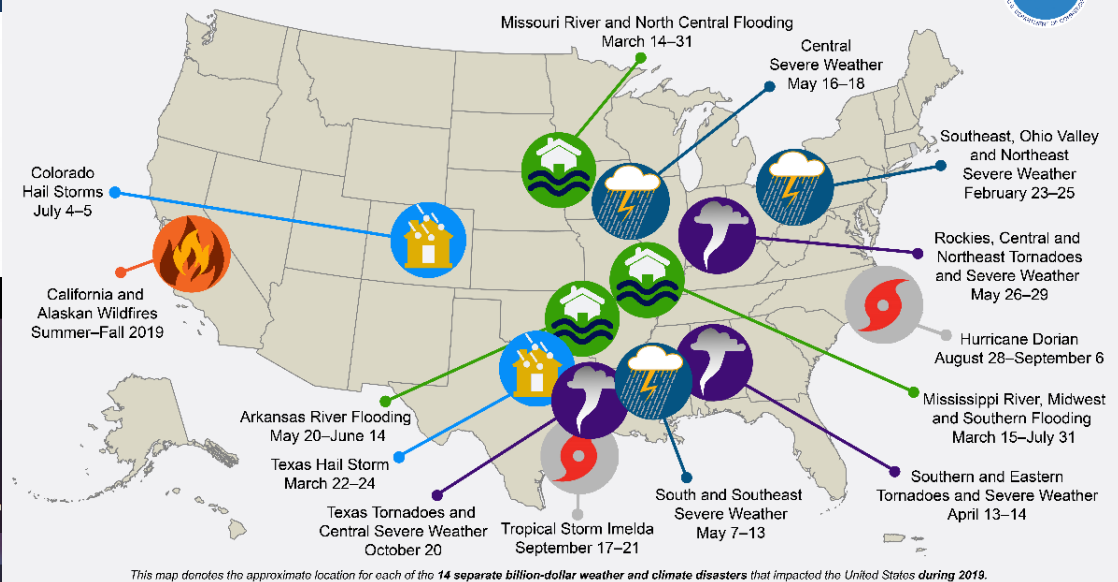
<https://nca2018.globalchange.gov/>

US Climate Resilience Toolkit:

<http://toolkit.climate.gov/>



U.S. 2019 Billion-Dollar Weather and Climate Disasters



U.S. Climate Resilience Toolkit

Steps to Resilience Case Studies Tools Expertise Regions Topics

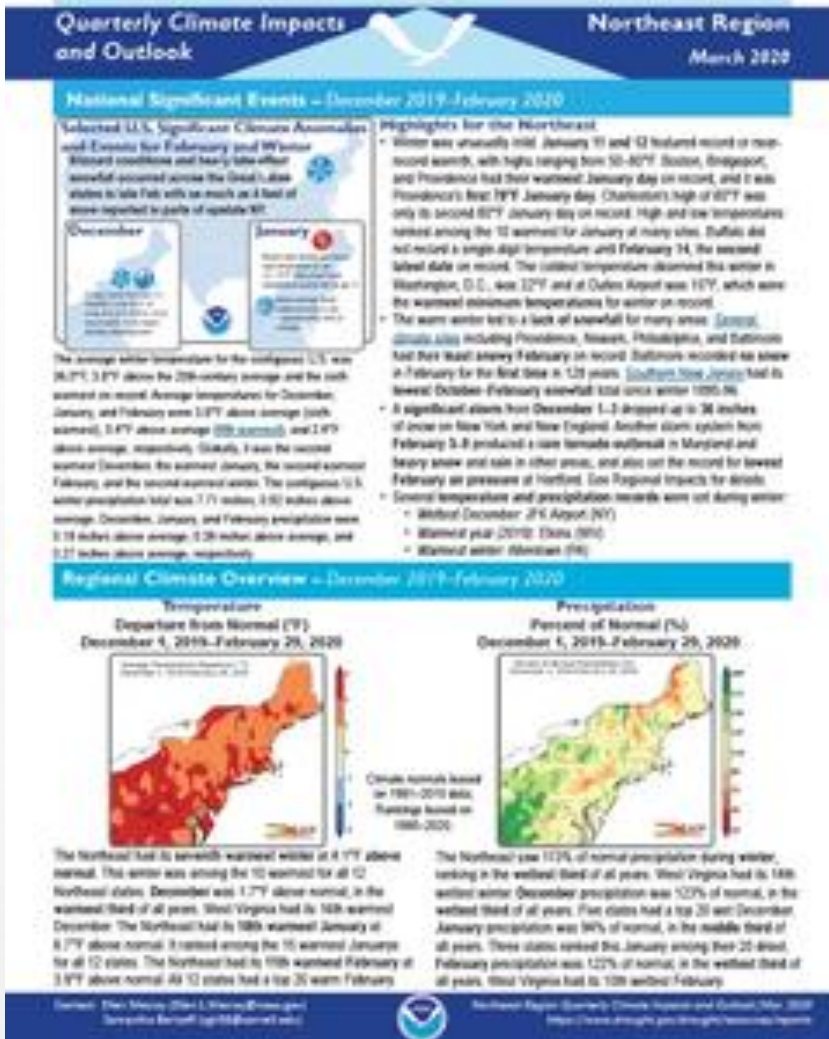
Meet the Challenges of a Changing Climate

Find information and tools to help you understand and address your climate risks.

LEARN ABOUT OUR RESILIENCE FRAMEWORK > SEE WHAT OTHERS ARE DOING > USE THE CLIMATE EXPLORER >

TOUR THE TOOLKIT v

Drought & User Friendly Maps



NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home Climate Information Data Access Customer Support Contact About

Home > Climate Monitoring > Climate at a Glance

Climate at a Glance

Climate Monitoring
State of the Climate
Temp, Precip, and Drought
Climate at a Glance
Extremes
Societal Impacts
Snow and Ice
Teleconnections
Monitoring References

Global National Regional **Statewide** Divisional County City

Mapping Time Series Rankings Haywood Plots Data Information Background

Statewide Mapping

Choose from the options below and click "Plot" to create a map. Select Temperature and Precipitation Maps are available for download.

State: Please note, Degree Days and Palmer Indices are not available for Alaska. Palmer Drought Severity Index (PDSI), Palmer Hydrological Drought Index (PHDI), and Palmer Modified Drought Index (PMDI) are not offered for multiple-month time scales. These data are available for bulk download.

Parameter:

Year:

Month:

Time Scale:

<https://www.ncdc.noaa.gov/cag/statewide/mapping>

<https://www.drought.gov/drought/resources/reports>



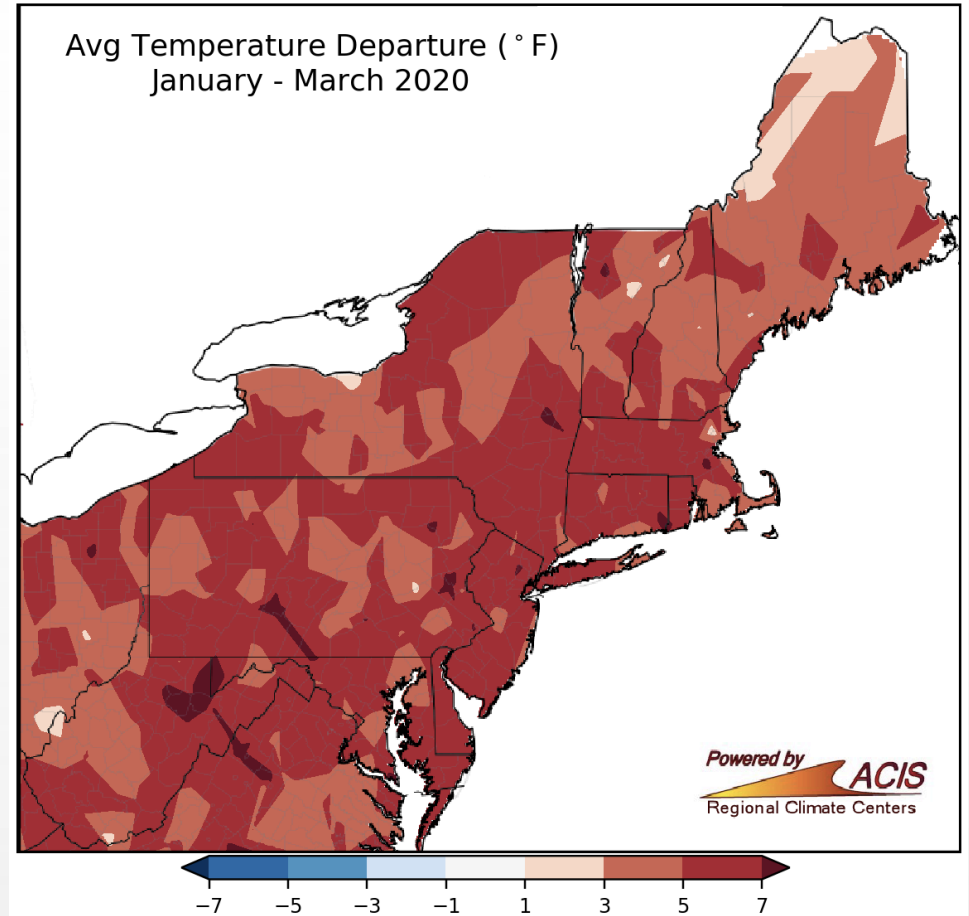
THANK YOU

Sarah.Kapnick@noaa.gov



Recently experienced climate

- 7th warmest winter (Dec-Feb) in NE region (+4.1°F) since 1895
- January 11th & 12th had a few days with record highs across the region, reaching 50-80°F



Map generated at: www.nrcc.cornell.edu/regional/monthly/monthly.html
Departure from 1981-2010 average