# Climate Change
# Key Concepts and FAQs

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Partners In Action
Sault Ste. Marie, MI
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NIACS
Northern Institute of Applied Climate Science

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

CLIMATE CHANGE
RESOURCE CENTER

# Northern Institute of Applied Climate Science

Climate

Carbon

Bioenergy

Provides **practical** information, resources, **education**, and **technical assistance** related to forests and climate change

Supports the **integration** of climate change information into natural resource management

NIACS
Northern Institute of Applied Climate Science

**Regional multi-institutional partnership:**

Forest Service U.S. Department of Agriculture

Michigan Tech

ncasi

University of Minnesota

The Trust for Public Land

www.nrs.fs.fed.us/niacs/

# Climate Change Resource Center

www.fs.usda.gov/ccrc/

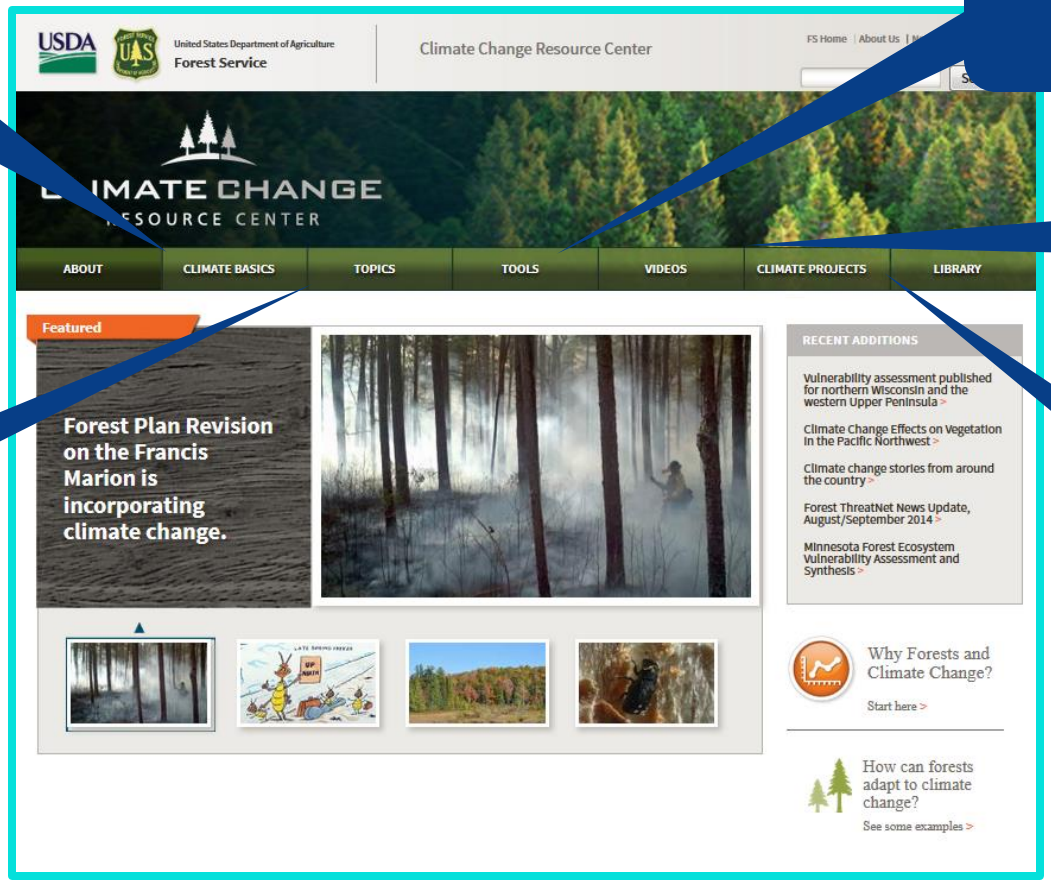
climate basics

climate/carbon tools

videos

topic pages

extras!

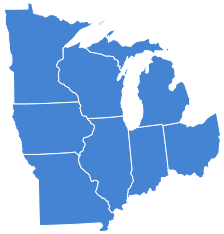


# Climate Change Concepts and FAQs

Refresher/introduction

FAQs

FAQs Answered



Climate Change in the Midwest

# Climate Change Concepts and FAQs

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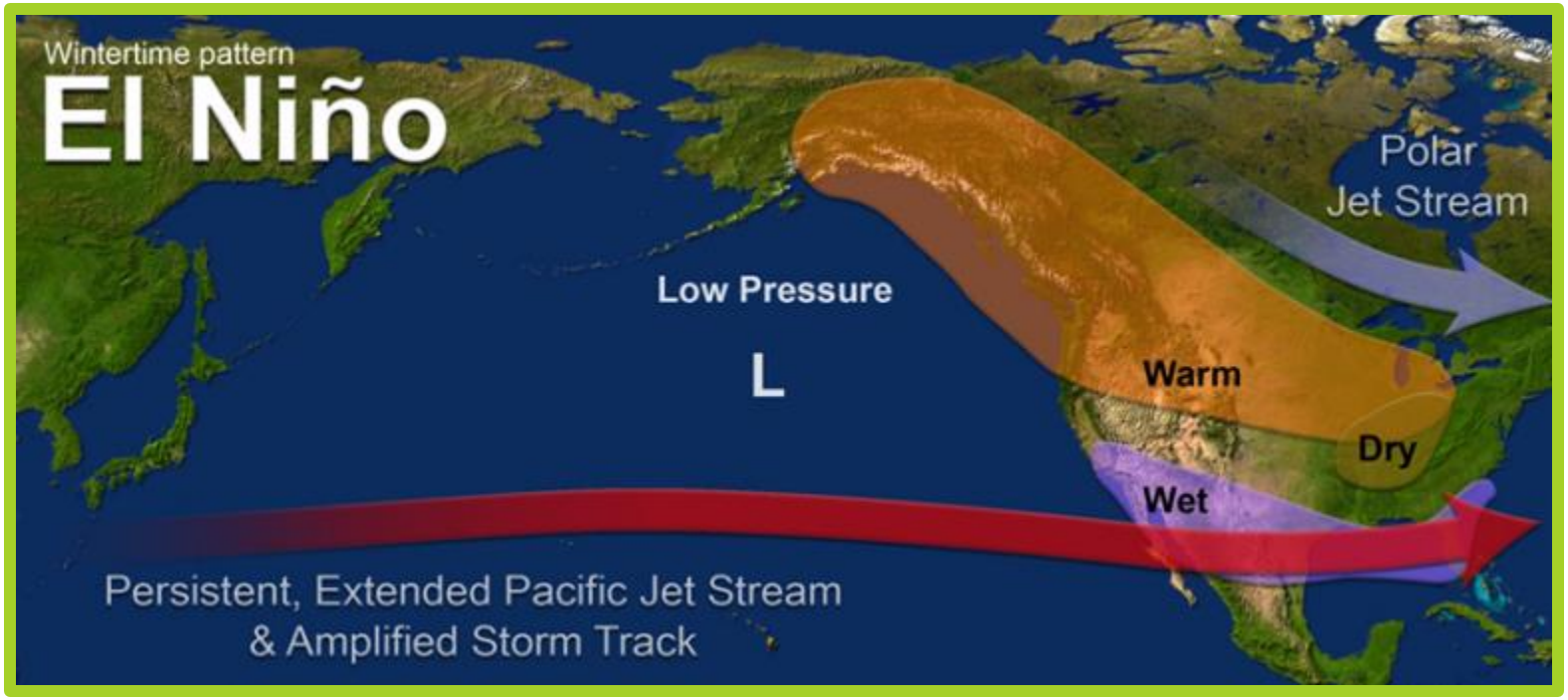
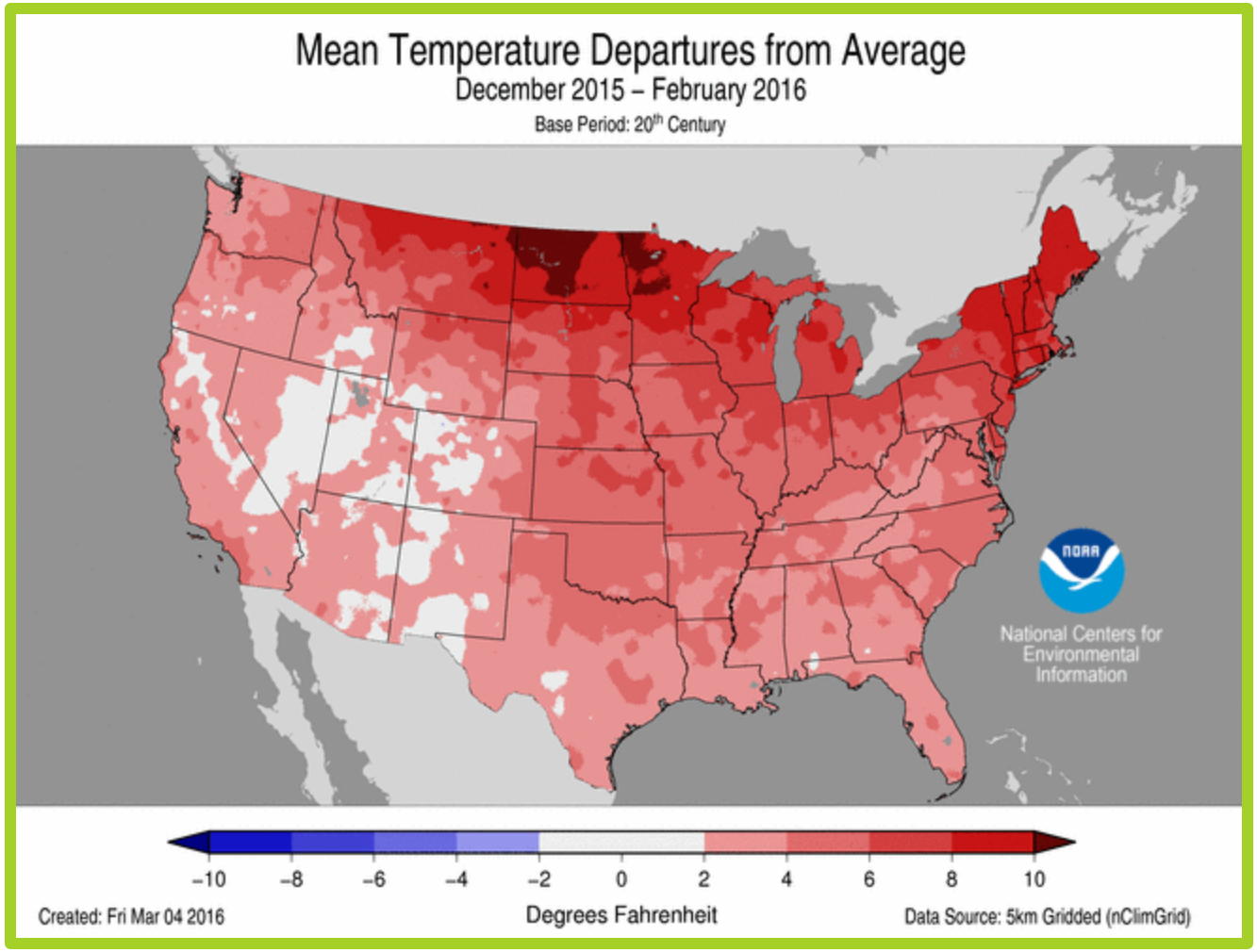



http://www.pmel.noaa.gov/elnino/impacts-of-el-nino/

# Climate Change Concepts and FAQs




https://www.ncdc.noaa.gov/sotc/national/201602

short term

long term

weather

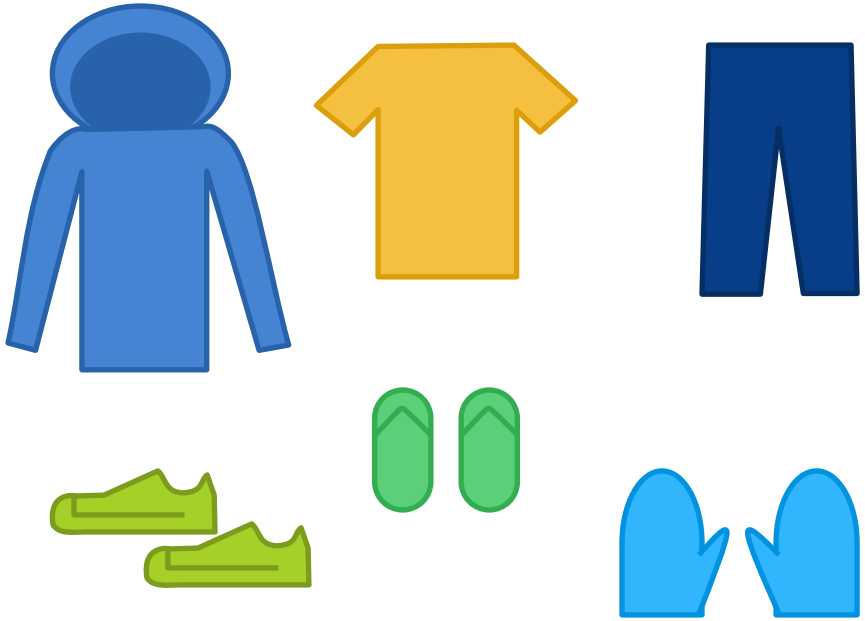
climate

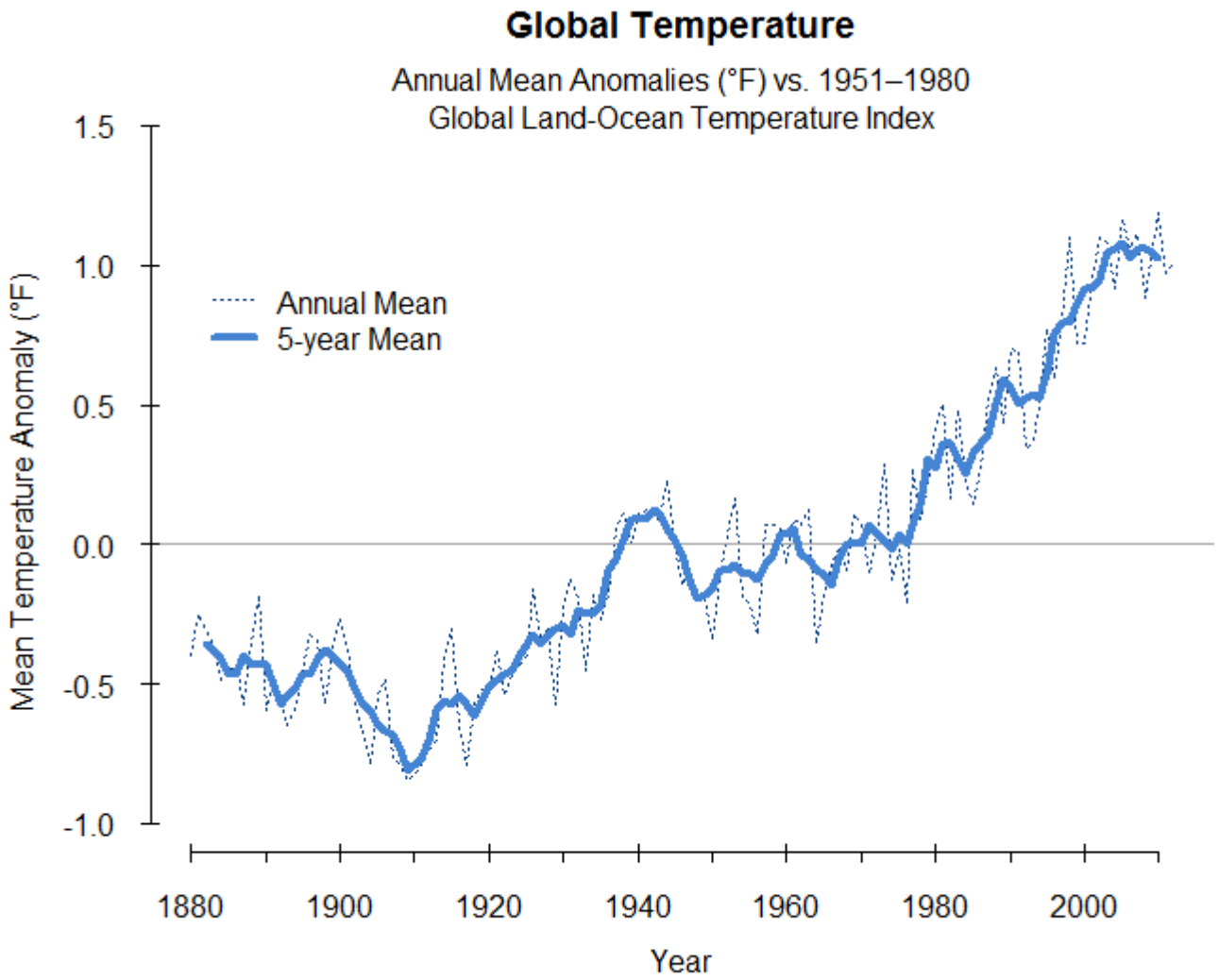
short term

long term

## weather

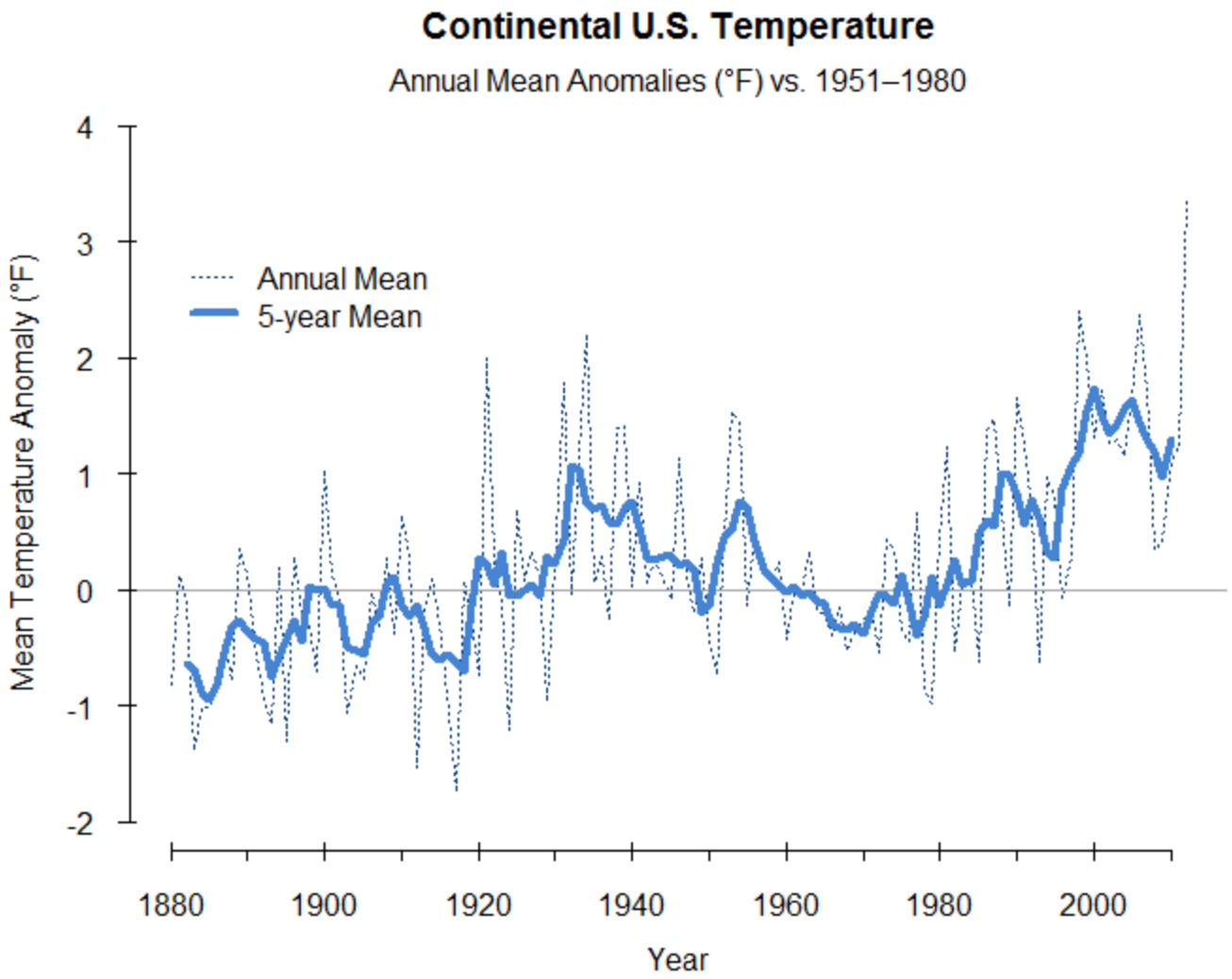
## climate






warming of about 1.4 degrees Fahrenheit for the globe from 1880 to 2012

graph data from the NASA Goddard Institute for Space Studies




warming of about 1.4 degrees Fahrenheit for the globe from 1880 to 2012

warming of around 2 degrees Fahrenheit for the United States since 1895

graph data from the NASA Goddard Institute for Space Studies

# hasn’t climate change happened before?

# isn’t climate change a natural process?

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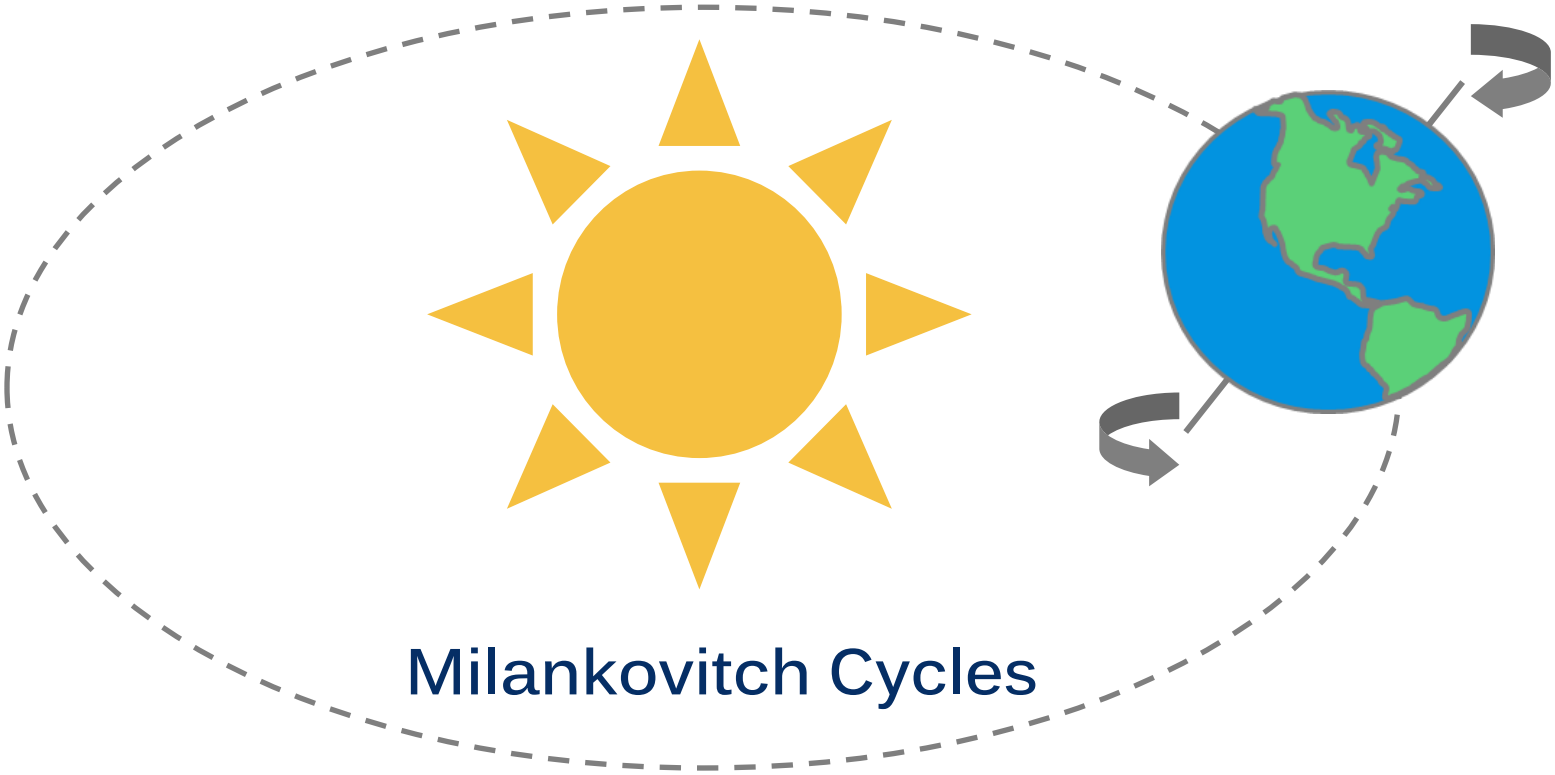
# yes!

# hasn’t climate change happened before?

# isn’t climate change a natural process?

## yes!



# hasn't climate change happened before?

# isn't climate change a natural process?

## yes!


surface temperature → ocean temperature → carbon dioxide

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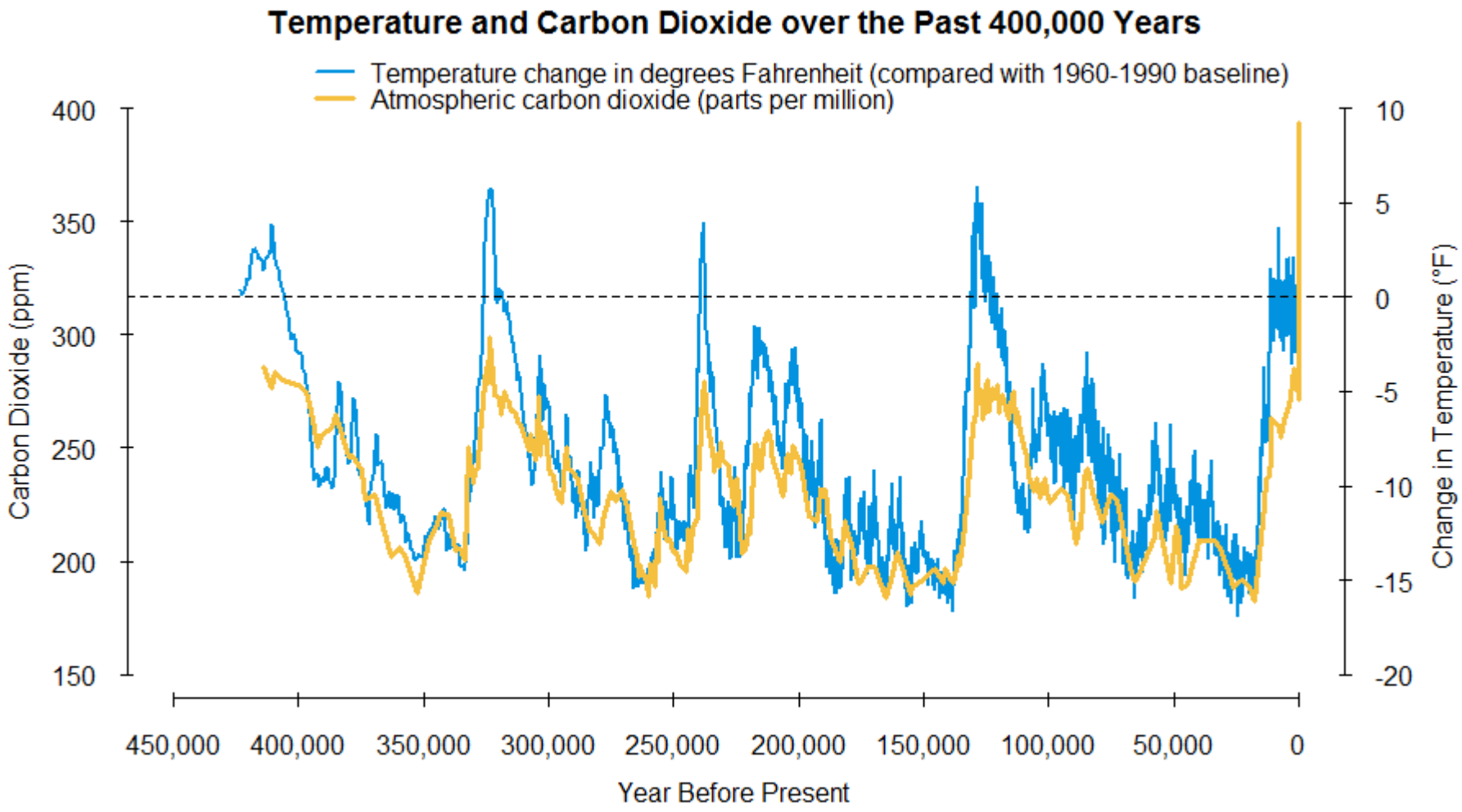
# isn't climate change a natural process?




graph data from the NOAA NCDC and Mauna Loa Observatory

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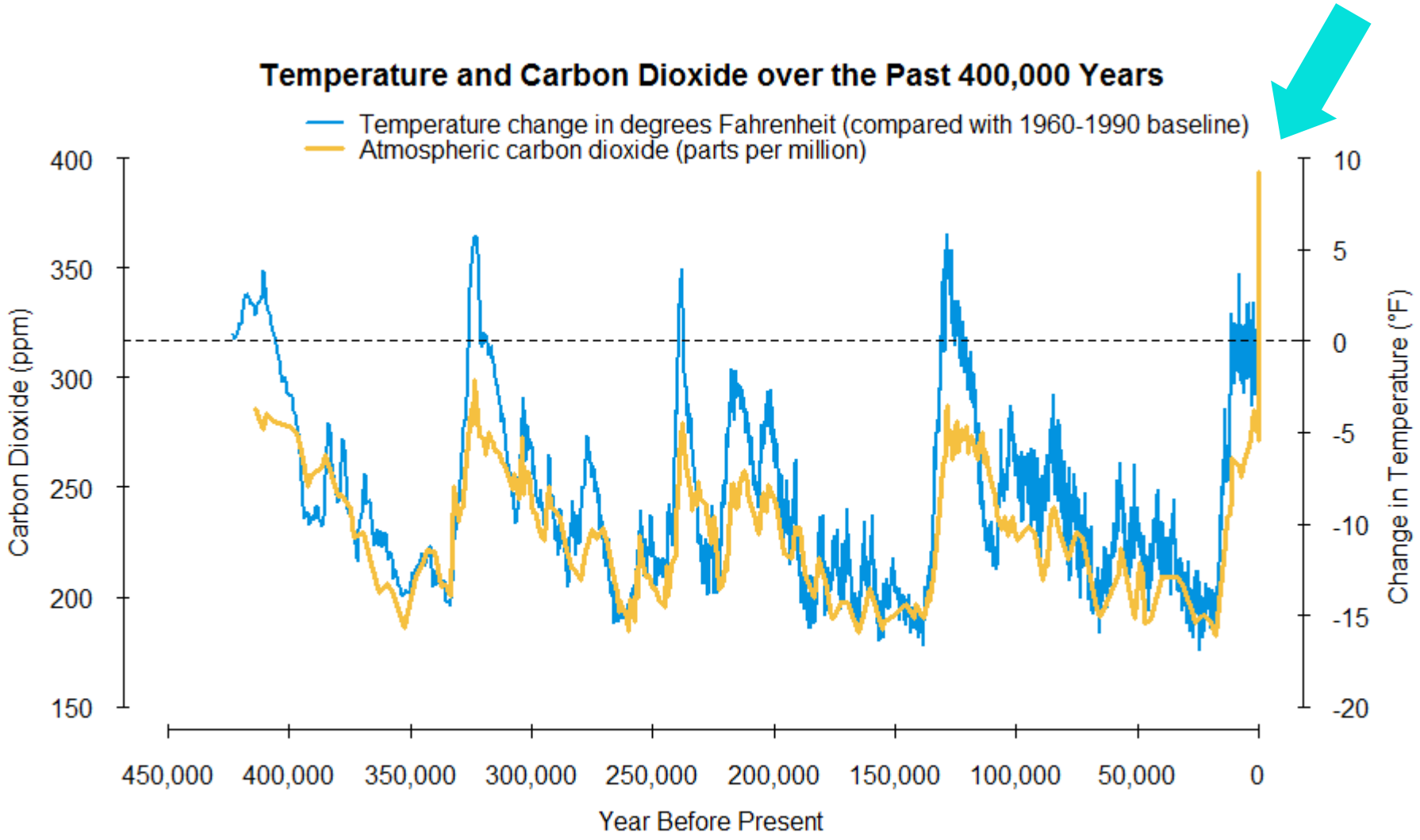
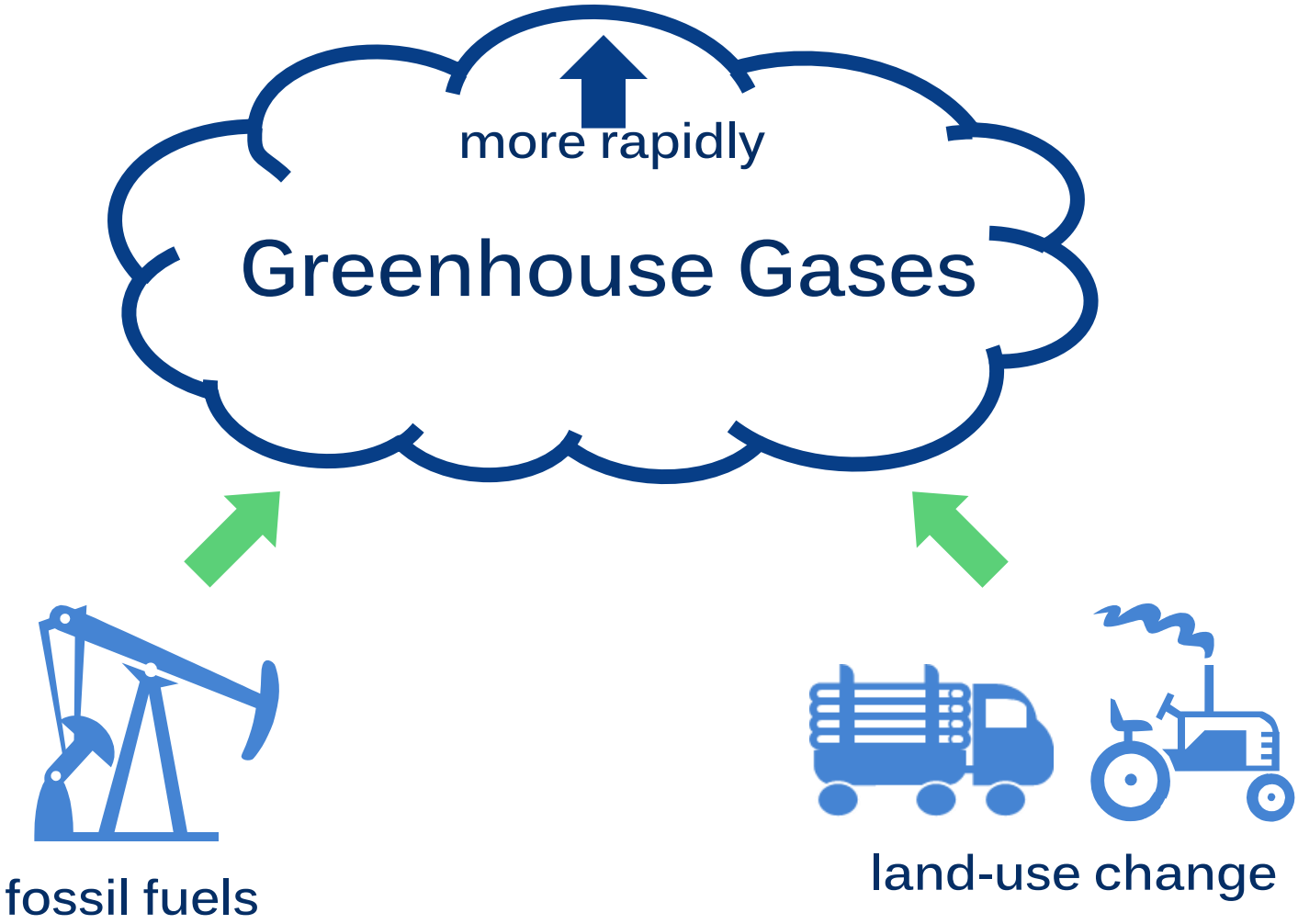



graph data from the NOAA NCDC and Mauna Loa Observatory

# is current climate change part of the natural process?



# is current climate change part of the natural process?

## Greenhouse Gases

### carbon dioxide

- fossil fuel use

### methane

- fossil fuel use
- livestock
- farming

### water vapor

- oceans
- large bodies of water
- water vapor increases as temperatures increase

# is current climate change part of the natural process?

## Greenhouse Gases

### carbon dioxide

- fossil fuel use

decades

### methane

- fossil fuel use
- livestock
- farming

years

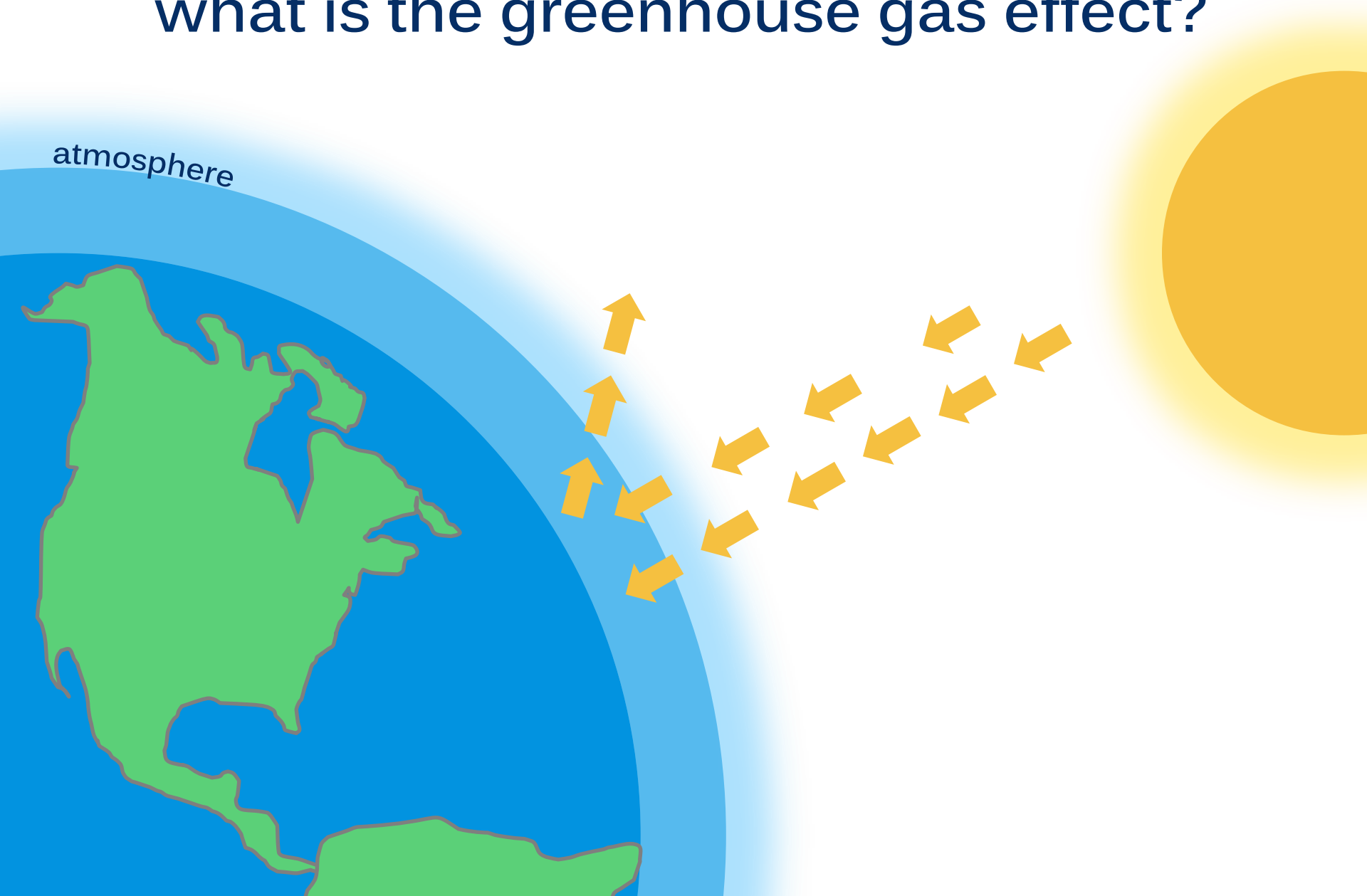
### water vapor

- oceans
- large bodies of water
- water vapor increases as temperatures increase

days

# why are they called “greenhouse” gases?

# what is the greenhouse gas effect?



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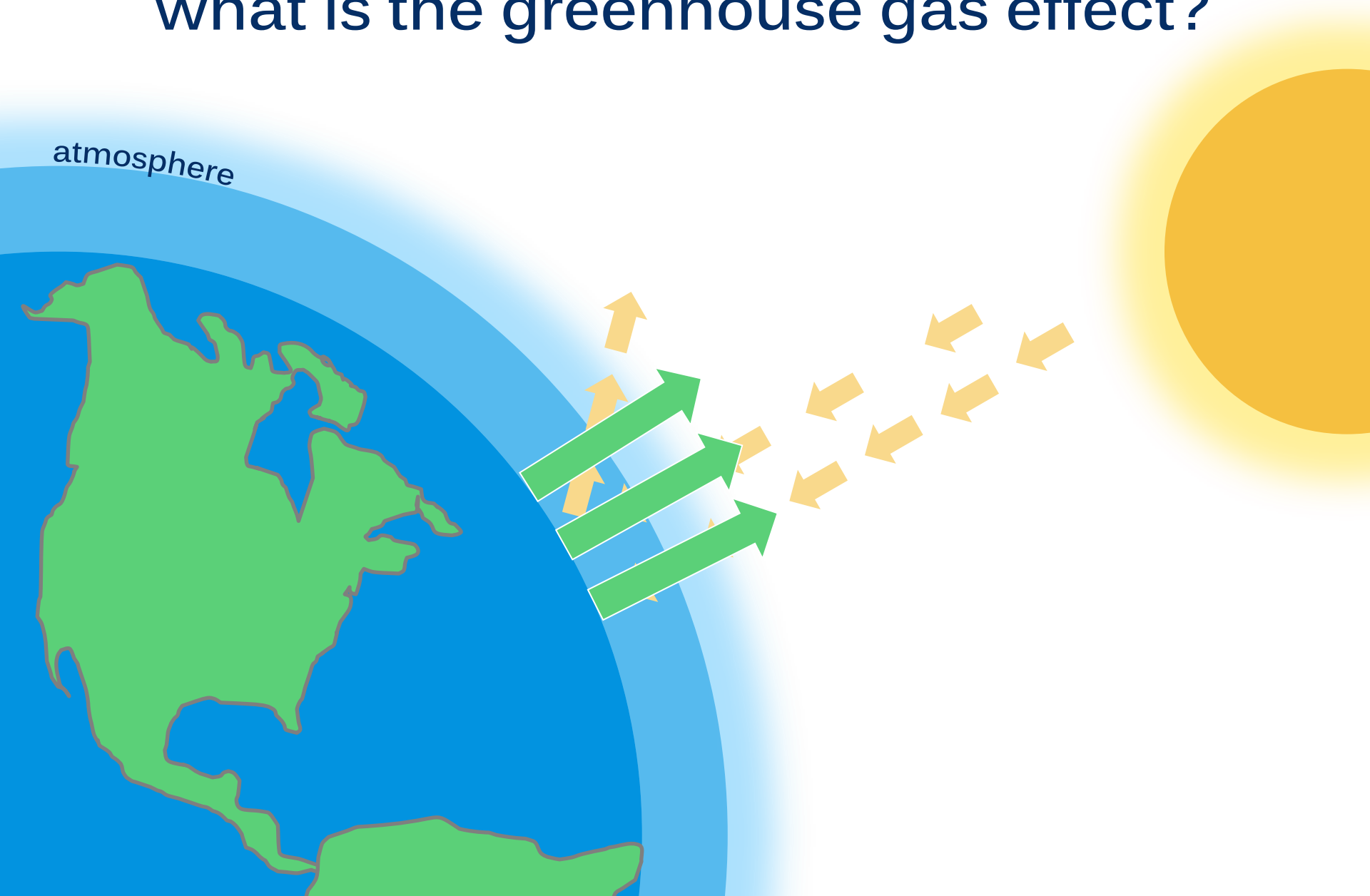

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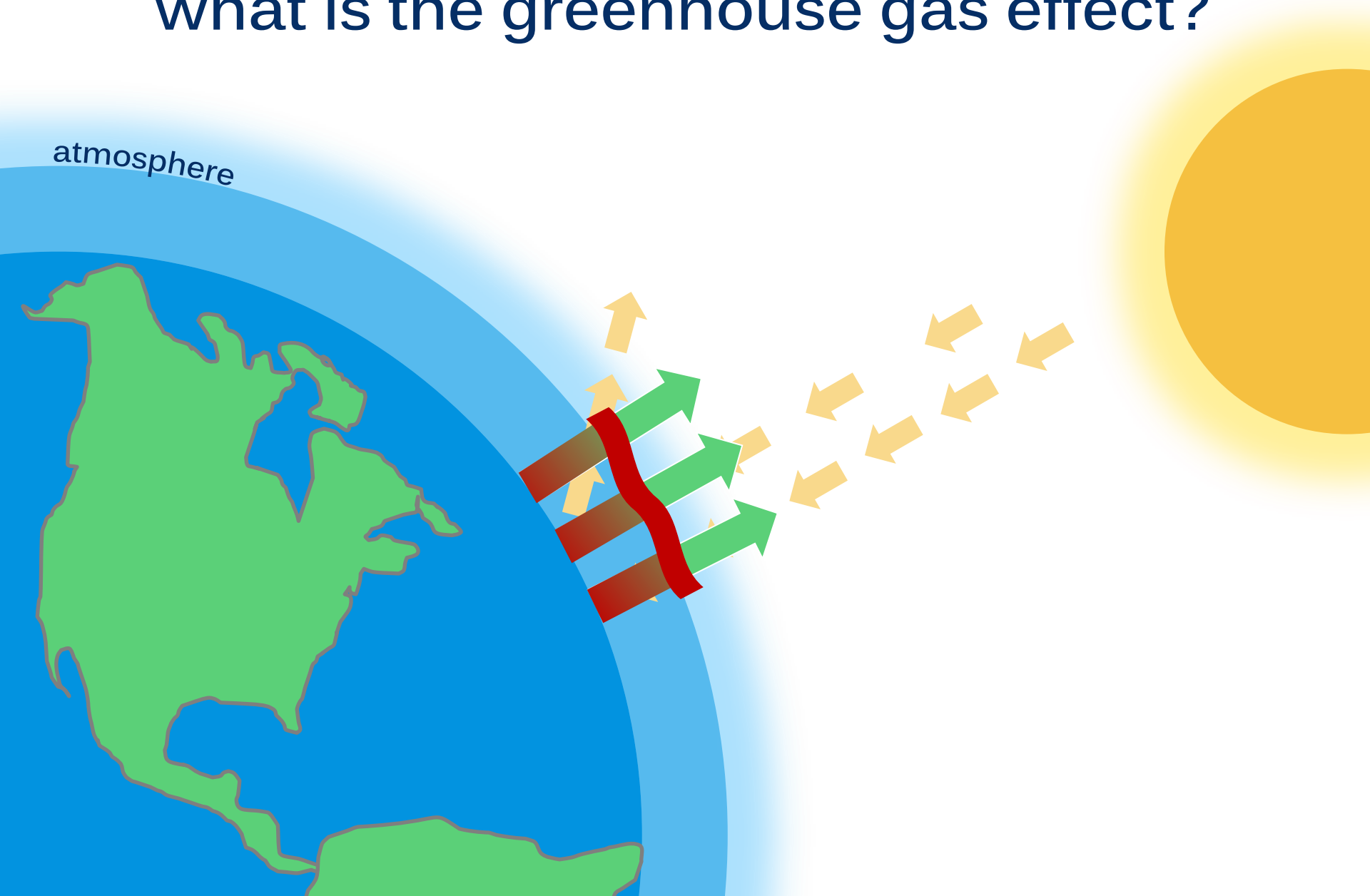

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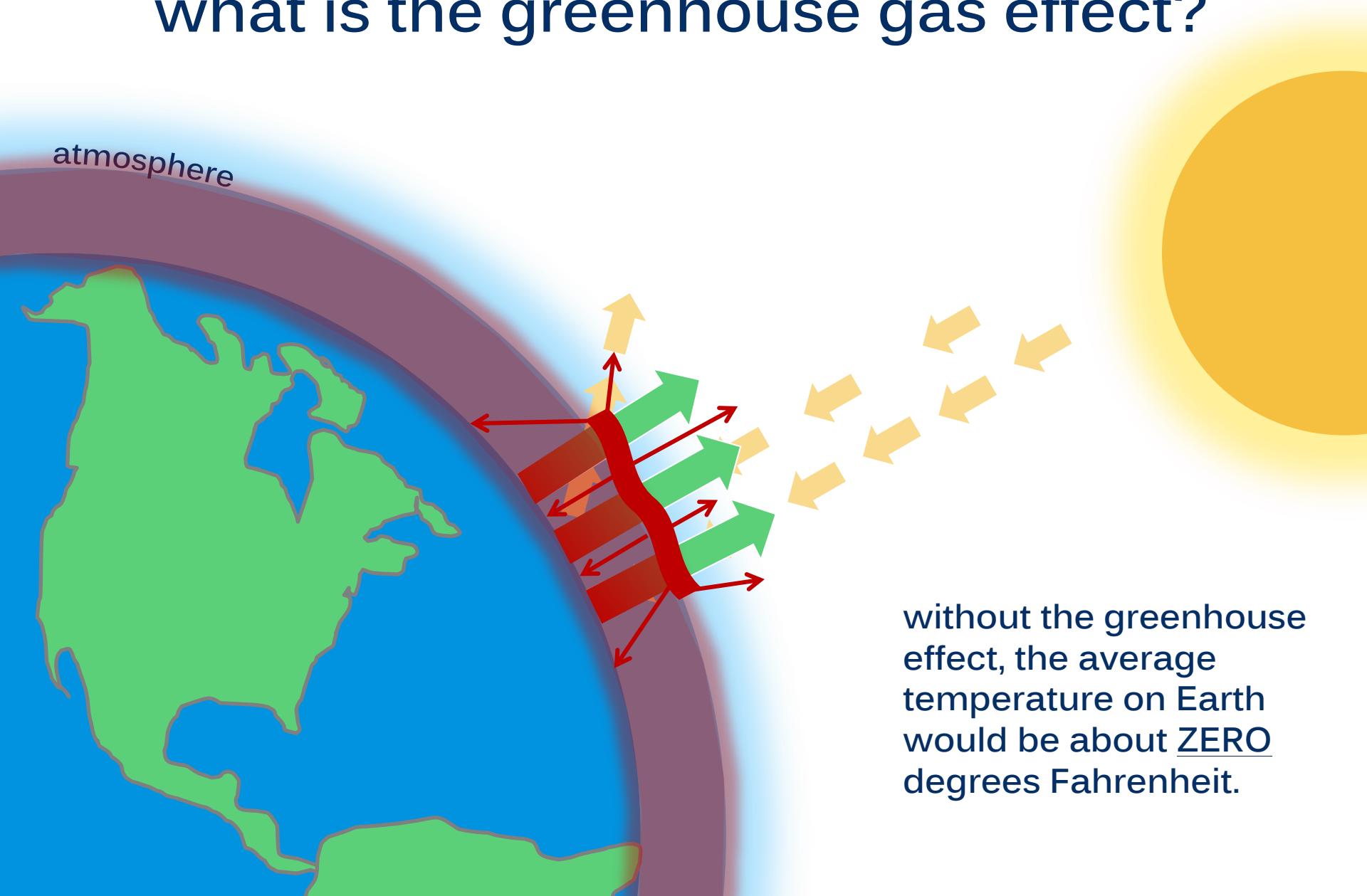
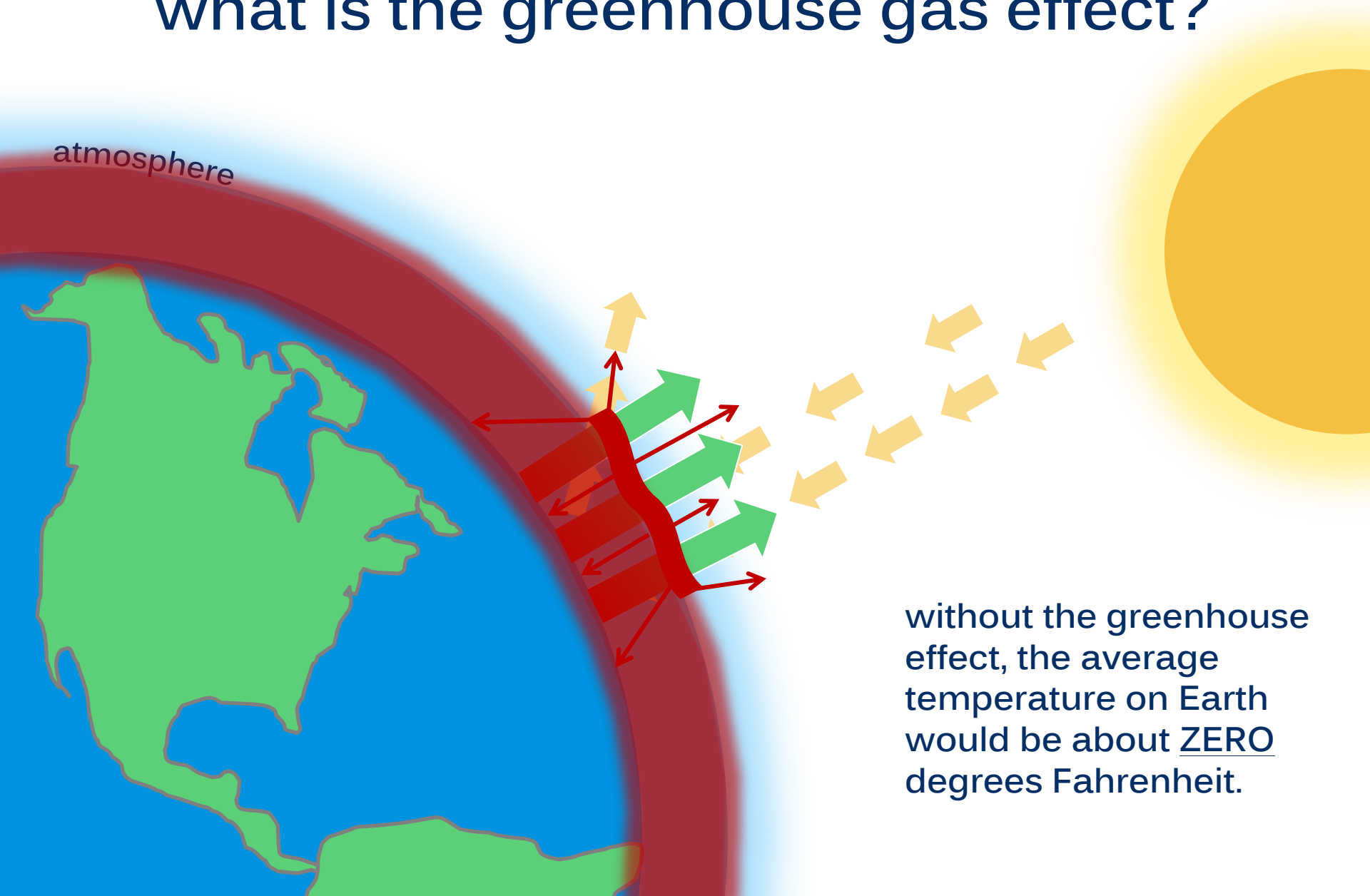



without the greenhouse effect, the average temperature on Earth would be about <u>ZERO</u> degrees Fahrenheit.

# why are they called “greenhouse” gases?

# what is the greenhouse gas effect?




without the greenhouse effect, the average temperature on Earth would be about ZERO degrees Fahrenheit.

# Just a short recap:

- weather and climate are different
  - think outfit vs. closet

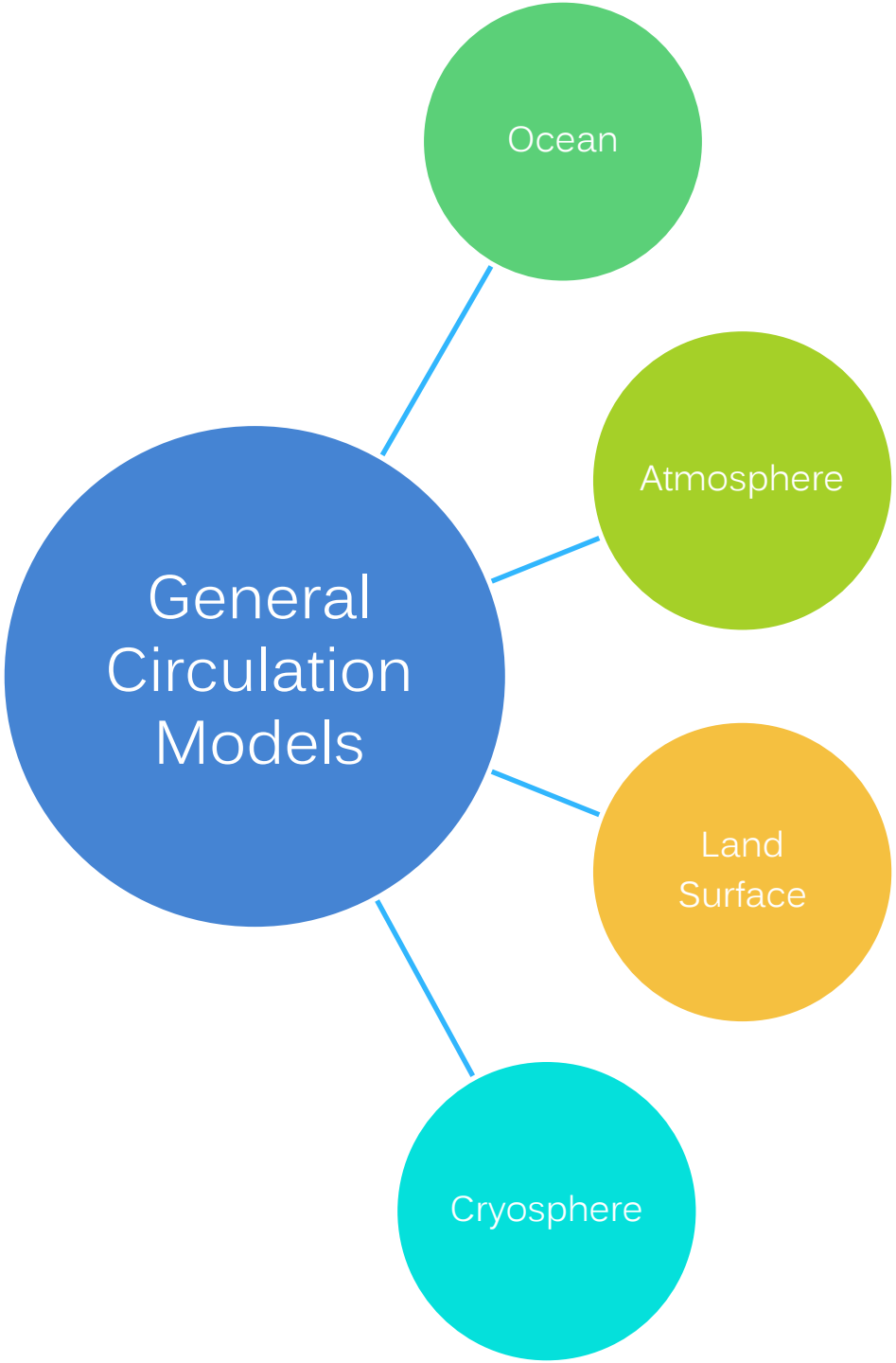
- increasing global temperatures
  - 1.4 degrees between 1880 and 2012

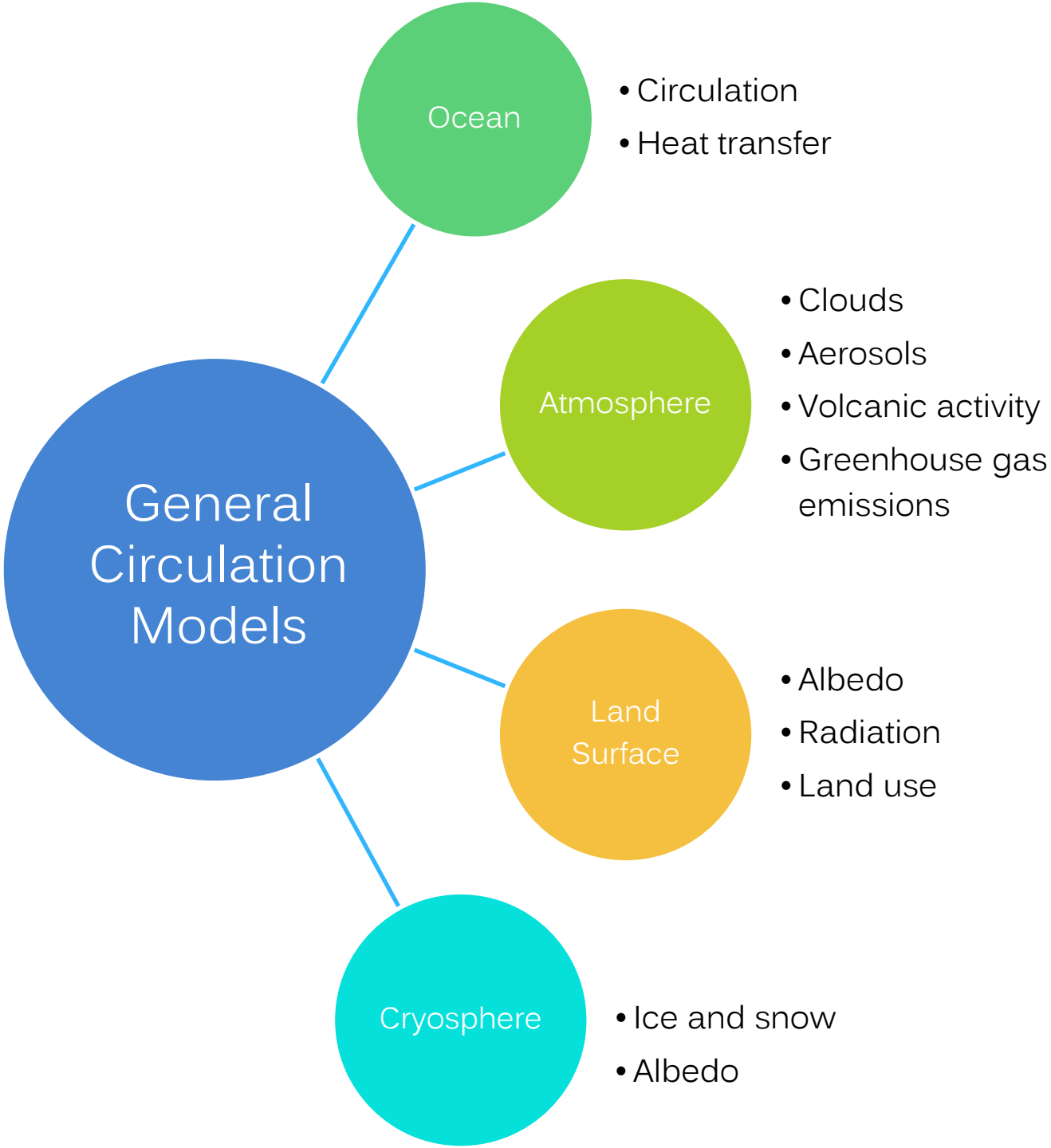
- increasing temperatures in the United States
  - nearly 2 degrees since 1895

- changes in climate are a natural process
  - humans disrupting natural climate system
  - concentration of carbon dioxide is highest its been in 400,000 years

- changes caused by increases in greenhouse gases
  - carbon dioxide, methane, water vapor
  - different lifetimes in the atmosphere (carbon dioxide = decades)

- greenhouse gas effect is a natural process
  - Earth would be 0 degrees without it!
  - more greenhouse gases in the atmosphere = more warming


General Circulation Models
Ocean
Atmosphere
Land Surface
Cryosphere


General Circulation Models
Ocean
• Circulation
• Heat transfer
Atmosphere
• Clouds
• Aerosols
• Volcanic activity
• Greenhouse gas emissions
Land Surface
• Albedo
• Radiation
• Land use
Cryosphere
• Ice and snow
• Albedo

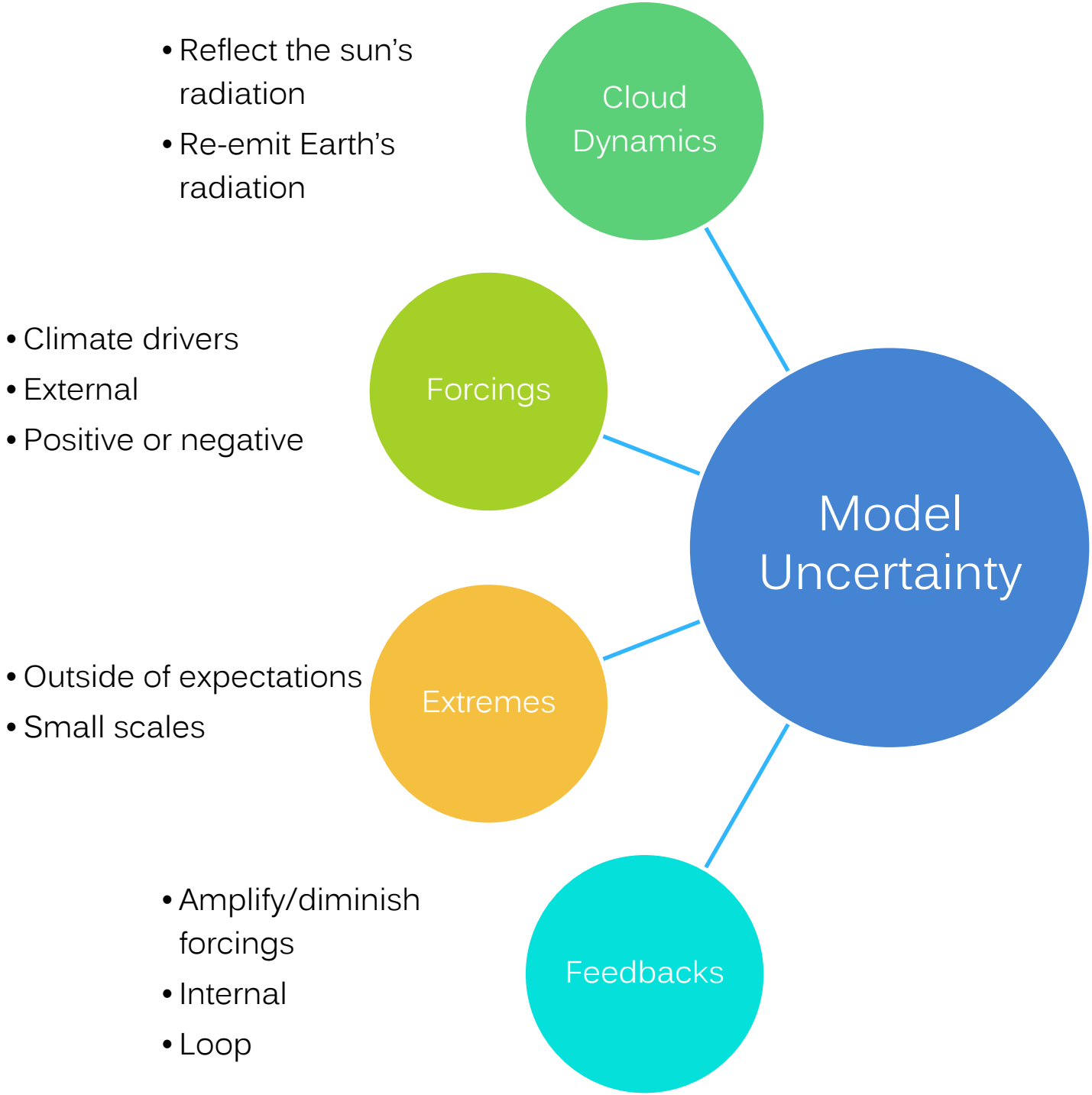
# aren’t climate models uncertain?

# isn’t there uncertainty in future projections?

aren’t climate models uncertain?

isn’t there uncertainty in future projections?

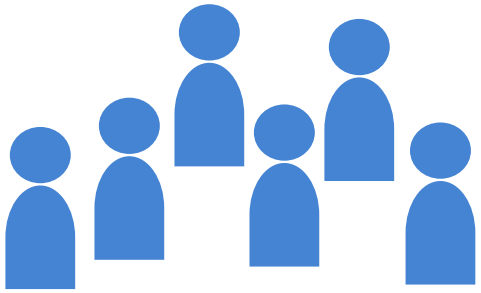
yes!


• Reflect the sun's radiation
• Re-emit Earth's radiation
Cloud Dynamics
• Climate drivers
• External
• Positive or negative
Forcings
Model Uncertainty
• Outside of expectations
• Small scales
Extremes
• Amplify/diminish forcings
• Internal
• Loop
Feedbacks

climate models

?

future greenhouse gas emissions

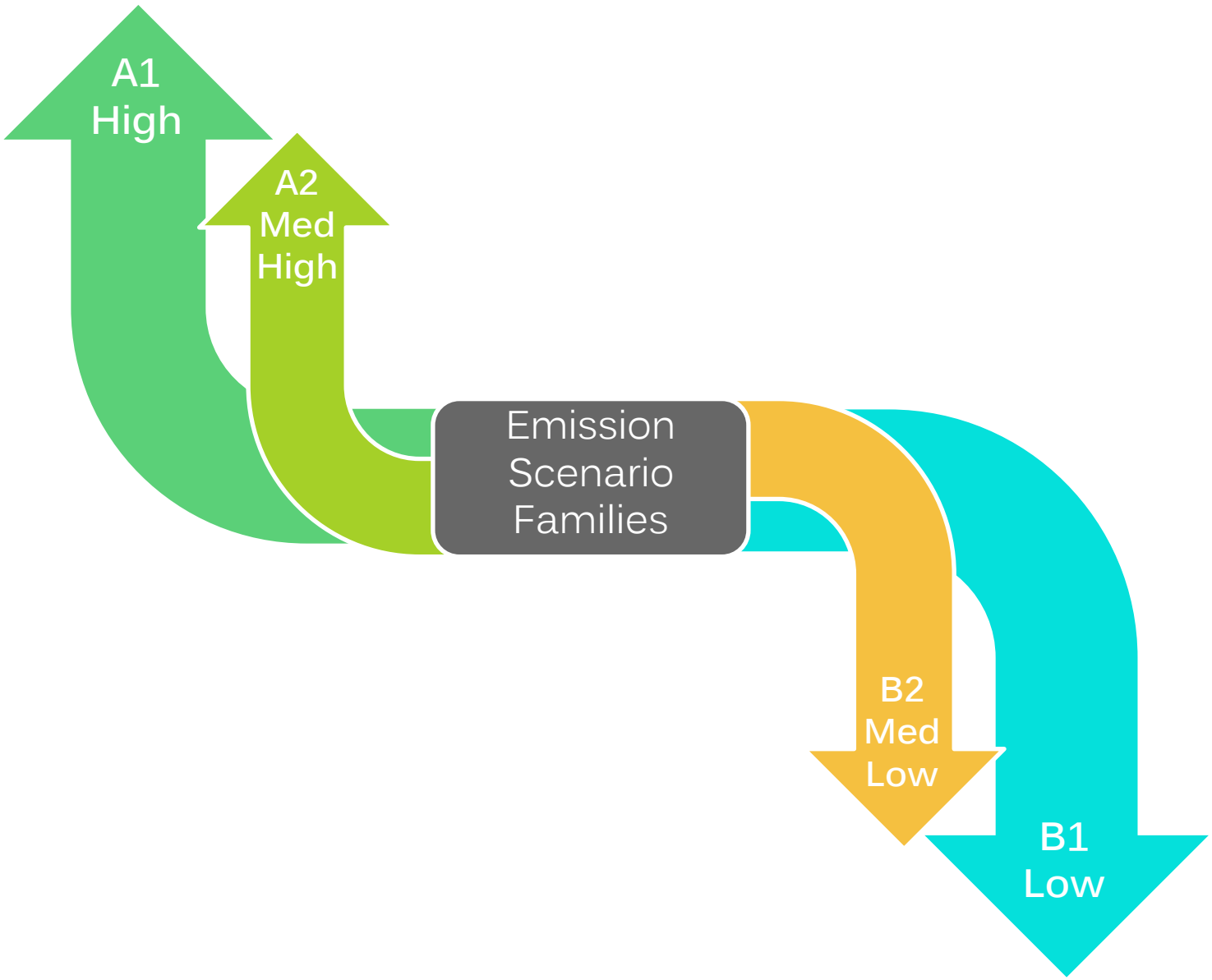


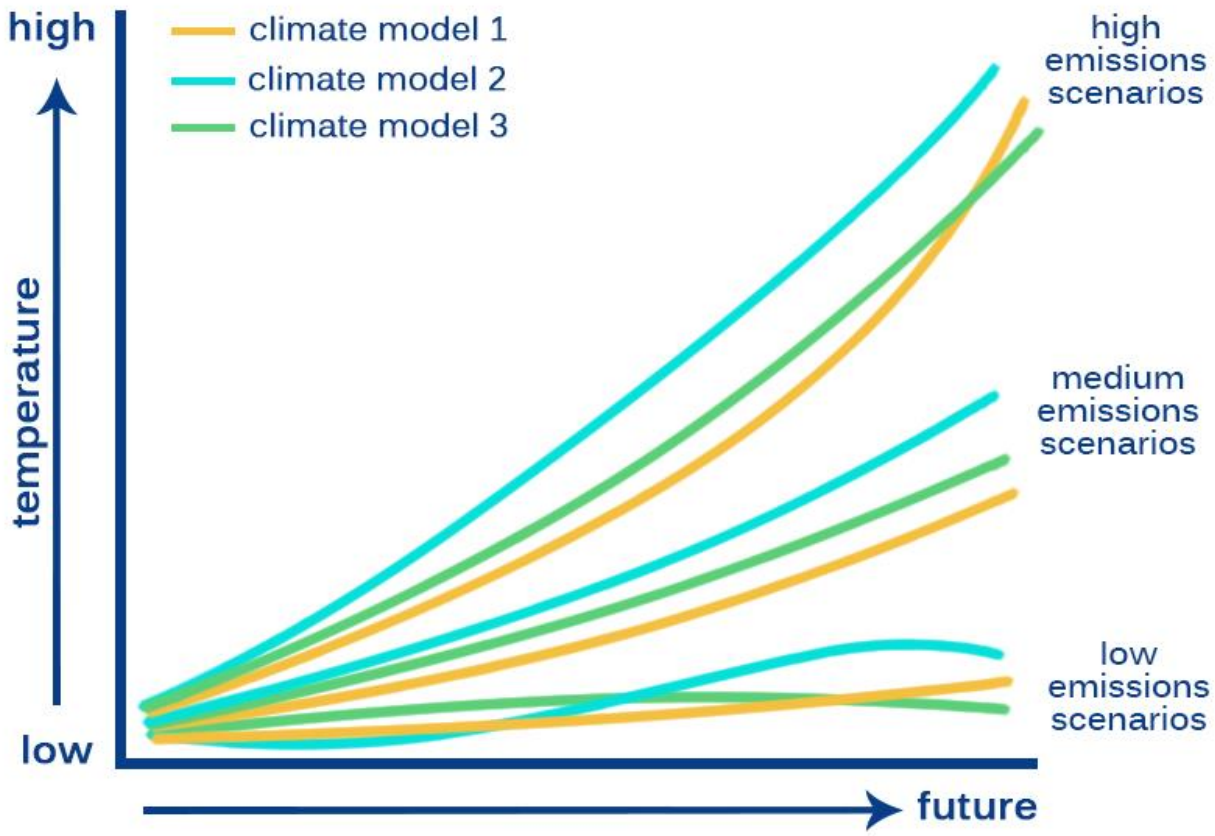
demographics

$$$

economics

technology


A1
High
A2
Med
High
Emission
Scenario
Families
B2
Med
Low
B1
Low


high
climate model 1
climate model 2
climate model 3
high emissions scenarios
temperature
medium emissions scenarios
low emissions scenarios
low
future

# Just a short recap:

- general circulation models simulate future global climate
  - oceans, atmosphere, land surfaces, cryosphere

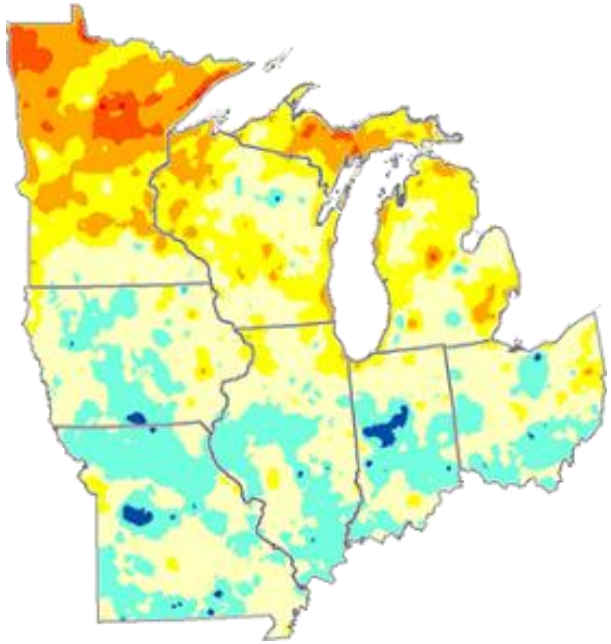
- uncertainty within general circulation models
  - cloud dynamics, forcings, extremes, feedbacks
  - models still do a good job of replicating past climate

- uncertainty with future greenhouse gas emissions
  - expectations about future demographics, economics, technology
  - emissions scenarios = inputs into climate models

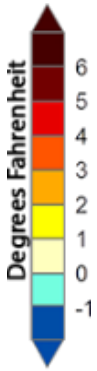
- range of plausible futures
  - use a range of climate models
  - use a range of emissions scenarios
  - despite uncertainties, can still plan for range of futures

# Regional Changes

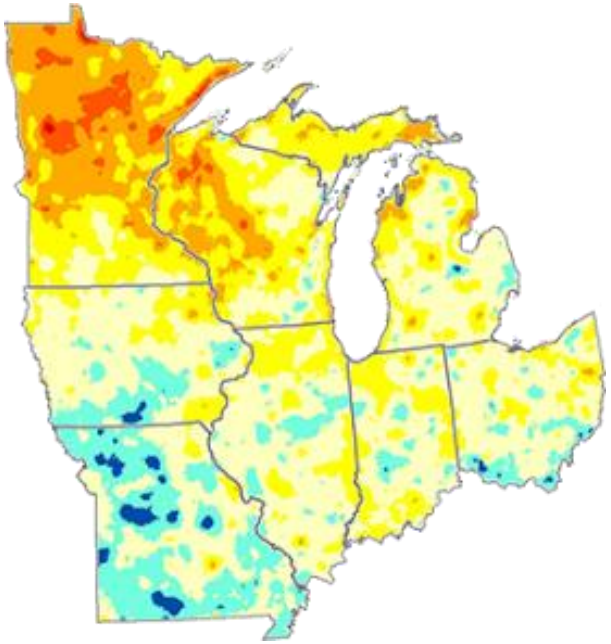
1895-2011



0.83°F



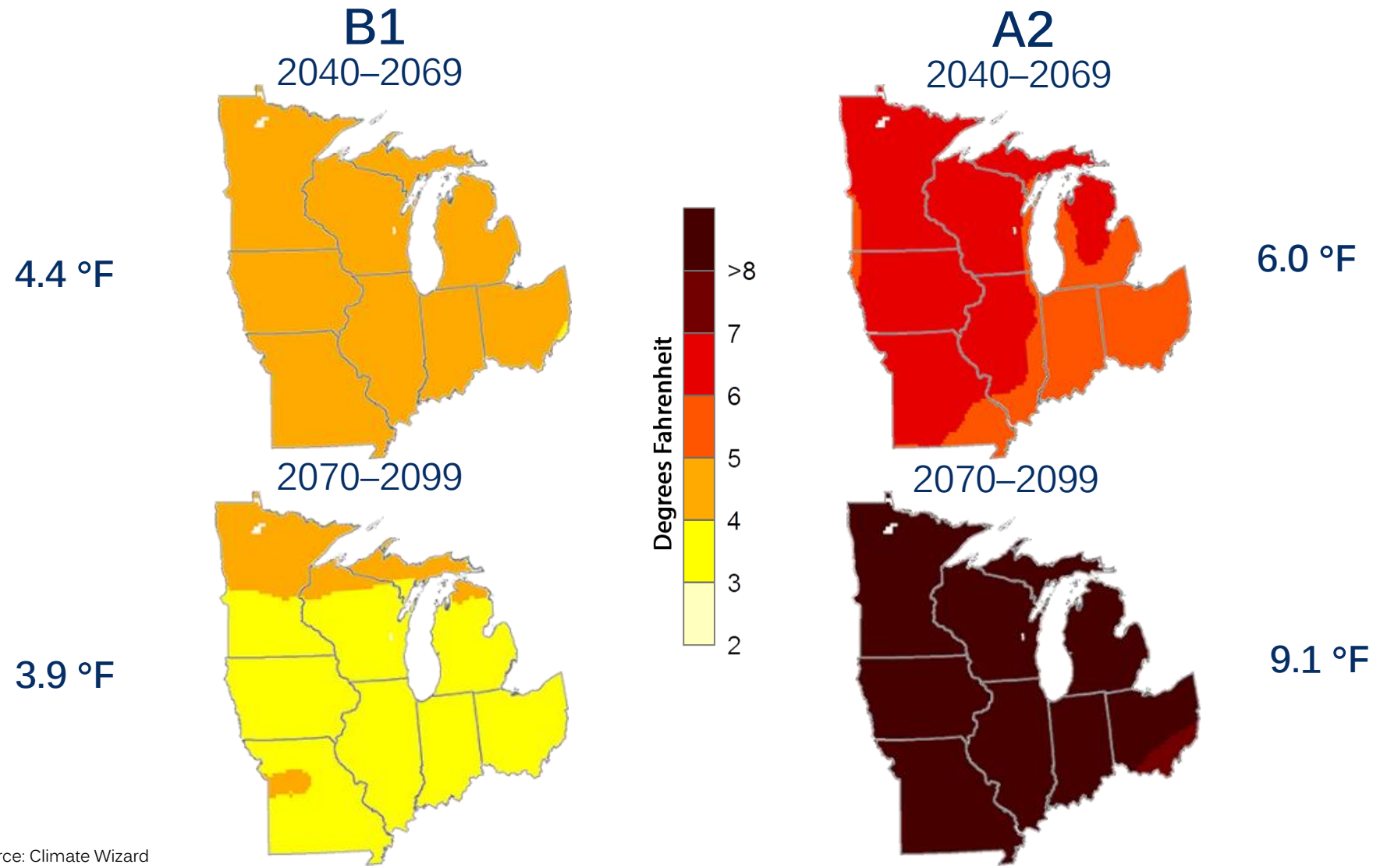

1950-2011



0.97°F

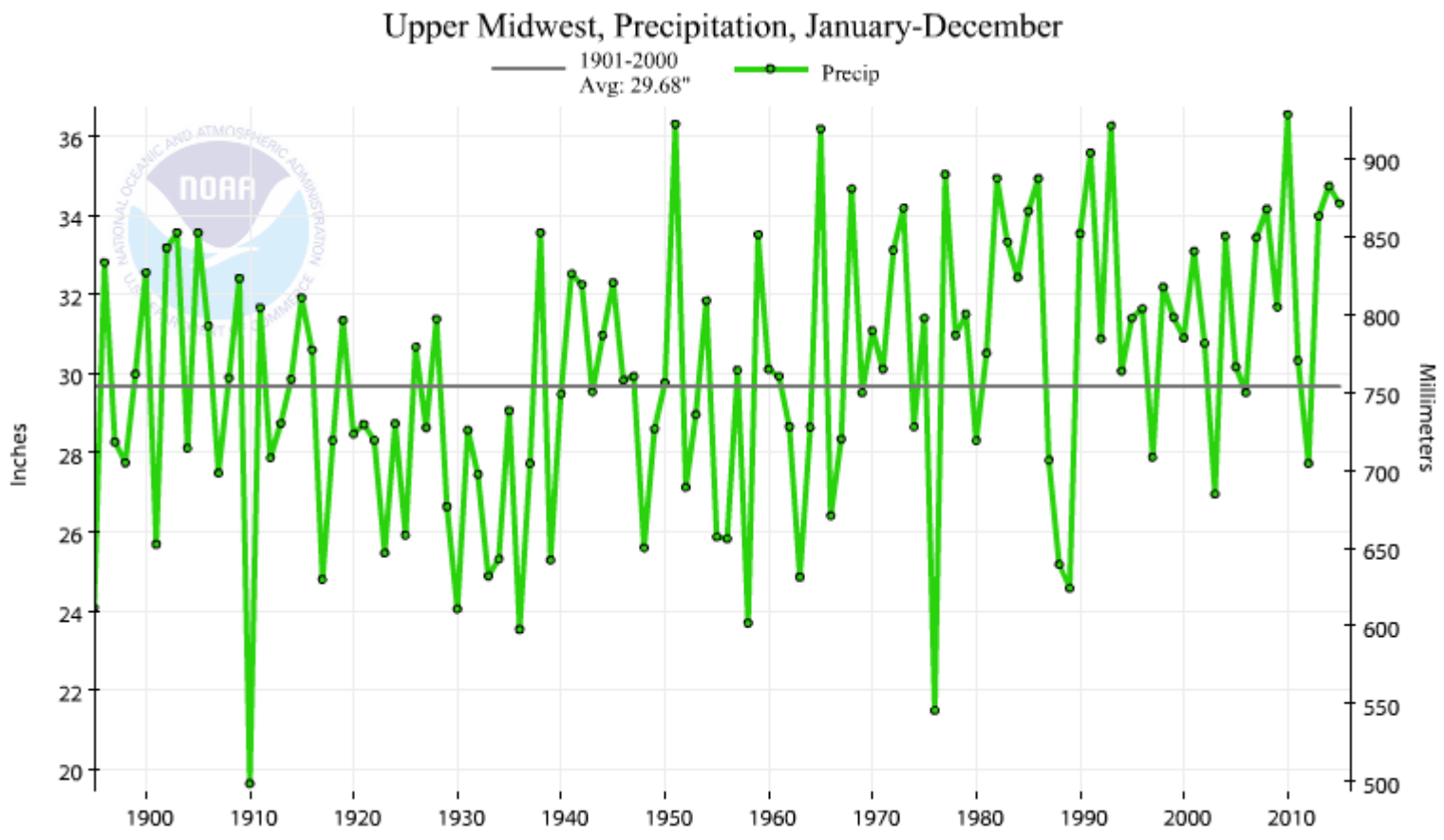
Source: Climate Wizard

# Regional Projections




Source: Climate Wizard

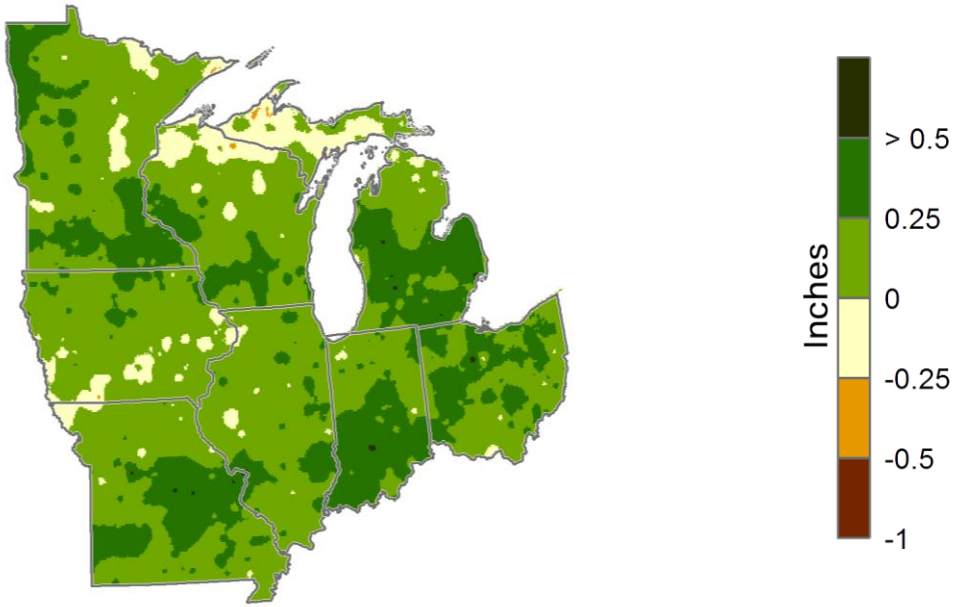
# Precipitation Trends




Source: NOAA NCDC

# Precipitation Trends

1951-2006




**0.18 in.**

Source: Climate Wizard

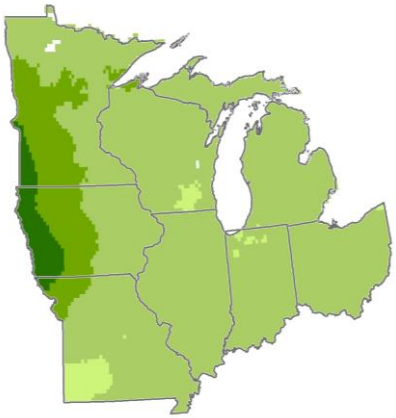
# Precipitation Projections

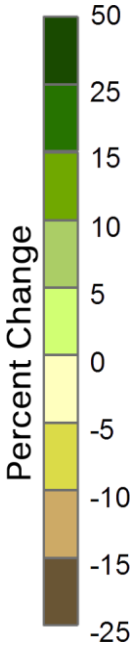
## B1
2040–2069

5.2%

2070–2099

8.0%

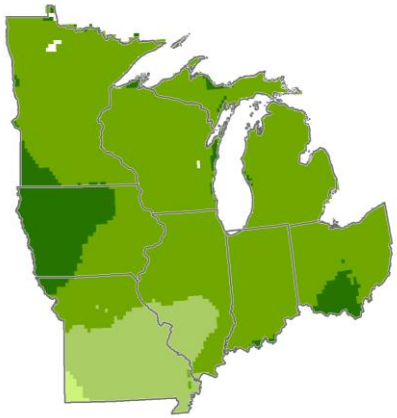





## A2
2040–2069

5.6%

2070–2099



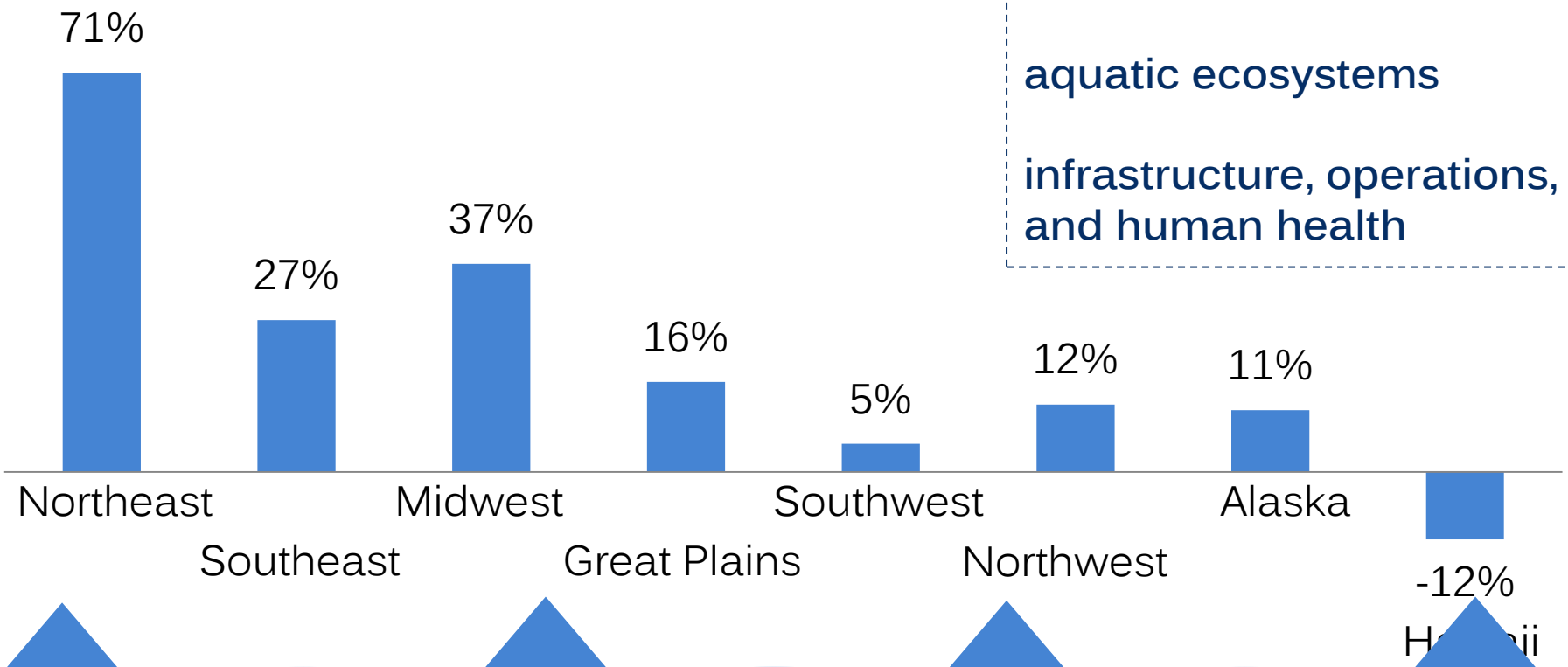
13.0%

Source: Climate Wizard

# Effects

# Water Resources

## Observed Percent Change in Very Heavy Precipitation 1958-2012




erosion

aquatic ecosystems

infrastructure, operations, and human health

National Climate Assessment 2014

# Water Resources

high magnitude snowfall

lake effect snowfall

National Climate Assessment 2014

# Water Resources

snow-water equivalent

earlier snowmelt

National Climate Assessment 2014

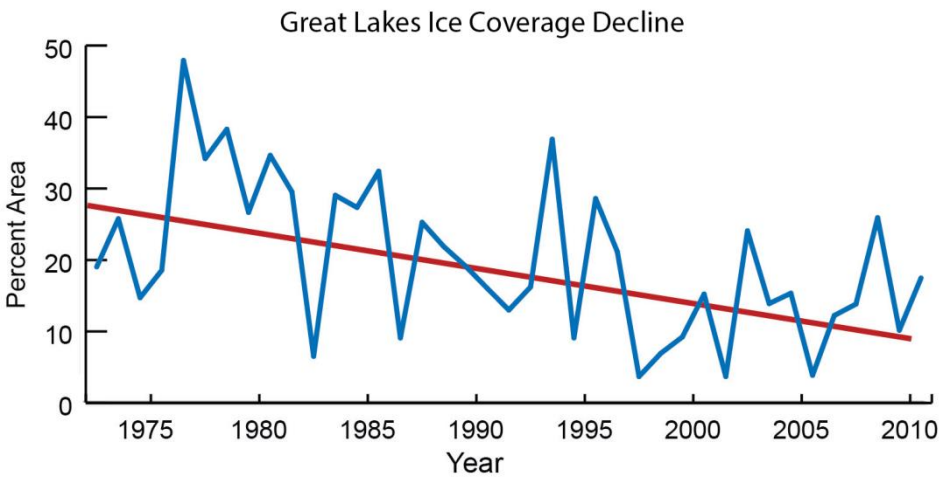
# Great Lakes

ice cover

erosion

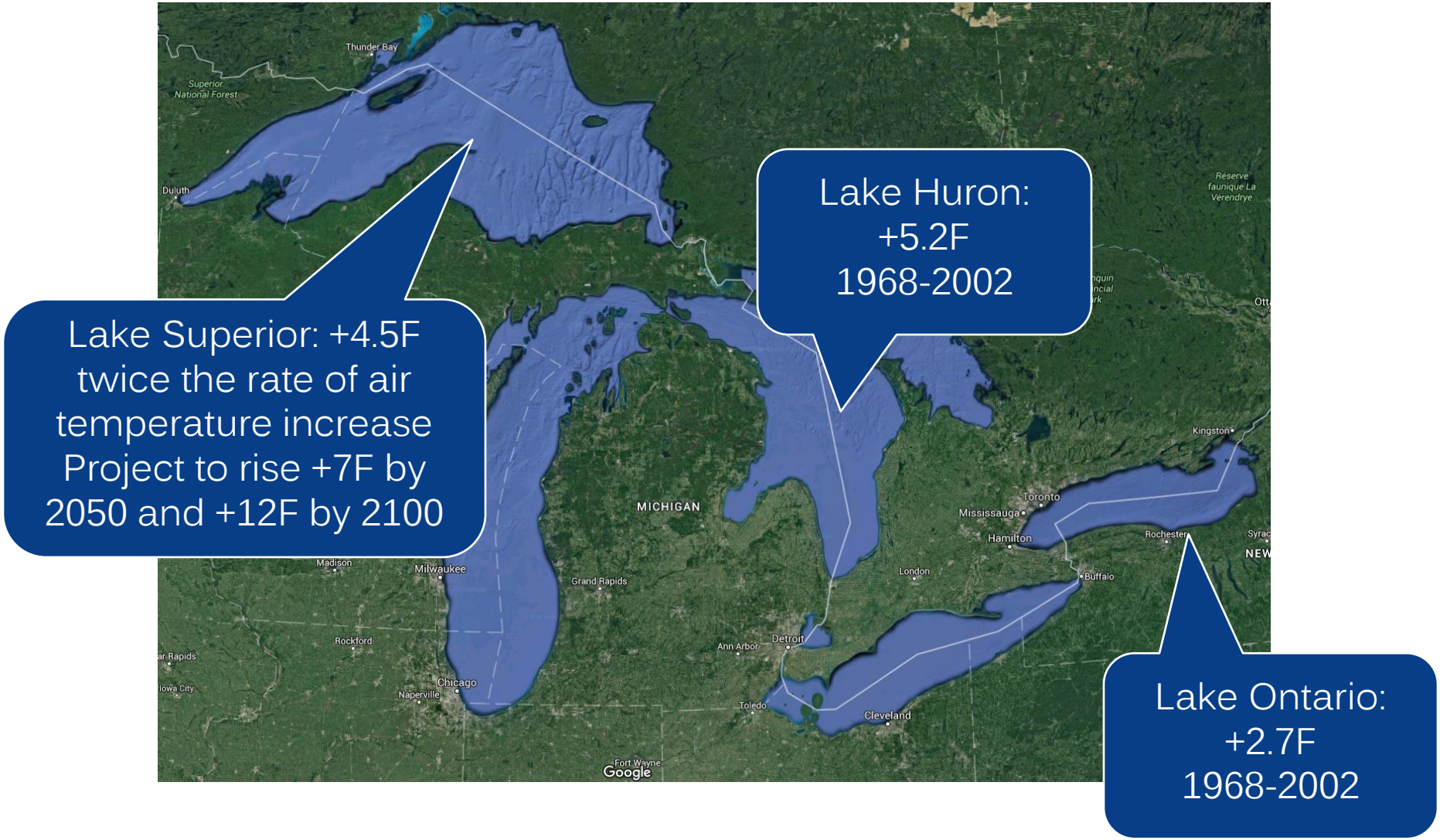
flooding

aquatic ecosystems

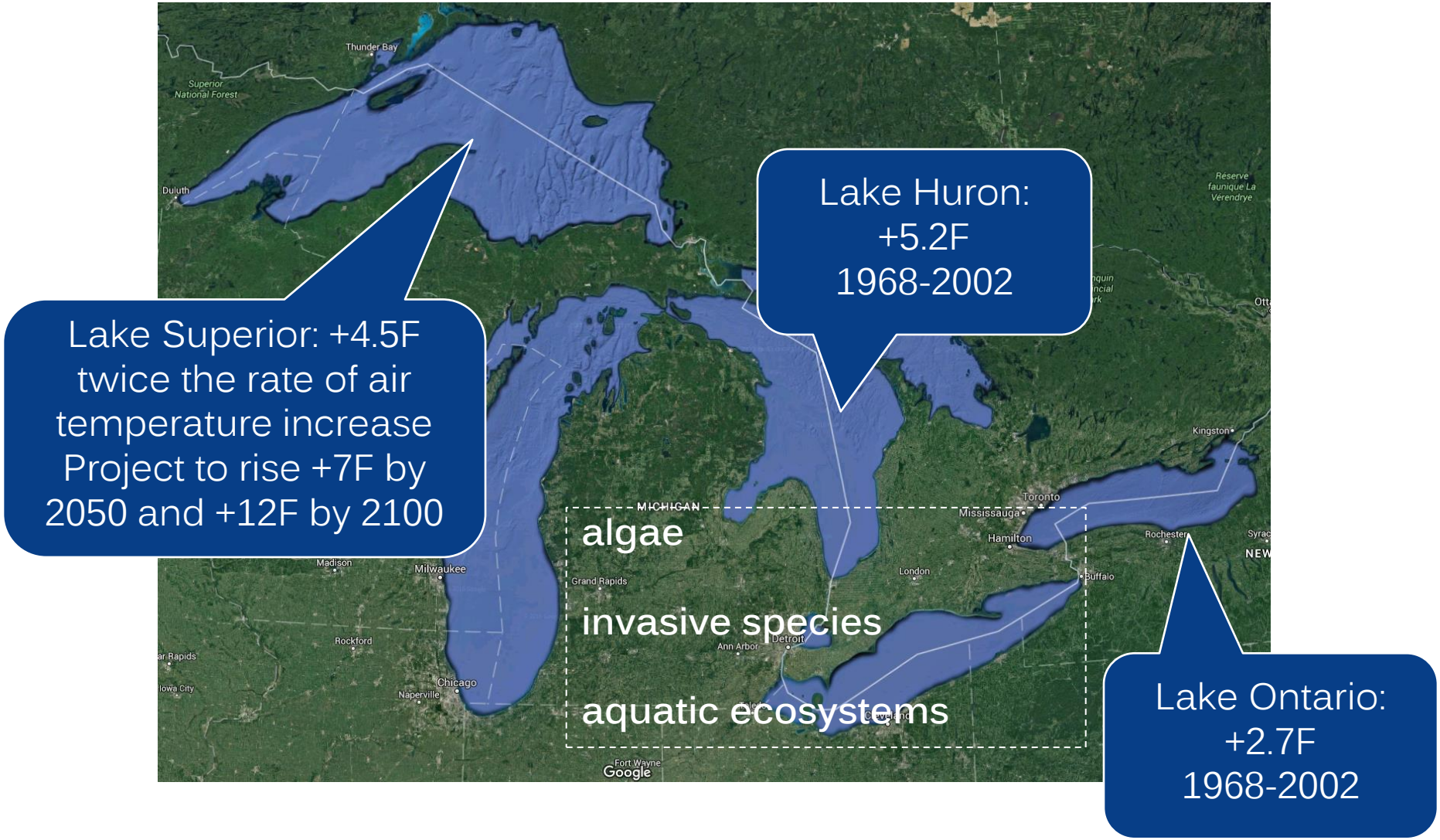

National Climate Assessment 2014 (and draft)

# Great Lakes




National Climate Assessment 2014

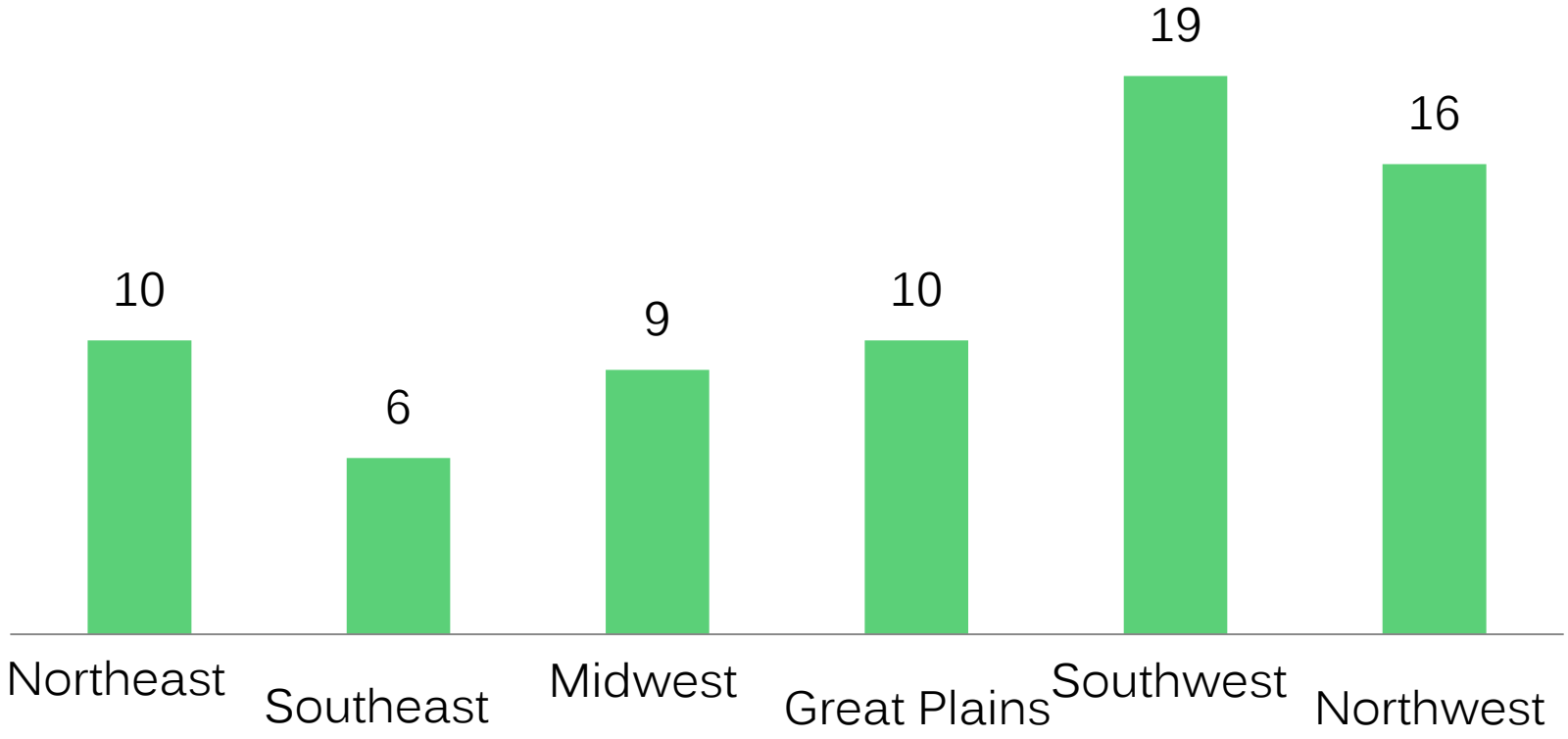
# Great Lakes




National Climate Assessment 2014

# Growing Season

## Observed Increase in Frost-free Season Length (days) 1991-2012 relative to 1901-1960




National Climate Assessment 2014

# Species Range Shift

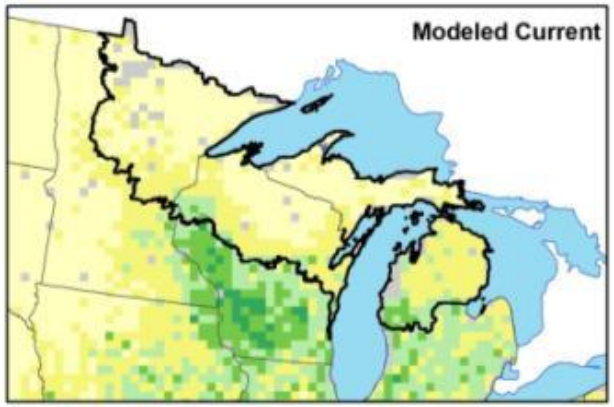
## White Oak

Current

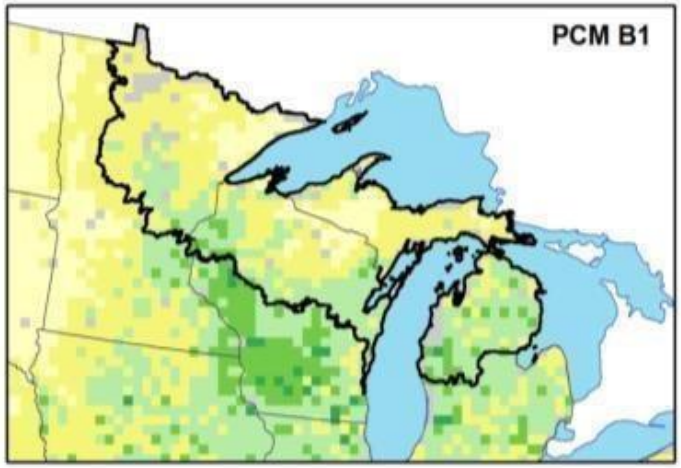
Importance Value

Low

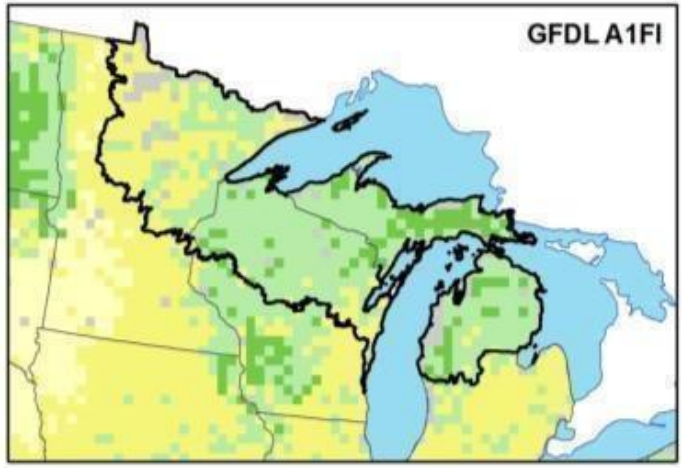
High




2070-2100 Low




2070-2100 High




www.fs.fed.us/nrs/atlas/

# Species Range Shift

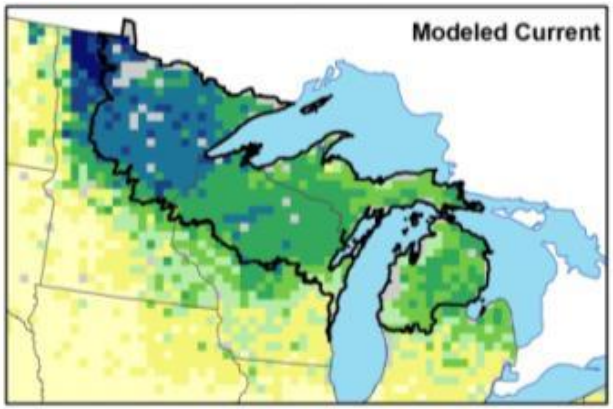
## Quaking Aspen

Current

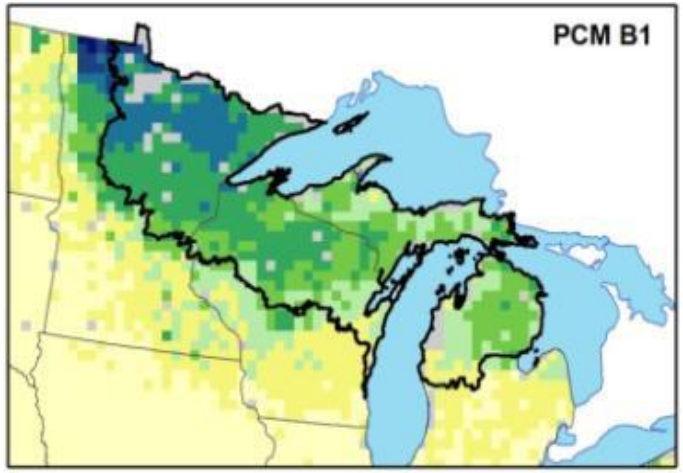
Importance Value

Low

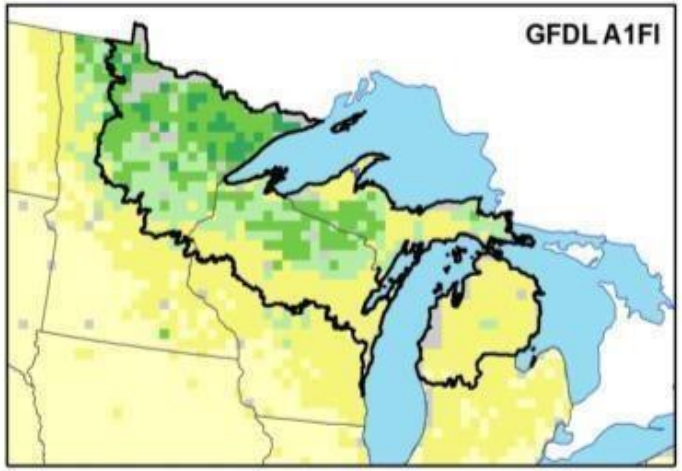
High




2070-2100 Low




2070-2100 High




National Climate Assessment 2014

# Just a short recap:

- Midwest temperature changes
  - increased over the last 100+ and 50+ years
  - projected to increase from 4-9 degrees Fahrenheit by 2100

- Midwest precipitation changes
  - slight increase over the past 50 years
  - projected to increase and become wetter by 2100

- climate change effects
  - more frequent heavy precipitation events
  - more lake effect snow, less SWE, earlier snowmelt
  - decreasing lake ice and increasing lake surface water temperatures
  - increase in length of growing season
  - changes in species range

# Who Ya Gonna Call?

## NIACS!

- **Advocate** for climate informed management and adaptation
- **Support/Coach**
  - Work with a diversity of landowners, agencies and groups
- **Facilitate**
- **Outreach/Educator/Cheerleader**
  - Climate change issues and impacts
  - Adaptation strategies and actions
- **Translate**
  - Synthesize and translate technical information to land managers

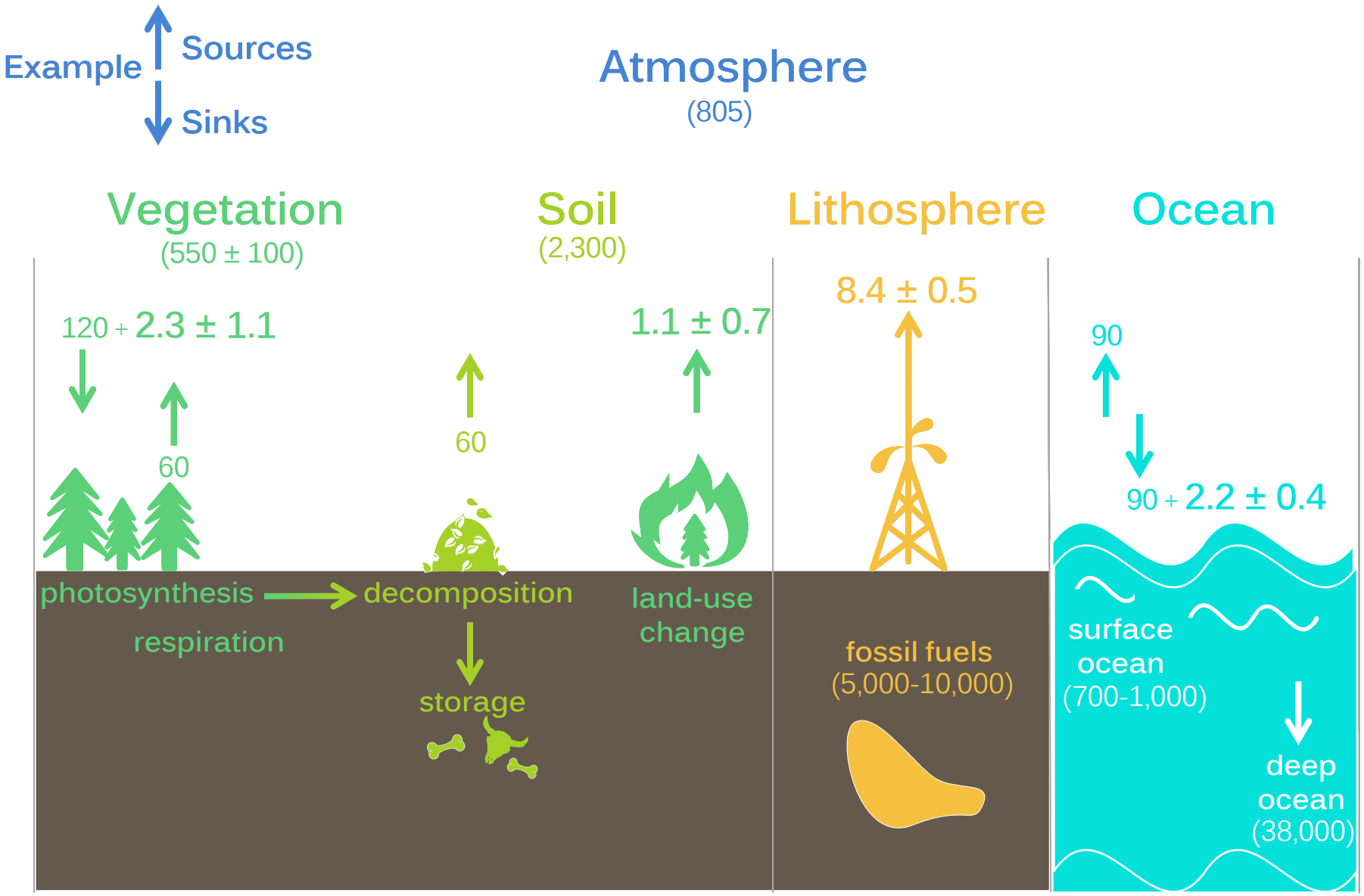
www.nrs.fs.fed.us/niacs/

# thank you!

if you'd like *even* more information, check out the climate change resource center (www.fs.usda.gov/ccrc/)

And feel free to contact me at kfmarcin@mtu.edu OR kfmarcinkowski@fs.fed.us

# questions?


Example
Sources
Sinks
Atmosphere
(805)
Vegetation
(550 ± 100)
Soil
(2,300)
Lithosphere
Ocean
120 + 2.3 ± 1.1
60
60
1.1 ± 0.7
8.4 ± 0.5
90
90 + 2.2 ± 0.4
photosynthesis
respiration
decomposition
storage
land-use change
fossil fuels
(5,000-10,000)
surface ocean
(700-1,000)
deep ocean
(38,000)