USDA Northeast Climate Hub
U.S. DEPARTMENT OF AGRICULTURE

WEATHERING THE CHANGE:

Helping Farmers Help the Land Through Climate Smart Farming

Natural Resources Conservation Service

nrcs1usda.gov/

Introductions:

Erin Lane

US Forest Service

USDA Northeast Climate Hub Coordinator

North Atlantic Fire Science Exchange

Elizabeth Marks

Biologist, NRCS NY

NRCS Liaison to Northeast Climate Hub 2020

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Today's Presentation
Abbreviated version of full training that will be in Ag Learn

- Climate change trends over the last 125 years
- Why these changes are occurring
- Some hope!
- Climate Smart Farming

Weather versus Climate

***Weather*: happening at a point in time**

***Climate*: general trend in weather**

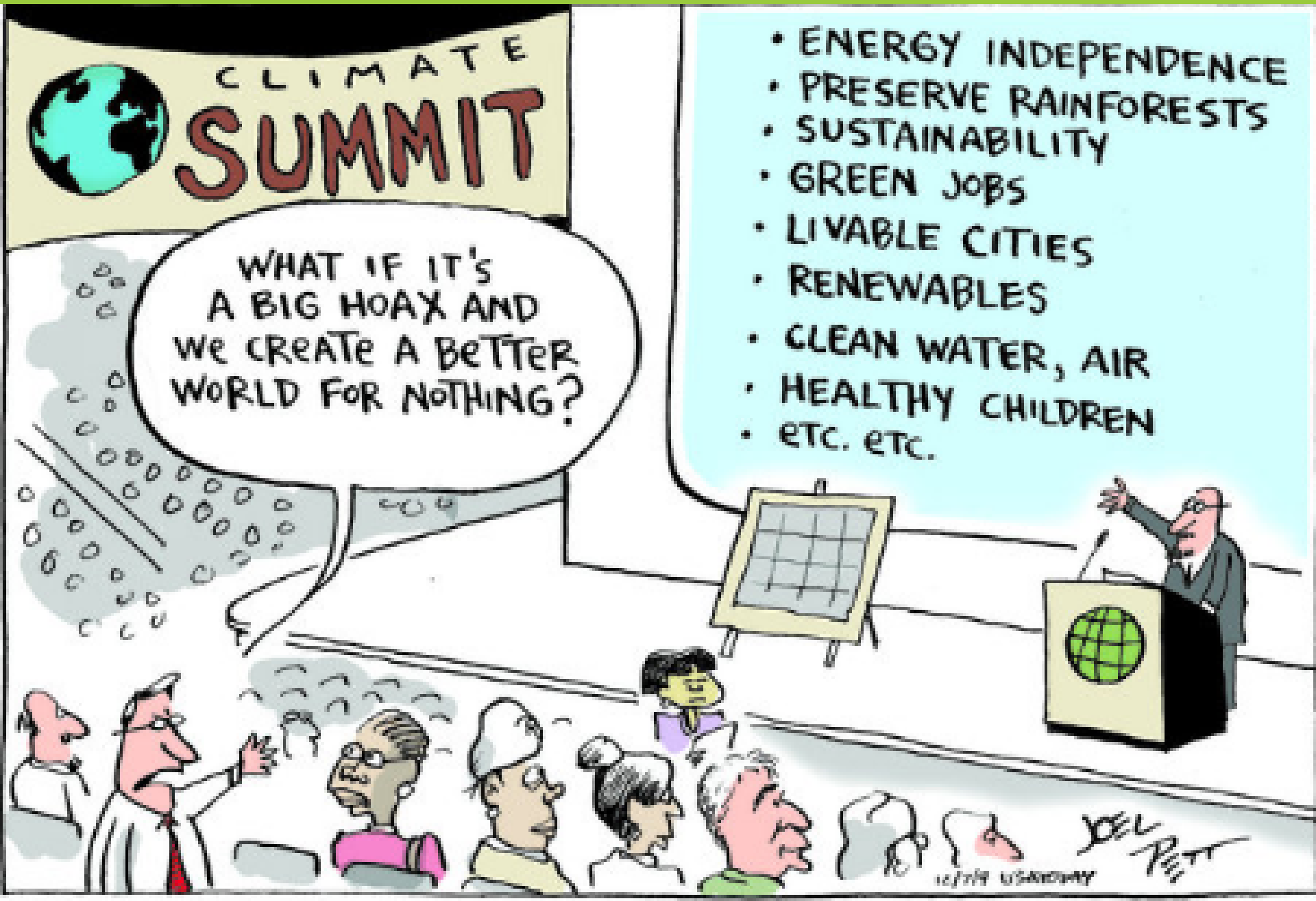
Climate Change - Other Terms/Phrases:

- Weather Volatility
- Weather Extremes
- Changing Weather Patterns
- Weather Unpredictability

Climate Smart Farming

Other terms:

- Natural Climate Solutions
- Engineering with Nature
- Weather/Drought Resiliency
- Soil Health


CLIMATE SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
JOEL PETT

Make it Personal:

What changes in weather have you noticed in your lifetime?

Climate Change Over the Last Century

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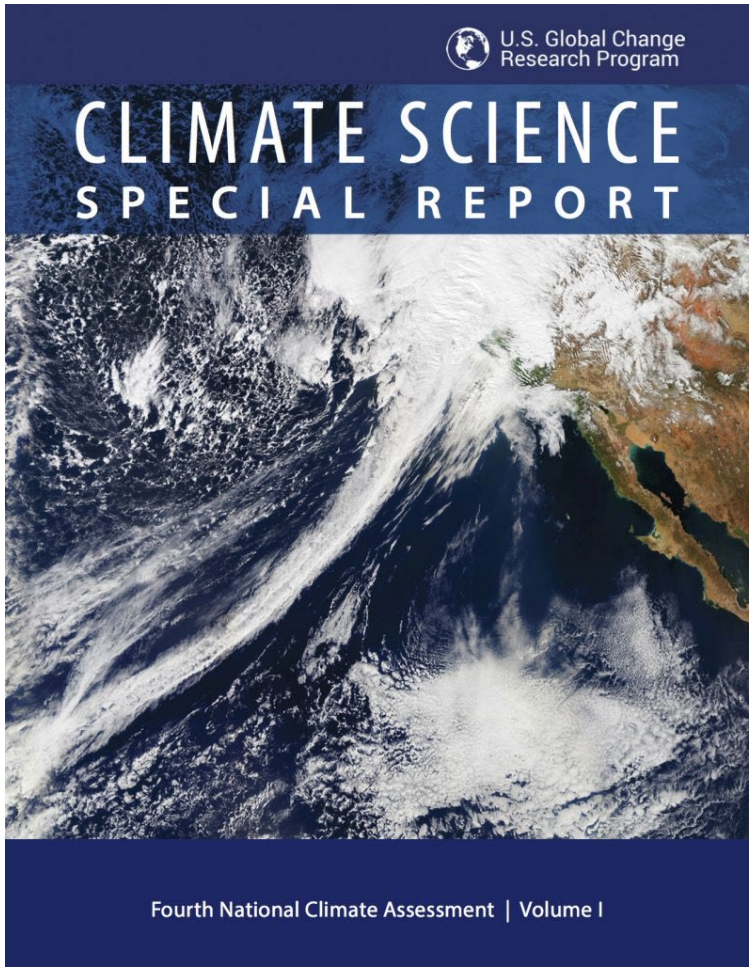
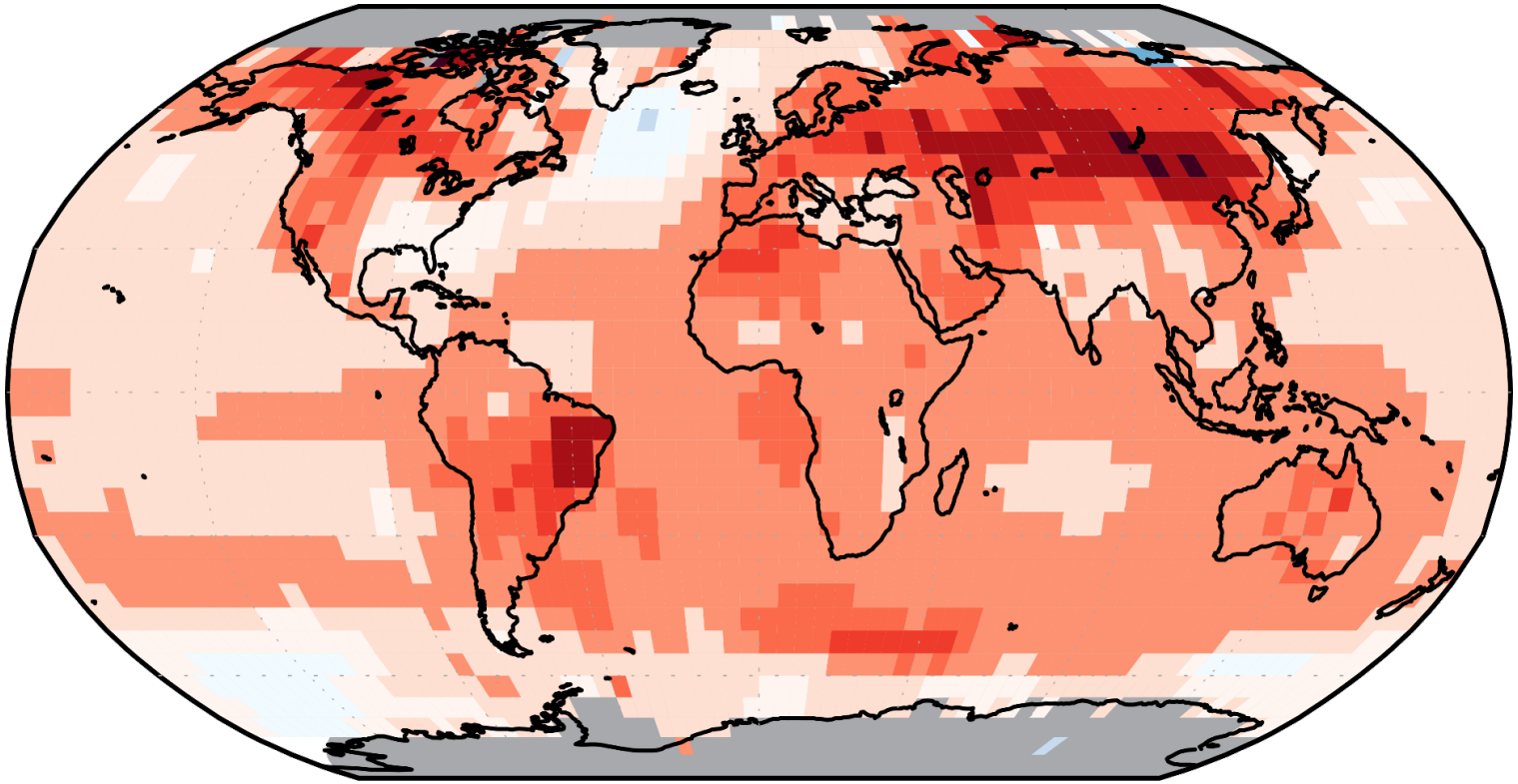
Fourth National Climate Assessment 2018

- 1,500 page congressionally mandated report done every four years by the US Global Change Research Program (federally funded).

- Lead agency: National Oceanic and Atmospheric Association, many other partner contributors including USDA

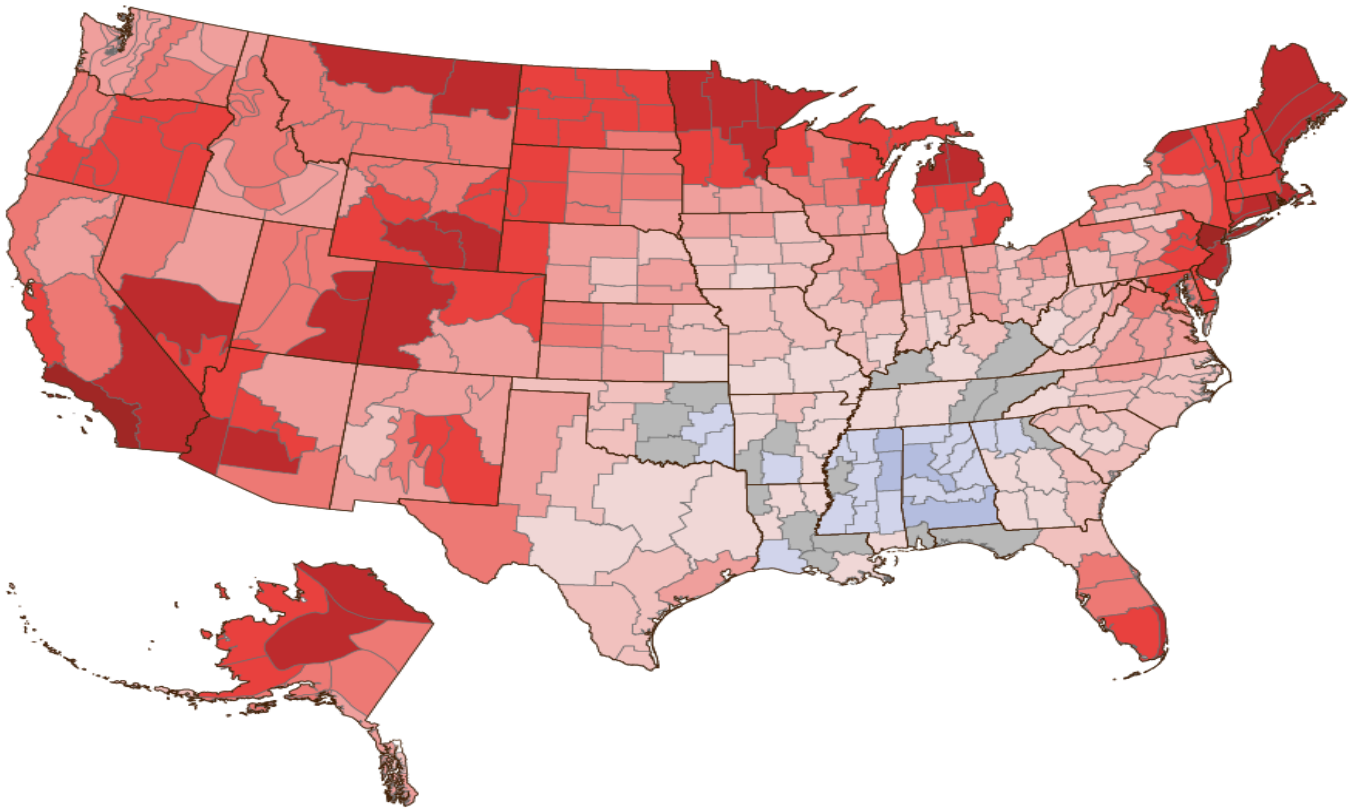


Average Global Rise in Temperature: 2° F (1° C) since 1880



Source: Fourth National Climate Assessment 2018

Rate of Temperature Change in the United States, 1901–2015



Rate of temperature change (°F per century):

-3.5 -3 -2 -1 0 1 2 3 3.5

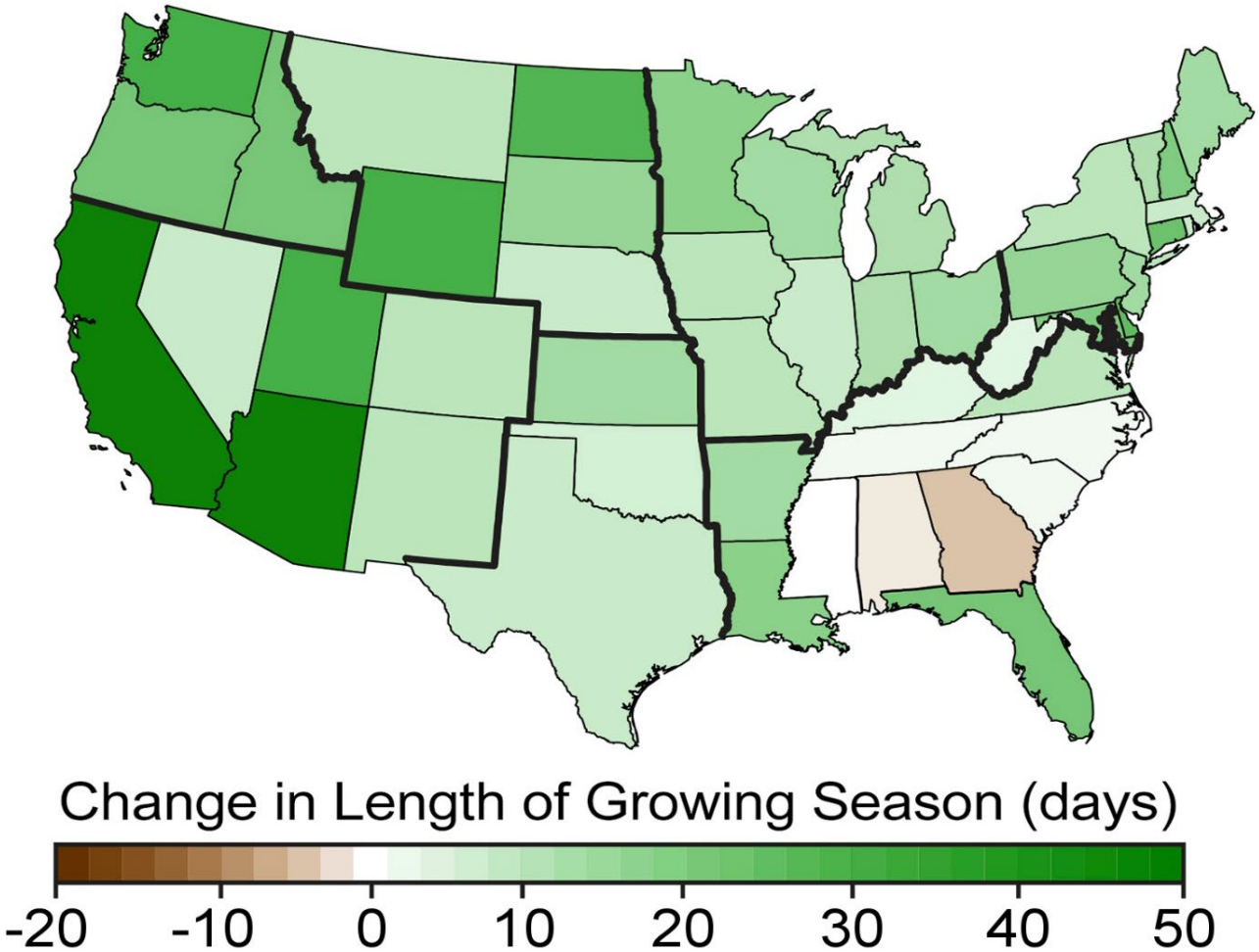
Gray interval: -0.1 to 0.1°F

*Alaska data start in 1925.

Data source: NOAA (National Oceanic and Atmospheric Administration). 2016. National Centers for Environmental Information. Accessed February 2016. www.ncei.noaa.gov.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Change in Growing Season Length Since 1895



Source: Fourth National Climate Assessment 2018

Increased Mosquito Season

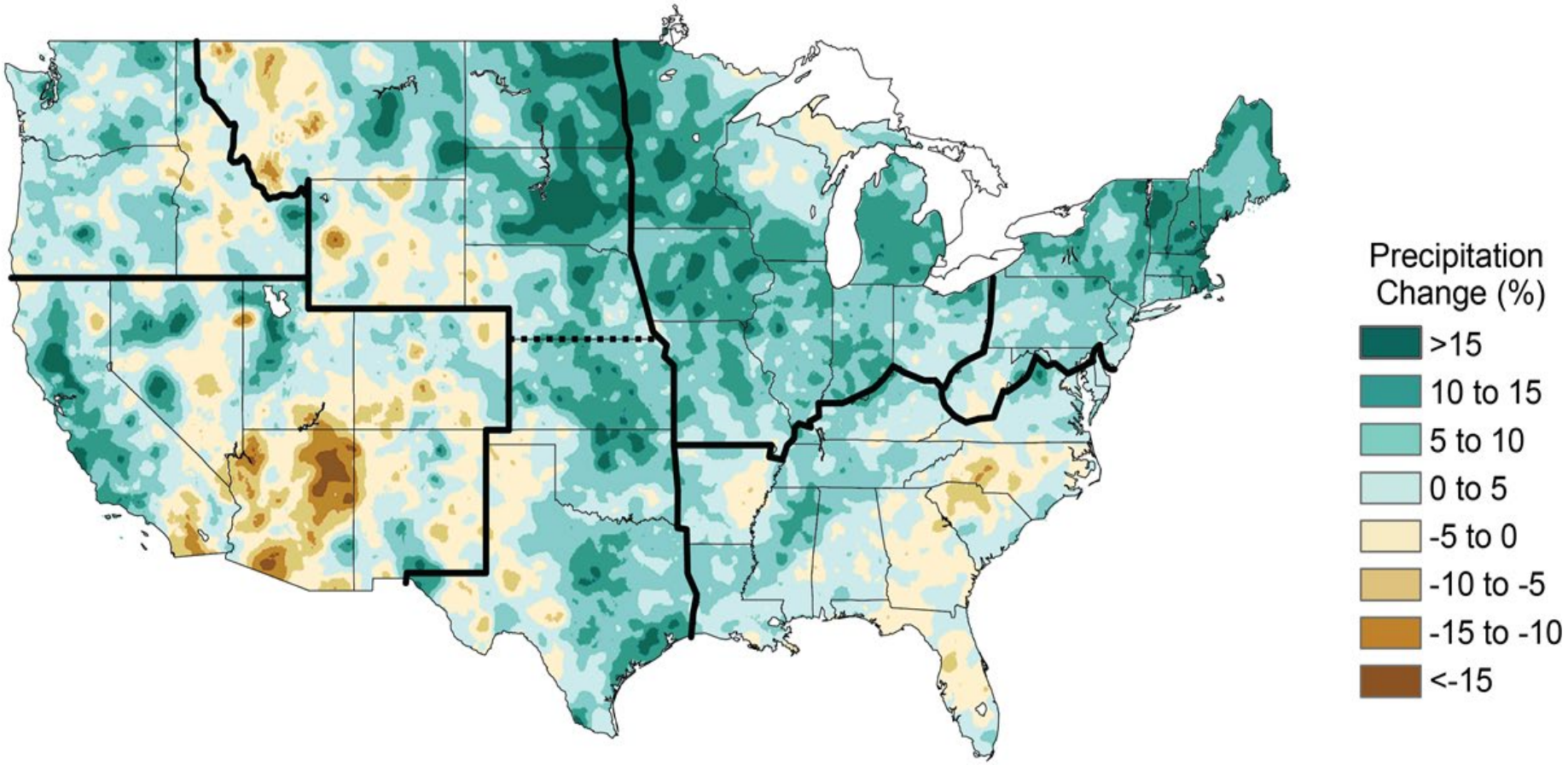
Much Longer Mosquito Seasons

Top 25 cities with the largest increase in annual average days with ideal climate conditions since 1980 (days)

1.	Baltimore	37
2.	Durham, N.C.	37
3.	Minneapolis	34
4.	Myrtle Beach, S.C.	34
5.	Raleigh, N.C.	33
6.	Portland, Maine	32
7.	St. Louis	31
8.	Pittsburgh	30
9.	Worcester, Mass	30
10.	Albany, N.Y.	30
11.	Washington, D.C.	29
12.	Hartford, Conn.	28
13.	Fargo, N.D.	27
14.	Springfield, Mass.	27
15.	Louisville, Ky.	26
16.	Atlantic City, N.J.	26
17.	Syracuse, N.Y.	25
18.	Daytona Beach, Fla.	25
19.	Cleveland	25
20.	Salisbury, Md.	25
21.	Bridgeport, Conn.	25
22.	Davenport, Iowa	25
23.	Greenville, S.C.	24
24.	Norwich, Conn.	24
25.	Trenton, N.J.	24

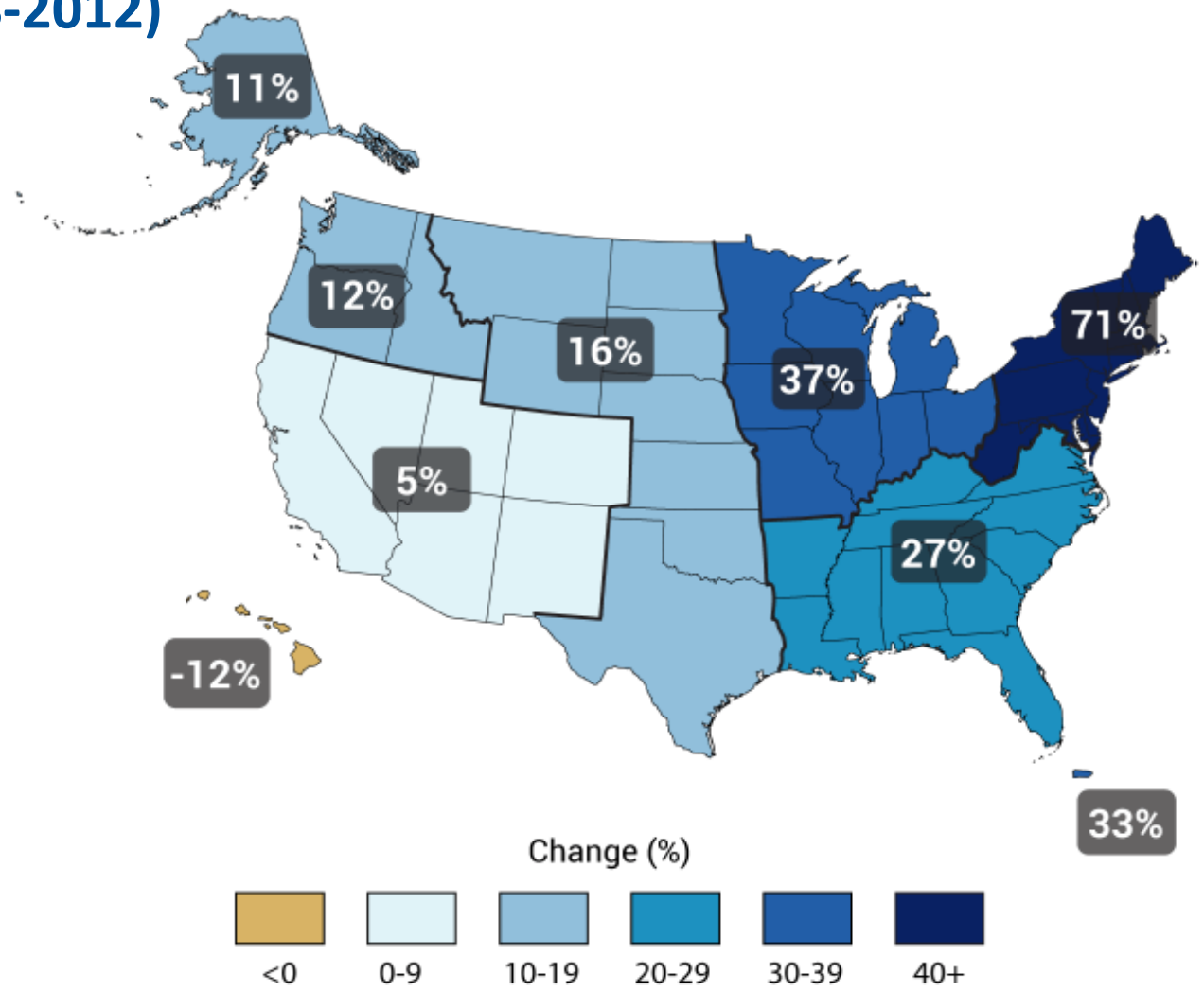
Source: Climate Central

Observed US Rainfall Change Since 1895



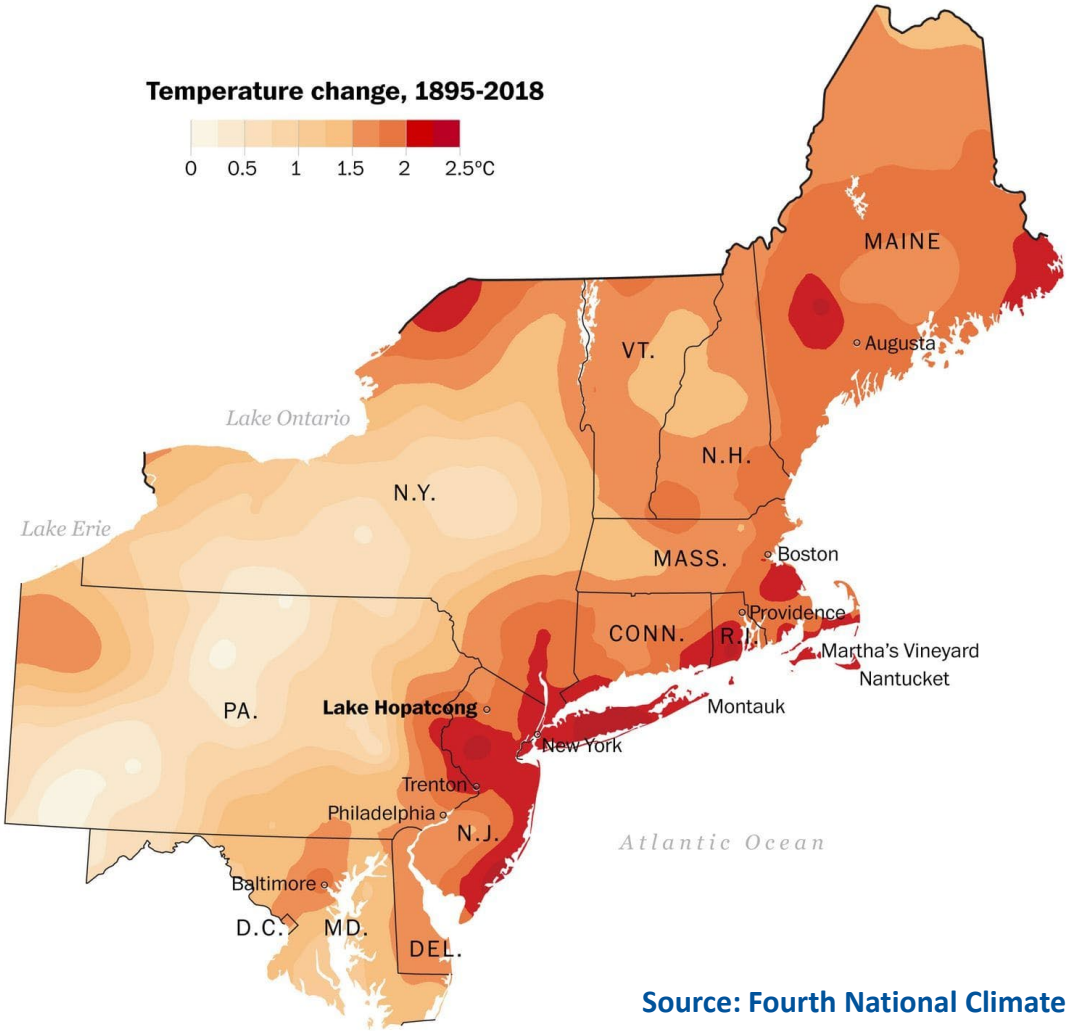
Source: Fourth National Climate Assessment 2018

Percent Increase in Very High Precipitation (1958-2012)



Source: Fourth National Climate Assessment 2018

Northeast is Experiencing Higher than Global Average Warming



Gulf of Maine is the fastest warming ocean in the world.

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Source: Fourth National Climate Assessment 2018

Changes at the State Level

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NOAA State Climate Summaries

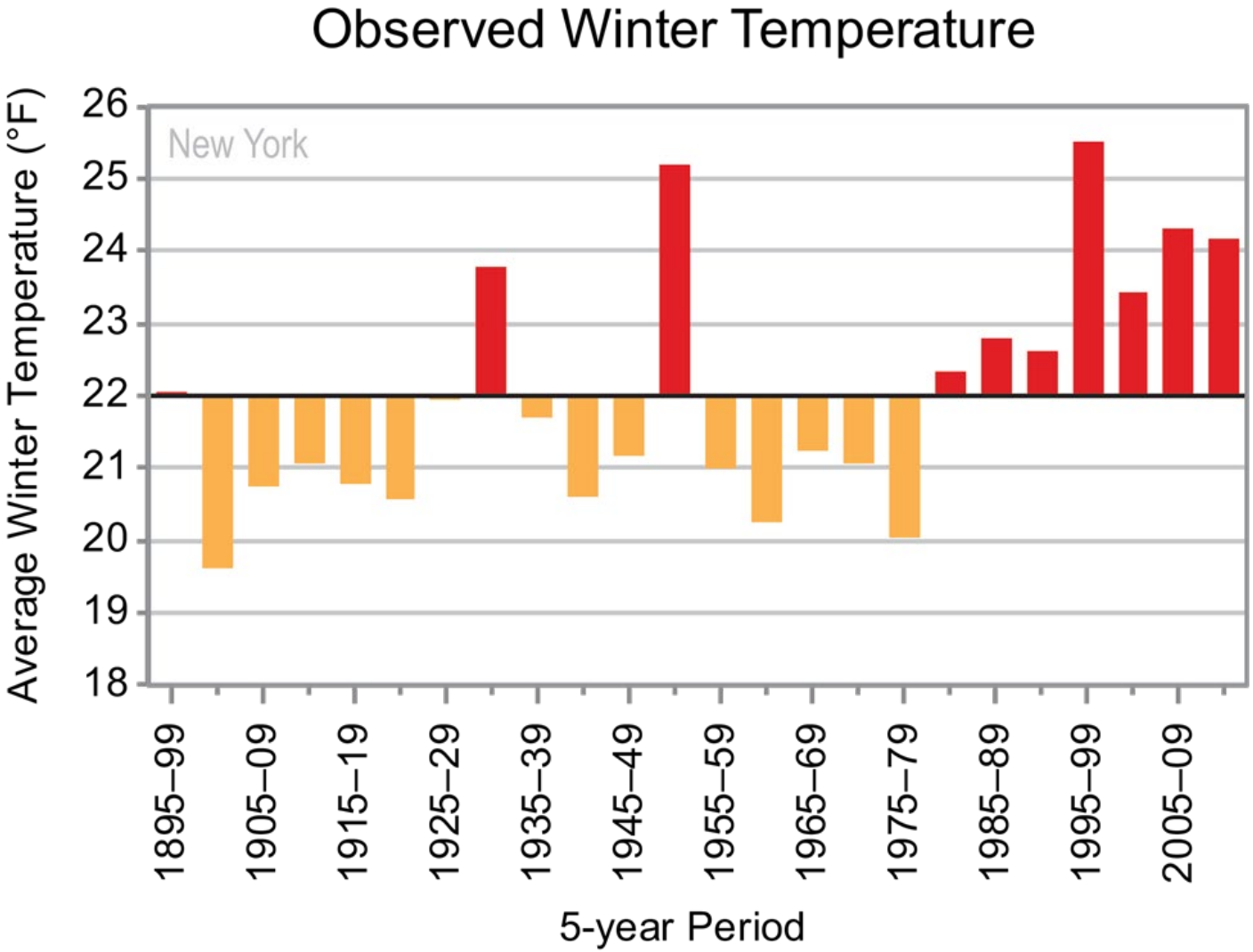
Excellent 4-5 page fact sheets for each state summarizing climate trends that are occurring.

Visit: statesummaries.ncics.org

New York

- Average temperatures have increased 2° F since 1900.
- Average rainfall has increased 15% since 1895; highest increase happening in Central NY.
- There has been a 143% increase in number of days where rainfall has exceeded 2” in 24 hours.
- Warmer winters and increased rain in winter and spring means longer mud season and delayed planting.
- Sea levels has risen 13” since 1880; higher than the global rise of 8”.

New York



Source: NOAA

Why Are These Changes Happening?

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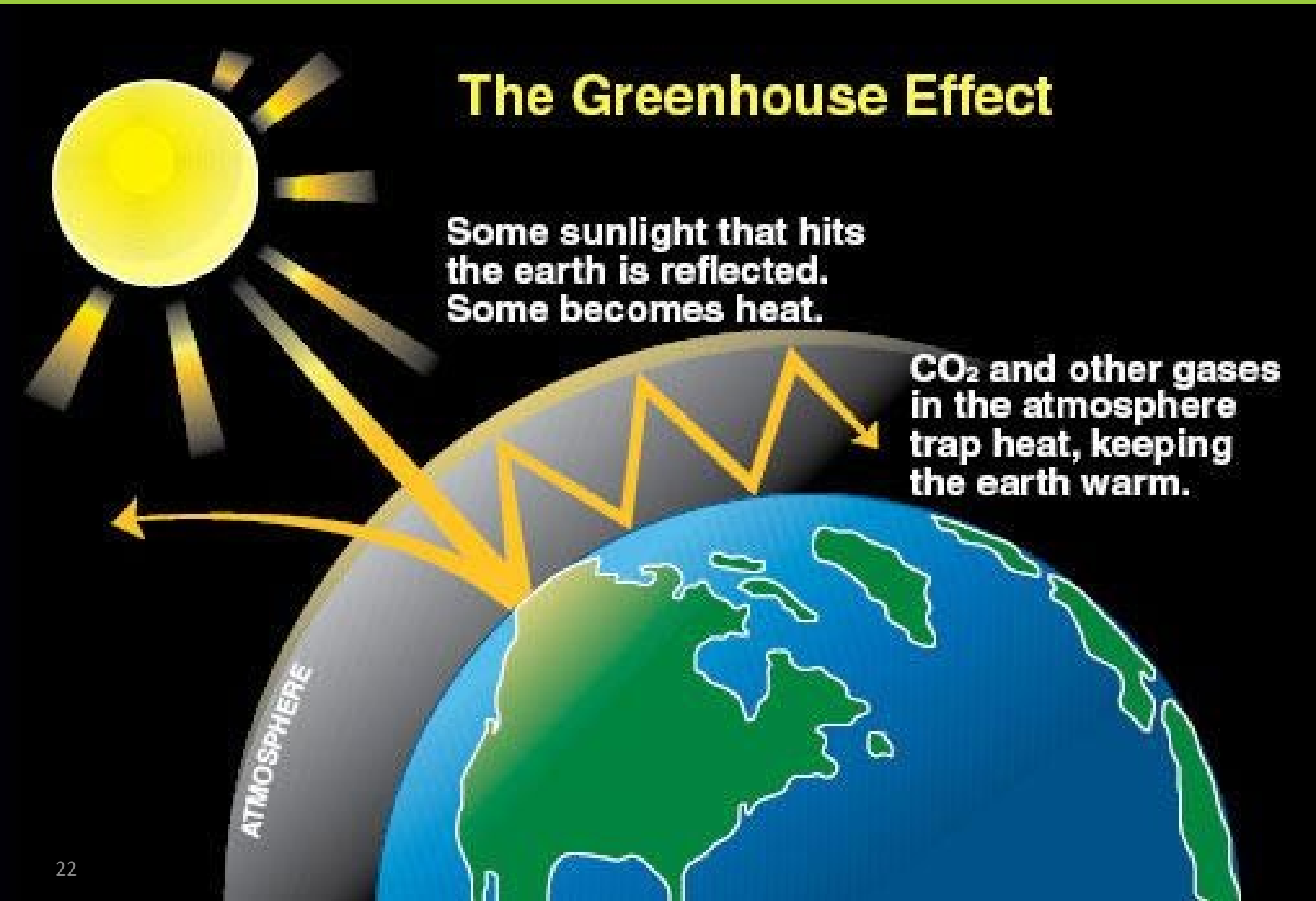
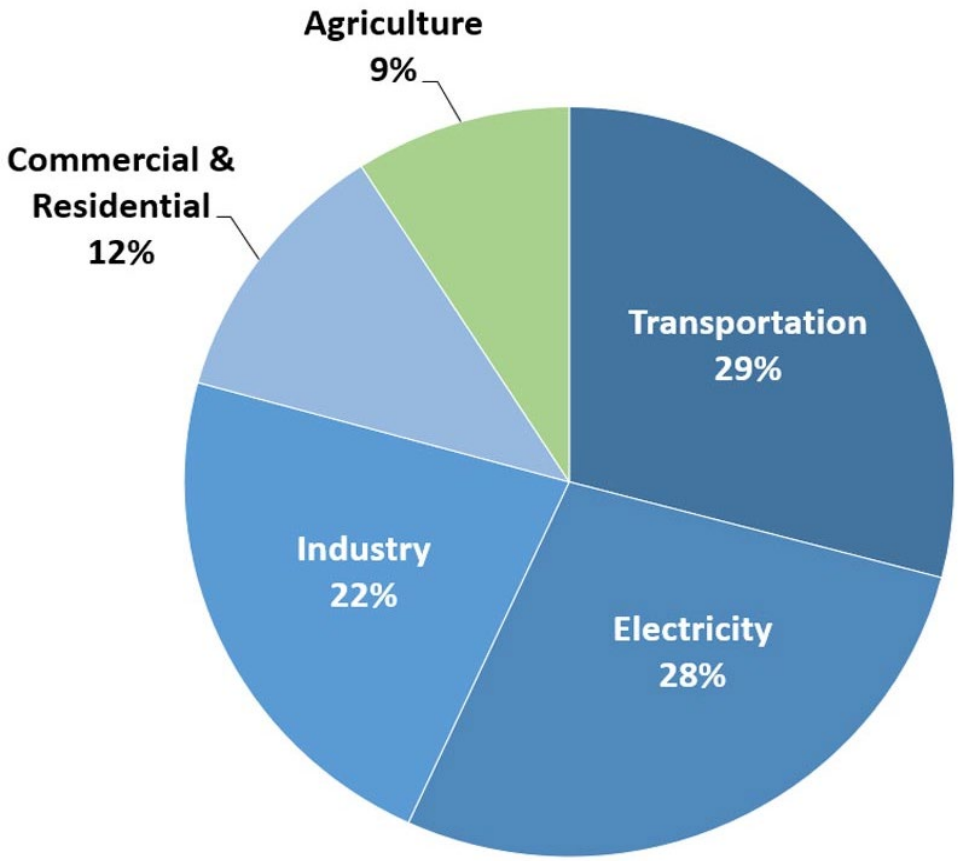

The Greenhouse Effect
Some sunlight that hits the earth is reflected. Some becomes heat.
CO_2 and other gases in the atmosphere trap heat, keeping the earth warm.
ATMOSPHERE

The "Pick Up Truck" Effect

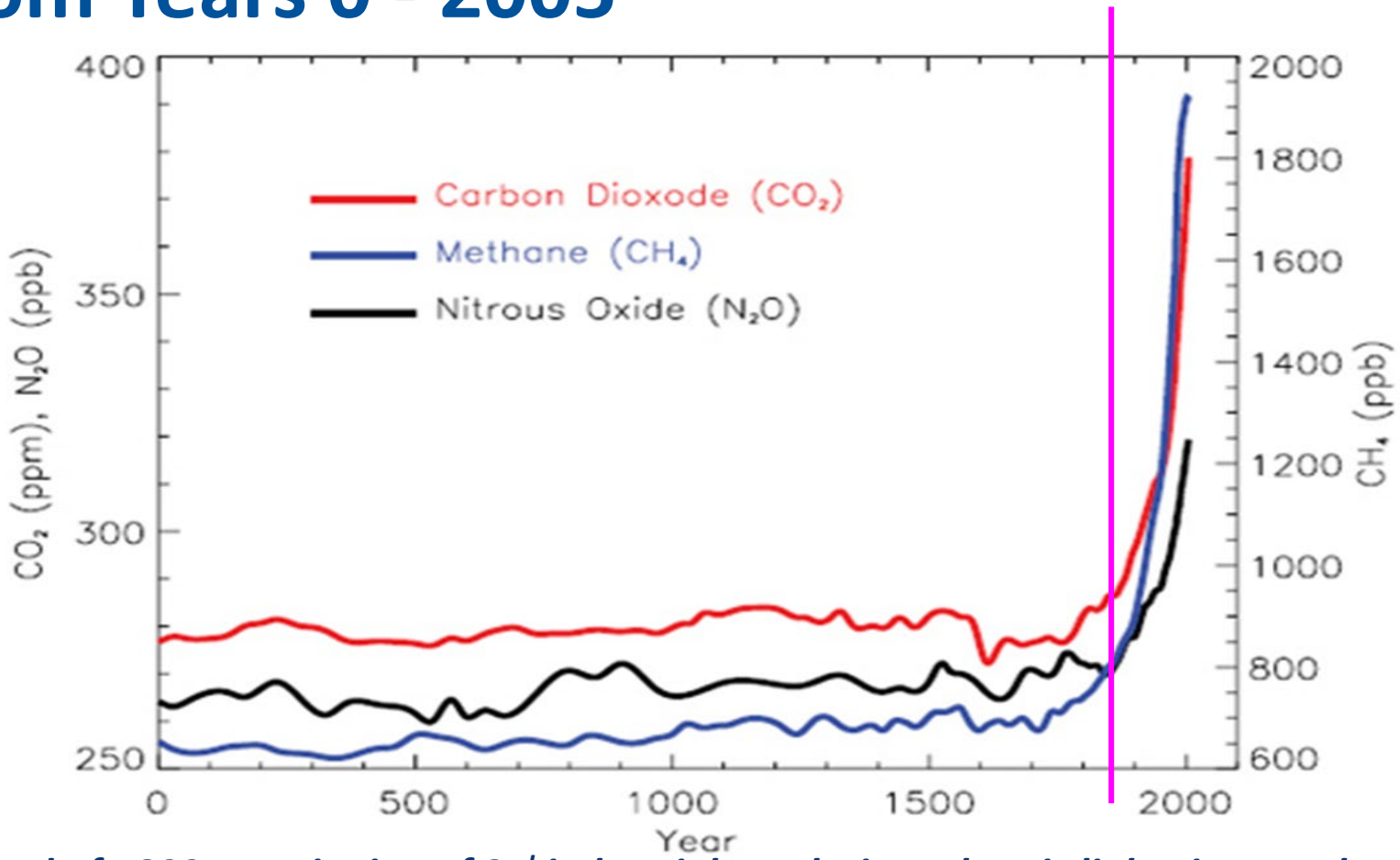
What are the Greenhouse Gasses and Where are they Coming From in the US?

- Water vapor (H_2O)
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Ozone (O_3)
- Chlorofluorocarbons and hydrofluorocarbons (CFCs and HFCs)



Source: EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks

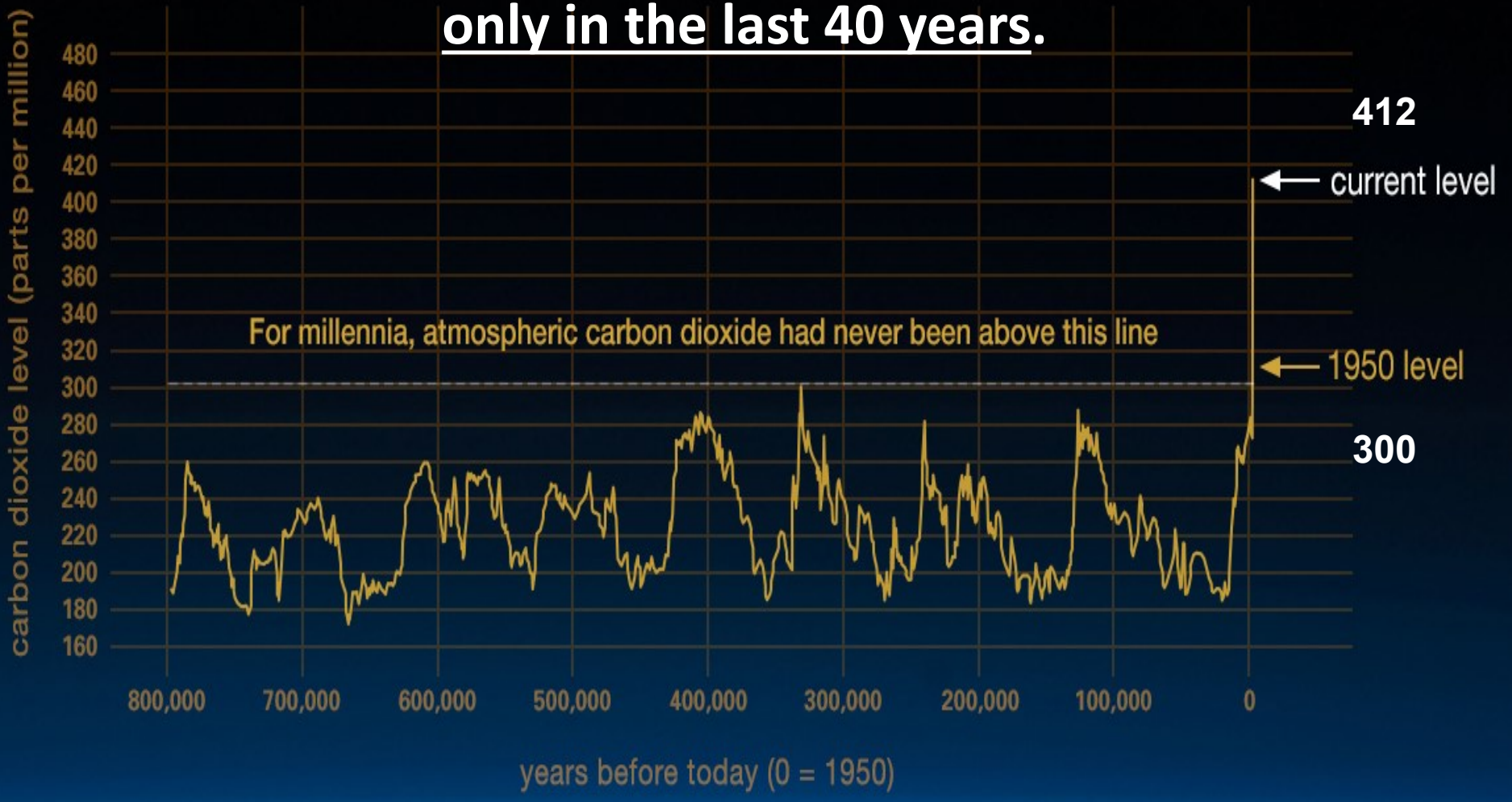
Concentrations of Greenhouse Gases From Years 0 - 2005



End of 1800s: Beginning of 2nd industrial revolution, electric lights invented, and introduction of the automobile.

Source: Intergovermental Panel on Climate Change Fourth Assessment Report 2007

Half of human-related CO_2 emissions has occurred only in the last 40 years.



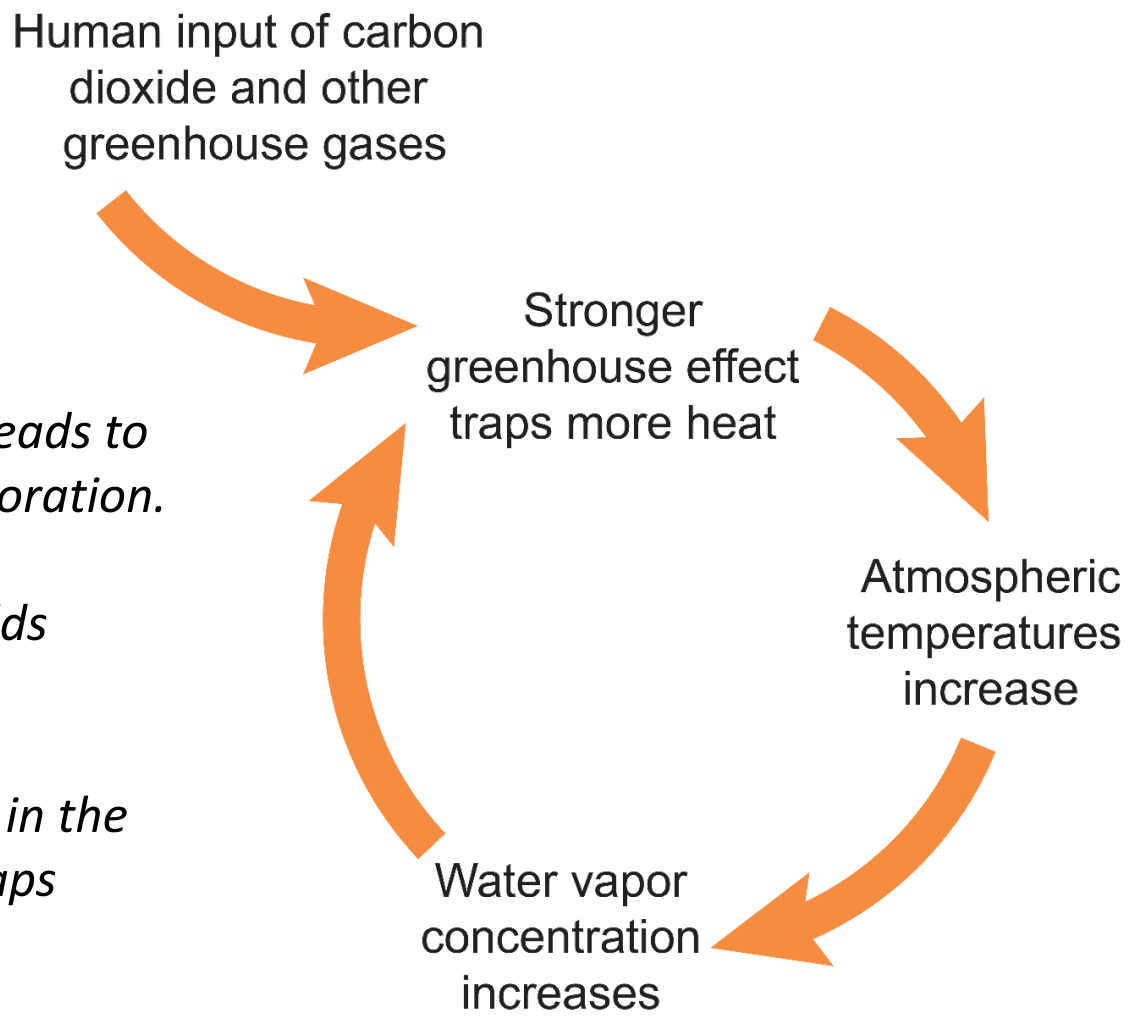
Source: Data: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.

Why are many areas getting wetter?

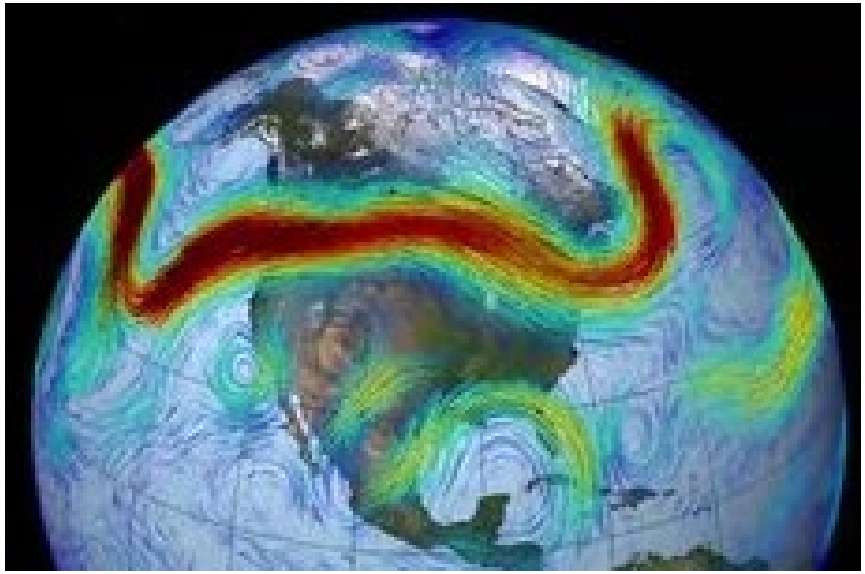
Increased temperatures leads to increased evaporation.

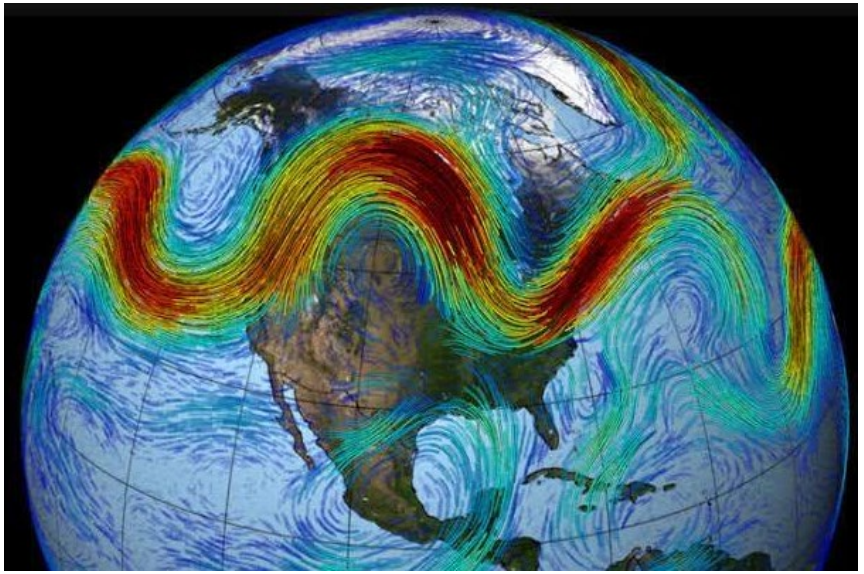
Warmer air holds more water.

More moisture in the atmosphere traps more heat.



Why does it seem like we have more extreme weather?

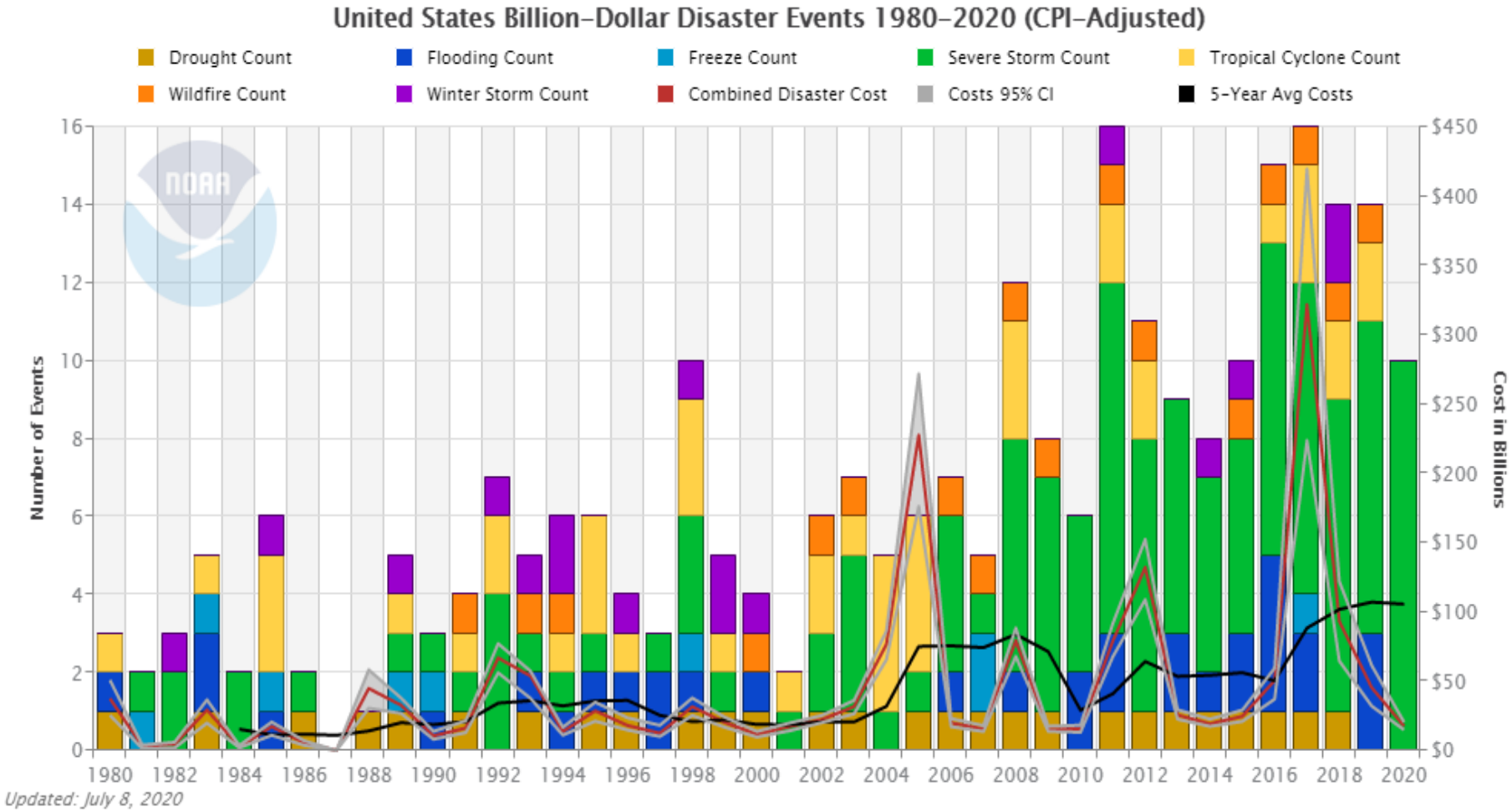




Wavier (Amplified) Jet Stream

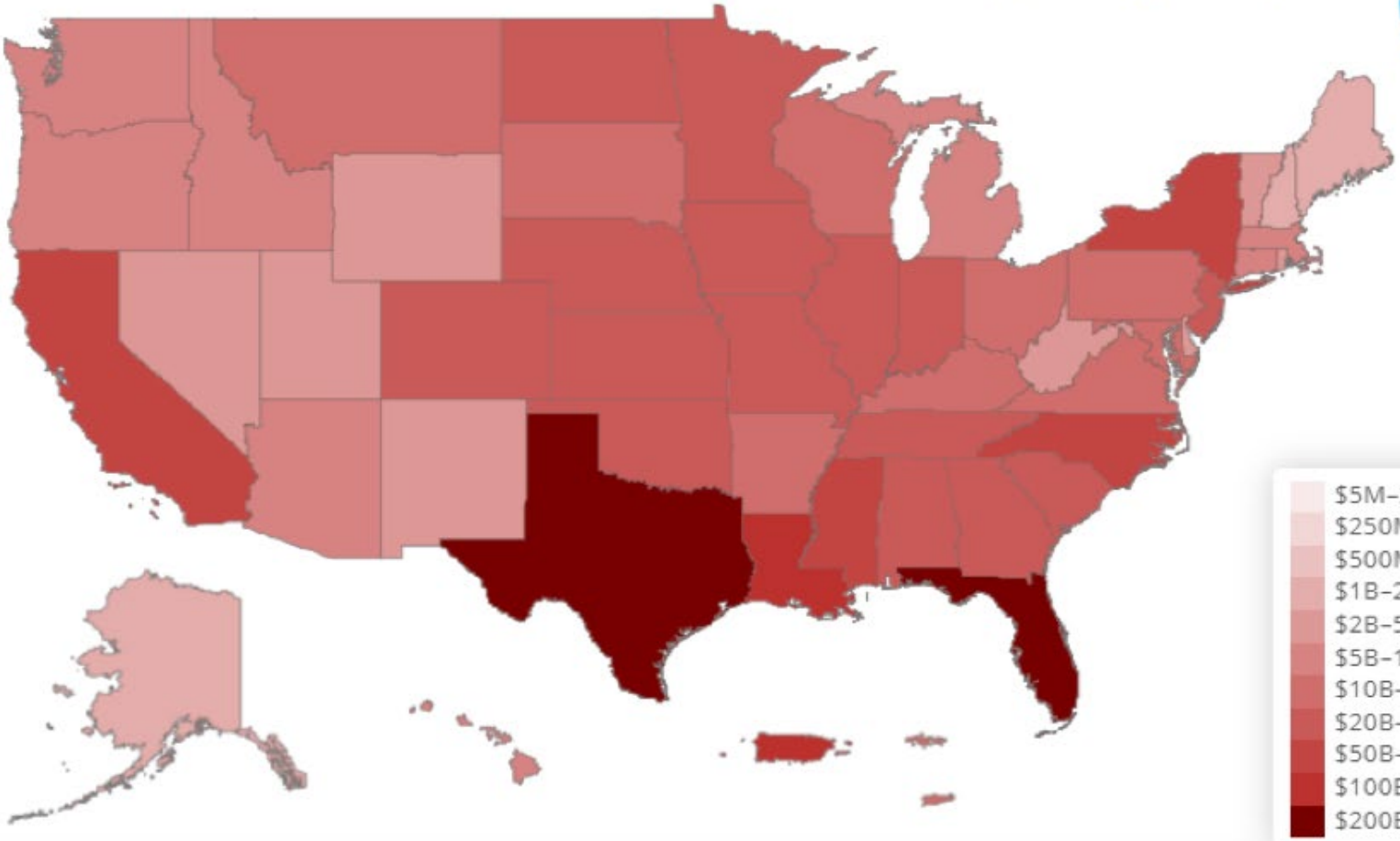
Source: NASA

US Billion Dollar Disaster Events 1980 - 2020



Source:NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2020).

1980-2019 Billion-Dollar Weather and Climate Disaster Cost (CPI-Adjusted)



United States

Drought:	$250B+	Flooding:	$100B–200B	Freeze:	$20B–50B	Severe Storm:	$250B+
Tropical Cyclone:	$750B+	Wildfire:	$50B–100B	Winter Storm:	$20B–50B	All Disasters:	$1.7T+

 NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2020).

Reasons for Hope

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President Elect's Plan for Addressing Climate Change

CLIMATE 21 PROJECT — Transition Memo

Department of Agriculture

LEAD AUTHORS

Robert Bonnie, former Undersecretary at USDA
Leslie Jones, former Deputy Undersecretary at USDA
Meryl Harrell, former Senior Advisor to the Undersecretary for Natural Resources and the Environment, USDA

** Professional affiliations do not imply organizational endorsement of these recommendations*

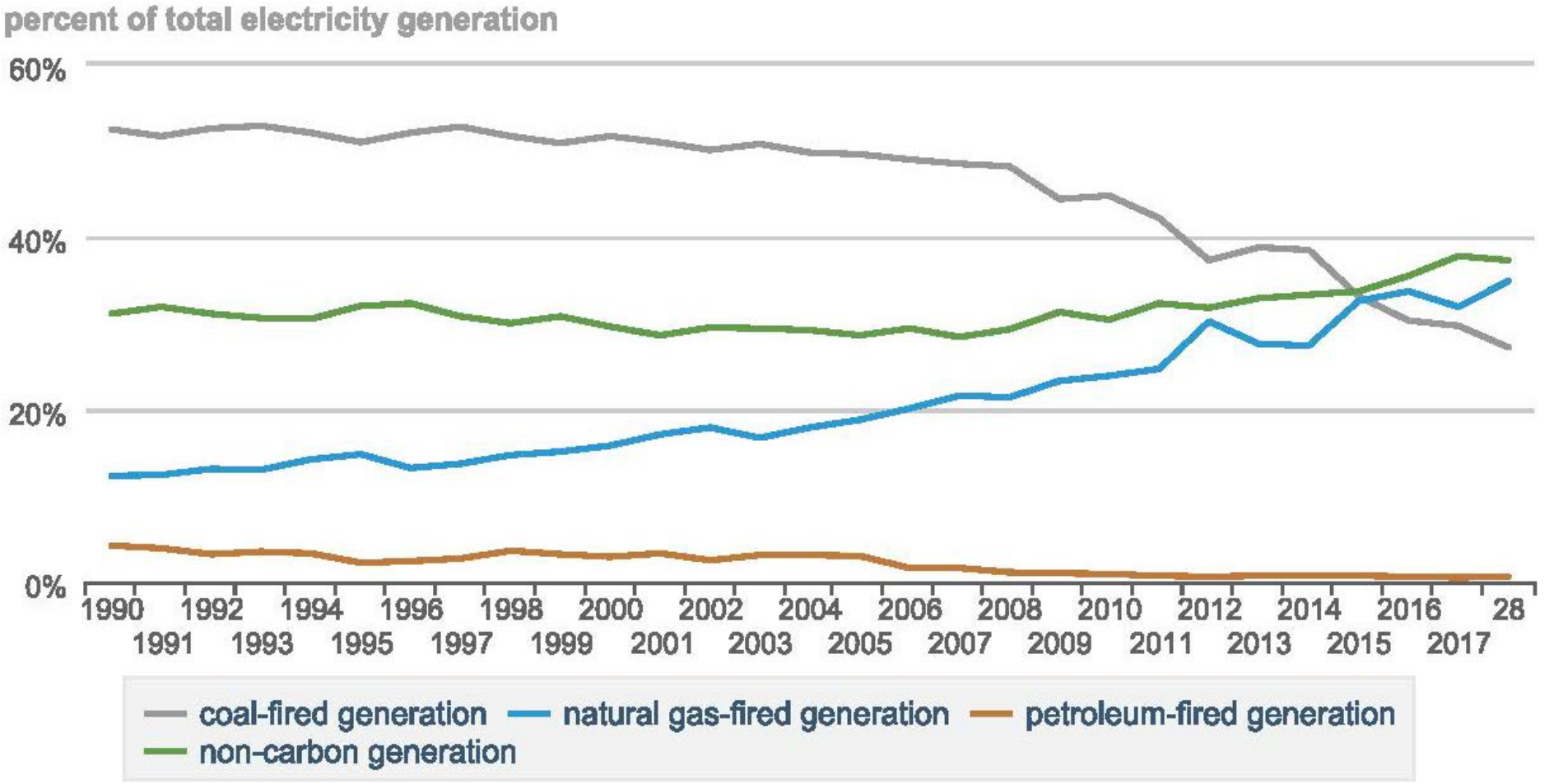
DAY 1

Issue a Secretarial Order on Climate Change and Rural Investment to signal climate change as a top priority of the department

US Hit Peak Greenhouse Gas Emissions in 2007

Source: Center for Climate and Energy Solutions

US Electricity Generation 1990 - 2018



Source:
https://cfpub.epa.gov/ghgdata/inventoryexplorer/#allsectors/allgas/gas/

USDA Resources

COMET Farm/Planner

Climate Hubs

NRI/CEAP/ Soil Monitoring

Snow Survey and Water Supply Forecasting

SCAN/TSCAN

USDA CarbonScapes

Conservation Funding: EQIP, CIG, CRP, CSP

Soil Health

Environmental Markets

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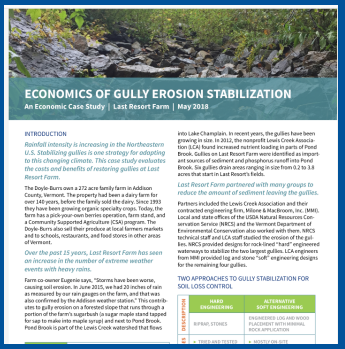
USDA Climate Hubs

Factsheets and summaries of scientific studies

Workshops and proceedings

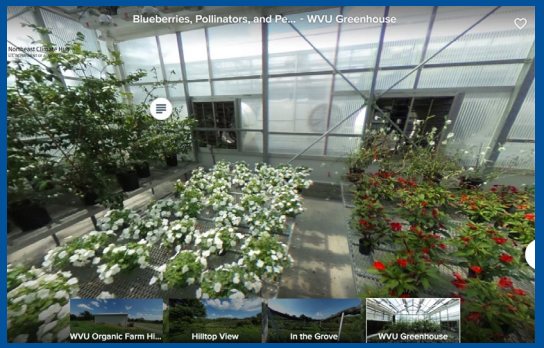
Economic case studies



Quarterly e-newsletters

Archived webinars

360 virtual tours demonstrating climate adaptation practices



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Climate Smart Farming

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Create Climate Smart Farms With Planning and Improving Natural Resources

- Address Landscape Vulnerability
  - Marginal land may only become more difficult to farm
- Improve Soil Health
  - Improve Soil Structure (Disturb Less)
  - Increase Organic Matter
  - Keep Soils Covered
  - Keep Plants Growing Throughout the Year
- Increase Health and Diversity of Biological Organisms (Above and Below Ground)

Practices That Are Going to Be Increasingly Problematic for Farmers

- Leaving Soil Bare
- Fall Tilling
- Moldboard Plowing
- Continuous Tilling
- Continuous Grazing
- Monocultures and crop field devoid of natural areas
- Farming Slopes/Floodplains/Wetlands/ Marginal Soils
- Climate Adaptations Involving Expensive Capital

Address Landscape Vulnerability

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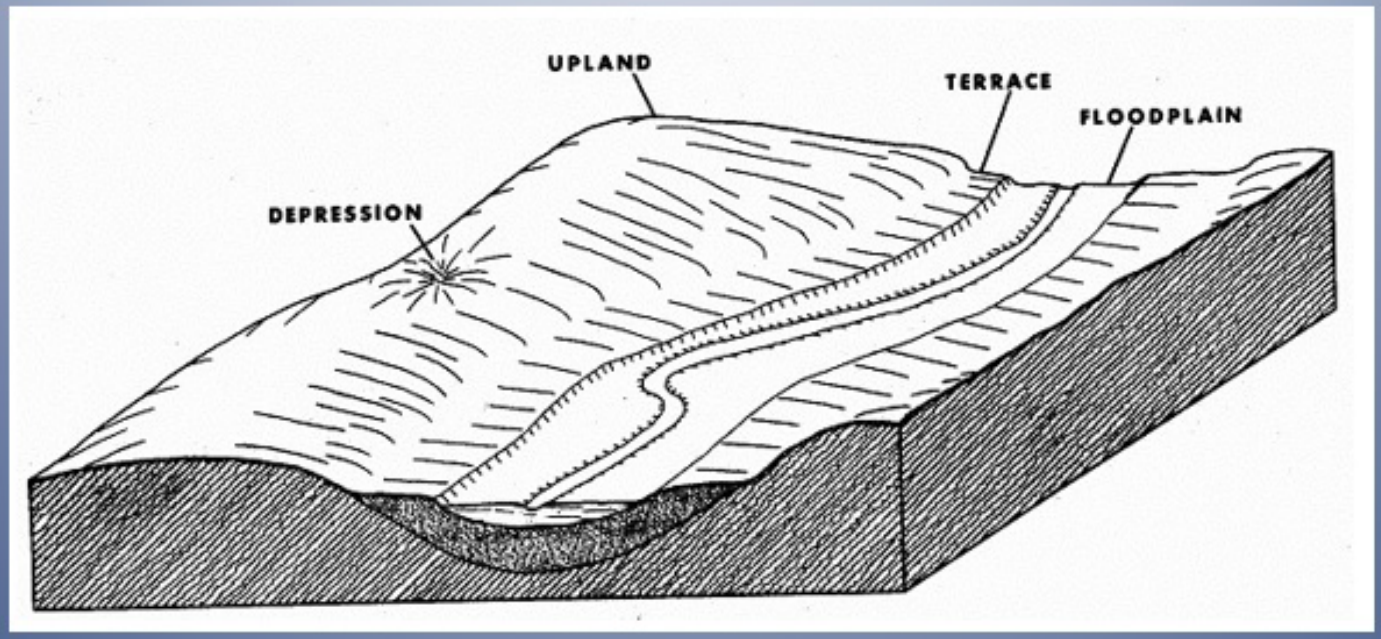
What are the inherent properties of the land?



- landscape positon and proximity to water
- inherent soil properties
- plant community composition and structure

Problem: Increased rainfall will make vulnerable parts of the farm more prone to flooding or erosion.

Solution: Take marginal land out of annual production; establish perennial systems

Marginal Land May Include:

- Steep slopes (HEL)
- Frequently flooded/ponded soils
- Shallow to bedrock soils
- Soils that easily compact

Perennial Systems May Include:

- Pasture or hay
- Perennial crops such fruit or flowers
- Pollinator or wildlife habitat
- Conservation buffers

Examples of Perennial Systems

Solution: Install Grassed Waterways, Diversions, Contour Buffer Strips, and Water and Sediment Control Basins (WASCOBs)

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Improve Soil Health

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Improve Soil Health

- Increase Organic Matter
- Improve Soil Structure (Disturb Less)
- Keep Soils Covered
- Keep Plants Growing Throughout the Year

What are some ways that improving soil health can help the climate smart farm?

- Decrease compaction so that there is an increase in infiltration (beneficial in times of excess rain).
- Increase soil organic matter to hold on to water and nutrients (for times of drought).
- Increase soil structure and cover to decrease erosion (beneficial in times of warmer winters).
- Providing cover to buffer rises in temperature.

Problem: Increased Soil Temperatures

Soil Temperature Can:

- Discourage or kill beneficial soil organisms.
- Alter root growth and nutrient uptake which affects yield.
- Influence soil evaporation rate – more water is lost the higher the temperature is.

Effects of Cover on Soil Temperature

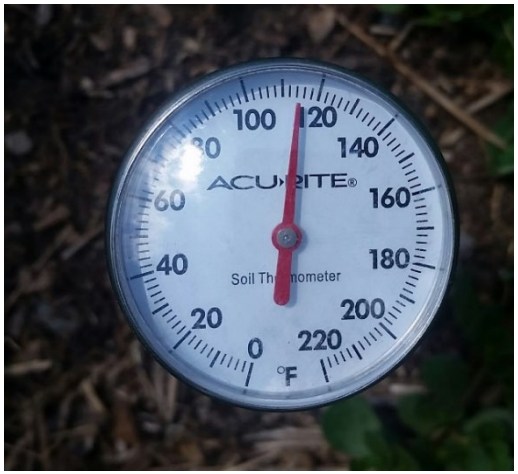
At 1” depth – same day Chatham, NY Farm – 45 degree difference

Ambient Temperature: 93° F

Tall Pasture (8-10”): 83° F

Mulched Veggie Beds: 90° F

Overgrazed Pasture (<1”): 108° F



Bare Soil: 115° F

Black Plastic: 128° F

Temperature Effect on Soil Biological Communities

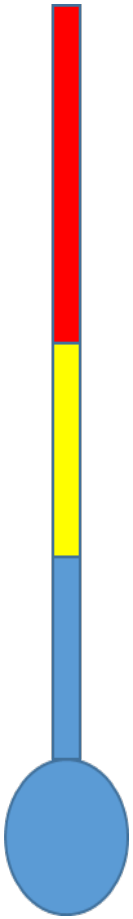
Micro-organisms:

- Ideal temperature range 50-96 F (Davidson and Janssens 2006)
- Soil organisms begin to die above 130 F.

Macro-organisms:

- Ideal temperature range 50-75.2 F (Bristow 1998)

Growth and Soil Temperature



~ 90° F and above: Plant and root growth stops; conditions become unfavorable to soil organisms.

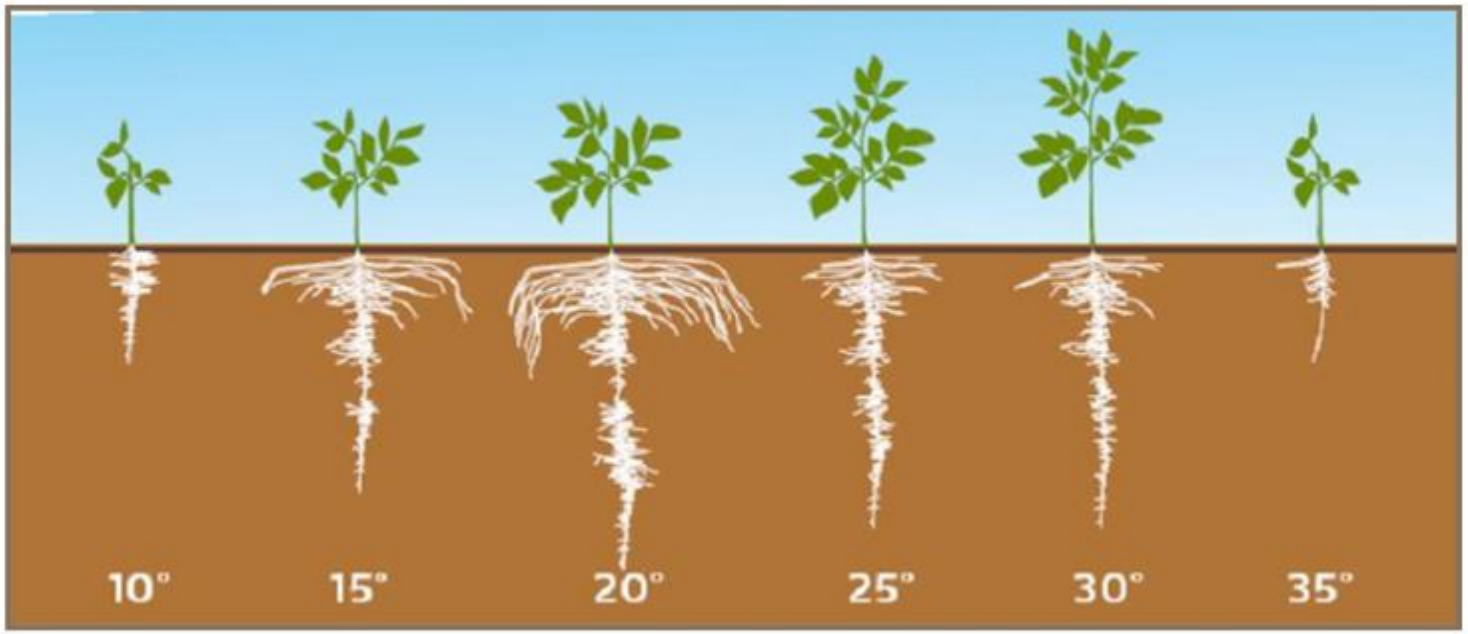
~ 80 ° F: Many plants reach peak growth of roots and plants and peak nutrient uptake.

65° – 86 ° F: Ideal range for nitrification, plant growth and planting

James A. Tindall, H.A. Mills & D.E. Radcliffe (1990) The effect of root zone temperature on nutrient uptake of tomato, Journal of Plant Nutrition, 13:8, 939-956

Soil Temperature Affects Root Growth

In most plants, as soil temperature increases above 86 degrees, root growth starts to shrink and nutrient uptake diminishes.



50° F 59° F 68° F 77° F 86 ° F 95 ° F

B. SATTELMACHER, H. MARSCHNER, R. KÜHNE, Effects of the Temperature of the Rooting Zone on the Growth and Development of Roots of Potato (*Solanum tuberosum*), *Annals of Botany*, Volume 65, Issue 1, January 1990, Pages 27–36,

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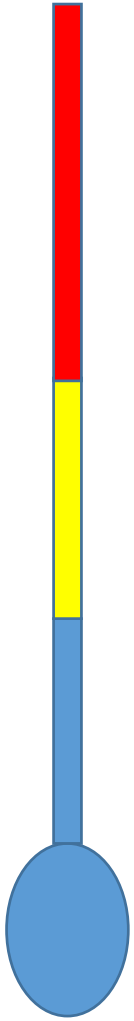
Soil Temperature and Moisture



Moisture loss rates from the soil increase on average about 1% per degree in the Northeast. Other factors affecting evaporation include solar radiation, wind and humidity.

98° F soil temperature = 30% higher evaporation rate than at 68°.

88° F soil temperature = 20% higher evaporation rate than at 68°.

68° F soil temperature: most of water in soil is available for plant growth

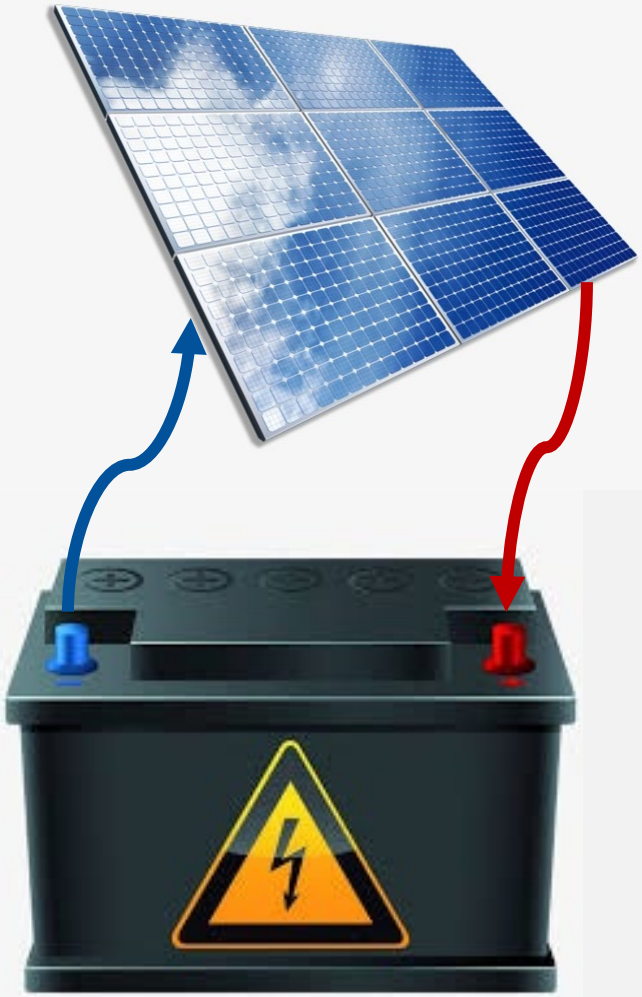
Solution: Cover Soil With Mulch or Plants

Photo: Lovin' Mama Farm

Solution: Covered Soil – Cover Crops

- Buffers soil temperature and moisture: cooler and dryer in the spring, cooler and wetter in the summer than bare soil.
- Improves energy flow by capturing sun rays.
- Provides living roots (food source) over a larger part of the growing season.

Improve Energy Flow and Soil Carbon Over a Longer Period



Plants

Solar Collectors

Soil

Battery

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Winter Annual Cover Crop

Opportunity!
Longer Growing Season

More opportunities for fall cover crops.

Fall Cover of Winter Rye By Planting and Seeding Rate (Big Flats, NY)

9/15, 25 lb/ac, 2.5 mo

10/1, 25 lb/ac, 2 mo

10/15, 25 lb/ac, 1.5 mo

9/15, 100 lb/ac, 2.5 mo

10/1, 100 lb/ac, 2 mo

10/15, 100 lb/ac, 1.5 mo

Increase Biological Communities Above and Below Ground

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Healthy Biological Communities Help Plants Deal With Stress

Temperature
Some soil microbes are very tolerant to harsh environments. *Pseudomonas putida* can significantly enhance growth of wheat under heat stress

Drought
Some *Bacillus subtilis* strains produce cytokinin, a plant hormone that interferes with drought induced suppression of shoot growth thereby enhancing plant growth throughout periods of drought

Insects
Many *Pseudomonas* and *Bacillus* isolates have insecticidal activity and can prime plants against insect attack

Waterlogging
Under stressful conditions plants produce the chemical substance ACC, a precursor to the hormone ethylene which stunts plant growth. Bacterium *Serratia* produces an enzyme that breaks down ACC which results in better plant growth

Pests and pathogens
Various bacteria including *Pseudomonas fluorescens,* produce antibiotic compounds like pyrrolnitrin, which confers resistance to various fungal pathogens such as *Rhizoctonia solani* which causes damping-off disease in cotton

Soil toxicity
Some salt or heavy metal resistant microbes can enhance plant growth and survivability. Siderophore producing bacteria, such as *Microbacterium* and *Pseudomonas*, can bind heavy metals and reduce toxicity to plants

Nutrient limitation
Some microbes can access nutrients that are unavailable to plants including atmospheric nitrogen and organic phosphorus. The best understood example is the rhizobia-legume symbiosis

Image: Mrs. Shelby Berg, Ph.D. candidate, The University of Queensland
http://www.uq.edu.au/research/impact/stories/promoting-plant-probiotics/

Problem: Increased Pests; Decreased Survivability of Honey Bees

Solution: Add/Protect Food and Habitat for Pollinators and Beneficial Insects

- If more than 20% of a farm is diverse habitat, pest control by beneficial insects is observed throughout the fields.

Bianchi et al (2006). Sustainable pest regulation in agricultural landscapes: A review on landscape composition, biodiversity and natural pest control. Proceedings. Biological sciences / The Royal Society. 273. 1715-27.

Tscharntke et al (2002). Contribution of small habitats to conservation of insect communities of grassland-cropland landscapes. Ecological Applications. 12. 354-363.

NRCS Planning and Resources for Farmers

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Planning

- Conservation Technical Assistance (CTA) and the 9 Step Planning Process

- GIS Layers: Lidar, HEL, Frequently Flooded Soils

- Water Erosion Prediction Project (WEPP)

Funding

- CTA – Conservation Technical Assistance
- EQIP – Environmental Quality Incentives Program
- CSP – Conservation Stewardship Program
- ACEP – Wetland Restoration
- CRP – Conservation Reserve Program
- CIG – Conservation Innovation Grant

WEPP – Water Erosion Prediction Project

- Proposed replacement for RUSLE 2
- Dynamic model that more accurately predicts soil loss
- Uses a variety of data including current rainfall predictions local to within 4 km
- Currently optional but will be replacing RUSLE2.

Resource Concerns

Soil

- Soil Organism Habitat Loss/Degradation New
- Aggregate Instability New
- Compaction
- Organic Matter Depletion

Weather Resilience New

- Ponding and Flooding New
- Naturally Available Moisture Use New

Resource Concerns Cont.

- Sheet and rill erosion
- Wind erosion
- Ephemeral gully erosion
- Classic gully erosion
- Bank erosion from streams
- Concentration of salts or other chemicals
- Sediment/nutrients transported to ground/surface water
- Plant productivity and health
- Energy efficiency of farming/ranching practices and field operations

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Common Climate Smart Practices

- Conservation Cover (327)
- Conservation Crop Rotation (328)
- Contour Buffer Strips (332)
- Controlled Traffic (334)
- Cover Crop (340)
- Critical Area Planting (342)
- Diversion (362)
- Fence (382)
- Forage and Biomass Planting (512)
- Grassed Waterways (412)
- Grazing Management Plan (110)
- Hedgerow Planting (422)
- High Tunnel System (325)
- Integrated Pest Management Plan (114)

Climate Smart Practices Cont.

- Irrigation System (441)
- Irrigation Water Management (449)
- Irrigation Water Management Plan (118)
- Mulching (484)
- Nutrient Management (590)
- Nutrient Management Plan (104)
- Pest Management Conservation System (595)
- Pollinator Habitat Plan (146)
- Prescribed Grazing (528)
- Residue and Tillage Management (329)
- Riparian Forest Buffer (391)
- Riparian Herbaceous Cover (390)

Climate Smart Practices Cont.

- Soil Carbon Amendment (808) New
- Soil Health Conservation Activity Plan (116) New
- Soil Testing (216) New
- Stream Habitat Improvement and Management (395)
- Stripcropping (585)
- Tree/Shrub Establishment (612)
- Vegetated Treatment Area (635)
- Water and Sediment Control Basin (638)
- Wildlife Habitat Planting (420)
- Windbreak/ Shelterbelt Establishment (380)

In Conclusion

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In Summary:

- **The Northeast is experiencing increased temperatures (especially in winter), more extreme temperatures, increased rainfall (especially inland and in mountainous areas), and increased frequency of intense rainfall (over 2" in a 24 hour period). These trends are predicted to continue.**

- **Improving natural resources on the farm can significantly help farmers be resilient to these changes. *Bonus! These improvements often reduce GHGs.***

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In Summary, cont.:

NRCS Planners and Ag Service Providers Can Help Farmers Adapt to Climate Change By:

- Addressing Landscape Vulnerability

- Improving Soil Health
  - Improve Soil Structure (Disturb Less)
  - Increase Organic Matter
  - Keep Soils Covered
  - Keep Plants Growing Throughout the Year

- Increasing Health and Diversity of Biological Organisms (Above and Below Ground)

Where to Get More!

In-state Webinars Scheduled for: VT (12/14), CT (12/17), Grassfed Green-up (1/13), MA (1/20), ME (1/27), and PA (1/28). NJ, RI, MD, DE, WV - TBD.

Course in Ag Learn: Coming soon! (Winter 2021)

USDA Northeast Climate Hub Website

USDA Northeast Climate Hub Open Team

Great for announcements and resources for USDA employees.

NRCS Vision: *A world of clean and abundant water, healthy soils, resilient landscapes, and thriving agricultural communities through voluntary conservation.*

Thank you for what you do!

And the people who serve them!

Questions?

Elizabeth Marks

USDA Natural Resources Conservation Service

Northeast Climate Hub Liaison

Ghent, New York

(518) 267-3310

elizabeth.marks@usda.gov

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