



Department of
Environmental
Conservation

DFS Webinar Series-

Physical Climate Risks in New York: Part 1



Mark Lowery

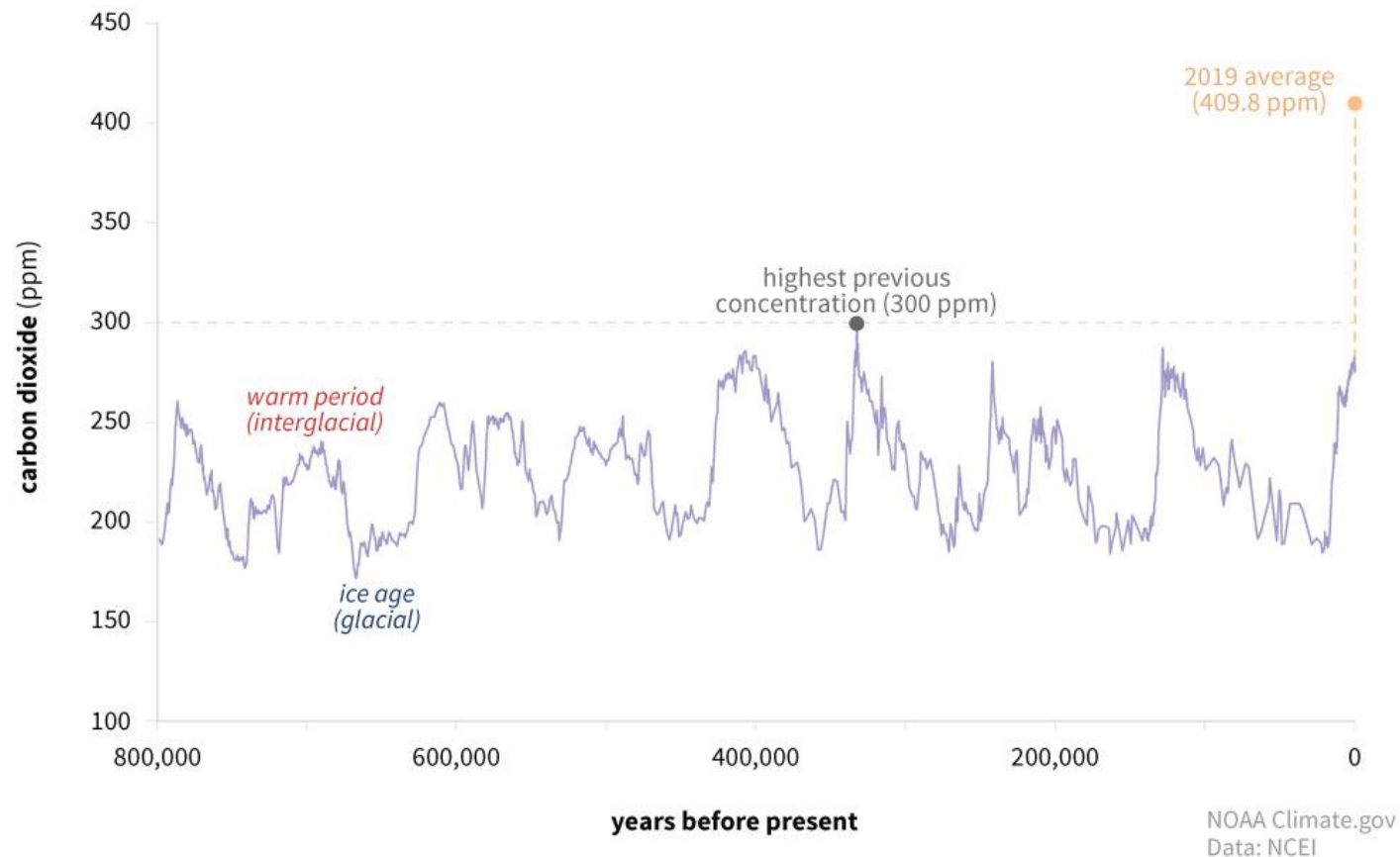
Assistant Director

Office of Climate Change

New York State Department of Environmental Conservation

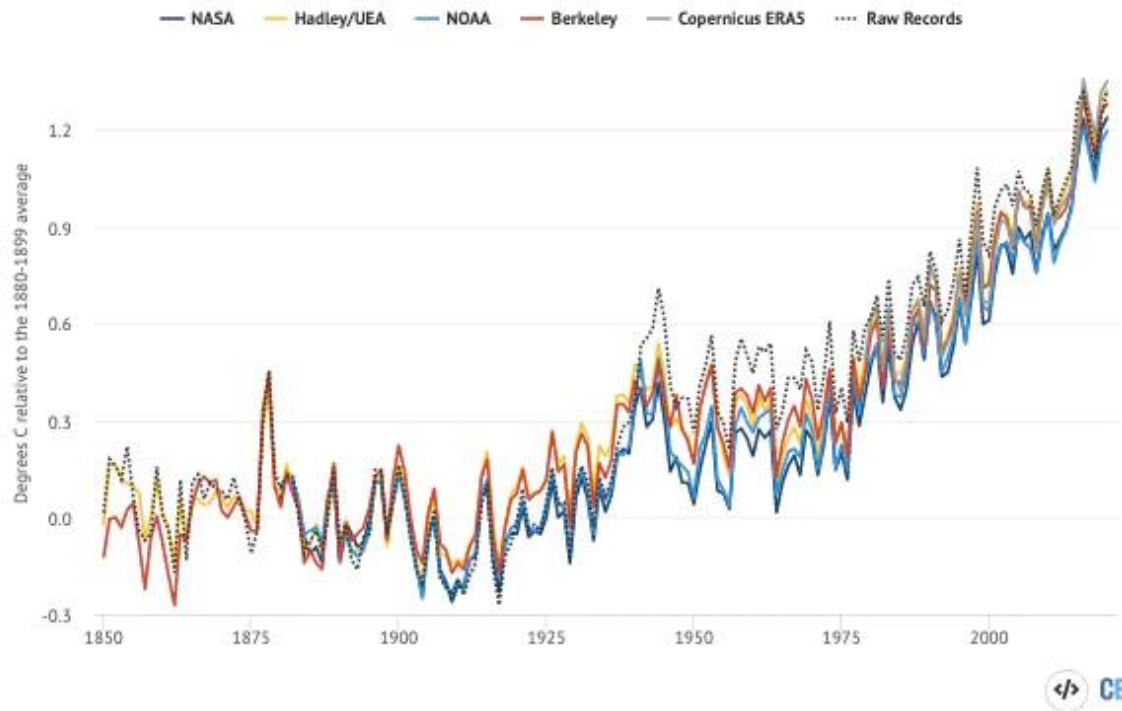
Carbon dioxide over 800,000 years

CARBON DIOXIDE OVER 800,000 YEARS



2020: Warmest (or 2nd warmest) on record

Global surface temperature records, 1850-2020

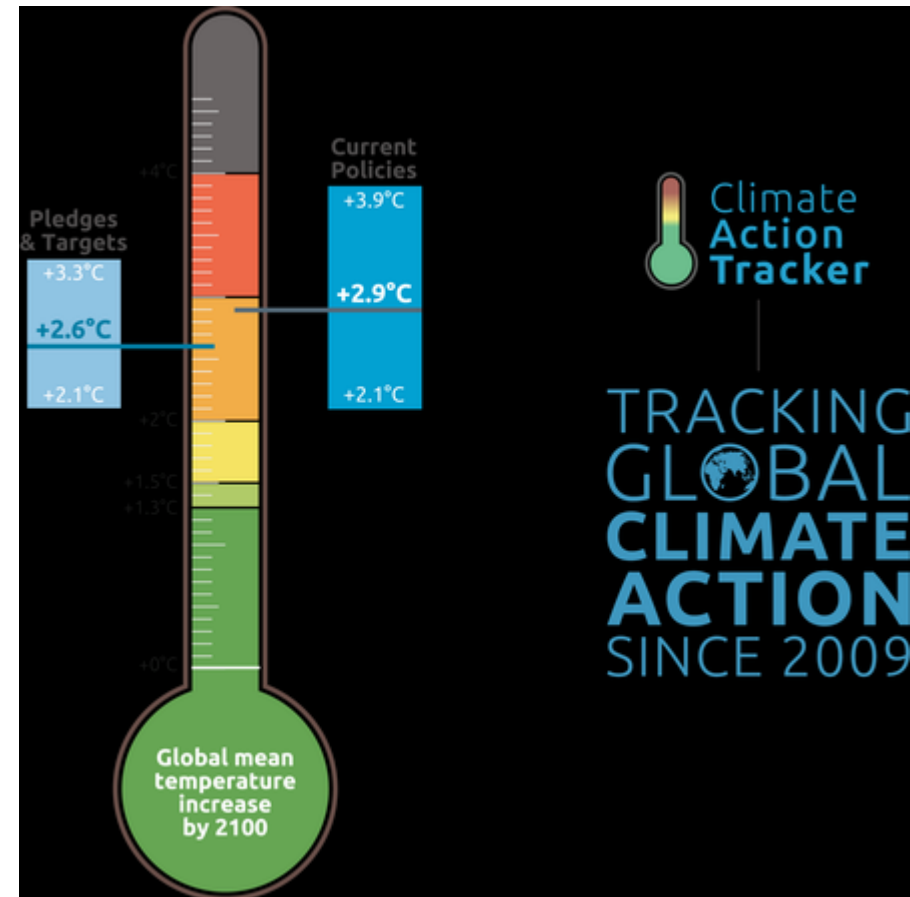


Annual global average surface temperatures from 1850-2020. Data from [NASA GISTEMP](#), [NOAA GlobalTemp](#), [Hadley/UEA HadCRUT5](#), [Berkeley Earth](#) and Carbon Brief's raw temperature record. 1979-2020 temperatures from [Copernicus ERA5](#) (as the reanalysis record starts in 1979). Anomalies plotted with respect to a 1880-1899 baseline to show warming since the preindustrial period. Chart by Carbon Brief using [Highcharts](#).

- 2020 and 2016 in a statistical tie
 - 2016 El Niño
 - 2020 La Niña
- 2020 1.2-1.3°C warmer than late 19th century

Significant Risk in Continuing GHG Emissions

- Economic damage attributable to climate change in the US will be in the 100s of billions of dollars per year by 2090 under a high emissions scenario – close to our current emissions track (NCA4).
- Even 1.5°C will carry significant risks, and risks are substantially higher at 2°C warming. Allowing warming of 1.5°C could trigger feedback loops with the potential to cause runaway warming.(IPCC)
- Current national commitments would lead to a 2.1-3.3°C rise. (Climate Action Tracker)
- On current track we will emit enough greenhouse gases by 2030 to make holding warming to 1.5°C impossible. (IPCC)



Effects in New York

- Higher temperatures
- More precipitation
- More frequent drought
- Sea-level rise
- More extreme events:
 - Floods
 - Heat
 - Ice/snow
 - Winds
 - Coastal storms
- Disease and pests



- Risks to people
- Stressed infrastructure
- Agricultural and ecosystem effects



Conservation Value Notes



Greenpeace International



NYSDEC



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T.B. Ryder



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Integrated Climate Assessments

- ClimAID
 - Published in 2011, updated in 2014
 - 24 global climate models
 - 2 Representative Concentration Pathways: 4.5, 8.5
 - 2020s, 2050s, 2080s, 2100
- Quantitative Projections
 - Temperature (mean and extreme events)
 - Precipitation (mean and extreme events)
 - Sea-level rise
- Qualitative Projections
 - Heat indices (heat and humidity)
 - Snow and ice storms
 - Lightning
 - Storms and tornadoes

- Sectors

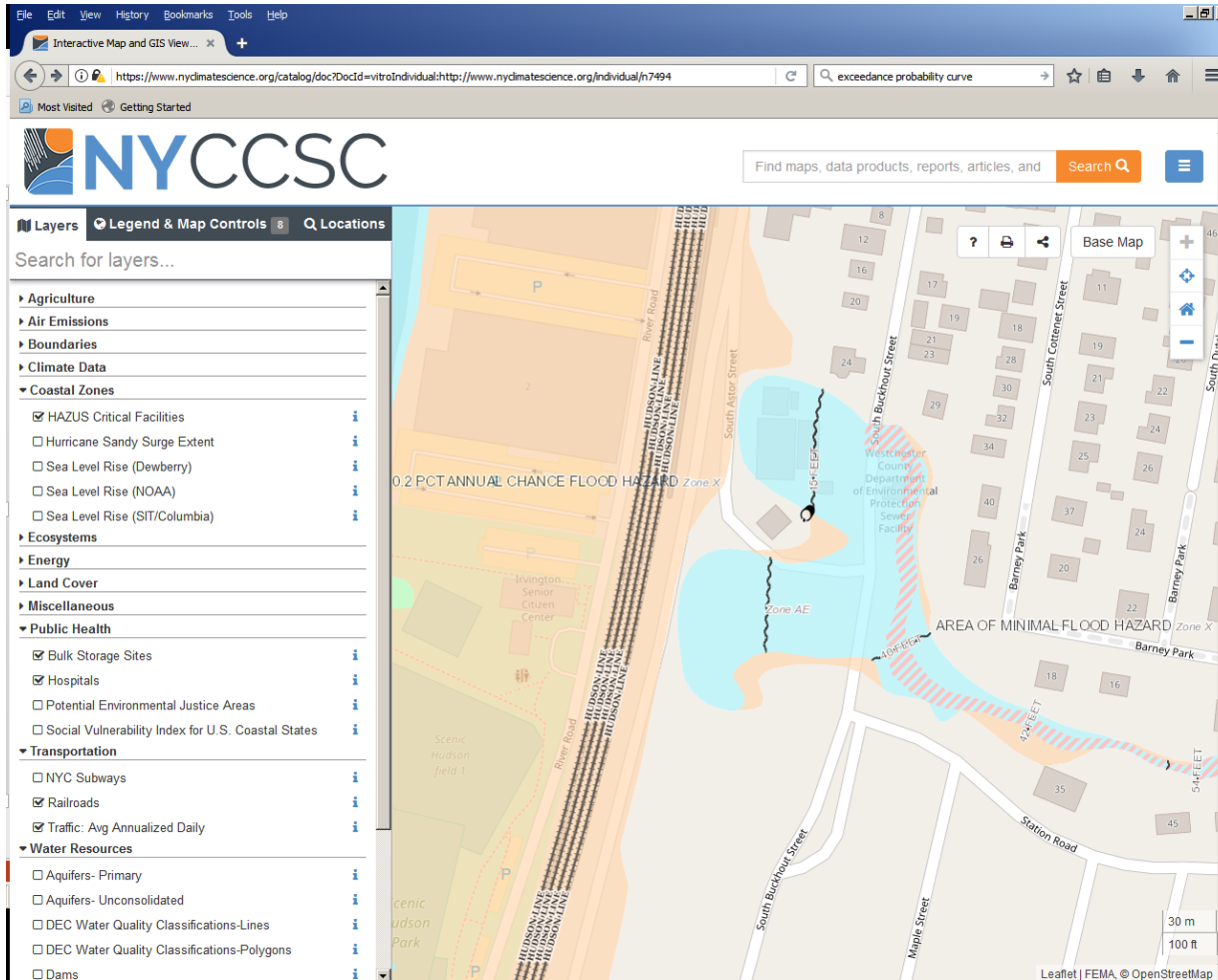
Agriculture	Public Health
Coastal Zones	Telecommunications
Ecosystems	Transportation
Energy	Water Resources



Climate Assessment Update

- Economic impacts
- Projections updates
- Sector-based impacts and adaptation

NY Climate Change Science Clearinghouse



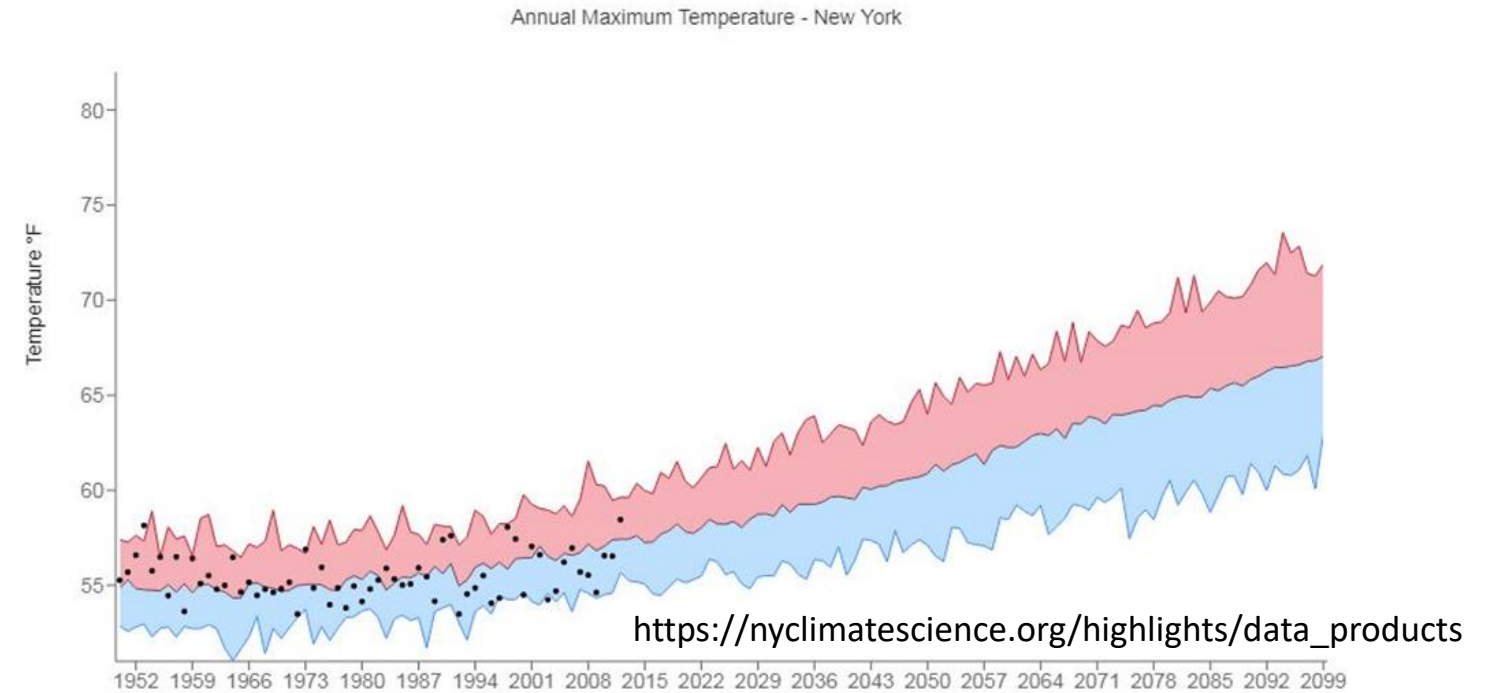
Clearinghouse:
Maps, data and
documents to
support decision
making

<https://www.nyclimatescience.org/>

Climate Data Grapher

Monthly, seasonal, and annual records:

- Daily maximum temperature (F)
- Daily minimum temperature (F)
- Daily average temperature (F)
- Growing degree day accumulation, base 50 F
- Heating degree day accumulation, base 65 F
- Cooling degree day accumulation, base 65 F
- Counts of days with maximum temperature above 90 F
- Counts of days with maximum temperature above 95 F
- Counts of days with maximum temperature above 100 F
- Counts of days with minimum temperature below 0 F
- Counts of days with minimum temperature below 32 F
- Total precipitation (inches)
- Total snowfall (inches; station data only)
- Maximum daily snow depth (inches; station data only)
- Counts of days with precipitation greater than 1 inch
- Counts of days with precipitation greater than 2 inches
- Counts of days with precipitation greater than 4 inches
- Counts of days with snow depth greater than 1 inch (station data only)
- Growing season length (station data only)



Observed and CMIP5 projected climate data at county and river-basin levels



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Northeast Regional Climate Center

NRCC Home Page

https://www.nrcc.cornell.edu

CLCPA MyDec DEC In-Site - Home The 7 climate tippin... An Excerpt from "A... Holidays and Obser... Climate Regulations... Holidays for May 1...

Northeast Regional Climate Center

Recent and historical weather data customized to meet your needs

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- Weather Station Data
- State & Regional Analyses
- Analyses for Industry
- Climate Resources
- Webinars & Workshops
- Publications & Services

Quick Links

Webinar

Blog

Like 1.4K

We appreciate any feedback:

Accumulated Precipitation – Boston Area, MA (ThreadEx)

Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values

Powered by ACIS

March 2016 Temperature Averages (°F)

State	Average	Departure	Rank	Coolest	Warmest
Connecticut	42.9	6.1	117	26.3 in 1916	45.8 in 2012
Delaware	49.2	5.2	118	32.2 in 1960	53.7 in 1921
Maine	29.0	2.1	97	17.0 in 1923	34.6 in 2010
Maryland	49.2	5.8	118	31.6 in 1960	53.0 in 1921
Massachusetts	41.0	5.7	116	25.7 in 1916	44.1 in 2012
New Hampshire	34.9	5.0	112	20.7 in 1916	38.9 in 2012
New Jersey	46.8	6.0	119	30.4 in 1916	49.8 in 2013
New York	37.6	5.9	113	21.5 in 1960	43.3 in 2012
Pennsylvania	43.2	6.4	117	24.5 in 1960	47.7 in 2012
Rhode Island	42.9	5.4	118	27.8 in 1916	45.5 in 2012
Vermont	33.3	4.9	111	18.6 in 2014+	38.7 in 2012
West Virginia	48.4	6.5	116	27.6 in 1960	52.6 in 2012
Northeast	39.8	5.4	114	24.6 in 1960	44.5 in 2012

Rankings are for the 122 years between 1895 and 2016. 1=coolest; 122=warmest.
Departures are calculated using the 1981-2010 normals.
+ indicates extreme also occurred in one or more previous years.

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- Weather Station Data
- State & Regional Analyses
- Analyses for Industry
- Turf Grass
- Apple Frost Risk
- Grape Bud Hardiness
- Roadway Freezing/Thawing
- Heating Degree Days
- Mosquito Control
- Extreme Precipitation
- East Coast Winter Storms
- Pest & Crop Management (NEWA)
- Emerald Ash Borer
- Gypsy Moth
- Lawn Watering
- Stewart's Disease Risk

Climate Resources

Webinars & Workshops

Publications & Services

Quick Links

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We appreciate any feedback: nrcc@cornell.edu

Periods to compare: (1981-2010) - (1971-2000)

Time period for map: Annual

Variable for map:

- Maximum Temperature
- Minimum Temperature
- Average Temperature
- Precipitation
- Snowfall
- Heating Degree Days
- Cooling Degree Days
- Growing Degree Days (Base 50)

Difference in Normal Max Temp (Deg F)
1981–2010 – 1971–2000 Annual

About Climate Normal Difference Maps

These maps compare the normals of temperature, precipitation, snow, HDD, CDD, and GDD for the different climate normals periods.

Climate normals are an arithmetic average of a variable such as temperature over a prescribed 30-year period. This base period changes every 10 years to reflect the previous 30 years of data.

For more information on climate normals, view the National Centers for Environmental Information's [U.S. Climate Normals page](#).

NRCC supports a three-tiered national climate services support program. The partners include: [State Climate Offices](#), [Regional Climate Centers](#), and the [National Centers for Environmental Information](#).

Mission Statement

Personnel

Links

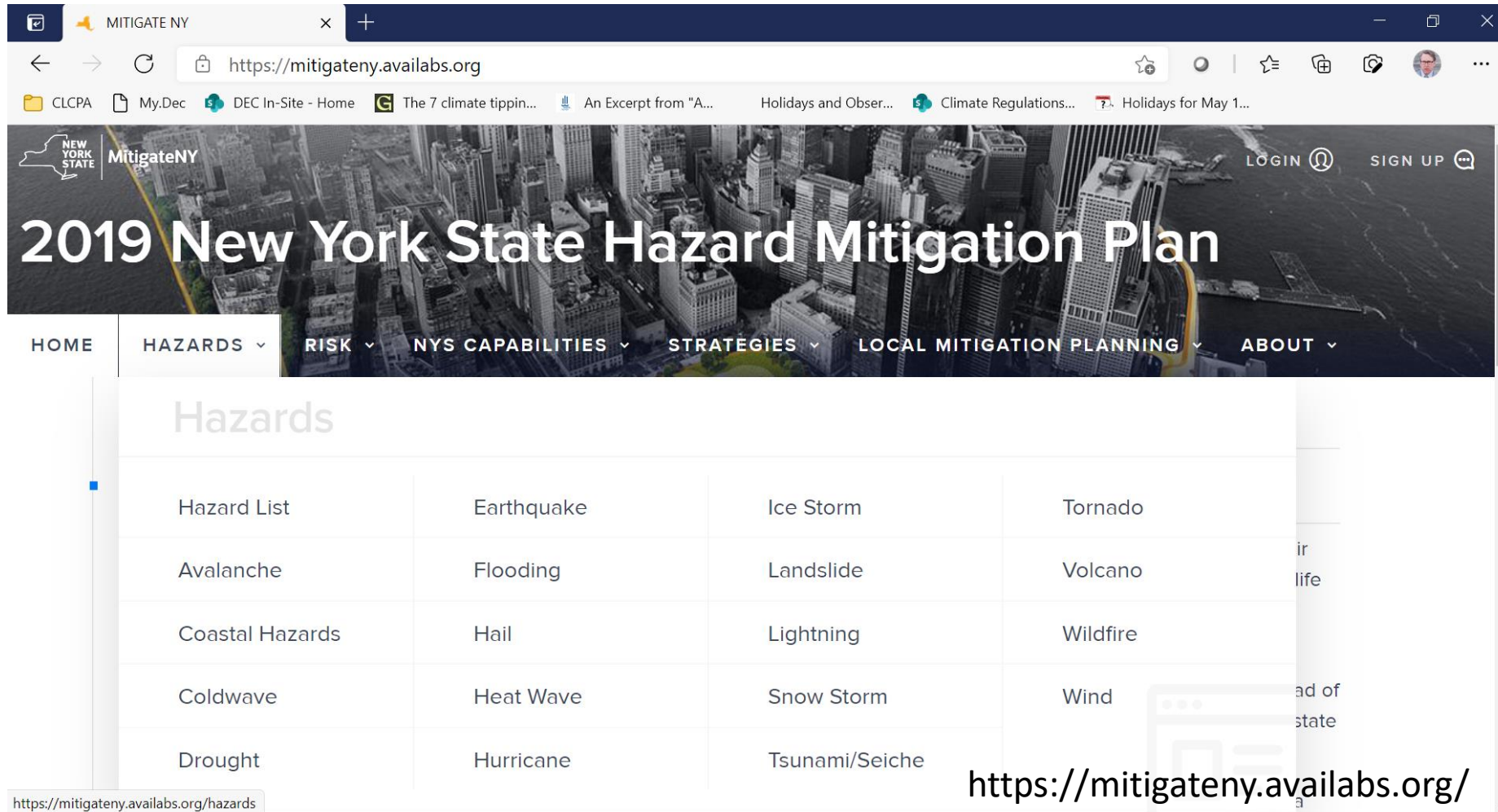
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Regional & Climate Centers

National Center for Environmental

Cornell University

<https://www.nrcc.cornell.edu/>

New York State Hazard Mitigation Plan



MITIGATE NY

https://mitigateny.availabs.org

CLCPA MyDec DEC In-Site - Home The 7 climate tippin... An Excerpt from "A... Holidays and Obser... Climate Regulations... Holidays for May 1...

NEW YORK STATE MitigateNY

2019 New York State Hazard Mitigation Plan

LOGIN SIGN UP

HOME HAZARDS RISK NYS CAPABILITIES STRATEGIES LOCAL MITIGATION PLANNING ABOUT

Hazards

Hazard List	Earthquake	Ice Storm	Tornado
Avalanche	Flooding	Landslide	Volcano
Coastal Hazards	Hail	Lightning	Wildfire
Coldwave	Heat Wave	Snow Storm	Wind
Drought	Hurricane	Tsunami/Seiche	

https://mitigateny.availabs.org/hazards

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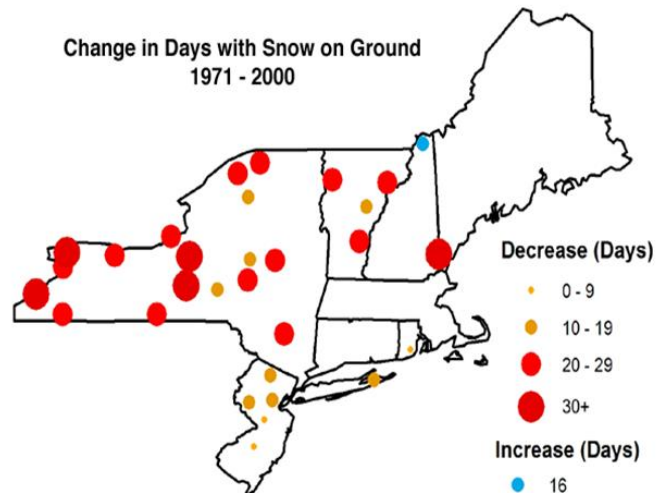
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https://mitigateny.availabs.org/

Increased Mean Annual Temperature (very likely)

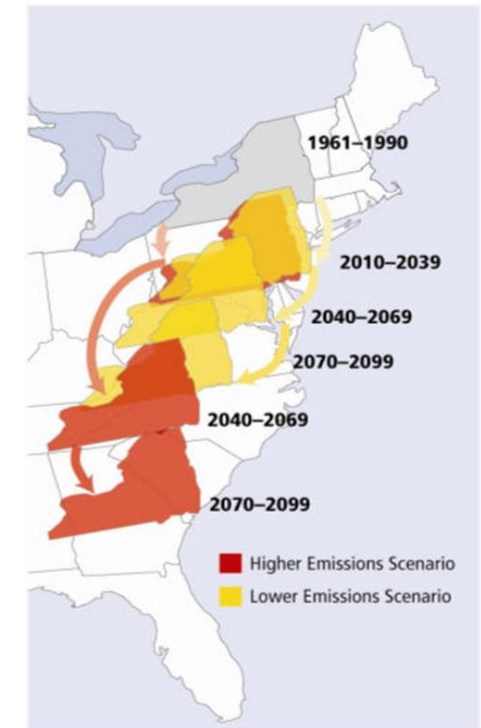
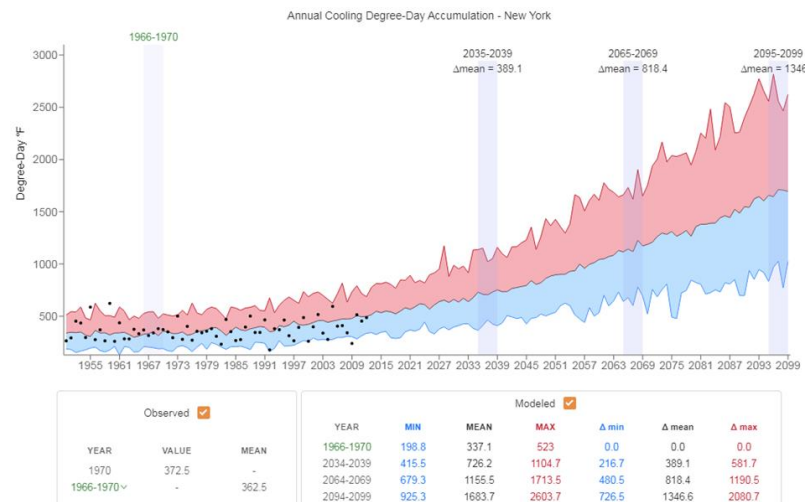
NYS since 1970

- Annual mean +1.3°C (2.3°F)
- Winter mean +2.4°C (4.3°F)
- Less snow cover



Projections (Capital Region)

- Warmer!
 - up to 3.9°C by 2050s
 - up to 6.3°C by 2080s
 - up to 7.6°C (13.6°F) by 2100



Vulnerabilities to Increasing Temperature

- Increased strain on A/C capacity
- Increased demand on water supplies
- Increased algal growth in water bodies
- Insects see more generations per season
- Increased weed, disease, and insect pressure
- Reduced water cooling capacity
- Sagging power lines
- Wear on transformers
- Increased energy demand
- Increased strain on runway material
- Rail buckling
- Increased strain on bridge materials



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More Extreme-heat Events (very likely)

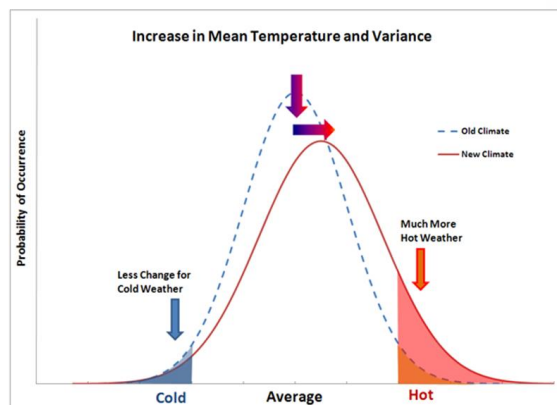
Capital Region



More extreme heat days
($> 90^{\circ}\text{F}$)

- 14 to 23 days by 2020s (instead of 10!)
- 27 to 82 days by 2080s

More heat waves

- 2 to 4 by 2020s (instead of 1!)
- 4 to 9 by 2080s



Observed 			Modeled 						
YEAR	VALUE	MEAN	YEAR	MIN	MEAN	MAX	Δ-min	Δ-mean	Δ-max
1995-2002	-	3.3	1995-2002	0.1	4.8	19.2	0.0	0.0	0.0
2003	11.2	-	2034-2039	2.1	17.2	47	2.0	12.4	27.6
1995-2002 -	-	-	2064-2069	6.6	37.5	73.8	6.5	32.5	63.6
			2094-2099	13.9	65.4	113	13.8	60.6	93.8

Adapted from IPCC (2001)



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Vulnerabilities to Extreme Heat Events

- Increased strain on A/C capacity
- Crop and livestock stress
- Increased energy demand/power failures
- Increased strain on runway material
- Rail buckling
- Increased strain on bridge materials

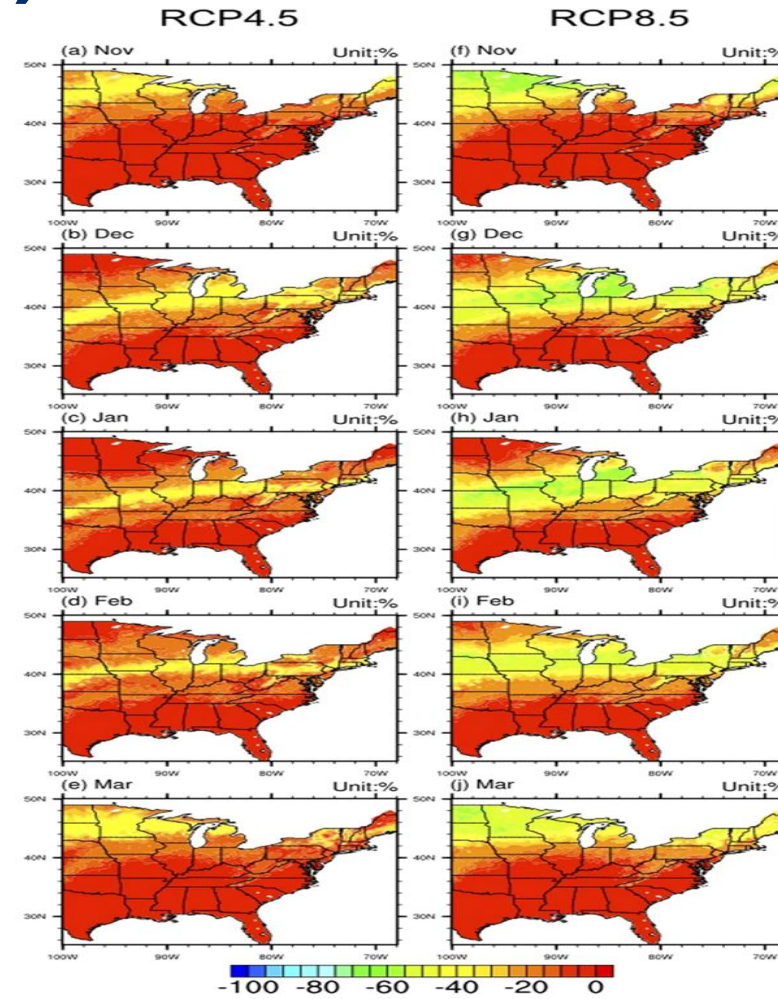


AP Photo/Peter Morgan



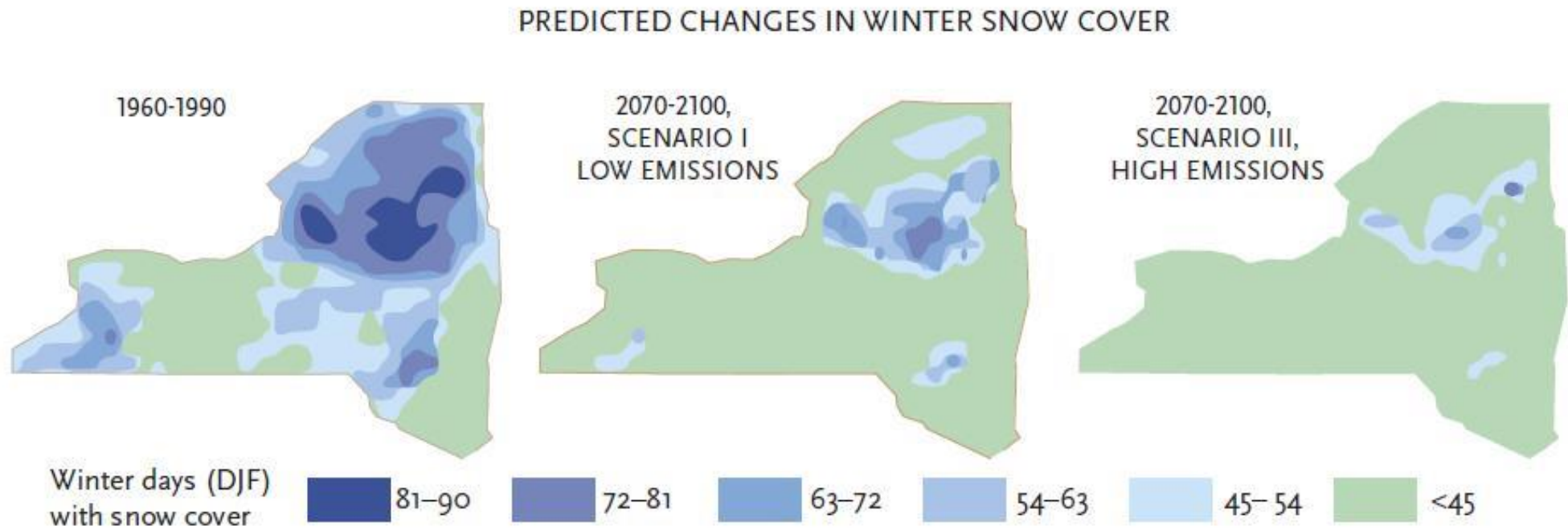
Warmer winters (very likely)

- Longer growing season
- Earlier blooming of perennials
- Not enough freeze days for certain crops
- Increased freeze or frost damage of woody perennials
- Potential changes in sap flow
- Increased winter survival of deer populations
- Increased survival of insect pests
- Earlier arrival of migratory birds
- Northward expansion of invasive weeds



Changes in ensemble averaged snow frequency relative to historical simulation (Unit: %). Ning et al., 2015.

Recreation and Tourism Effects



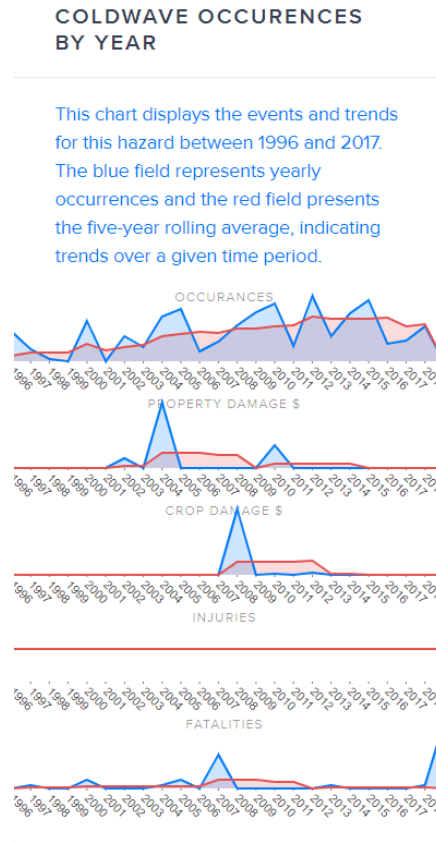
From: Climate Change in the Adirondacks, J. Jenkins



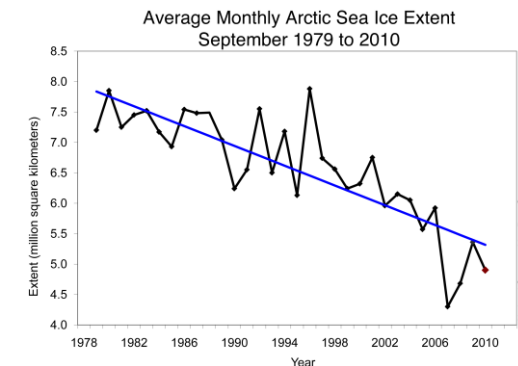
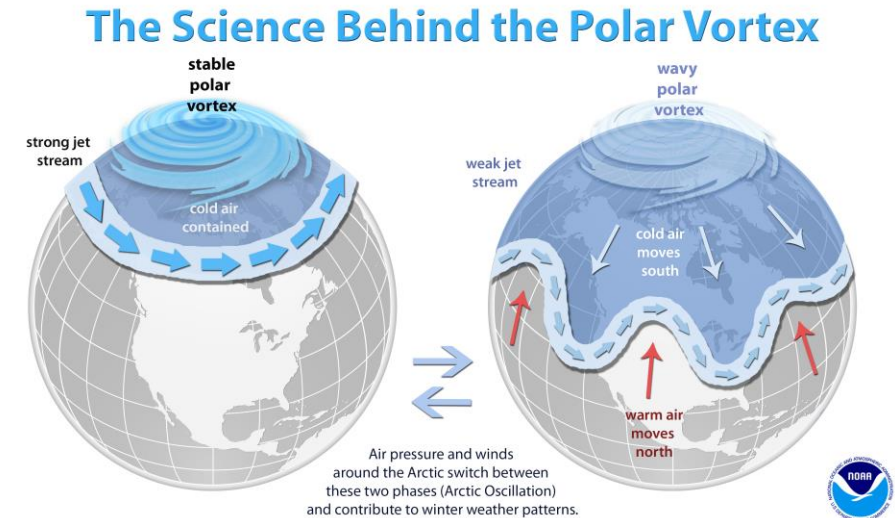
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Fewer Extreme Cold Events (likely overall, but potential for extreme cold)

- Extreme Cold
 - Damage to property, public infrastructure
 - Crop damage
 - Demand for electricity (heating)
 - Fatalities



Source: NOAA NCEI Storm Events Dataset



Increased mean annual precipitation (more likely than not)

Region 1 (Rochester) – Precipitation

Baseline (1971-2000) 34.0 inches	Low Estimate (10th Percentile)	Middle Range (25th to 75th Percentile)	High Estimate (90th Percentile)
2020s	0 percent	+ 2 to + 7 percent	+ 8 percent
2050s	+ 2 percent	+ 4 to + 10 percent	+ 12 percent
2080s	+ 1 percent	+ 4 to + 13 percent	+ 17 percent
2100	- 3 percent	+ 4 to + 19 percent	+ 24 percent

Region 4 (New York City) – Precipitation

Baseline (1971-2000) 49.7 inches	Low Estimate (10th Percentile)	Middle Range (25th to 75th Percentile)	High Estimate (90th Percentile)
2020s	- 1 percent	+ 1 to + 8 percent	+ 10 percent
2050s	+ 1 percent	+ 4 to + 11 percent	+ 13 percent
2080s	+ 2 percent	+ 5 to + 13 percent	+ 19 percent
2100	- 6 percent	- 1 to + 19 percent	+ 25 percent

- Increased across state since 1900
- More variable
- Shift to winter
- Projections less certain than for temperature

Vulnerabilities to Increased Mean Annual Precipitation/Flooding

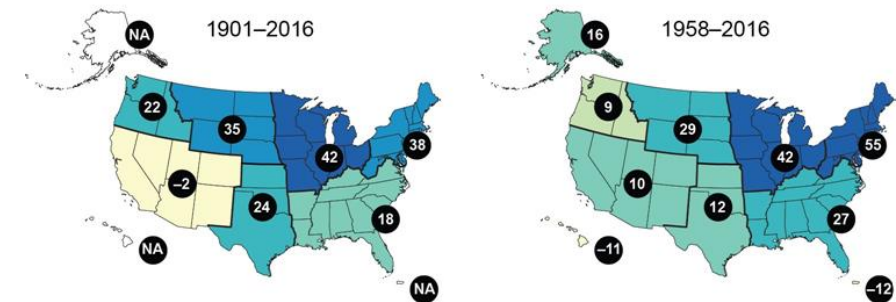
- Urbanized watersheds rapidly aggregate water and have a limited capacity to attenuate rainfall inputs flow/flooding in large basins
- Increased turbidity of water supply reservoirs
- Increased flooding of wastewater treatment plants
- Increased flooding resulting in inability to access agricultural fields during critical times
- Increased flooding risk could delay spring planting and harvest
- Increased soil compaction because of tractor use on wet soils



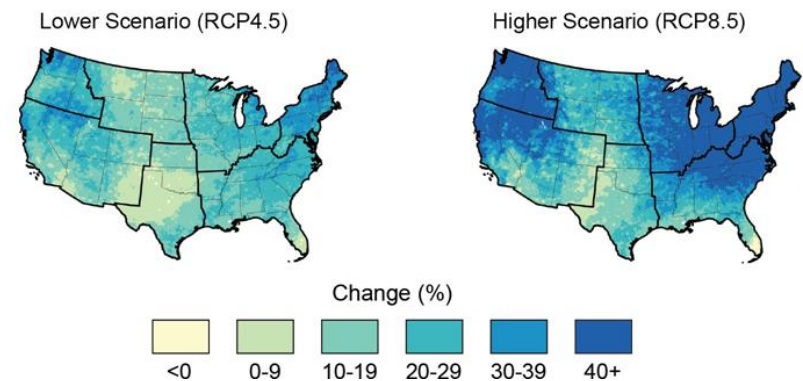
Extreme Precipitation/Flooding (more likely than not)

- Primary weather hazard in NYS
- “Where it rains, it can flood”
- Significant shift to extreme precipitation events, more to come
- 1996-2018 (not including hurricanes)
 - Avg. annual loss: \$130 million
 - Avg. annual flooding episodes: 80
 - Avg. annual severe flooding episodes: 7
 - Total flooding fatalities: 84

Observed Change in Total Annual Precipitation
Falling in the Heaviest 1% of Events



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



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Resources: Future Extreme Precipitation

Extreme Precipitation in New York & New England
An Interactive Web Tool for Extreme Precipitation Analysis

About this Project **Data & Products** **Daily Monitoring** **Documentation**

Select Product?

- Extreme Precipitation Tables - HTML
- Extreme Precipitation Tables - Text/CSV
- Partial Duration Series - by Point
- Partial Duration Series - by Station
- Distribution Curves - Graphical
- Distribution Curves - Text/TBL
- Intensity Frequency Duration Graphs
- Precipitation Frequency Duration Graphs
- GIS Data Files
- Regional/State Maps

Select Location? Double-click the map to place a marker, or enter address or latitude/longitude.

Map Satellite

Locate by Address? Locate by Lat/Lon? Locate by State/County?

Map data ©2021 Google Imagery ©2021 TerraMetrics Terms of Use

Select Options?

Smoothing?

Submit

Version 1.12 Copyright 2010-2021.
This project is a joint collaboration between:

Northeast Regional Climate Center (NRCC) Natural Resources Conservation Service (NRCS)

USDA NRCS

Contact: precip@cornell.edu

<http://precip.eas.cornell.edu/>

Intensity Duration Frequency Curves for New York State
Future Projections for a Changing Climate

Station-specific IDF Graphs **Statewide Maps of Projected Changes** **Probability of Occurrence** **Technical Document**

Select a Station Location by Clicking Map

Select a RETURN PERIOD: 2-yr 5-yr 10-yr 25-yr 50-yr 100-yr

Select an EMISSION SCENARIO: High RCP 8.5 Low RCP 4.5

Select a TIME PERIOD: 2010-2039 2040-2069 2070-2099

Show NOAA Atlas 14 IDF ☐

Need Help? View an Instructional Video

About this Project Numerous studies have documented significant increases in both the frequency and magnitude of extreme precipitation in the northeastern U.S. since the mid-to-late 20th century. The most recent assessment from the Intergovernmental Panel on Climate Change (IPCC) suggests that the frequency and magnitude of extreme precipitation in this region will likely continue to increase throughout the 21st century. Such changes could greatly exacerbate the societal impacts of extreme precipitation in the future. In consideration of these impacts, the Northeast Regional Climate Center (NRCC) has partnered with the New York State Energy Research and Development Authority (NYSED) to downscale global climate model output and create extreme precipitation projections that will ultimately be incorporated into climate change adaptation planning for New York State. [Read more...](#)

Intensity Duration Frequency Curves: 100-yr Return Period RCP 8.5 Projection 2040-2069 vs. Observed (1970-1999)

ITHACA

Intensity (inches/hour)

Duration (hours)

80% Range of Model Projections
Observed 90% Confidence Interval
Projected Mean
Observed 1970-1999

Duration (hr)	Projected 2040-2069 Intensity				Observed 1970-1999 Intensity			
	10 th	Mean	90 th	Ensemble Member	Low CI	Mean	High CI	
1	2.38	2.67	3.08	1.98	2.31	2.45		
2	1.47	1.65	1.91	1.23	1.43	1.52		
5	1.11	1.25	1.44	0.93	1.08	1.12		
6	0.69	0.77	0.89	0.57	0.67	0.71		
12	0.48	0.48	0.55	0.36	0.42	0.44		
18	0.32	0.36	0.42	0.27	0.31	0.33		
24	0.27	0.30	0.34	0.22	0.26	0.27		

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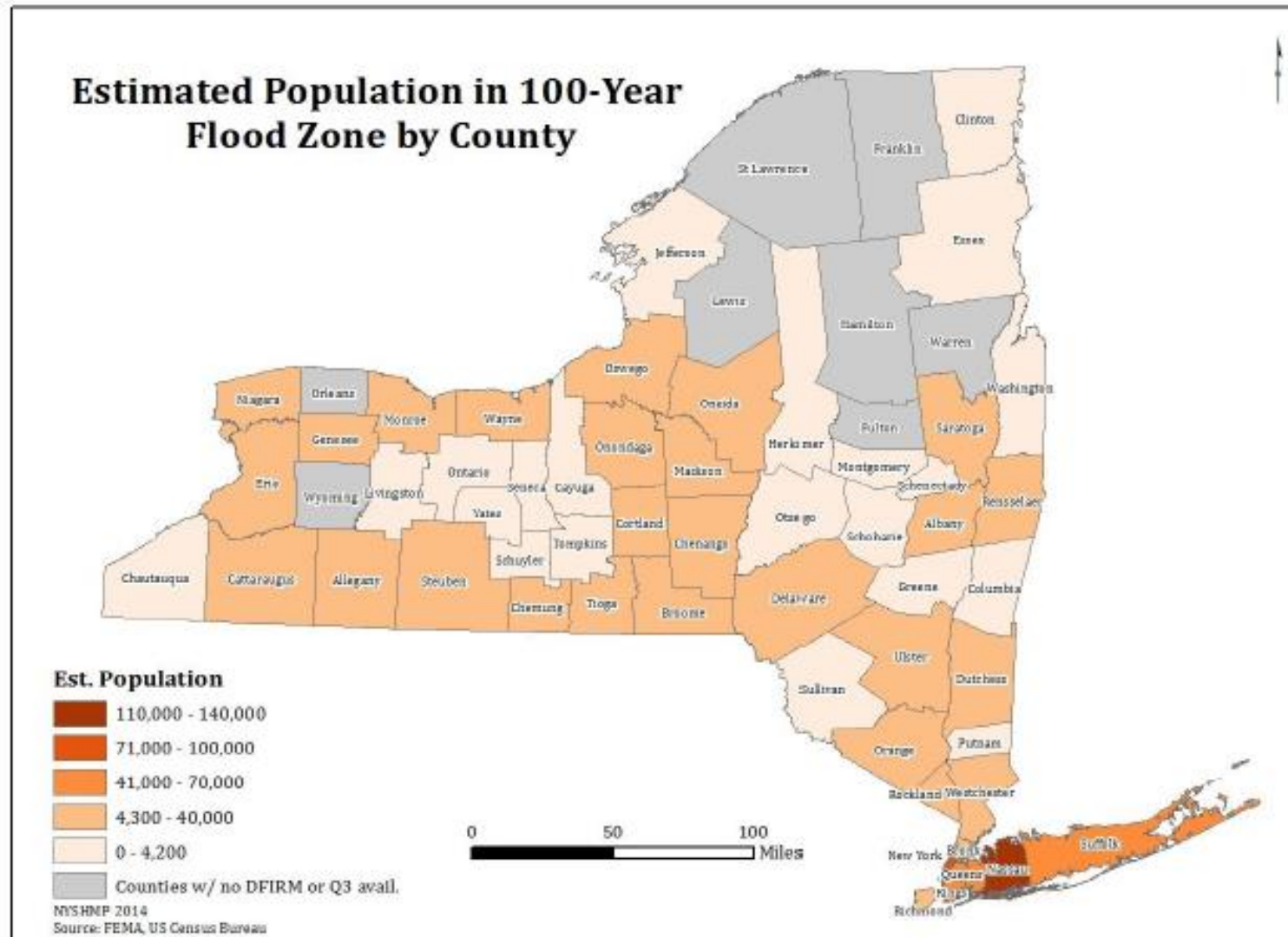
Cornell University

<http://ny-idf-projections.nrcc.cornell.edu/>



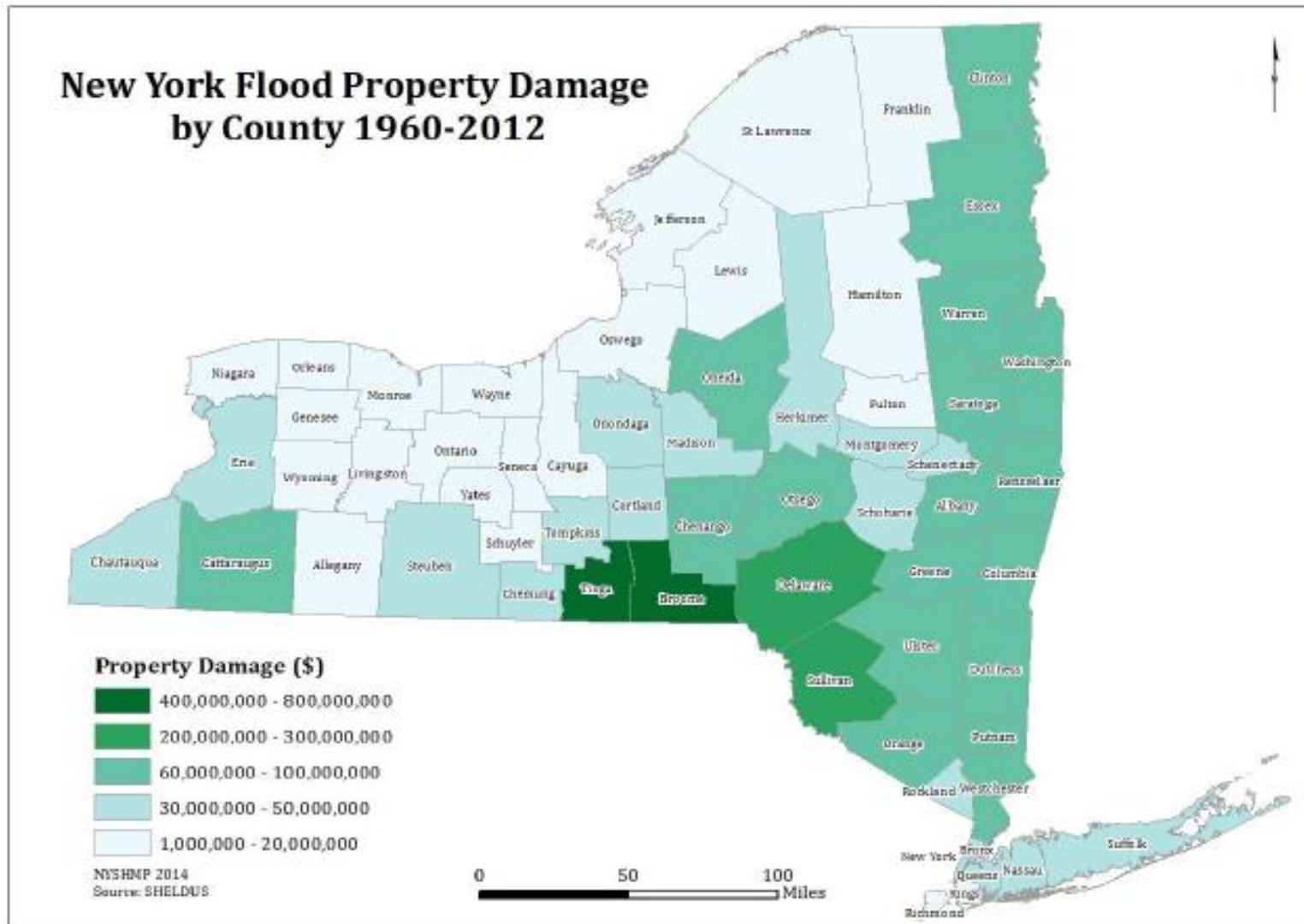
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Flood Risk in New York



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Flood Risk in New York



NYS Insured Losses

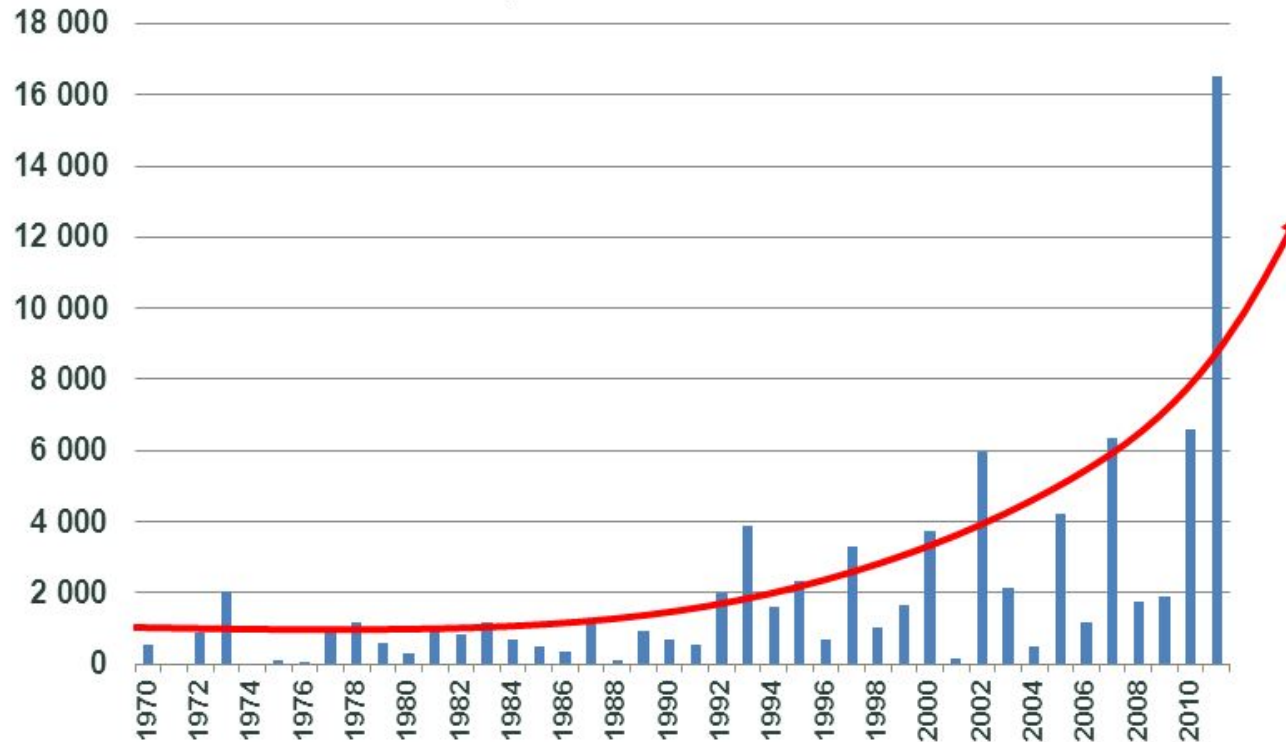
Decade	Losses (millions)
1950s	\$44
1960s	\$37
1970s	\$866
1980s	\$152
1990s	\$757
2000s	\$762
2010s	\$11,547



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Increasing Flood Damage Nationally

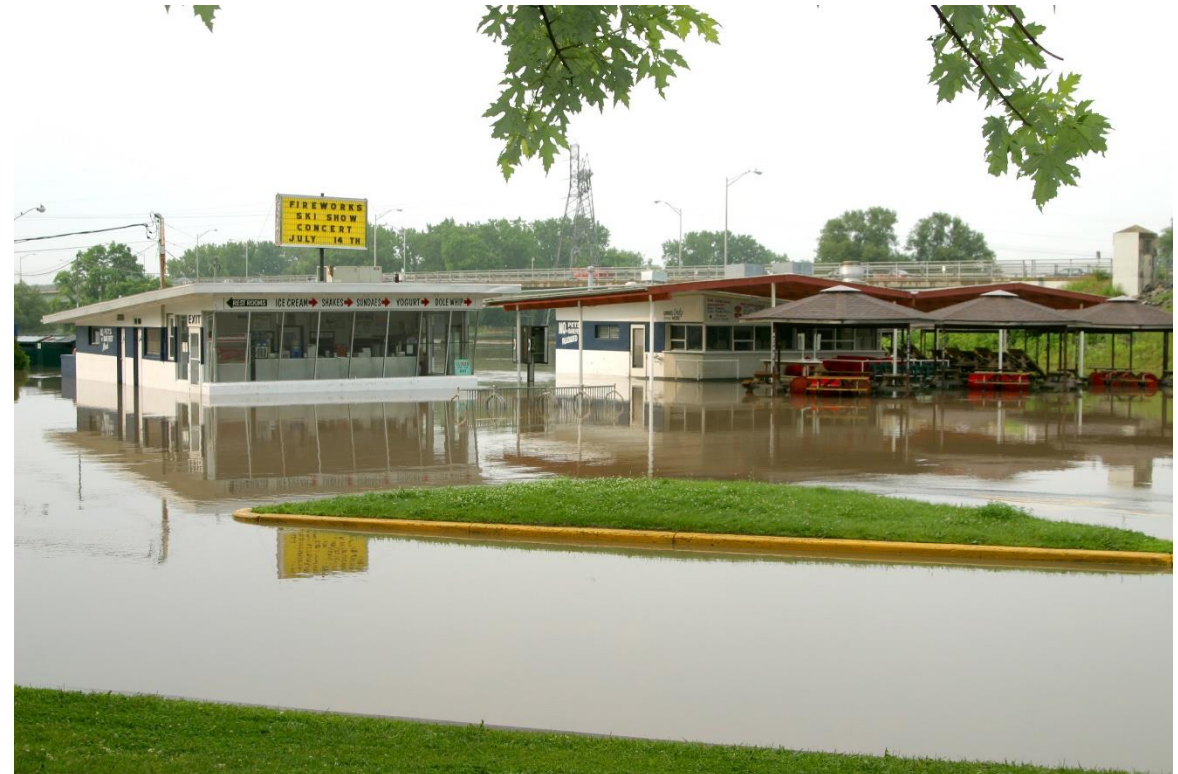
insured loss in m USD at 2011 price



- National flood damage costs are increasing
 - Function of changing precipitation, floodplain development, real estate values
 - Ca. 33% losses in X zone
 - Riverine SFHAs 45% broader and deeper by 2100, 55% for coastal SFHAs
- NFIP premiums 10 to 70% higher

Vulnerabilities to Extreme Precipitation/Flooding

- Increased runoff and reduced infiltration of rain into natural ground cover and soils
- Stress on crops, especially if extreme events occur in clusters
- Low lying areas susceptible to more frequent flooding
- Increased scour potential for bridge foundations
- Damage to road and rail embankments
- Spread of contamination
- Mudslides and landslides



Community Risk and Resiliency Act Guidance Documents

- Using Natural Measures to Reduce the Risk of Flooding and Erosion
- New York State Flood Risk Management Guidance
- Guidance for Smart Growth Public Infrastructure Assessment
- Estimating Guideline Elevations

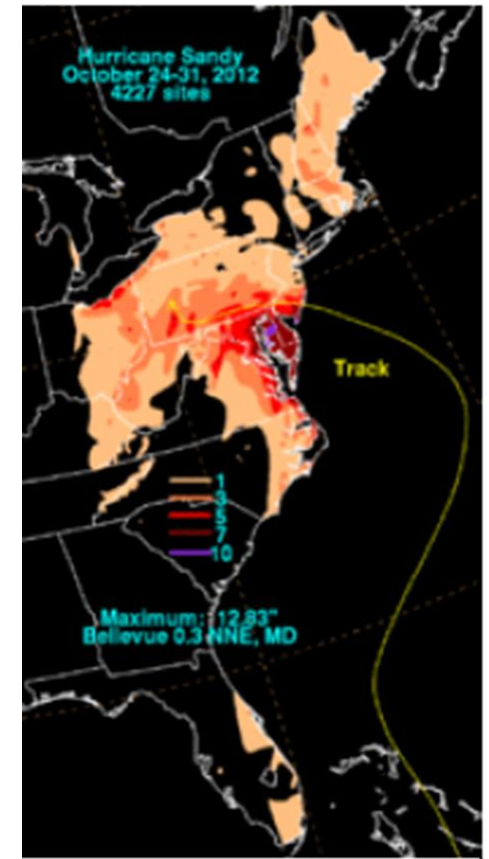
<https://www.dec.ny.gov/energy/102559.html>



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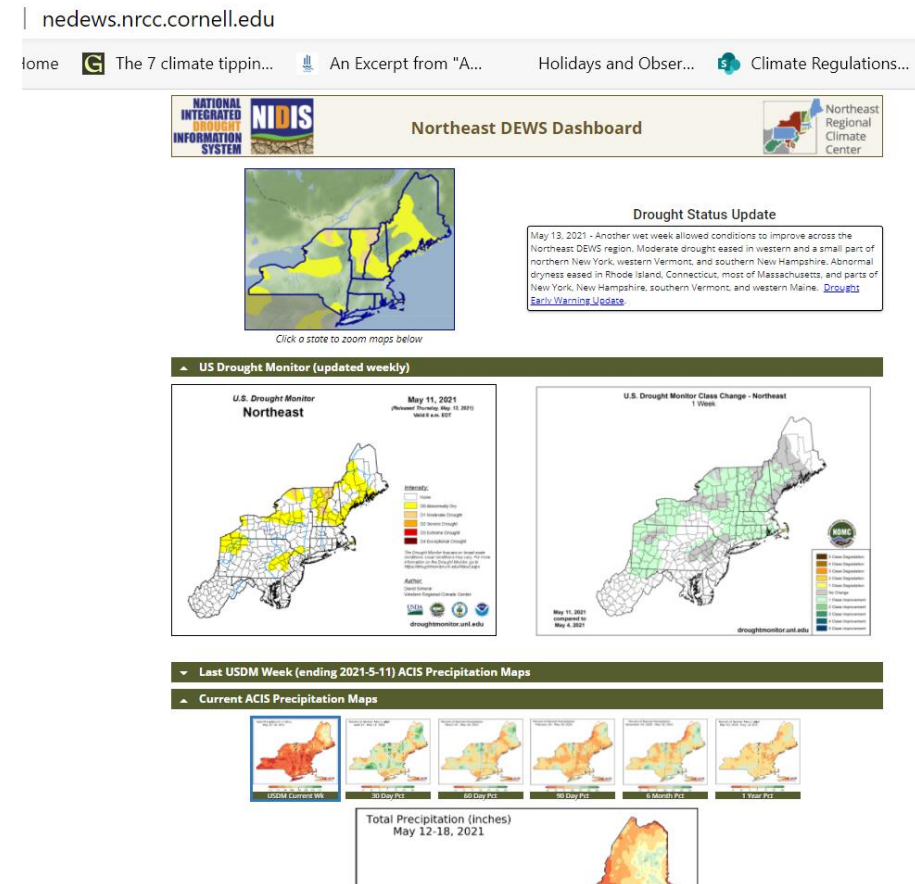
Coastal Storms (uncertain)

- Tropical cyclones:
 - Hurricanes, tropical storms
 - July –October
 - Storm surge, high winds, heavy rain
- Nor'easters
 - September – April
 - High winds, wave action, several tide cycles



More Frequent Drought (uncertain)

- Summer droughts likely more frequent
- Trend in multi-year droughts
- Exacerbated by high temperatures
- Long-range projections not available



<http://nedews.nrcc.cornell.edu/>



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Vulnerabilities to Drought

- Changes in groundwater depths
- Dry streams or wells
- Seasonal variation in reservoir inflow and aquifer recharge
- Reduced supply in shallow wells, wells in moderately productive aquifers and small reservoirs
- Greater competition for water between potable, commercial uses, and ecological needs
- Decrease in availability for equipment cooling industrial and power-generation equipment
- Increased crop root disease and anoxia
- Increased stress on agricultural and native plants
- Inadequate irrigation capacity for some high value crop growers
- Lower water level of lakes and canals due to higher rates of evaporation



Tornadoes/thunderstorms (uncertain)

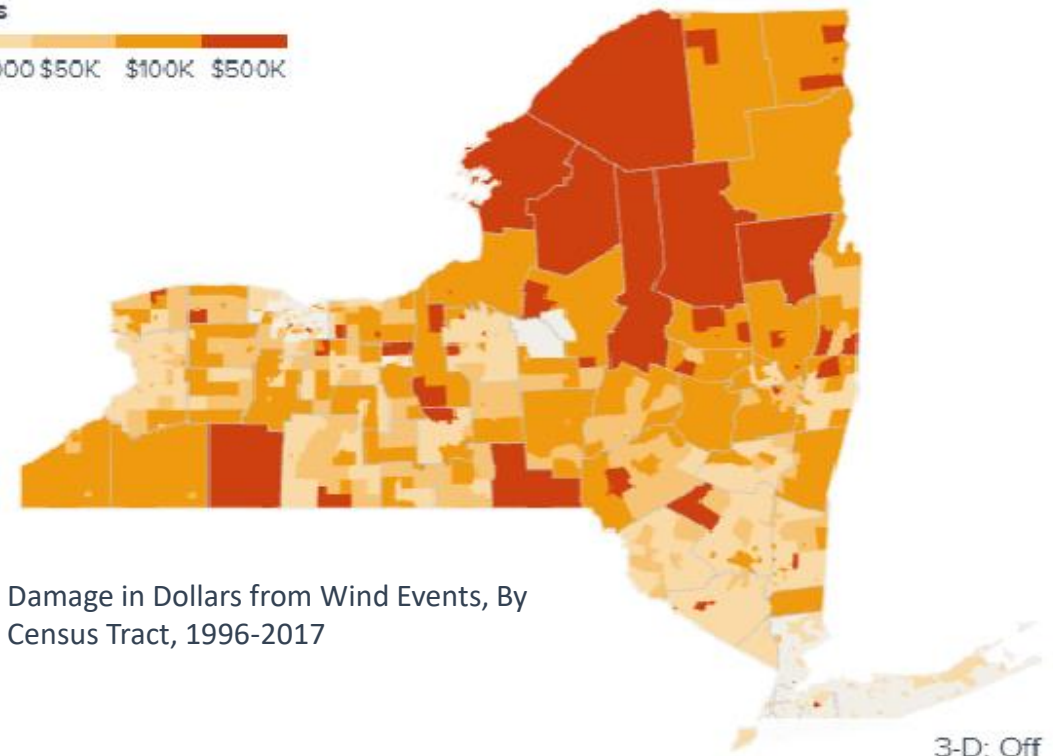
Source: NOAA NCEI Storm Events

- 1996-2018 (not including hurricanes)
 - Avg. annual tornado loss: \$3.4 million
 - Avg. annual tornadoes: 7
 - Avg. annual wind damage: \$13.5 million
- No strong trends in frequency or severity
- Future trends uncertain

Damage in Dollars from Wind Events, By Census Tract, 1996-2017

Total Loss

\$0 \$5,000 \$50K \$100K \$500K



Damage in Dollars from Wind Events, By
Census Tract, 1996-2017



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Interacting Hazards and Cascading Effects



Kingston, NY



Breezy Point, NY

Thank You

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Connect with us:

- DEC: www.dec.ny.gov
- Community Risk and Resiliency Act:
www.dec.ny.gov/energy/102559.html
- Climate Smart Communities:
www.dec.ny.gov/energy/76483.html
- Facebook: www.facebook.com/NYSDEC
- Twitter: twitter.com/NYSDEC
- Flickr: www.flickr.com/photos/nysdec