Farmer Response to Changing Weather

Ag Trade Show 2019
Glen Koehler

1865 THE UNIVERSITY OF MAINE Cooperative Extension

Image: oozie.org

thirteen

‘I study climate change

The ~~nine~~ most terrifying words in the English language are, ‘I’m from the government and I’m here to help.’

~ Ronald Reagan

Steve McNulty slide

Outline:

A quick look at the big picture

Weather vs. Climate

Observed and potential weather changes in Maine

Adapting to new weather:

- Examples

- Resources

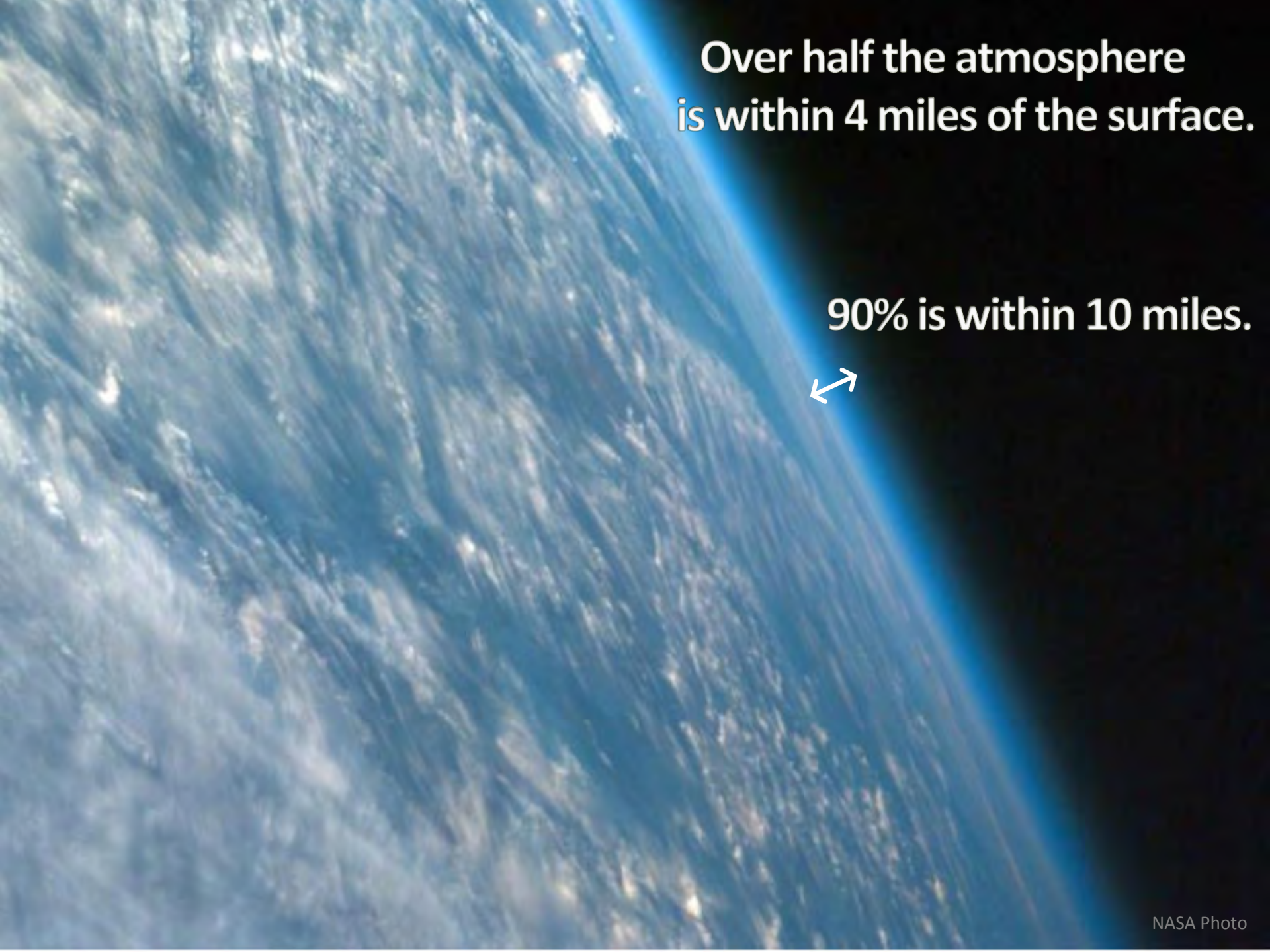
- Principles

If Earth was the size of an apple …

NASA photo

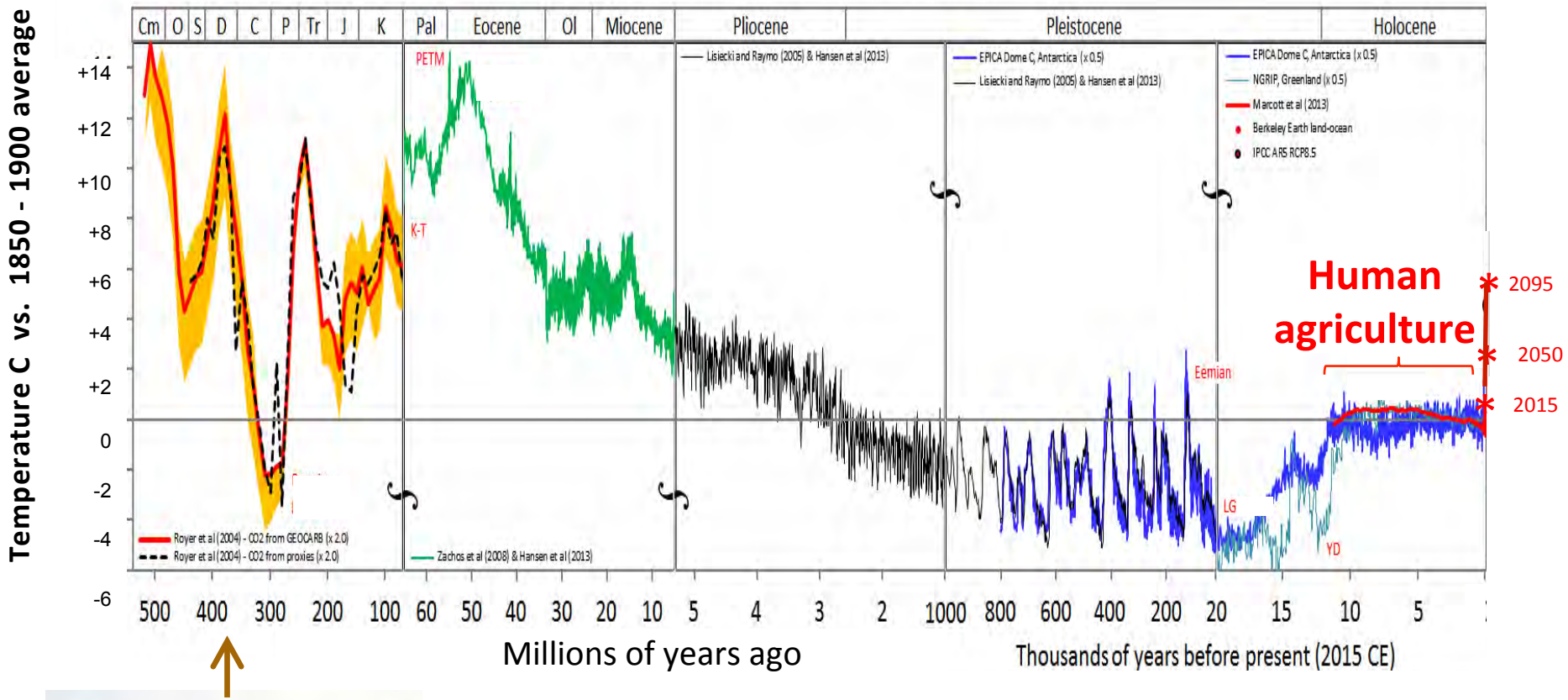
… the atmosphere would be thinner than the skin.

Image by Kevin Van Aelst. http://www.kevinvanaelst.com

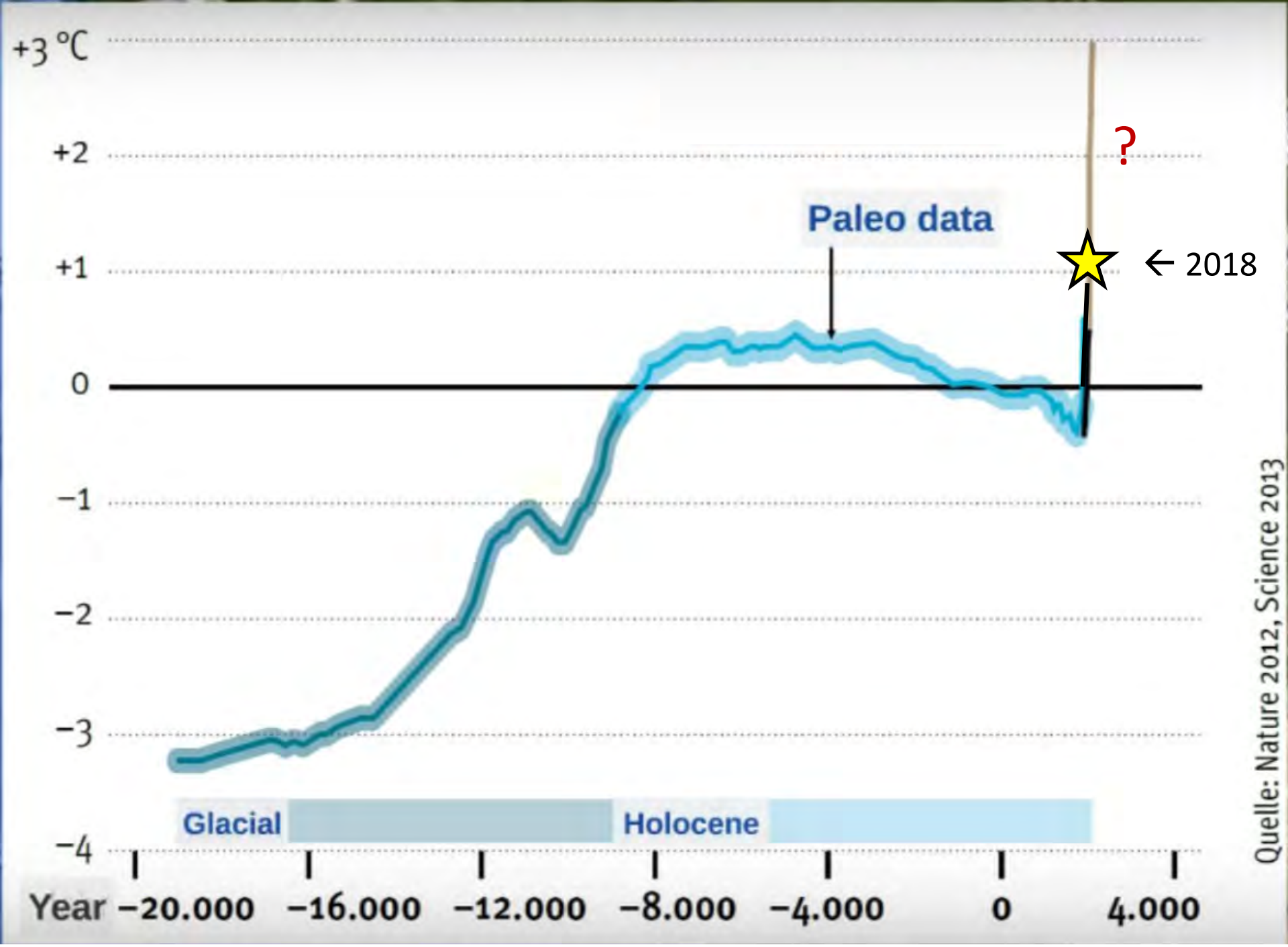

Over half the atmosphere
is within 4 miles of the surface.
90% is within 10 miles.
NASA Photo

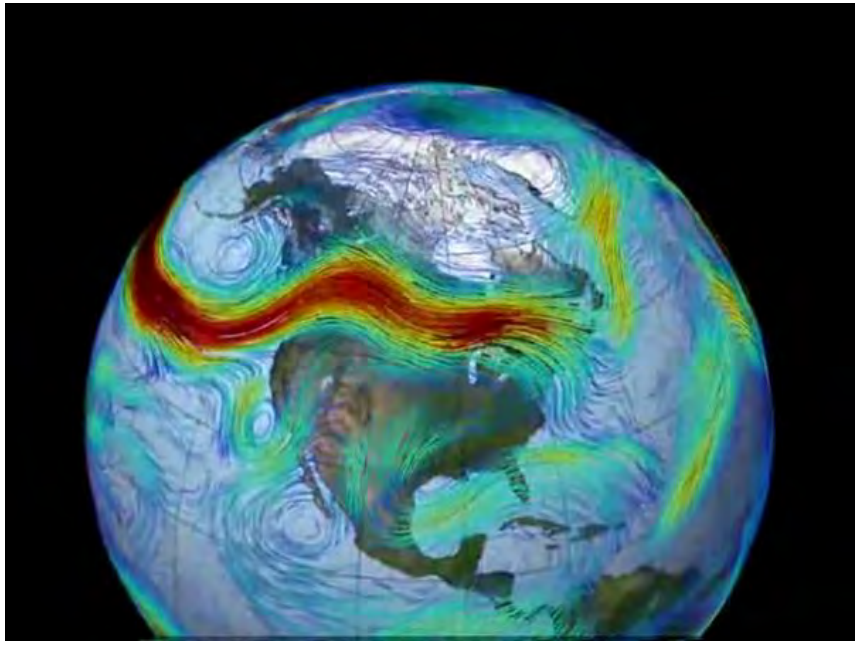
Earth has a long history of climate change

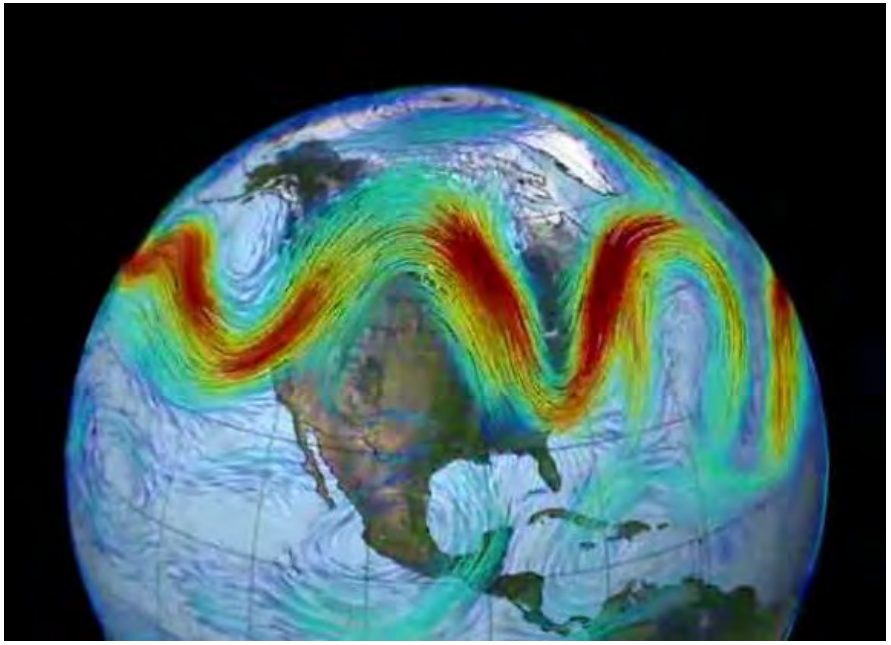
Temperature over last 500 million years



350 million years ago - 1st cockroaches!


+3 °C
+2
+1
0
−1
−2
−3
−4
?
Paleo data
← 2018
Glacial
Holocene
Year −20.000
−16.000
−12.000
−8.000
−4.000
0
4.000
Quelle: Nature 2012, Science 2013





Images: NASA Goddard Space Flight Center

Recent Weather Events associated with wavy jet stream

Russian heat wave – Summer 2010

Pakistan floods – Summer 2010

Early spring, then frost Eastern US – Spring 2012

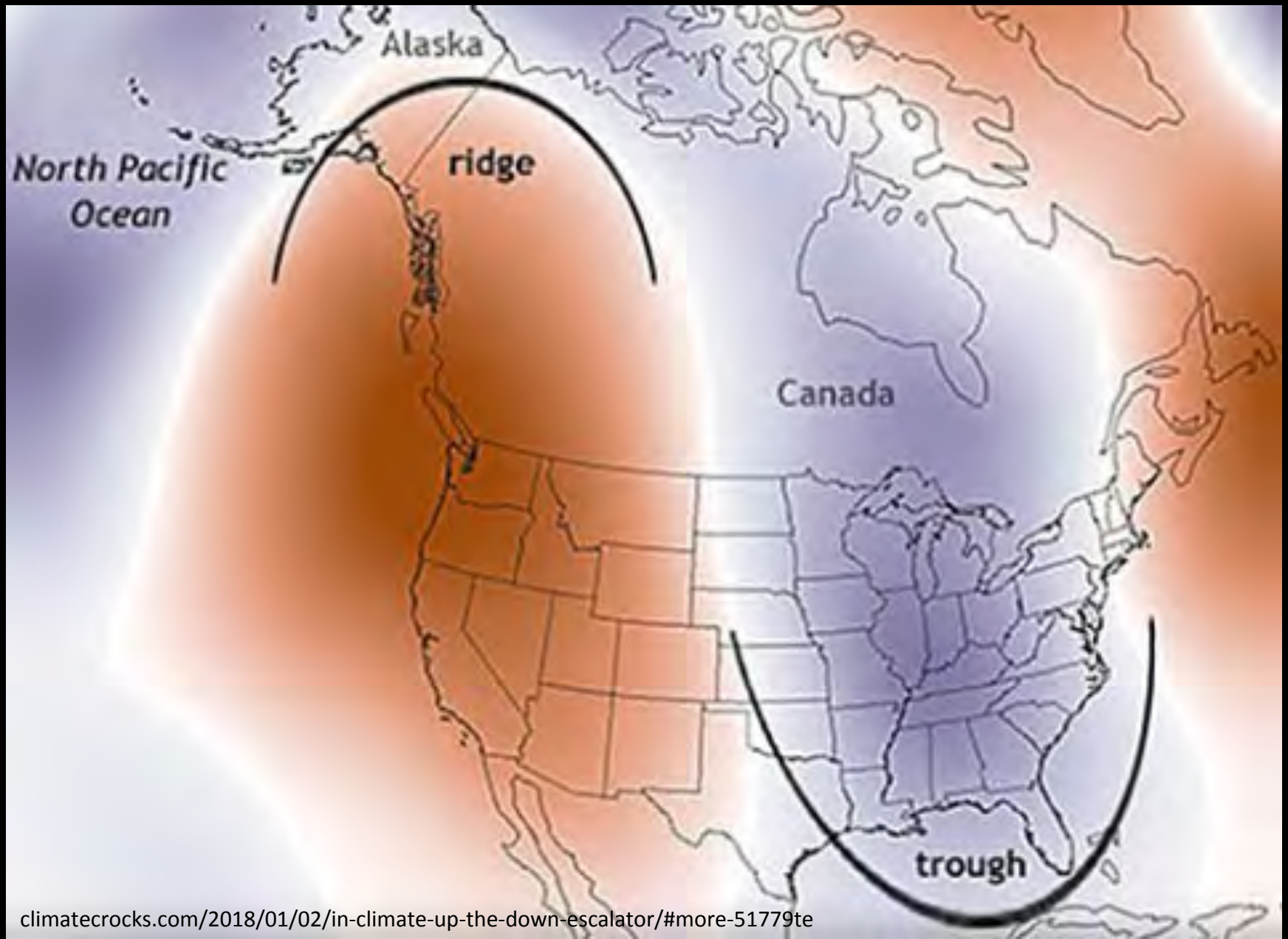
Midwestern US drought – Summer 2012

United Kingdom floods - February 2014

Cold snowy winters Eastern US – 2010, 2011, 2014, 2015, Jan. 2018

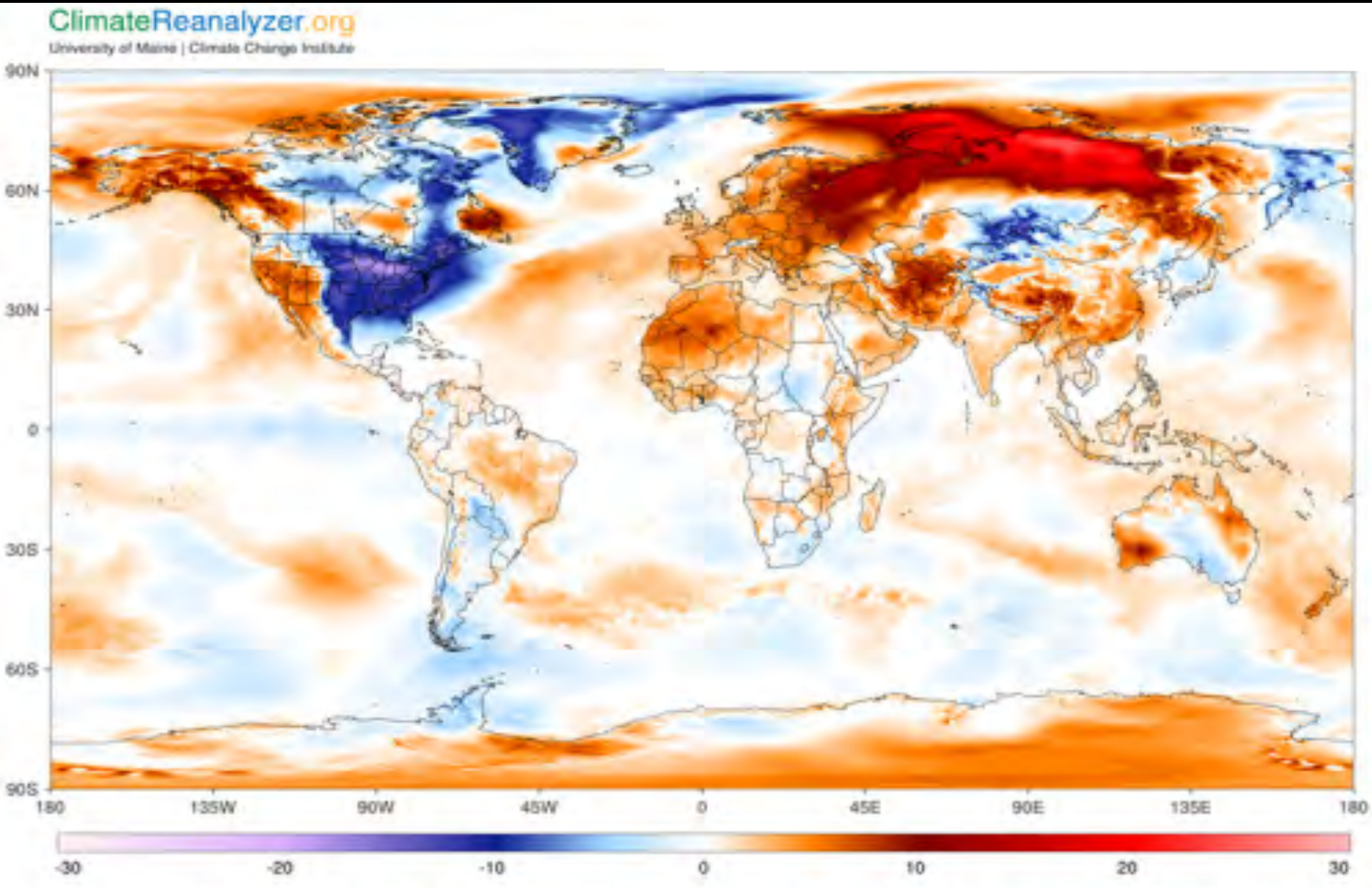
California drought – 2012-2015

Wavy Jet Stream



climatecrocks.com/2018/01/02/in-climate-up-the-down-escalator/#more-51779te

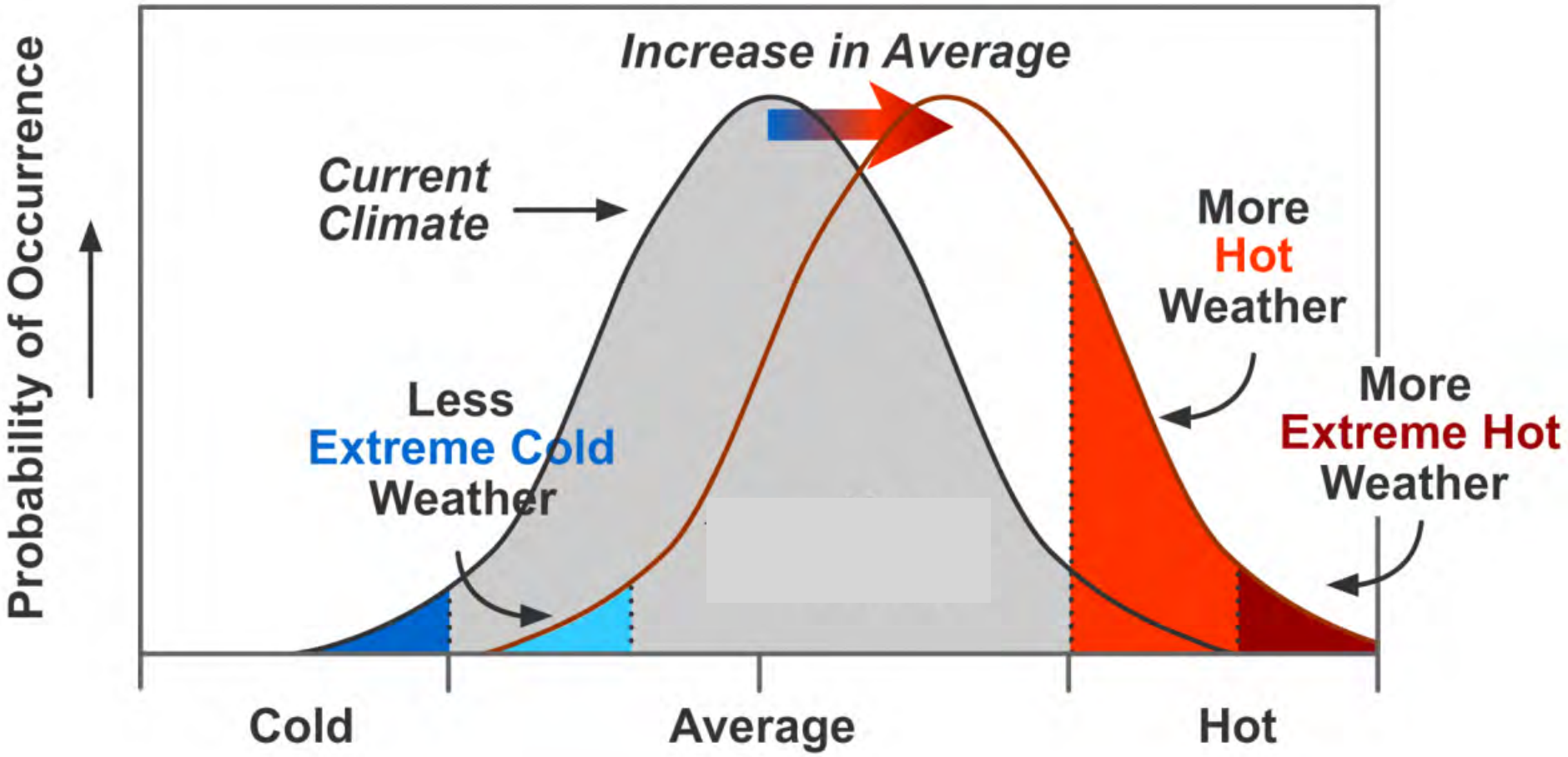
Temperature Difference from 1951-1980 average – January 2, 2018

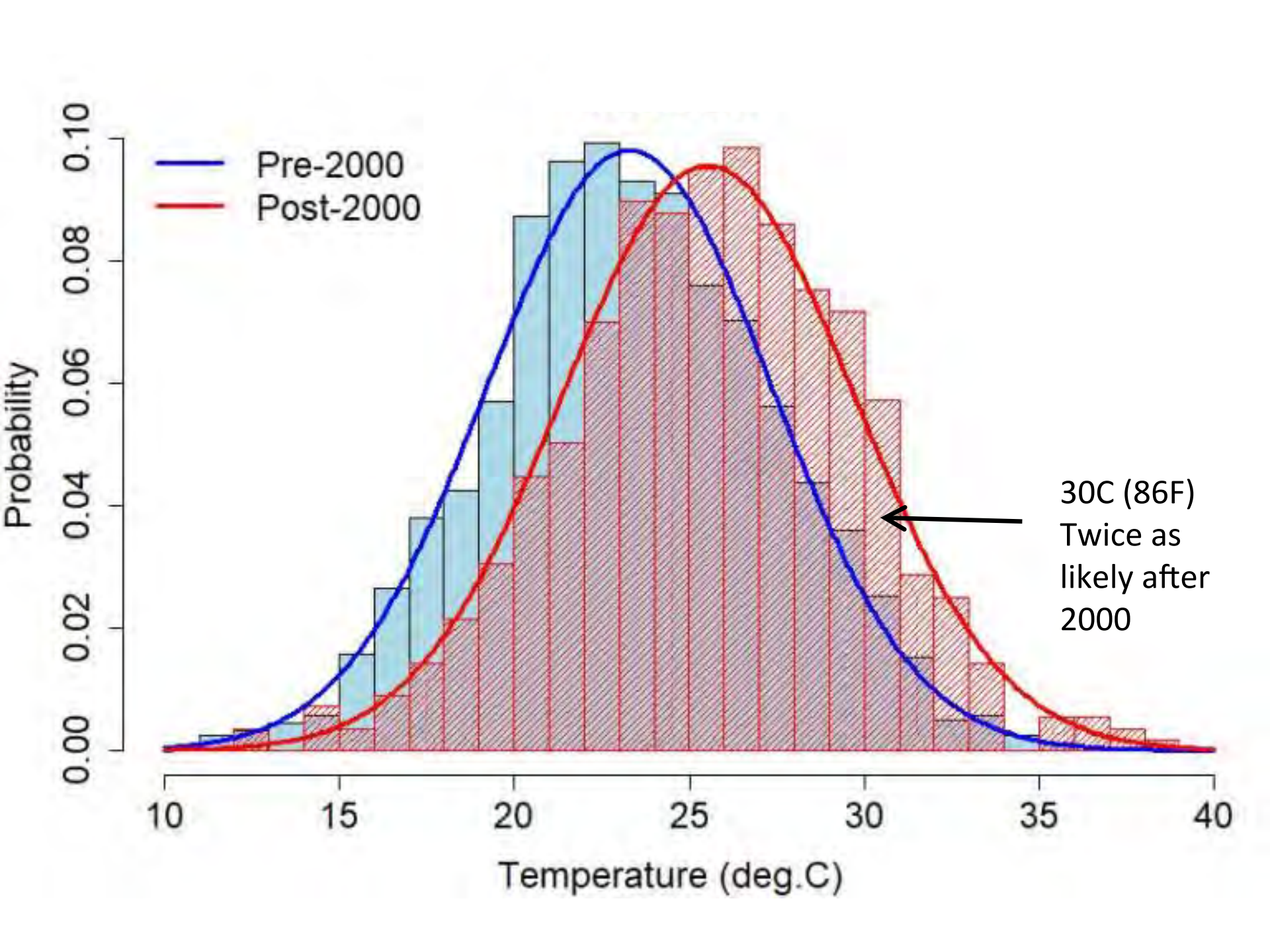


climatecrocks.com/2018/01/02/in-climate-up-the-down-escalator/#more-51779te

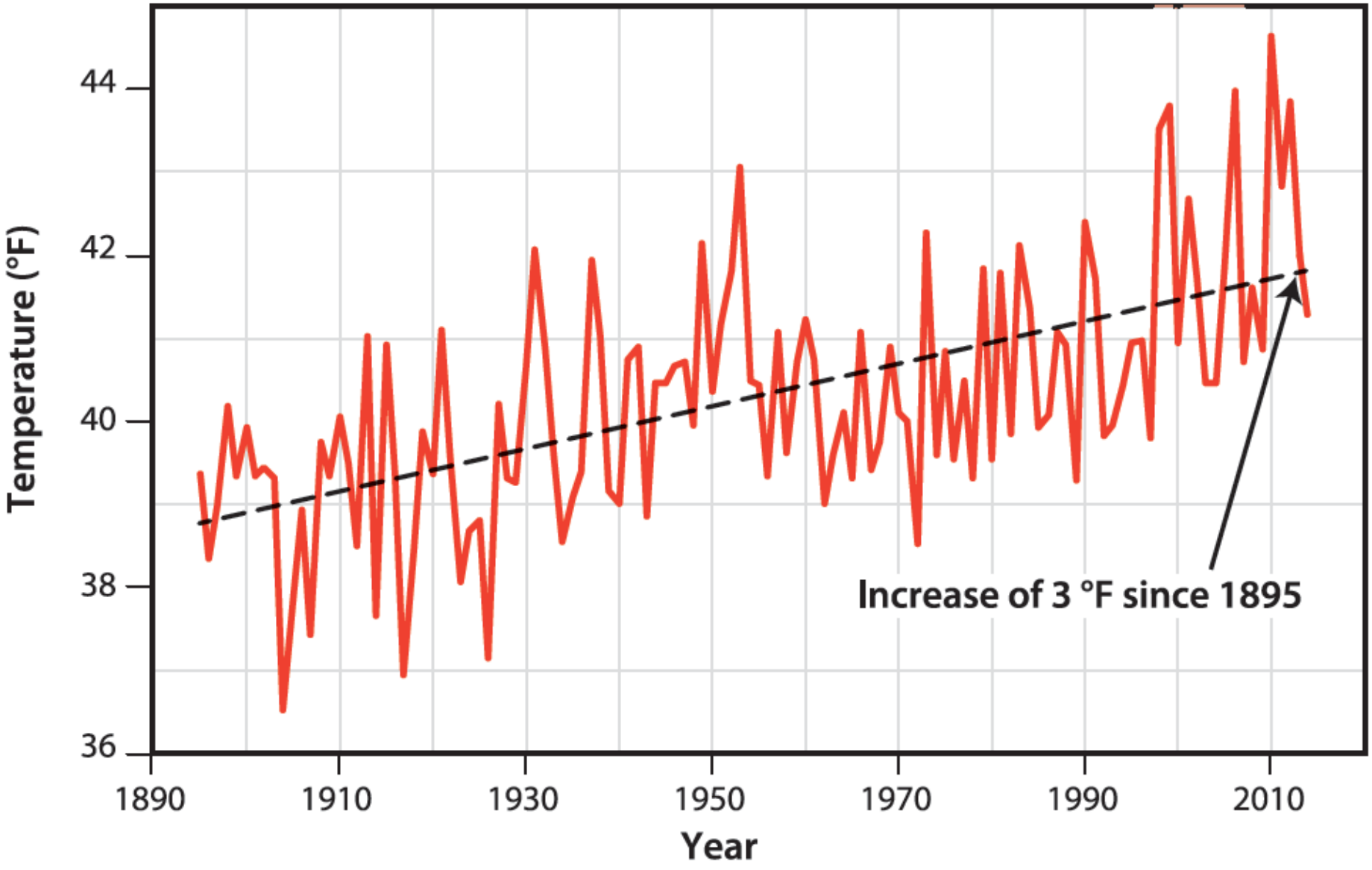
Crops don't grow in annual average conditions,
they are subject to daily, monthly, seasonal and year to year variations

Not just averages, but also Weather
Variability and Extremes
are expected to increase


Probability of Occurrence
Increase in Average
Current Climate
More Hot Weather
More Extreme Hot Weather
Less Extreme Cold Weather
Cold
Average
Hot

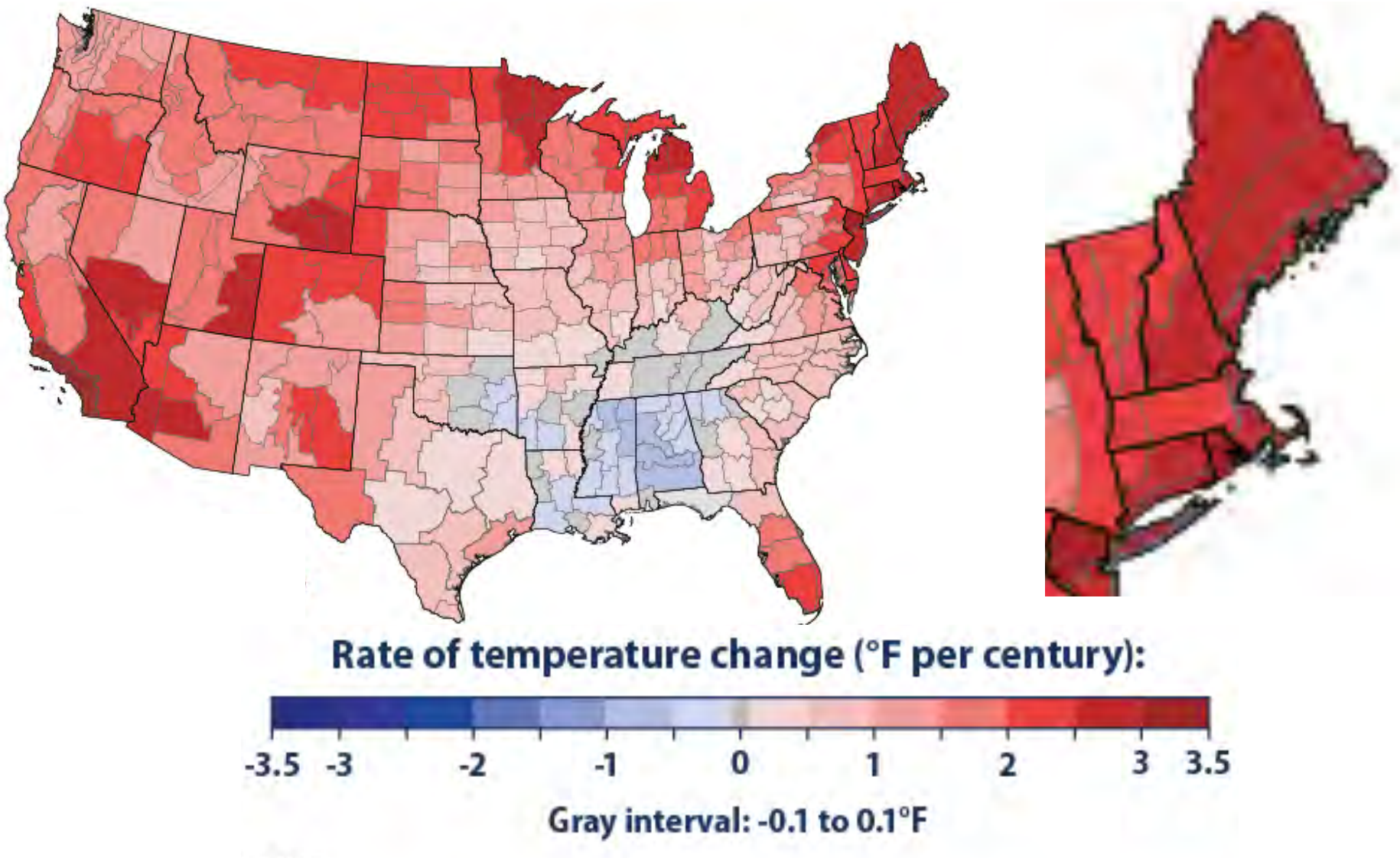

Pre-2000
Post-2000
Probability
0.00
0.02
0.04
0.06
0.08
0.10
10
15
20
25
30
35
40
Temperature (deg.C)
30C (86F)
Twice as
likely after
2000

Maine's Average Annual Temperature



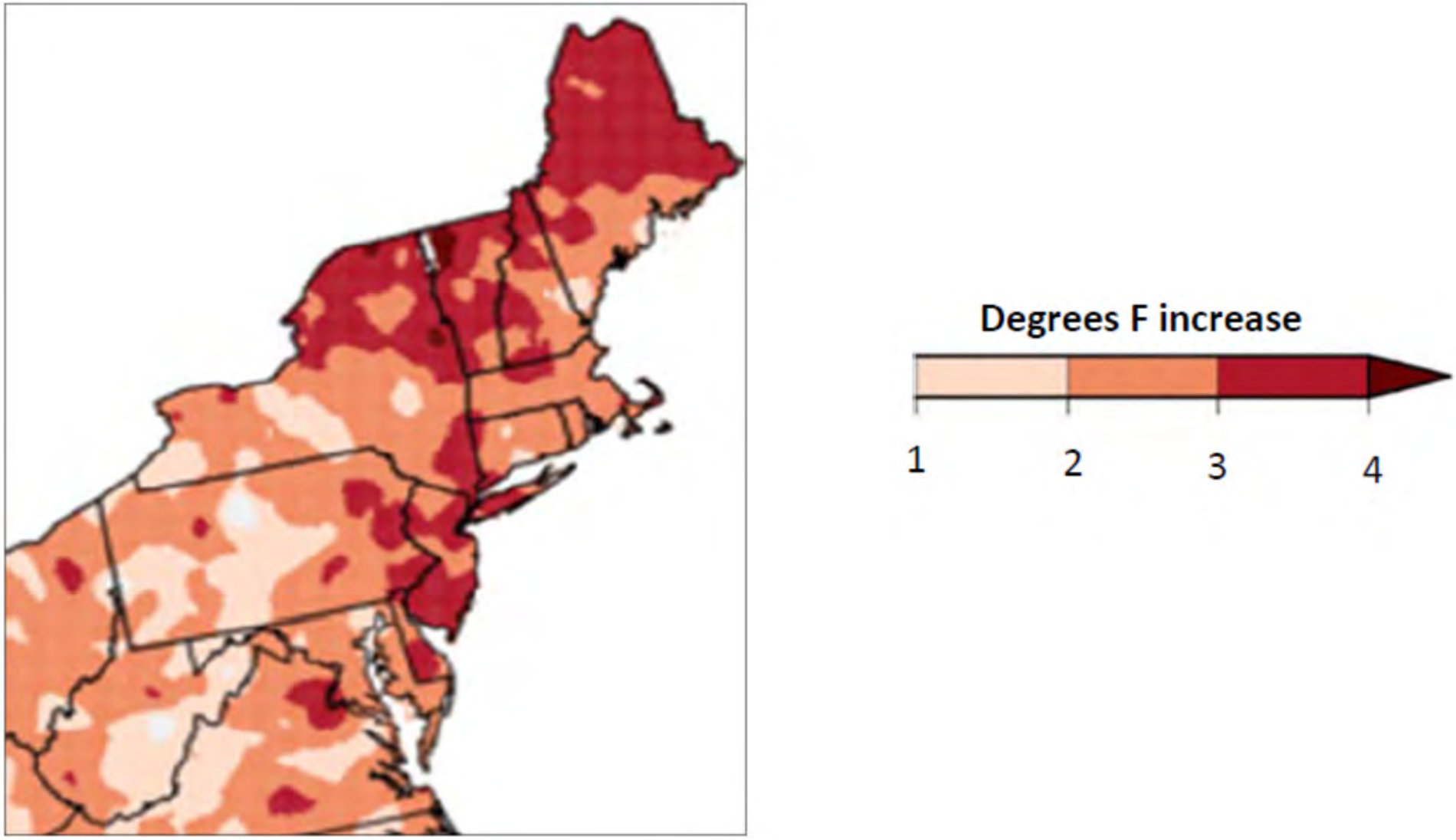
Fernandez, I. J., et al. 2015. Maine's Climate Future: 2015 Update. Orono, ME: University of Maine. 24pp.

Temperature Change Rate, 1901-2014



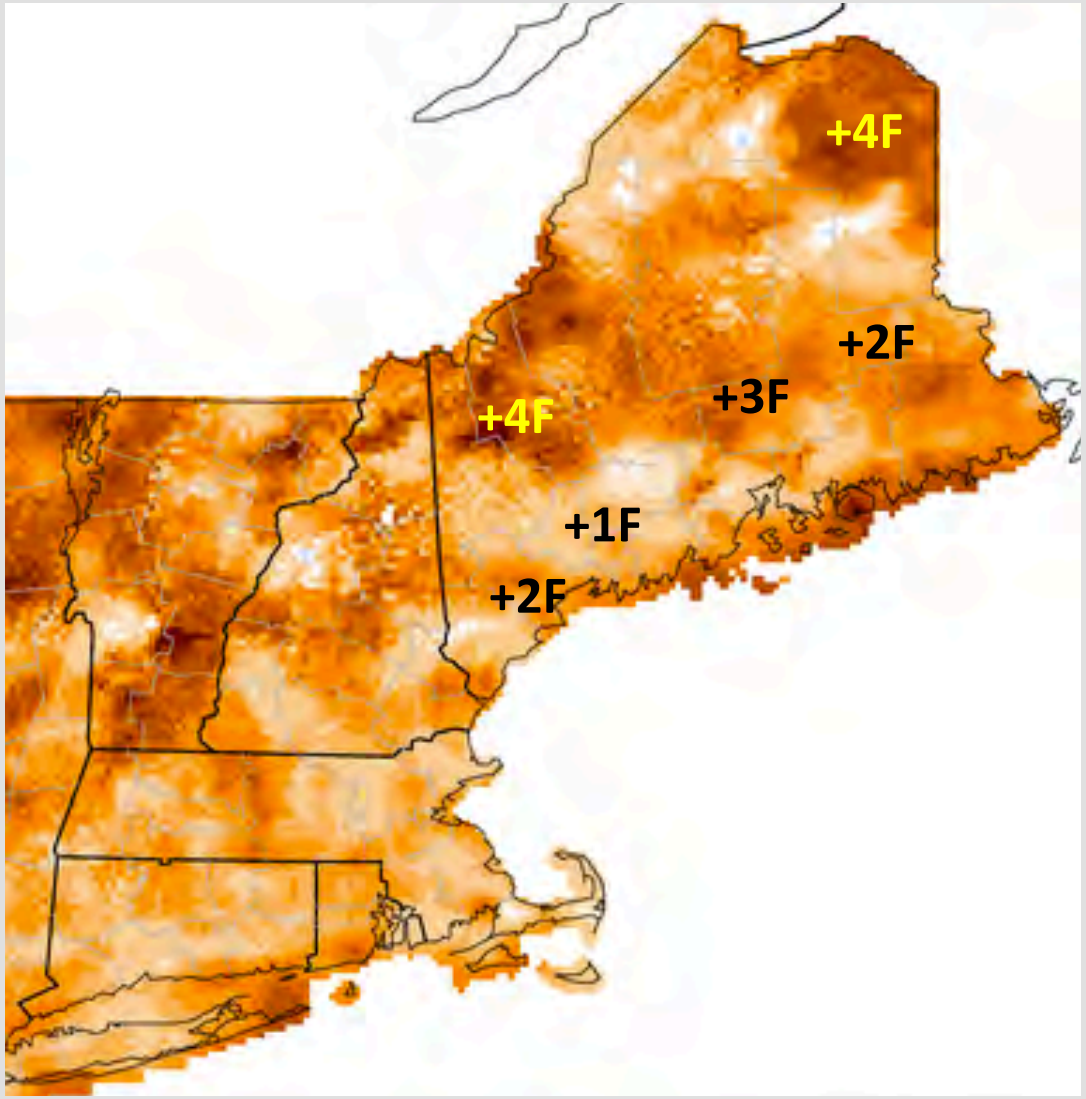
Graphic adapted from: USEPA, Climate Change Indicators in the United States
Accessed 6-16-2016. https://www3.epa.gov/climatechange/science/indicators/weather-climate/temperature.html

Observed average annual temperature increase from 1988 to 2017

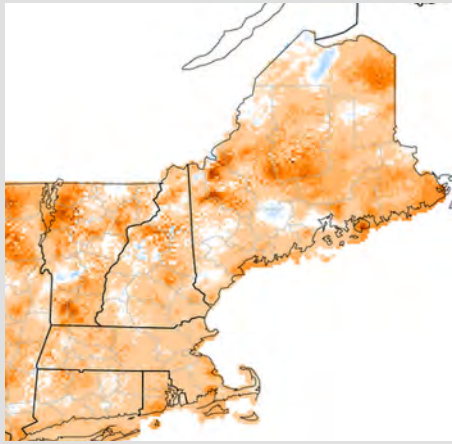


Winter Temperature Change: Average **Dec.-Jan.-Feb.** ~1980 to ~2010

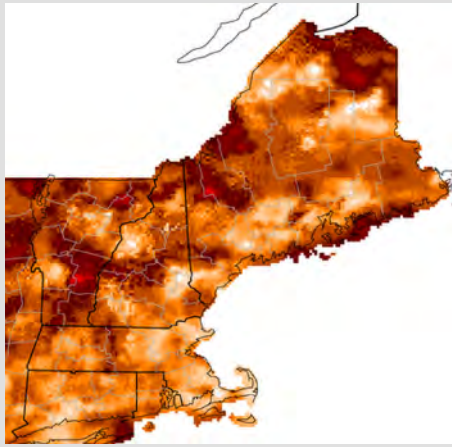
(30 year change in daily average from 1970-1990 to 2007-2013)



Change in average daily **High**



Change in average daily **Low**

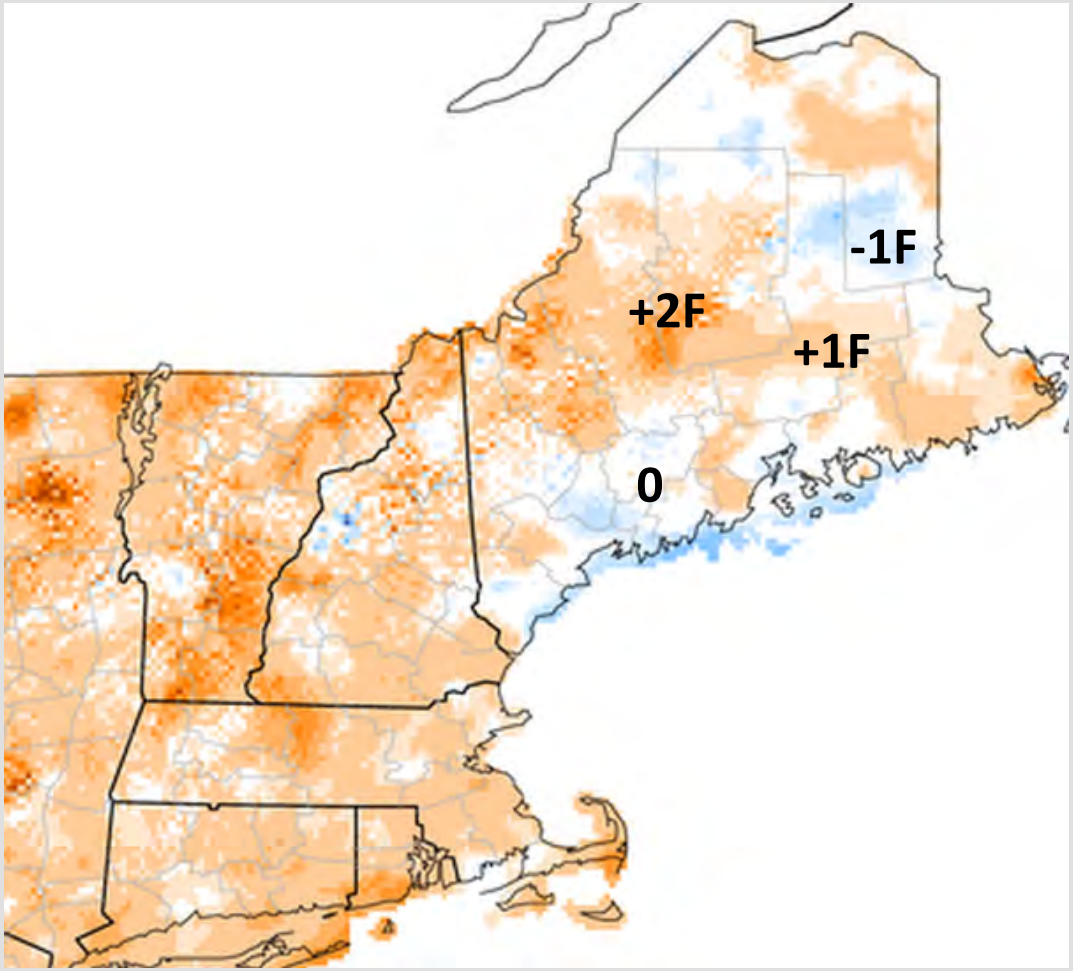


Change in degrees F

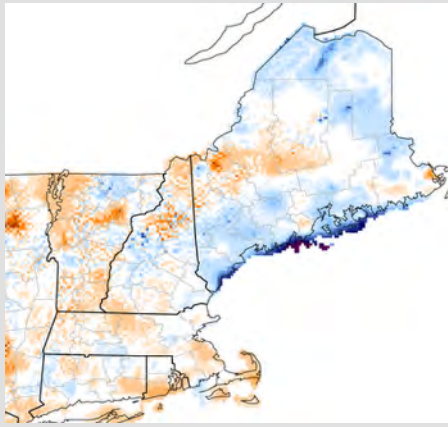
Image from Climate Reanalyzer™ (http://cci-reanalyzer.org), Climate Change Institute, University of Maine, Orono, Maine, USA

Summer Temperature Change: Average June-July-August ~1980 to ~2010

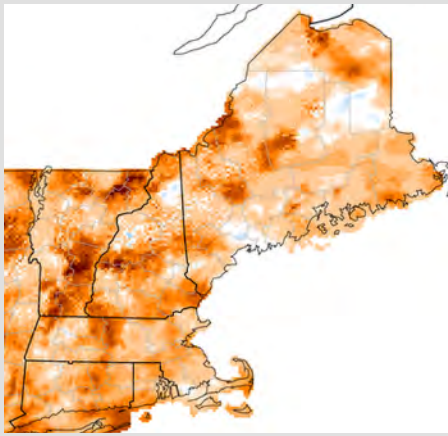
(30 year change in daily average from 1970-1990 to 2007-2013)



Change in average daily **High**

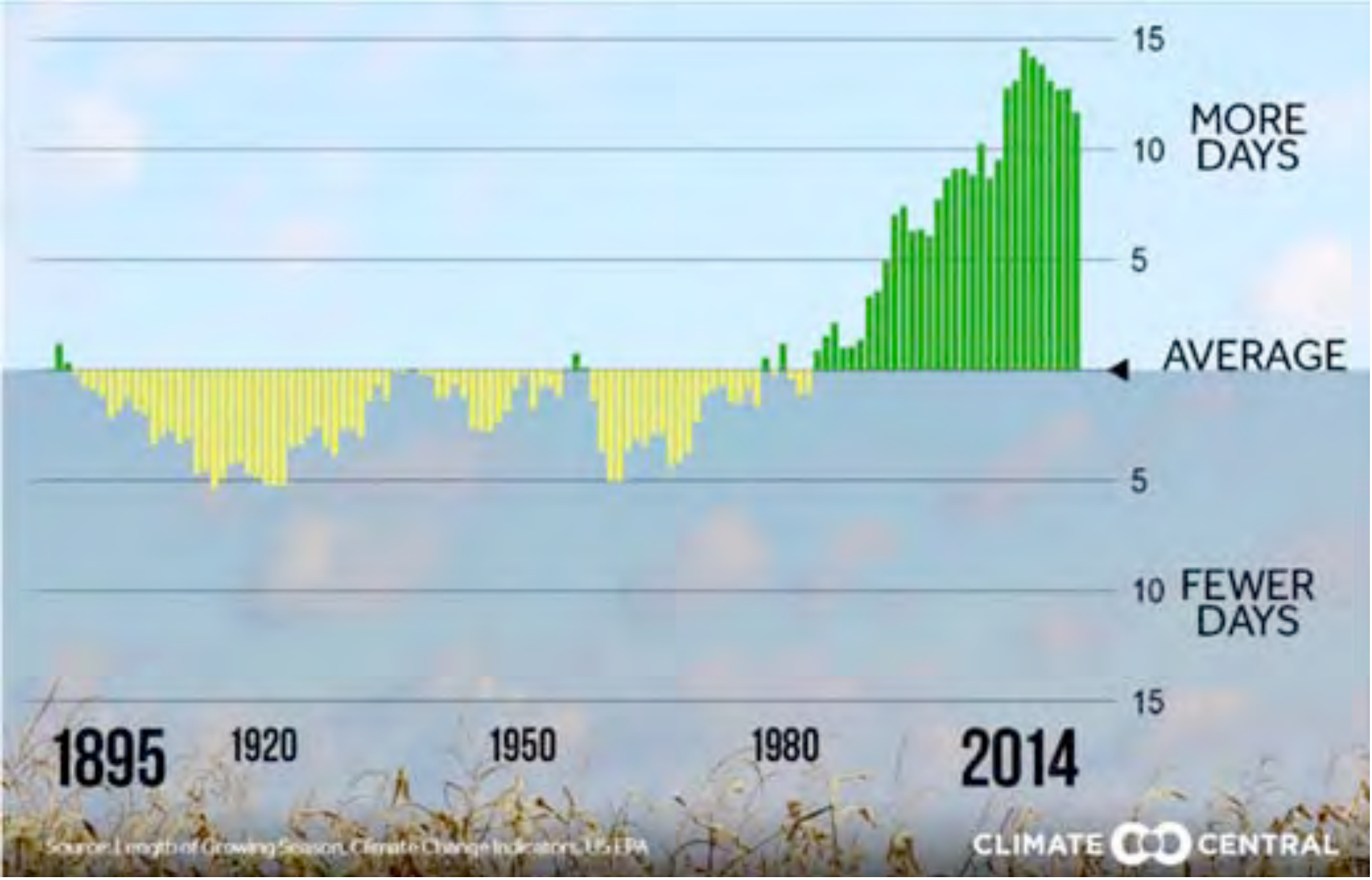


Change in average daily **Low**

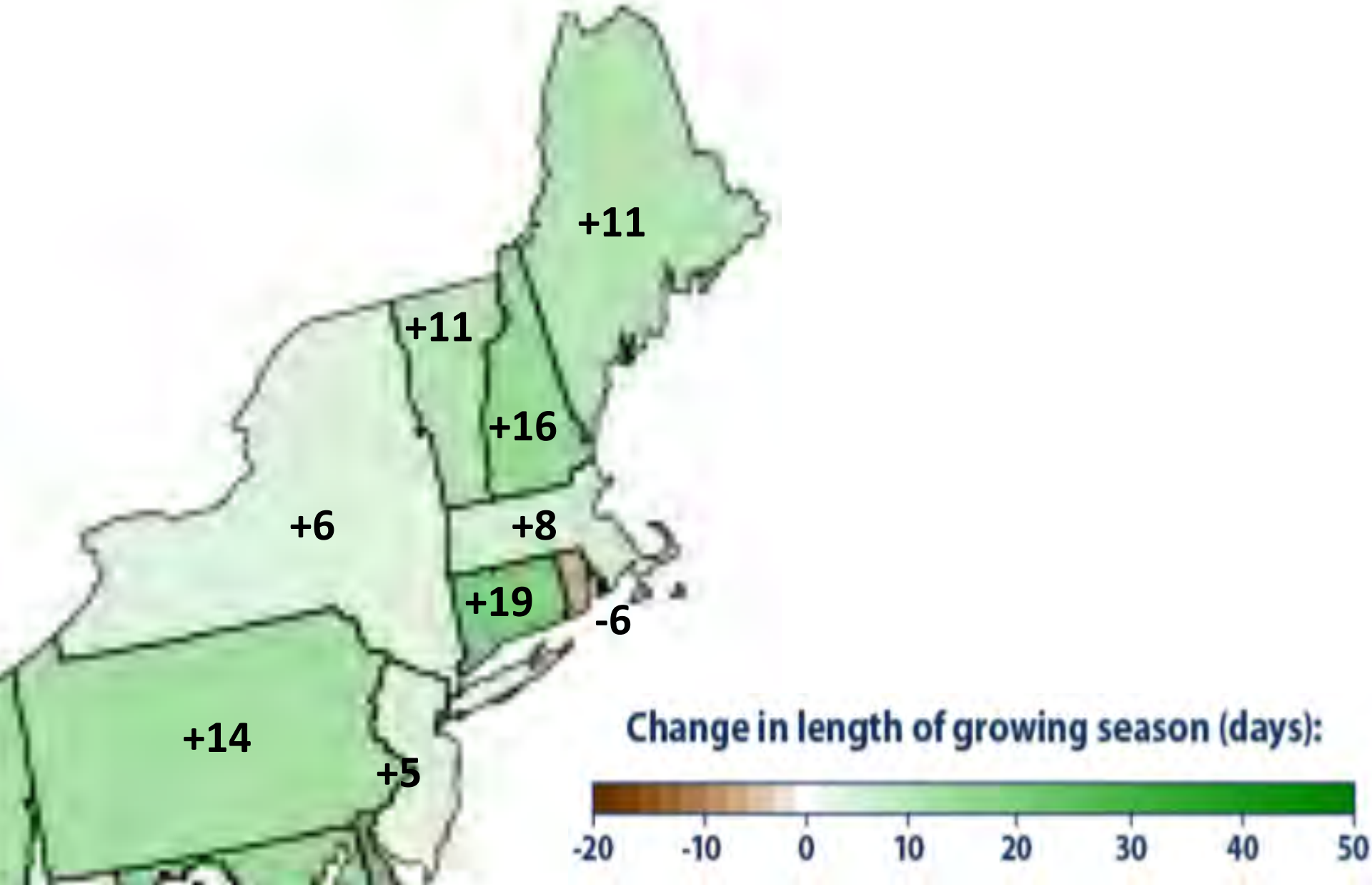


Change in degrees F

Image from Climate Reanalyzer™ (http://cci-reanalyzer.org), Climate Change Institute, University of Maine, Orono, Maine, USA

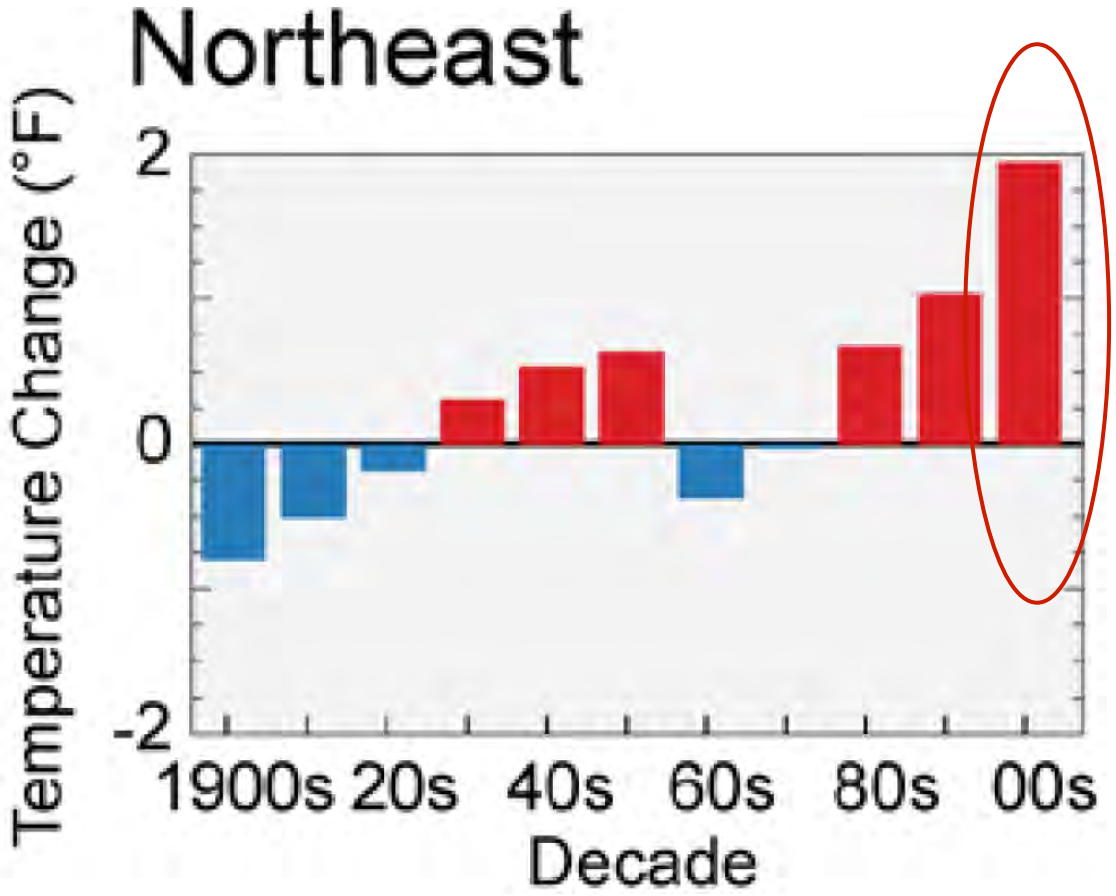

15
10
5
MORE DAYS
AVERAGE
5
10
15
FEWER DAYS
1895
1920
1950
1980
2014
Source: Length of Growing Season, Climate Change Indicators, U.S. EPA
CLIMATE CENTRAL

Change in Length of Growing Season 1895-2014



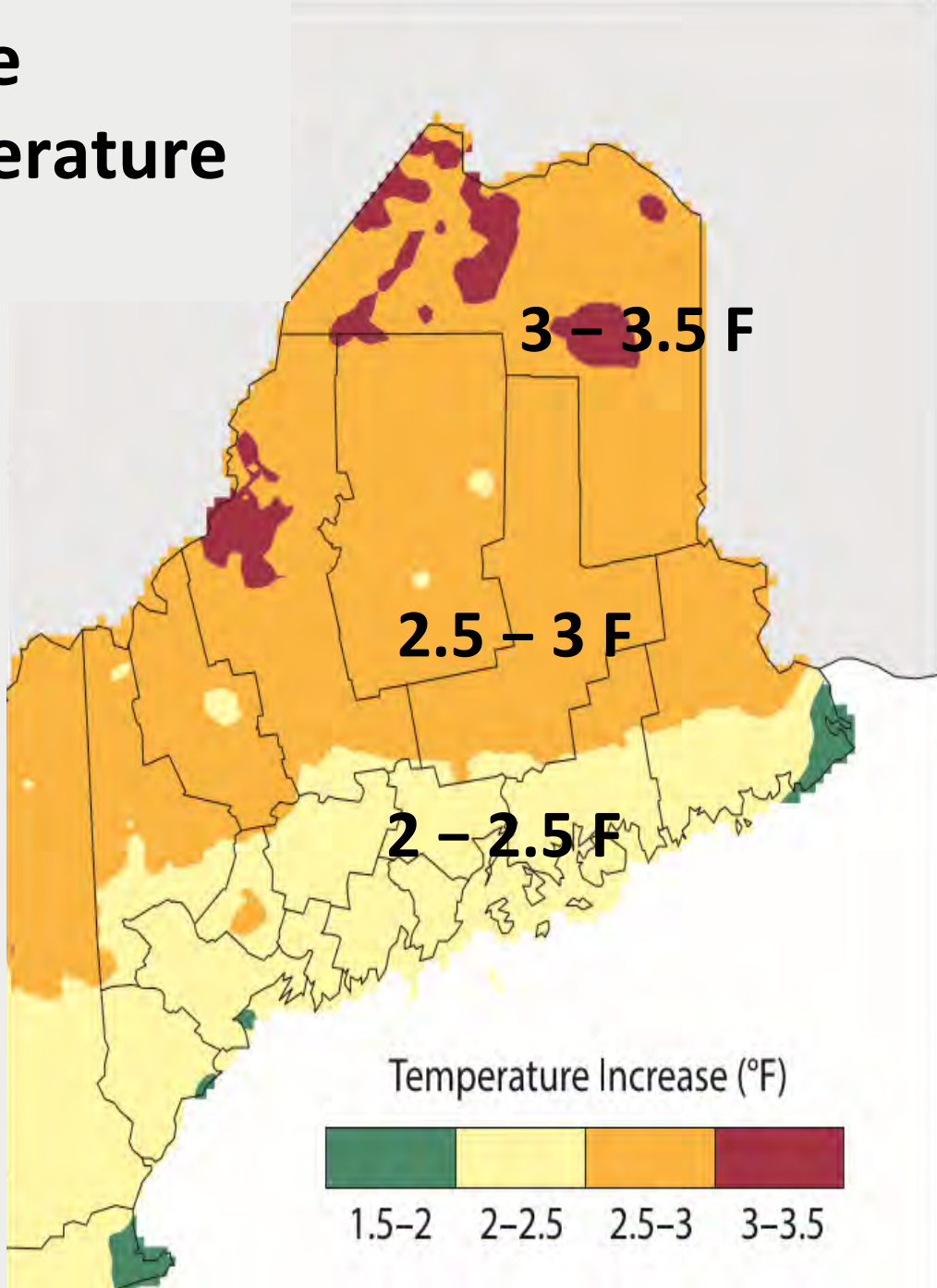
Graphic adapted from: USEPA, Climate Change Indicators in the United States
Accessed 6-16-2016. https://www3.epa.gov/climatechange/science/indicators/health-society/growing-season.html

Warming has accelerated since 2000



Graphic adapted from: Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Expected increase in Maine average temperature 2005 to 2045



Fernandez, I.J., C.V. Schmitt, S.D. Birkel, E. Stancioff, A.J. Pershing, J.T. Kelley, J.A. Runge, G.L. Jacobson, and P.A. Mayewski. 2015. Maine's Climate Future: 2015 Update. Orono, ME: University of Maine. 24pp.

Observed 30-year average annual temperature from 1981 to 2010

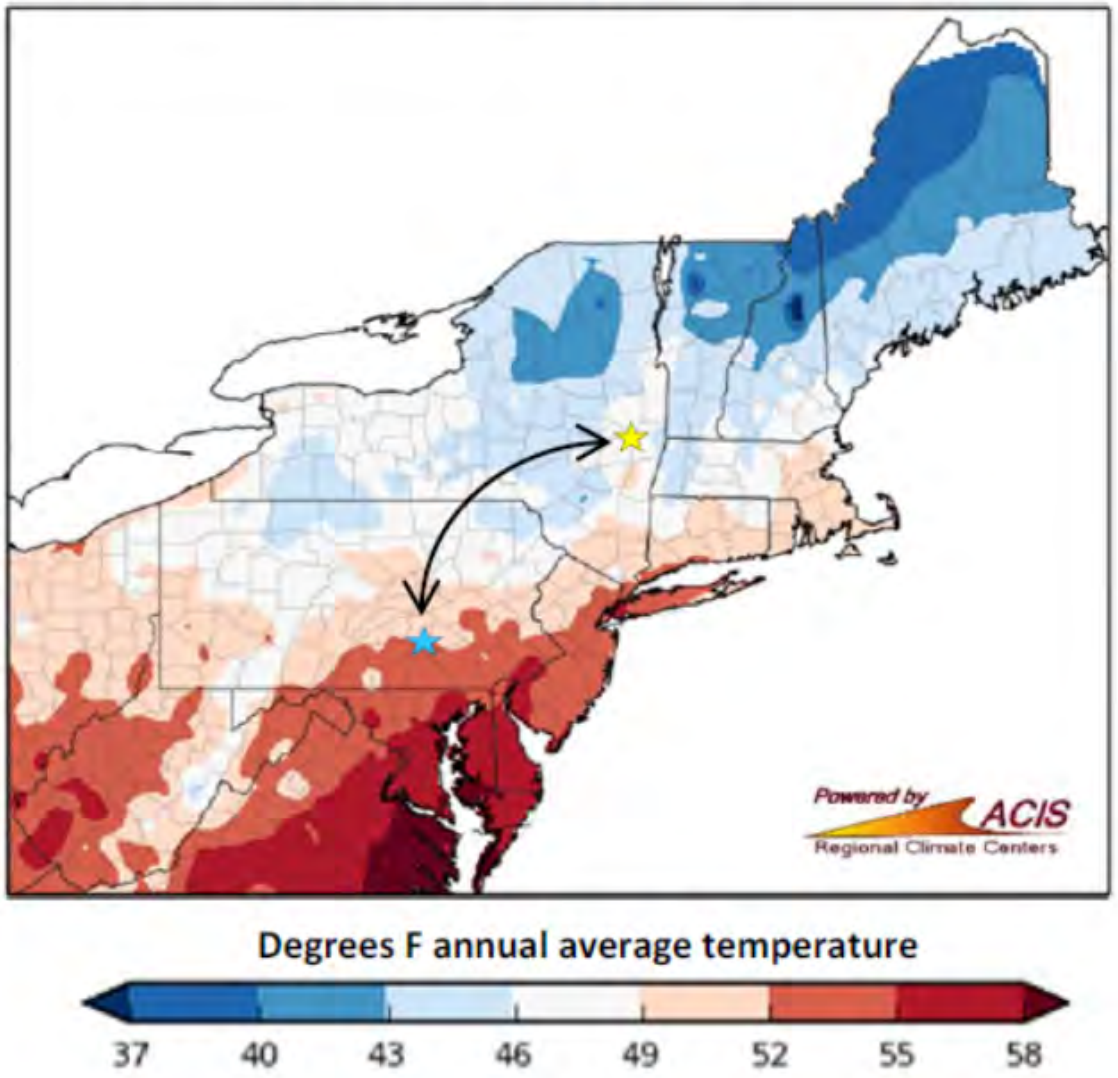


Figure 5. Average annual temperature, 1981–2010. Adapted from Northeast Regional Climate Center, 2018.

Forecast Changes in Growing Season

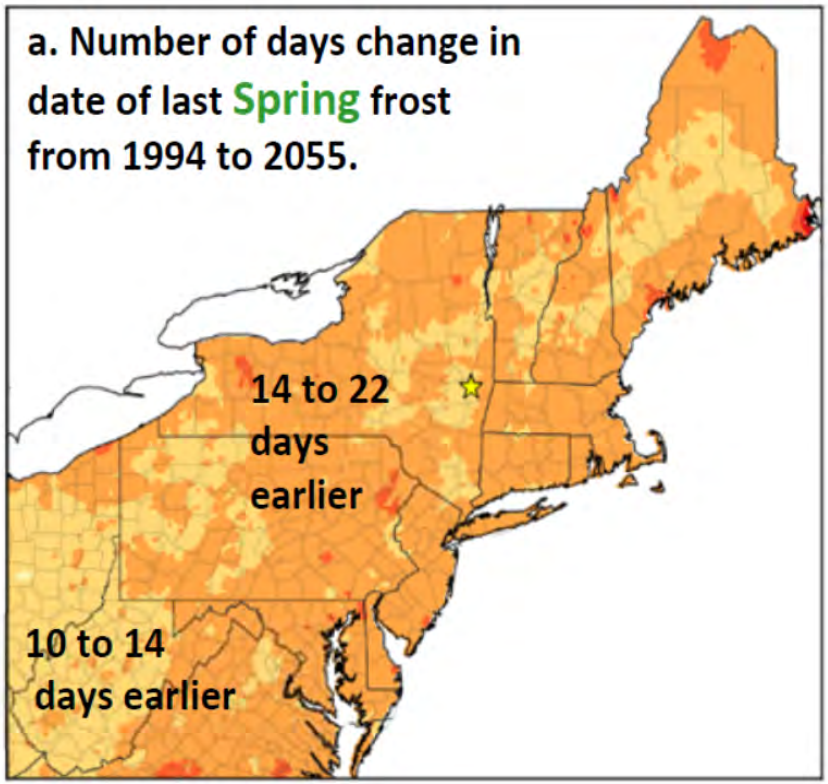
Prediction for 2045 (27 years from now)

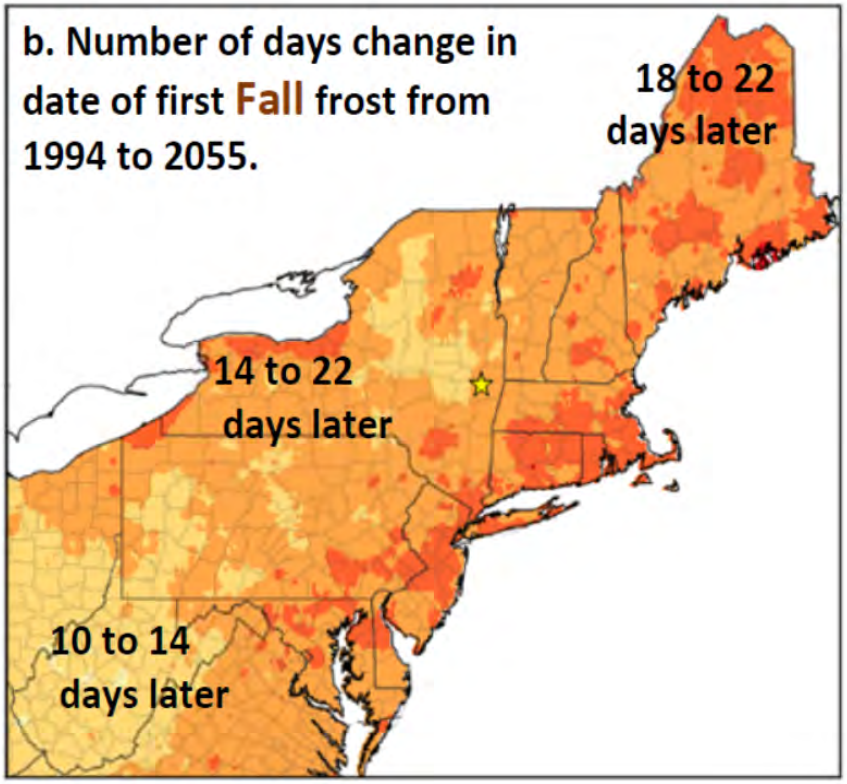
*** Growing season in Northeast expected to add another +10 to +17 days**
(primarily because of earlier date of last spring freeze)

*** Apple Bud break and Bloom dates expected to occur 3 to 6 days earlier than now**

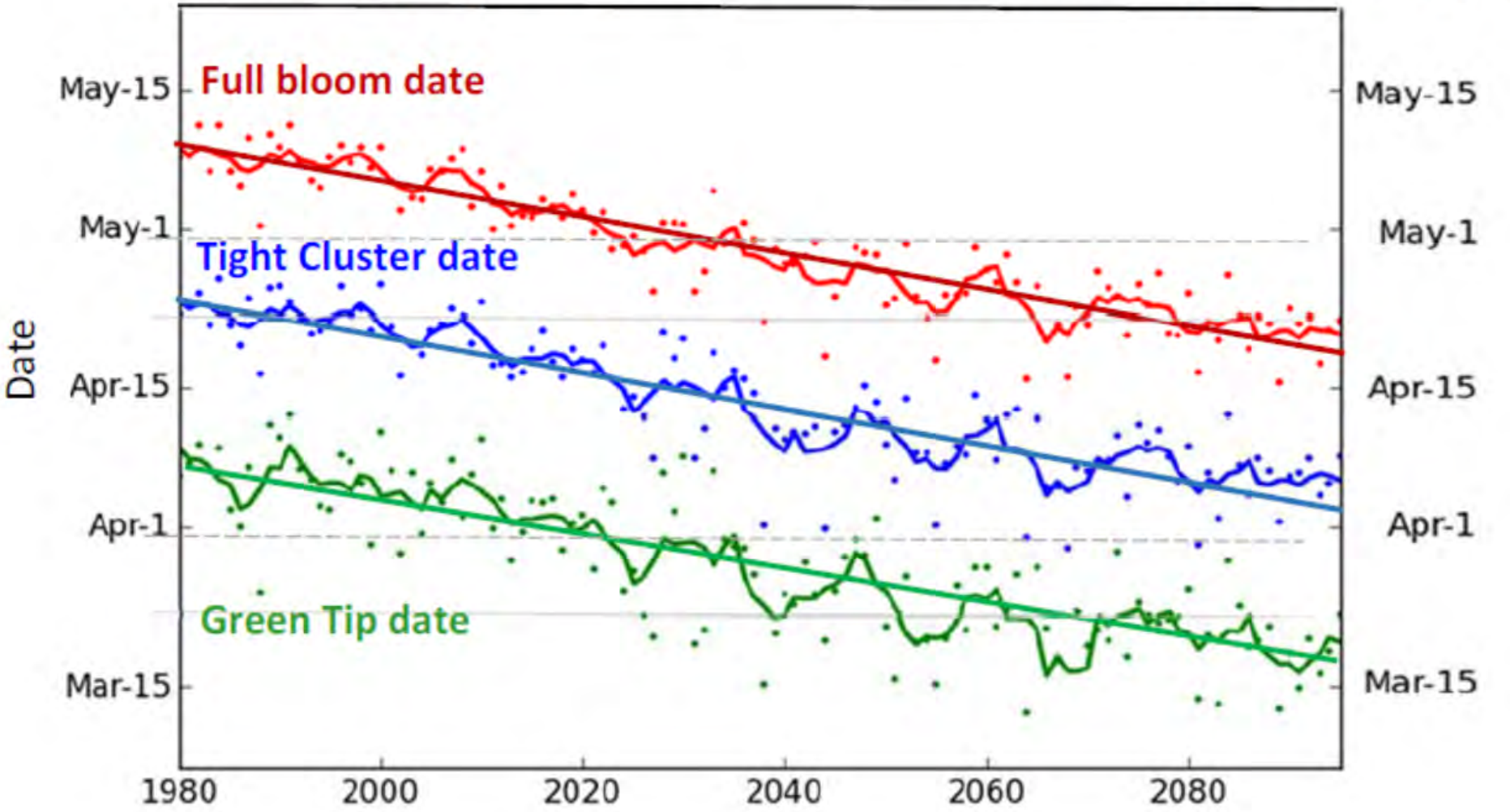
Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

Projected change in final spring, and first fall, frost dates from 1994 to 2055.



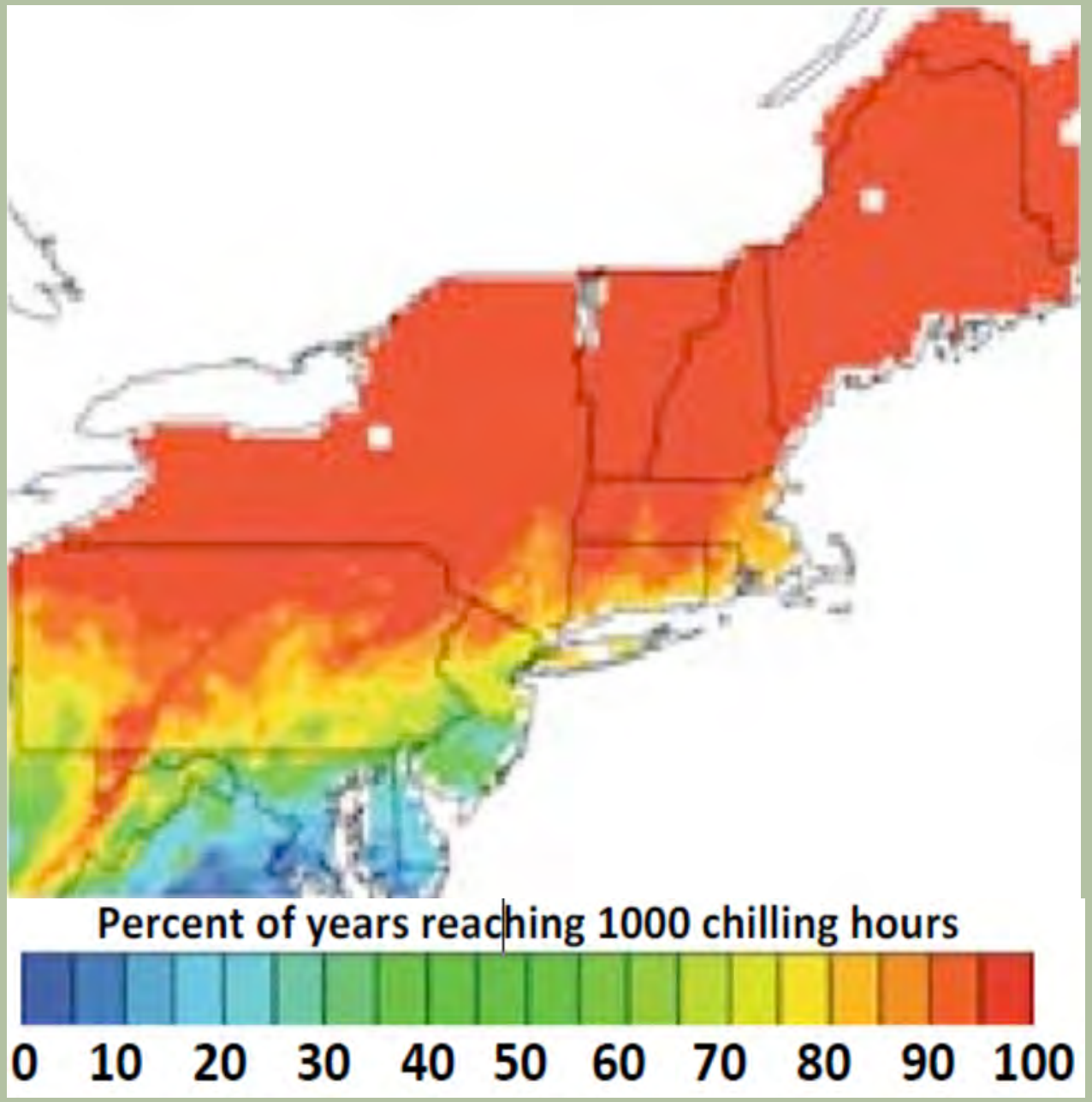


Observed and projected earlier calendar dates for apple budstages.



Wolfe et al., 2018.

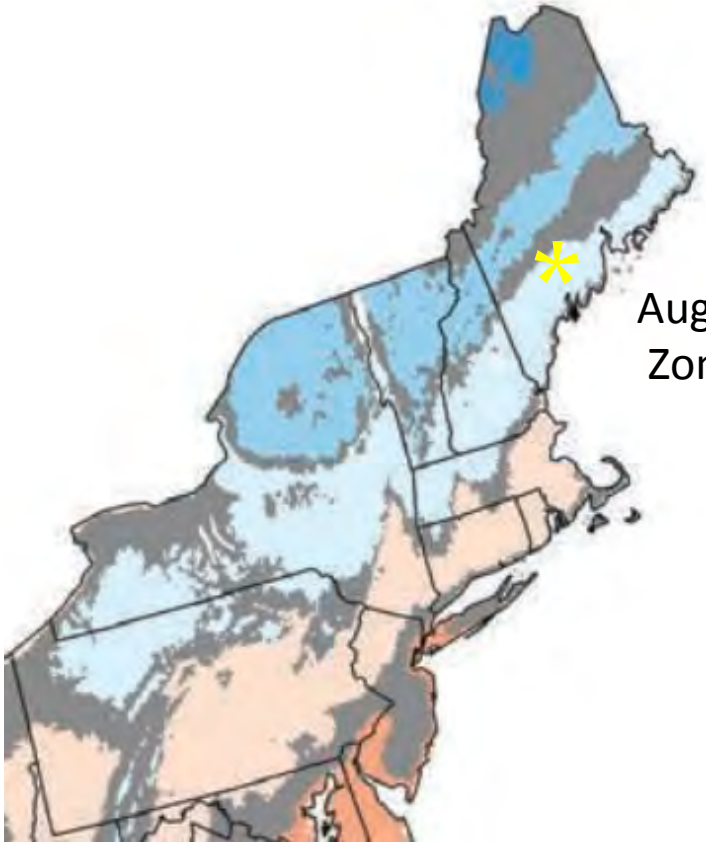
Projected chilling hours in 2025



Wolfe et al.2008.

Plant Hardiness Zones Changes Expected by 2045

Colors show areas with new Zone number



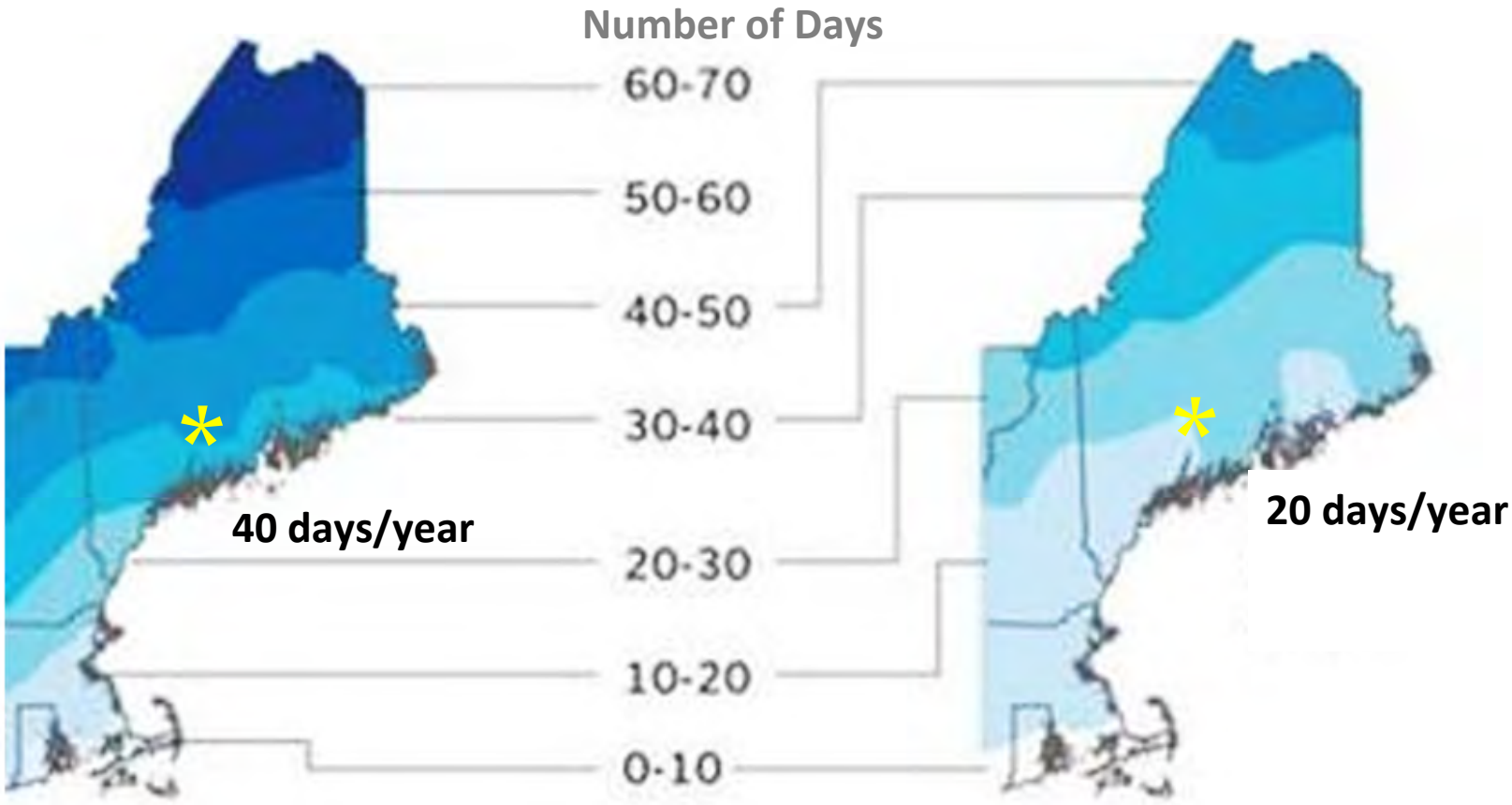
Augusta changes from Zone 5 to Zone 6

Graphic adapted from: Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Fewer Days with Temperature Below 10F *

1990 (1980 – 2000 average)

2055 Predicted
(2041 – 2070 average)

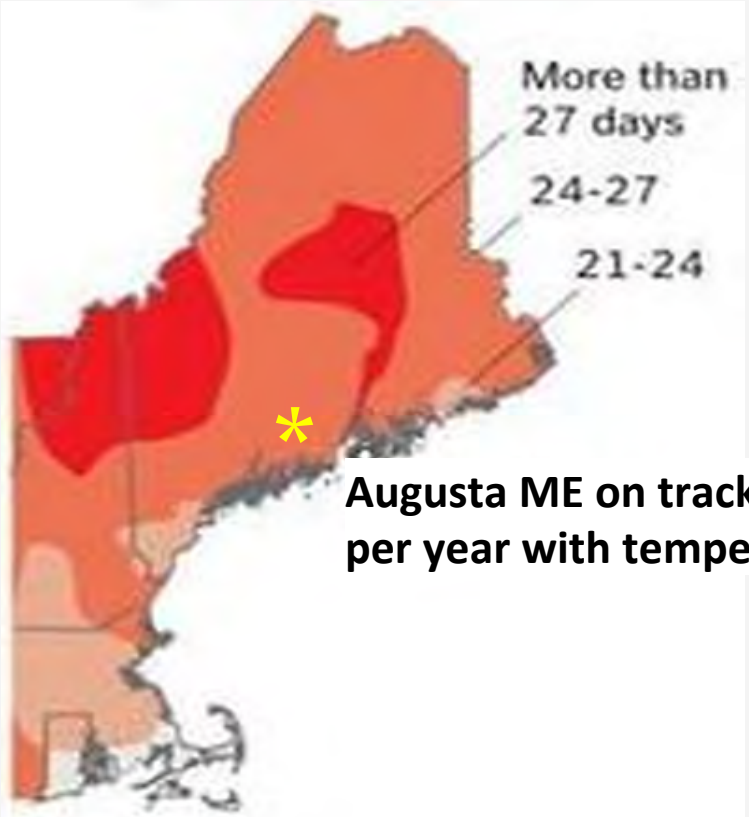


Augusta ME on track to lose 20 days per year below 10F between 1990 and 2055

Image credit. "In Maine, scientists see signs of climate change." David Abel. Boston Globe. September 21, 2014

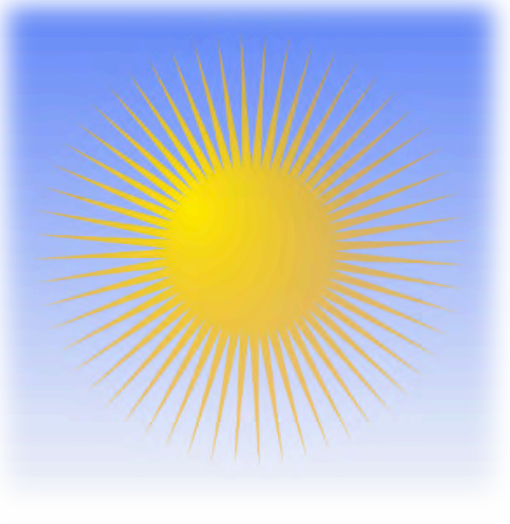
Additional Days with Temperature Above 32F *

Expected change from 1990 (1980–2000) **to 2055** (2041–2070)



Augusta ME on track to add 25 days per year with temperature above 32F

Image credit. "In Maine, scientists see signs of climate change." David Abel. Boston Globe. September 21, 2014

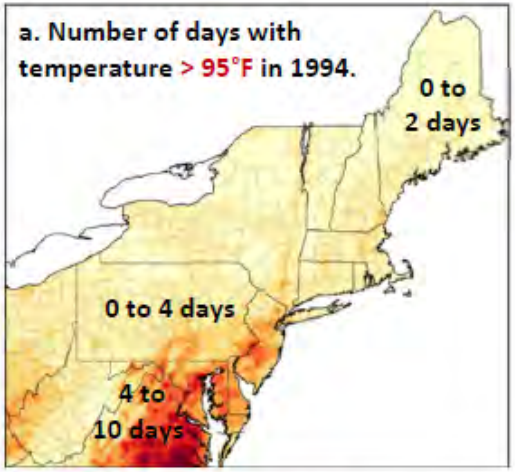


… Temperature Extremes

Frequency of "1 in 20 year" Extreme temperature events is likely to increase to "1 in 3" years by 2055 (2046-2065 average)

From IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.. Image credit: Emmanuel Boutet Creative Commons CC-BY-SA

Projected increase in number of days with temperature over 95°F, from 1994 to 2055, and from 1994 to 2085.



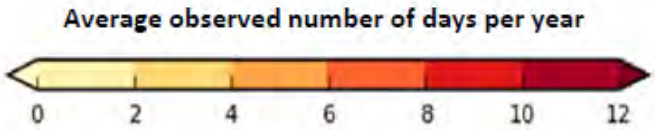
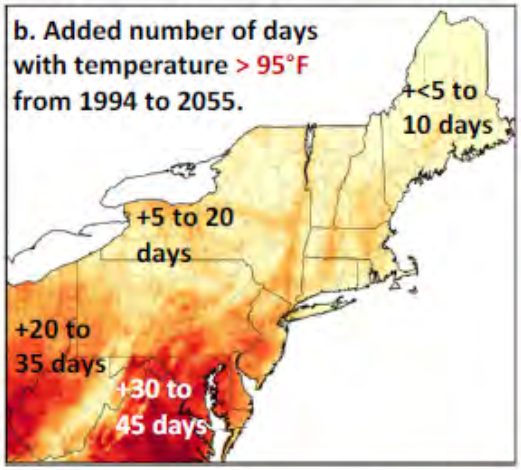
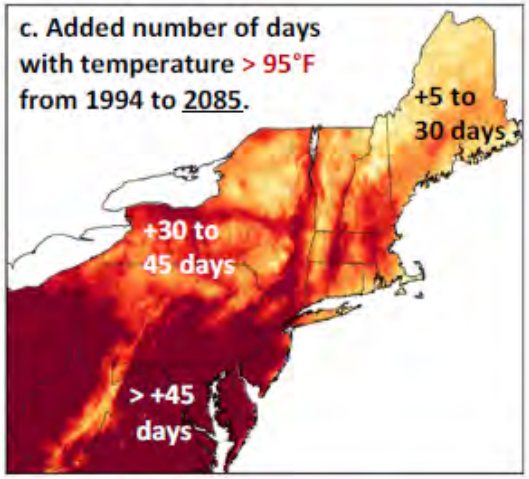
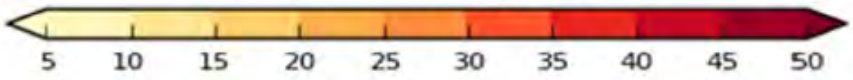


Figure 10a. Model simulated number of days per year with maximum temperatures >=95°F in 1994 (1979–2008 average).

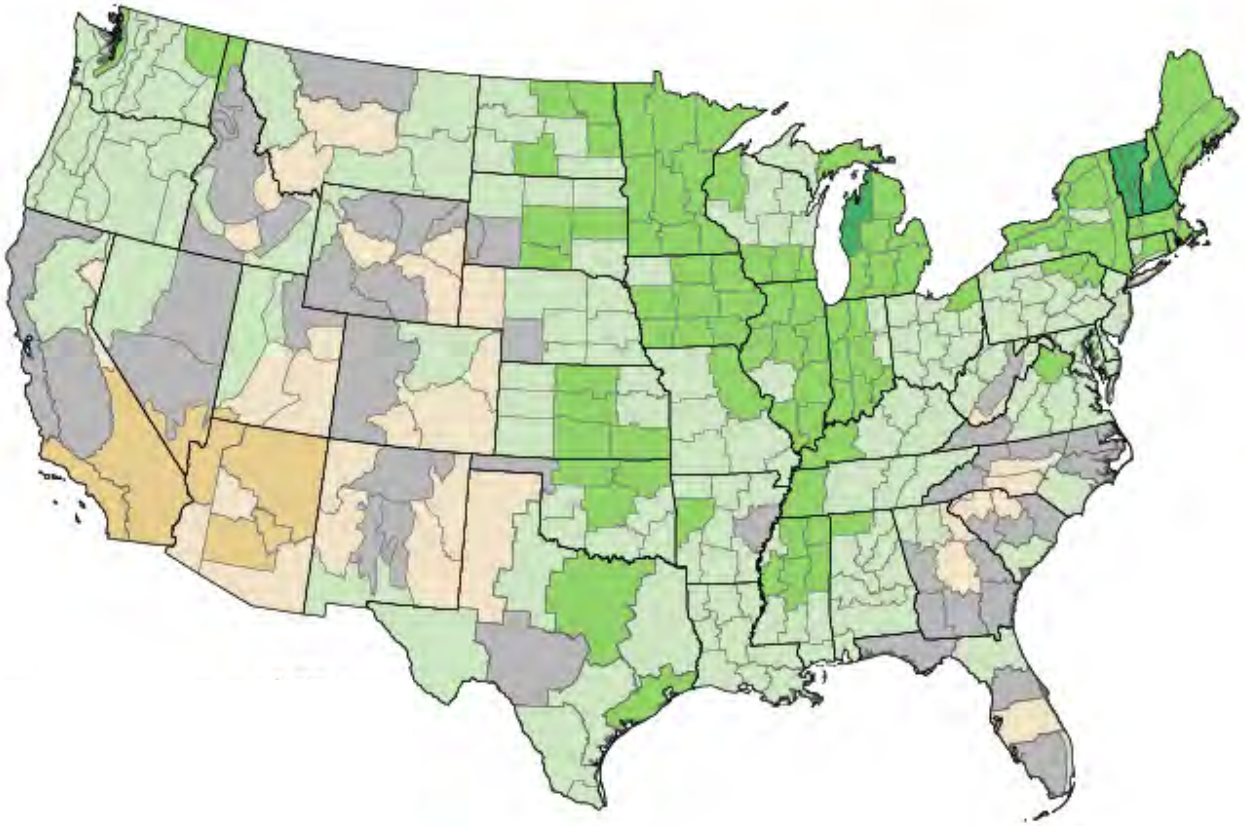






Precipitation Change 1901 – 2014

Maine +15%



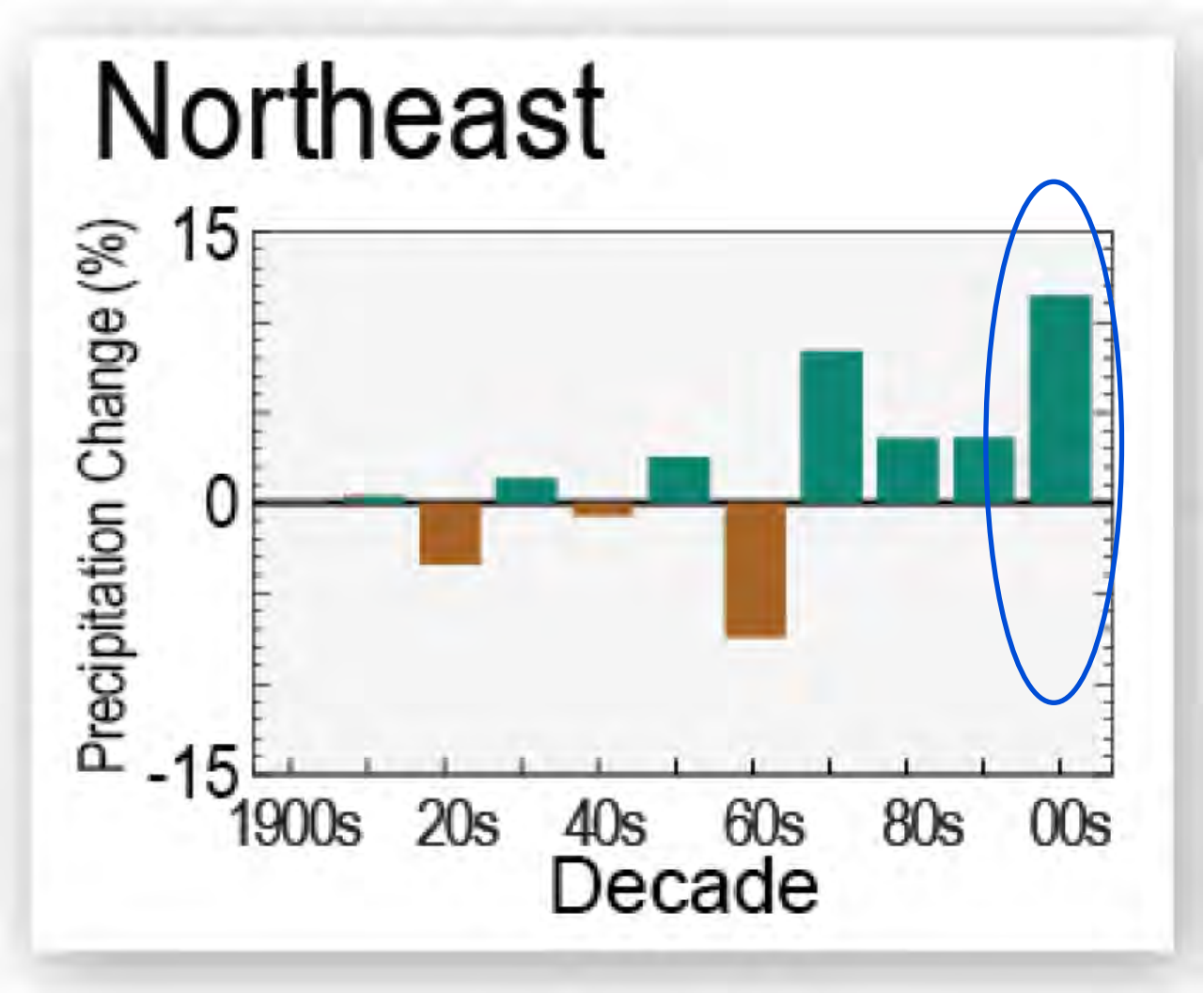
Percent change in precipitation:

-30 -20 -10 -2 2 10 20 30

Graphic adapted from: USEPA, Climate Change Indicators in the United States
https://www3.epa.gov/climatechange/science/indicators/weather-climate/precipitation.html

Amount of precipitation by decade

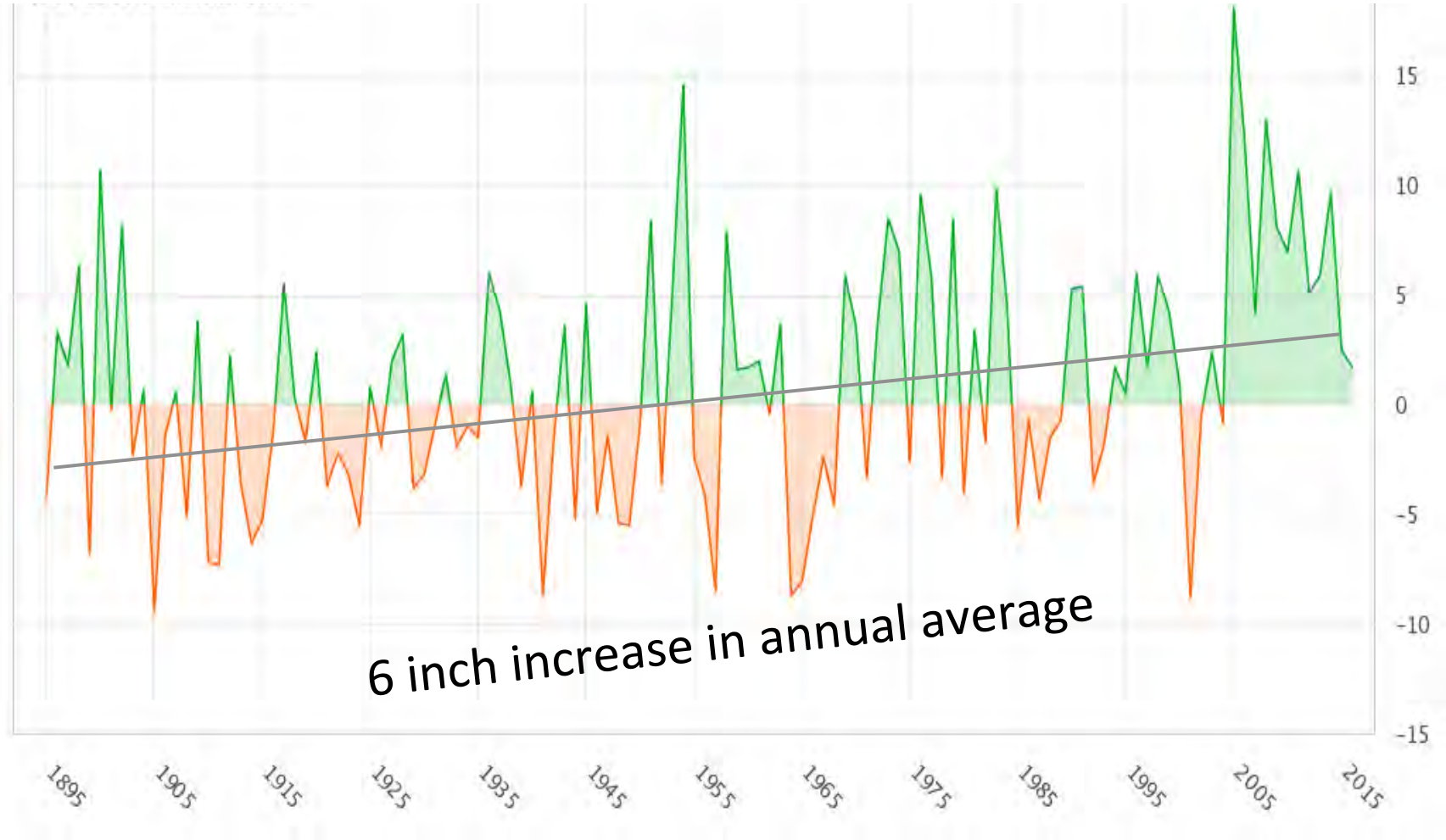
0 = 1901-1960 average



Graphic adapted from: Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Maine annual precipitation (inches) 1895 to 2015

vs. 1901-2000 average

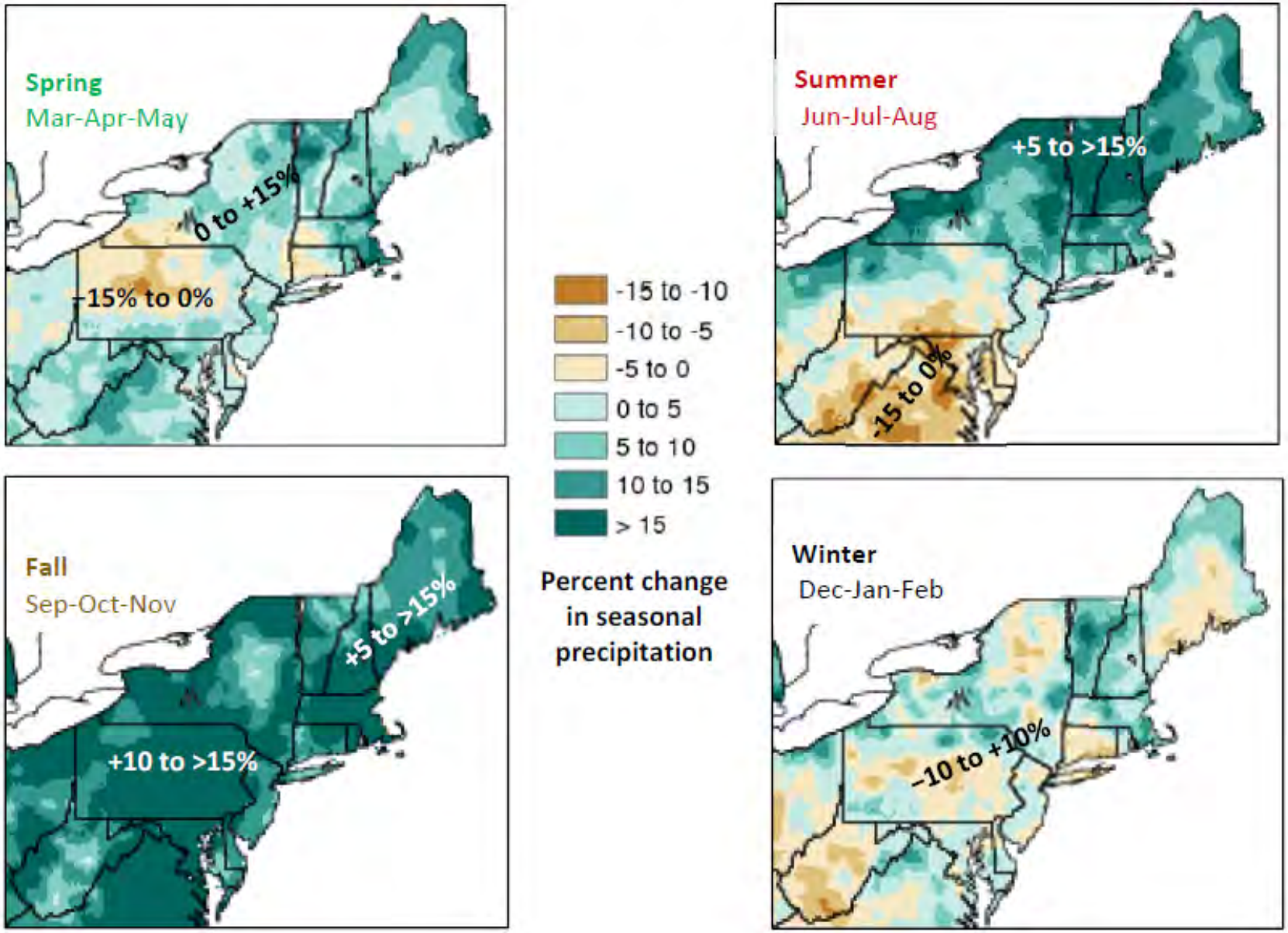


Inches Above or Below average

Year

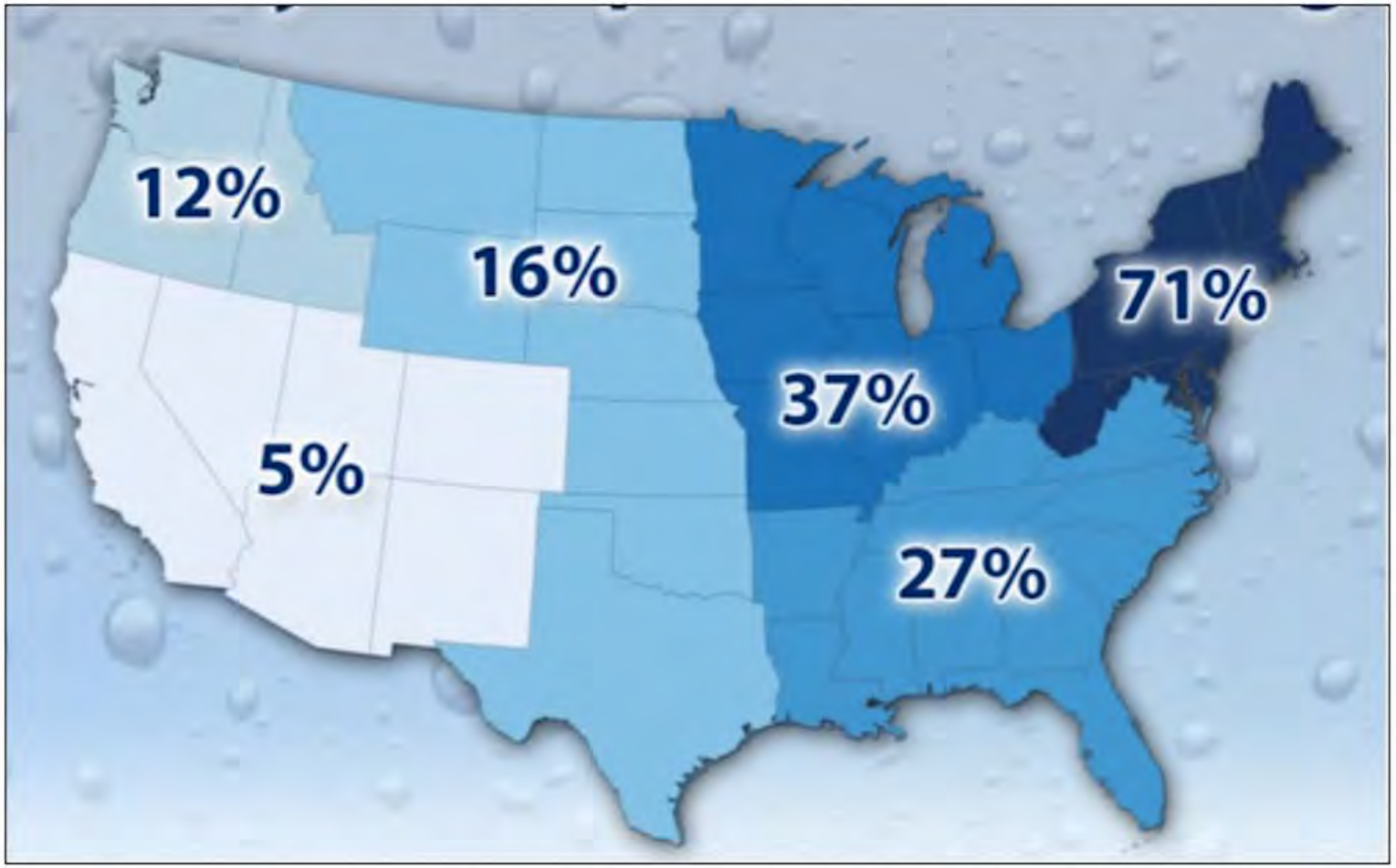
http://charts.srcc.lsu.edu/trends/

Observed change in seasonal average precipitation, 1930 to 2001.



When it rains … it pours

Trends in Extreme Precipitation



Mellilo et al 2014

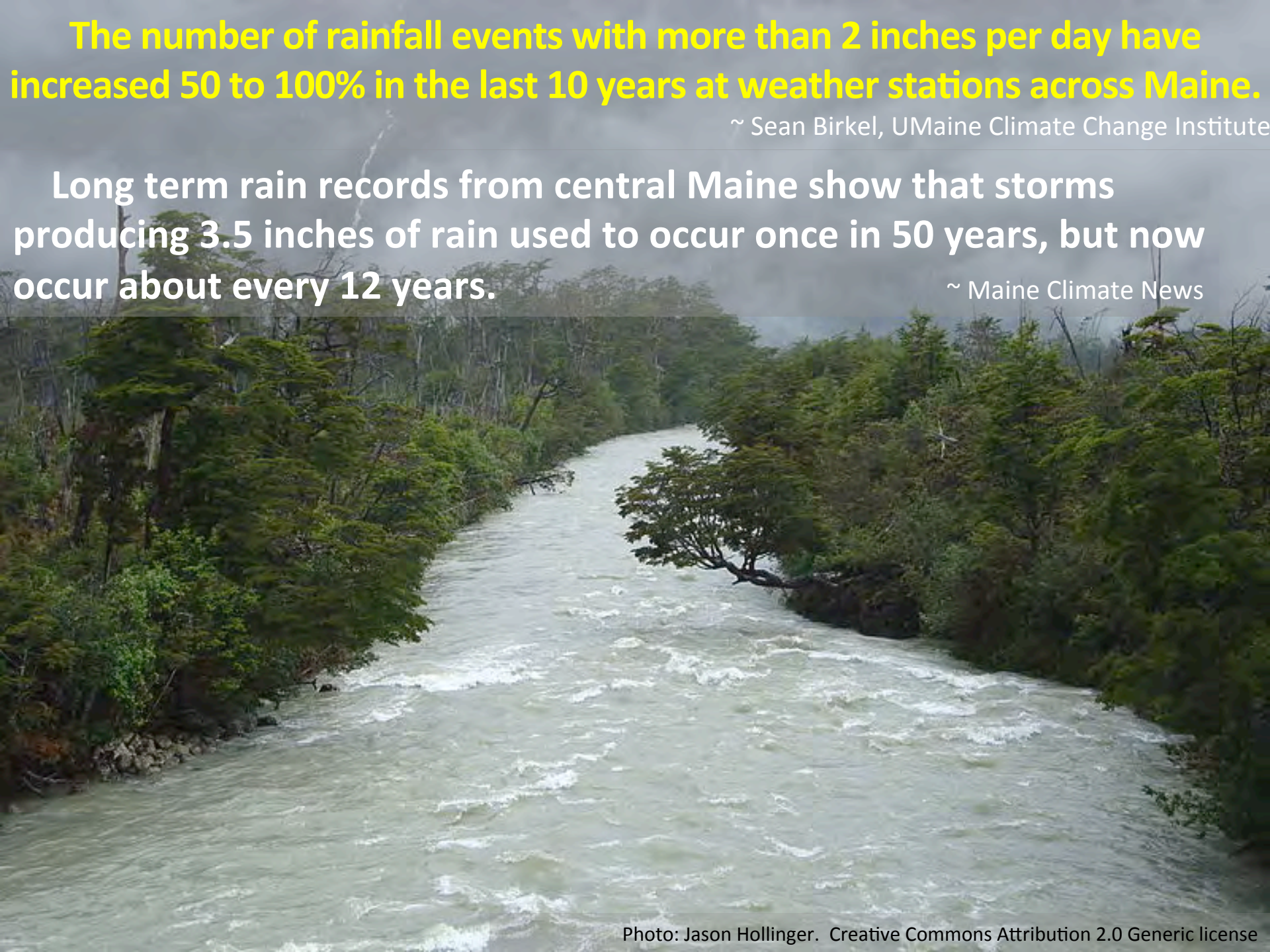
Increase in the number of 2” rainfalls per year from 1958 to 2011

The number of rainfall events with more than 2 inches per day have increased 50 to 100% in the last 10 years at weather stations across Maine.

~ Sean Birkel, UMaine Climate Change Institute

Long term rain records from central Maine show that storms producing 3.5 inches of rain used to occur once in 50 years, but now occur about every 12 years.

~ Maine Climate News



Observed increase in frequency of 2+ inch precipitation in 24 hours in Maine.

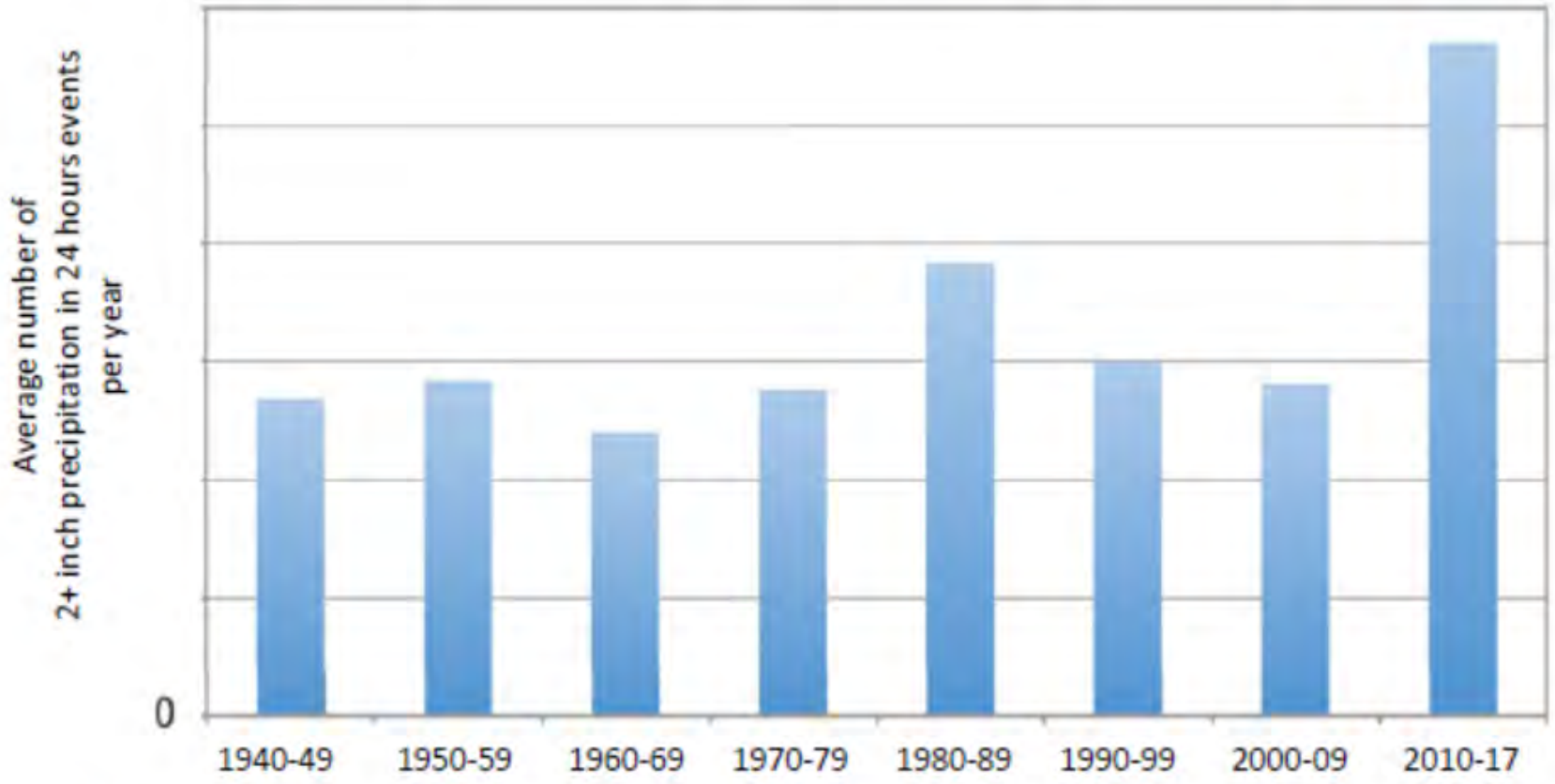
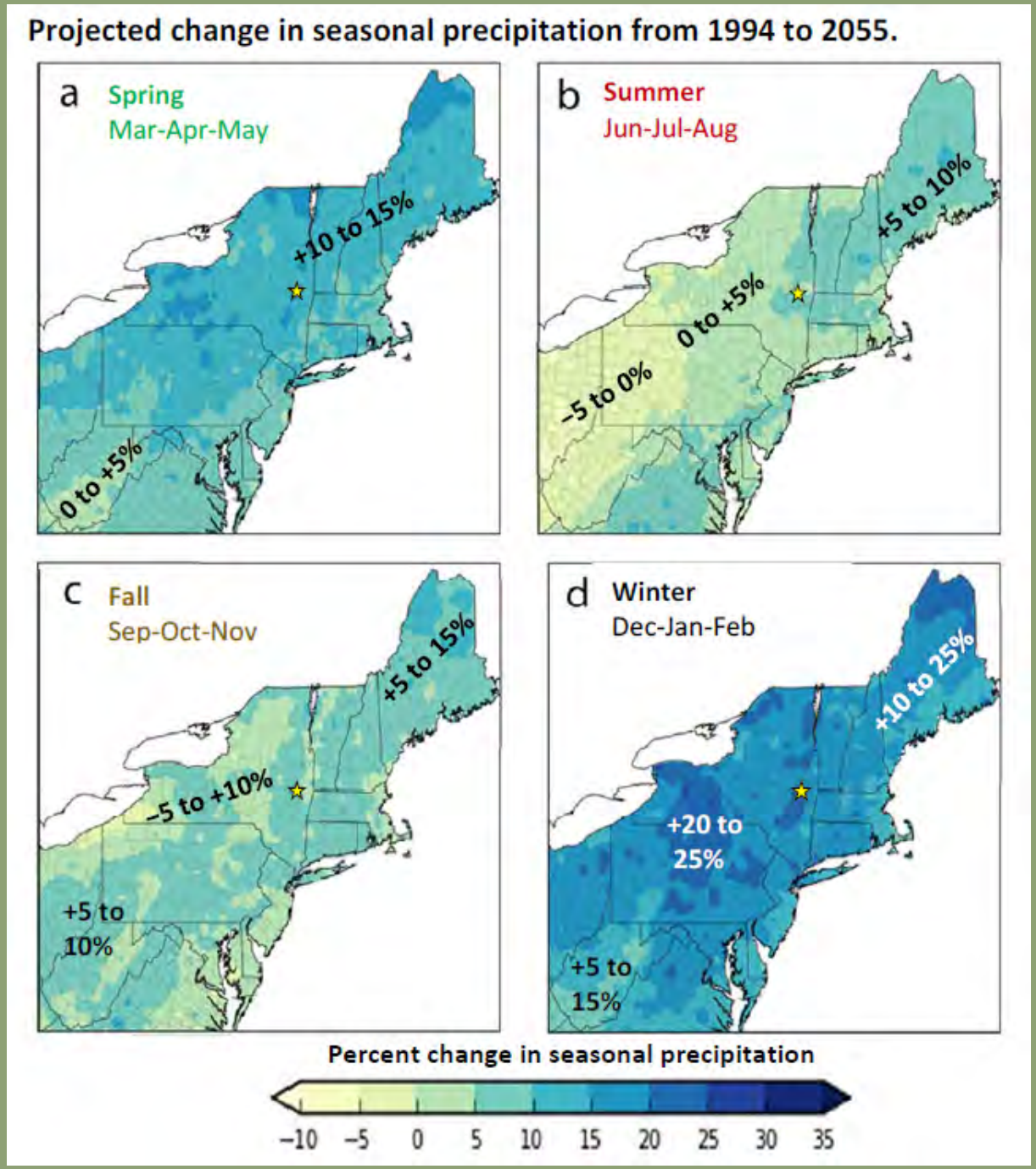
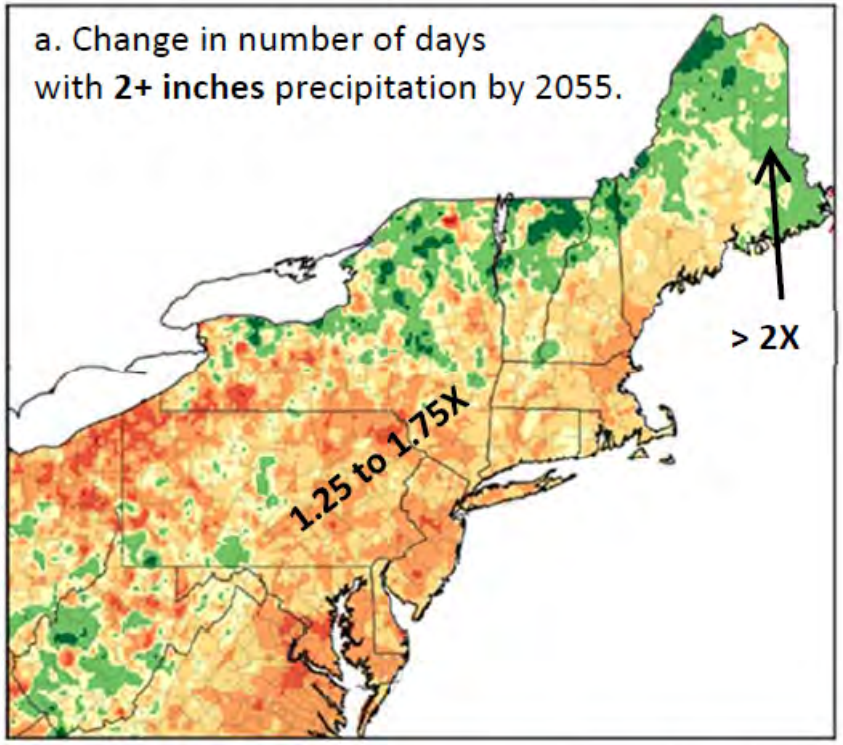


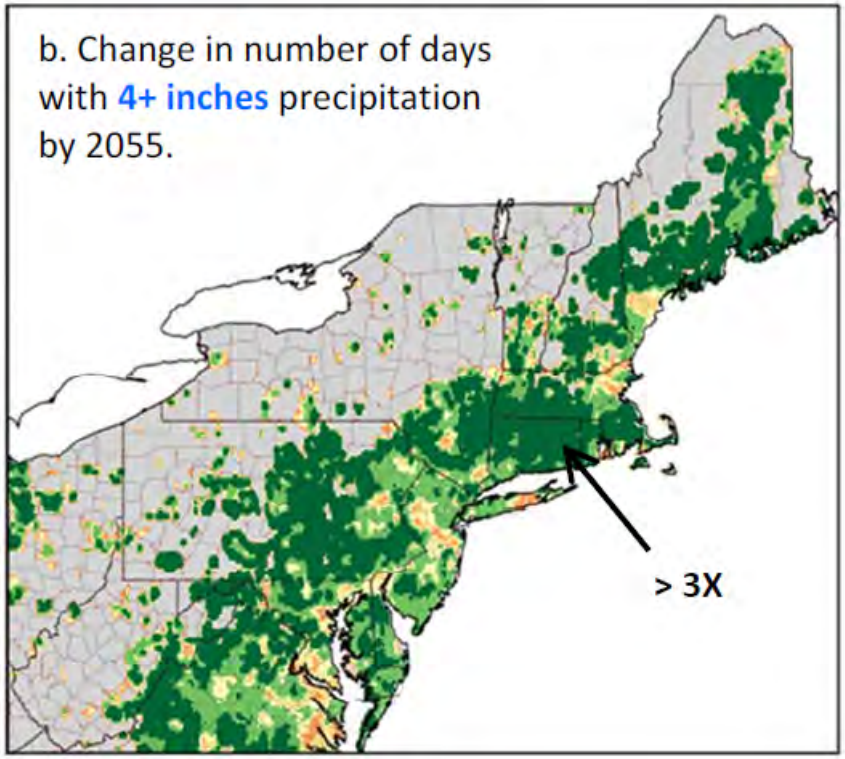
Figure 20. Average number of 2+ inch precipitation within 24 hours events per year at 17 long-term observation sites in Maine. Data from the NOAA Global Historical Climatology Network (https://www.ncdc.noaa.gov/ghcn-daily-description). Chart adapted from Birkel and Mayewski, 2018.

USDA

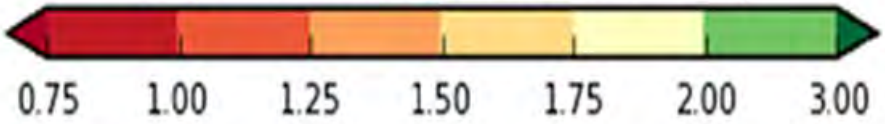

Projected change in seasonal precipitation from 1994 to 2055.
a Spring
Mar-Apr-May
+10 to 15%
0 to +5%
b Summer
Jun-Jul-Aug
+5 to 10%
0 to +5%
–5 to 0%
c Fall
Sep-Oct-Nov
+5 to 15%
–5 to +10%
+5 to 10%
d Winter
Dec-Jan-Feb
+10 to 25%
+20 to 25%
+5 to 15%
Percent change in seasonal precipitation
–10 –5 0 5 10 15 20 25 30 35

Projected increase in number of days with 2+ inch and 4+ inch precipitation, from 1994 to 2055.

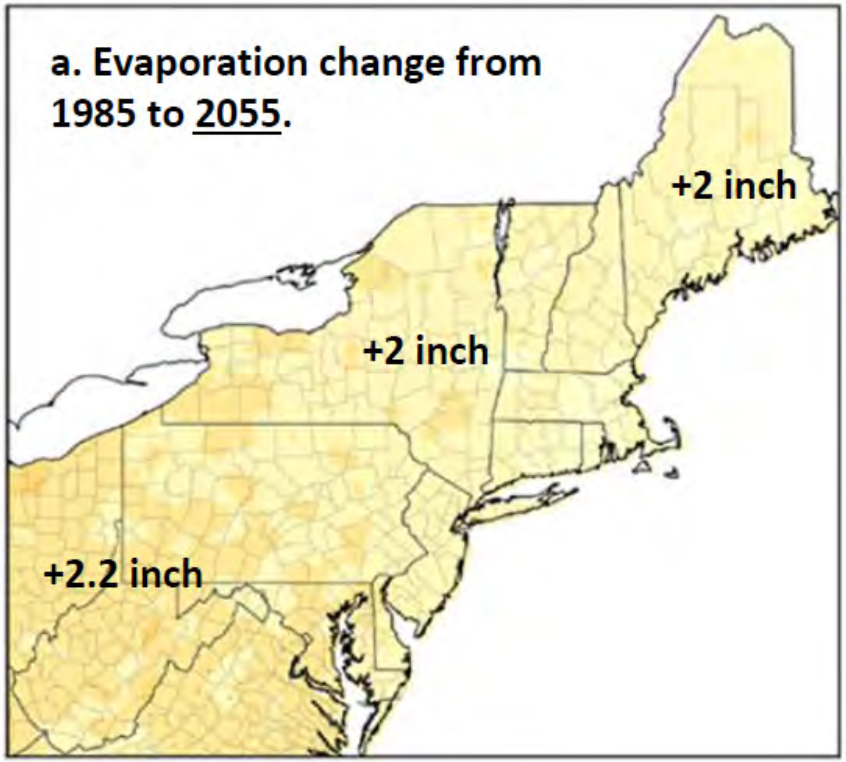


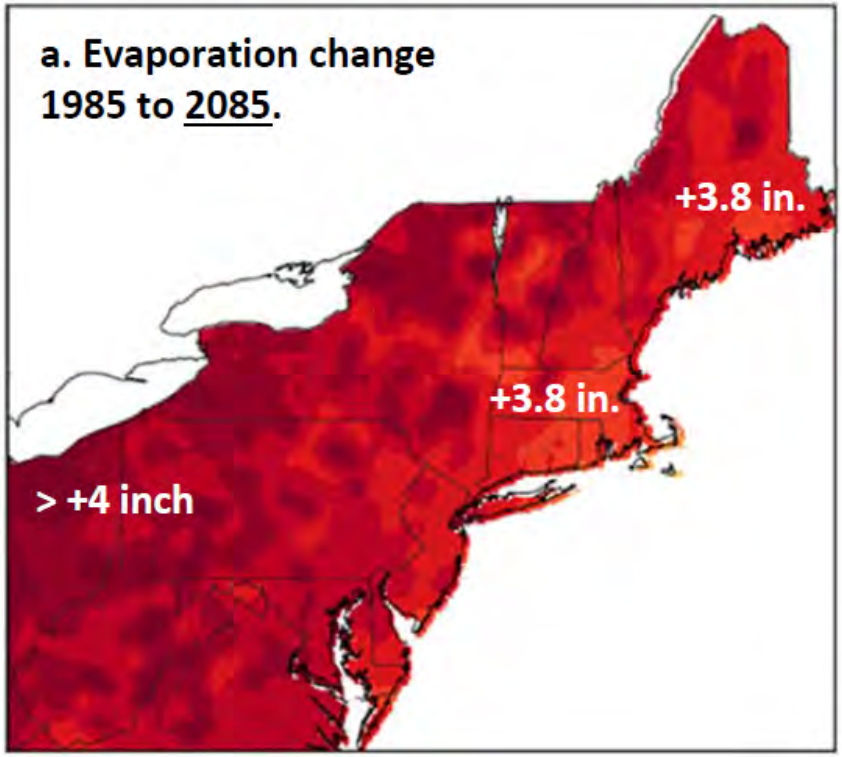


Proportional change in number of days



1.00 = no change. 1.50 = 50% more days. 2.00 = Twice as many days.



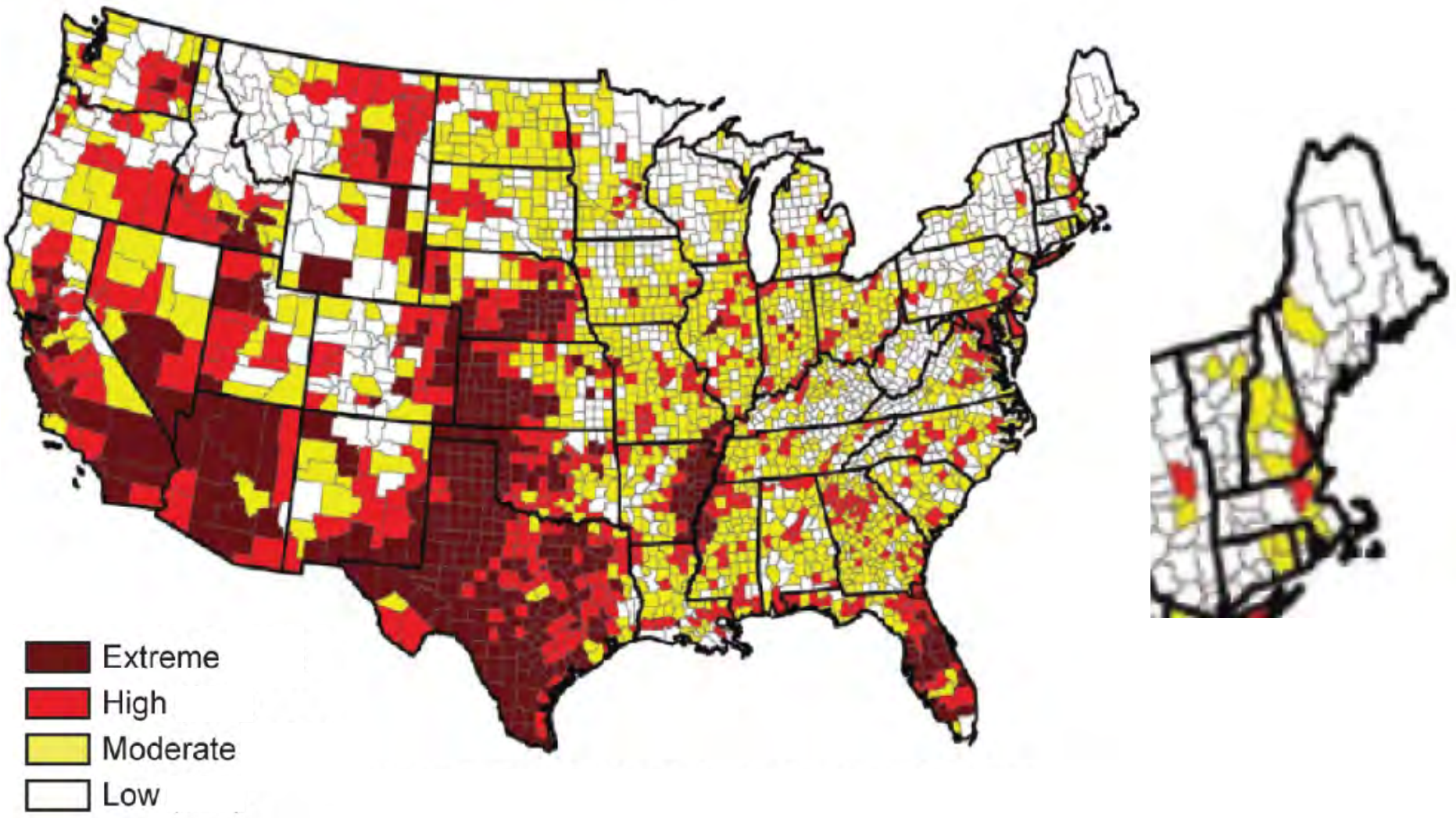


Summer increase in inches of potential evaporation

+2 +3 +4

Water Supply Risk Index by 2050

A1B scenario

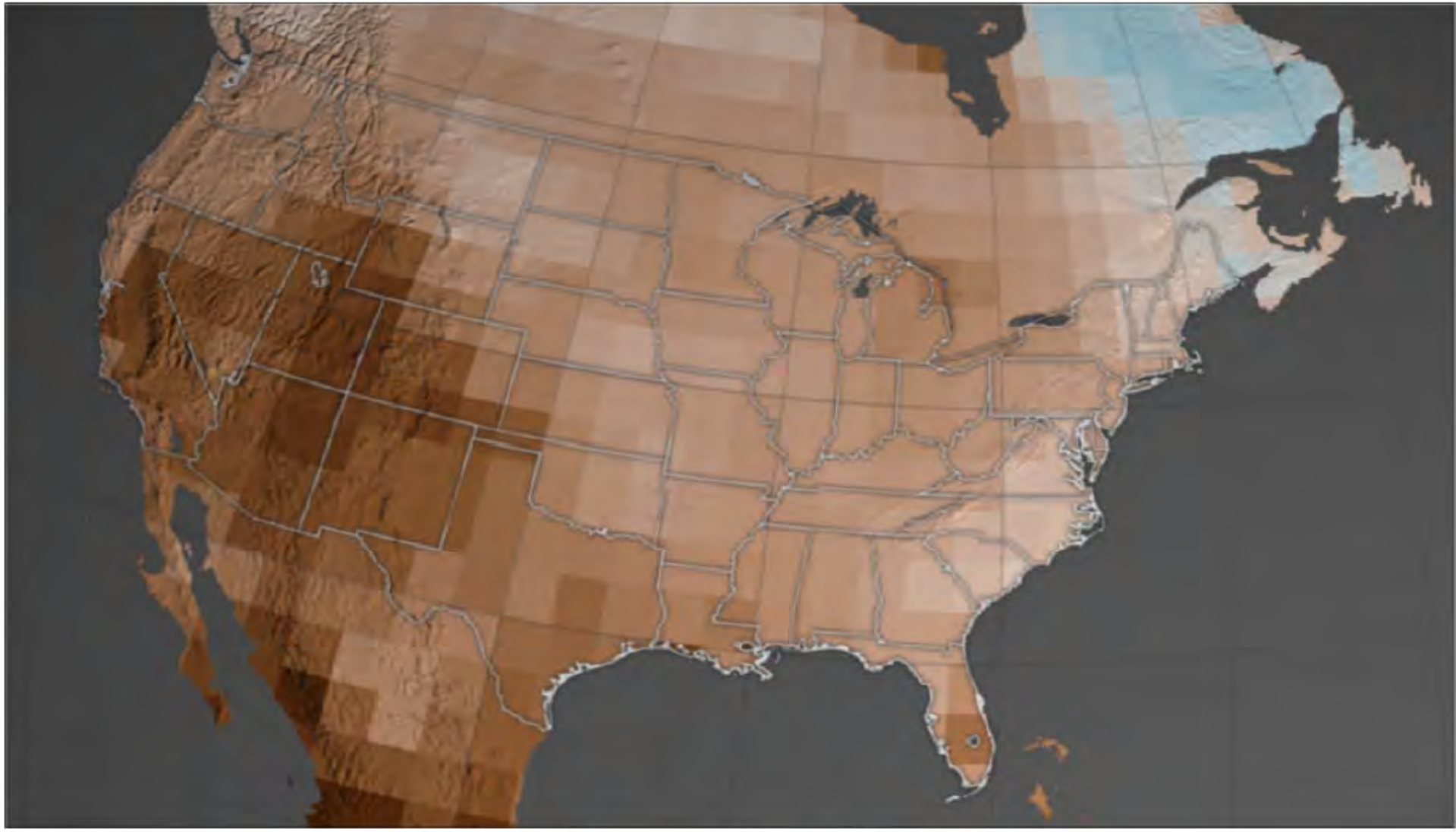


Portion of U.S. counties at High or Extreme risk

10% in 2014, 32% by 2050

Graphic adapted from: Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

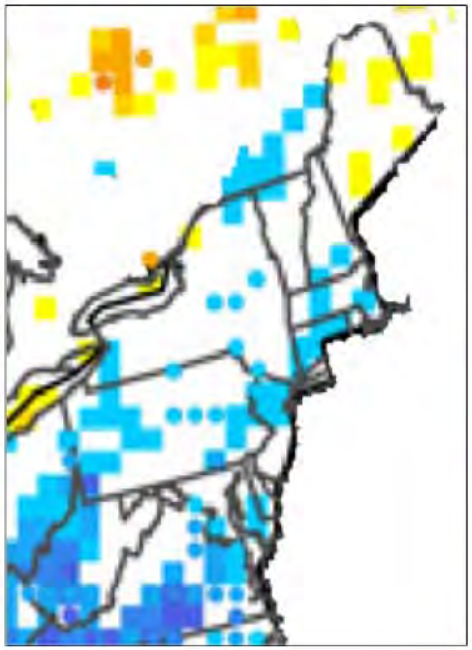
Projected annual average soil moisture in 2050 under a high emissions scenario.



Annual soil moisture would match what used to be

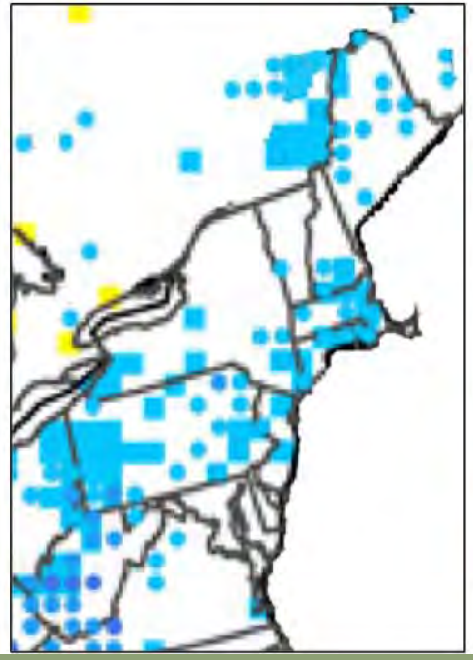
Driest year in			↑	Wettest year in		
740	44	6	Average	6	44	740

Projected change in number of hail days, from 1986 to 2056.



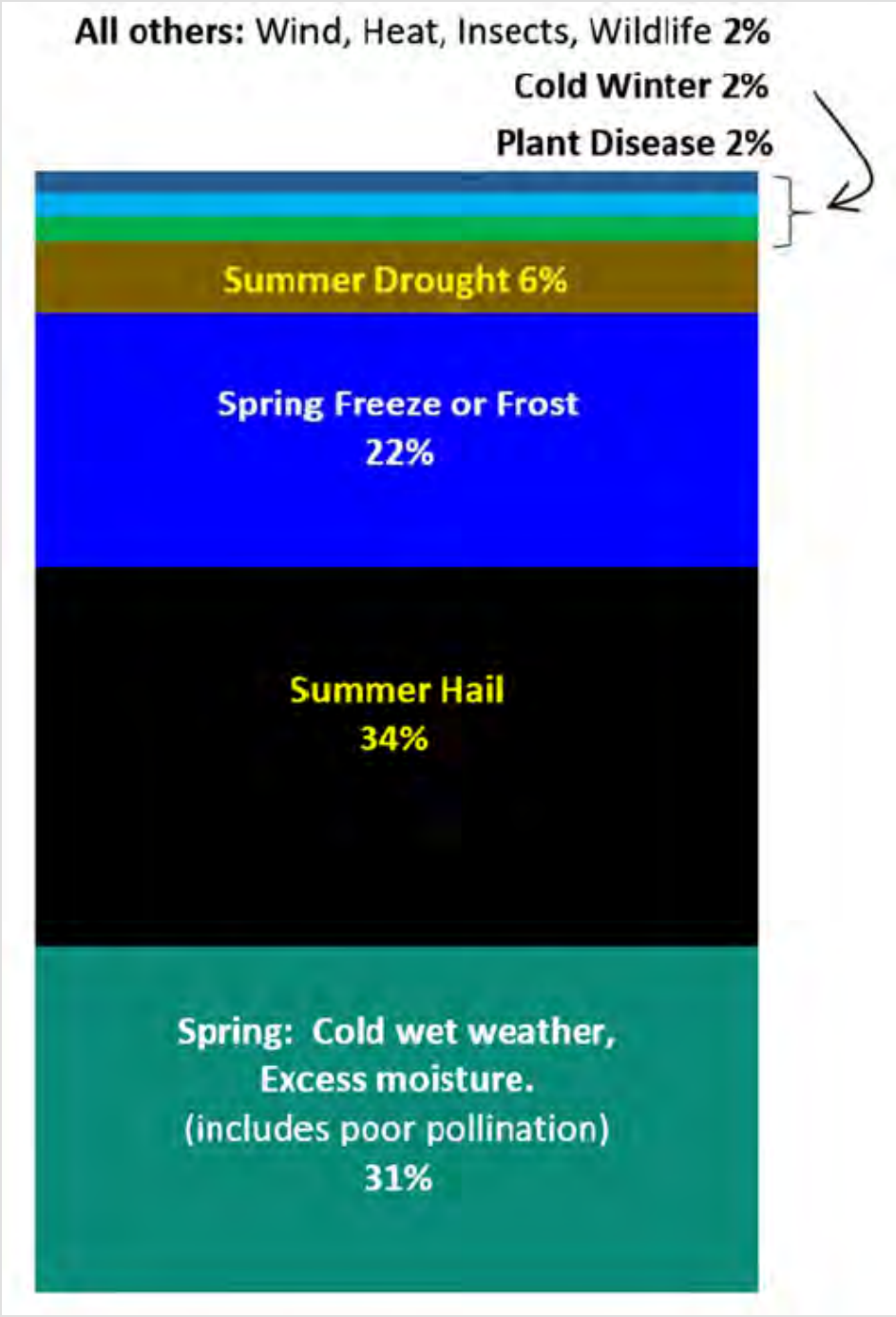
← Change in number of **spring** hail days from 1986 to 2056.

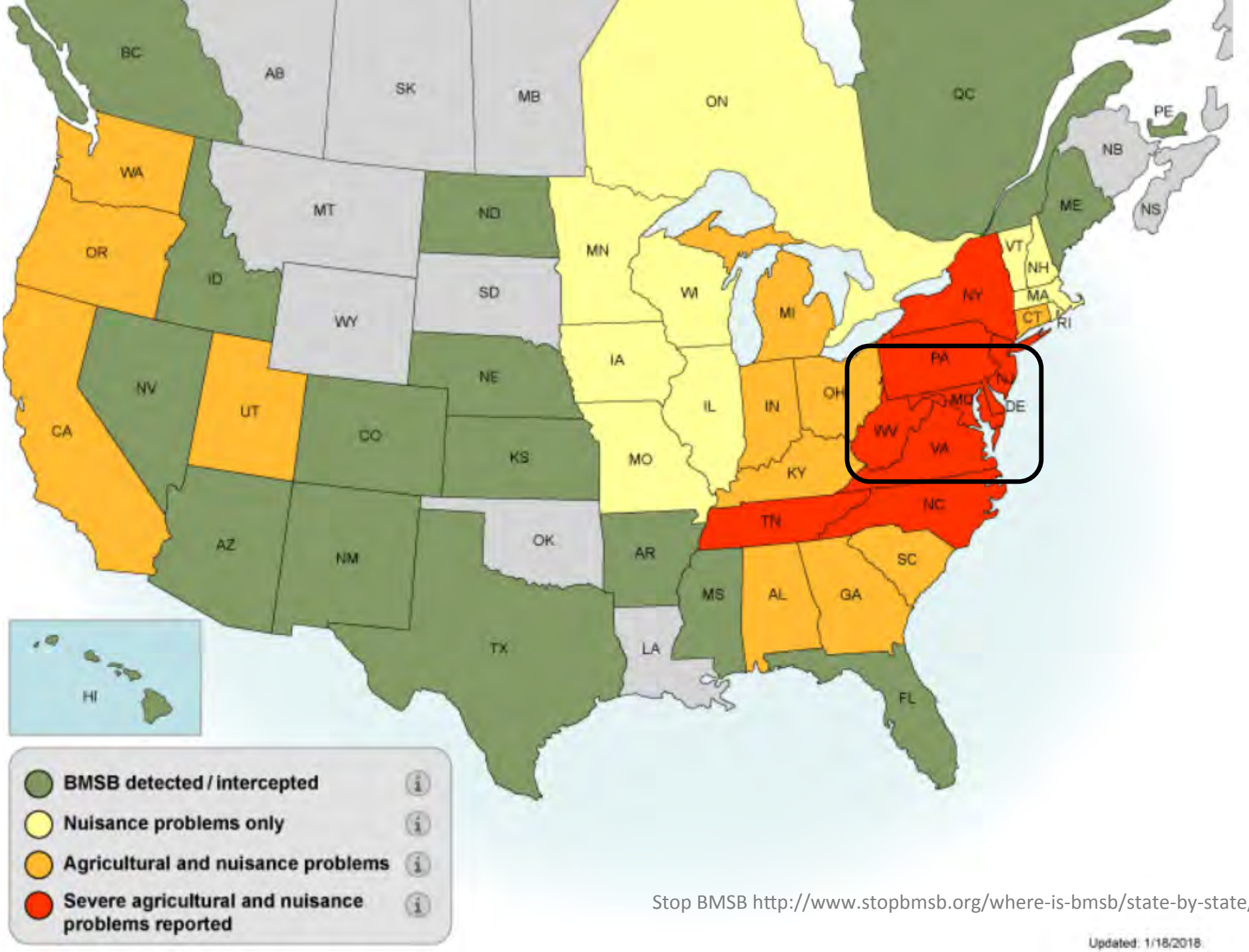
0.75 to 1.00
0.50 to 0.75
0.10 to 0.50
−0.10 to 0.10
−0.50 to −0.10
−0.75 to −0.50
−1.00 to −0.75



← Change in number of **summer** hail days from 1986 to 2056.

0.2 to 1.0
−0.2 to 0.2
−1.0 to −0.2
−1.5 to −1.0


All others: Wind, Heat, Insects, Wildlife 2%
Cold Winter 2%
Plant Disease 2%
Summer Drought 6%
Spring Freeze or Frost
22%
Summer Hail
34%
Spring: Cold wet weather,
Excess moisture.
(includes poor pollination)
31%

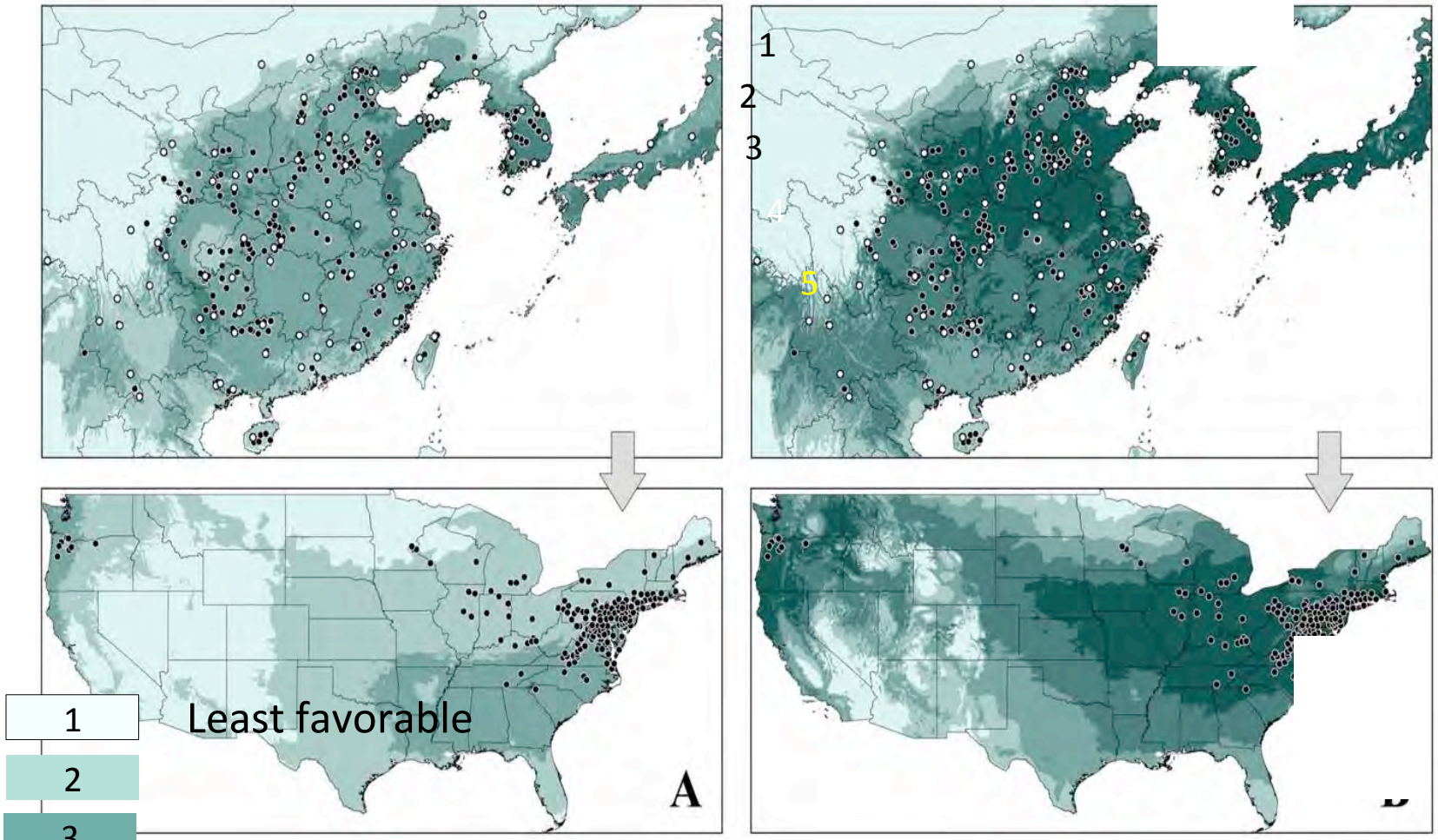


Stop BMSB http://www.stopbmsb.org/where-is-bmsb/state-by-state/

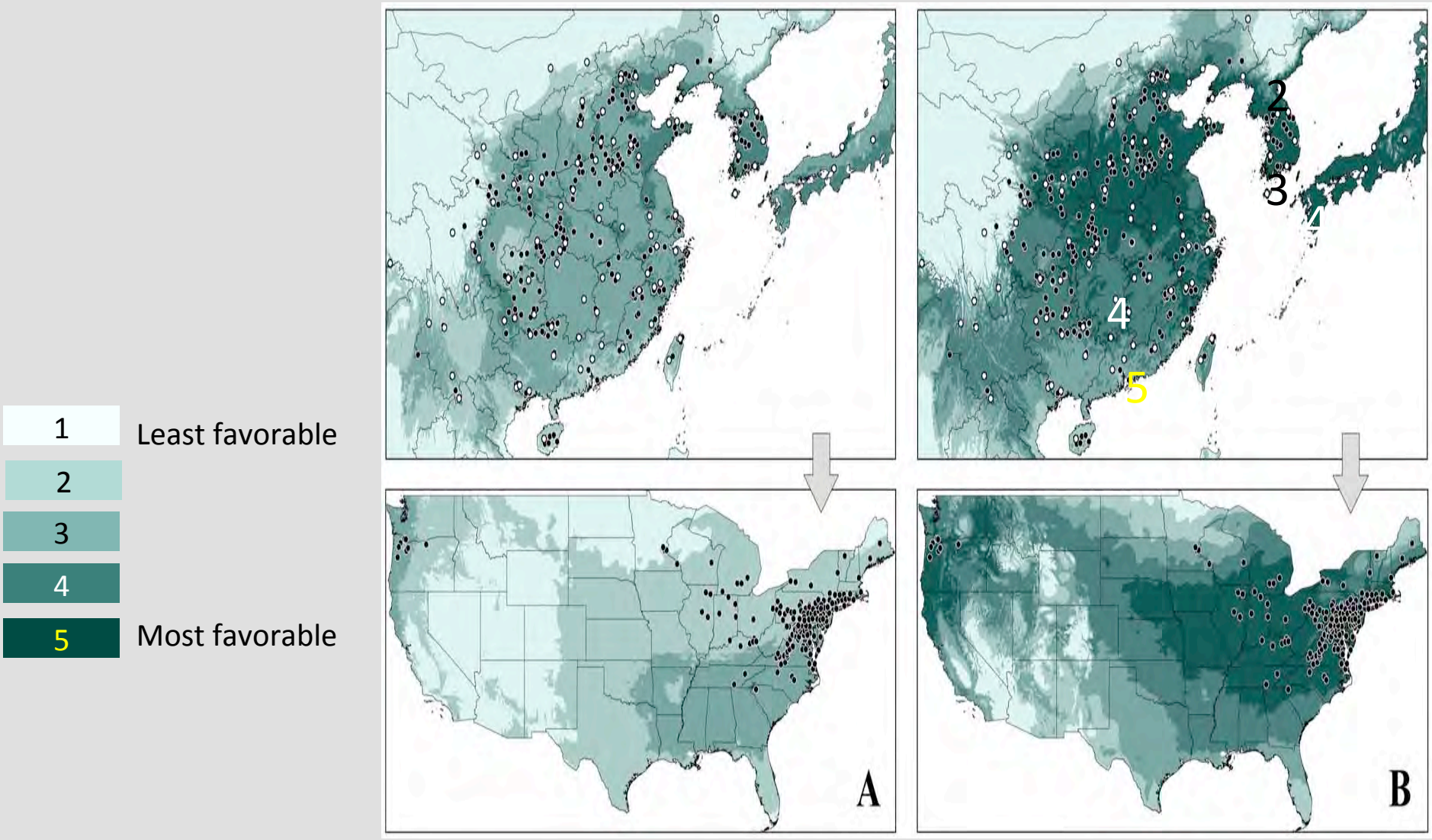
Updated: 1/18/2018

Potential geographic distribution of brown marmorated stink bug

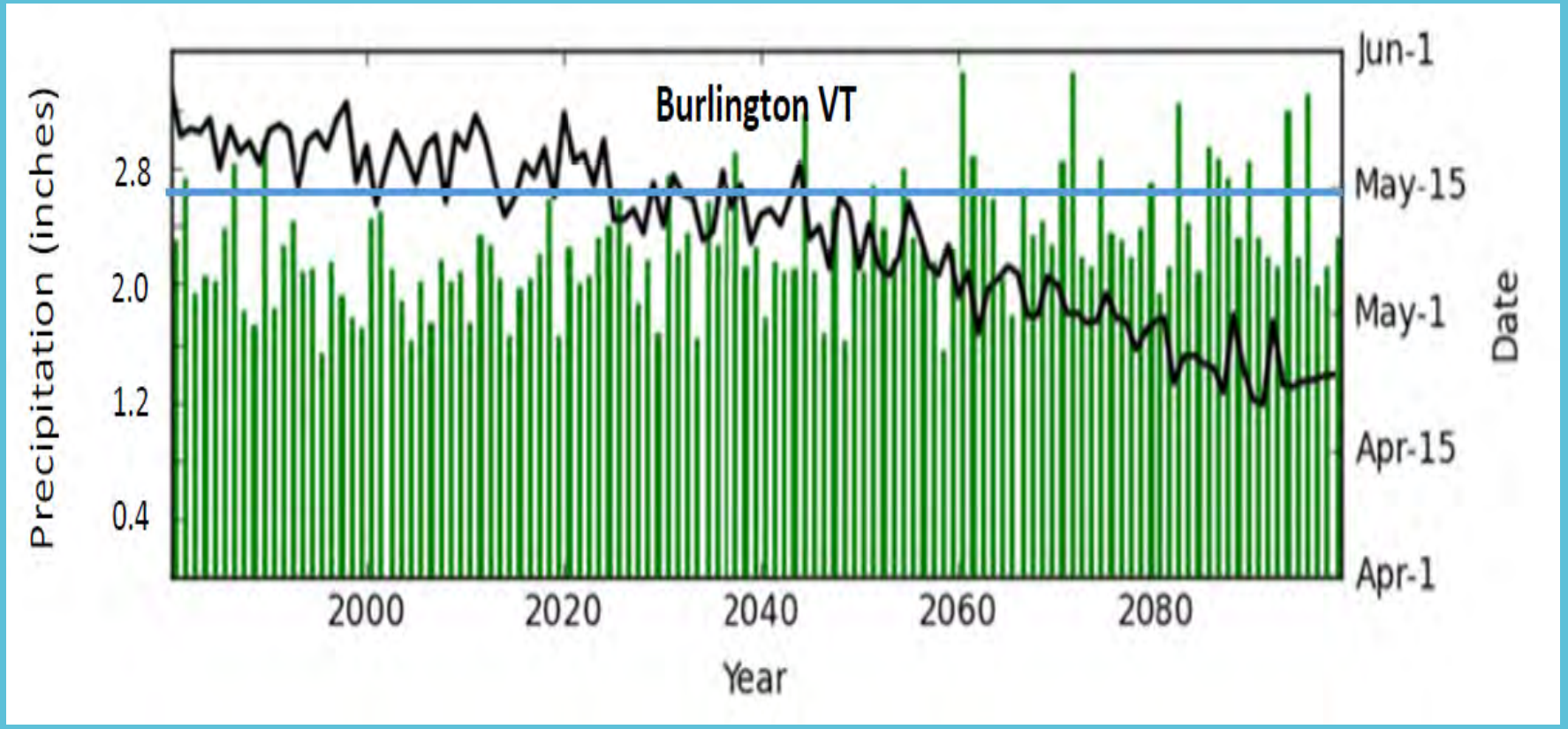
Based on average annual temperature, coldest month, warmest month, precipitation, sunlight, & elevation.



Zhu G, Bu W, Gao Y, Liu G. Potential geographic distribution of brown marmorated stink bug invasion (Halyomorpha halys). *PLoS One*. 2012 7(2):e31246



Zhu G, Bu W, Gao Y, Liu G. Potential geographic distribution of brown marmorated stink bug invasion (Halyomorpha halys). *PLoS One*. 2012; 7(2):e31246.


Burlington VT
Precipitation (inches)
2.8
2.0
1.2
0.4
2000
2020
2040
2060
2080
Year
Jun-1
May-15
May-1
Apr-15
Apr-1
Date

Have you noticed changes in the weather over the last 10-20 years?

Have you noticed changes in the weather over the last 10-20 years?

Will changing weather patterns affect your farm in the future?

Have you noticed changes in the weather over the last 10-20 years?

Will changing weather patterns affect your farm in the future?

If you could manage your farm to better adapt to changing weather patterns, would you do it?

Solutions to weather-proof your farm against too little water?

- ✓ **Good farming**

- ✓ **Irrigation** system installation/efficiency improvements.

USDA

- ✓ **Irrigation**

- ✓ Farm pond, wells, and other **water source** acquisition and storage improvements.

- ✓ **Irrigation**
- ✓ **Water sources**
- ✓ **Soil monitoring**
  and weather-based **irrigation scheduling.**


- ✓ **Irrigation**
- ✓ **Water sources**
- ✓ **Soil monitoring and irrigation scheduling.**
- ✓ Increase **soil organic matter**.

USDA

- ✓ **Irrigation**
- ✓ **Water sources**
- ✓ **Soil monitoring and irrigation scheduling.**
- ✓ **Soil organic matter**.
- ✓ Site/crop/variety **selection** for drought tolerance.


Too little, just right, or too much.

Goldilocks got it just right, but you might not be so lucky.

Water supply: **Bust …**

or **Boom!**

Solutions to weather-proof your farm against too much water?

- ✓ **Good farming**

- ✓ **Strategies to reduce soil losses** (cover and companion crops, reduced/no-till, crop residue, increase soil organic matter, contour planting, avoid slopes and flood zones).

Corn planted into wheat stubble, USDA

- ✓ **Reduce soil losses**

- ✓ **Select flood-tolerant crops/varieties**, **overseeding** to advance crop establishment.

- ✓ **Reduce soil losses**
- ✓ **Flood-tolerant crops/varieties/seeding**
- ✓ High-capacity equipment or short-term labor to **accelerate fieldwork** if number of suitable days is limited.

- ✓ **Reduce soil losses**
- ✓ **Flood-tolerant crops/varieties/seeding**
- ✓ **High-capacity equipment, extra labor**
- ✓ **Ditches, berms, drainage tiles**, and engineered solutions to handle excess water.

- ✓ **Reduce soil losses**
- ✓ **Flood-tolerant crops/varieties/seeding**
- ✓ **High-capacity equipment, extra labor**
- ✓ **Ditches, berms, drainage tiles**
- ✓ **Reduce vehicle traffic** on wet soils.

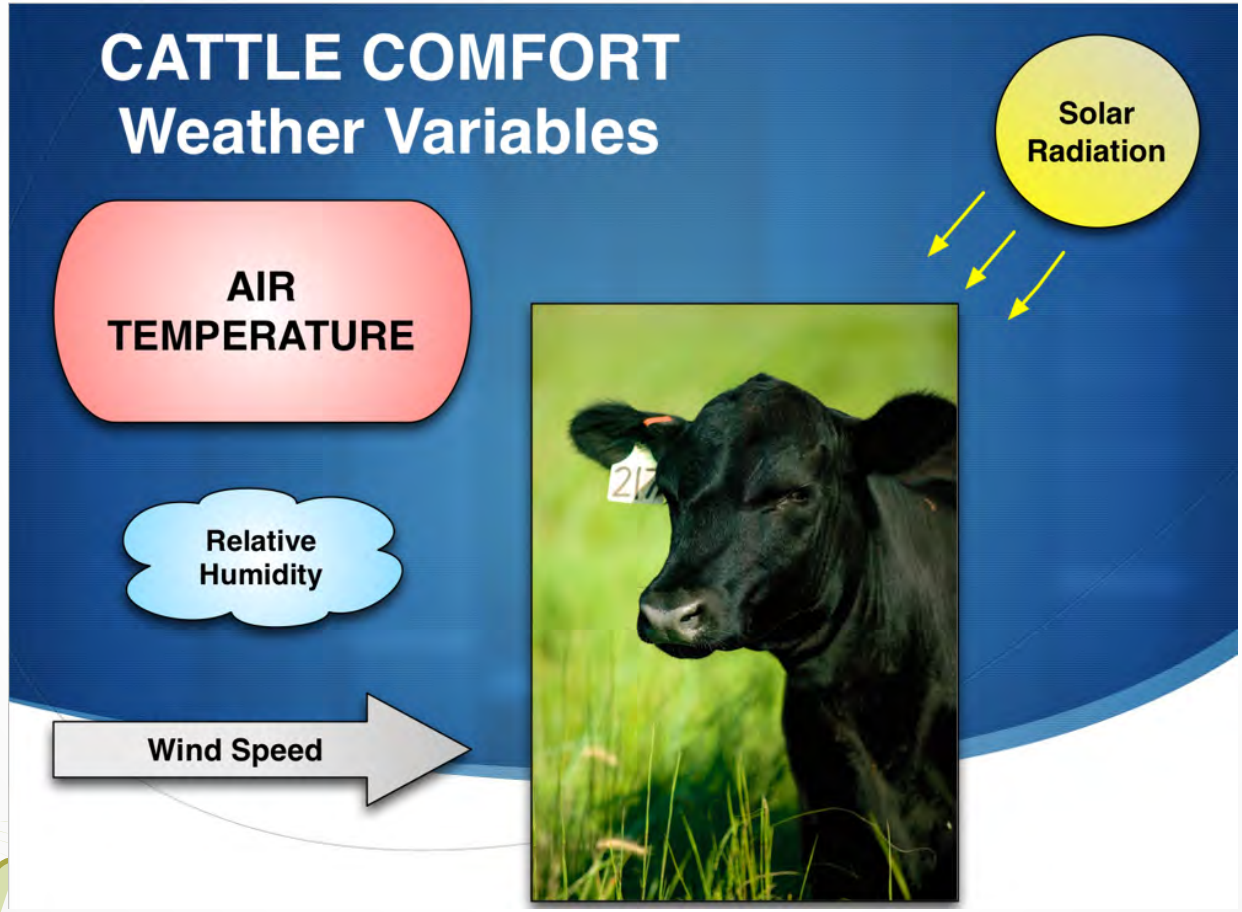
- ✓ **Reduce soil losses**
- ✓ **Flood-tolerant crops/varieties/seeding**
- ✓ **High-capacity equipment, extra labor**
- ✓ **Ditches, berms, drainage tiles**
- ✓ **Reduce vehicle traffic**

- ✓ **Just-in-time fertilizer** application. Nitrogen side-dress.

Solutions to weather-proof your farm against temperature variation?

✓ **Good farming**

- ✓ **Strategies to avoid heat stress** (adjust planting dates to avoid peak heat during critical crop stage, shade cloth for crops, sprinklers and shade for livestock, timing of livestock movement/ feeding/reproduction, livestock monitoring).



Graphic by Albert Sutherland, "The National Cattle Comfort Advisor: a Tool for Managing Cold and Heat Stress", Climate Learning Network, Sept. 7, 2017

- ✓ **Strategies to avoid heat stress**

- ✓ **Take advantage of higher temperatures** (crop variety selection for heat tolerance, longer season varieties, new crop options, new crop rotations, double cropping, greater use of cover crops).

- ✓ **Strategies to avoid heat stress**
- ✓ **Take advantage of higher temperatures**
- ✓ **Spring freeze risk reduction** (hoop house, row covers, mulch, overhead sprinklers, even drip irrigation can help, wind breaks, heaters)

- ✓ **Strategies to avoid heat stress**
- ✓ **Take advantage of higher temperatures**
- ✓ **Spring freeze risk reduction**
- ✓ **Site considerations** (match crop to field slope/aspect/microsite, adjust pasture stocking rates and timing).

- ✓ Strategies to avoid heat stress
- ✓ Take advantage of higher temperatures
- ✓ Spring freeze risk reduction
- ✓ Site considerations

- ✓ Adjust fertilizer and irrigation timing

Where to get help to better adapt to changing weather?

Other farmers, Grower associations

Maine State Pomological Society Annual Winter Meeting

Maine Organic Farmers and Gardeners Association Meeting

Maine State Florists' and Growers' Association

Maine Farmland Trust, Maine Landscape and Nursery Association (MELNA) & Maine Beef Producers Association Meeting

Maine Christmas Tree Association Meeting

Maine Woodland Owners Annual Meeting and Forestry Forum

Maine Vegetable & Small Fruit Growers Association Annual Meeting

Maine Maple Producers Association Meeting

NOAA's partial shutdown means operations that are considered “mission critical” are still functioning. Those operations include things like populating the weather.gov website with forecasts, and ensuring major weather events are watched and warned across the country. Those government employees whose jobs fall under the status “mission critical” are still working, while not being paid.

Unfortunately, maintenance on the American computer model, known as the Global Forecasting System (GFS), is not considered critical.

The result?

According to the Washington Post’s Capital Weather Gang, the GFS is running poorly.

Weather models are not being maintained, launched or improved.

But in the meantime, the current Global Forecast System — or the GFS — the United States' premier weather model, is running poorly, and there's no one on duty to fix it.

Effects could stretch well beyond when the government reopens.

There are about 50 full-time federal employees at EMC and 150 contractors. Only one person is working during the shutdown, she said — a manager who does not work on data or the models. "Things are going to break, and that really worries me

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USDA United States Department of Agriculture
Farm Service Agency
Maine

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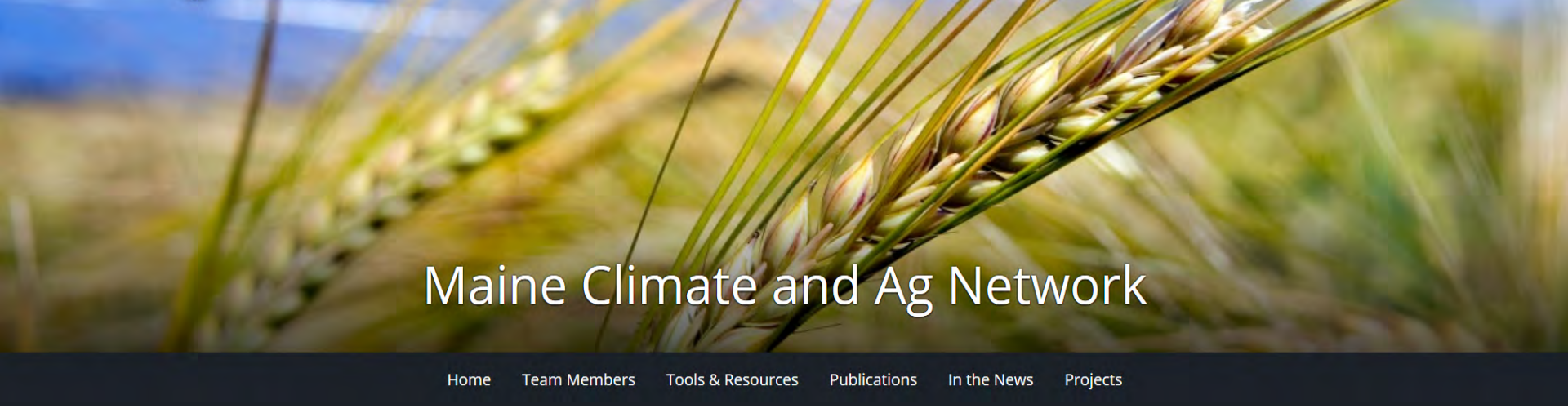
USDA Risk Management Agency
United States Department of Agriculture

Erin Roche Crop Insurance Program Manager, erin.roche@maine.edu, 949-2490



THE UNIVERSITY OF MAINE
Climate and Agriculture Network

Our Mission:

To increase communication and identify challenges, opportunities, and potential solutions for climate change and Maine agriculture.

www.umaine.edu/climate-ag/

What resources might help you better plan for current and changing weather?

- Weather data for your records or ag software?
- Short-range forecasts tuned for farmers?
- Long-range, or seasonal weather outlooks?
- Management tools?
- Workshops or educational events?
- Policy work with ME Dept. Ag, etc.?