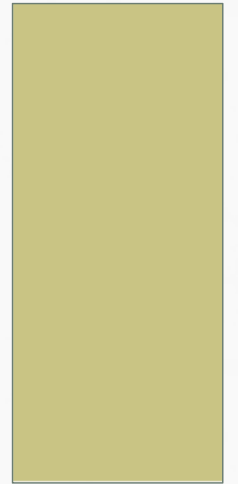


EXTREME WEATHER EVENTS



WHY ARE YOU HERE?

- Required by law and NH Solid Waste Rules.
- Build your resume

WHY THIS WORKSHOP?

Extreme Weather Events

- To prepare for the changing climate.
- To offer insight on how extreme weather can affect your facility.
- Tie together the concepts you learned in Basic Training and other CPD.



TODAY'S AGENDA

- **Extreme Weather**
 - What is it? How has it changed over time?
- **Terminology**
 - Weather & Climate; Climate change; Global Warming; CO₂; Methane; Greenhouse Gases
- **Impacts**
 - How have extreme weather events affect NH's SW Facilities?

TODAY'S AGENDA

- Extreme Weather Scenarios
- Behavior Changes
 - How we can change our behaviors to prepare for these weather events
- Extreme Weather Prevention & Preparedness

INSTRUCTORS FOR TODAY

- Sherry Godlewski, Resilience & Adaptation Manager
 - Sherry.Godlewski@des.nh.gov
- Cynthia Nelson, Pollution Prevention Program Manager
 - Cynthia.L.Nelson@des.nh.gov
- Tara Mae Albert, SWOT Coordinator
 - Tara.M.Albert@des.nh.gov

Extreme Weather Events: How They Might Affect Your Facility & What You Can do to Prepare



Sherry Godlewski
NH Department of Environmental Services

November 17, 2021

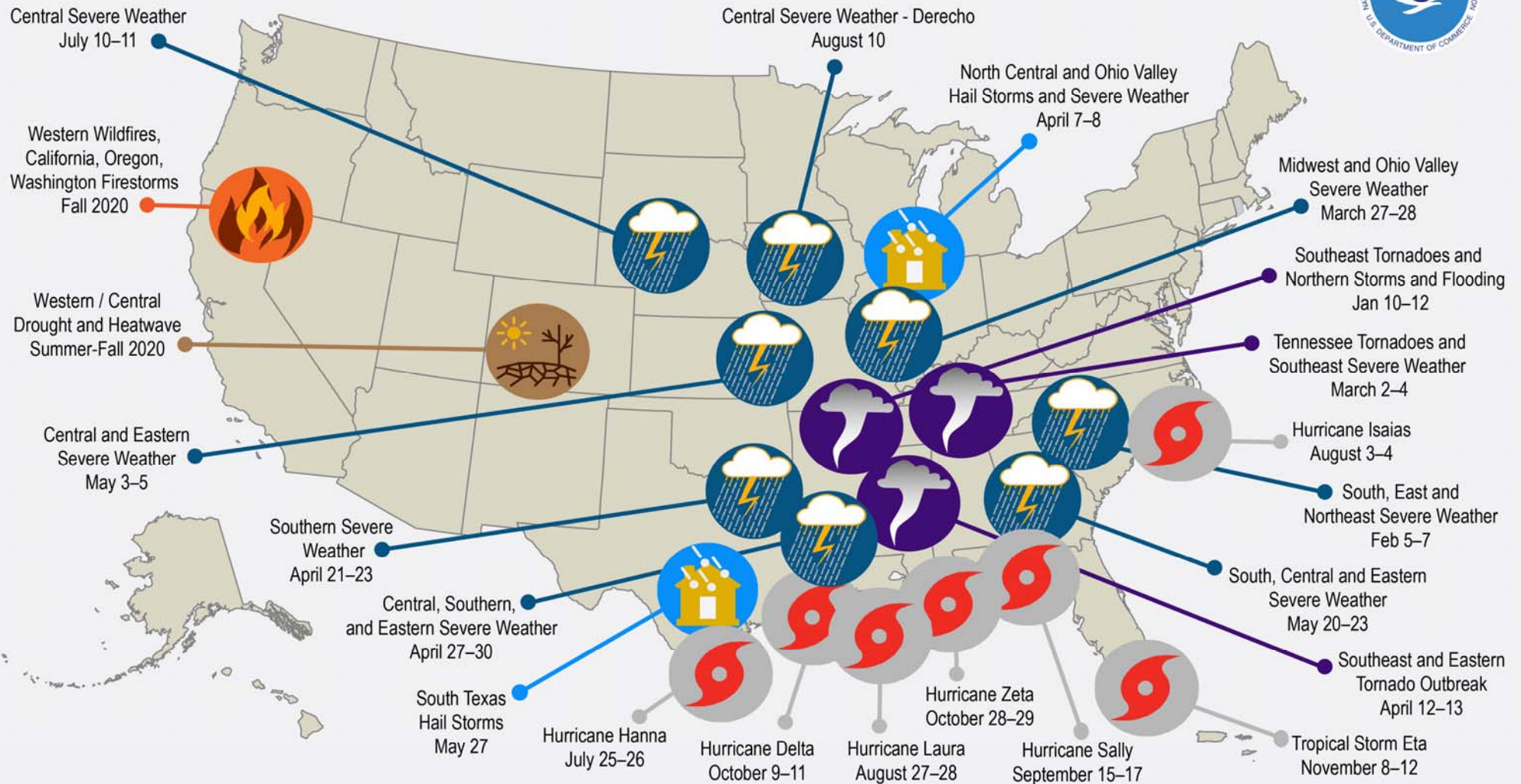
Extreme Weather

- **Defined:** Weather that is extreme compared to historical averages
- **Extreme weather causes widespread destruction**
 - Inconvenient
 - Costly
 - Loss of life
- Extreme weather events cause **power outages**; one lasted 10 days in 2011
- **Extreme weather is becoming more common!**



95 billion total

U.S. 2020 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the 22 separate billion-dollar weather and climate disasters that impacted the United States during 2020.

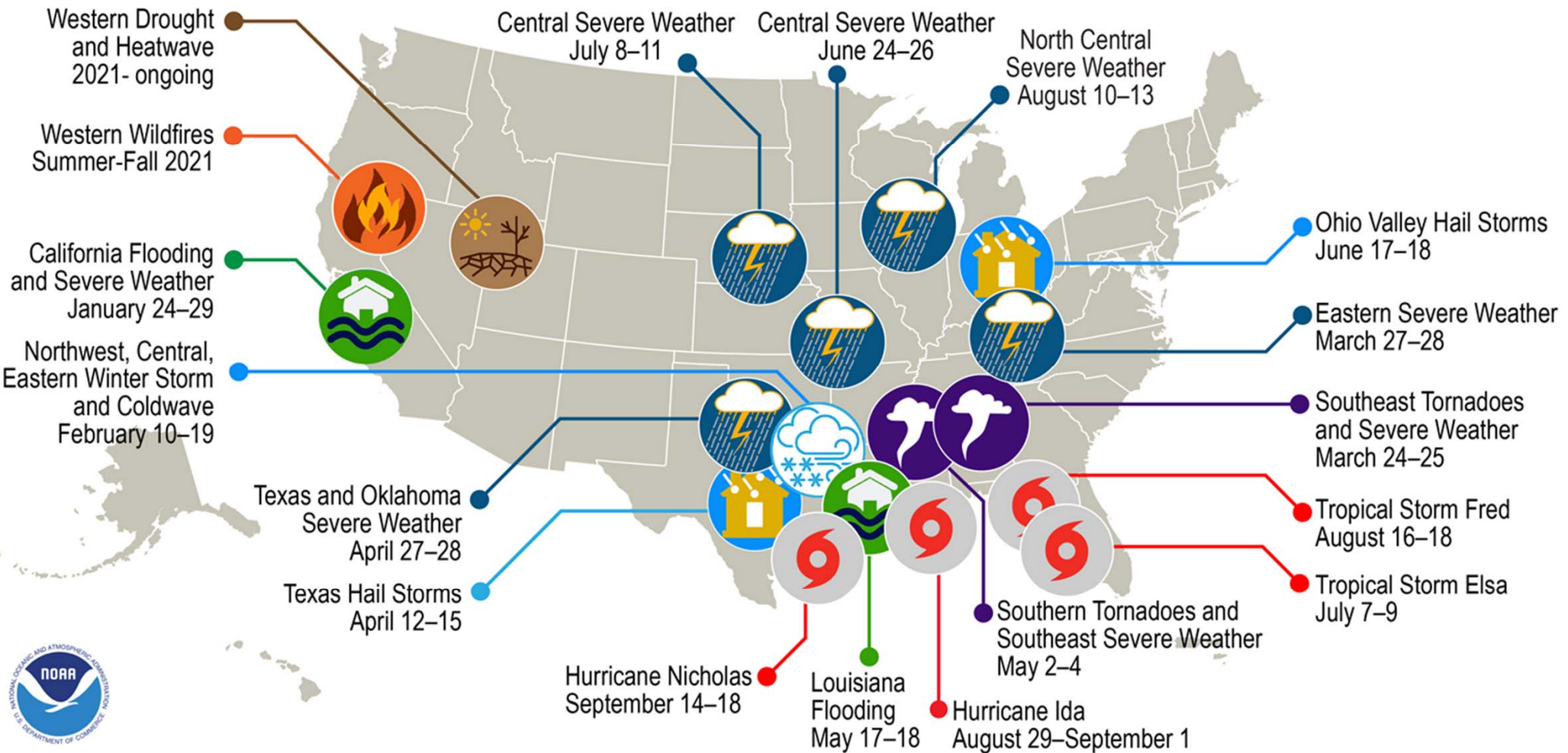
New annual record of 22 events

2020 marks the sixth consecutive year (2015-2020) in which 10 or more separate billion-dollar disaster events have impacted the U.S.

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

~100 Billion total... so far

U.S. 2021 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the 18 separate billion-dollar weather and climate disasters that impacted the United States January-September 2021.

Updated October 8, 2021; does not include costs of western wildfires (summer - fall 2021); western drought and heatwave (2021); Hurricane Nicholas (September 2021)

NH Presidentially-Declared Extreme Weather Events

- 1953-2002 (**50 Years**)
 - 15 Disaster Declarations
 - 3 Emergency Declarations
- 2003-2018 (**16 Years**)
 - 21 Disaster Declarations
 - Hurricane
 - Tropical Storm
 - Severe Storms
 - Fall Snow Storm
 - Flooding events
 - Winter Storms
 - Landslide
 - Tornado
 - 10 Emergency Declarations

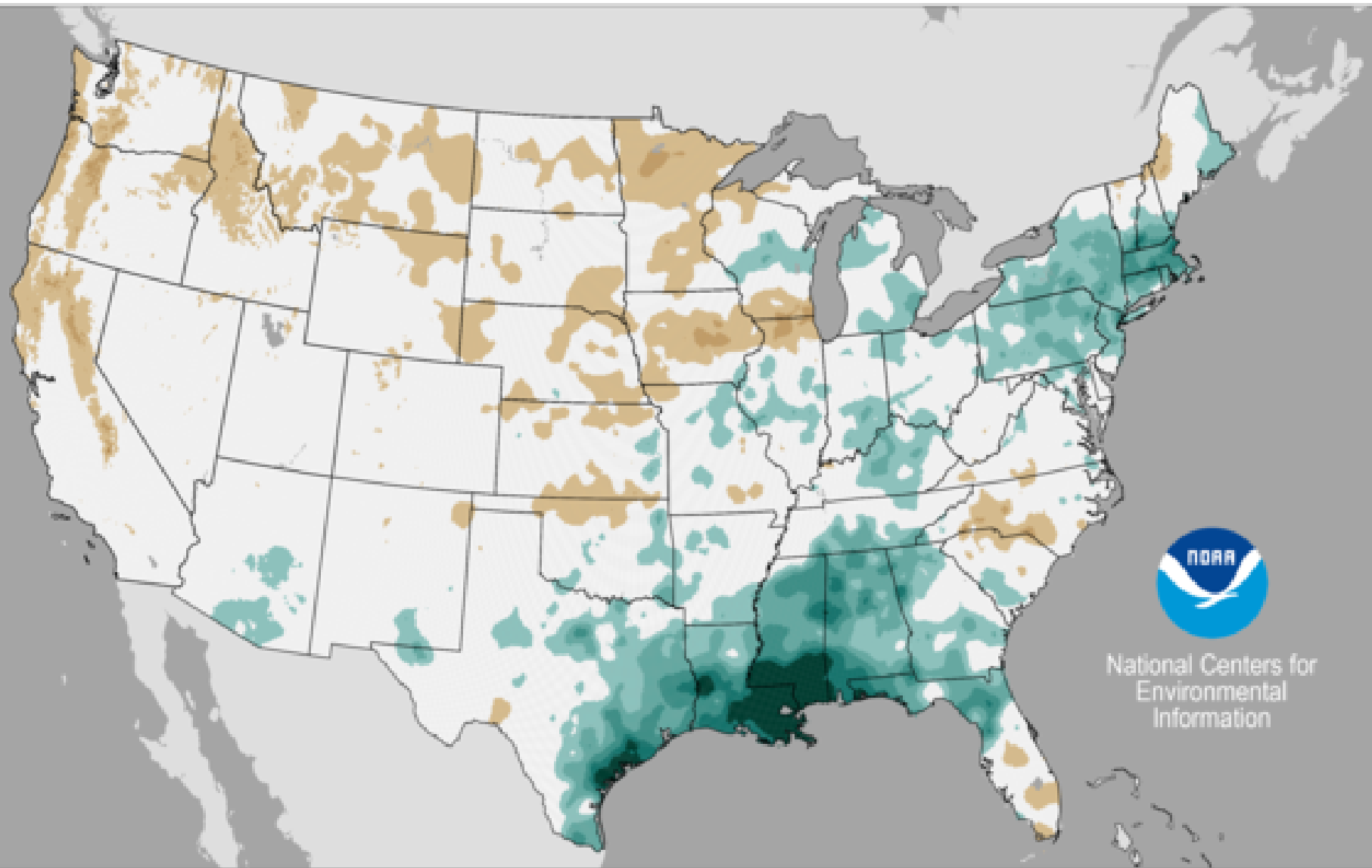


Axe Handle Brook, Rochester, NH, May 2006

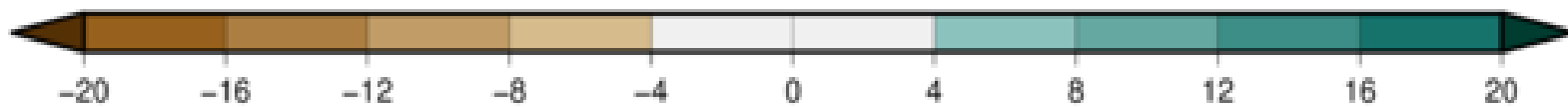
Precipitation Departures from Average

April–September 2021

Average Period: 20th Century



National Centers for
Environmental
Information



-20

-16

-12

-8

-4

0

4

8

12

16

20

Inches

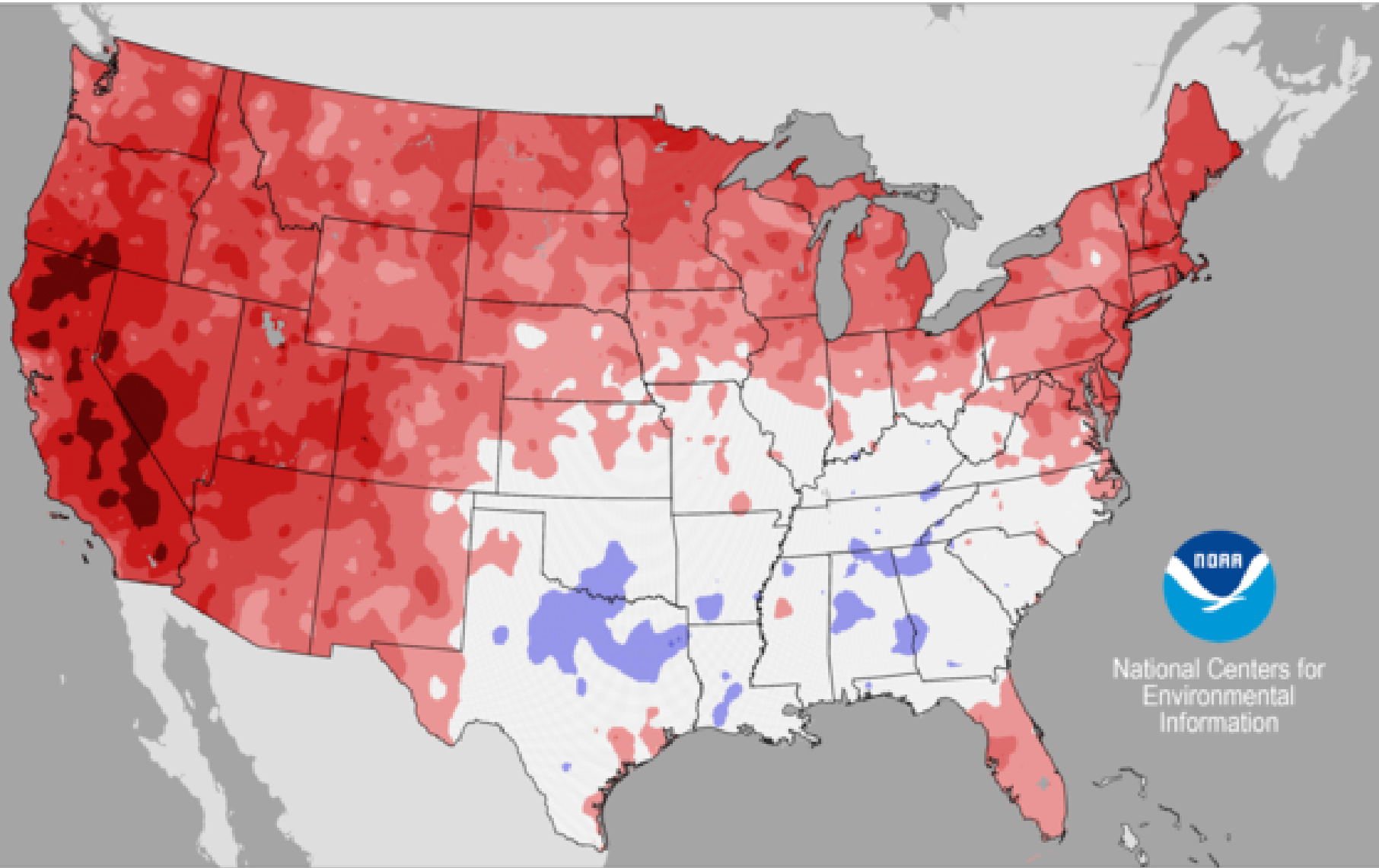
Created: Wed Oct 06 2021

Data Source: nClimGrid

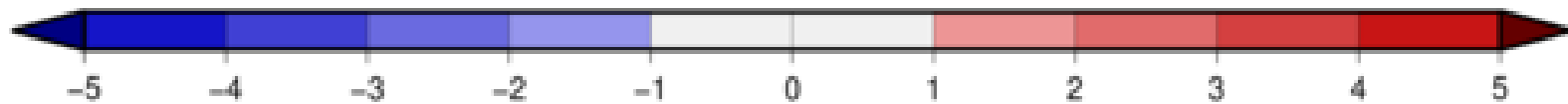
Mean Temperature Departures from Average

April–September 2021

Average Period: 20th Century



National Centers for
Environmental
Information



-5

-4

-3

-2

-1

0

1

2

3

4

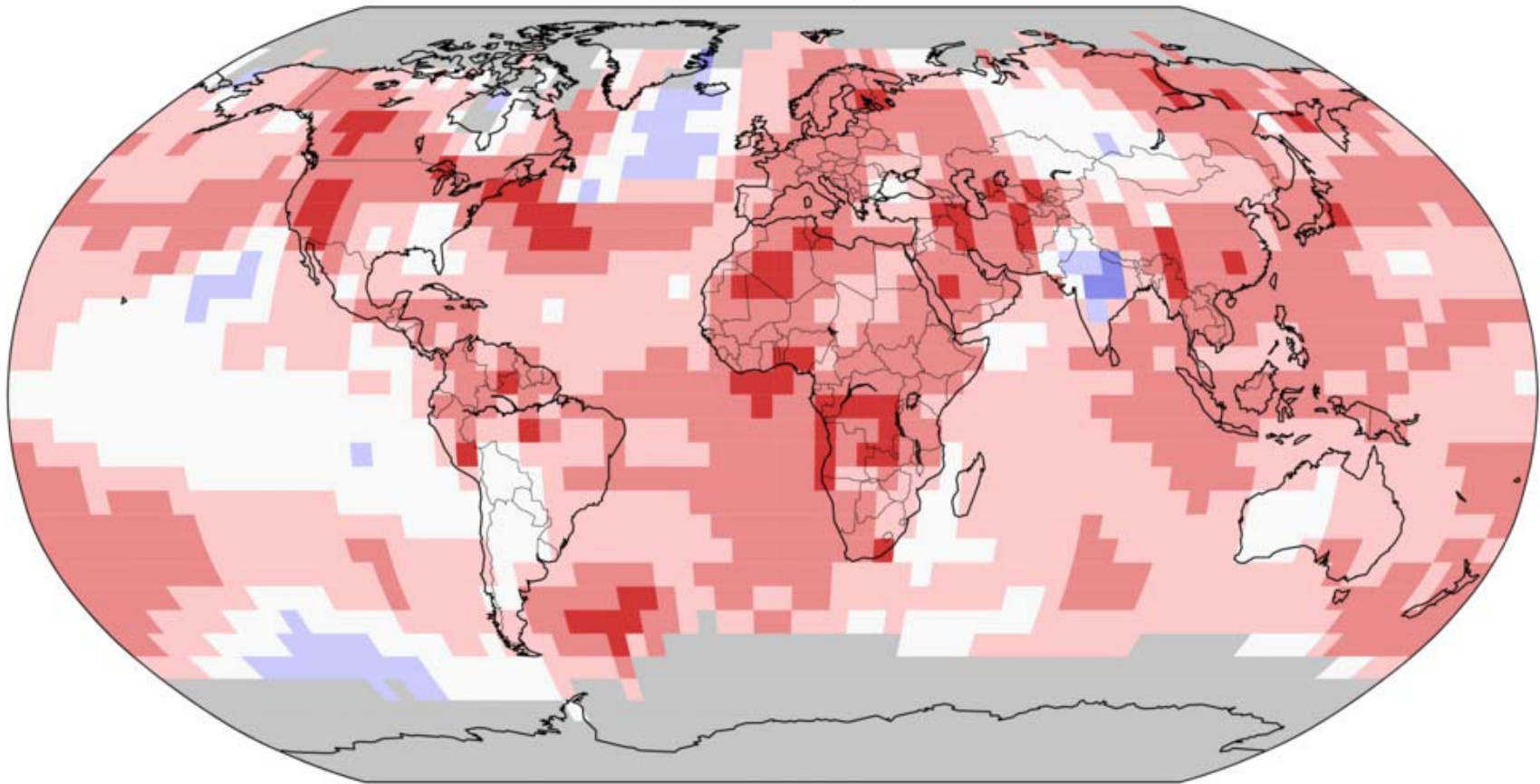
5

Degrees Fahrenheit

Land & Ocean Temperature Percentiles Jun 2021


NOAA's National Centers for Environmental Information


Data Source: NOAA GlobalTemp v5.0.0-20210707





Record
Coldest


Much
Cooler than
Average


Cooler than
Average


Near
Average


Warmer than
Average


Much
Warmer than
Average


Record
Warmest



GHCNM v4.0.1.20210706.qfe

Hottest on record for US (land temperatures).
Globally, the fifth-hottest June in the 142-year record.

HISTORIC HEAT DOME

MOST INTENSE ON RECORD

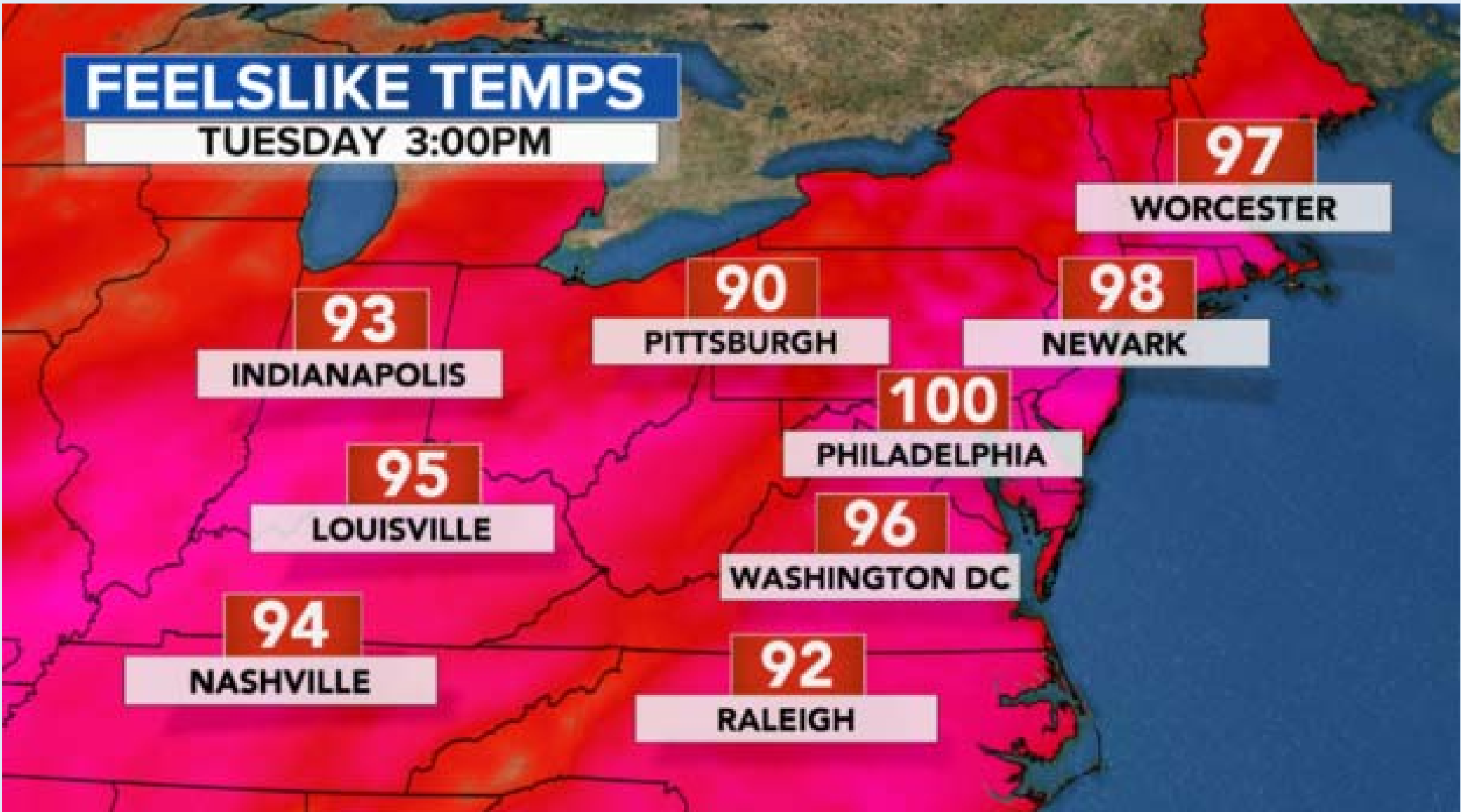
1 IN 1000
YEAR EVENT

HEAT DOME

The core of the heat dome, measured by the thickness of the air column over British Columbia + the Pacific Northwest, is - statistically speaking - equivalent to a 1-in-1,000-year event or even a 1-in-10,000-year event.

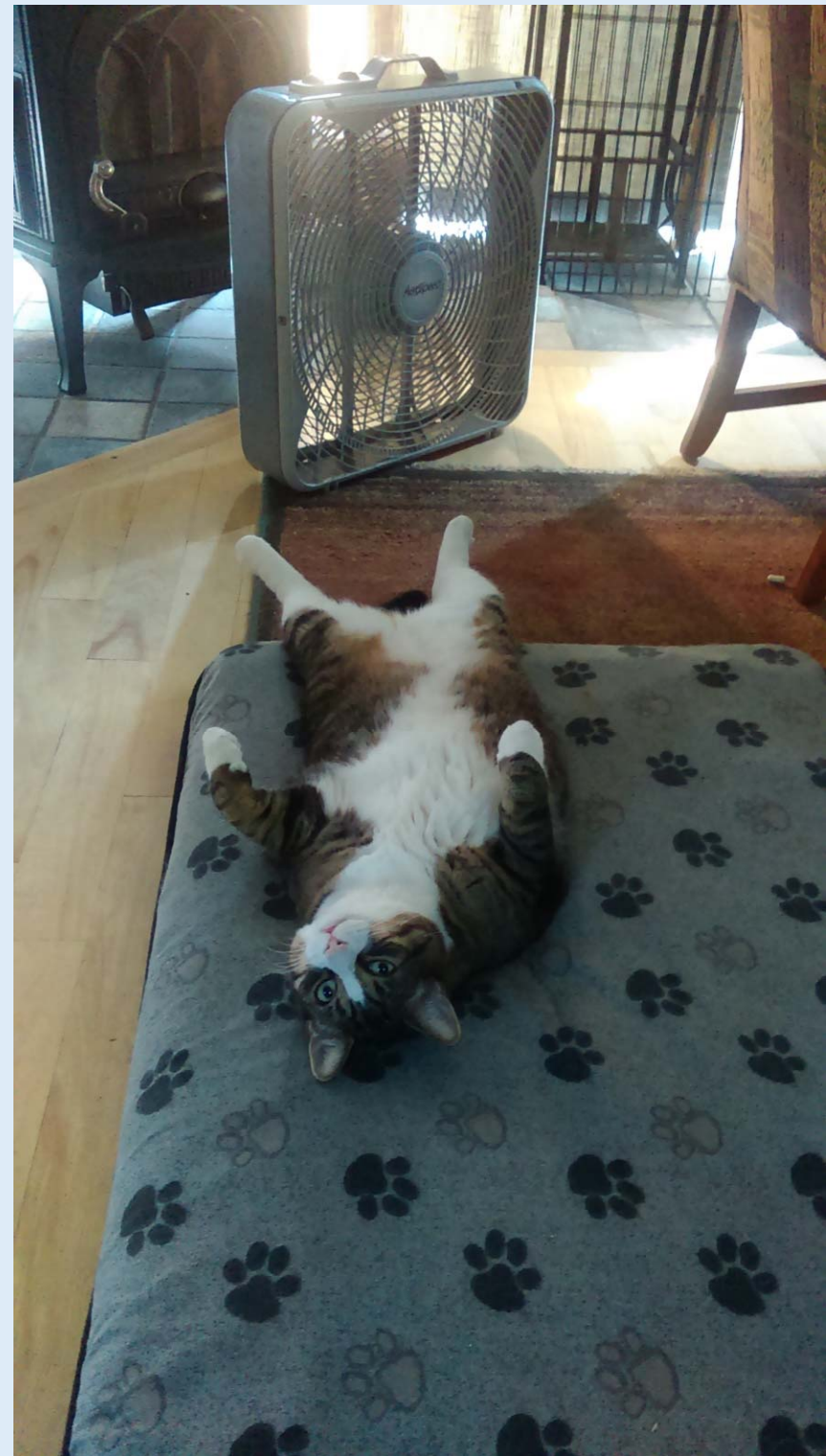
FEELSLIKE TEMPS

TUESDAY 3:00PM



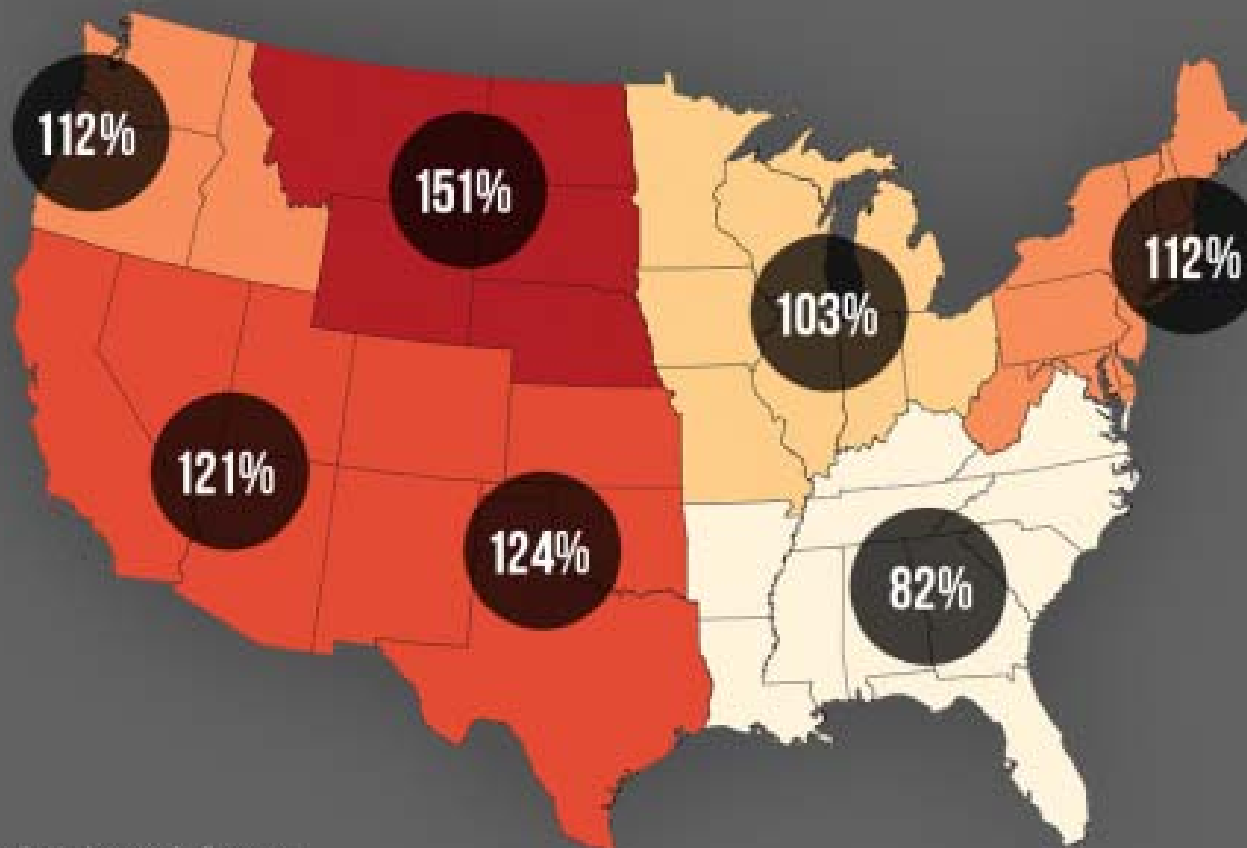
Summer Heat

- Increasing days over 90 degrees are happening, but more significantly...
- Nighttime temps are increasing at a faster rate
- From 1940-2017 minimum temperatures have increased by 2.5 degrees F (statistically significant)
- Reducing night time cooling can have serious health effects
- Concord had its 4th hottest summer on record with 25 days above 90° in 2020
- Manchester had 32 days above 90° usually less than 10 (since 1980)
- Humidity in the Northeast has crushed records
- Not going to change – will continue to move in this warmer than average direction



HIGH HUMID HEAT DAYS

% INCREASE



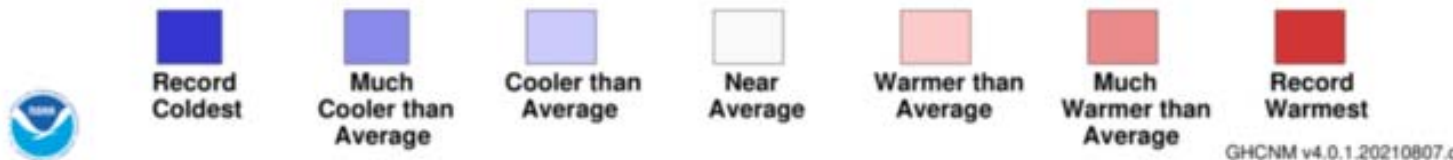
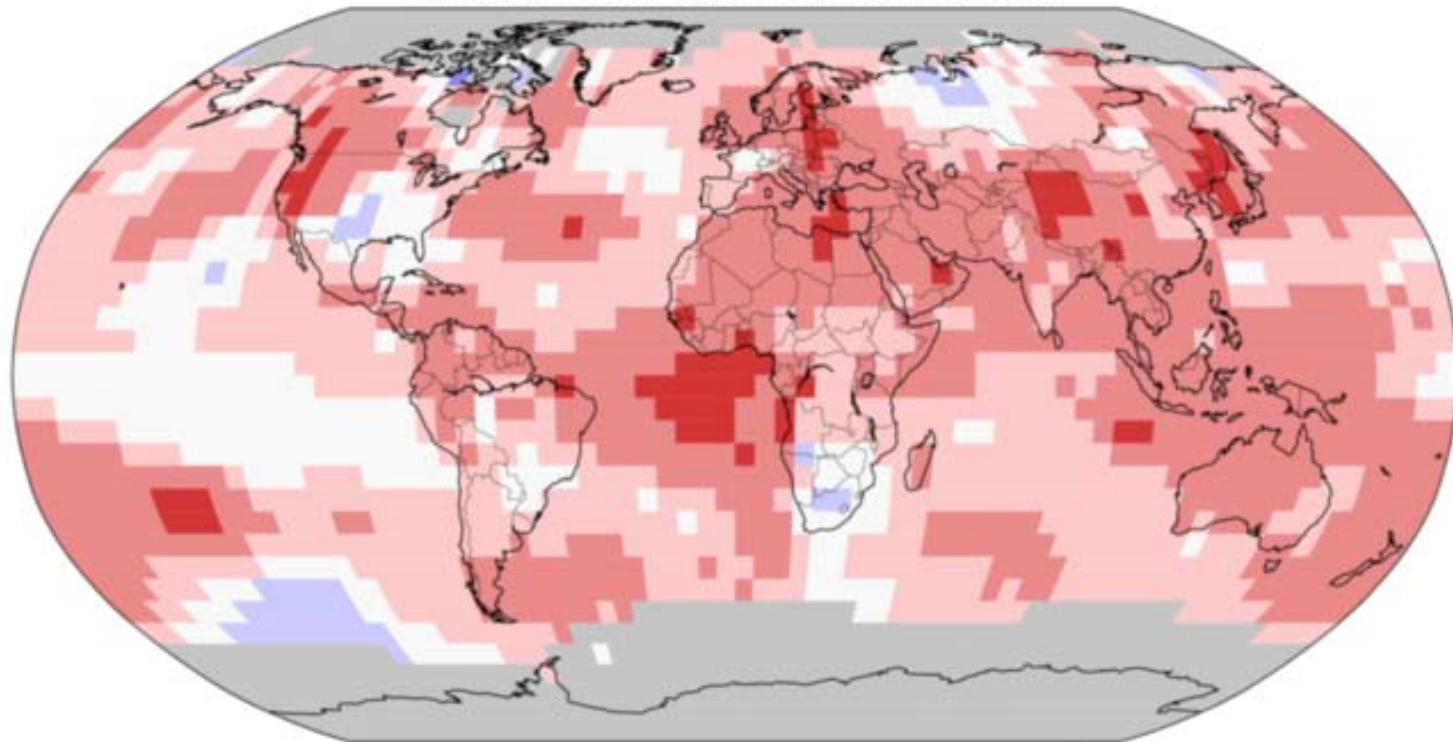
Humid heat days based on wet bulb temp.
% change measures frequency of 95th percentile in 1980-1999 vs. in 2000-2019.
Source: U.S.A. National Phenology Network

CLIMATE  CENTRAL

Land & Ocean Temperature Percentiles Jul 2021

NOAA's National Centers for Environmental Information

Data Source: NOAA GlobalTemp v5.0.0-20210808



Globally, hottest July on record since global records began in 1880
United States had its hottest summer on record this year,
narrowly edging out the previous milestone that was set 85 years
ago during the Dust Bowl (1936)

ARCTIC SEA ICE MINIMUM

NEAR RECORD LOW EXTENT

MILLION SQUARE MILES



1981-2010 average. Produced 9/21/2020.
Source: NSIDC

CLIMATE CENTRAL

September 15, 2020 was the second lowest in the 42-year satellite record

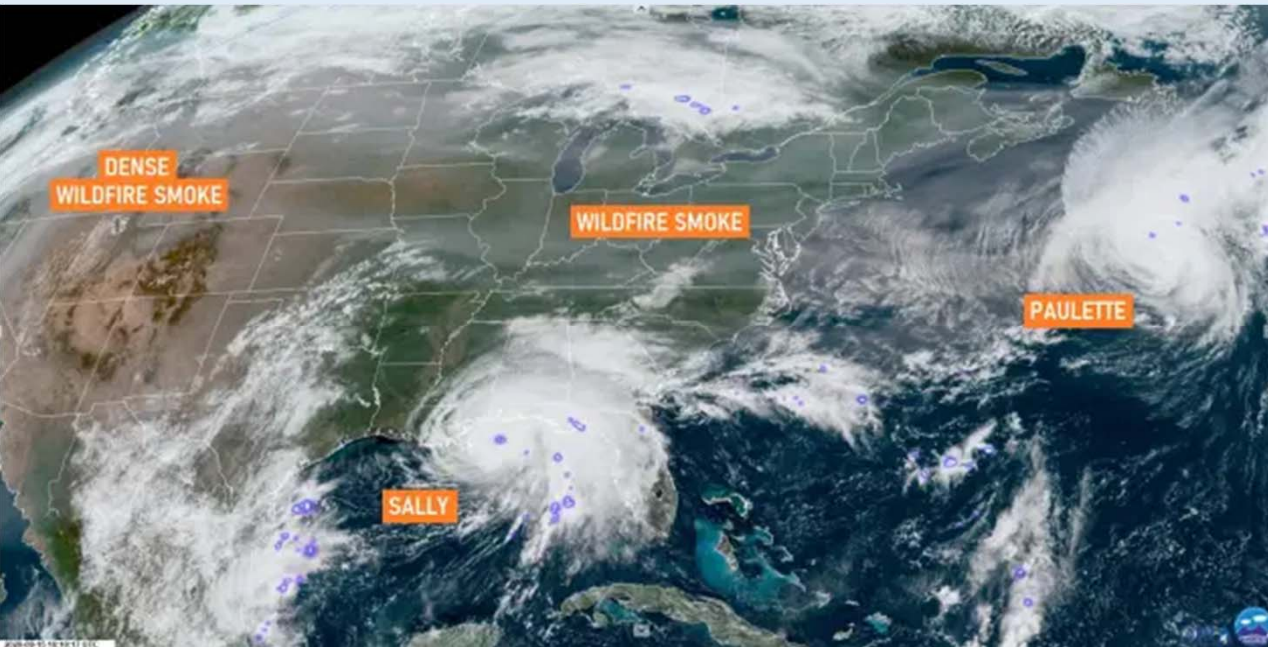
The 15 lowest extents in the satellite era have all occurred in the last 15 years

As of Oct 26, 2020 Arctic Sea Ice Had Still Not Formed in Siberia
— the Latest Date on Record

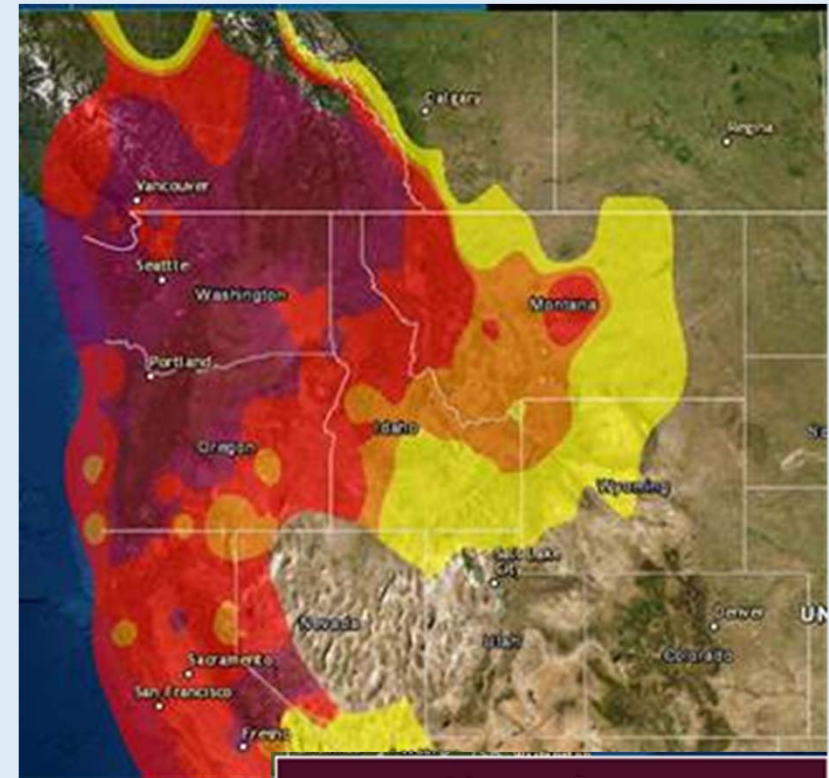
Western Wildfires and Air Quality

“Smoke from Western Wildfires leading to hazy skies, vibrant sunsets over NH”

WMUR Sept 15, 2020



Accuweather



AirNow.gov



NY
July 20, 2021

Wildfires in NH

207 fires, ~ 83 acres

Merrimack River Island Fire Burns Out of Control in Concord (9/22/20)



Wildfires in White Mountains

“The fire had burned two feet down into the ground... no soil moisture”

Fire Chief Steven Sherman





Drought

Known Water Use Restrictions


Last Update: 10/1/2020

Legend


 County Boundary

 Town Boundary

Drought Condition

 Abnormally Dry


 Moderate Drought

 Severe Drought

 Extreme Drought

Municipality or Water System Status

 Voluntary Restriction

 Mandatory Restriction

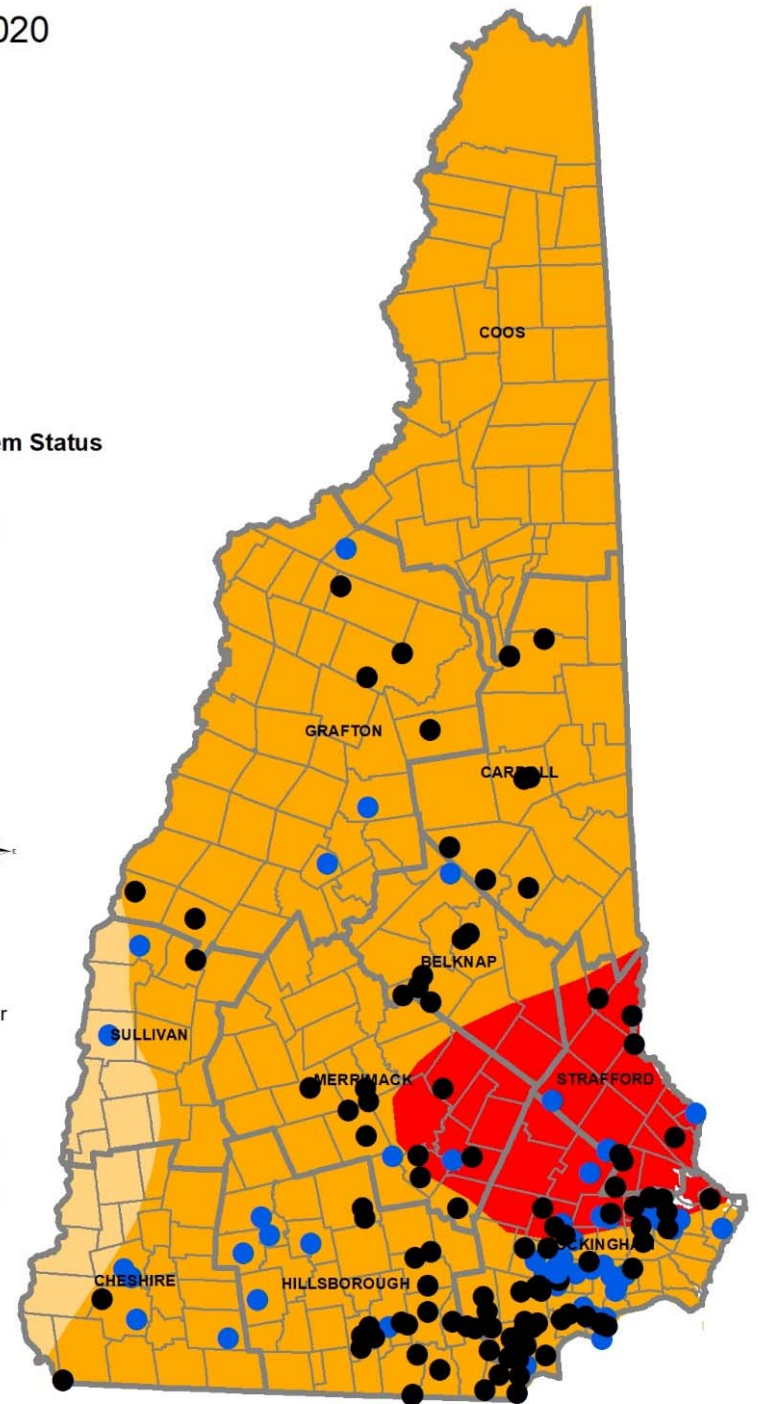


0 5 10 20
Miles



Drought Conditions based on
United States Drought Monitor
(<https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?NH>)

Disclaimer: The status of water
use restrictions is based on
information submitted to the New
Hampshire Department of
Environmental Services and may
not be comprehensive.

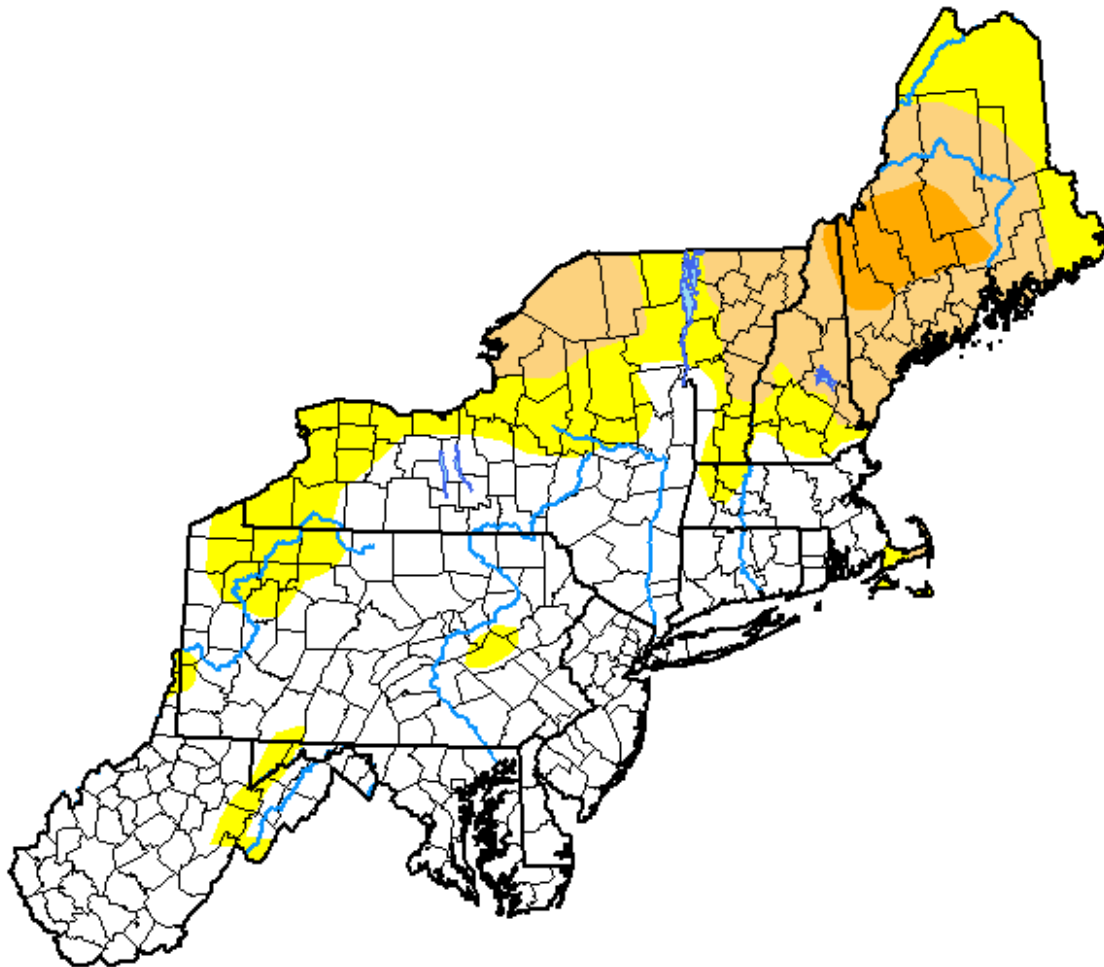


DES Raises Risk Of Multi-Year Drought As NH Heads Toward Winter



U.S. Drought Monitor Northeast Climate Region

June 29, 2021
(Released Thursday, Jul. 1, 2021)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	58.59	41.41	20.05	3.51	0.00	0.00
Last Week 06-22-2021	58.57	41.43	19.45	1.11	0.00	0.00
3 Months Ago 03-30-2021	62.96	37.04	8.69	0.00	0.00	0.00
Start of Calendar Year 12-29-2020	77.60	22.40	3.63	0.00	0.00	0.00
Start of Water Year 09-29-2020	29.84	70.16	45.31	26.26	3.89	0.00
One Year Ago 06-30-2020	54.44	45.56	14.23	0.00	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Deborah Bathke
National Drought Mitigation Center



Flooding In New Hampshire July 2021



Alstead



Barnstead



Gilford



Goshen



Webster



Newport

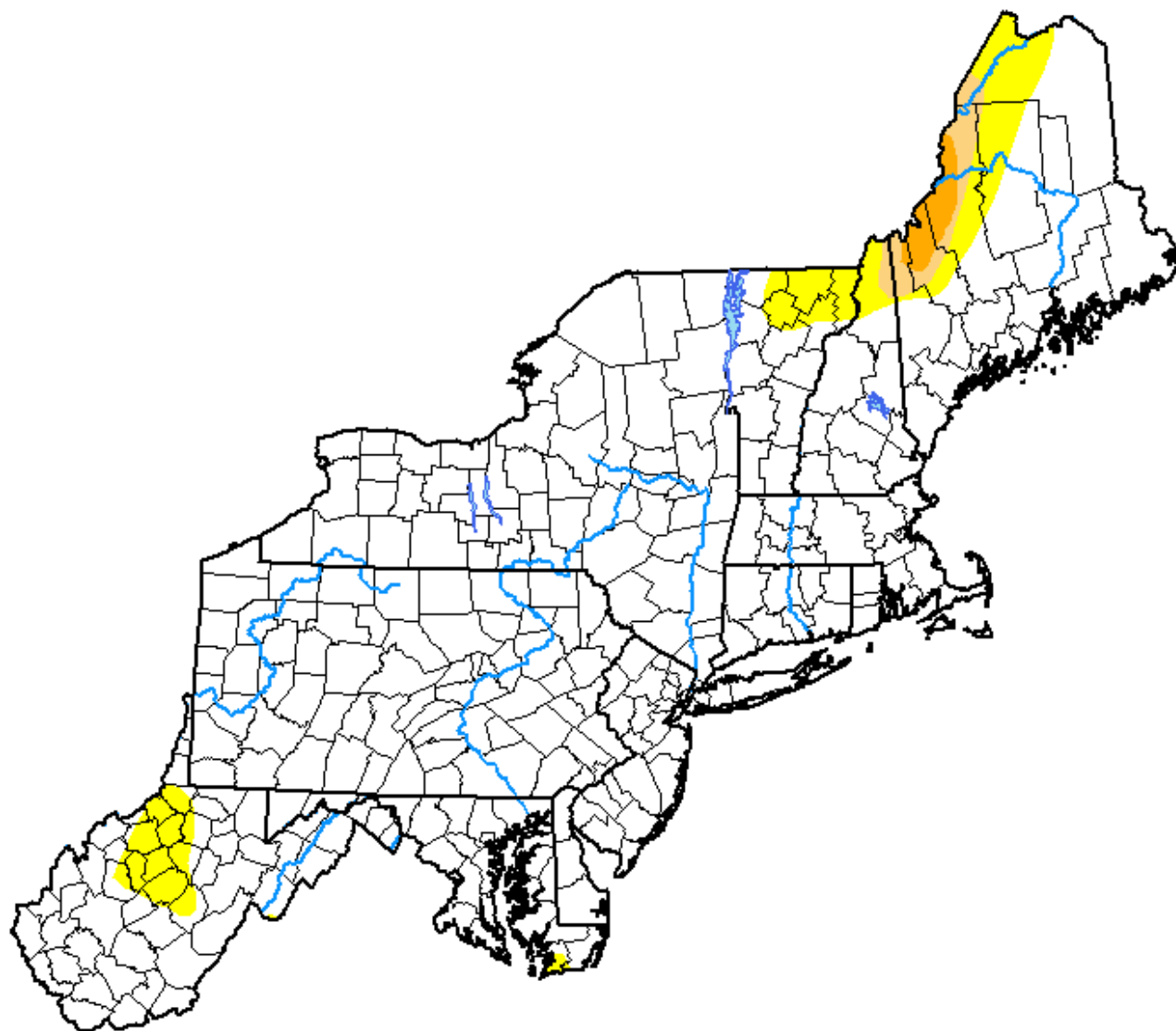


Newbury

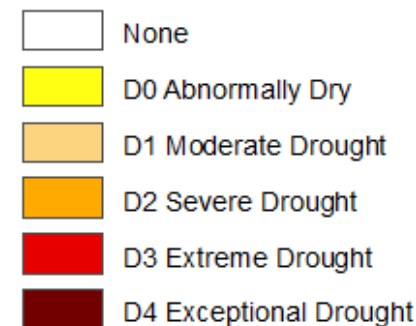
No named storm,
Just rain ...
Fast moving impacts

U.S. Drought Monitor Northeast

November 9, 2021
(Released Thursday, Nov. 11, 2021)
Valid 7 a.m. EST



Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Curtis Riganti
National Drought Mitigation Center

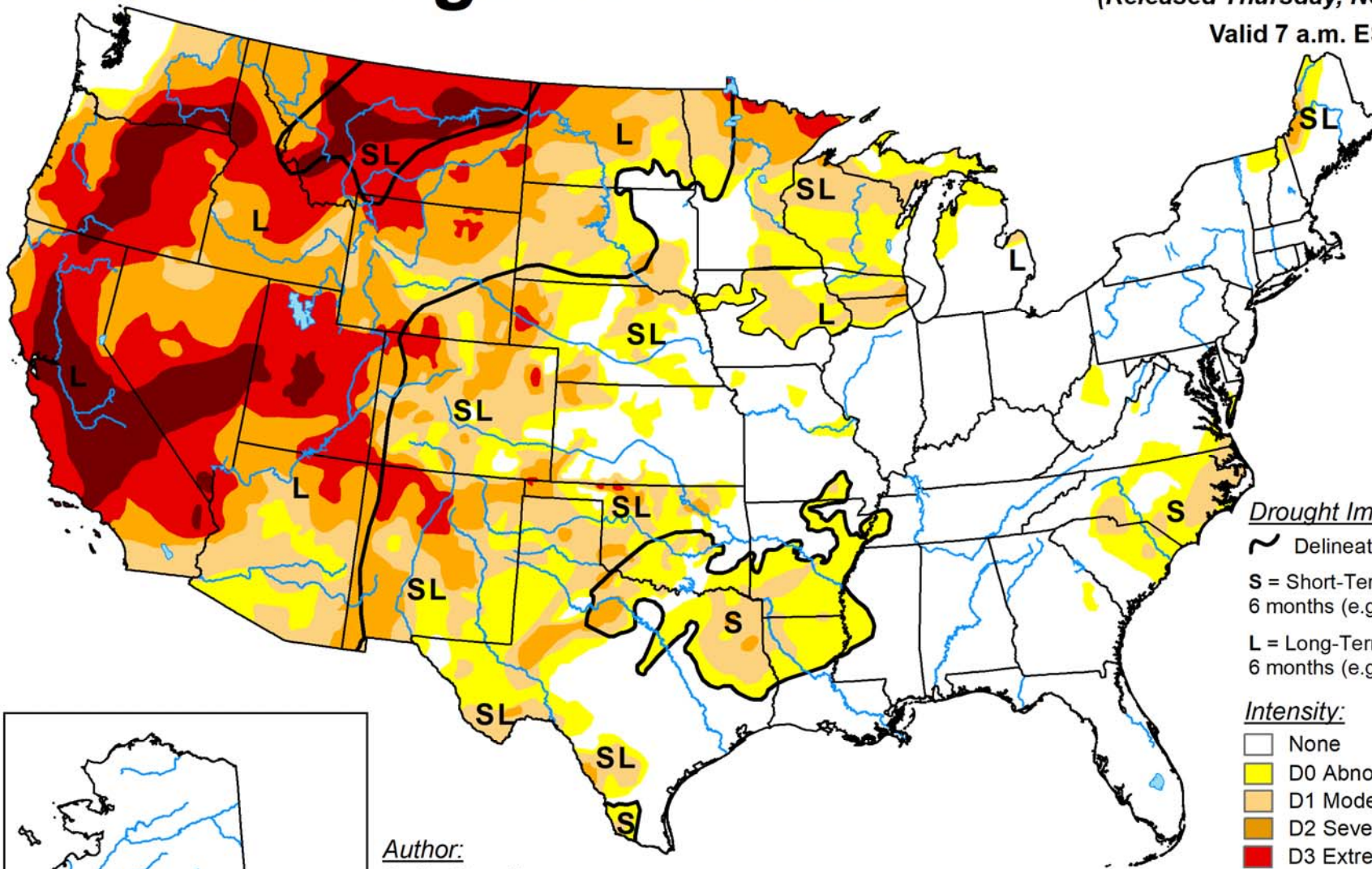


droughtmonitor.unl.edu


U.S. Drought Monitor

November 9, 2021
(Released Thursday, Nov. 11, 2021)







Valid 7 a.m. EST

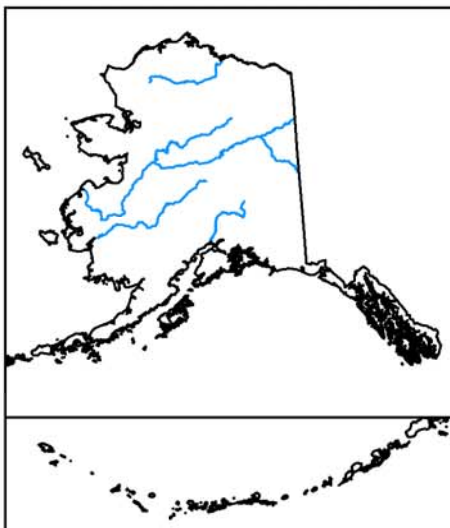


Drought Impact Types:

-  Delineates dominant impacts
- S** = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L** = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

-  None
-  D0 Abnormally Dry
-  D1 Moderate Drought
-  D2 Severe Drought
-  D3 Extreme Drought
-  D4 Exceptional Drought



Author:
Curtis Riganti
National Drought Mitigation Center

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

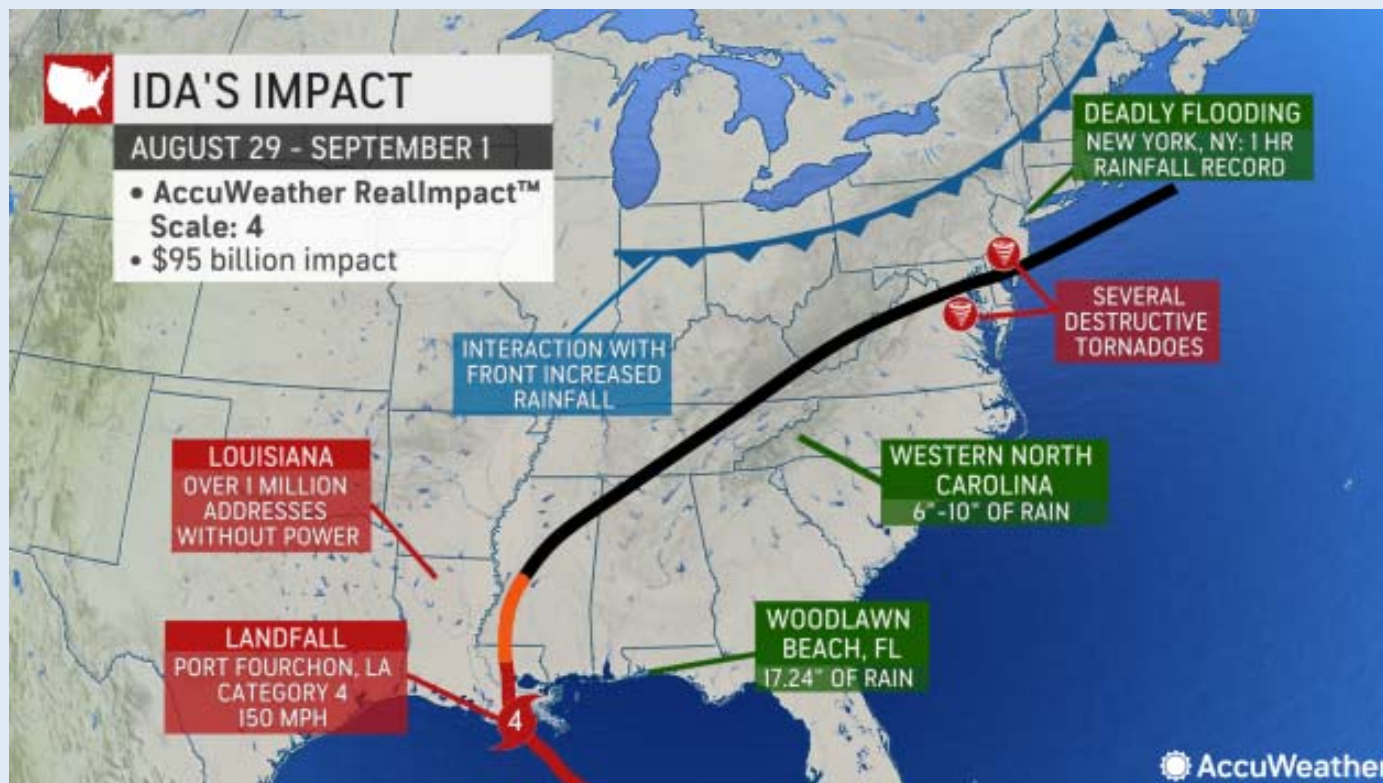


droughtmonitor.unl.edu

Hurricanes

Summer 2021 - an unusually high number of tropical cyclones impacting the U.S.

- 20 named storms and 4 major hurricanes (Oct 5)
- 7 of made landfall in the United States.
- 2021 Atlantic hurricane season has been the [third-fastest pace on record](#), only behind the hyperactive 2005 and 2020 seasons.



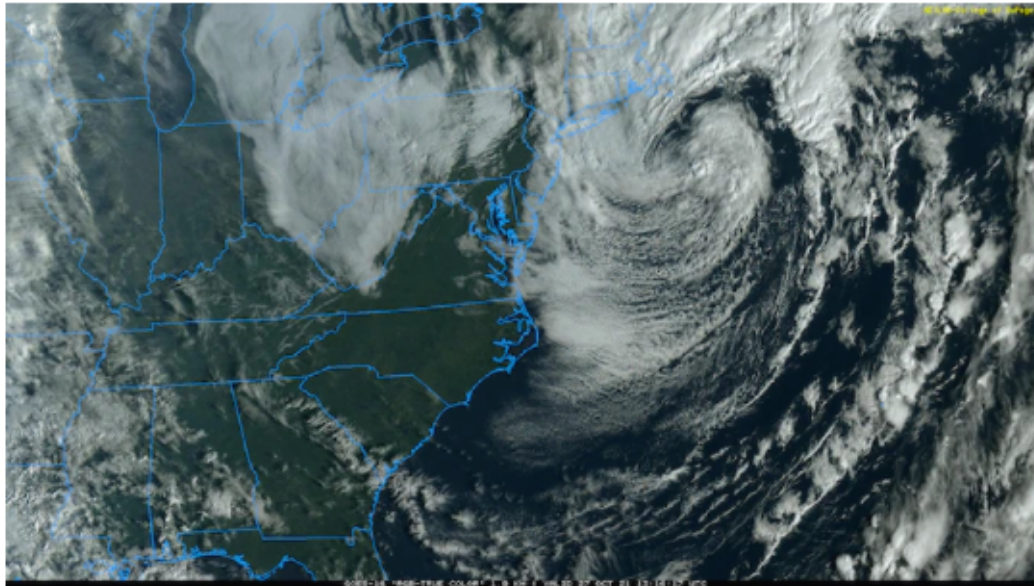
Northeast had 1,000 year rainfall event; 7.2" in NYC.

Also impacted by Henri a week earlier with 14" of rain in NJ.

Aug 21 extreme rainfall in TN – 17"

'Bomb cyclone' brings 90 mph gusts to New England; hundreds of thousands without power

More than 600,000 customers in the Northeast are in the dark



The GOES East weather satellite peers down on a bombogenetic cyclone lashing the East Coast from 22,000 miles above the Earth. (College of DuPage)

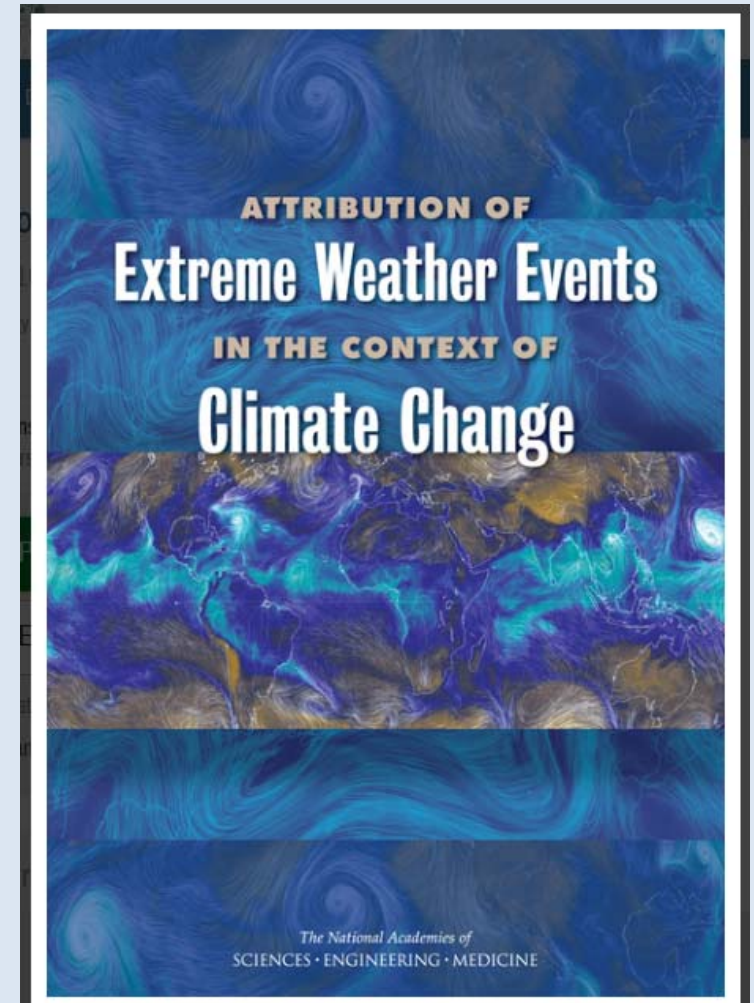
MOST READ WEATHER >







1 'Bomb cyclone' brings 90 mph gusts to New England; hundreds of thousands — without power

More CO₂ = More Extreme Weather

- Scientists now link extreme weather events to carbon dioxide in the air from the burning of fossil fuels.
- More atmospheric CO₂ has boosted the odds of extreme heat, extreme cold, drought, & punishing rain/snow storms....

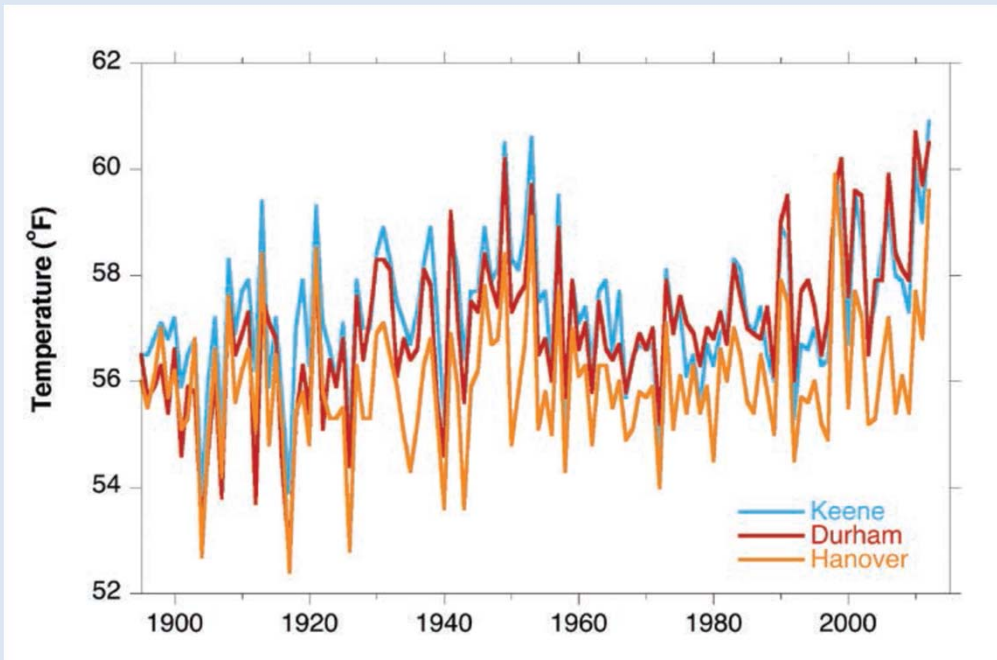


Weather and Climate

Mon 11/15	Tue 11/16	Wed 11/17	Thu 11/18
45° 31°F	44° 29°F	52° 44°F	55° 31°F
			
AM Showers	Mostly Sunny	Mostly Cloudy	Mostly Cloudy
0.03 in	0 in	0 in	0 in

Weather – the set of conditions at any given point in time

- today, tomorrow, this week



Climate - the average set of conditions over a period of decades

- 30 year averages

Global Warming or Climate Change?

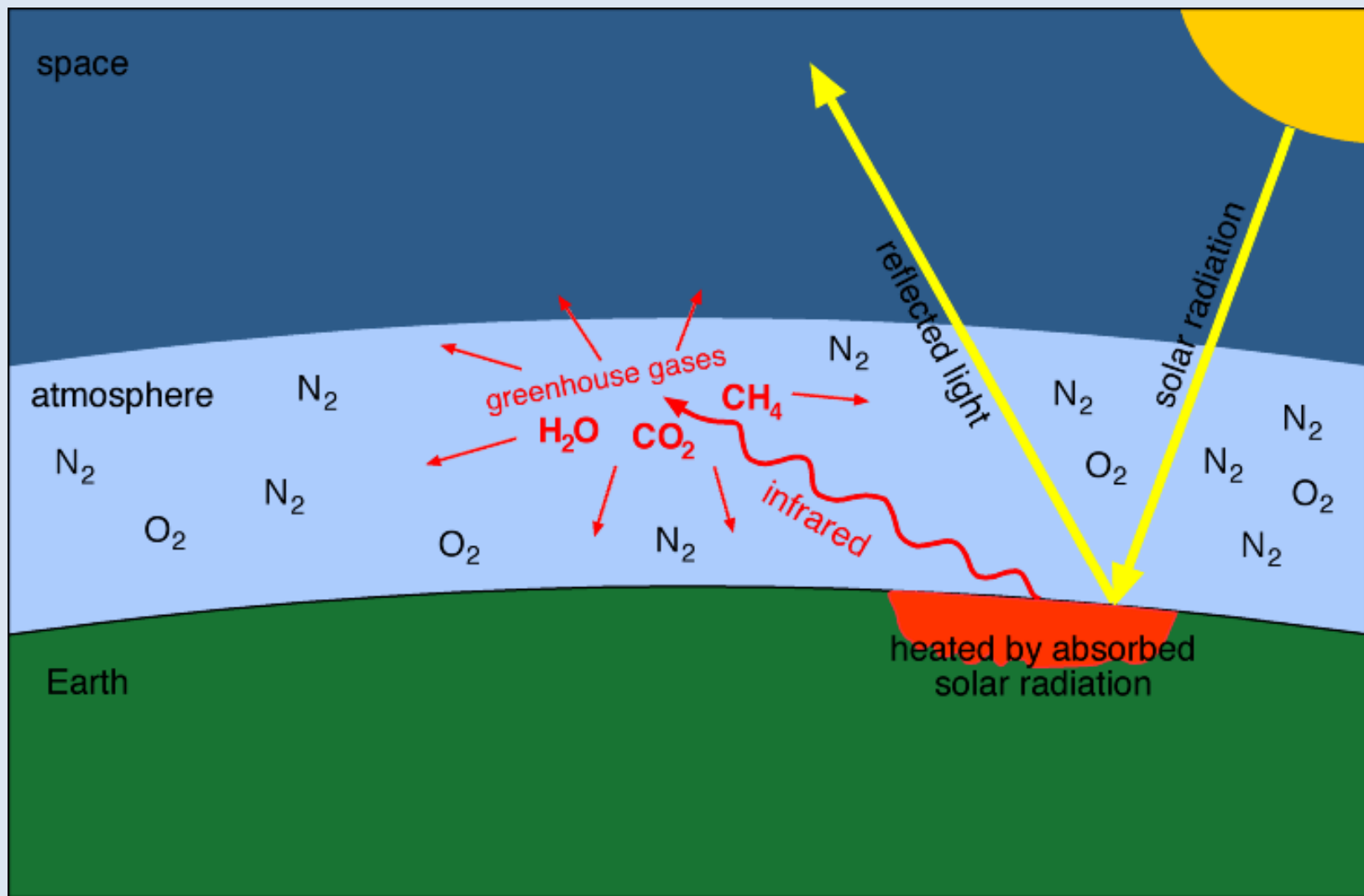
- **Greenhouse gas** - CO_2 , N_2O , H_2O , CH_4
 - Gases trap sunlight that radiates from the Earth's surface
 - Like glass panes of a greenhouse
 - Causes the lower atmosphere to warm
- **Global warming**
 - The unusually rapid increase in Earth's average surface temperature over the past century; fossil fuels...GHGs
 - Normally, radiation would escape into space—but these pollutants, trap the heat and cause the planet to get hotter = the greenhouse effect



Methane – CH₄

- Methane traps up to 100 x more heat than CO₂ in the atmosphere in a 5 yr period
- Shorter lived than CO₂
 - CH₄ – 12 years
 - CO₂ – 20-200 years
- Explosive!
- Largest source is oil + gas industry
- Landfills, agriculture

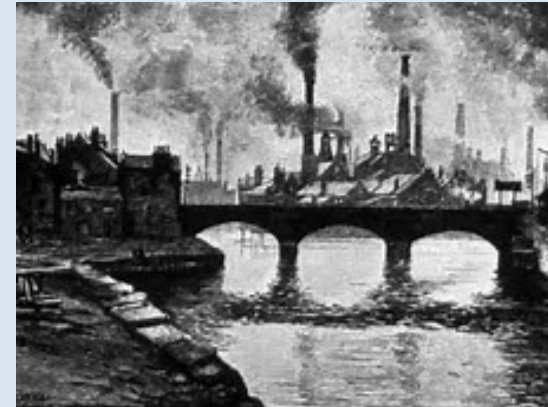




- Over the past 50 years, the average global temperature has increased at the fastest rate in recorded history.
- Burning of **fossil fuels** for **transportation** is the largest source of greenhouse gas emissions. Second is **electricity generation** (2016)

Global Warming Causes the Climate to Change

- Greenhouse gases trap heat
 - Warming of our atmosphere causes warmer overall temperatures
 - Changes to water cycle (some more rain, some less rain)
 - Warms oceans, Melts glaciers, Sea-level Rise
 - Effects plant growth
- Industrial Revolution
 - Raised atmospheric carbon dioxide levels from 280 parts per million to 414 parts per million in the last 150 years

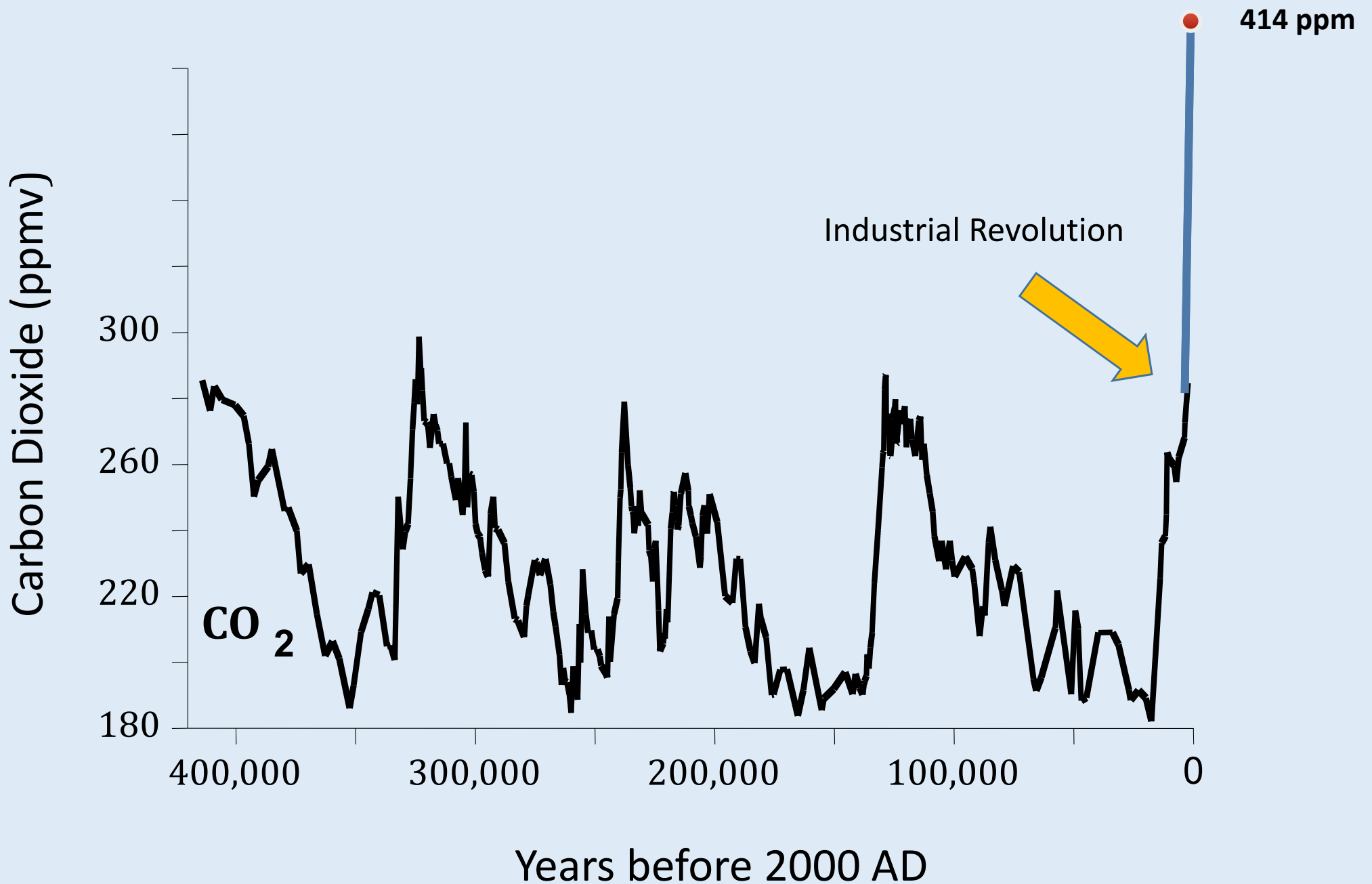


Measuring Carbon Dioxide

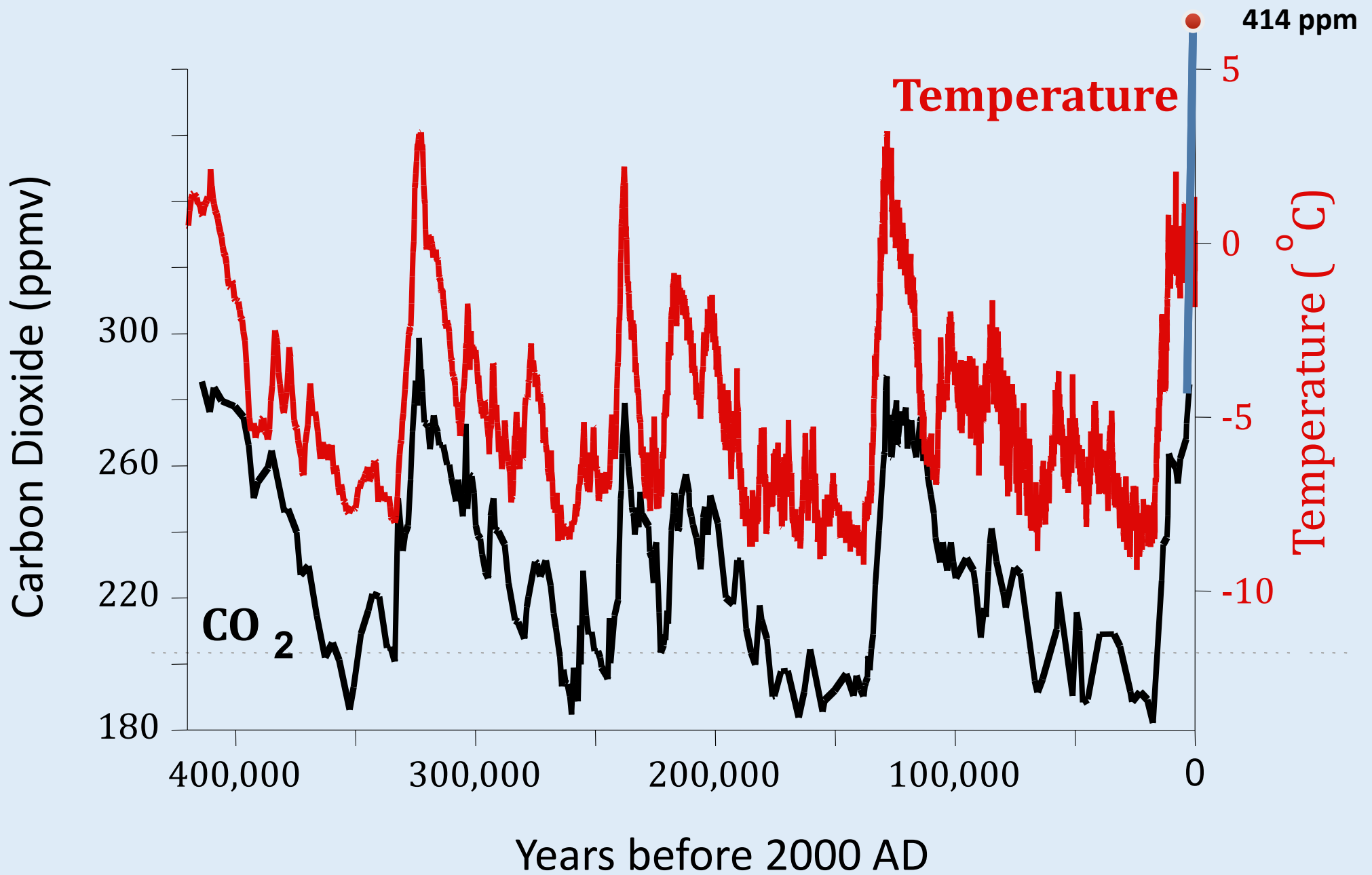
- Ice cores
- Ambient Monitoring
 - Mauna Loa
collecting data since 1956



Atmospheric Carbon Dioxide Record

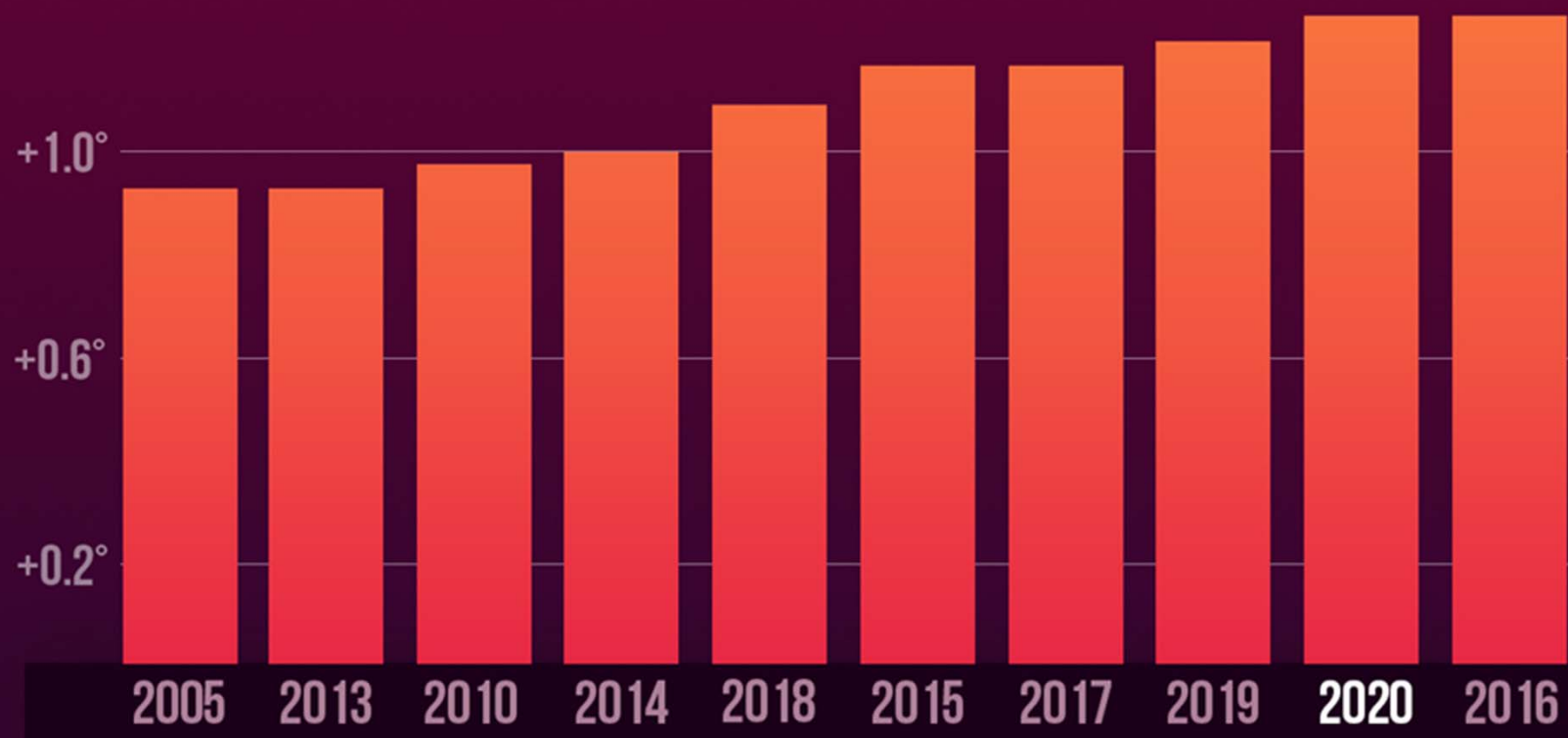


Atmospheric Carbon Dioxide & Temperature Record



10 HOTTEST GLOBAL YEARS ON RECORD

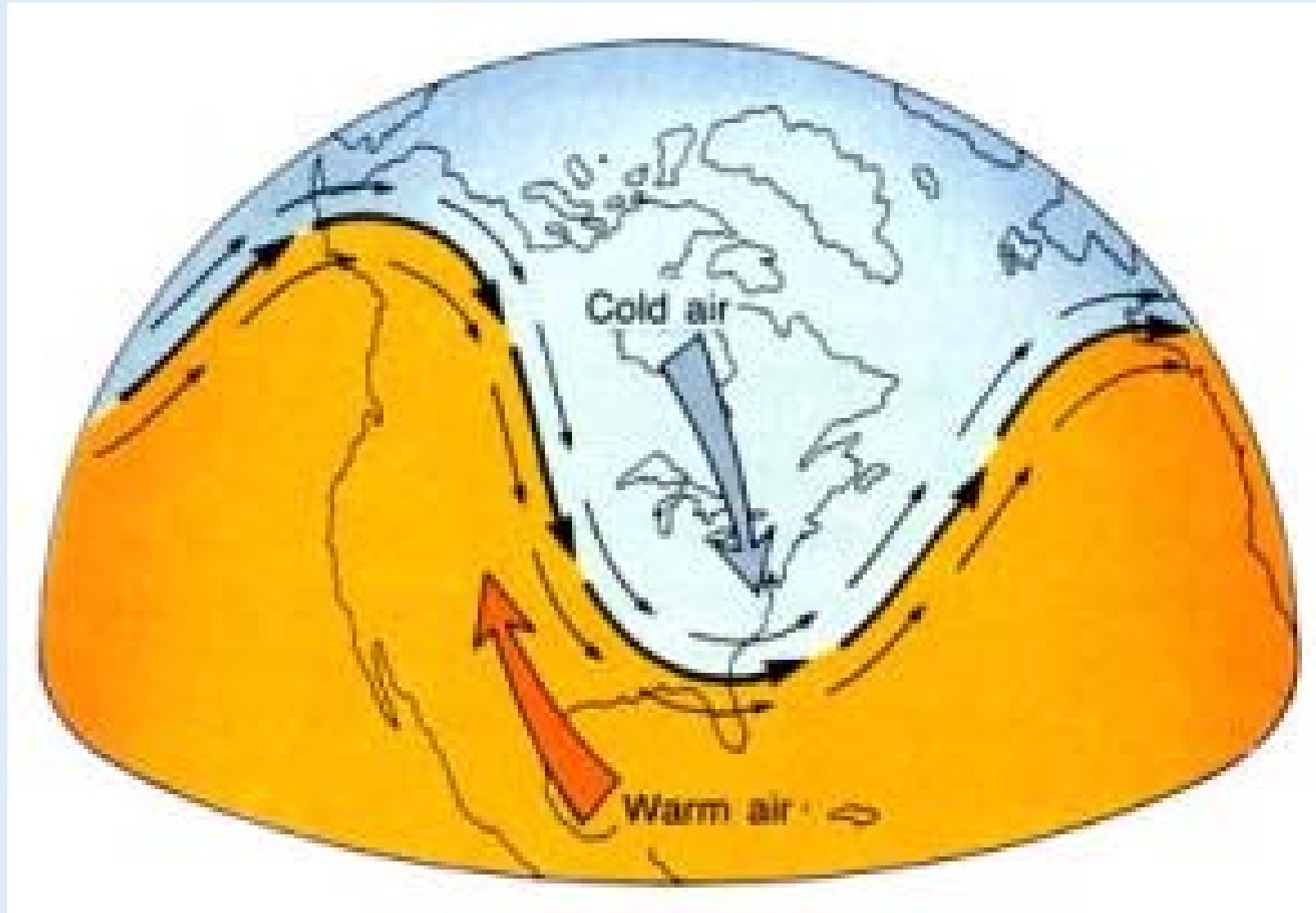
+1.4°C 2.52°F



Source: NASA GISS & NOAA NCEI global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910). Data as of 1/14/2021.

CLIMATE  CENTRAL

Wobbly Jet Stream

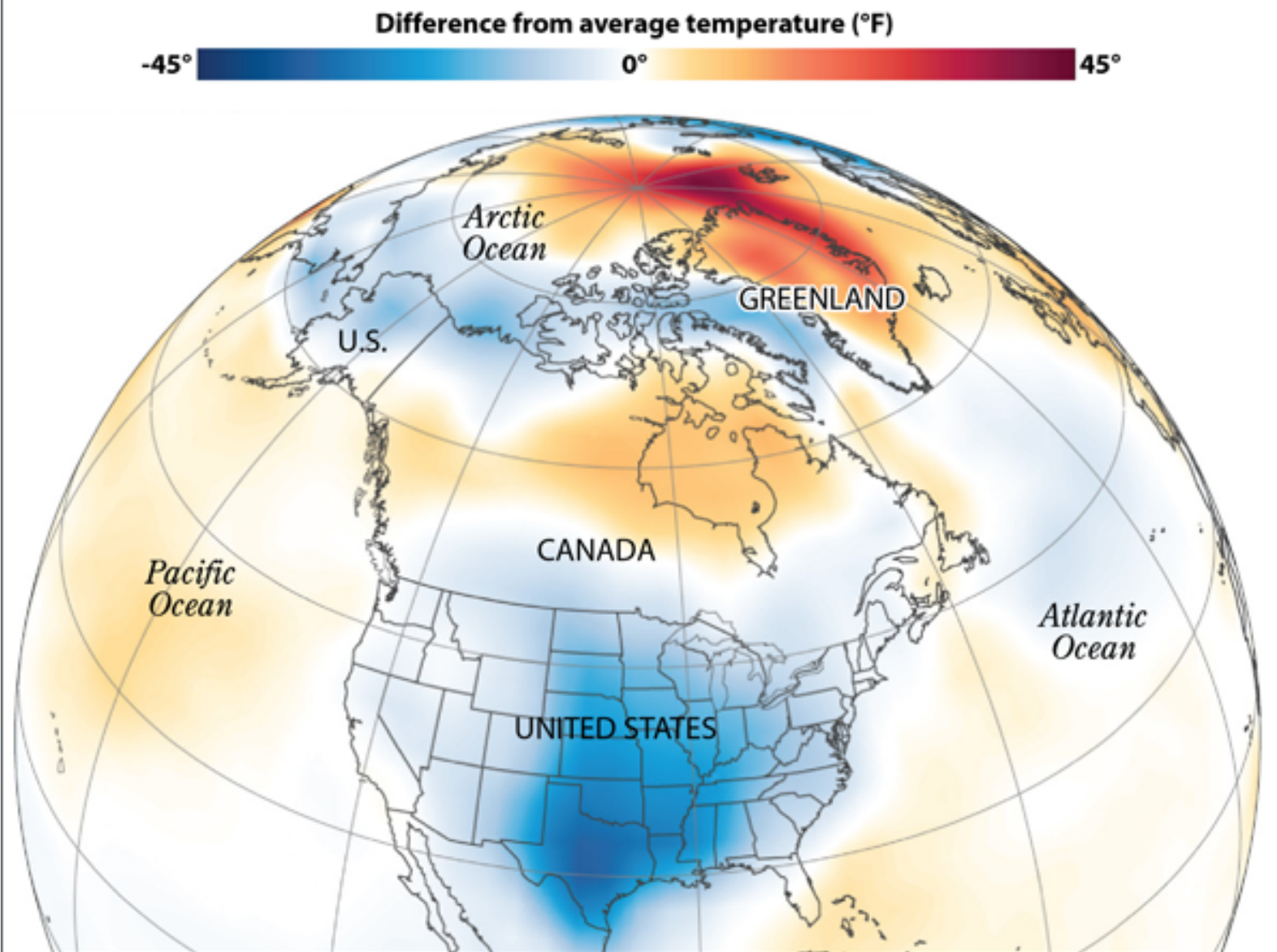


Wide Temp Swings from February's Polar Vortex

The disruption of the polar vortex that affected much of the United States and Canada in February not only brought extreme cold to Texas but temperatures far above average to eastern Greenland and the North Pole.

U.S./CANADA TEMPERATURE DEVIATION

Degrees Fahrenheit difference from average (1981-2010), Feb. 15-22, 2021

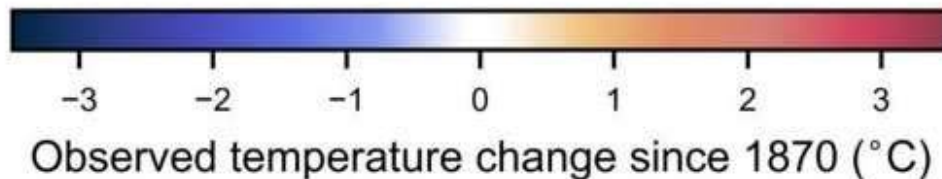
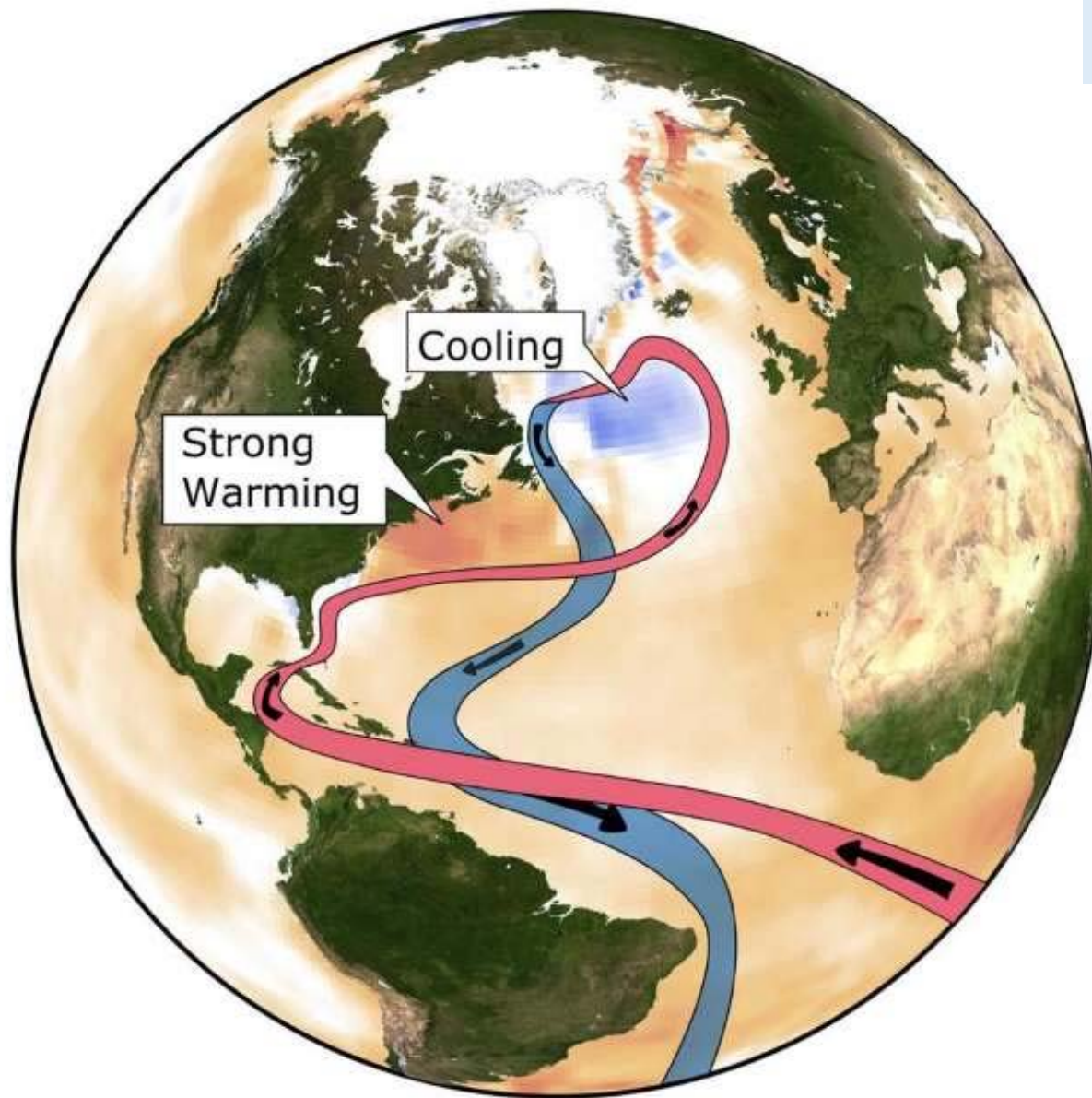


The Changing Jet Stream

- The jet stream exhibits extreme behavior
- During the summer, warm air holds more moisture + when stirred by a hurricane, the moisture manifests as intense rainfall
- Same phenomena as the polar vortex in winter
- Predicted to increase by 50 % this century if emissions of carbon dioxide + other GHG continue unchecked



Gulf Stream Weakening



The oceans' circulation hasn't been this sluggish in 1,000 years

The ocean circulation has declined in strength by 15% since the mid-20th century

This is a new record low

Over the past 15 years the Gulf of Maine has warmed 7 times faster than the rest of the ocean

Potsdam Institute for Climate Impact Research

April 11, 2018

Gulf of Maine Research Institute

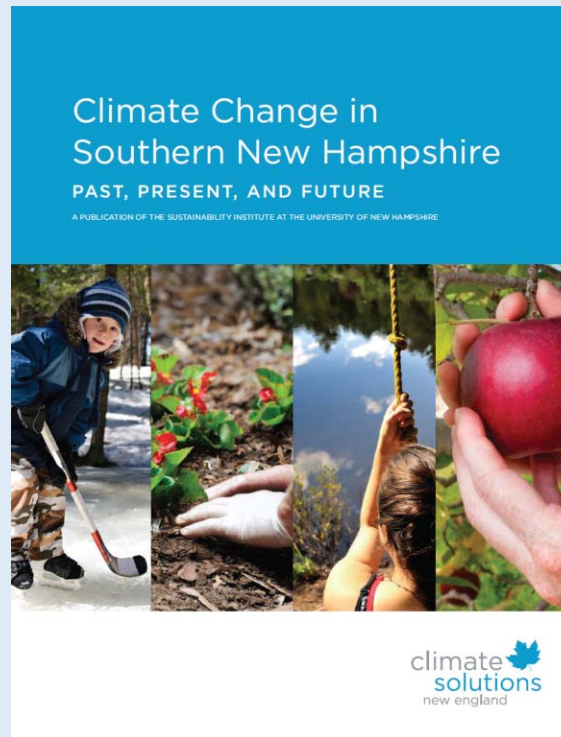
So what about our area?



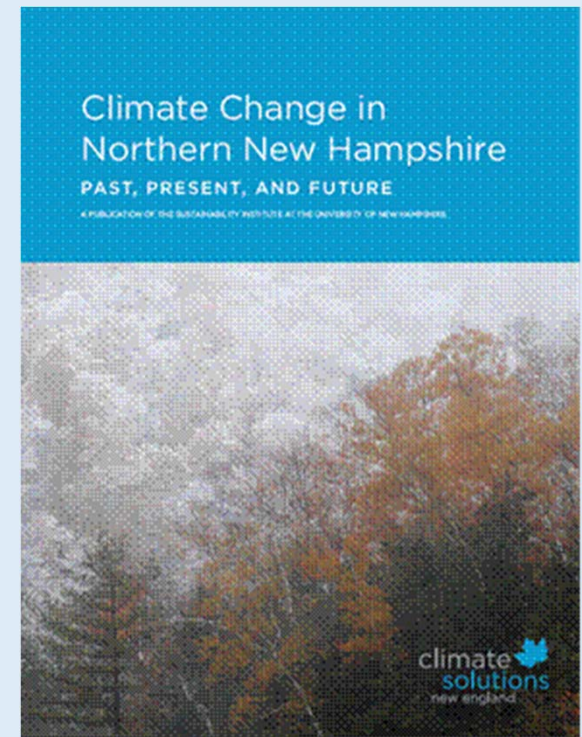
Local and Regional Climate Assessments



Seacoast



Southern NH

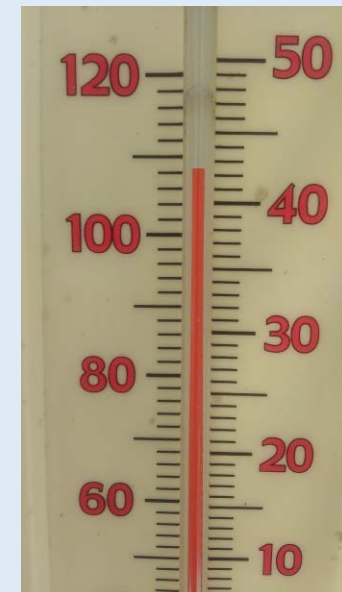


Northern NH

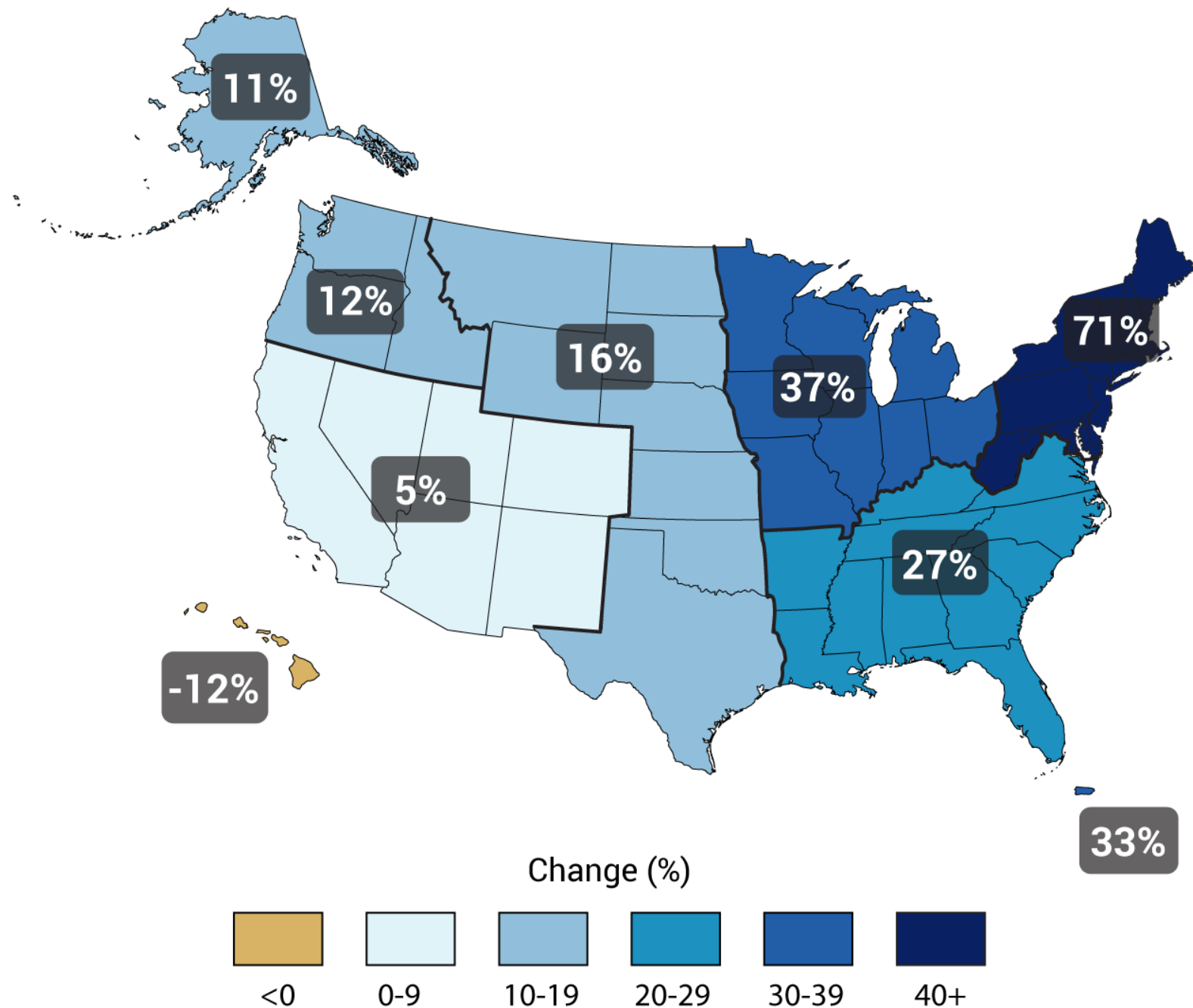
Local Data!

Observed Climate Patterns and How This Impacts Us

- Increase in precipitation – rain + snow
 - Amount + intensity
- Increase in average temperature
- Increase in extreme weather
- Changing seasonality
- Drought
- Sea-level rise
 - Portsmouth's sea level has risen 8" (1912-2018)
 - Weekly high tide flooding in Hampton
 - Increases in ground water levels



Observed Change in Very Heavy Precipitation

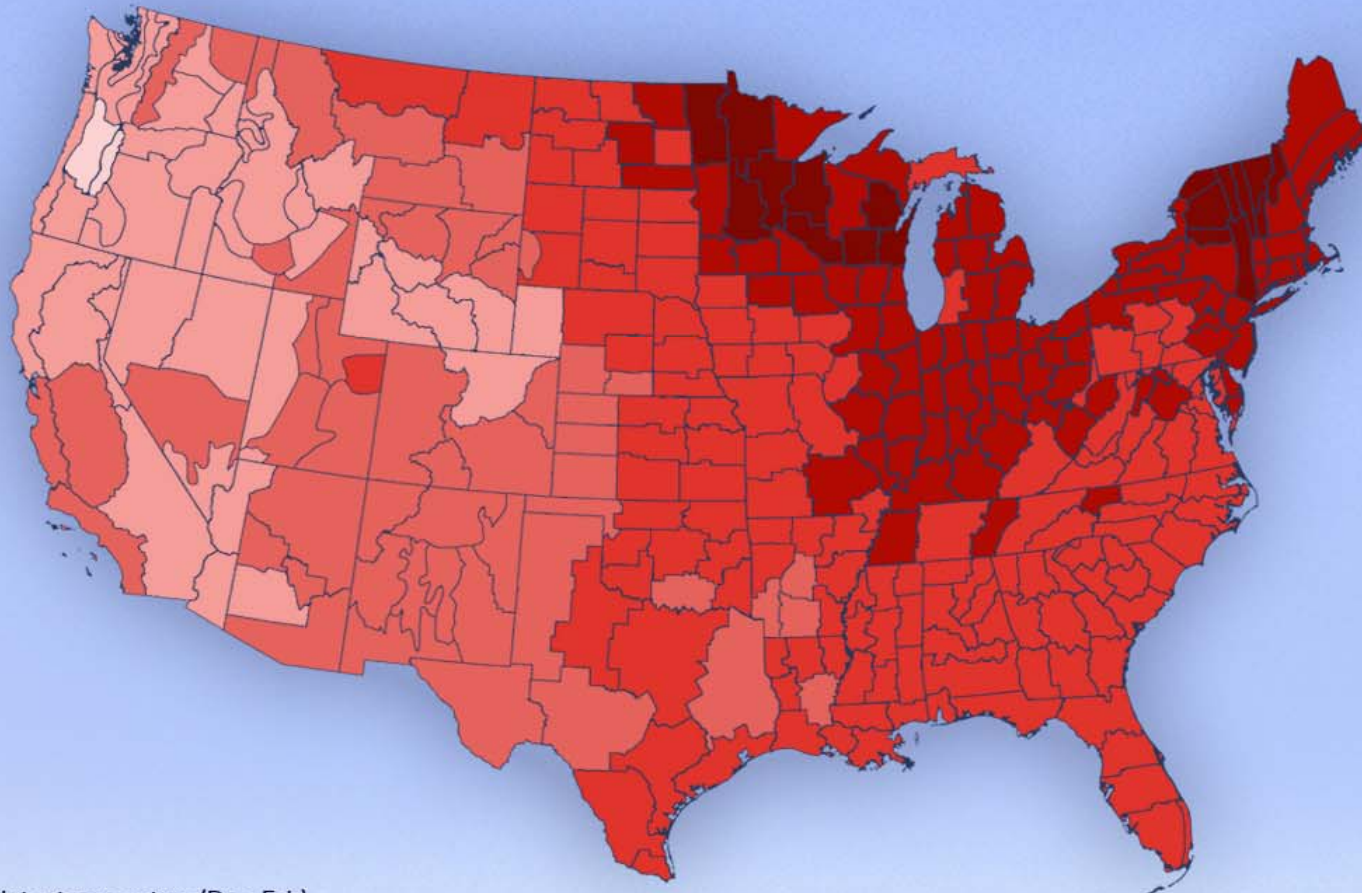
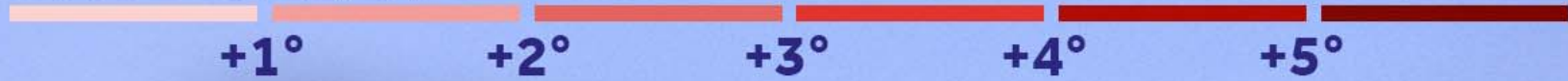


from 1958 to 2012

<https://nca2014.globalchange.gov/report/regions/northeast>

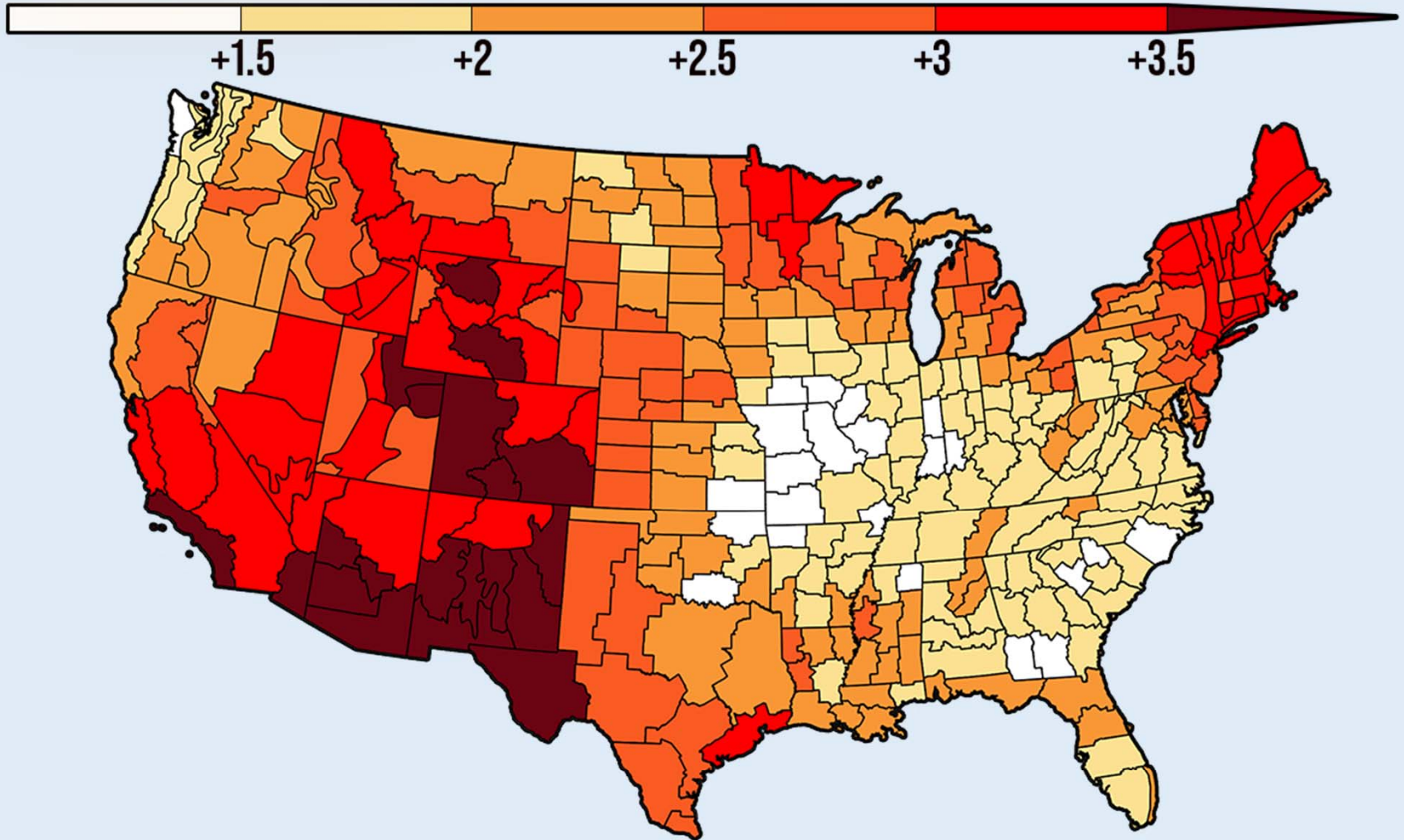
WINTER WARMING

SINCE 1970 (°F)



Average winter temperature (Dec-Feb).
Source: NOAA/NCEI Climate at a Glance

FALL WARMING SINCE 1970 (°F)



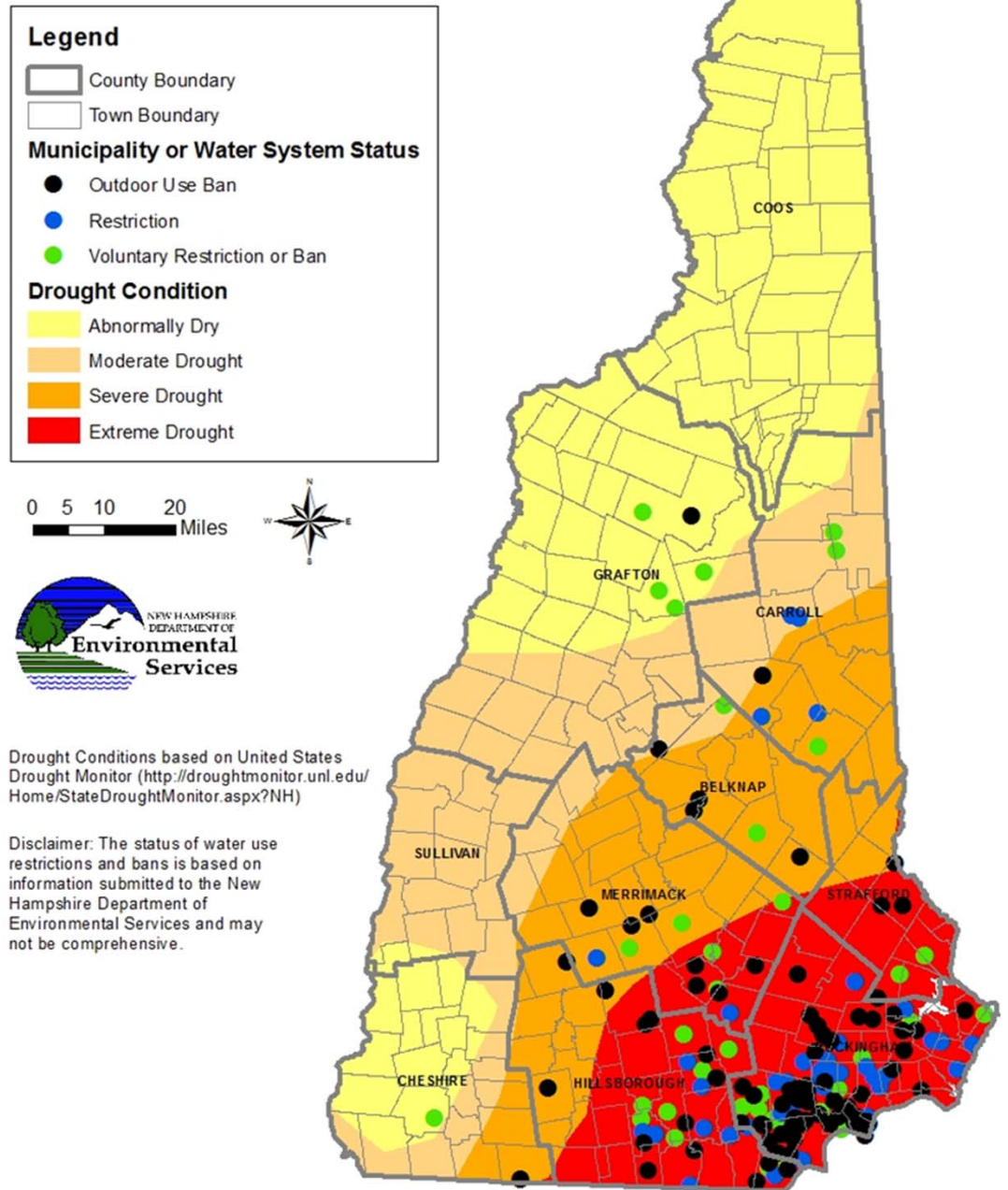
Source: NOAA/NCEI Climate at a Glance. Average fall temperature (Sep-Nov).

Drought 2016



Known Water Use Restrictions and Bans

Last Update: October 13, 2016



Sea-Level Rise



Portsmouth, NH



Hampton, NH

King Tide

Sneezy and Itchy

Increases in pollens + other allergens

- Longer allergy season
- Observed increase of 13 to 27 days in the ragweed pollen season in the northeast



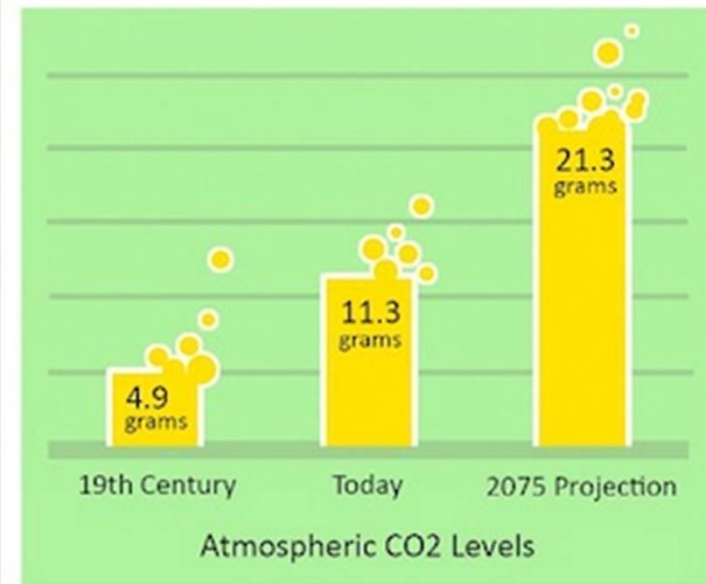
Poison Ivy loves CO₂

- Grows bigger
- Has more toxic oils
- More abundant and more irritating



More Ragweed Pollen

These bars show how pollen per plant rises as we fill the air with more CO₂.

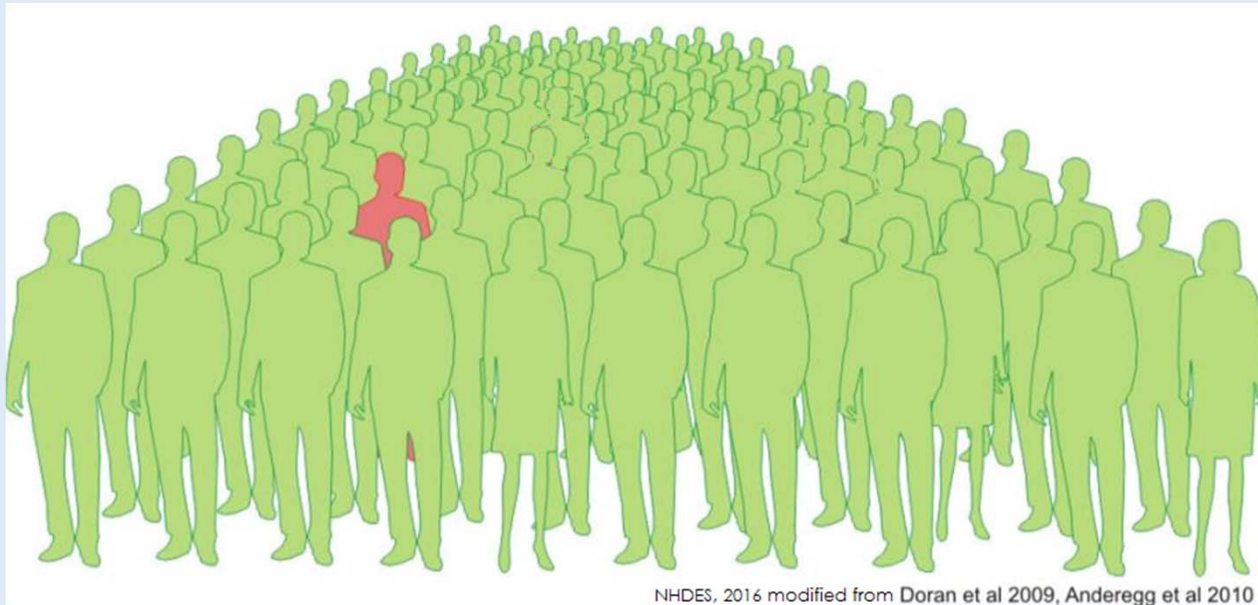


Loss of Electricity

- Lack of heating on cold days
- Lack of cooling on hot days
- Carbon monoxide poisoning
- Interrupts communication + utilities
 - Rural areas - no flushing
no drinking water



Climate Change is Real



NHDES, 2016 modified from Doran et al 2009, Anderegg et al 2010

99% of climate scientists agree that climate-warming trends are likely due to human activity

Climate Change is Already Occurring



The impacts of climate change are already being felt by communities across the country

These extreme events (heat, cold, storms, drought) are disrupting and damaging critical infrastructure, labor/economies, natural resources, and the vitality of our communities

We Have a Choice

Do nothing – Continue with business as usual



We Have a Choice

- Mitigation
 - Reduce emissions of CO₂ + other greenhouse gases
 - Reduce our use of fossil fuels

- Adaptation
 - Prepare for the current and future impacts



Already Adapting – “Yankee Ingenuity”

- Power companies trimming trees and limbs
- Maintaining + upgrading culverts when replacing
- On-going road/drainage maintenance
- Ski areas have alpine slides, canopy tours + mountain biking
- Communities are making changes at wastewater, drinking water and solid waste facilities
- Backup generators



Investment in Adaptation

It's not a question of **IF** we'll pay to adapt

It's a question of **WHEN** we'll pay

We can plan ahead + get
where we want to go

We can incur damages, clean up
the mess + live with the consequences

Anticipatory Adaptation

River & Stream buffers

Help to Decrease :

- storm water runoff
- erosion
- flooding

\$1.00

OR

\$7.00

Reactionary Adaptation

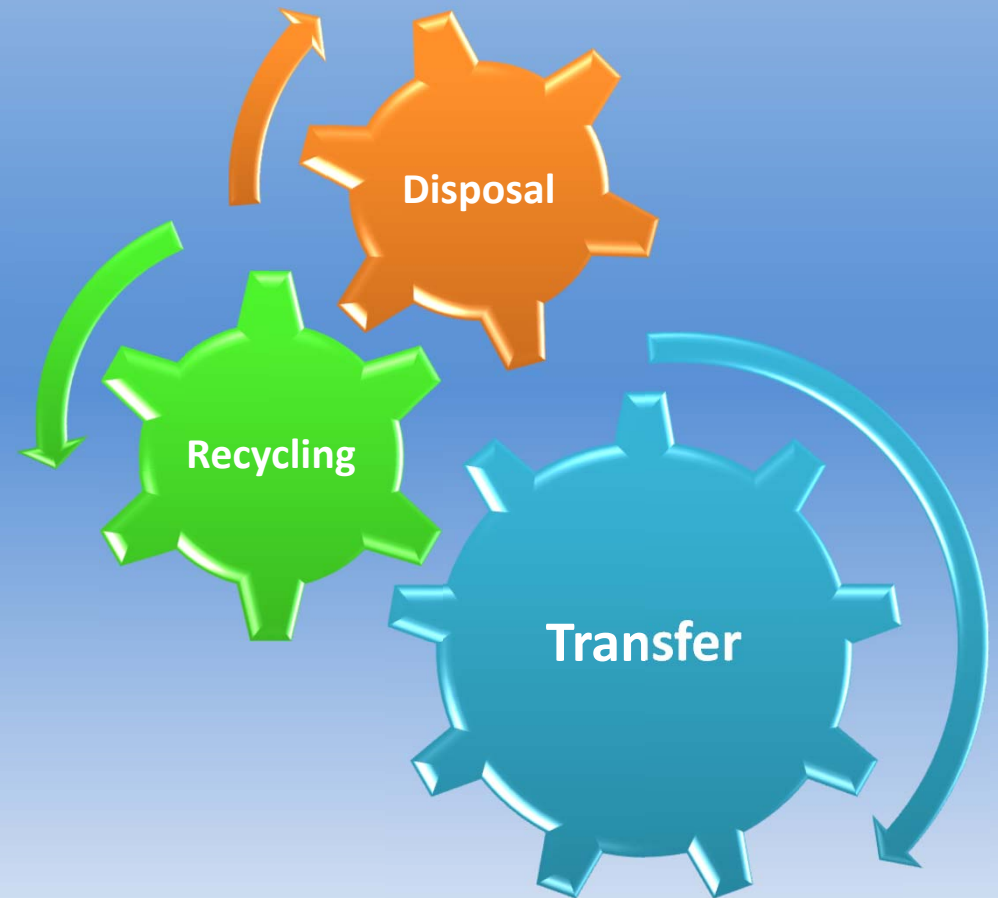


Impacts to Your Solid Waste Facility



Two Ways to Think About...

- Your facility's issues
- Everyone else's issues



Facility Types

- Collection/Storage/Transfer stations
- Processing/Treatment facilities
- Landfills



Extreme Weather Events

Drought

Flood

Hurricane

Blizzard

Ice Storm

Heat wave

High winds

Sea level rise



Transfer Stations



Processing/Treatment Facilities



Landfills



Landfills



Everyone Else's Issues



So, do you have a...?

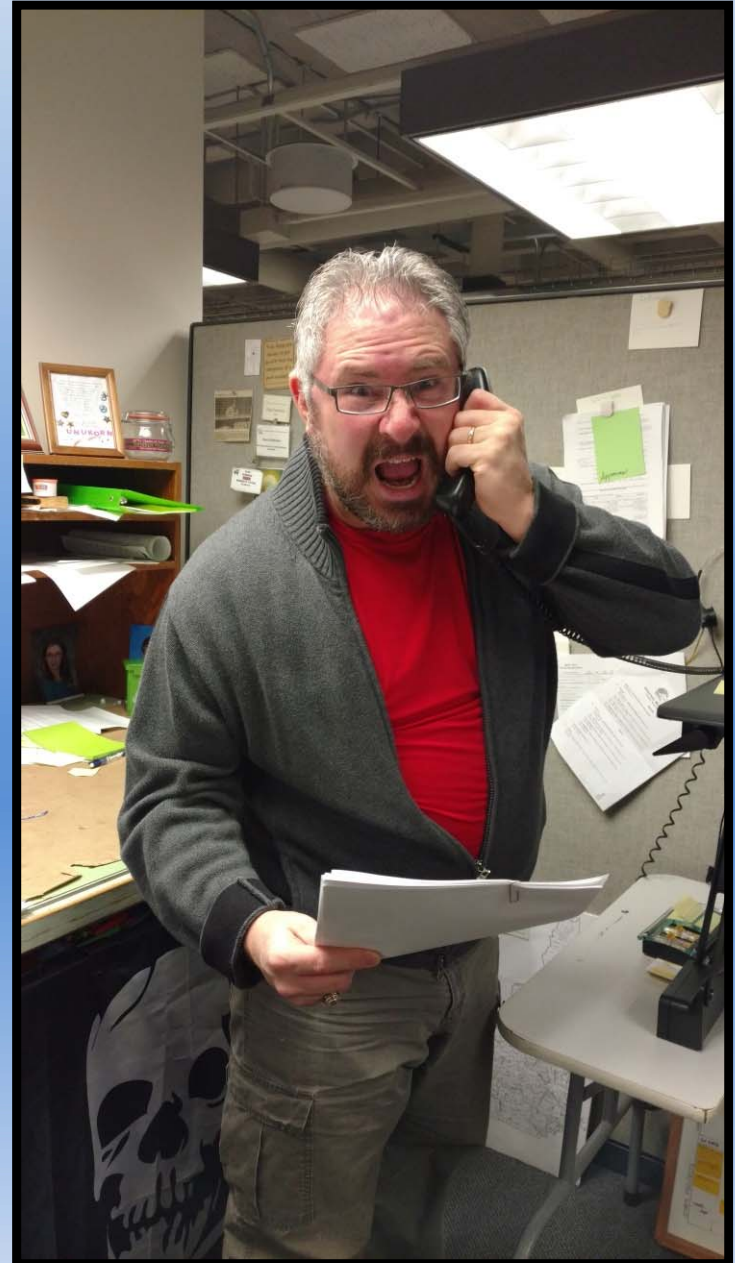
- *Contingency Plan*
 - **Section 6** of your Operating Plan
 - This is your **Emergency Action Plan**
- A good plan includes:
 - How to report emergencies
 - What you need to do in an emergency

This Guy... or That Guy?



Behavior Change

Cynthia Nelson



Why?





SAVE MONEY



BE A GOOD
CITIZEN



SAVE THE
PLANET

Poll Question



**KNOWLEDGE DOES NOT
NECESSARILY LEAD TO
BEHAVIOR CHANGE**



Information works when:

- New
- Significant revision
- Long time since it has been given

SO?

What works?

Vision

Sometimes knowing *why* you should do something motivates people to change.

It is not enough to say “Because I told you to.”



Poll Question



Social Norms



Social norms are a powerful tool of change



Social norms are a powerful tool of change





SAVE MONEY



BE A GOOD
CITIZEN



SAVE THE
PLANET



YOUR NEIGHBORS
ARE DOING BETTER



PREVENTION AND PREPAREDNESS

Prevention

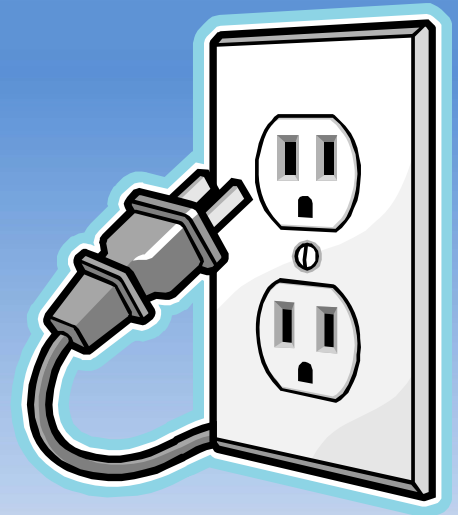
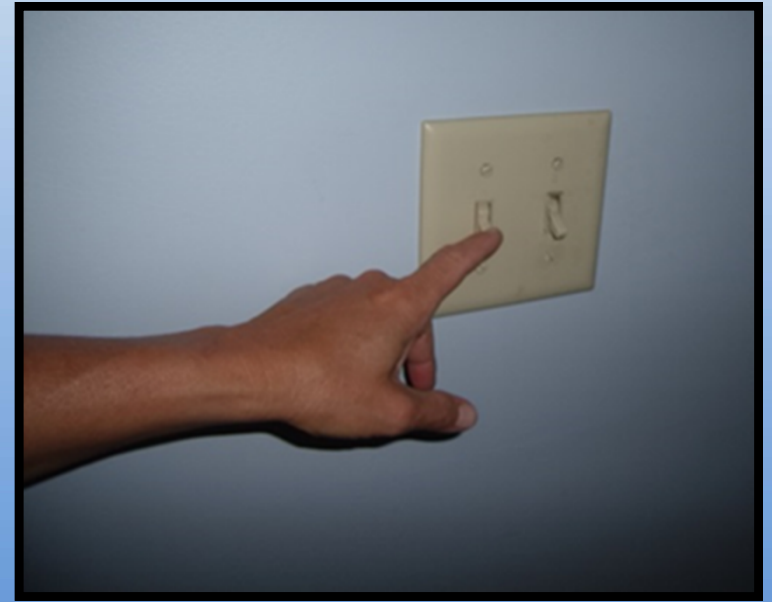
Little things make
a difference.





Energy Use ... and the obvious

- Shut stuff off!
- Unplug stuff not in use!



Would you like \$200 per year?

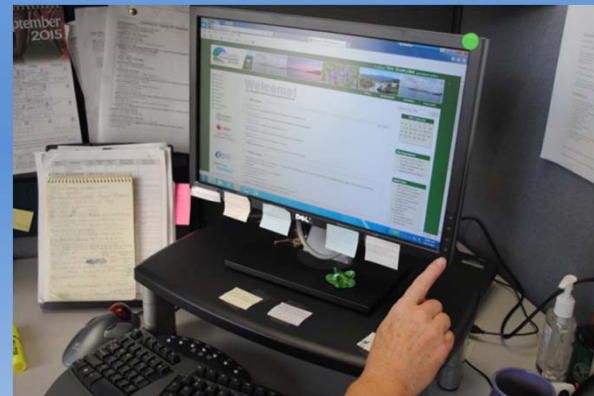


Phantom Energy!

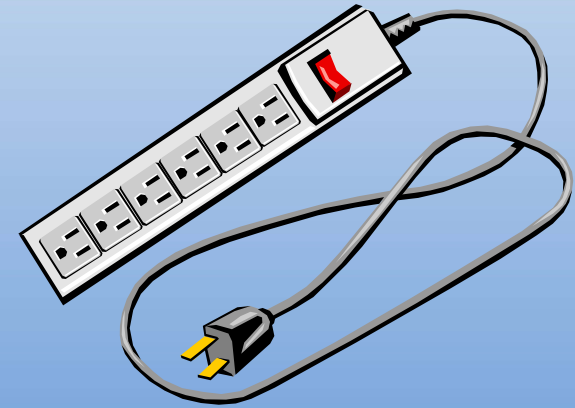
20% of energy is wasted

The US spends \$40 billion dollars each year on wasted energy

Turning off computers and monitors (and other electric items) saves energy and reduces pollution!



Phantom Energy Phact



Phantom Load fact:

The consumption from **phantom loads** of electricity in the United States is said to **equal the electricity use of Greece, Peru, and Vietnam combined**. When an appliance is not in use, unplug it at the wall.

"Energy savers are the real stars,"
The Christchurch Press, September 11, 2001

No Idling



Reuse



Recycle



Rain Barrels



Wasted Food

- 20-40% of landfill is wasted food
- Methane is a very potent greenhouse gas



PREPAREDNESS

You can help get prepared!

- Pay attention to warnings for strong storms
- Have plans for emergencies and different kinds of storm events.



- Be prepared to be without electricity
- Evaluate whether you need to purchase a generator for periods of no electricity



- Check for ticks after being outside and know the early warning signs of Lyme Disease and other tick related illness



Check your facility
and driveway for
adequate drainage
to prevent
washouts



Have large and/or diseased trees around buildings removed to prevent them from hitting structures during storms



- Participate in community conversations to support initiatives in your town
- Support local initiatives including increased efficiency in municipal buildings, culvert maintenance, solar initiatives etc...



Planning in the Face of Uncertainty

- Winters
 - Lots of road salt one year; No winter another year
 - Rain on snow events lead to flooding



Planning in the Face of Uncertainty

- Summers
 - Longer mowing season
 - Longer tick season
 - Cyanobacteria blooms
 - Reduced water availability



Planning in the Face of Uncertainty

- Sometimes flooding
- Sometimes drought

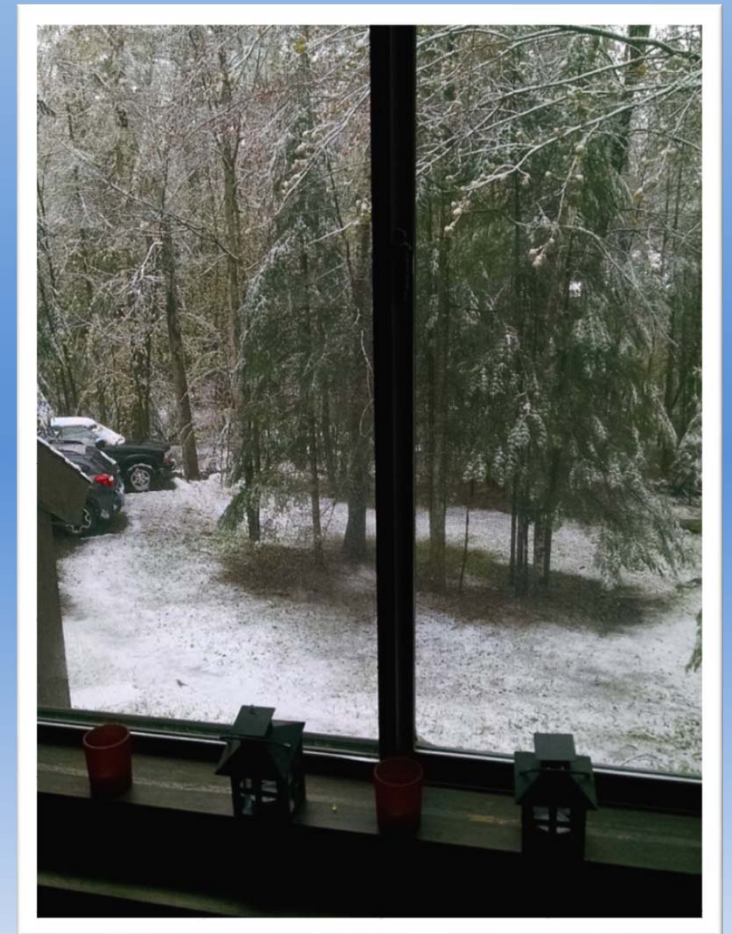


Mother's Day

2006



2017



So what do we do?

- This uncertainty makes it imperative for us to understand the issues and the potential changes we will experience and bring that information into our planning; both at home and in our jobs.

We have the ability to make a
difference.