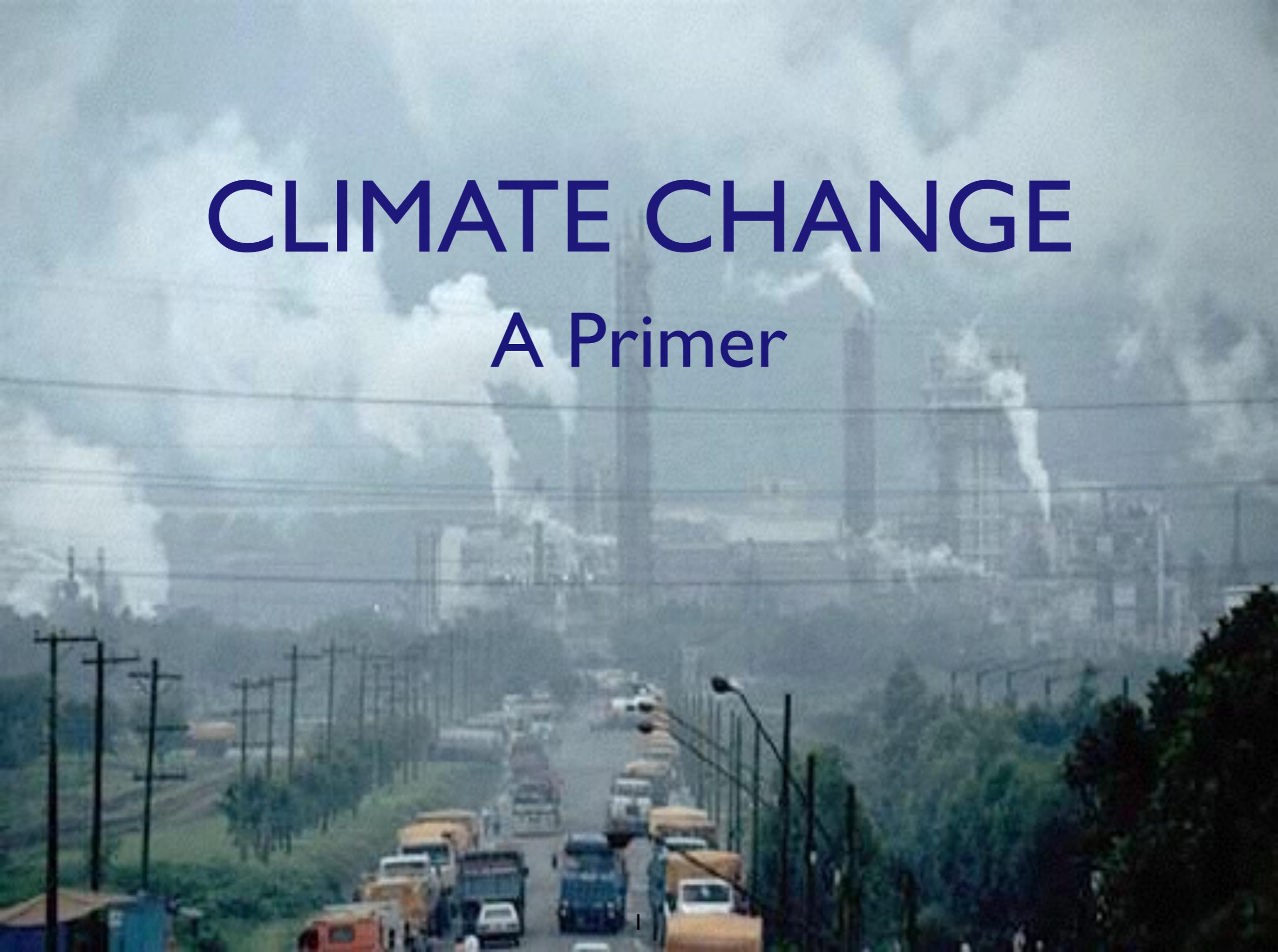


CLIMATE CHANGE

A Primer



Overview

- What is “climate?”
- How is climate changing?
- Why is climate changing?
- What are the impacts?
- What are the costs?
- What can we do about it?

What is Climate?

- It's not weather



Climate

- Pattern of weather in a region
- weather is what's occurring day-to-day
- average weather is determined by climate
- Climate defined over decades (~30 yrs)
- Complex interplay of factors determines climate

Tropical climates

- Rain forest
- Savannah

Dry climates

- Desert
- Steppe

Temperate climates

- Warm with dry winter
- Warm with dry summer
- Humid with hot summer
- Humid with cool summer

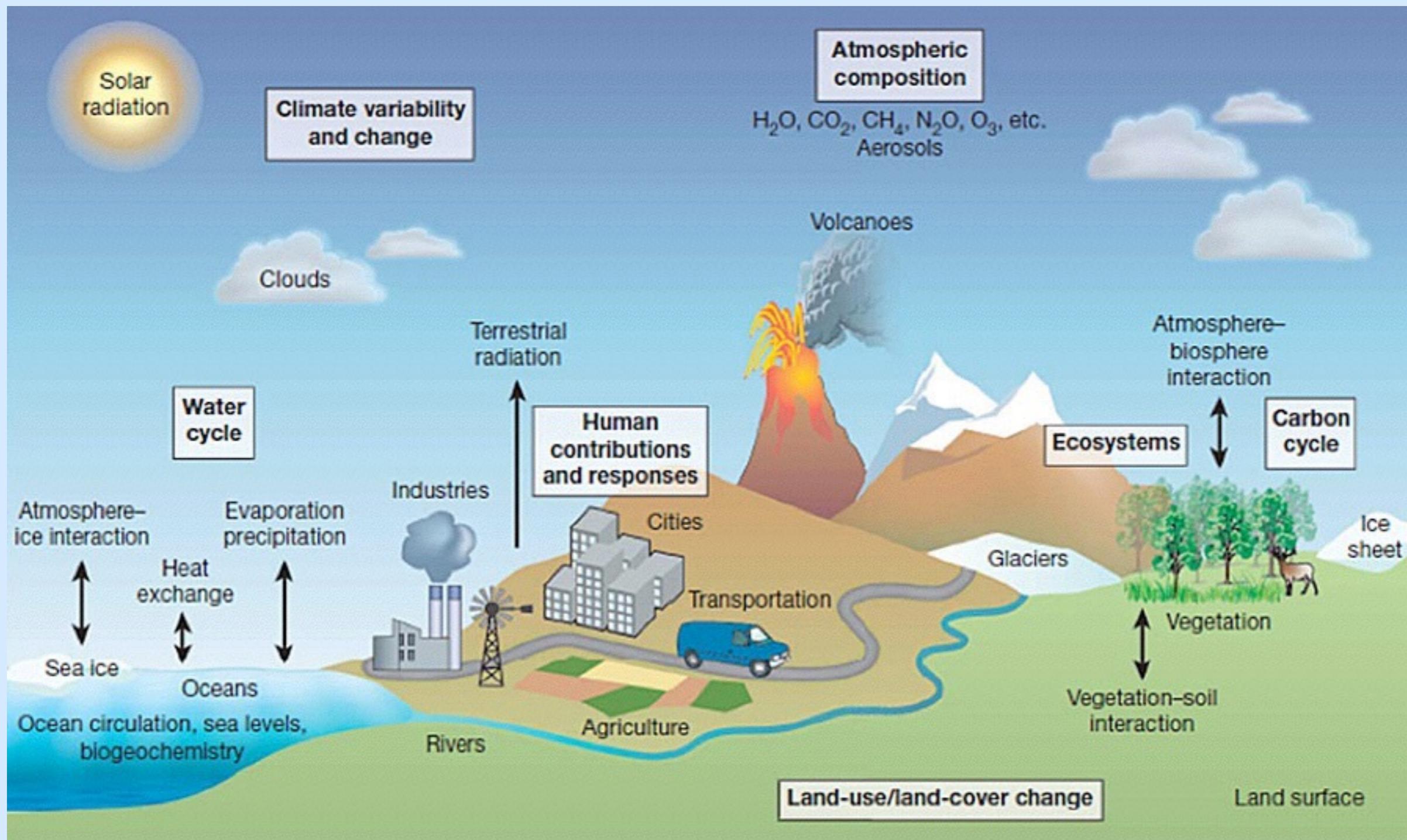
Continental climates

- Cold winter
- Cold, wet winter
- Cold, dry winter

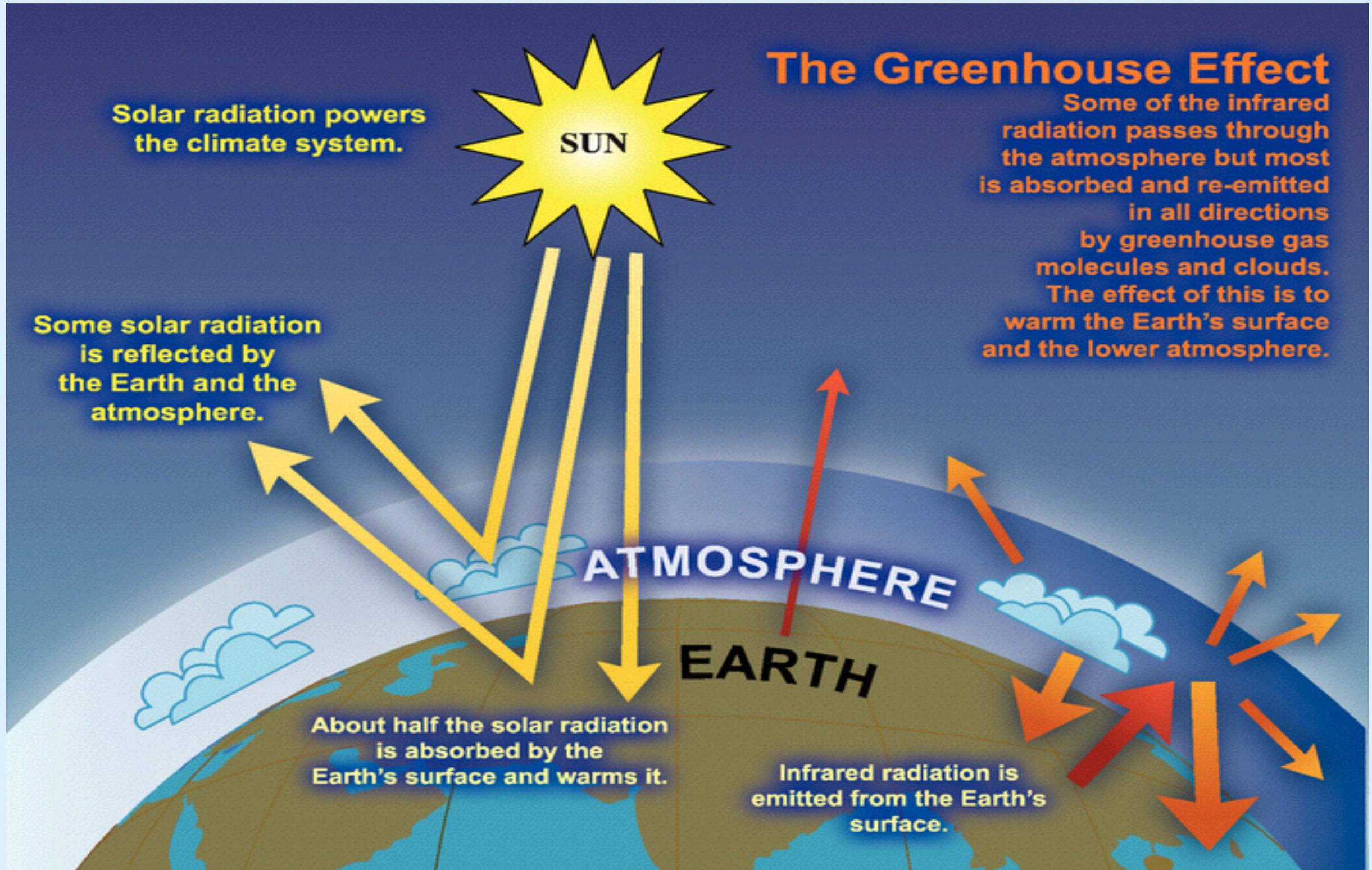
Polar & mountain climates

- Tundra
- Perpetual frost

Factors in Climate System

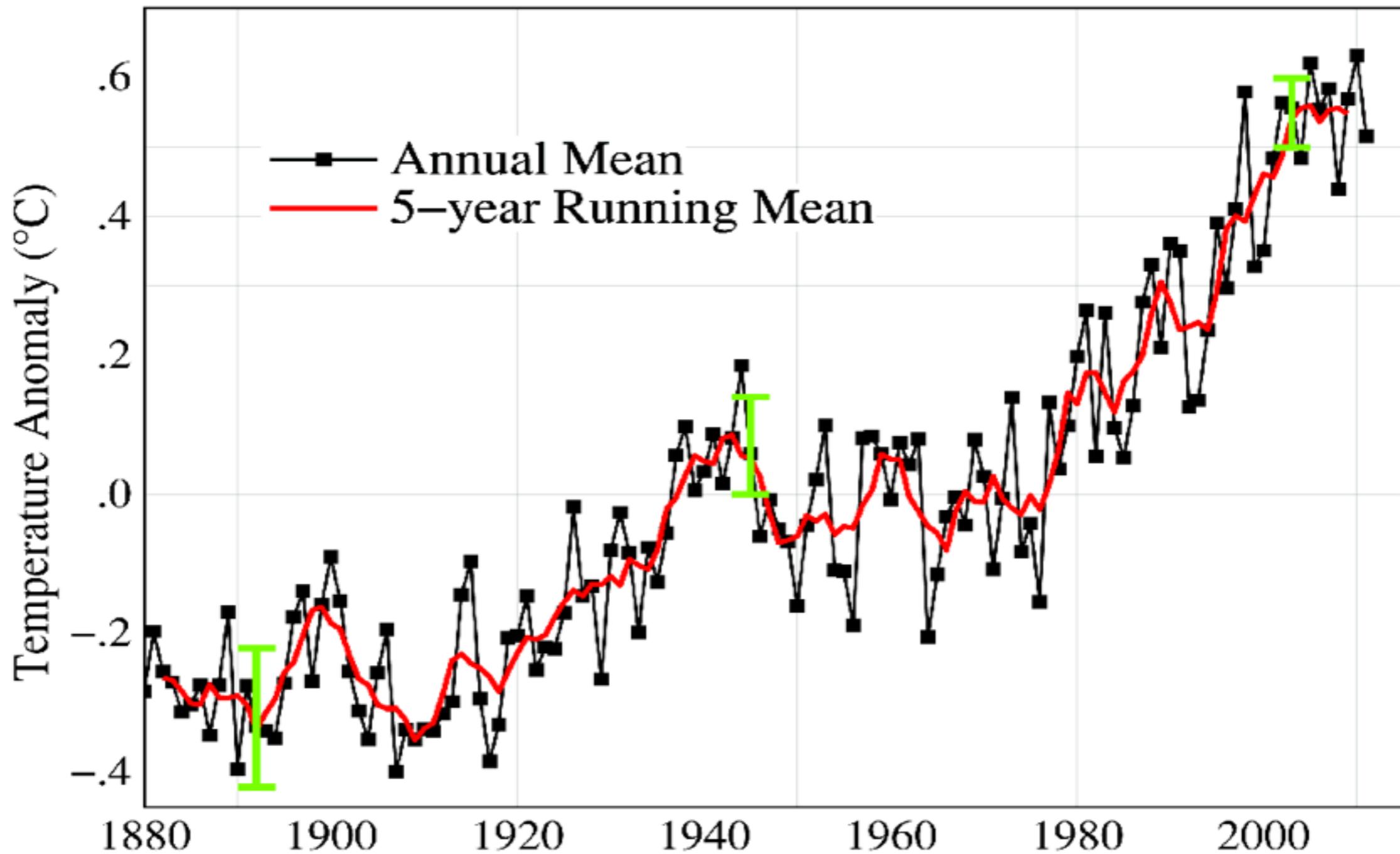


The Greenhouse Effect



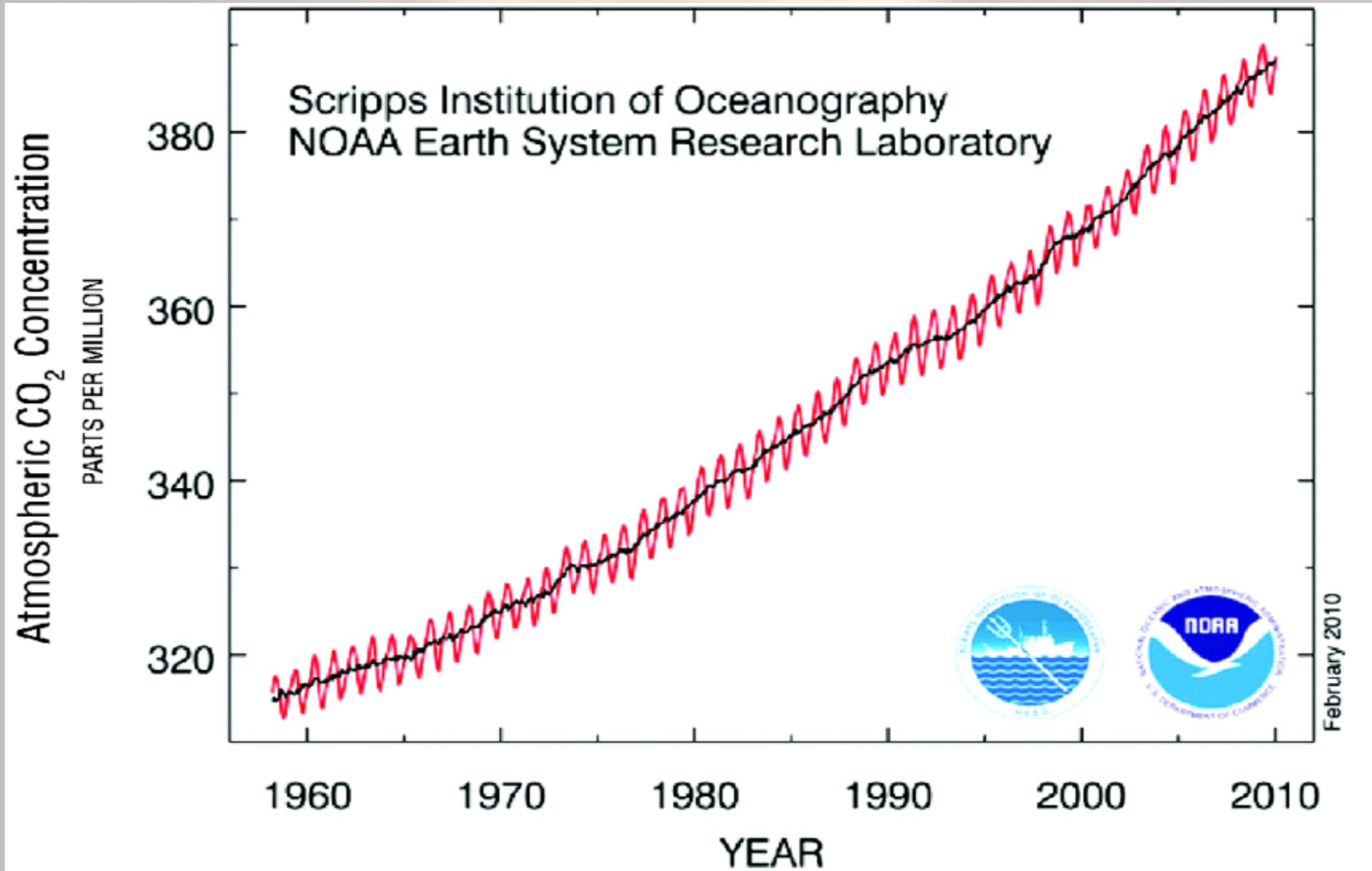
How is Climate Changing?

Global Land–Ocean Temperature Index

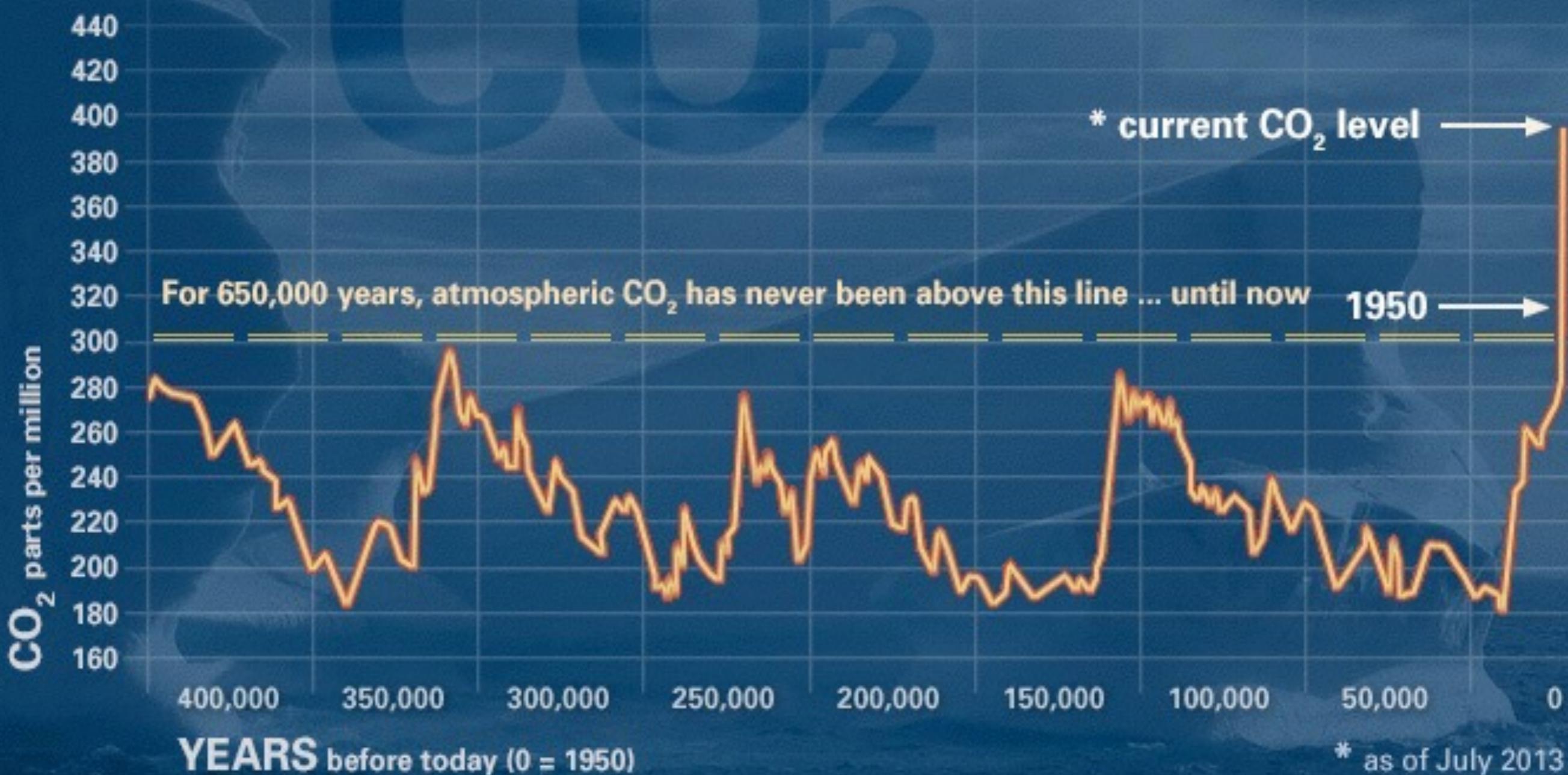


Why is Climate Changing?

CO₂



CO₂



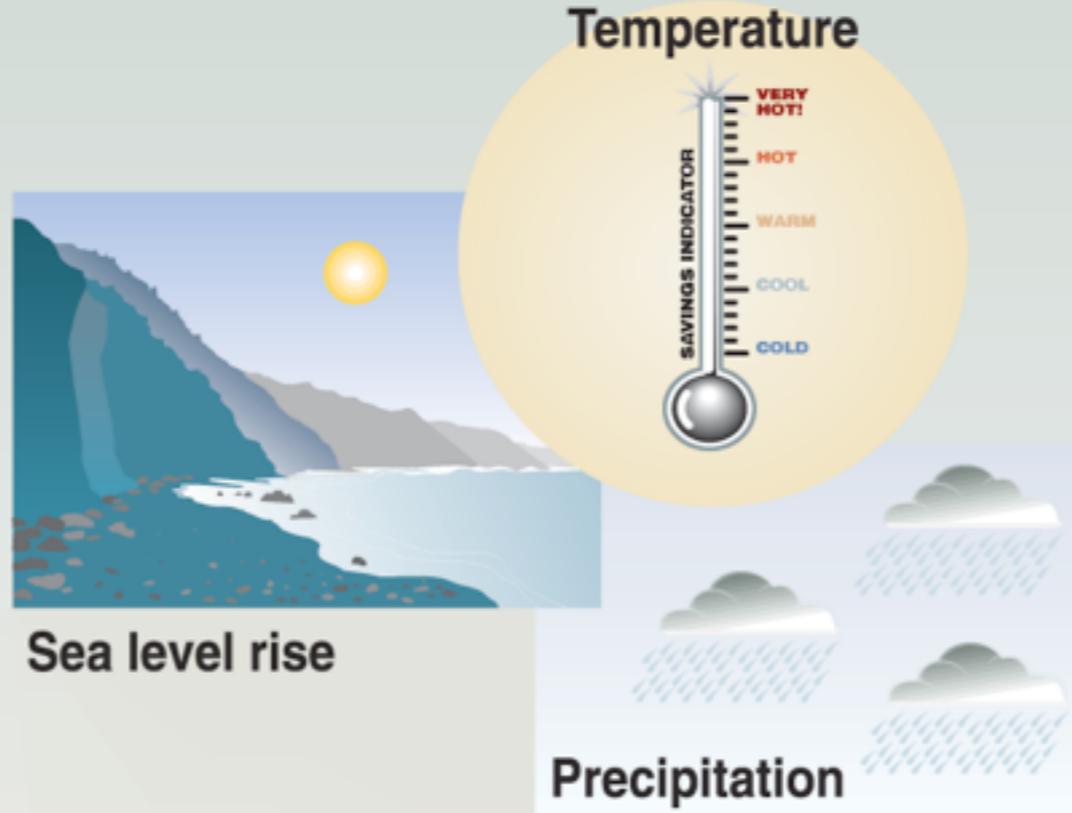
GLOBAL CLIMATE CHANGE
climate.nasa.gov

Other Human Activities Contribute to Climate Change

Deforestation/Land Use Changes



Impact



Impacts on...

Health



Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses

Agriculture



Crop yields
Irrigation demands

Forest



Forest composition
Geographic range of forest
Forest health and productivity

Water resources



Water supply
Water quality
Competition for water

coastal areas



Erosion of beaches
Inundation of coastal lands
additional costs to protect coastal communities

Species and natural areas



Loss of habitat and species
Cryosphere: diminishing glaciers

In Eastern Washington

- **2014 and 2015 hottest Junes on record since 1992**
- **Precipitation down 33%**
- **Declining snow pack**
- **Salmon dying in overheated rivers**

In Eastern Washington

- **Wheat yields down 30% to 60% in 2015**
- **Yakima Valley apple and cherry yields to decline by 20% to 25% by 2020s**

Pest Infestations

Spotted-wing drosophila first detected in California in 2008, was found in western Washington and parts of Oregon in 2009, and by 2010, it was detected in eastern Washington, Michigan, and six other states.



SOURCE: BETSY BEERS, WASHINGTON STATE UNIVERSITY

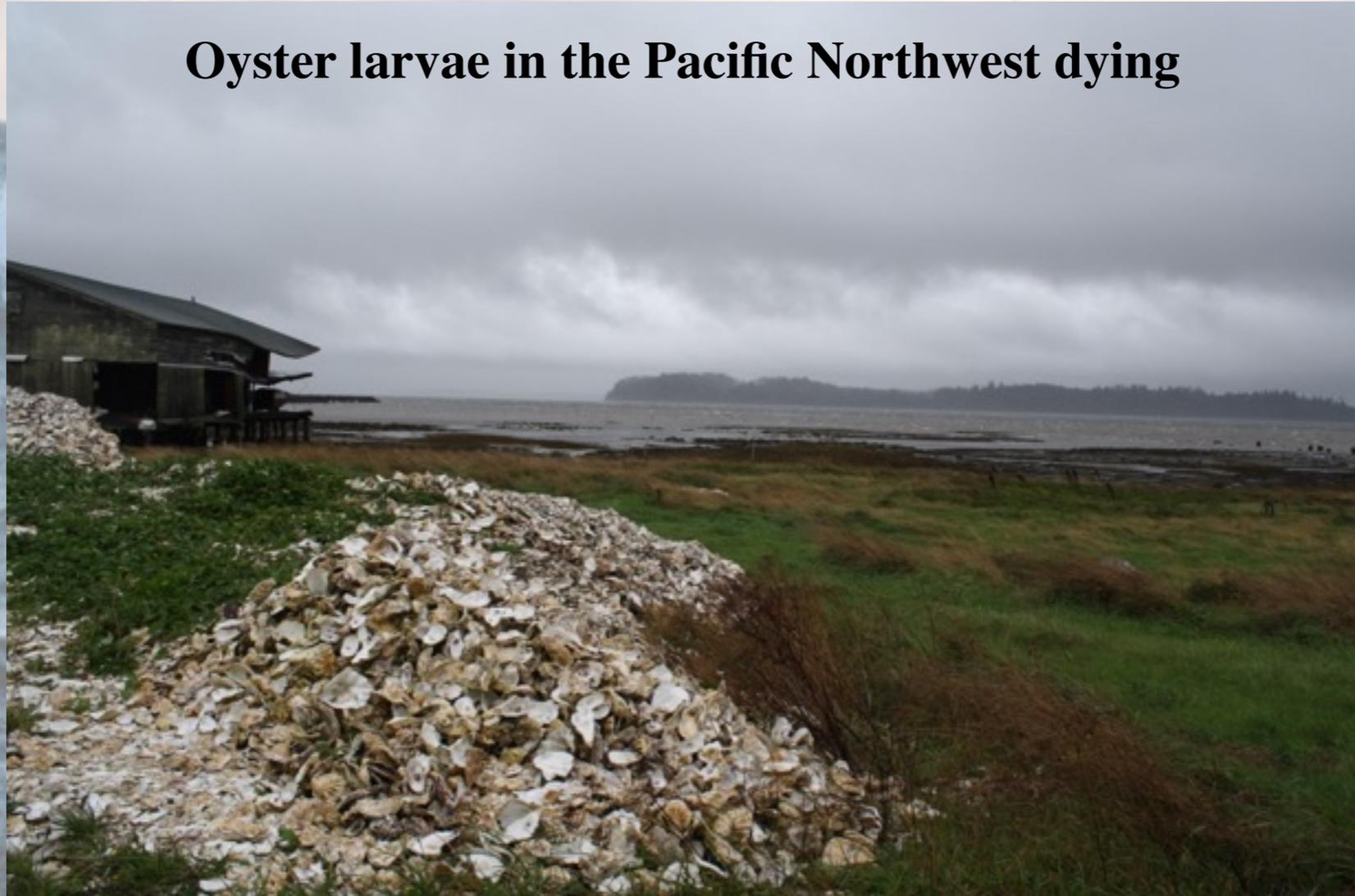
Ocean Acidification

Fundamental change in seawater chemistry

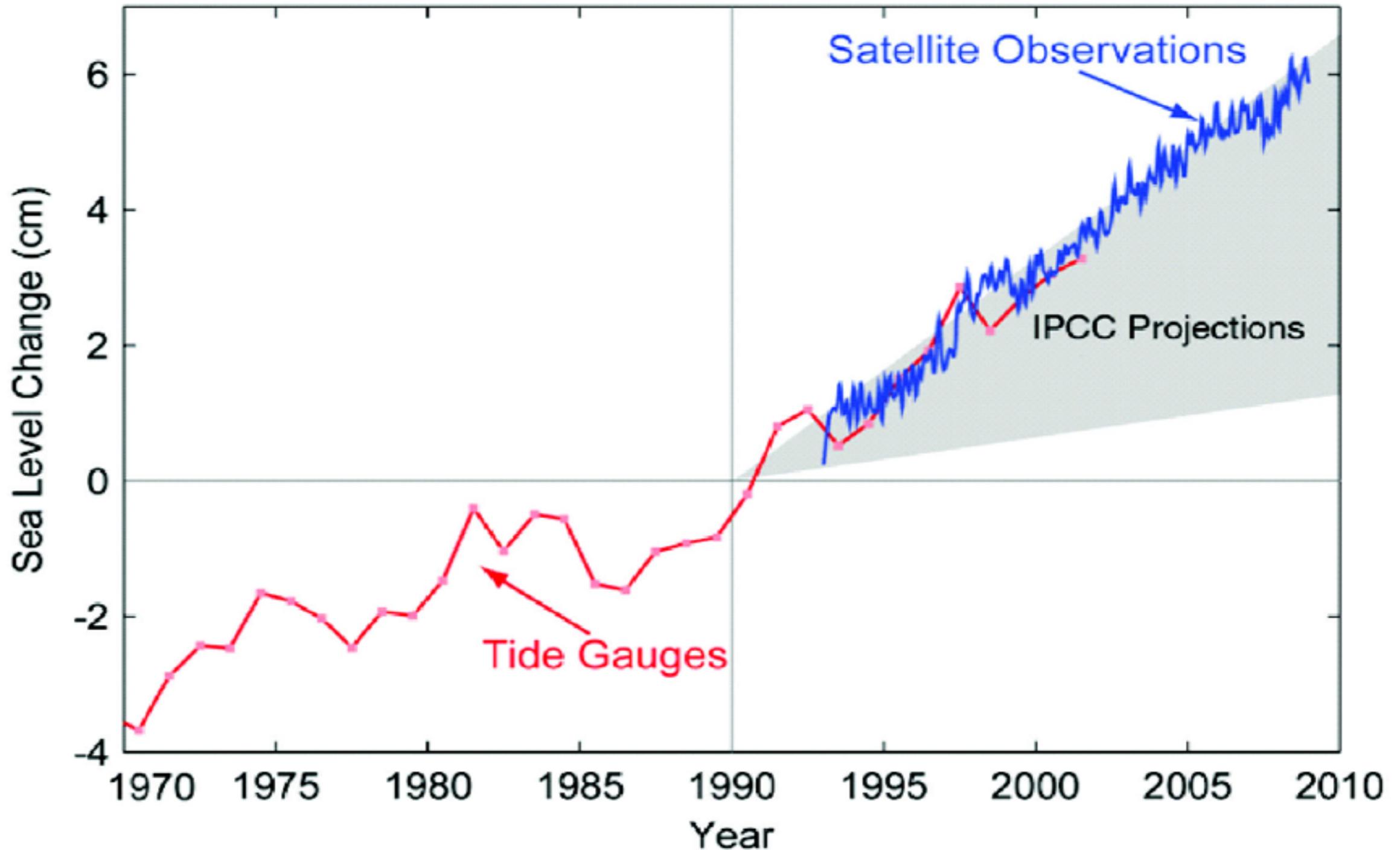
- Ocean absorbs ~25% of CO₂ released
- CO₂ makes seawater more acidic
- Changing ocean chemistry degrading marine ecosystems

Ocean Acidification Degrading Marine Ecosystems

Oyster larvae in the Pacific Northwest dying



Sea Level Rise



Sea Level Rise



Water Scarcity

- Persistent droughts
 - No ground water recharge for aquifers
- Lack of snowpack
 - Reduced stream flows

Wildfires

Over 10 million acres were burned in wildfires in the US in 2015 for the first time ever. Wildfire season in Washington was the largest in state history.

Extreme Weather

- Increased hurricane intensity, storm surges
- Increased incidence of heat waves



Changes in Ecosystems

“While warnings of melting glaciers, rising sea levels and other environmental changes are illustrative and important, ultimately, it's the ecological consequences that matter most.”

(JC Bergengren, et al, J. Climate Change, 2011)

Global Climate Change will “Terraform” the Planet

- ~40% land-based ecosystem from one type to another, e.g., grassland to desert
- Plant and animal species unable to migrate
- Crop, livestock, fishery losses
- Extinction --loss of biodiversity
- Invasive species

What are the Costs of Climate Change?

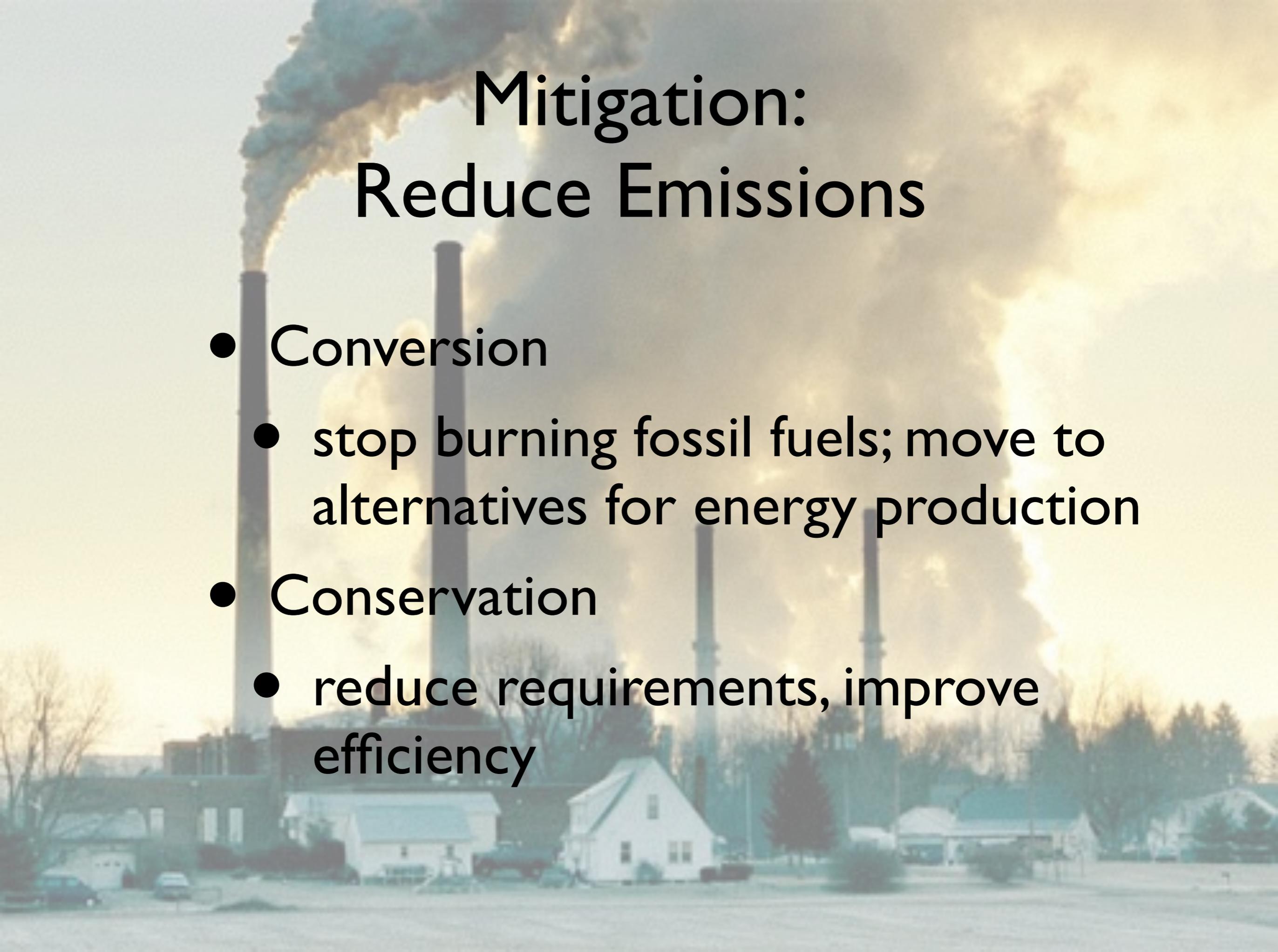
- Remedies for human health and well-being
- Disaster relief/rebuilding & adaptation
- Loss of income from agriculture, fisheries, forest product losses
- Societal displacement



What Can We Do About Climate Change?

- Mitigate
 - Fix it
- Adapt
 - Live with it (or not!)

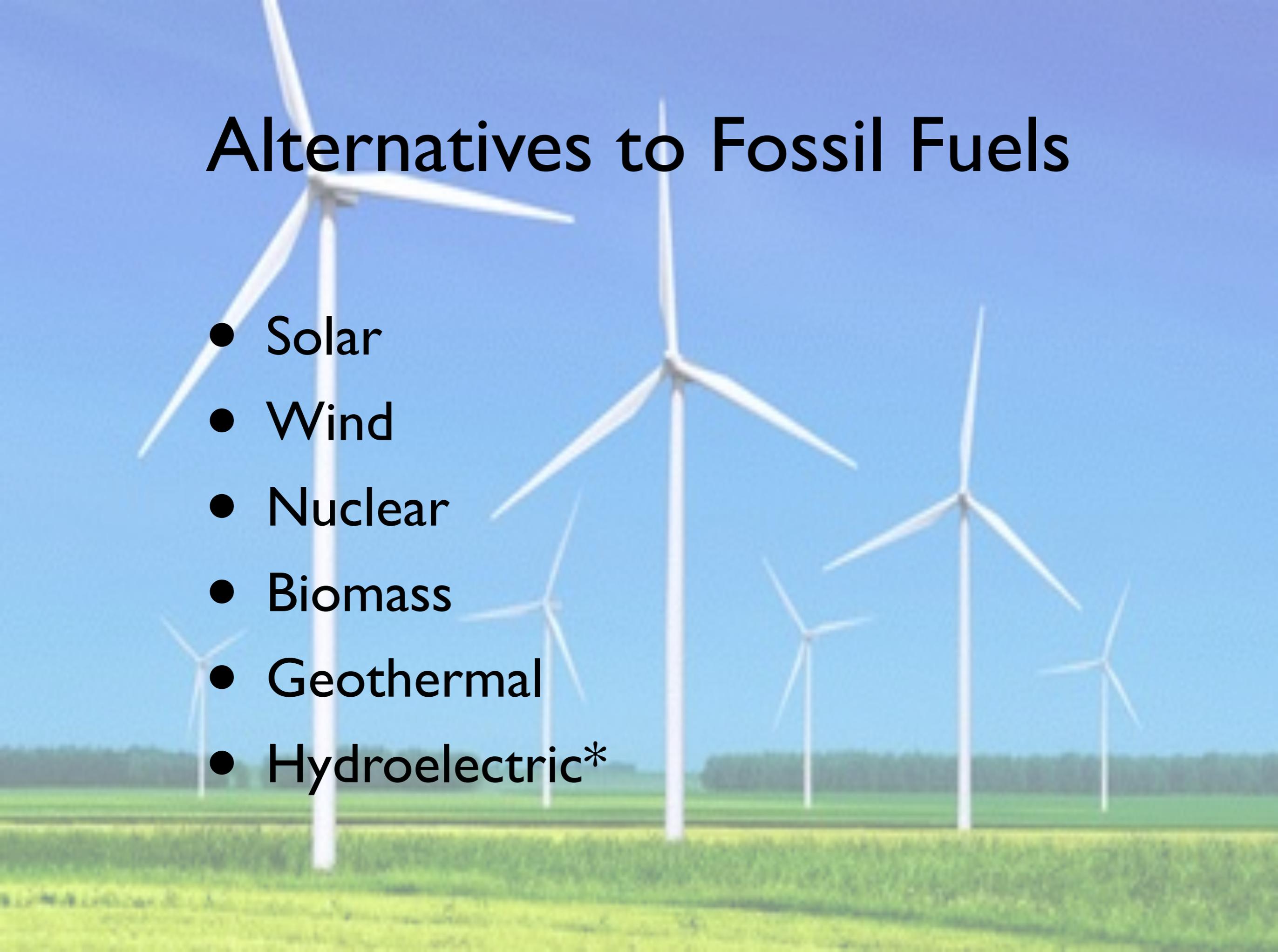




Mitigation: Reduce Emissions

- Conversion
 - stop burning fossil fuels; move to alternatives for energy production
- Conservation
 - reduce requirements, improve efficiency

Alternatives to Fossil Fuels

A photograph of a wind farm with several white wind turbines in a green field under a clear blue sky. The turbines are arranged in a line, and the foreground is a lush green field. The sky is a clear, bright blue.

- Solar
- Wind
- Nuclear
- Biomass
- Geothermal
- Hydroelectric*

Mitigation: Remove CO₂

- Natural
 - “Terraforming” the Earth
 - e.g., reforestation
- Geoengineering
 - Carbon capture & sequestration

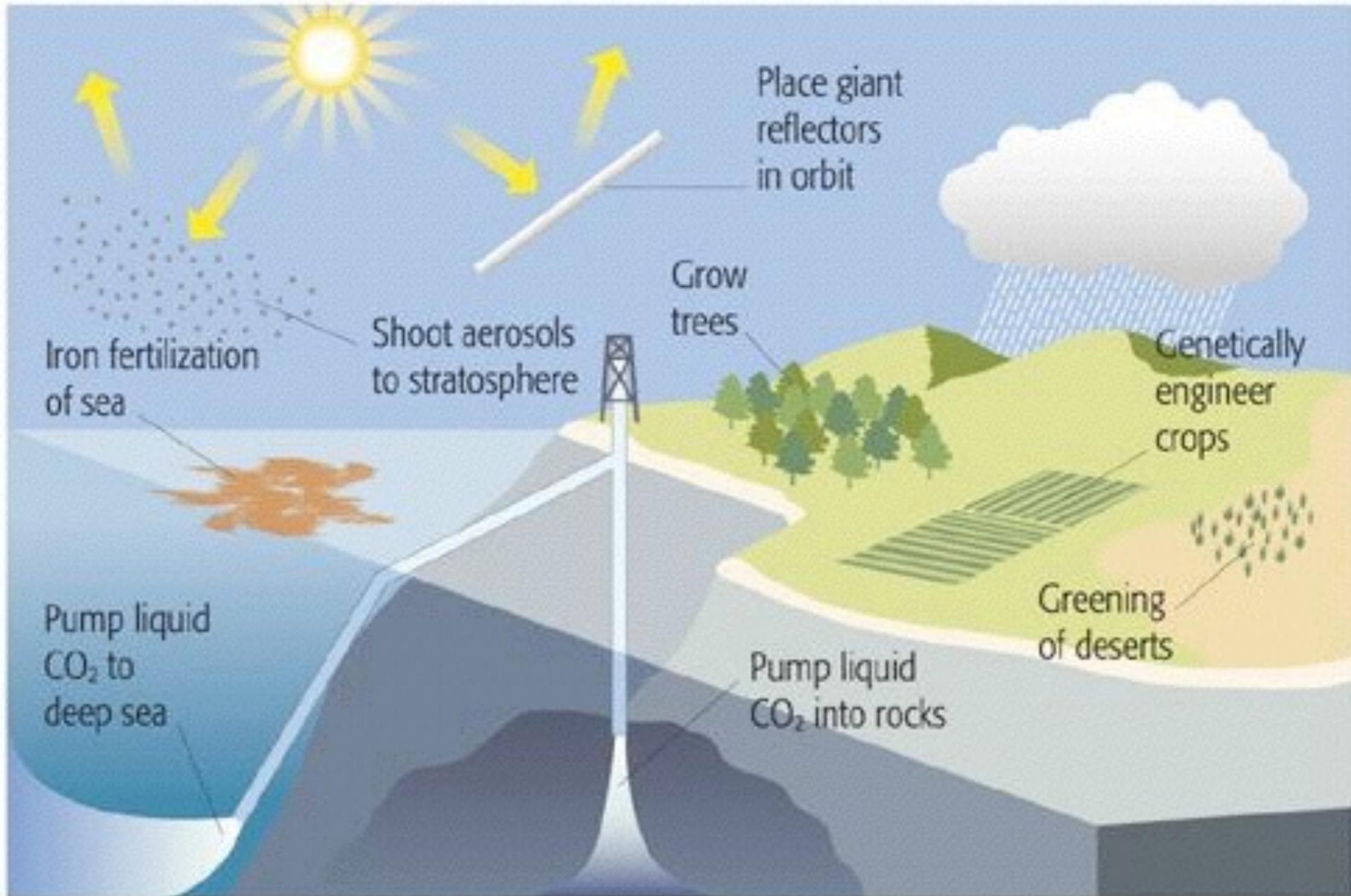
Adaptation



- Protect infrastructure, esp. coastlines
- Store & conserve water
- Enhance disaster response, prepare for health effects
- Modify land use, crops, and crop species

Other Mitigation Ideas

GEOENGINEERING SOLUTIONS TO CLIMATE CHANGE



Accomplishments Under Obama Administration

- Produced a comprehensive Climate Action Plan
- Issued new fuel-economy (“CAFE”) standards
- Instituted appliance efficiency standards
- Promoted clean energy innovations through loan guarantees & tax incentives
- Increased use of solar energy twenty fold and tripled electricity produced by wind power

Accomplishments Under Obama Administration, cont.

- Rejected Keystone-XL Pipeline
- Issued stringent rule on mercury emissions (coal plants shutdown or switch to natural gas)
- Regulating CO₂ emissions from coal-fired power plants to reduce carbon pollution by 30% by 2030
- Negotiated landmark agreement with China to reduce carbon pollution in next 15 years

Accomplishments Under Obama Administration, cont.

Played key role in epic 2015
international (COP21) climate agreement



Summary

- Climate change is a result of human activities
- The impacts of climate change are already being felt worldwide
- Costs of climate change are immense and escalating
- Continued use of fossil fuels unsustainable
- We can, and must solve this problem

