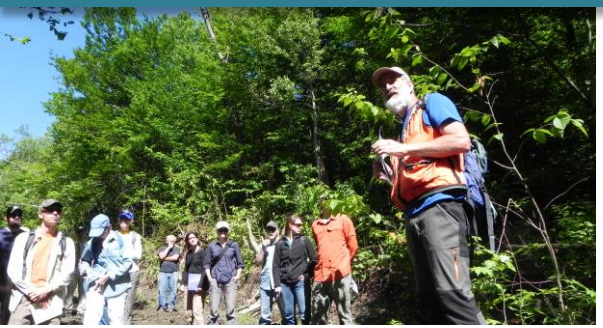
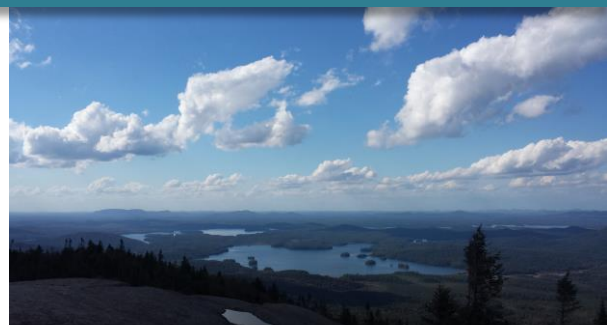
Adapting to climate change:

practical ideas for you and your business





Maria Janowiak maria.janowiak@usda.gov
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www.niacs.org / www.forestadaptation.org

Training Objectives

- Describe how changes in the climate affect weather patterns and impact forests
- Share examples of how (and why) foresters are changing management prescriptions to help forests cope with changing conditions, and what that could mean for logging contracts and activities
- Discuss how increased weather and climate variability create challenges and opportunities for logging activities and businesses operations

Climate Change Science

Climate Change Science

Poll: What do you think?

*Is it **climate change** or **global warming**?*

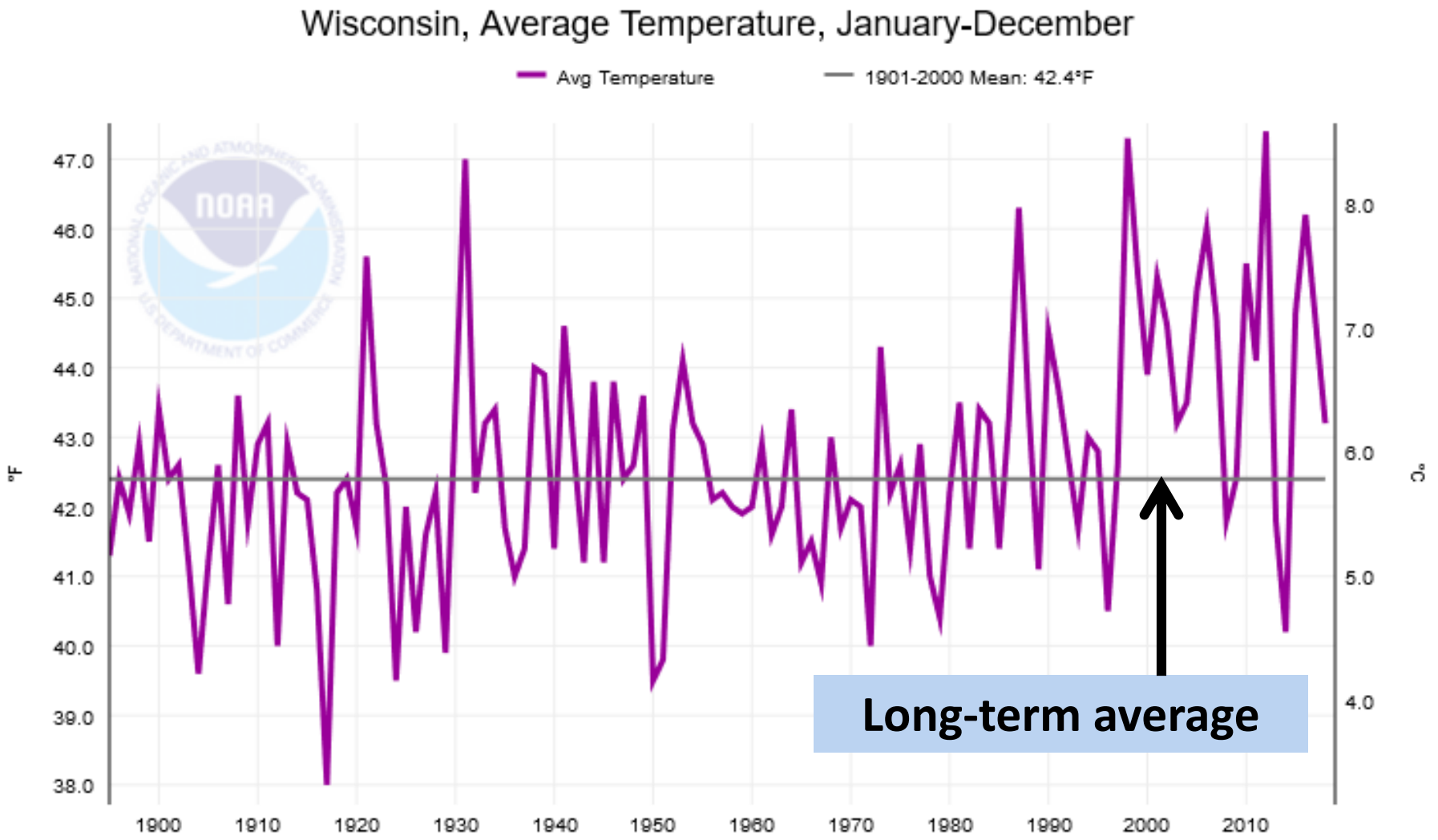
Weather vs. Climate

Weather vs. Climate

Climate – What you expect.

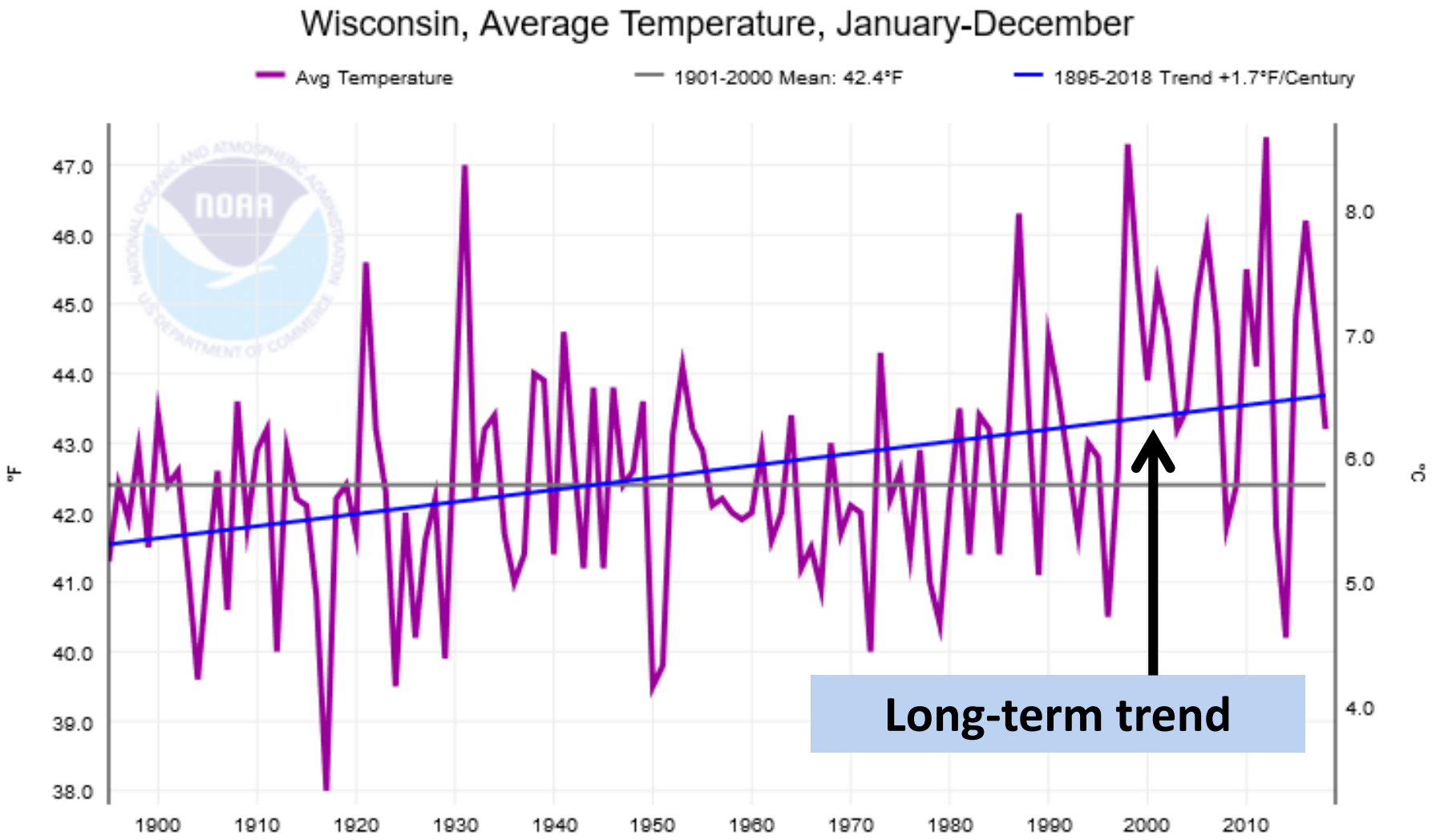
Weather – What you get!

A Warmer Climate… in Wisconsin



NOAA Climate-at-a-Glance

A Warmer Climate… in Wisconsin



NOAA Climate-at-a-Glance

Not Just Warming

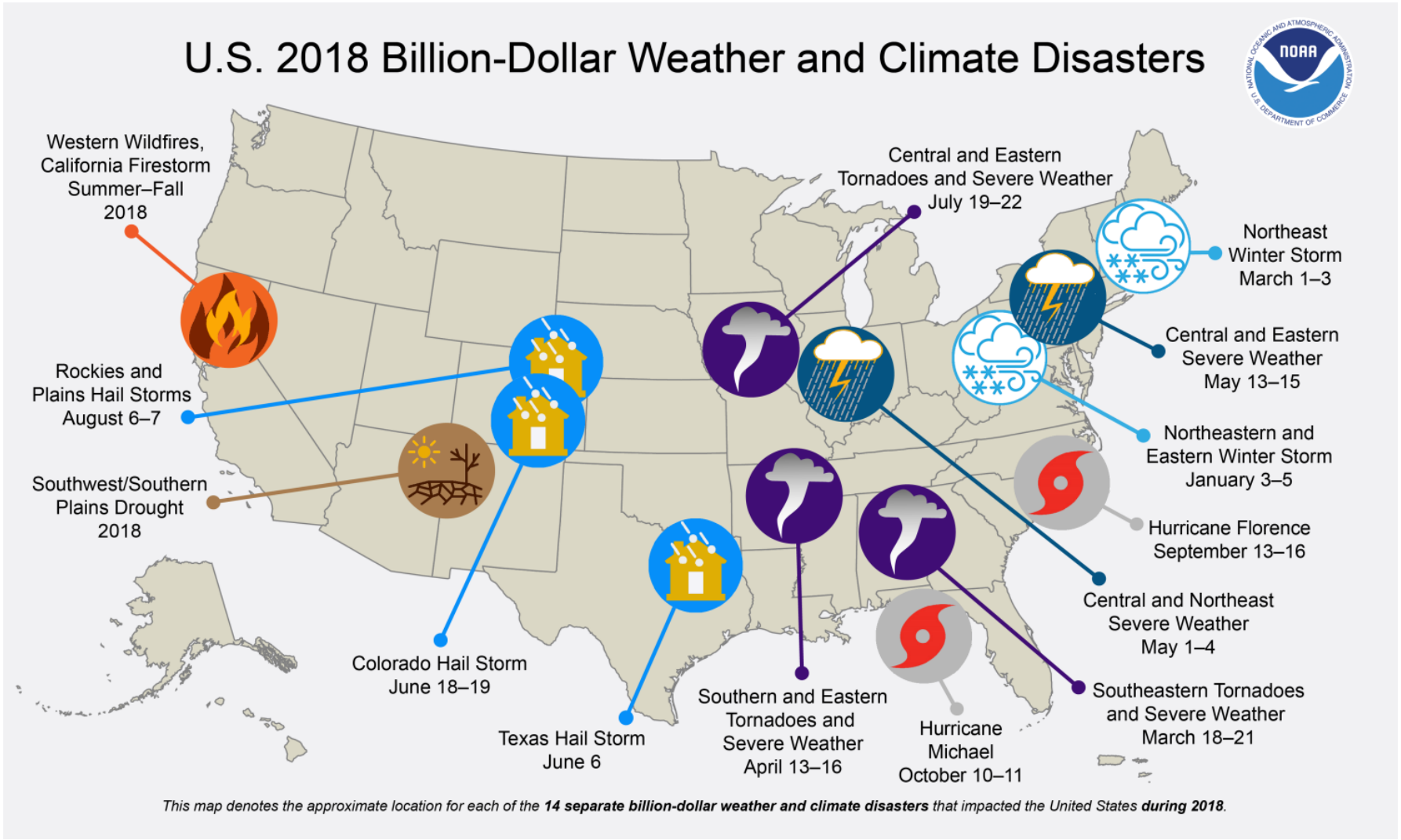
- More days with extreme heat
- Precipitation increased >3 inches
- Extreme rain events
- Extreme storms

Ashland Daily Press

ReadyWisconsin.wi.gov

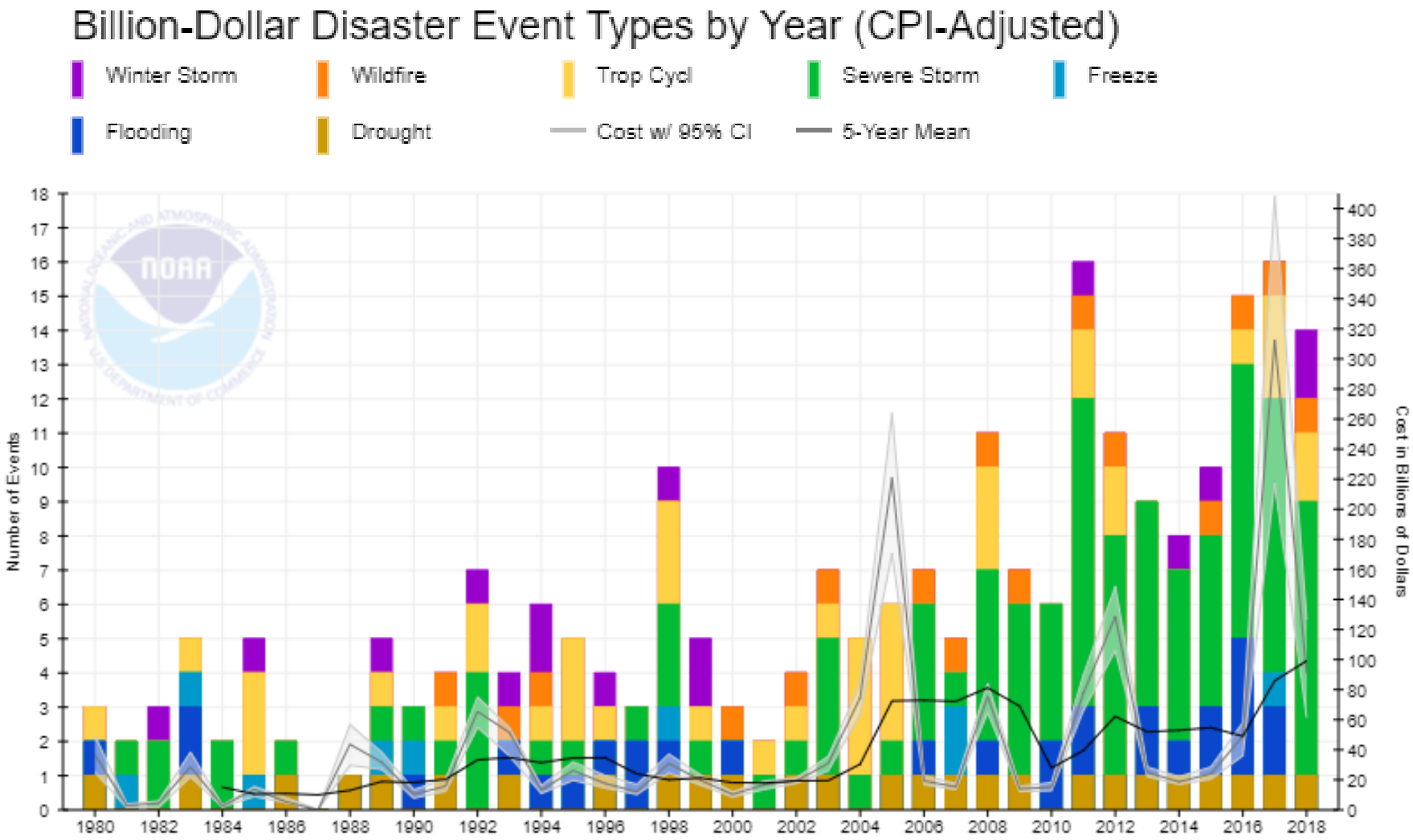
Fox 6

Not Just Warming



NOAA

Not Just Warming



NOAA

Is it climate change or global warming?

Both. The earth has warmed and the climate is changing as a result.

Isn't there still a scientific debate about climate change and its causes?

Scientific Consensus

Intergovernmental Panel on Climate Change (2007, 2010, 2013, 2018)

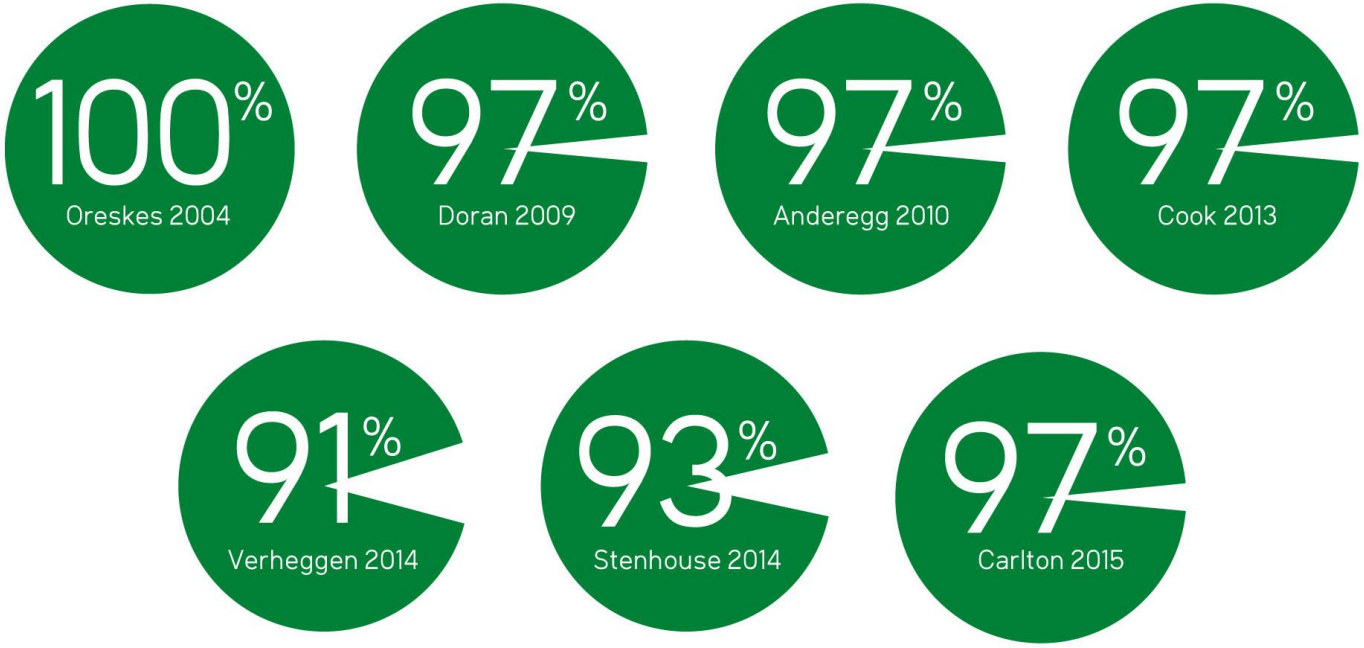
- Evidence for climate change is “unequivocal”
- It is “extremely likely” that humans are main cause since 1950

US National Climate Assessment (2017, 2018)

- “…human activities…are the dominant cause of the observed warming since the mid-20th century.”
- “…there is no convincing alternative explanation supported by the extent of the observational evidence.”

Scientific Confidence

~97% of scientists are confident that the climate is changing….



…compared to ~70% of the US general population.

"Consensus on Consensus" by Cook et al. (2016);
Yale Program on Climate Change Communication

Debate?

See: Oreskes et al. 2004, Doran et al. 2009, Anderegg et al. 2010, Cook et al. 2013, Verheggen et al. 2014, Stenhouse et al. 2014, Carlton 2015

http://sks.to/consensus

Isn't there still a scientific debate about climate change and its causes?

No scientific debate on "if".

Virtually all climate scientists agree humans are the primary driver in the last 50+ years.

Current scientific debate revolves around how much and how fast the climate will change.

What causes climate change?

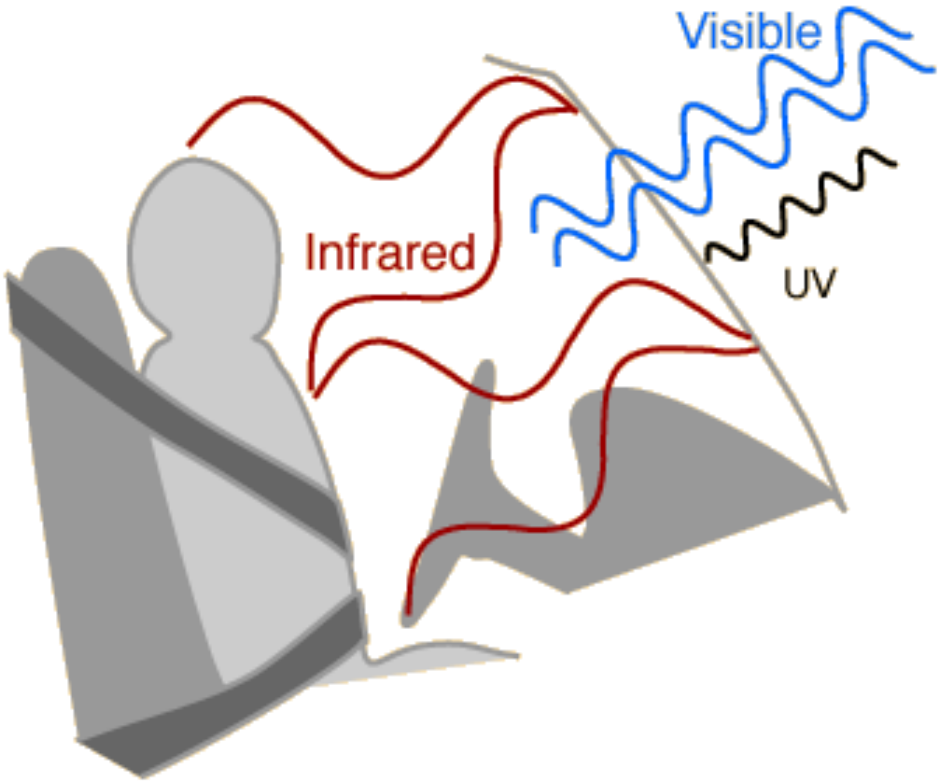
Why is it a million degrees inside my truck?

Outside temp: 83º
Time in sun: 15 minutes
Inside truck: 100-110º

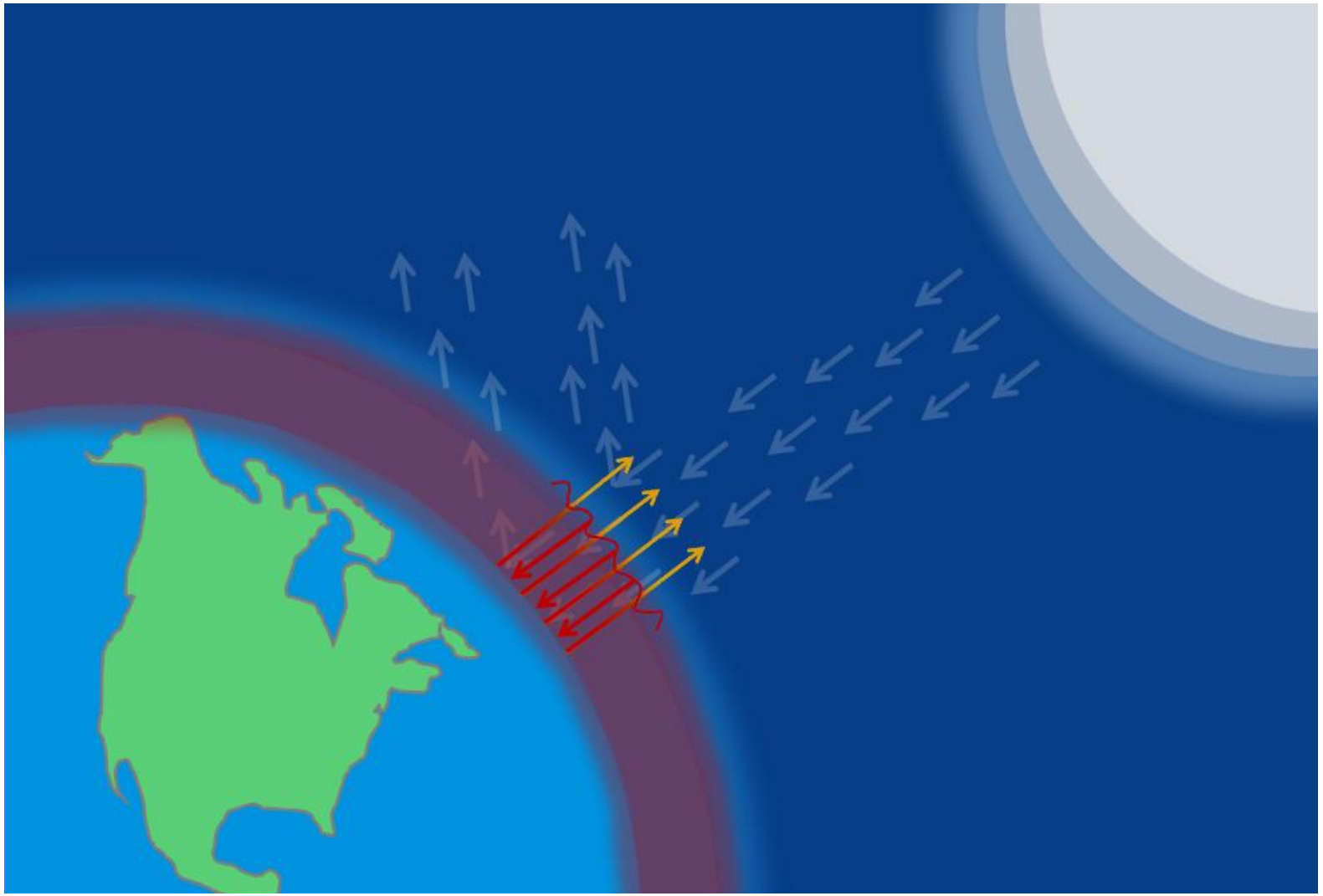
Why is it a million degrees inside my truck?

Greenhouse Effect

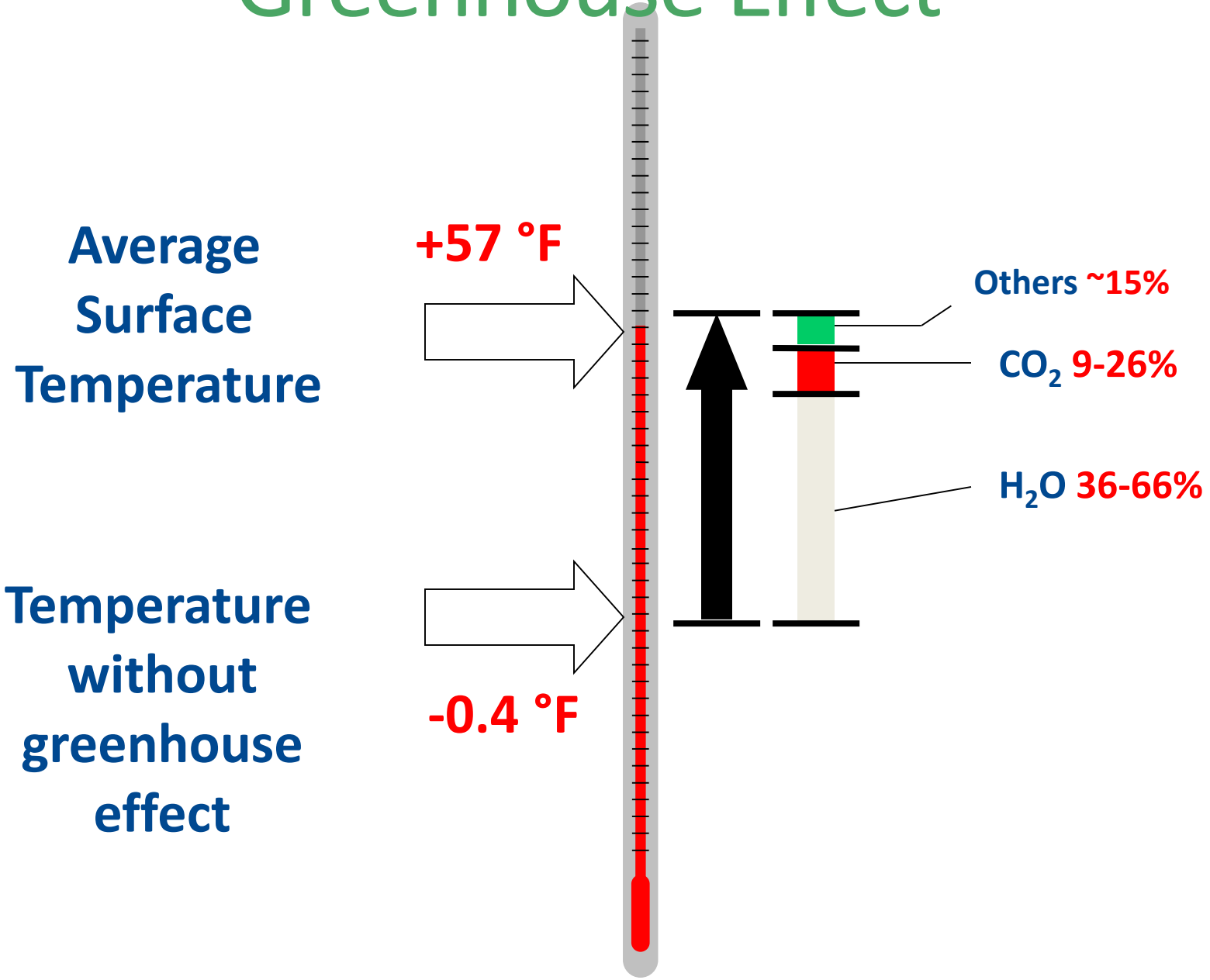
Visible light can penetrate the glass, but infrared light is trapped and causes heating.



Greenhouse Effect

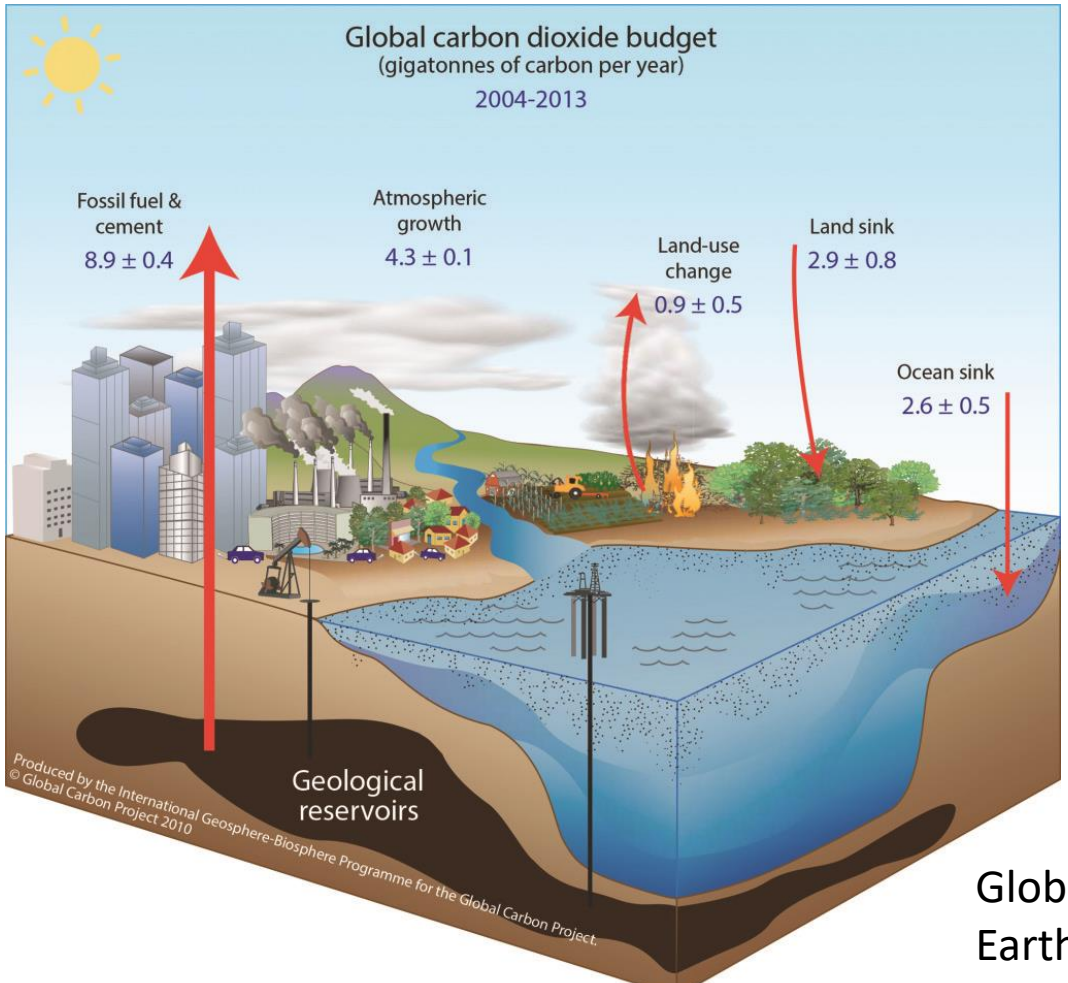


Greenhouse Effect



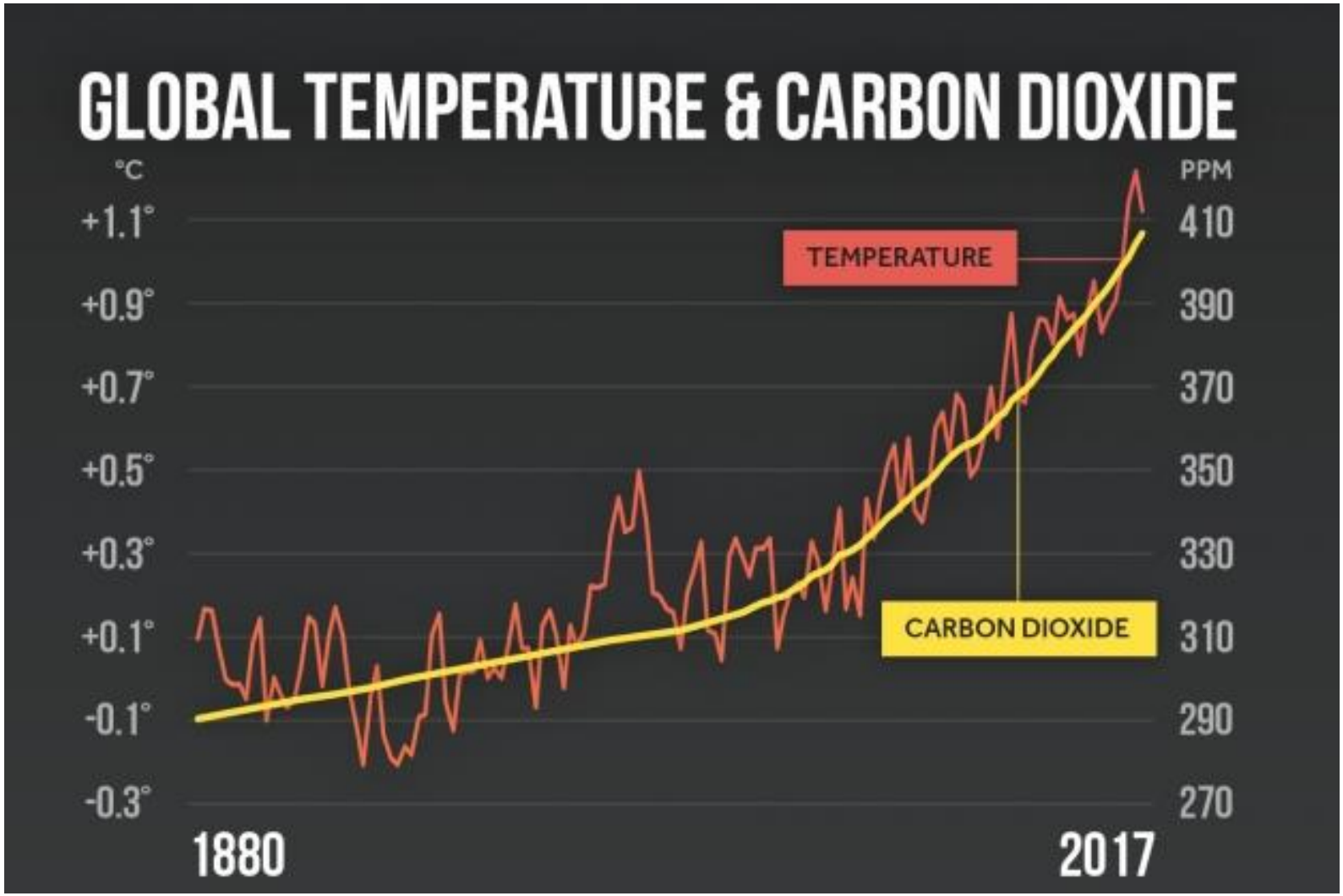
Enhanced Greenhouse Effect

Humans activities are adding greenhouse gases into the atmosphere, causing warming.



Global Carbon Project;
EarthLabs, serc.carleton.edu

Enhanced Greenhouse Effect



www.ClimateCentral.org

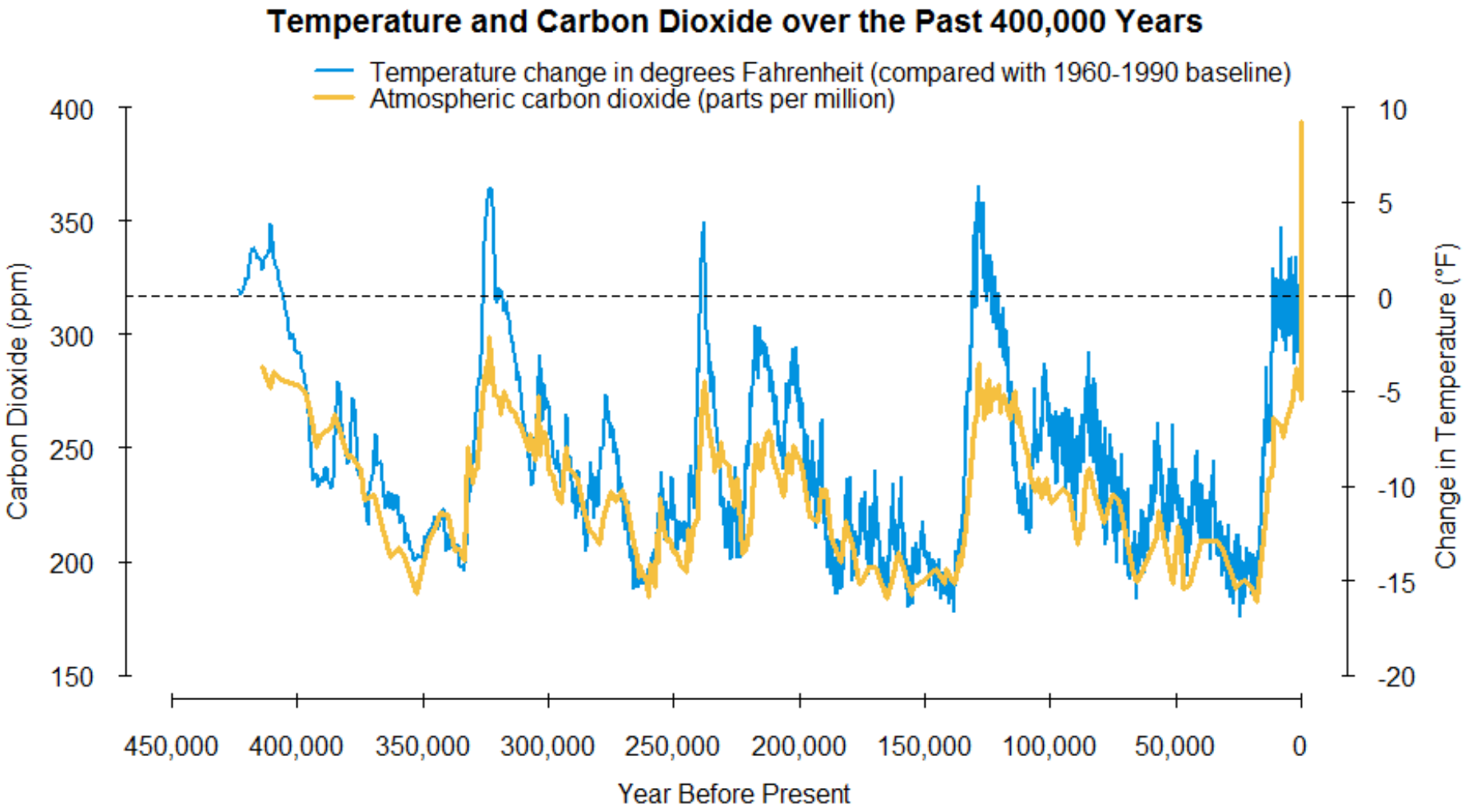
What causes climate change?

The greenhouse effect naturally heats the earth.

Humans activities are adding greenhouse gases into the atmosphere, making it warmer.

Hasn't climate always changed?
Why worry now?

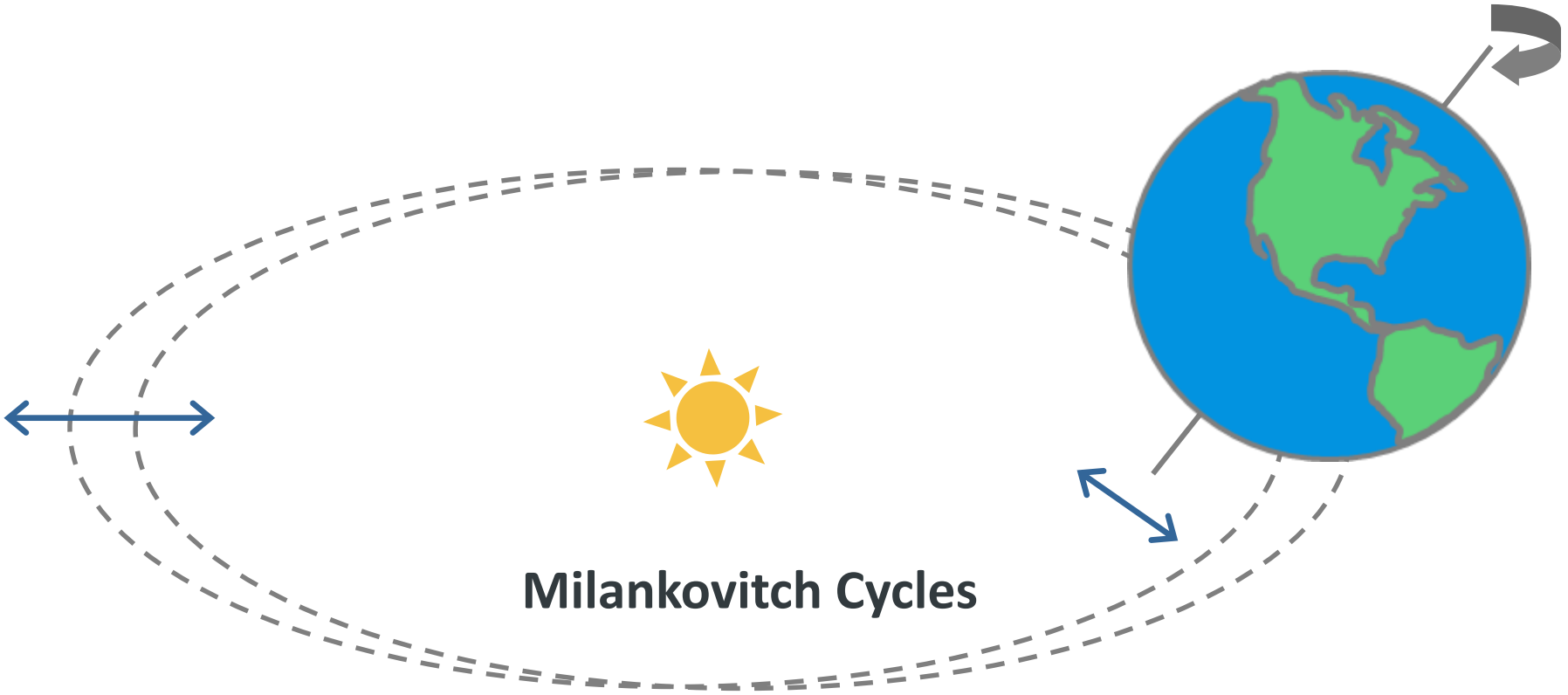
Changes in Climate



Courtesy of K. Marcinkowski, NIACS;

see also: Hansen et al. 1990, Petit et al. 1999, Shackleton 2000, Ruddiman 2006, Shakun et al. 2012

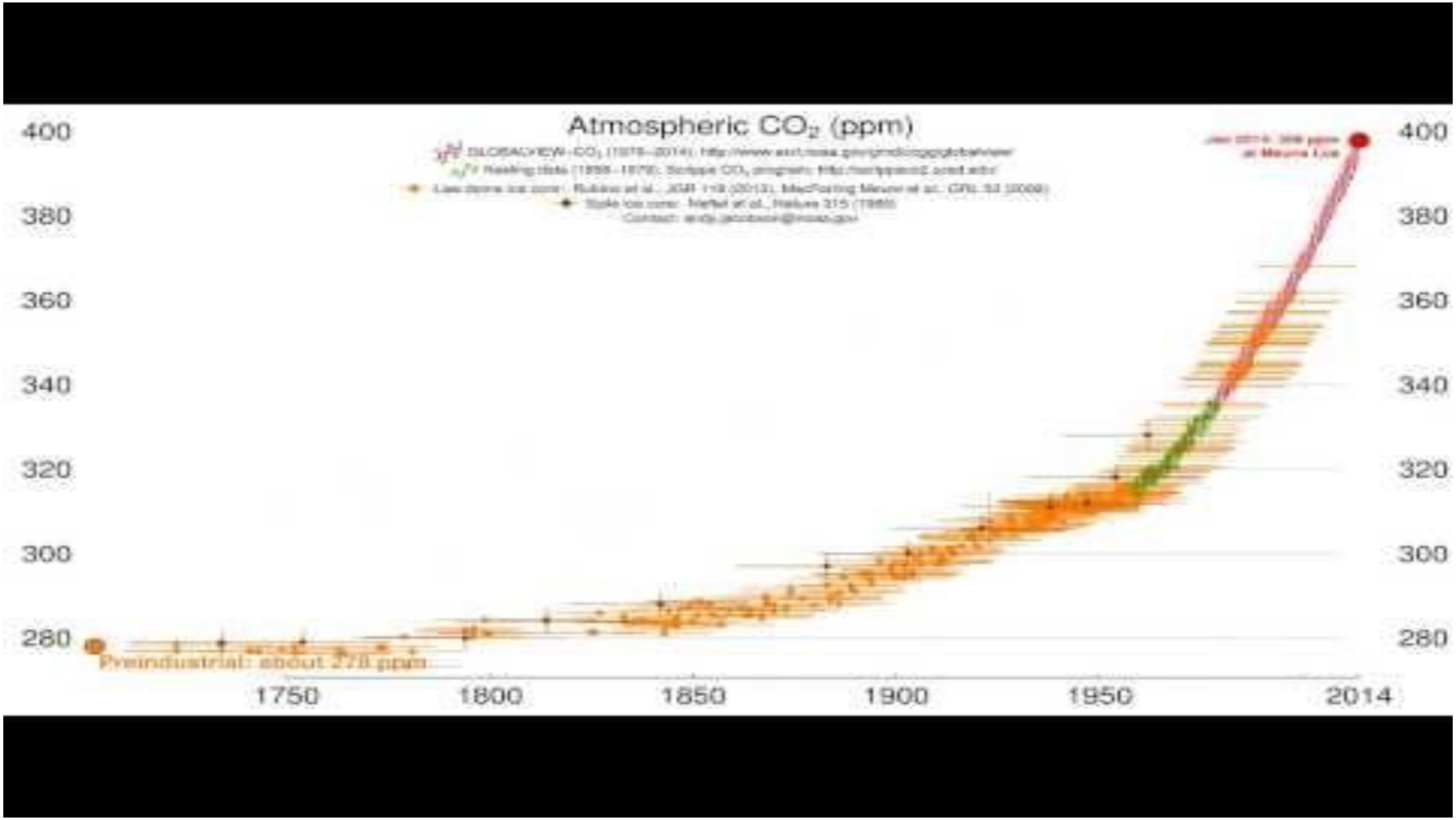
Changes in Climate



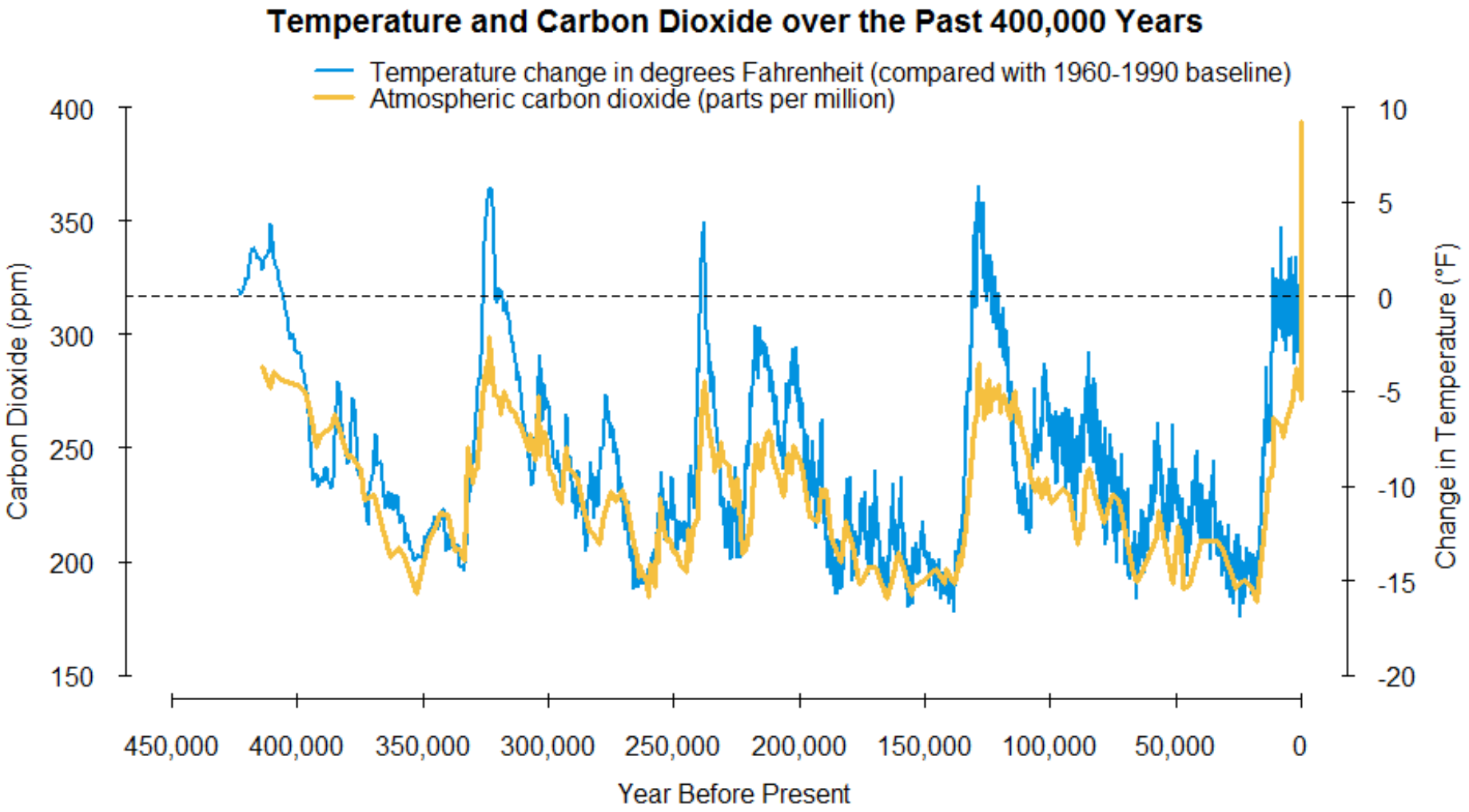
Eccentricity – more or less oval orbit, every ~100,000 years
Tilt – earth shifts its tilt every ~41,000 years
Precession – earth wobbles on its axis, every ~23,000 years

graph data from the NOAA NCDC and Mauna Loa Observatory

Changes in Carbon Dioxide (CO^2)



Changes in Climate



Courtesy of K. Marcinkowski, NIACS;

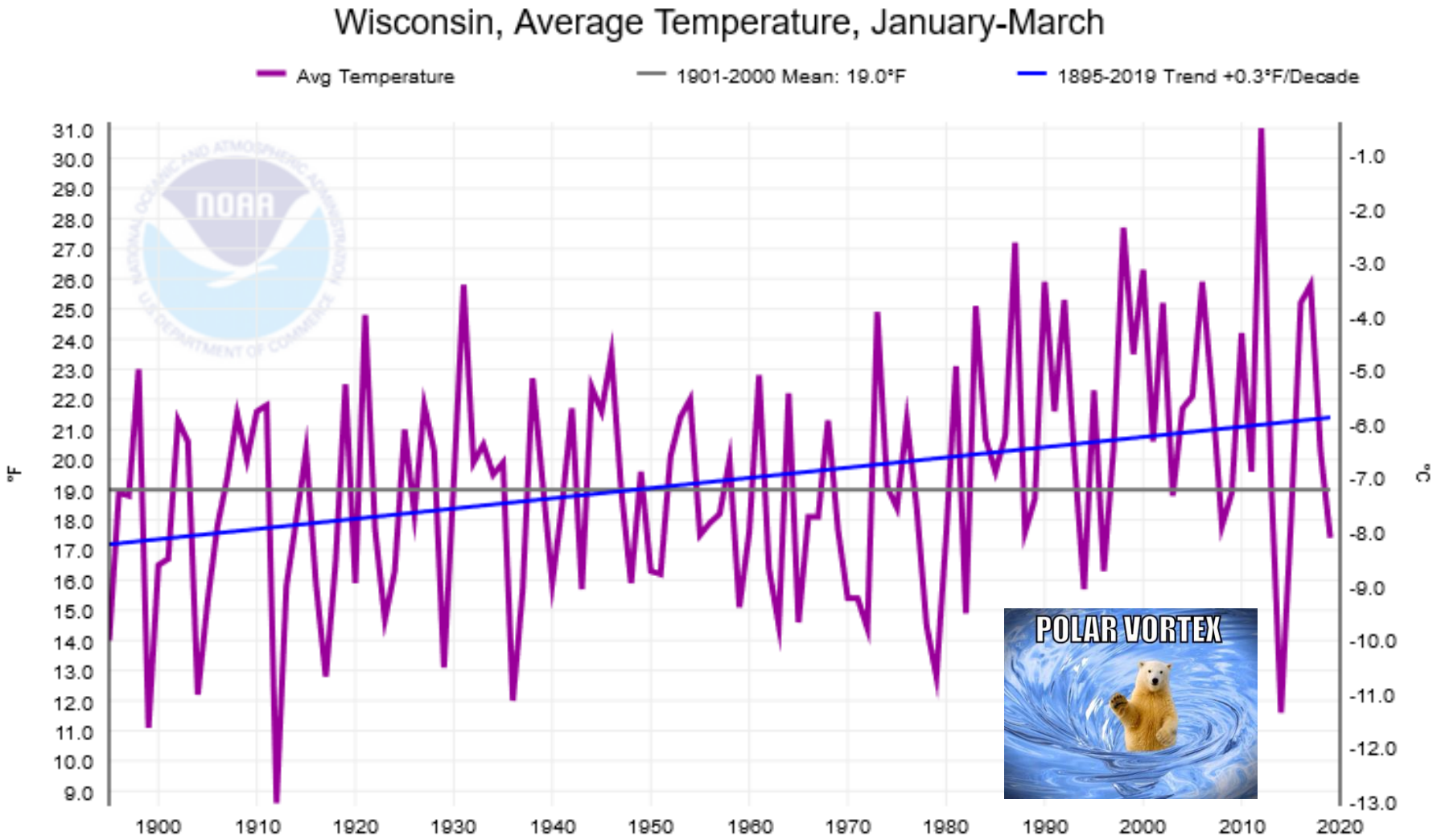
see also: Hansen et al. 1990, Petit et al. 1999, Shackleton 2000, Ruddiman 2006, Shakun et al. 2012

Hasn't climate always changed? Why worry now?

The rapidity and potential severity of climate change will affect forestry, agriculture, infrastructure, demographics, economies, …virtually everything.

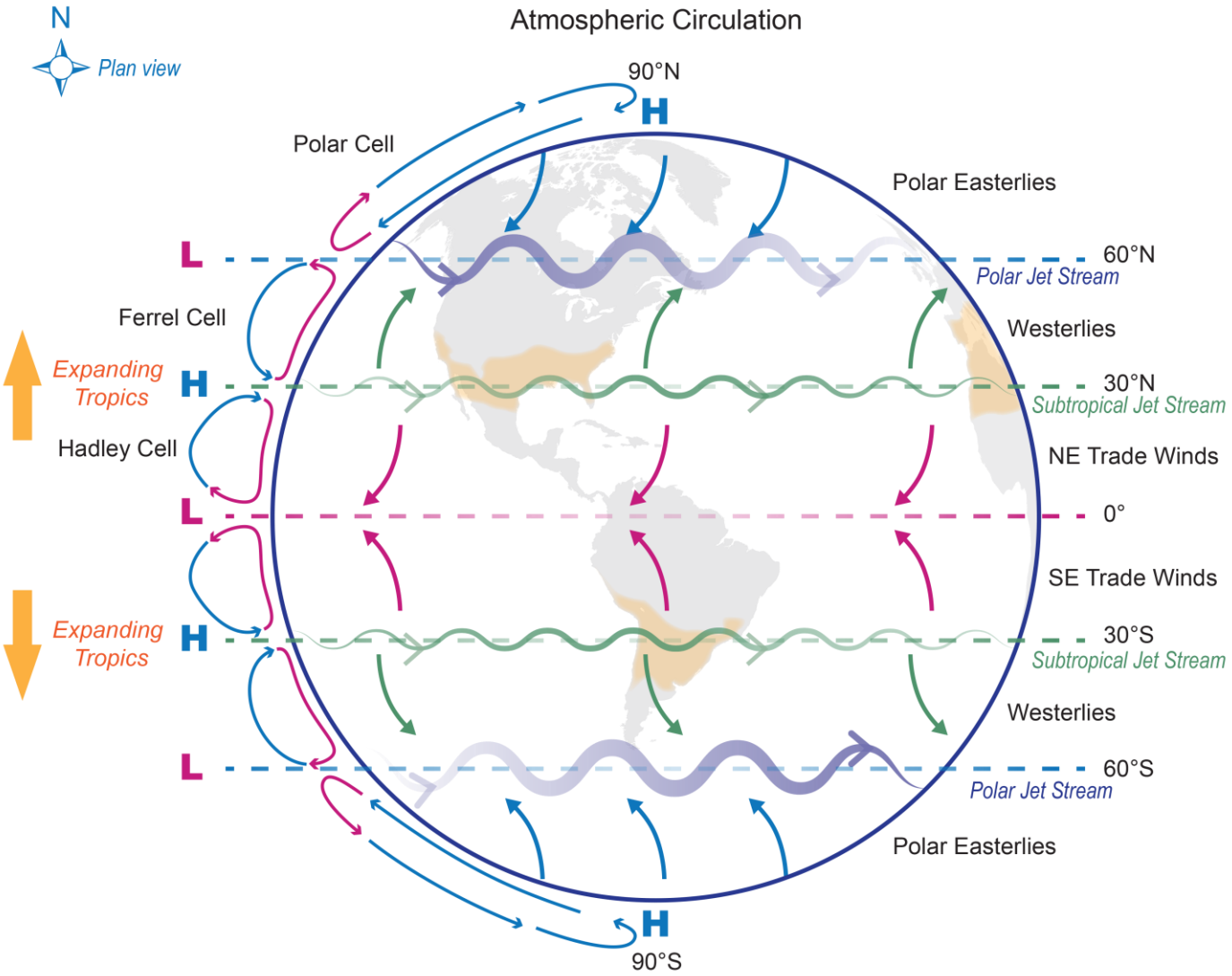
If it's getting warmer, what's with the extreme cold in winter?

Like 2014

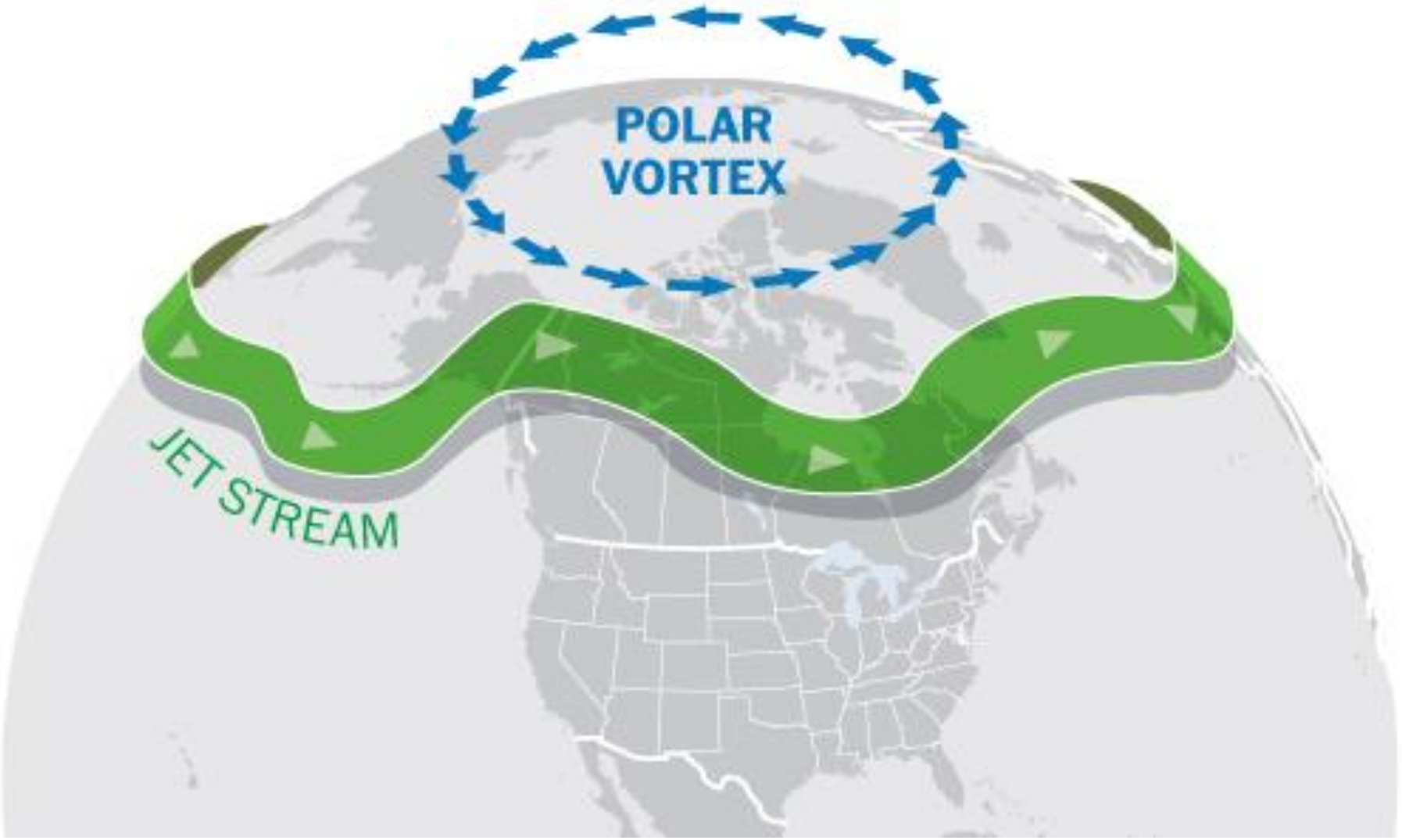


NOAA Climate-at-a-Glance

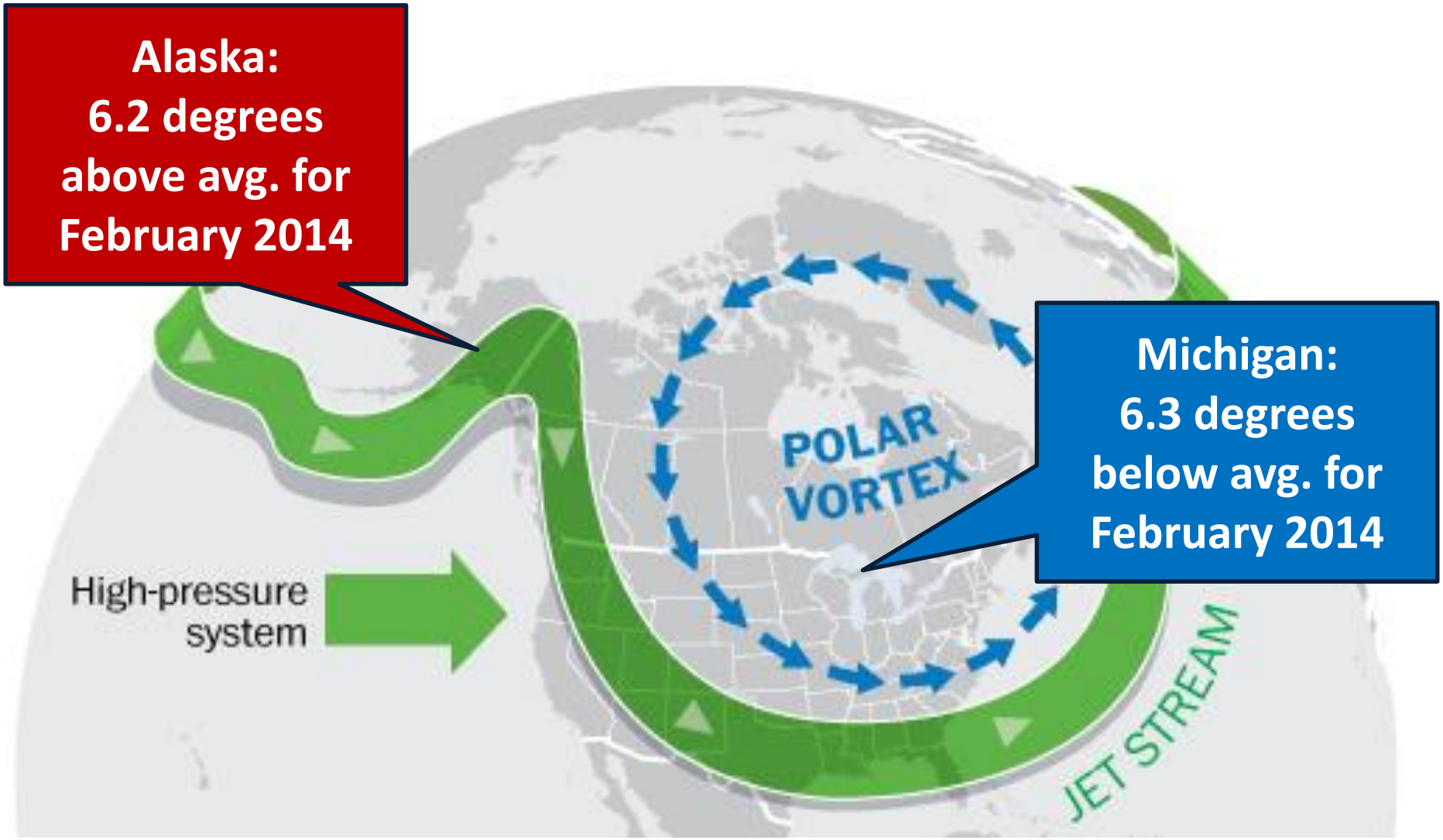
Atmospheric Circulation



How it usually works



Weak and wobbly jetstream



If it's getting warmer, what's with the extreme cold in winter?

Even with **climate** warming, the **weather** at any point in time will continue to vary.

Changes in the **climate** system can alter the likelihood that some **weather** events will occur.

How can we know what the future climate will be like?

How can we predict the future?

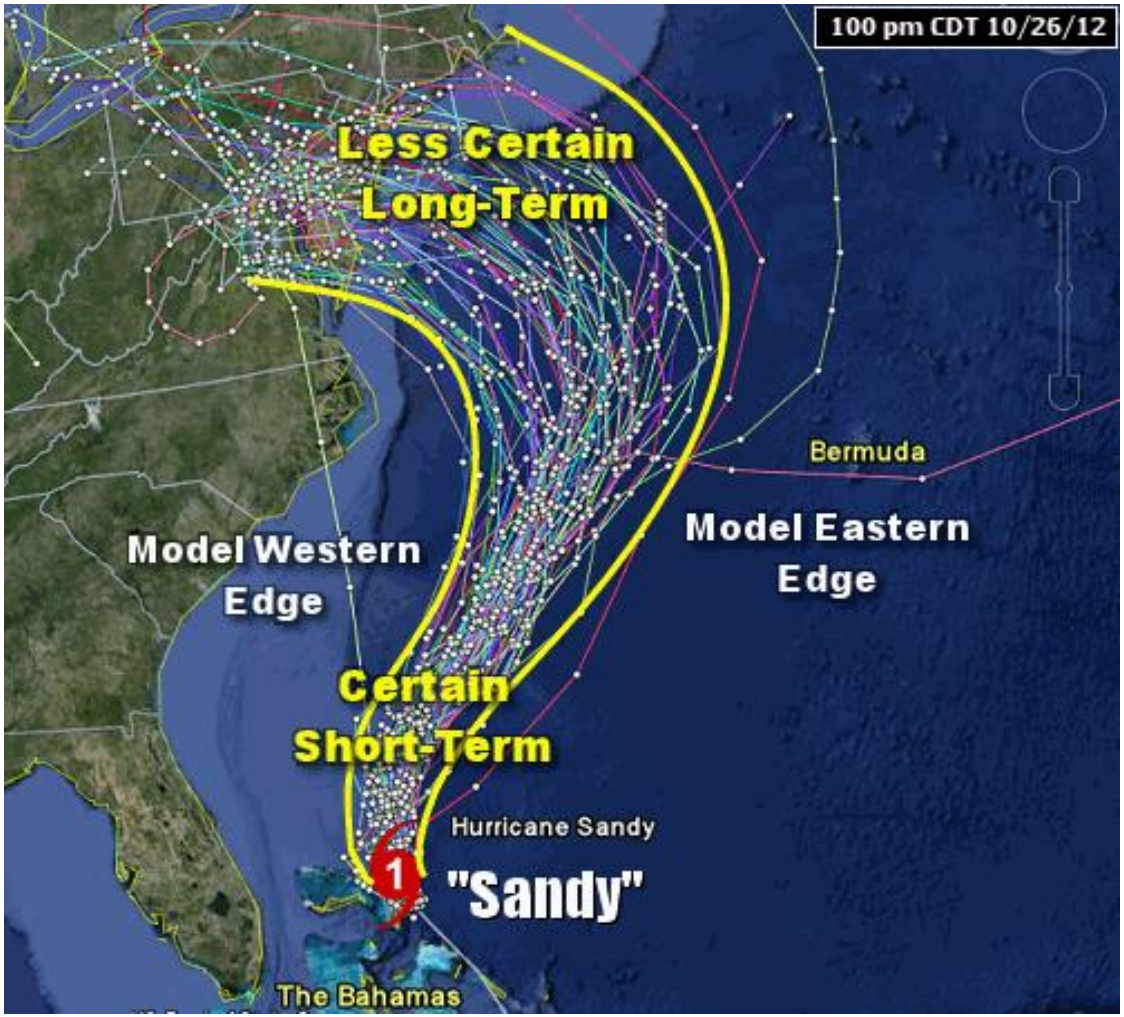
Forecasts

Wittenberg, WI 10 Day Weather

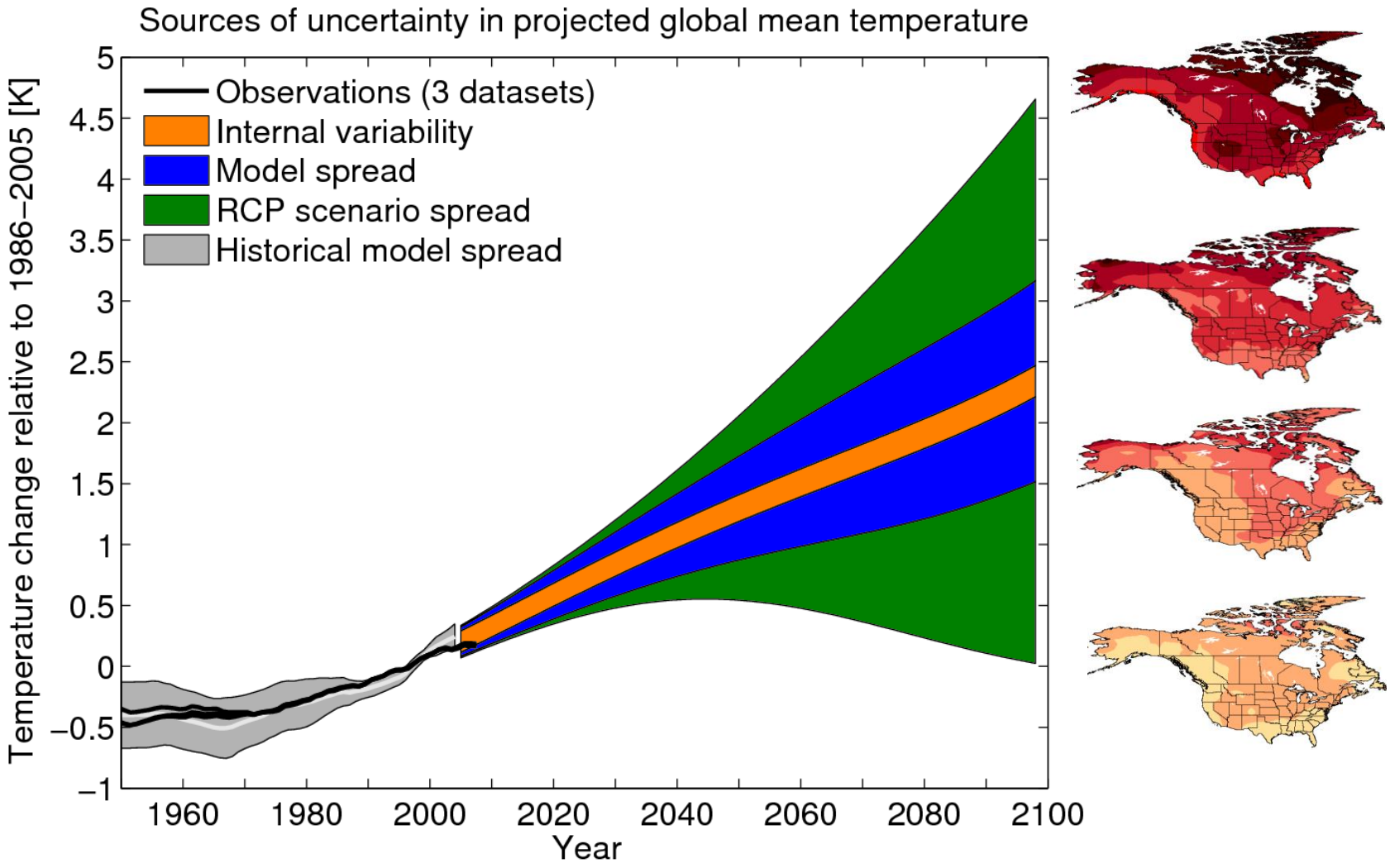
6:25 am CDT Print

DAY	DESCRIPTION	HIGH / LOW	PRECIP	WIND	HUMIDITY
TODAY AUG 8	Mostly Sunny	73°/51°	0%	NW 13 mph	57%
FRI AUG 9	Mostly Sunny	76°/52°	10%	NW 11 mph	56%
SAT AUG 10	Partly Cloudy	79°/60°	10%	WSW 7 mph	60%
SUN AUG 11	Partly Cloudy	80°/56°	20%	W 7 mph	68%
MON AUG 12	PM Showers	74°/56°	40%	ESE 8 mph	73%
TUE AUG 13	Mostly Cloudy	73°/53°	20%	NE 7 mph	77%
WED AUG 14	Partly Cloudy	71°/51°	20%	N 6 mph	69%
THU AUG 15	Partly Cloudy	75°/55°	20%	S 7 mph	66%
FRI AUG 16	Scattered Thunderstorms	77°/58°	40%	SSW 7 mph	71%
SAT AUG 17	Partly Cloudy	79°/59°	20%	SSW 6 mph	70%
SUN AUG 18	Partly Cloudy	81°/61°	20%	SSW 10 mph	71%
MON AUG 19	Isolated Thunderstorms	79°/58°	30%	WSW 10 mph	70%
TUE AUG 20	Mostly Sunny	79°/59°	20%	SW 8 mph	69%
WED AUG 21	Partly Cloudy	80°/58°	20%	WSW 10 mph	68%
THU AUG 22	Partly Cloudy	79°/59°	20%	WSW 10 mph	64%

Uncertainty of Future Change



Uncertainty of Future Change



How can we know what the future climate will be like?

- Warming is certain. Change is certain.
- Models are good at predicting general trends over decades, but the specifics are murky.
- Consider a range of potential future conditions.

Climate Change Impacts on Forests and Forest Management

How will climate change affect forests?

Effects on Forests

SHIFTING SEASONS

SHIFTING SPECIES

SHIFTING STRESSORS

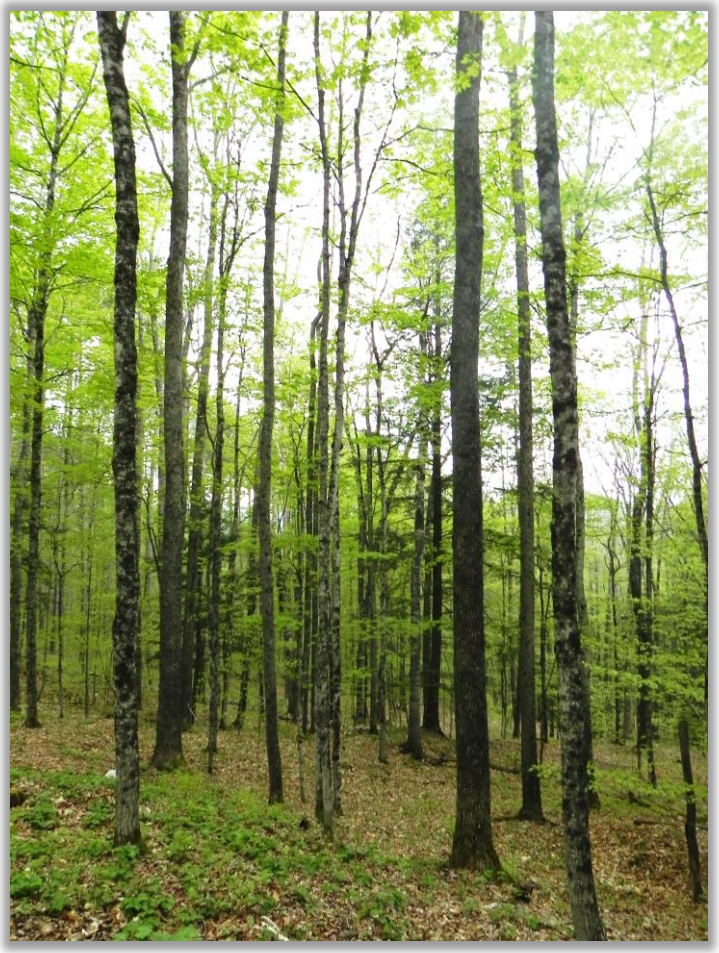
Longer Growing Season

Longer Growing Season

Warmer temps result in longer growing seasons

- Evidence of phenological shifts
- Projected to increase 3-7+ more weeks

Longer period for plant growth



Melillo et al. 2014, Nelson Center 2014

Shorter, Warmer Winters

Decreases in snow fall, cover, and depth

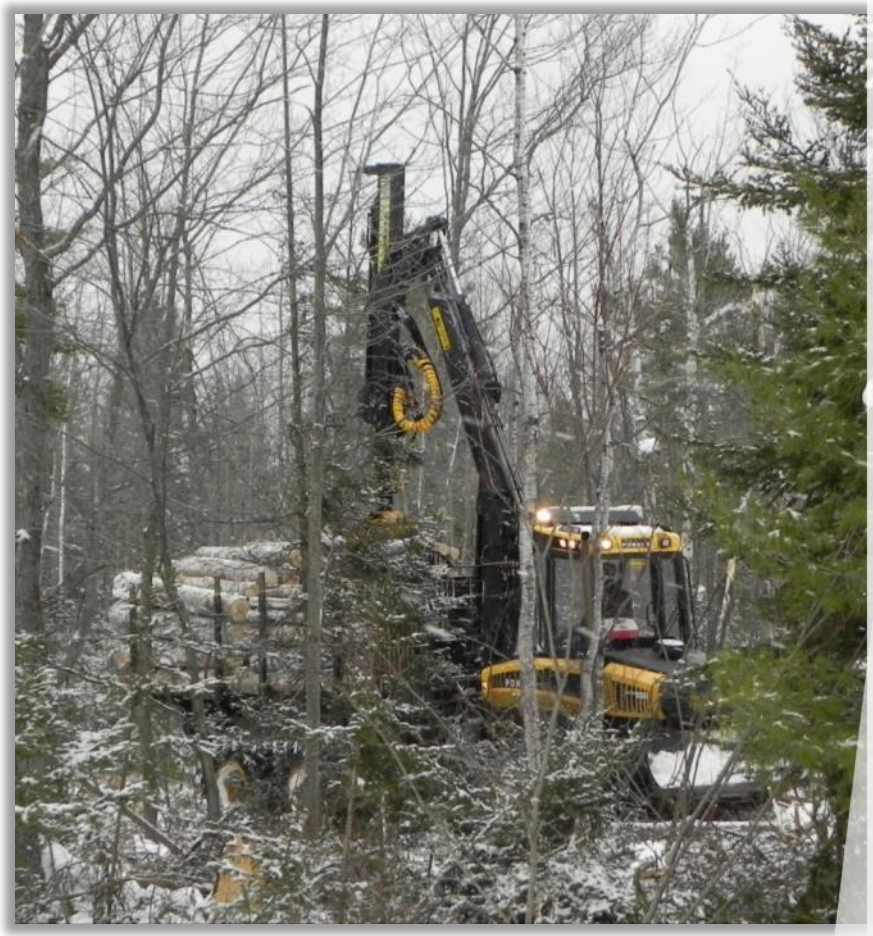
- 30-70% decreases in snowfall
- Greatest loss in December/January

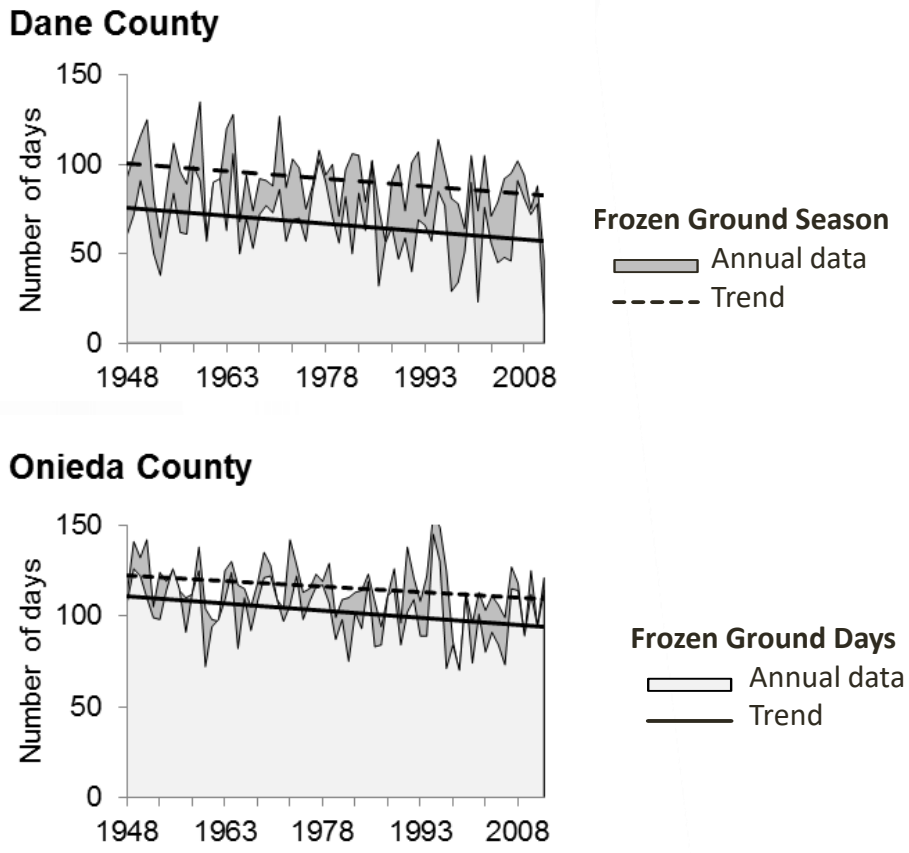
Decreased snowpack

- Increased soil freeze-thaw cycles can damage roots and alter soil processes

Shorter, Warmer Winters

Decreases in snow fall, cover, and depth





Rittenhouse and Rissman 2014

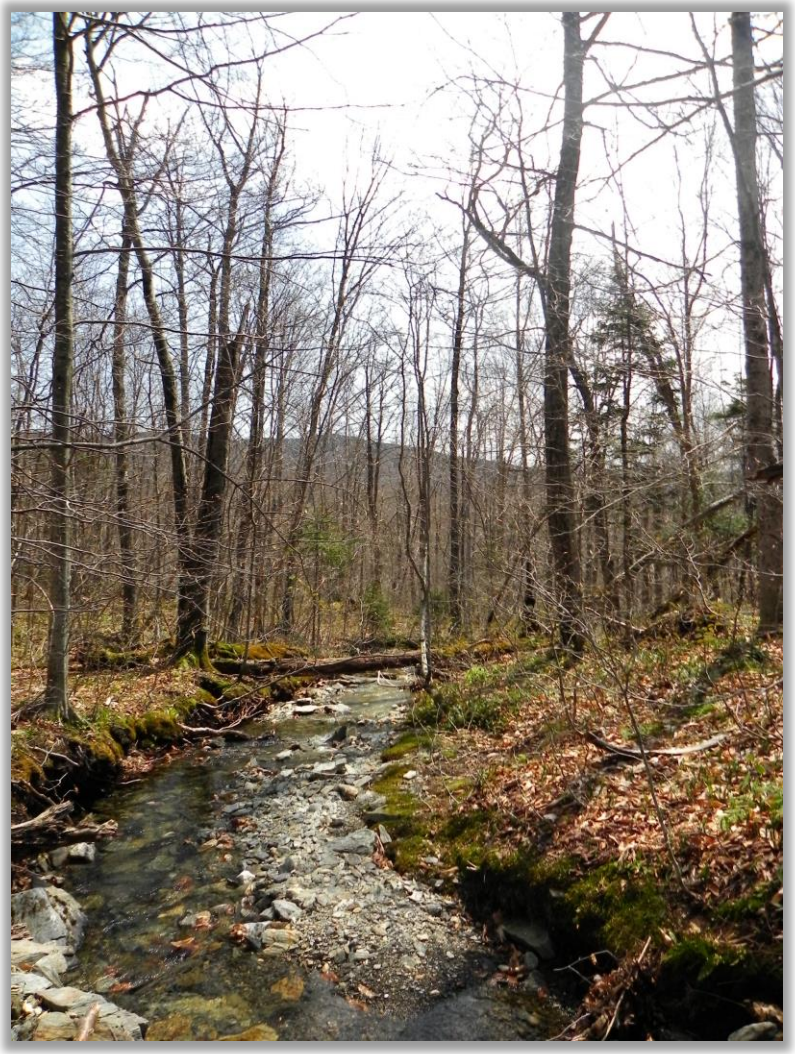
Shorter, Warmer Winters

Less snow, but <u>more rain</u>

- Warmer temperatures
- Increased precipitation
- Extreme rain events

Earlier peak stream flows

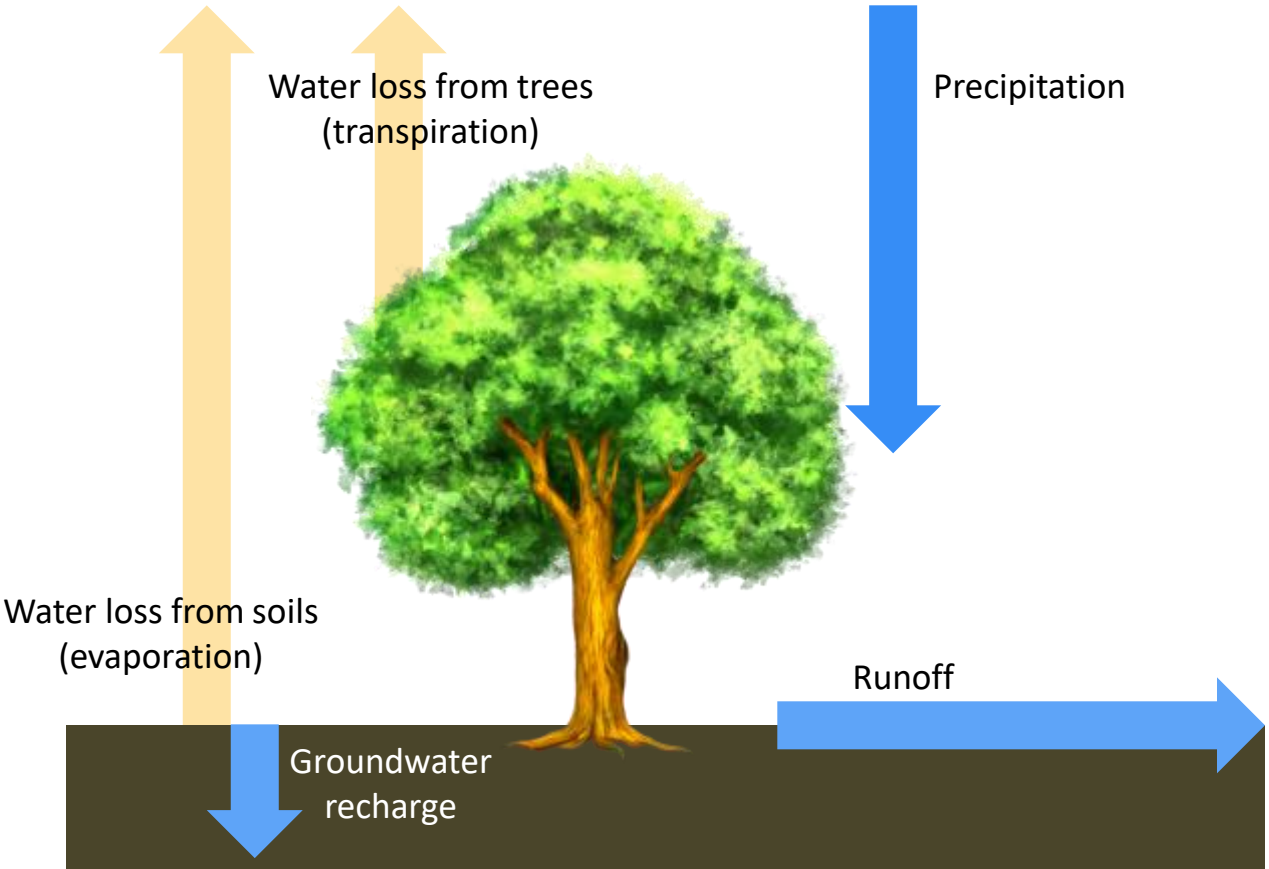
- Flashiness and episodic high flows may increase



Dale et al 2001, Huntingon 2004, Parmesan 2006

Increased Risk of Moisture Stress

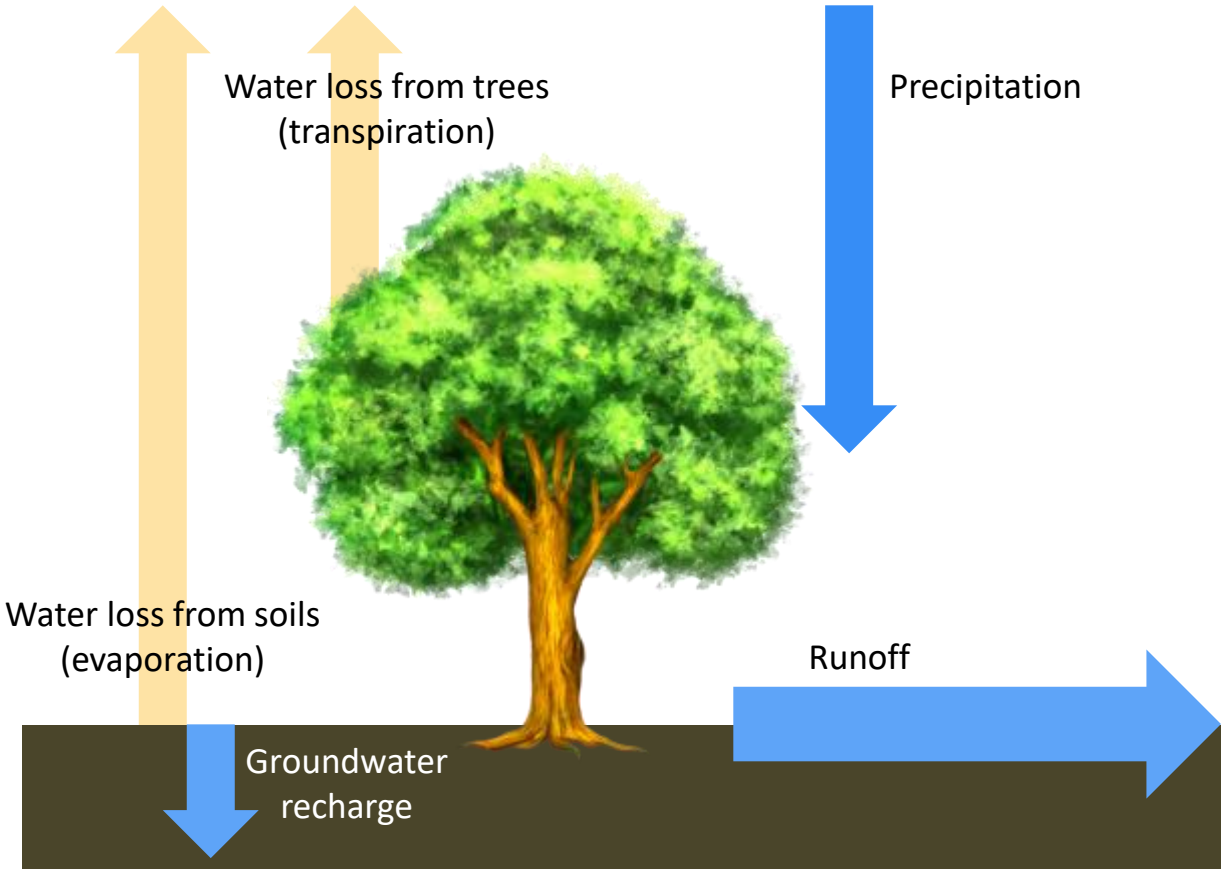
Longer and warmer growing seasons may lead to drier conditions during the growing season.



Increased Risk of Moisture Stress

Longer and warmer growing seasons may lead to drier conditions during the growing season.

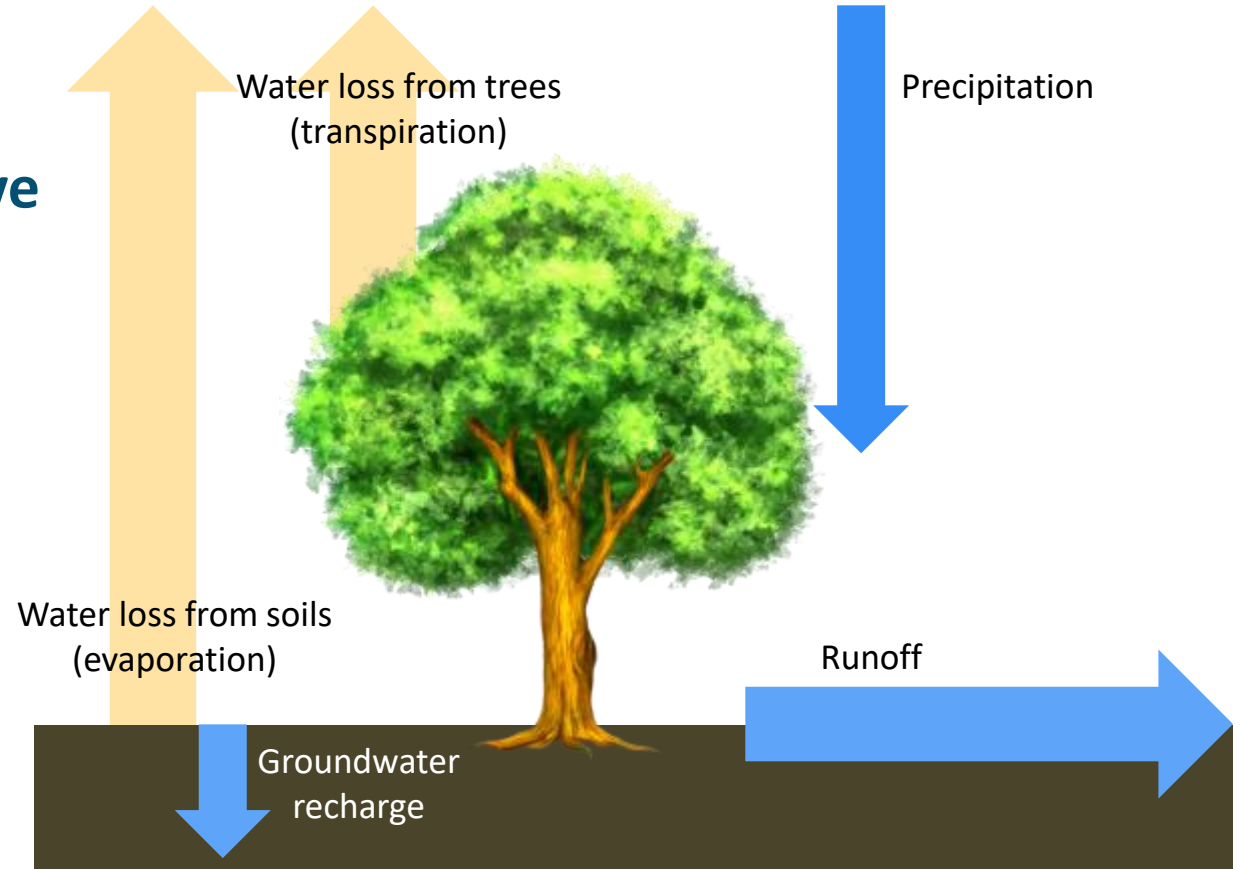
Earlier spring runoff and increased runoff during extreme rain events



Increased Risk of Moisture Stress

Longer and warmer growing seasons may lead to drier conditions during the growing season.

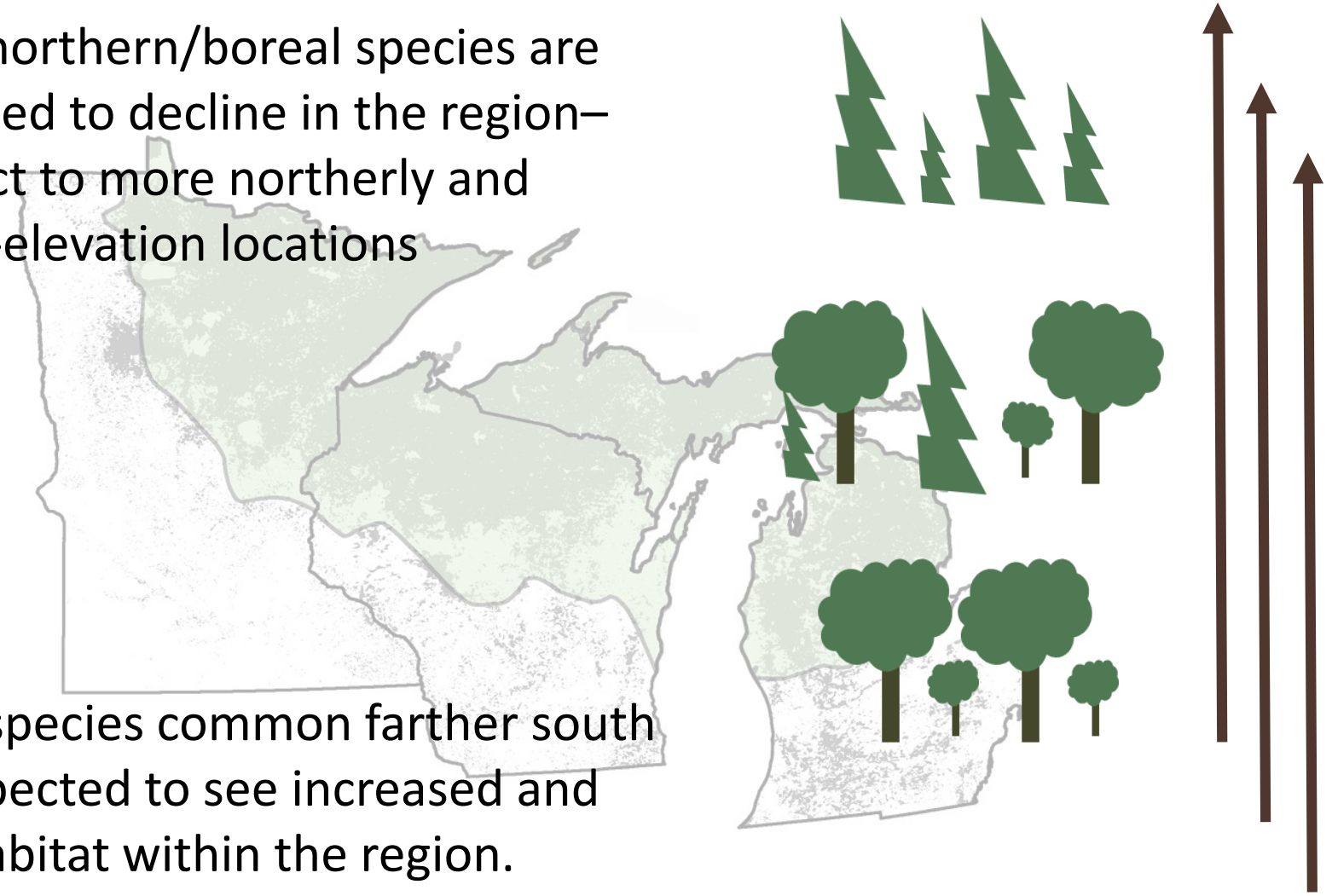
Warmer temperatures drive water loss from soils and plants



Tree Species Range Shifts

Tree Species Range Shifts

Many northern/boreal species are projected to decline in the region– contract to more northerly and higher-elevation locations



Many species common farther south are expected to see increased and new habitat within the region.

Tree Species Range Shifts

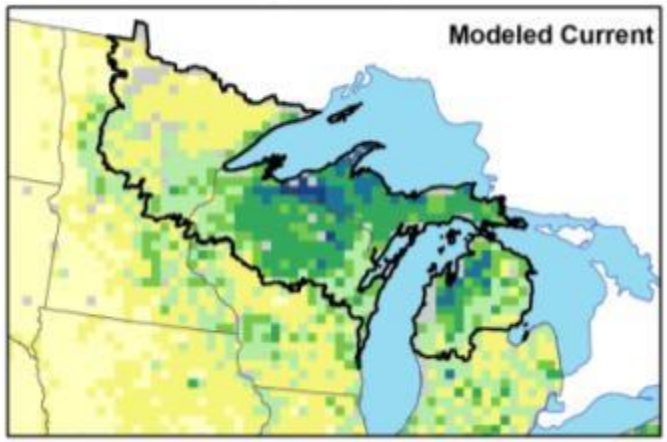
Sugar Maple

Importance Value

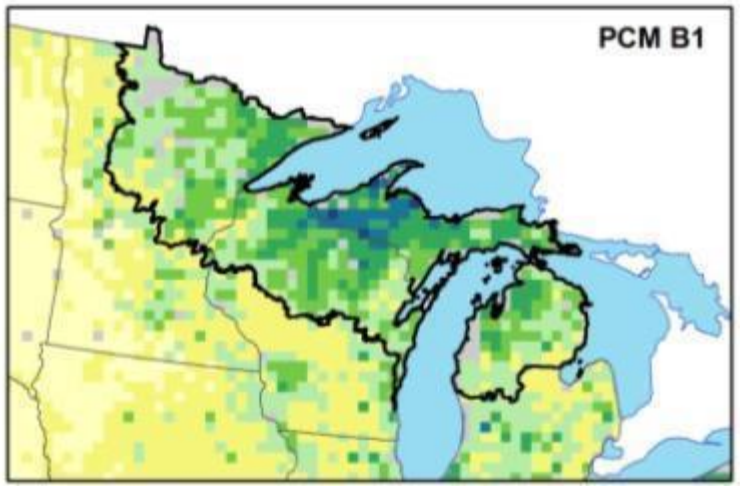
Low

High

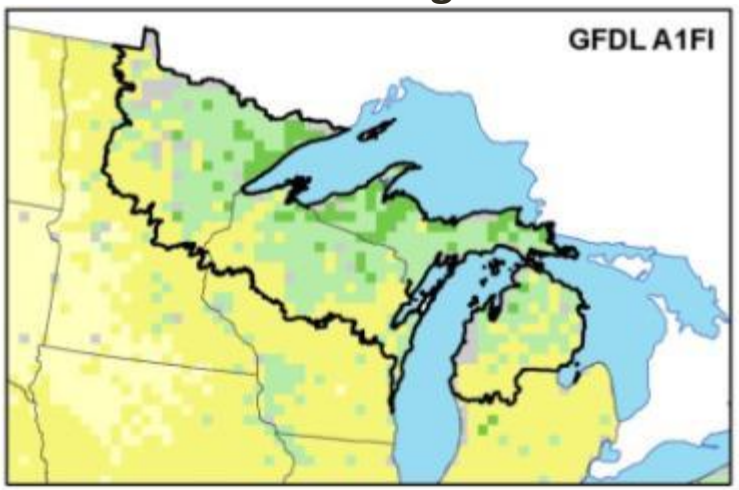
Current



2070-2100 Low



2070-2100 High



Climate Change Tree Atlas

Tree Species Range Shifts

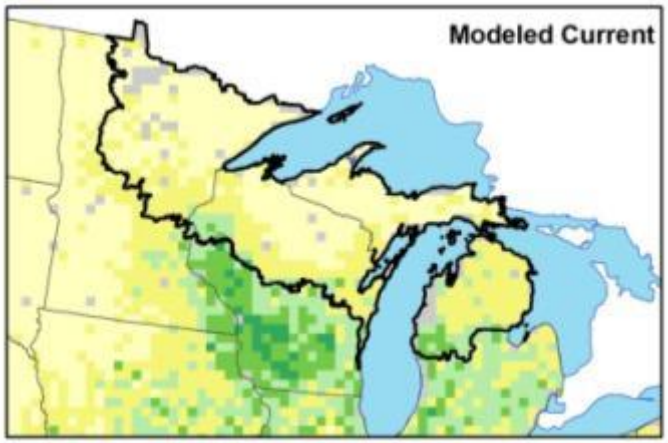
White Oak

Importance Value

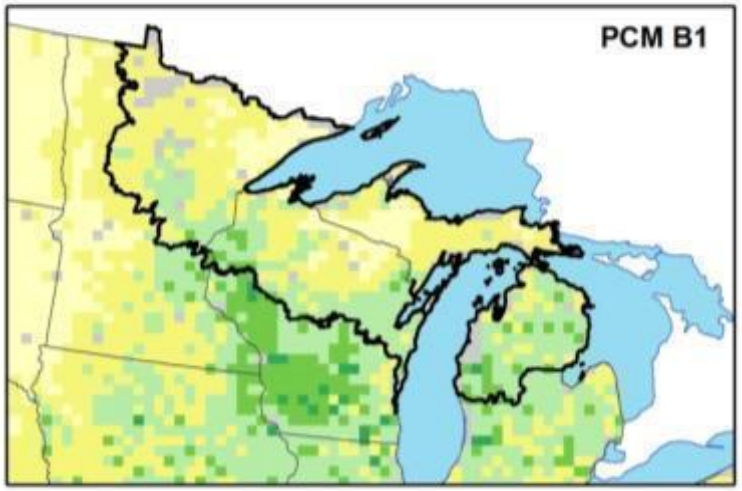
Low

High

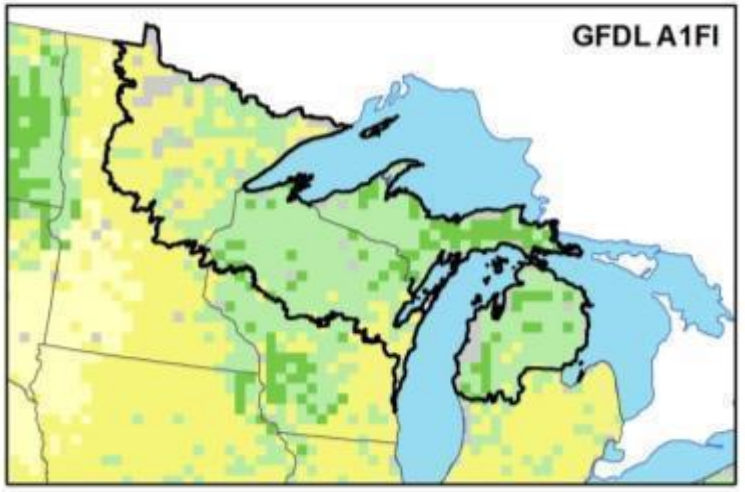
Current



2070-2100 Low



2070-2100 High



Climate Change Tree Atlas

Tree Species Range Shifts

- Range shifts ≠ instant catastrophic dieback
- Mature trees should fare better
  - Developed root system
  - Greater carbohydrate reserves
- Stress factors will increase in severity
  - Temperature
  - Moisture
  - Competition
- Increased susceptibility to disturbance

Dale et al 2001, Iverson et al 2008

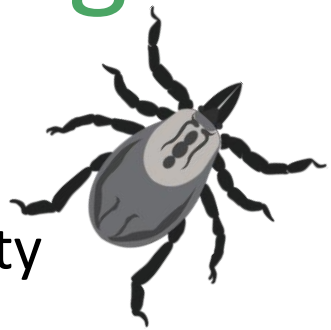
Extreme Weather

Extreme events may become more frequent or severe

- Heavy precipitation
- Ice storms
- Heat waves/droughts
- HurricanWind storms
- es
- **“Events” are not well modeled**

Ciais 2005, Mills 2005, WMO 2007, IPCC 2007, NCA, 2017, Coumou and Rahmstorf 2012; Image: NWS/weather.gov

Expanded Pest and Disease Ranges



Increased damage from forest insects & diseases

Indirect: Stress from other impacts increases susceptibility

Direct:

- Pests migrating northward
- Decreased probability of cold lethal temperatures
- Accelerated lifecycles

Ayres and Lombardero 2000, Woods et al 2005, Parmesan 2006, Soja et al 2006, Parmesan 2006, Dukes et al. 2009, Weed et al. 2013, Sturrock et al. 2011

Invasive Plants

Undesirable species moving northward (invasives)

Indirect:

- Stress or disturbance from other impacts can affect the potential for invasion or success

Direct:

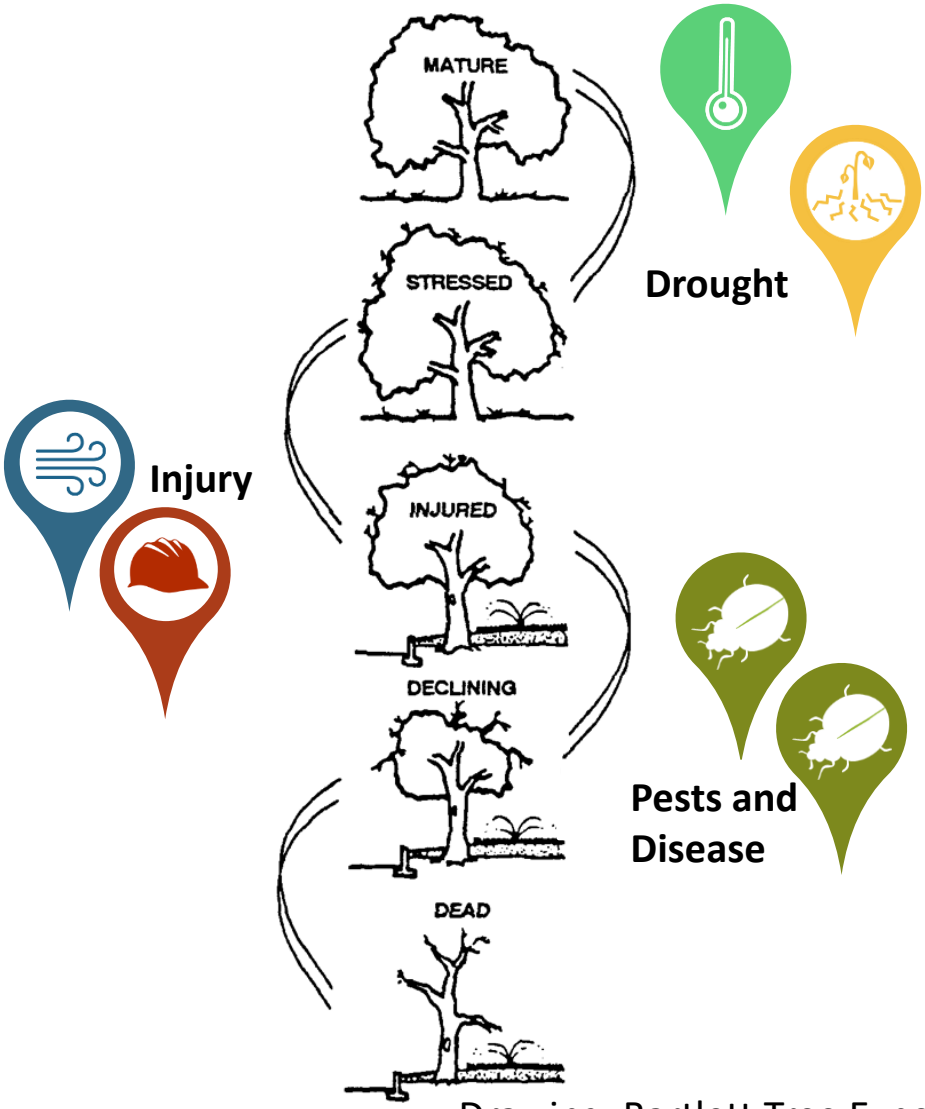
- Expanded ranges under warmer conditions
- Increased competitiveness from ability of some plants to take advantage of elevated CO_2

Hellman et al. 2008; Photos: Invasives Plants Atlas of New England (www.eddmaps.org)

Climate change is a "threat multiplier"

- Chronic stress
- Disturbances
- Insect pests
- Forest diseases
- Invasive species

Interactions make all the difference.



Drawing: Bartlett Tree Experts

Location, Location, Location

Research and assessments describe **broad trends** but **local conditions** and **management** make the difference.

How will climate change affect forest management?

Adaptation

Adaptation = taking action to prepare for climate change.




Adaptation activities can build on sustainable management, conservation, and restoration of forests

Parry et al. 2007, SCBD 2009, Groves et al. 2010

If you want a single “answer” for how to respond to climate change

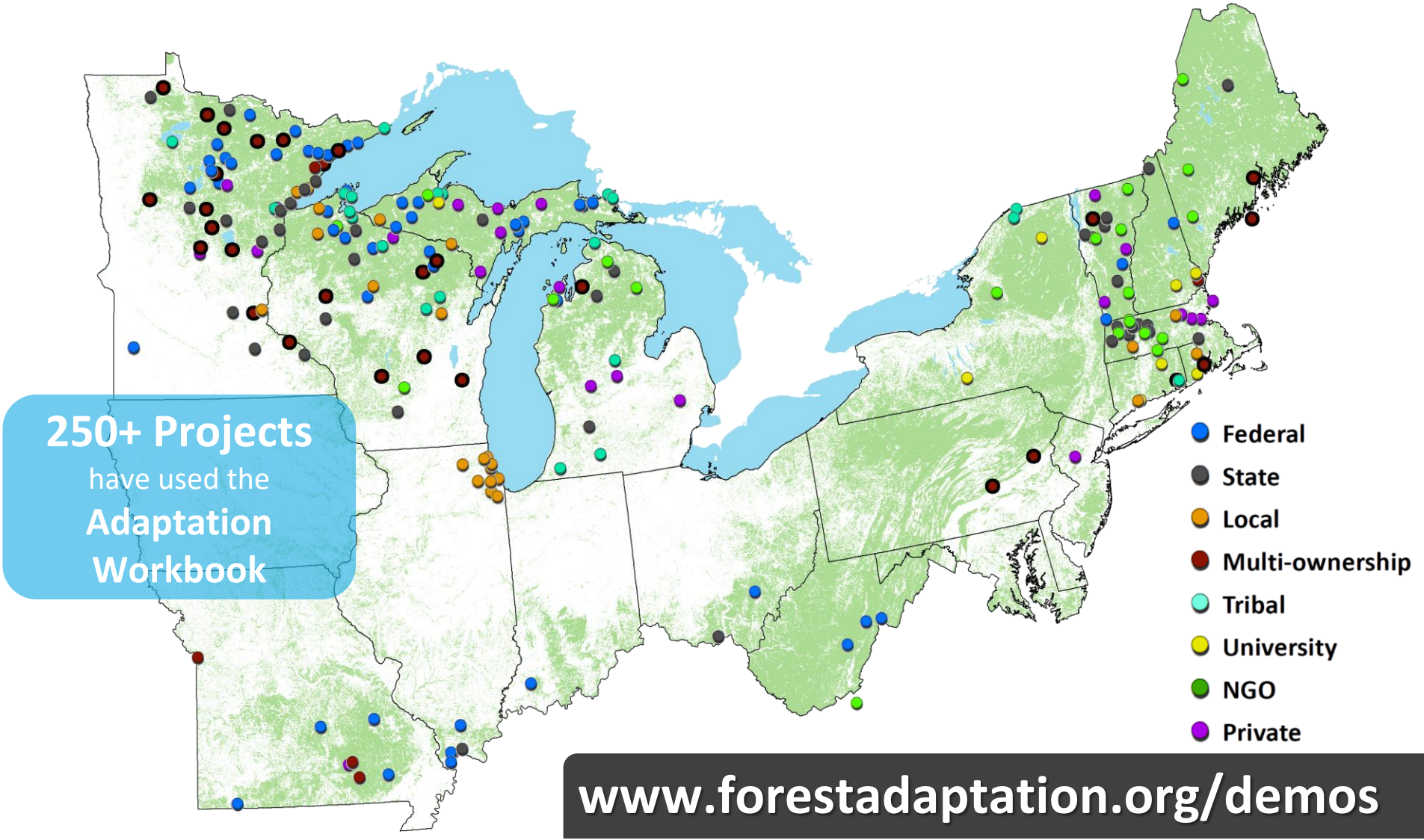
If you want a single “answer” for how to respond to climate change, it’s

“It depends”

It depends on **where** you are working and **what** you’re trying to achieve.

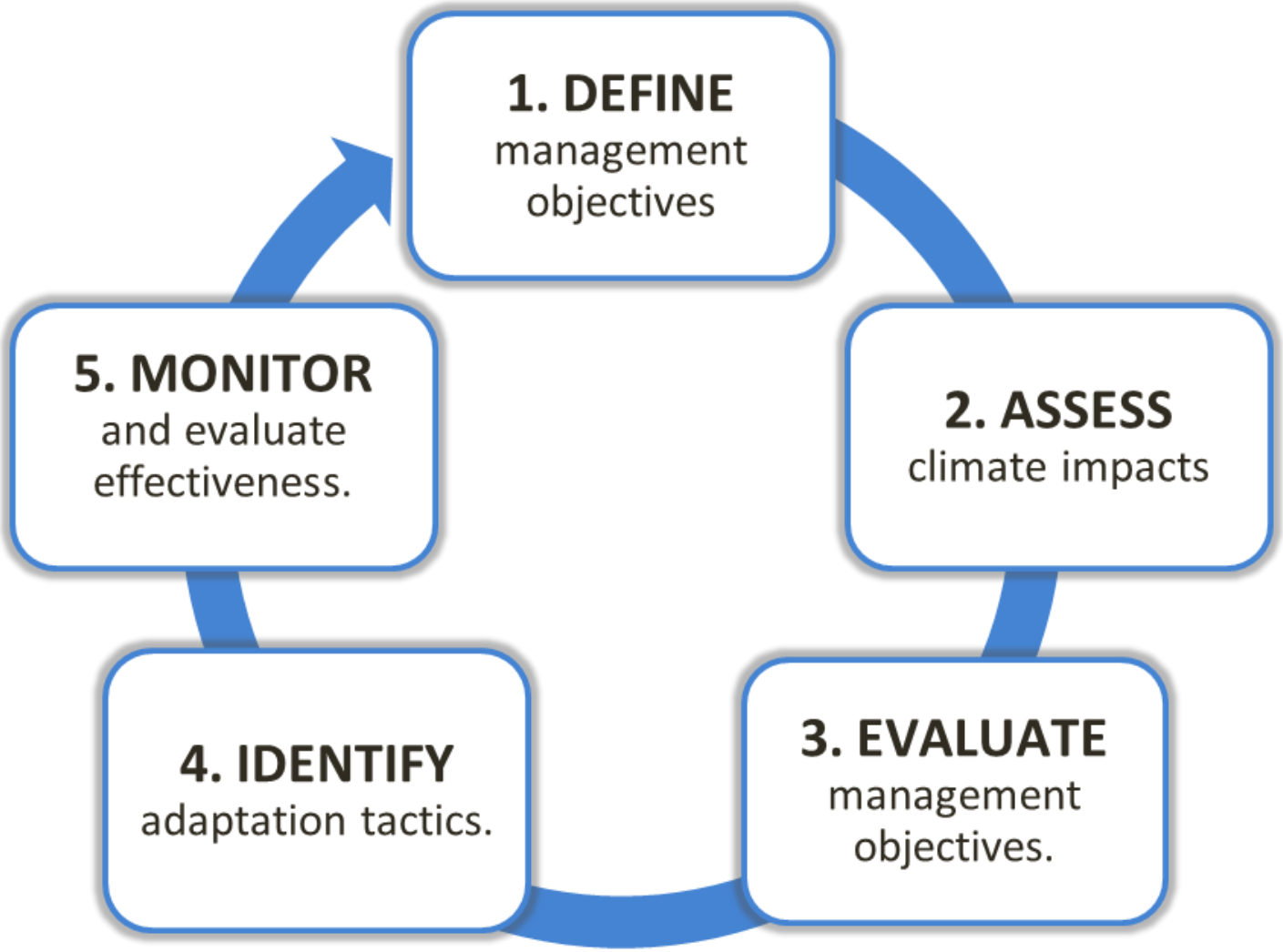
Adaptation in Action

Real-world examples of climate-informed management



www.forestadaptation.org/demos

Adaptation Workbook



Swanston et al. 2016 (2nd edition); www.treesearch.fs.fed.us/pubs/52760

Improve your wood's defenses against unwanted change.

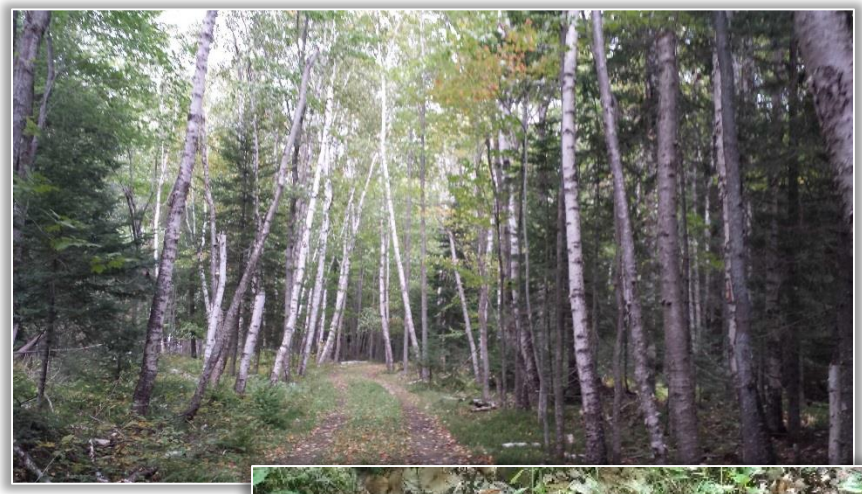
Protect water and soils on your land.

Good road and trail systems

- Improve access
- Concentrate impacts to designated locations

Stream crossings

- Ensure culverts and bridges can withstand extreme events
- Protects habitat for fish and aquatic organisms
- Protects water quality



Improve your wood's defenses against unwanted change.

Prevent and control non-native plants and weeds.

Early detection and action

- Stress or disturbance from other causes can allow plants to establish or expand
- Learn your local offenders!

Images: Invasives Plants Atlas of New England (www.eddmaps.org)

Improve your wood's defenses against unwanted change.

Improve ability of your trees to resist bugs and disease.

Early detection and action – again!

- Promote healthy and vigorous trees
- Remove unhealthy trees
- Stress or disturbance from other causes can increase risk from pests or diseases
- Specific treatments for different insects and diseases

Images: USFS Northeastern Area, Mass Audubon

Improve your wood's defenses against unwanted change.

Protect rare or sensitive plant and animal communities.

Consider what is special or sensitive in your woods

- Rare plants or plant communities
- Rare animals or unique habitat features
- Streams, creeks, seeps, and other water features
- Wetlands, including seasonal pools

Promote diversity in your woods.

Promote a diversity of tree species and sizes.

Tree species diversity

- Different tree species in case one performs poorly
- Species that are more tolerant of hotter and drier conditions

Tree size diversity reduces risk

- More sizes generally means a variety of ages, including young trees
- Can increase resistance to strong winds

Promote diversity in your woods.

Promote a diversity of tree species and sizes.

Forest management

- Unhealthy trees targeted for removal (worst first)
- Keep trees of less common species
- Keep trees that may do well in future
- Retain good habitat

Promote diversity in your woods.

Promote a diversity of tree species and sizes.

Forest management practices = Thinning

- Removes some trees, providing more space to the remainder

Promote diversity in your woods.

Promote a diversity of tree species and sizes.

Forest management practices = Patch or group selection

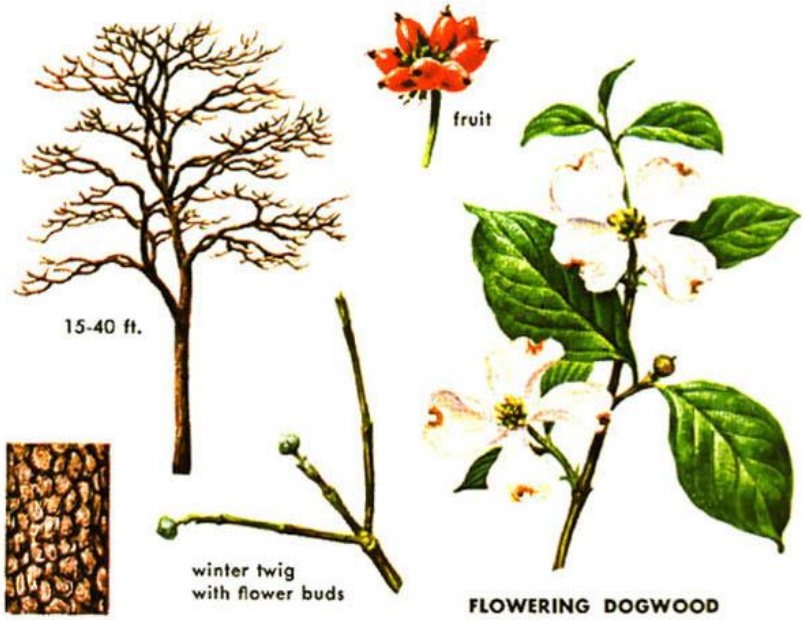
- Removes trees in a more concentrated area to promote small and baby trees

Be pro-active to adapt your woods to changing conditions.

Consider which tree species you might want to promote.

Trees adapted to future conditions

- Match trees to site
- Trees that can take a wide range of conditions
- Trees that can handle hotter and drier conditions



Be pro-active to adapt your woods to changing conditions.

Manage damage to young trees from excessive deer browsing.

Deer look cute but threaten baby trees

- Deterrence – *shoo, deer!*
- Avoidance – less palatable species
- Protection – fenced exclosures, fencing individual trees, tree shelters, piled tree tops
- Repellents – sprays, etc.

Be pro-active to adapt your woods to changing conditions.

Monitor your woods and the effect of different management tactics.

Be observant to changes in your woods

- Look for changes and “weird things”
- Early spring – many invasives green up first
- After big rains – soil erosion, sedimentation, ponding, etc.
- If nothing else: take photos!

Be pro-active to adapt your woods to changing conditions.

Get advice from professionals.

Take advantage of specific expertise

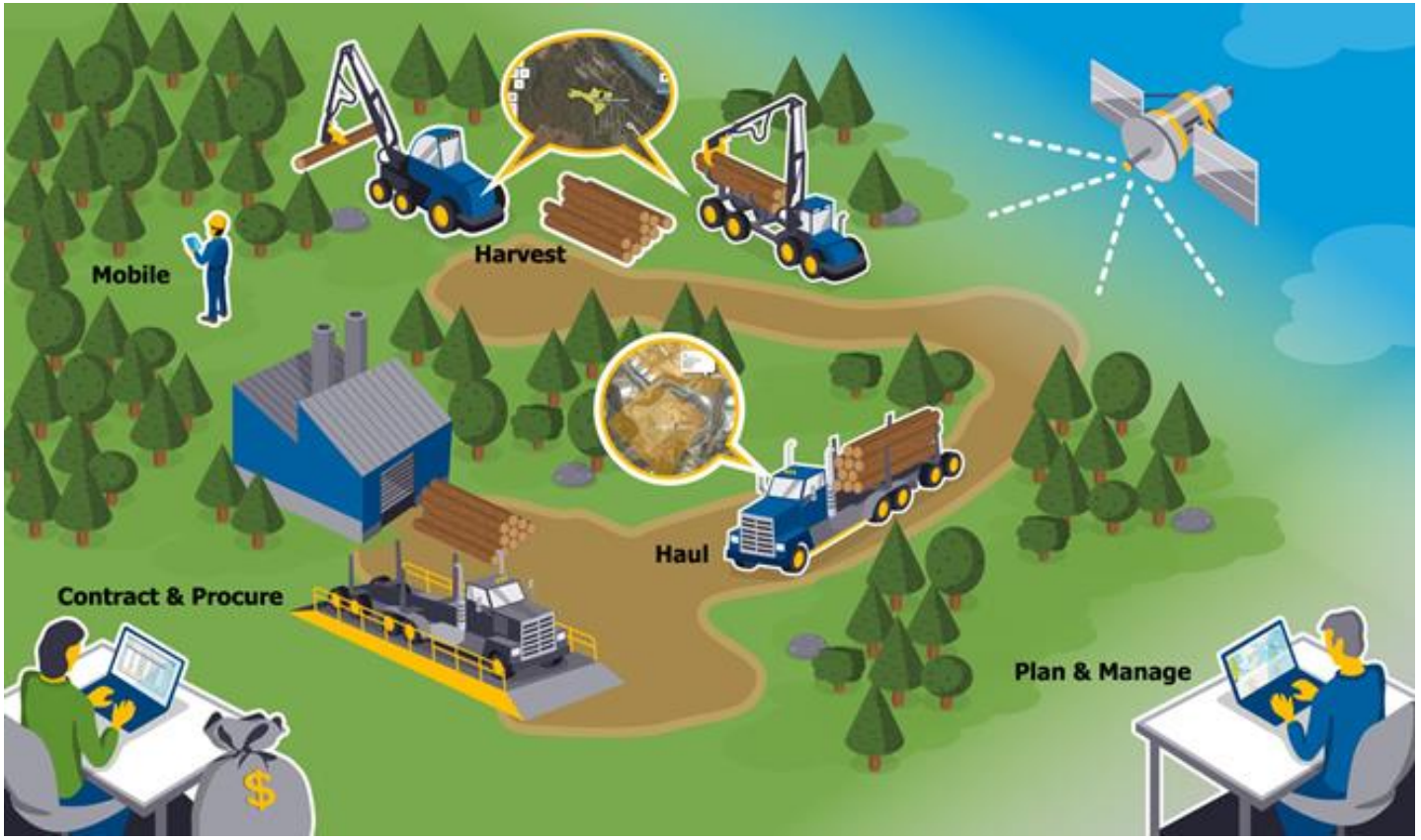
- Consulting foresters
- Wildlife biologists, ecologists
- Agencies – NRCS, state agency
- Land trusts
- University Extension programs
- Lawyers, legal professionals

Safety

- Protect yourself from changes in your environment.

Planning your Work

- Logistics are going to be even more important

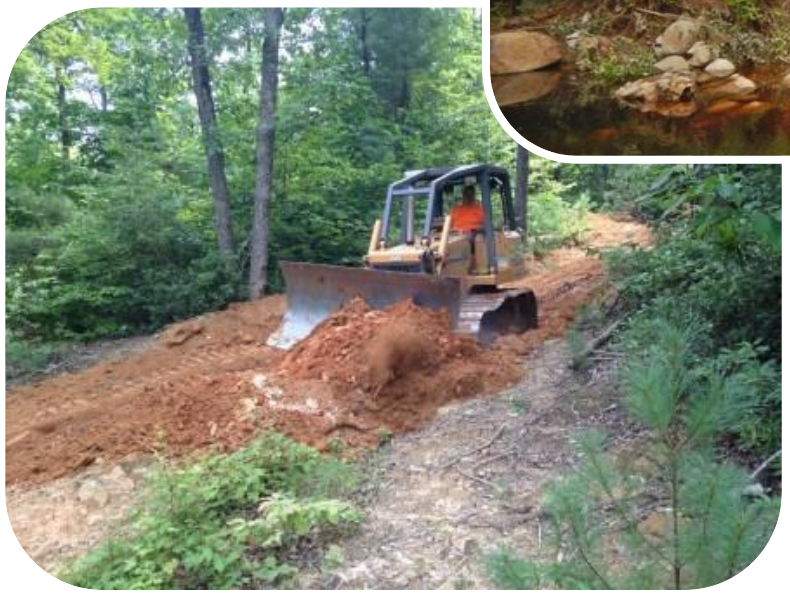


Communication

- Share what you're seeing with foresters, landowners, or sale admins

Diversity is your Friend

- Think about multiple income streams



Equipment Investments

- Judge equipment purchases with expected conditions in mind

The Take-Home Messages

- Climate change is real.
- The future is always uncertain, but we know enough to begin preparing.
- Loggers and business owners can adapt to stay in front.