Climate Conversation: Climate 101

Paul J. Pickett
Stream Team of Thurston County

February 12, 2020

WHAT WE'LL COVER
(in less than two hours)

- What is Climate Change?
- What is the evidence for Climate Change?
- What are Greenhouse Gases (GHGs)?
- How are scientists modeling climate change?
- Why are GHGs rising?
- What impacts will we see in the PNW?
- How do we adapt to unavoidable change?
- How can we reduce GHG levels?

CLIMATE CHANGE OR GLOBAL WARMING?

"Global warming" -

Increase of the Earth's average surface temperature, due to a build-up of greenhouse gases in the atmosphere.

"Climate change" –

Long-term changes in climate,

including average temperature and precipitation.

Can include both trends and variability.

Can include both human-caused and natural forcing.

IS IT CLIMATE? OR WEATHER?

- Weather
  - whatever is happening outdoors in a given place and time, i.e what's in your daily weather forecast
    - precipitation, barometric pressure, temperature, wind
- Climate
  - All of the weather occurring over a long time in a given place.
    - New Orleans – warm, humid summers, Buffalo – cold, snowy winters
    - San Diego – mild, sunny summers; Olympia – cloudy, cool, & rainy
  - Average conditions – what it's usually like in a given place
  - Typical variability –highs/lows and extremes
  - Weather cycles – seasonal, inter-annual, decadal
  - Long-term trends – over decades or centuries

EVIDENCE OF CLIMATE CHANGE

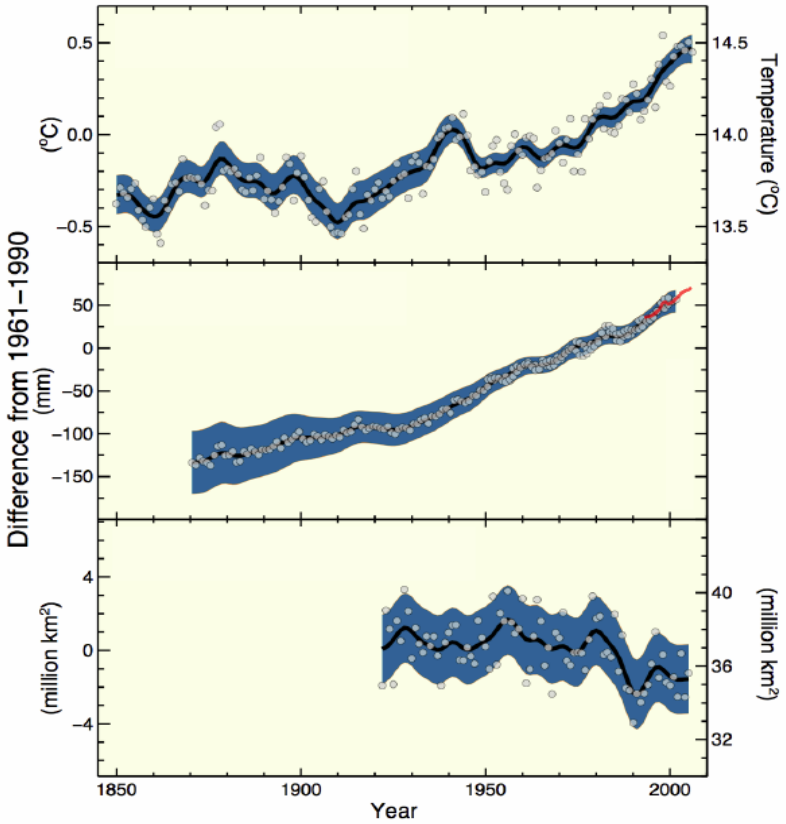
Direct observations of recent climate change

Global average temperature

Global average sea level

Northern hemisphere snow cover

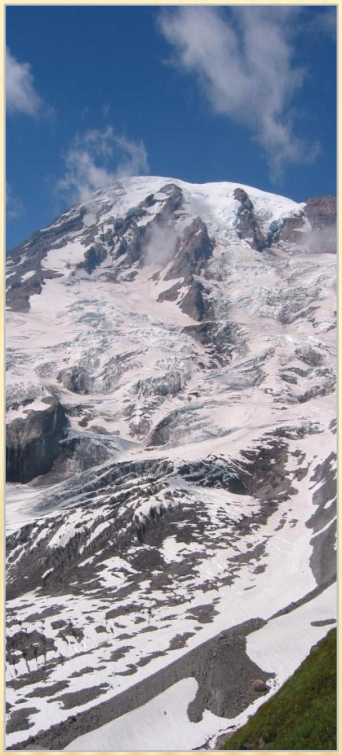
Changes in temperature, sea level and northern hemisphere snow cover

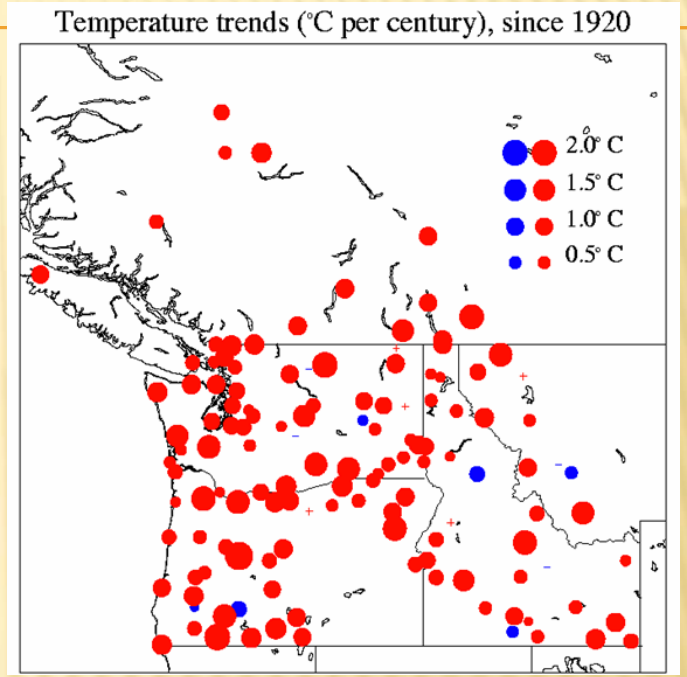


Evidence of change in the Pacific Northwest

Observed 20th century change

- **Spring snow cover has declined**
- **Glaciers are losing mass and/or length.**
- **Spring snowmelt and peak runoff have shifted earlier**
  (1 to 4 weeks in much of the western U.S., 1948-2002)
  (Stewart et al. 2005)





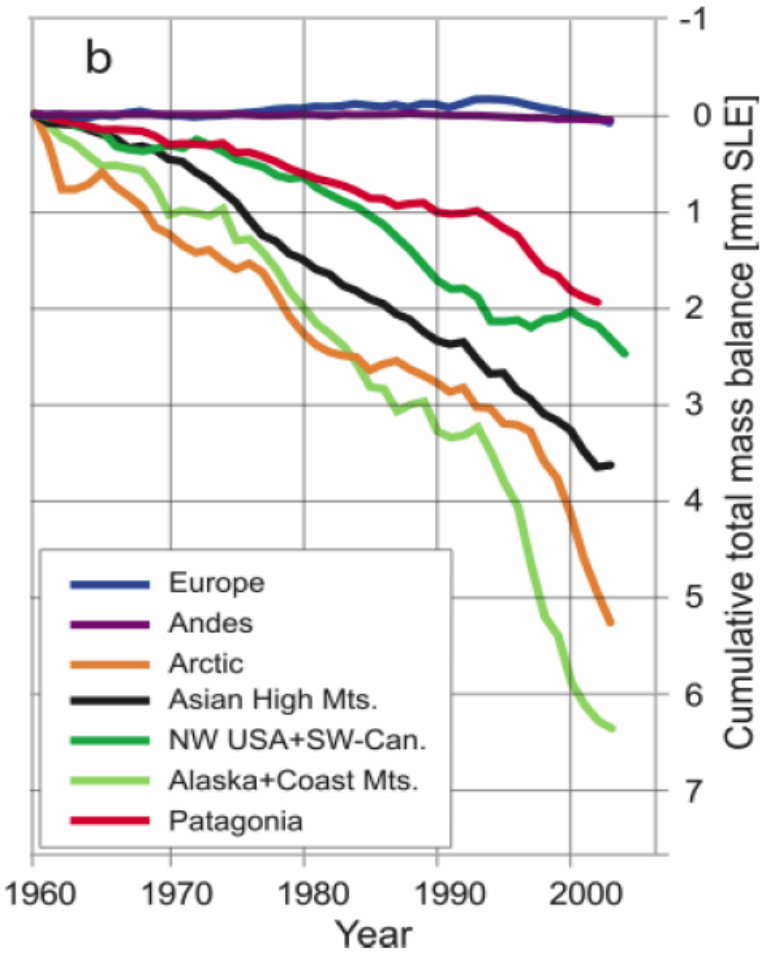
- 154 stations with long records
- Almost every station showed **warming**
- Urbanization not a major source of warming
- **Regional average = +1.5 F/century**

Glacier mass balance

During the 20th century, glaciers and ice caps have experienced **widespread mass losses** and have contributed to **sea level rise**

Further **decline of mountain glaciers** projected to **reduce water availability** in many regions

Cumulative balance of glacier mass in some regions



GLACIAL RECESSION

1909 McCarty Glacier, Alaska 2004

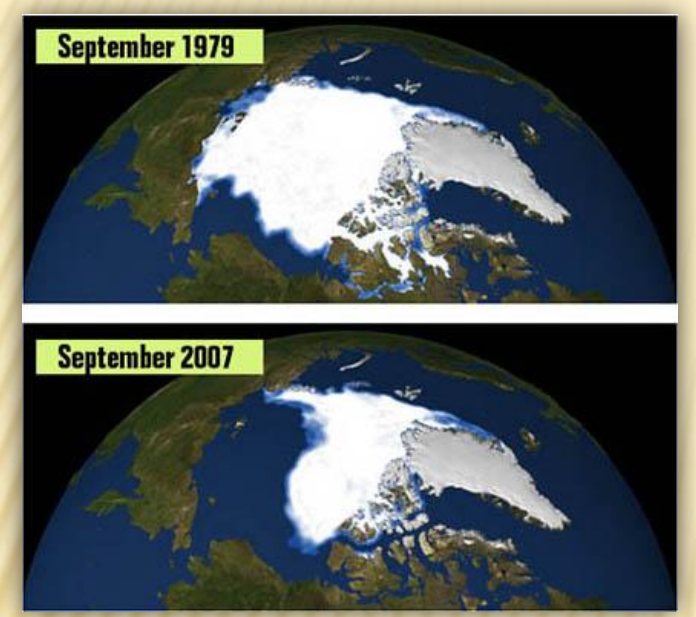
http://www.thisisclimatechange.org/glacial-retreat/

Boulder Glacier
Glacier National Park, MT

1932 2005

1894 Mendenhall Glacier, Alaska 2008

ARCTIC SEA ICE LOSS



NASA says:

- declining 12.9%/decade
- 2012 lowest ever recorded
- https://climate.nasa.gov/vital-signs/arctic-sea-ice/

theguardian

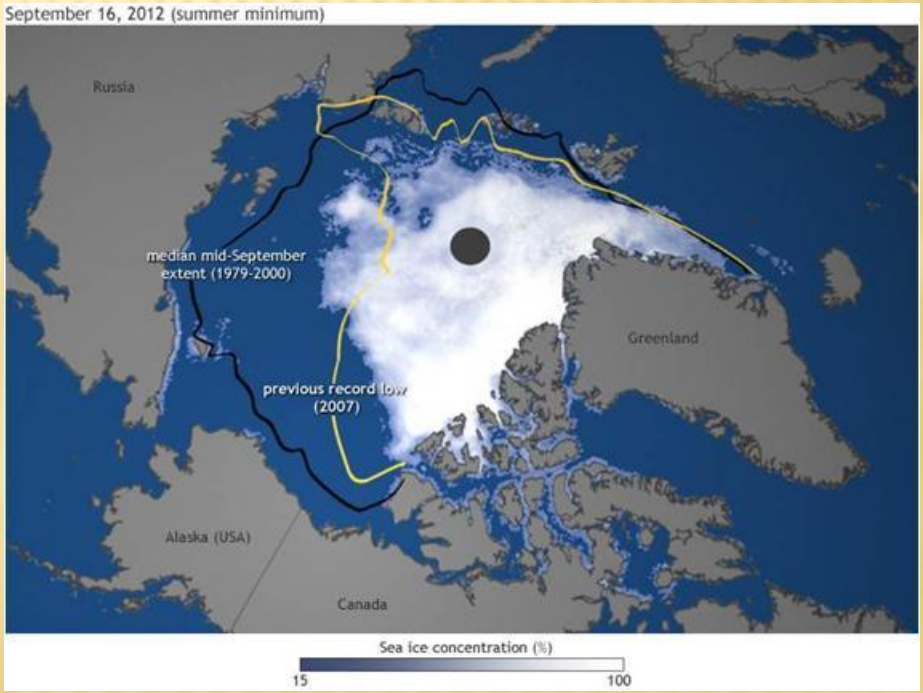
News | US | World | Sports | Comment | Culture | Business | Environ

Environment › Polar regions

Climate change could lead to Arctic conflict, warns senior Nato commander

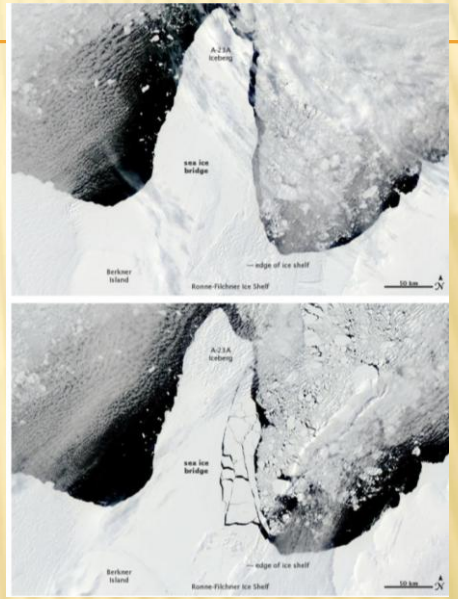
Global warming and a race for resources could spark a new 'cold war' in the Arctic, US naval admiral warns ahead of key talks on environmental security

Terry Macalister
The Guardian, Monday 11 October 2010 10.46 EDT

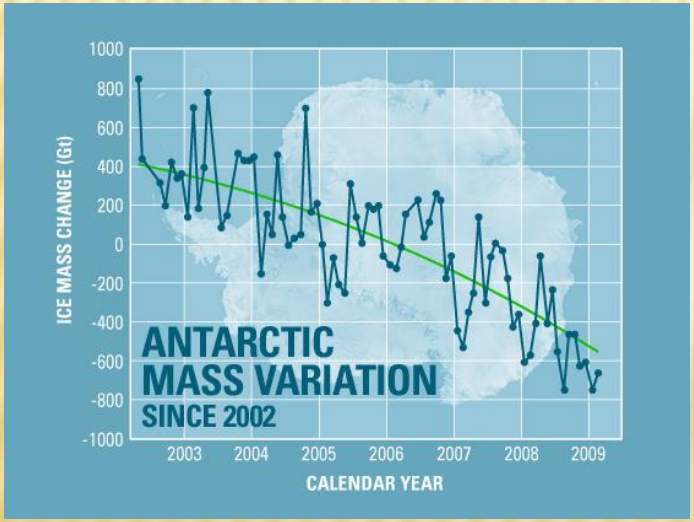


ANTARCTIC ICE SHELF BREAKUP

Over a 35-day period in early 2002, Larsen B ice shelf lost 1,255 sq mi



During 24 hours in Feb 2010, Ronne-Filchner ice shelf lost over 1,200 sq mi

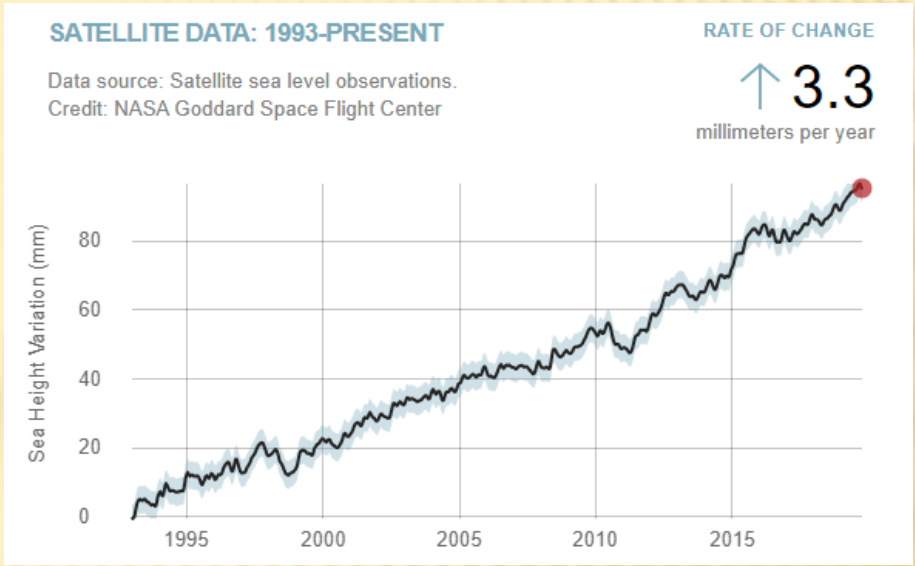


Antarctica Sets Record High Temperature: 64.9 Degrees

"This is the foreshadowing of what is to come," a researcher said. "It's exactly in line of what we've been seeing for decades."

(New York Times, February 8, 2020)

SEA-LEVEL RISE



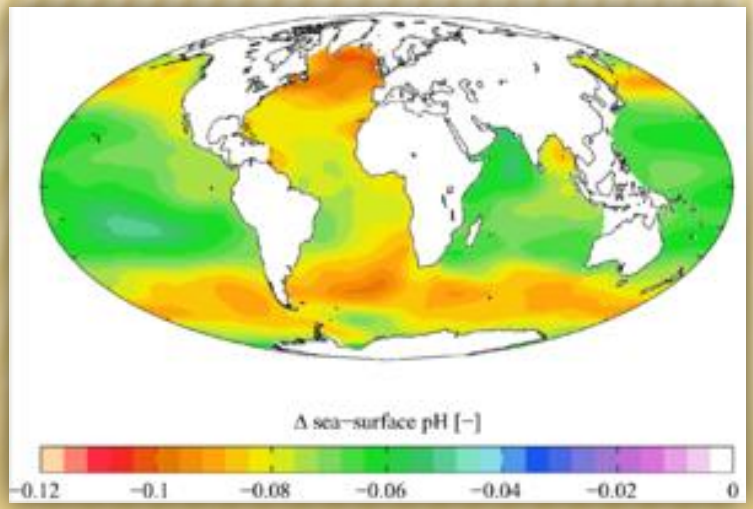
OCEAN ACIDIFICATION (CLIMATE CHANGE'S EVIL TWIN)

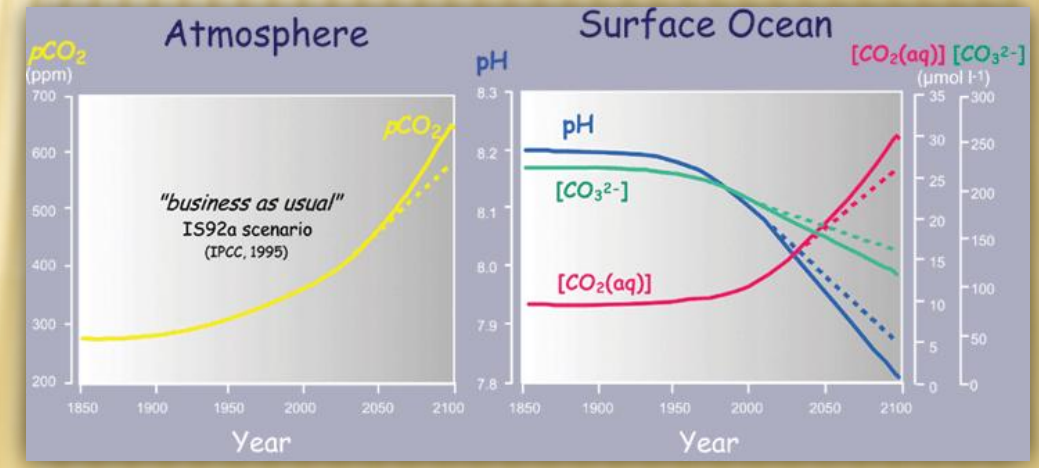
- CO_2 is corrosive to the shells and skeletons of many marine organisms

Corals

Calcareous plankton

Coral bleaching

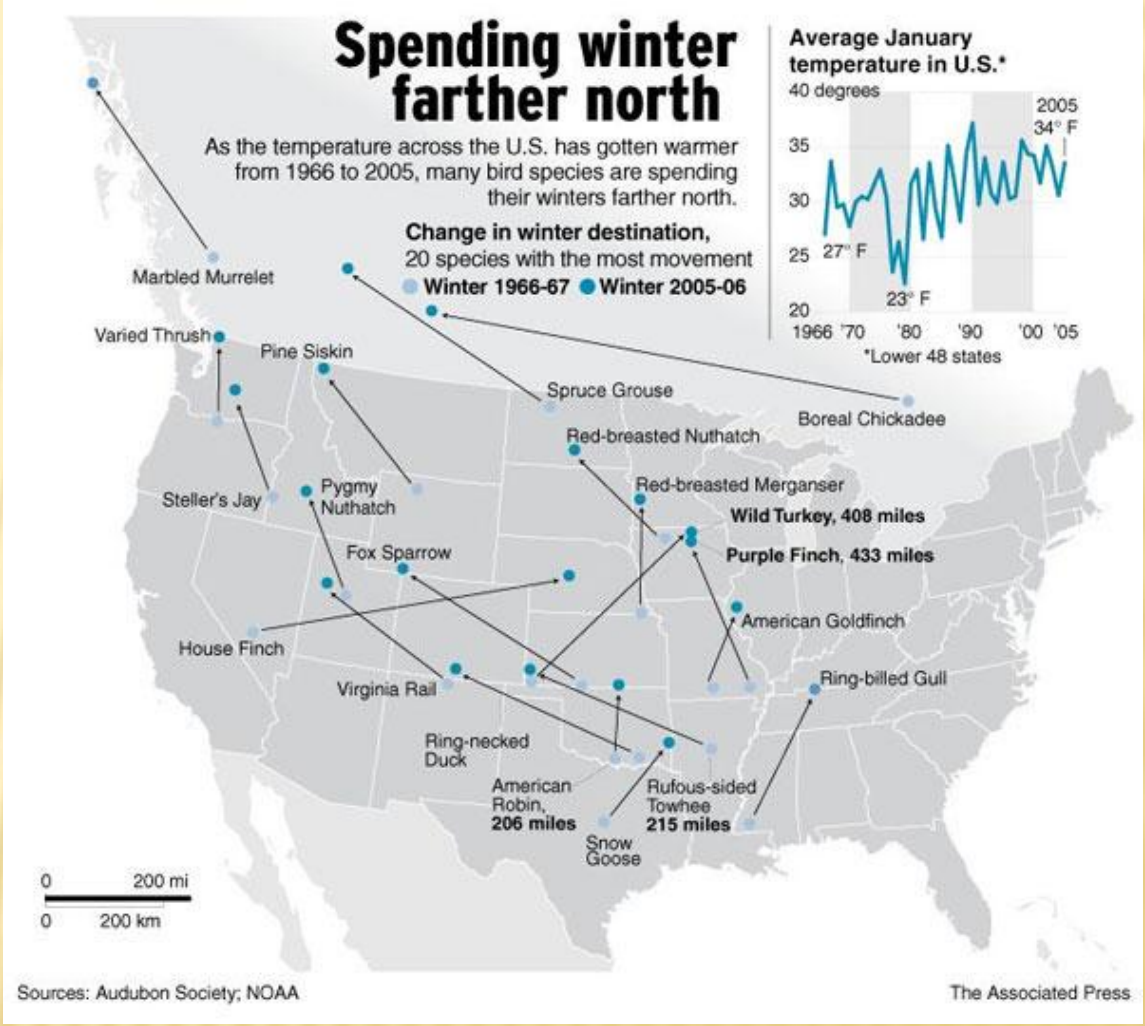




BIRD MIGRATION

40 years of Christmas bird count citizen data

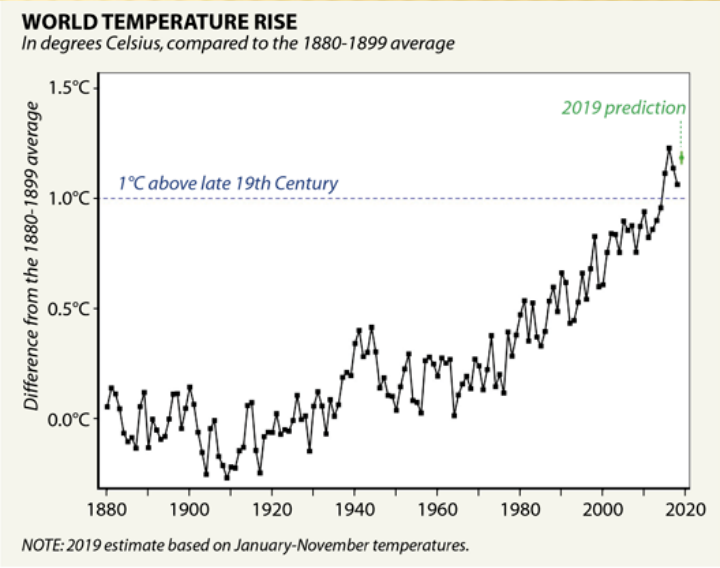
- 60% of 305 species shifting north an average of 35 miles



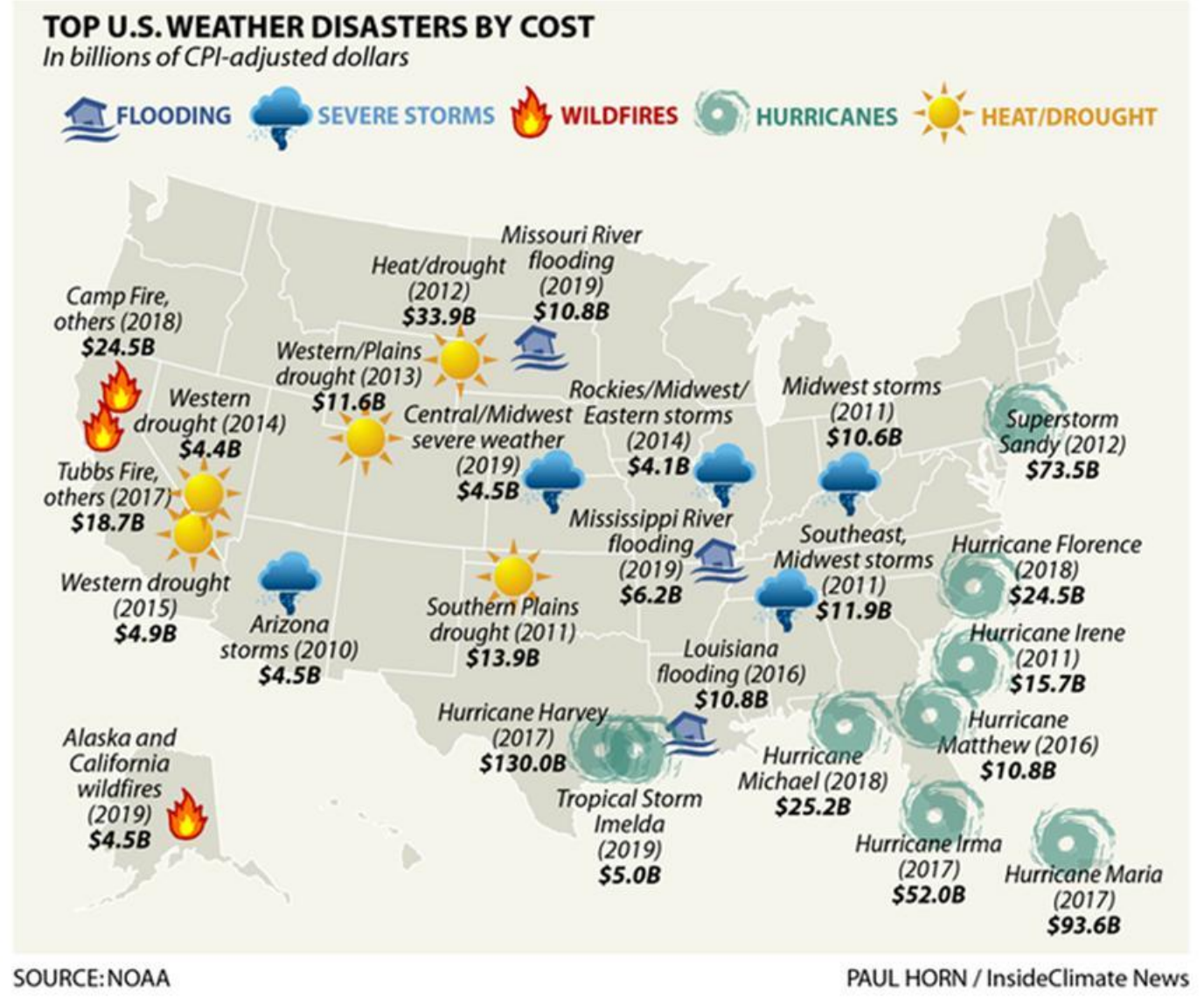
http://birdsandclimate.audubon.org/

RECENT EXTREME EVENTS

- Globally: 2010-2019 hottest decade on record
- U.S.A
  - Warmest December-January on record
  - Wettest July-June year in history
- Europe
  - Warmest January on record
- Brazil
  - Record rainfall and flooding
- Australia
  - Unprecedented wildfires
  - 2019 hottest year on record; January 2019 hottest month on record; 18 December hottest day on record



TOP 25 WEATHER DISASTERS, 2010-19



ARE SCIENTISTS DIVIDED? NO!!!

PNAS
Proceedings of the National Academy of Sciences of the United States of America

Expert credibility in climate change

William R. L. Anderegg [a, 1], James W. Prall [b], Jacob Harold [c], and Stephen H. Schneider [a, d, 1]

+ Author Affiliations

Contributed by Stephen H. Schneider, April 9, 2010 (sent for review December 22, 2009)

Abstract

Although preliminary estimates from published literature and expert surveys suggest striking agreement among climate scientists on the tenets of anthropogenic climate change (ACC), the American public expresses substantial doubt about both the anthropogenic cause and the level of scientific agreement underpinning ACC. A broad analysis of the climate scientist community itself, the distribution of credibility of dissenting researchers relative to agreeing researchers, and the level of agreement among top climate experts has not been conducted and would inform future ACC discussions. Here, we use an extensive dataset of 1,372 climate researchers and their publication and citation data to show that (*i*) 97–98% of the climate researchers most actively publishing in the field support the tenets of ACC outlined by the Intergovernmental Panel on Climate Change, and (*ii*) the relative climate expertise and scientific prominence of the researchers unconvinced of ACC are substantially below that of the convinced researchers.

97-98% of 1,372 climate researchers support the tenets of anthropogenic climate change

IPCC

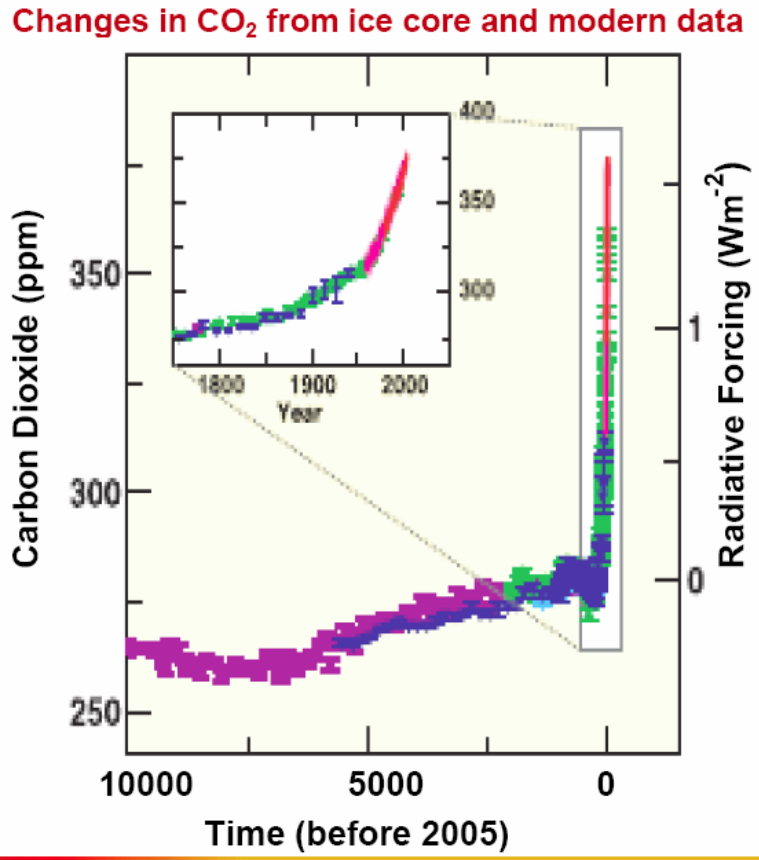
- Intergovernmental Panel on Climate Change
  - Formed by UNEP and WMO
  - Thousands of climate scientists from around the world
- Fourth Assessment report - 2007
  - Synthesis; Physical Basis; Impacts; Mitigation
- Extreme Events Report - 2012
  - 220 authors, 62 countries, 18,611 reviewers
- Fifth Assessment report - 2013
  - Over 800 authors
- Updated emission scenarios
- Reports on oceans, cyrosphere, lands (2019)
- Many other reports (https://www.ipcc.ch/reports/)

THE PROBLEM: RISING LEVELS OF GREENHOUSE GASSES (GHG'S)

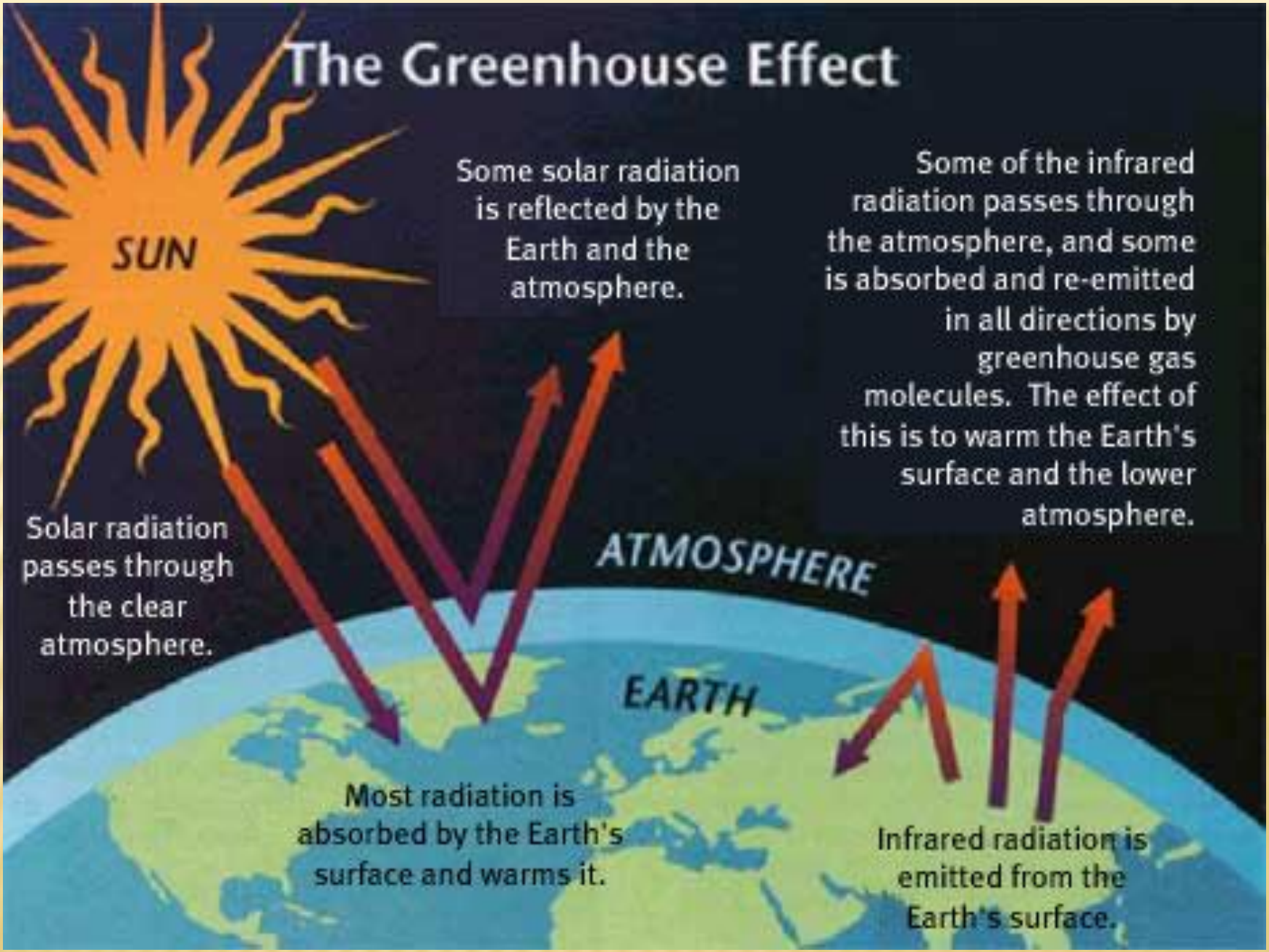
Human contribution to climate change

Global atmospheric concentrations of greenhouse gases **increased markedly as result of human activities**

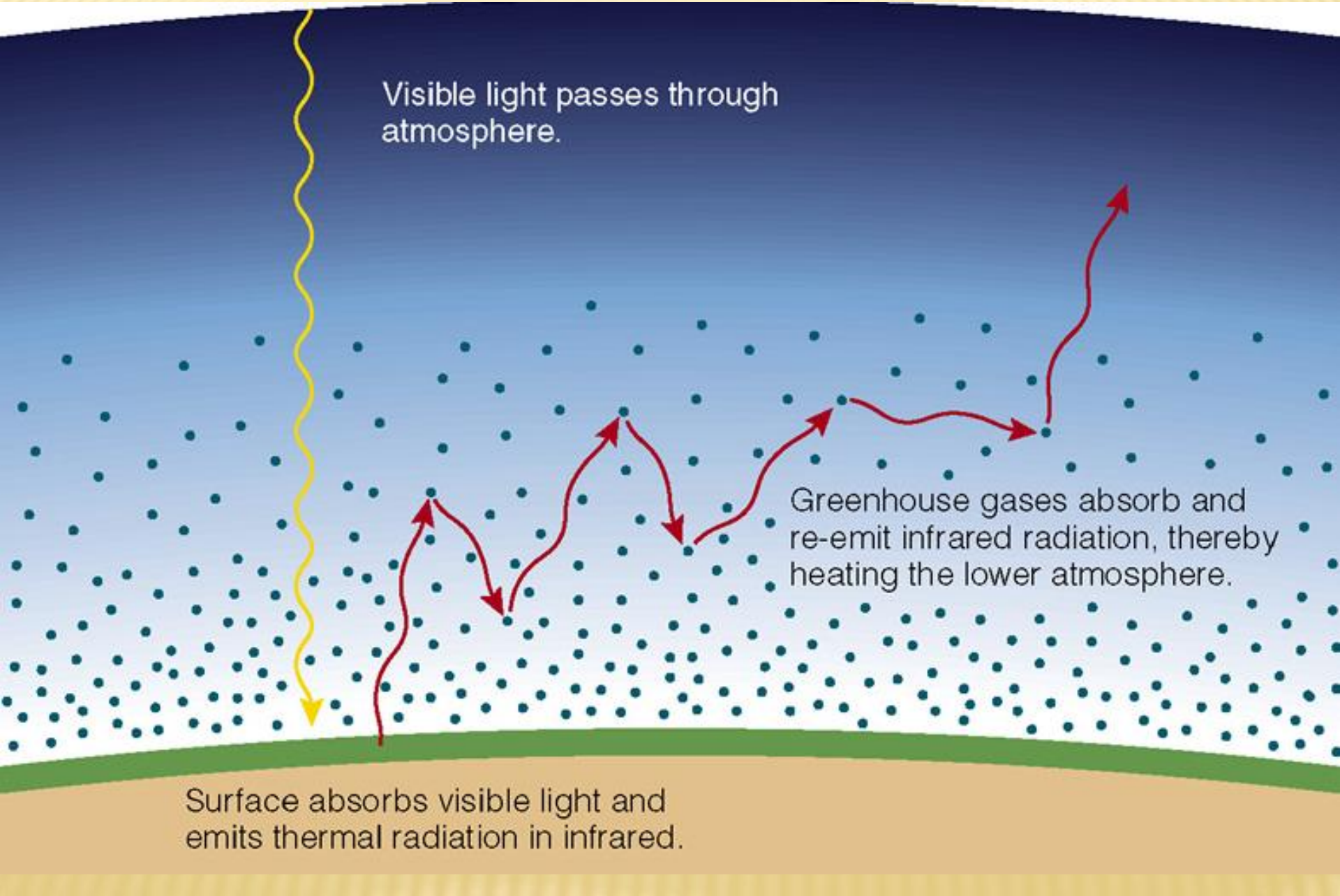
In 2005 concentration of CO_2 **exceeded by far the natural range** over the last 650,000 years



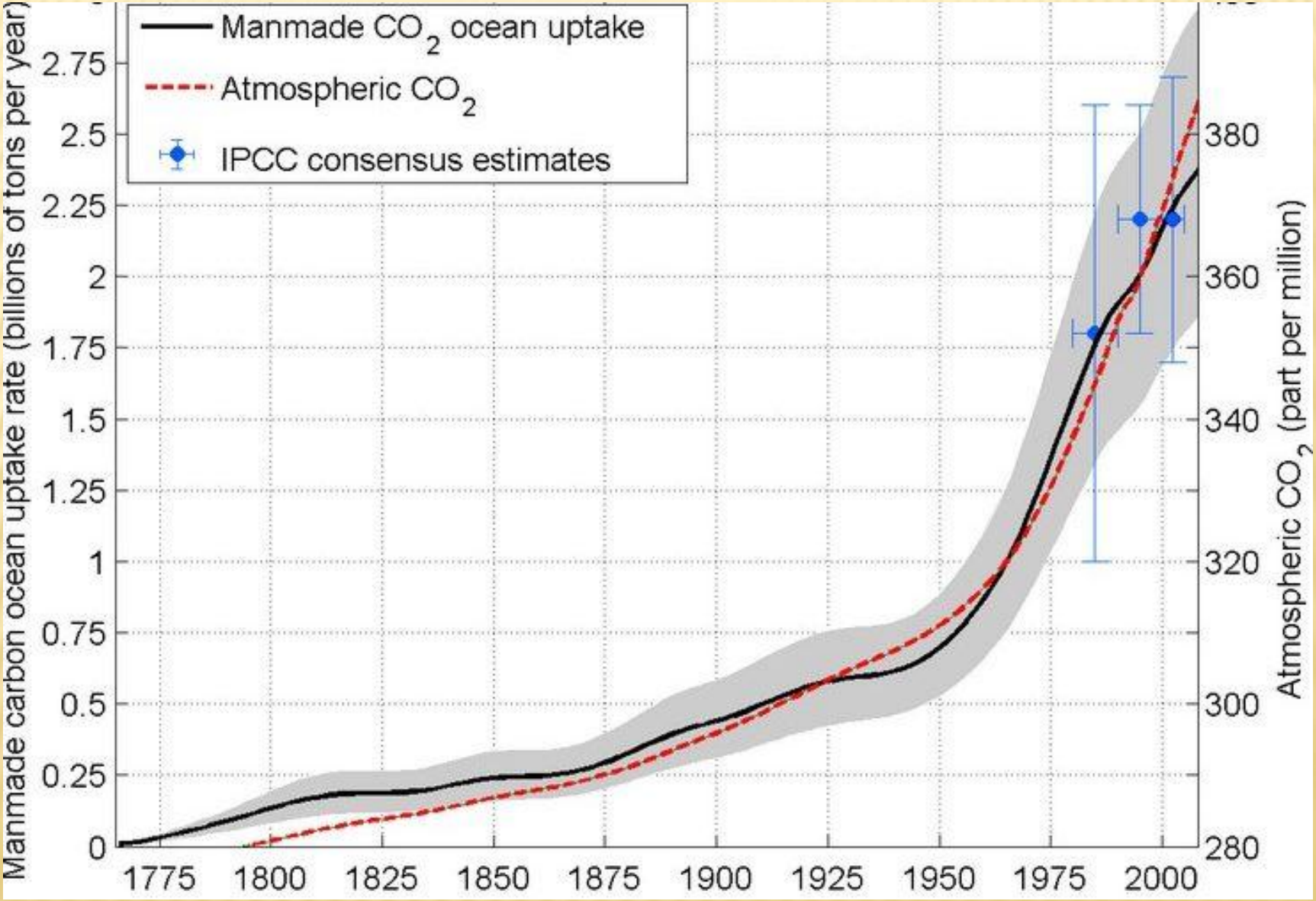
The "Hockey Stick" graph


The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere.
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

The Greenhouse Effect



ATMOSPHERIC AND OCEAN CO_2



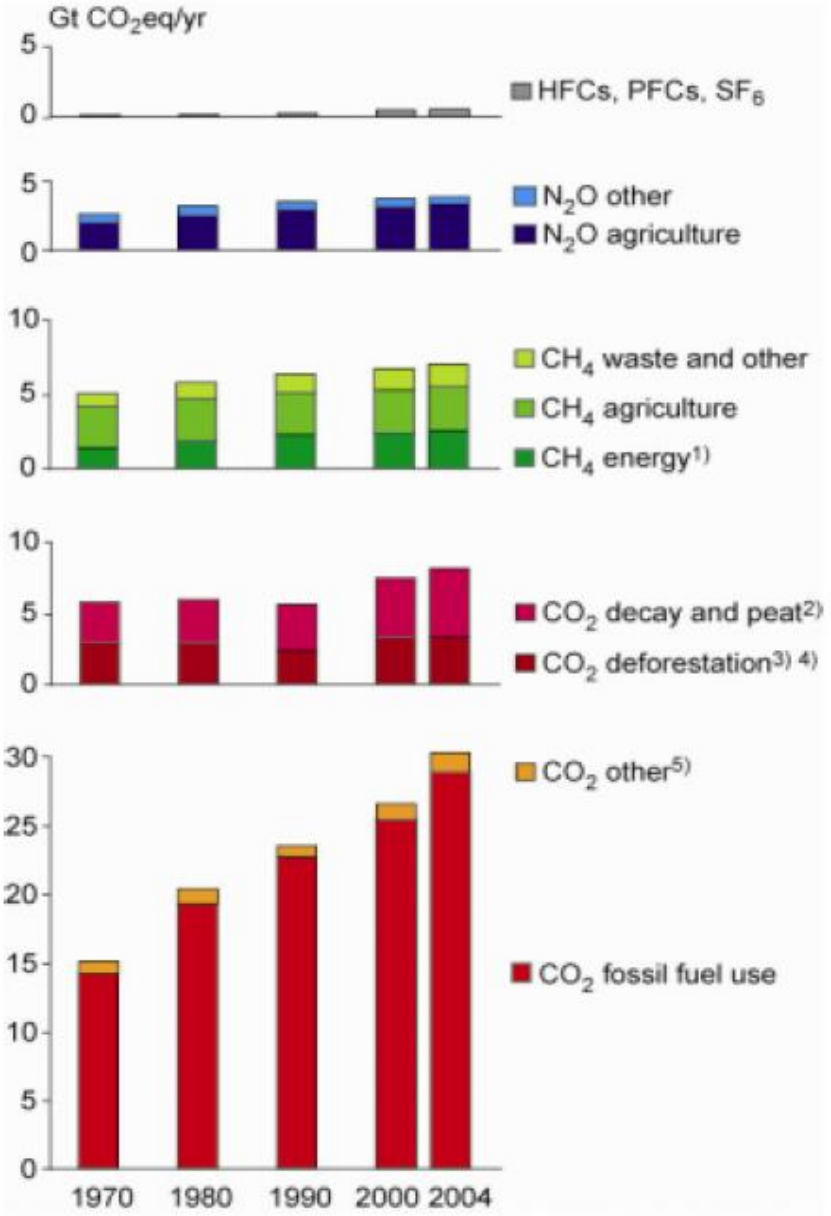
WHAT ARE GHG'S?

Gases that trap heat in the atmosphere

- Carbon dioxide
- Methane
- Nitrous oxide
- Hydrofluorocarbons
- Perfluorocarbons
- Sulfur Hexafluorides

Greenhouse gases differ in their impact on climate change. For example, one pound of nitrous oxide is ~300 times more intense than a pound of carbon dioxide in affecting climate change.

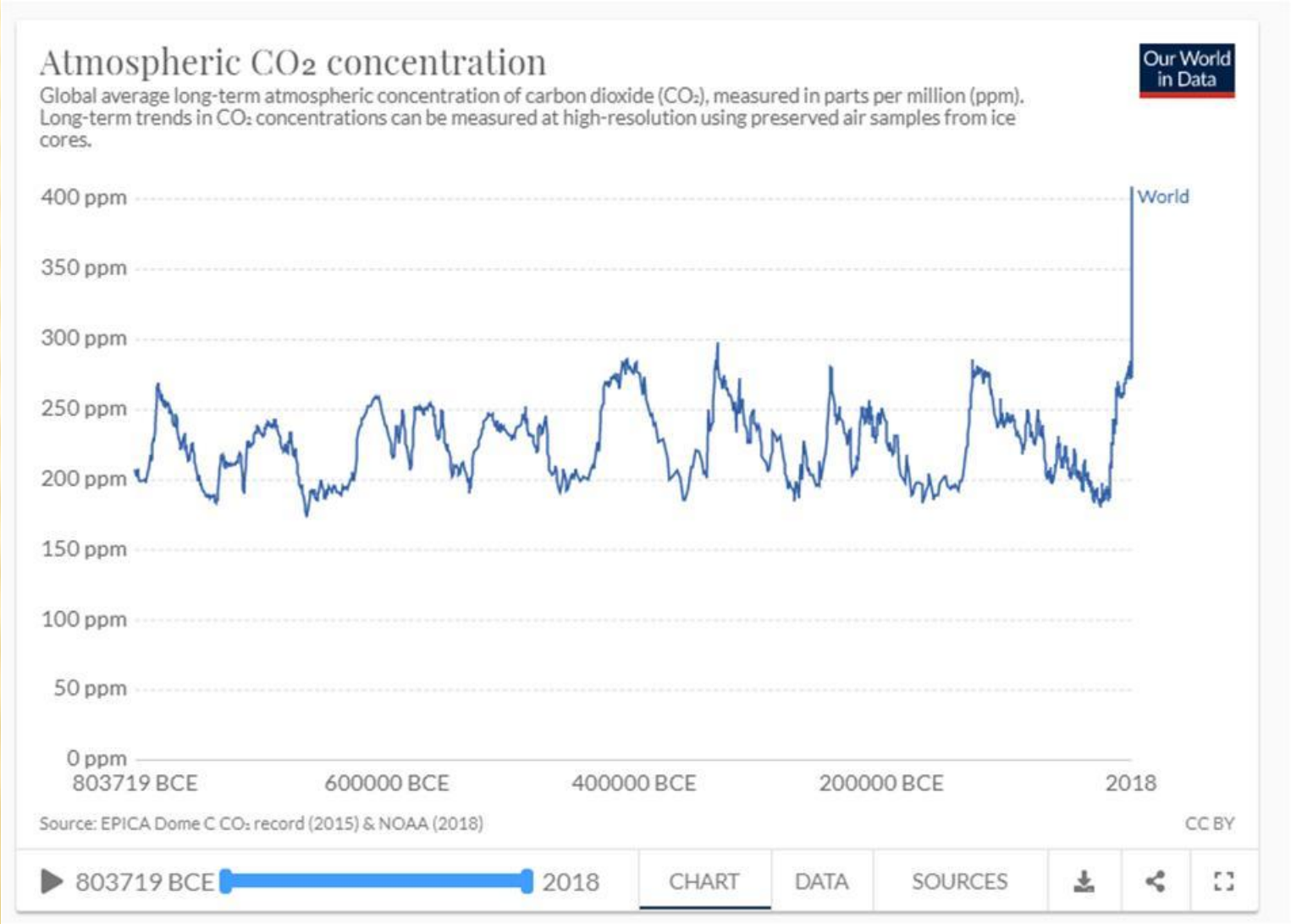
Carbon dioxide is the largest contributor



CARBON DIOXIDE (CO_2)

- Most abundant greenhouse gas
- Needed to keep Earth hospitable to life
- Directly or indirectly causes 80% of all global warming
- Burning fossil fuels causes 2/3 of CO_2 emissions
- Can last for centuries in the atmosphere
  - About 55% of all CO_2 from burning fossil fuels is still in the atmosphere
- Coal emits the most CO_2 of all fossil fuels
- Washington sources:
  - Fossil fuel combustion
  - Cement & Lime
  - Aluminum

PREHISTORIC CO_2

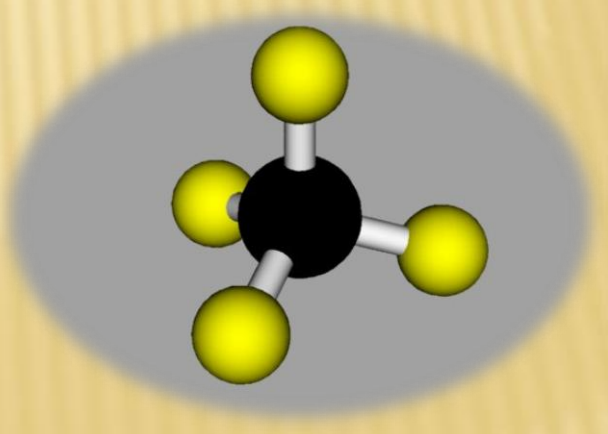


ATMOSPHERIC CO_2 – 180, 280, 380, 413

- Last ice age: 180 parts per million (ppm) CO_2
- Pre-industrial levels (until 1850s): 280 ppm
- By 2006: over 380 ppm
- January 2020: 413 ppm (http://co2now.org/)
- The rise closely parallels the emissions history from fossil fuels and land-use changes
- What is the tipping point of unacceptable, irreversible environmental changes?
  - 1,200 ppm ? 450? 400?
  - Loss of ice caps, permafrost methane released…

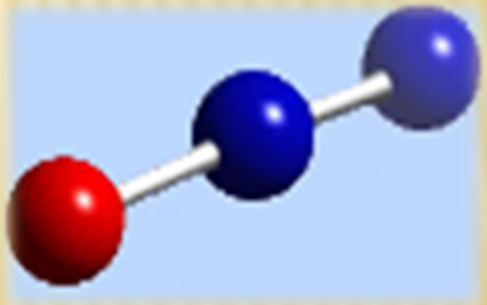
METHANE (CH_4)

- 20 times more effective at trapping heat than CO_2 (i.e., it has a higher "intensity")
- Short lifetime (~ 12 years)
- Washington sources:
  - Enteric fermentation from ruminant animals (animals like cows, sheep, buffalo that have a rumen (can eat grass))
  - Manure management
  - Coal mining & natural gas distribution
  - Energy production
  - Solid waste/landfills
  - Sewage treatment plants



NITROUS OXIDE (N_2O)

- 300 times more intense than CO_2
- Washington sources:
  - Nitrogen-based fertilizers
  - Livestock manure (bacteria)
  - Solid waste/landfills
  - Fossil fuel combustion

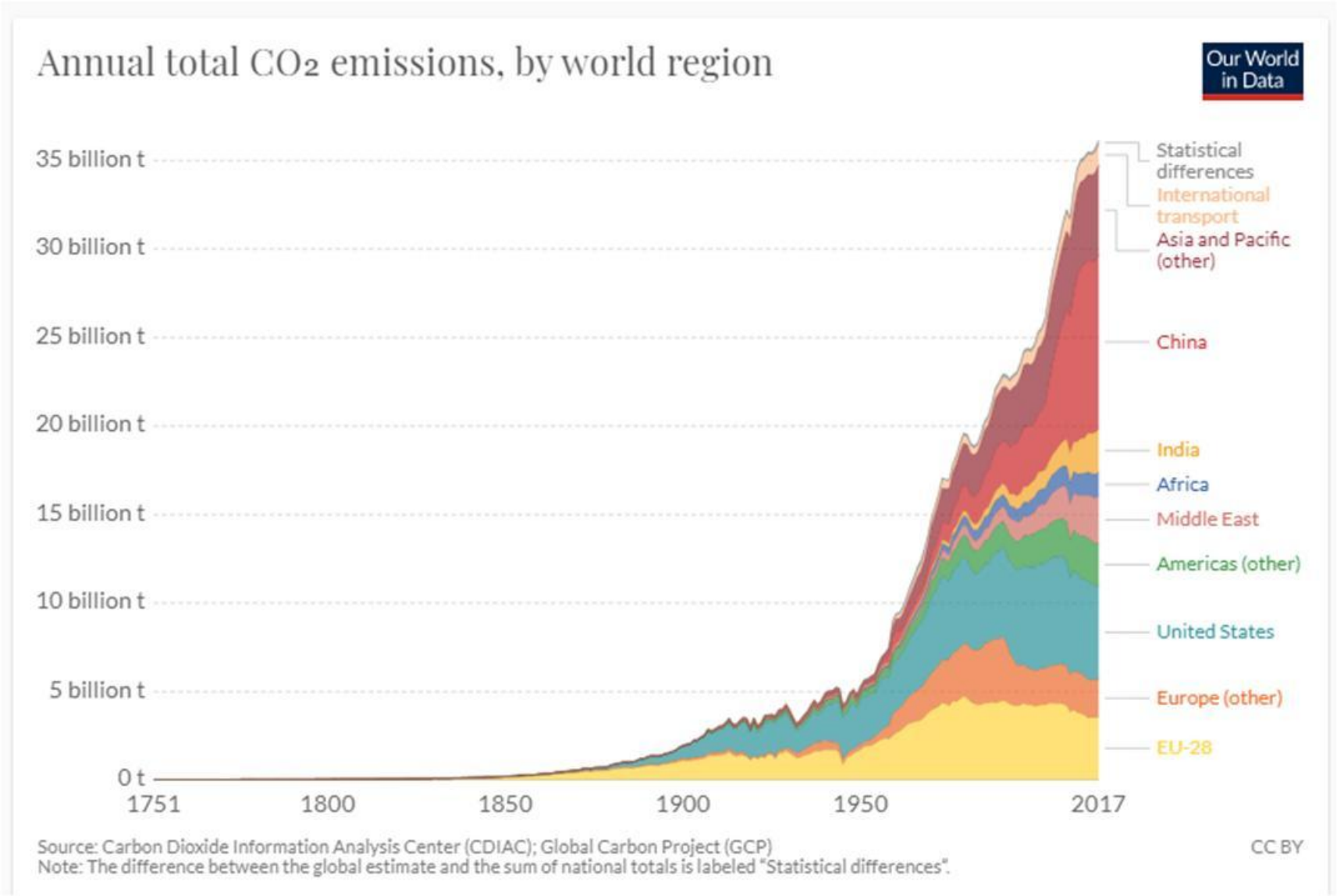


OTHER GHG'S

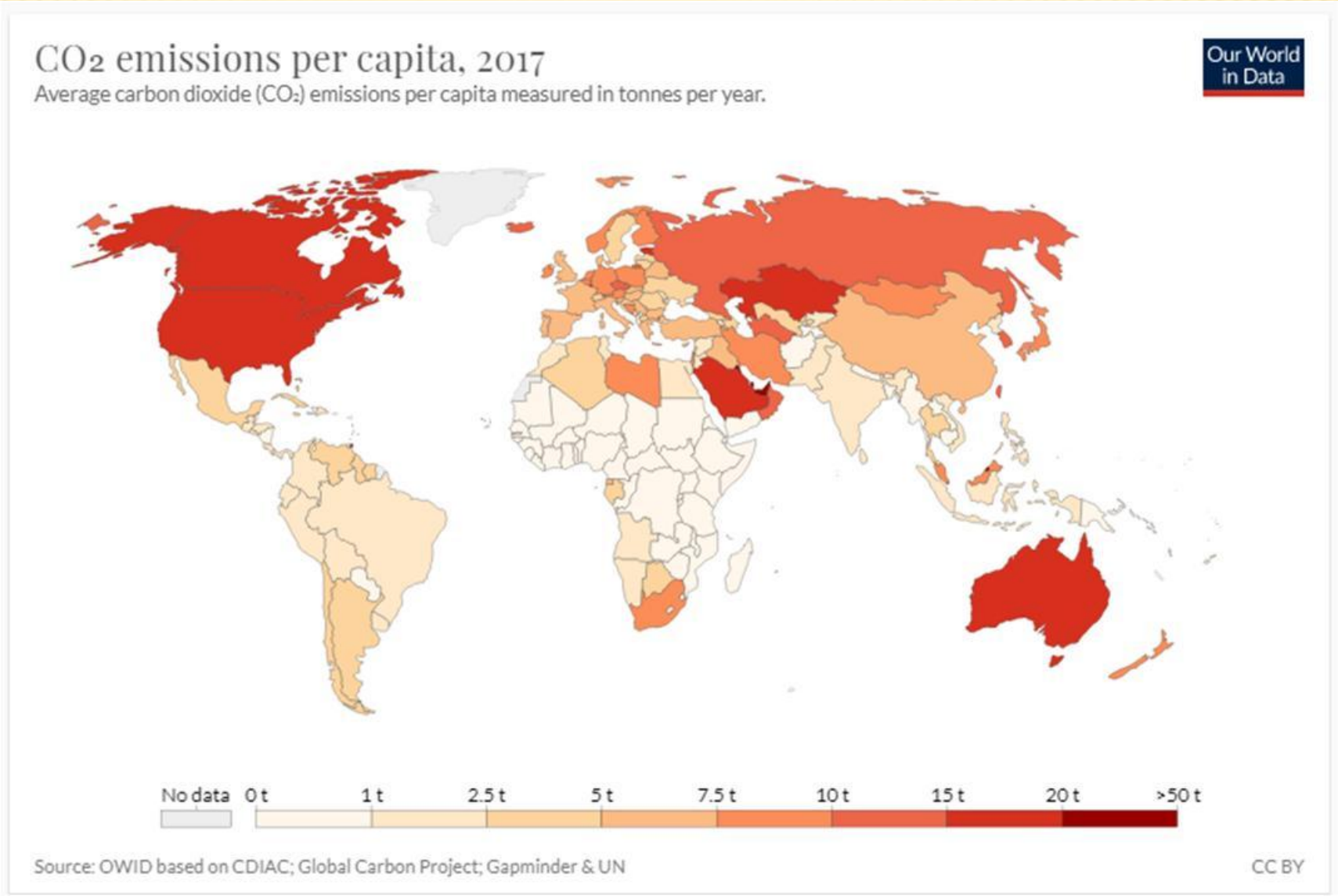
Manufactured gases with long atmospheric lifetimes

- Perfluorocarbons (PFCs)
  - Aluminum production
- Hydrofluorocarbons (HFCs)
  - Refrigerant
  - Semi-conductor production
- Sulfur Hexafluoride (SF_6)
  - Electric power transmission and distribution (used as an insulator)
- Many of these are being regulated under the Montreal Protocols to protect the ozone layer

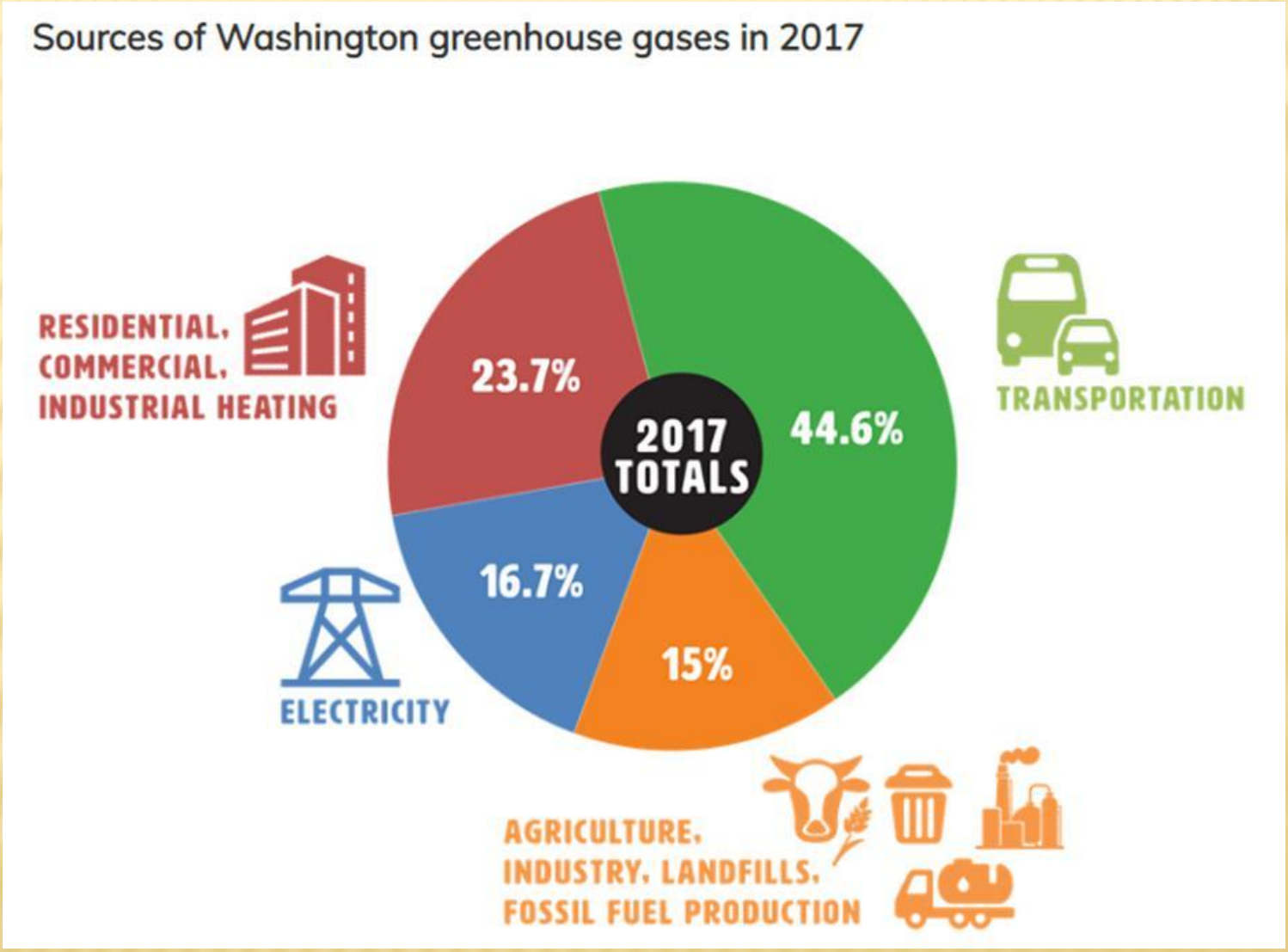
GLOBAL GHG EMISSIONS BY NATION

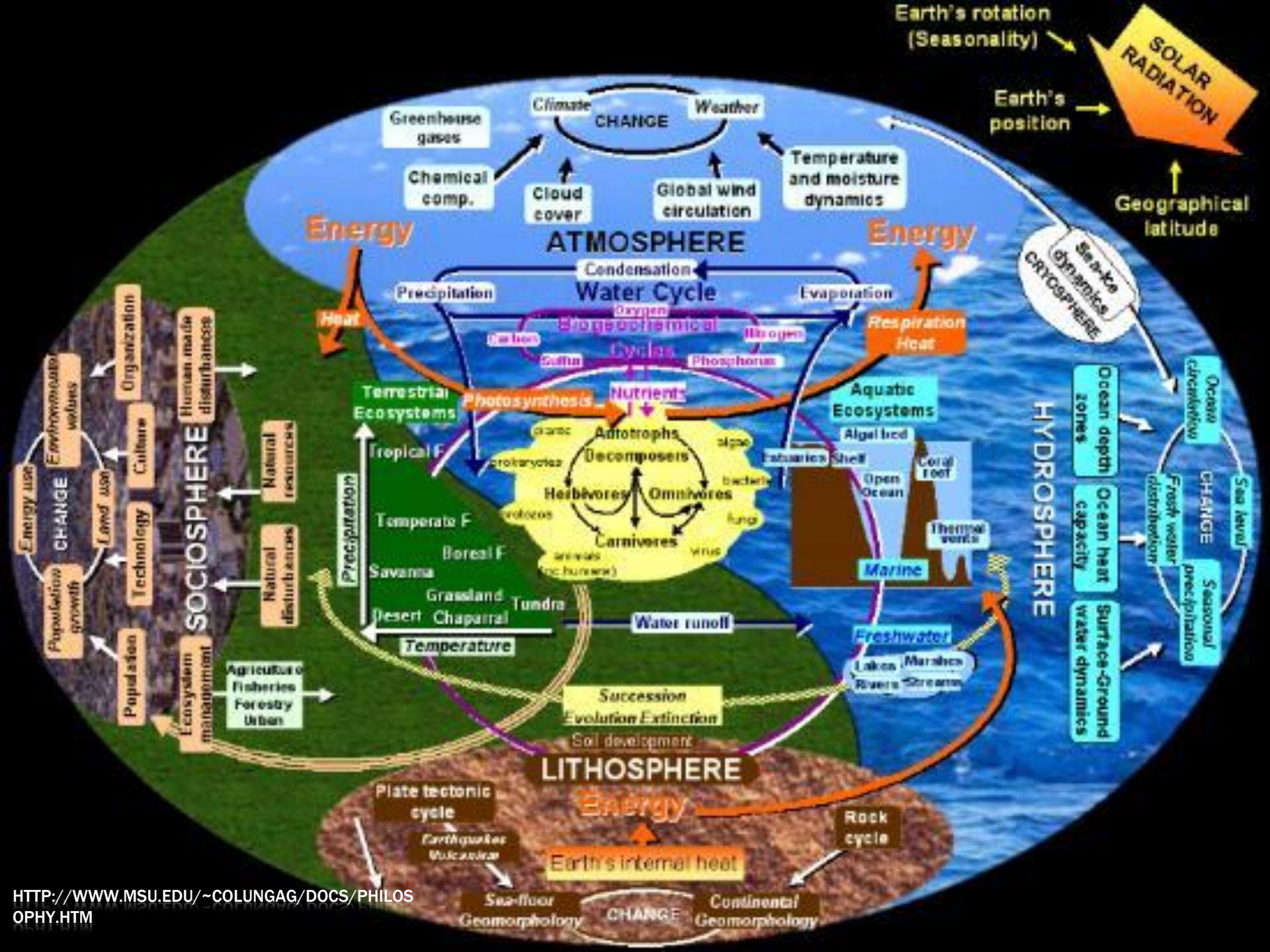


GLOBAL GHG EMISSIONS BY NATION



WA GHG EMISSIONS (2017)

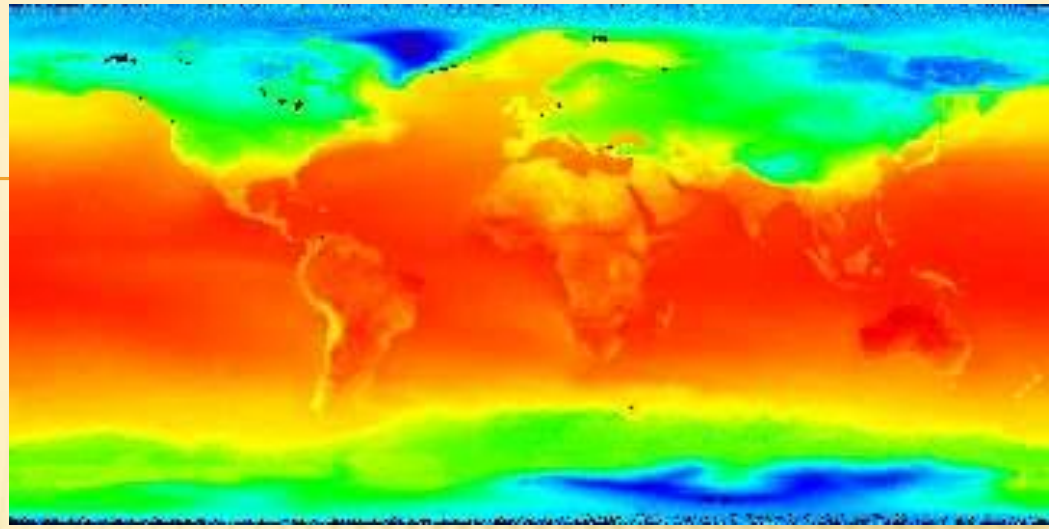


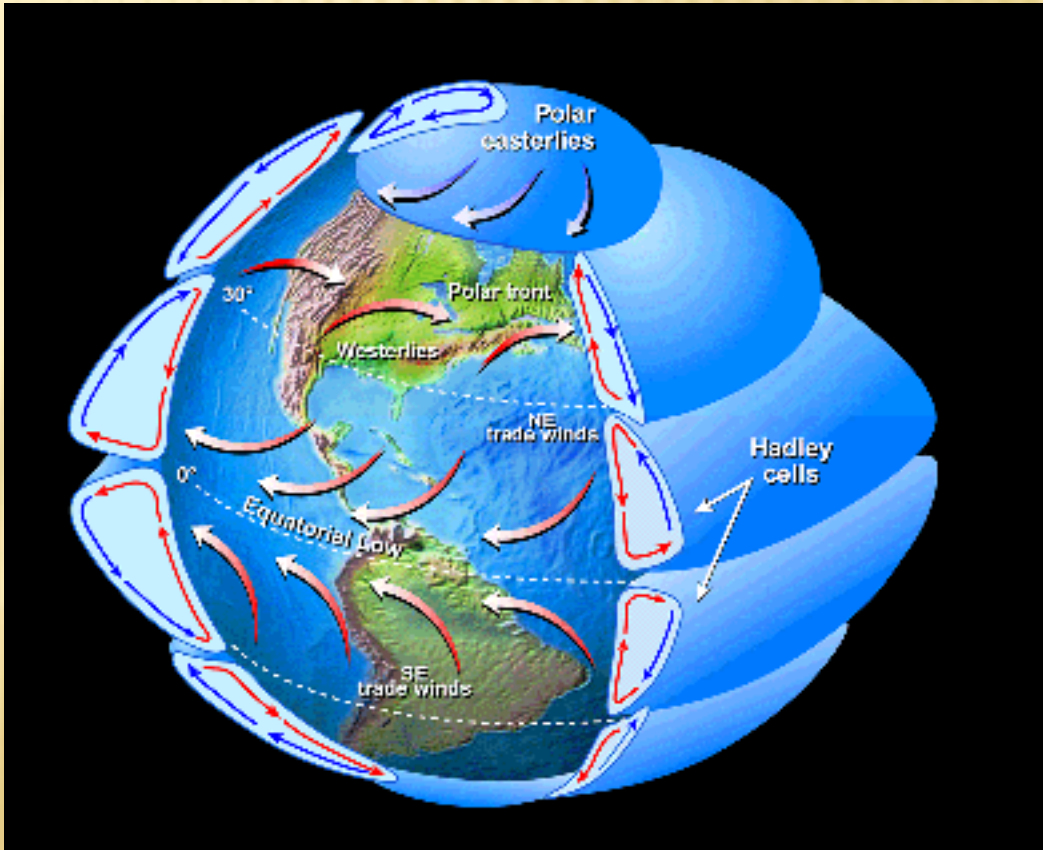


HTTP://WWW.MSU.EDU/~COLUNGAG/DOCS/PHILOSOPHY.HTM

ATMOSPHERIC CIRCULATION

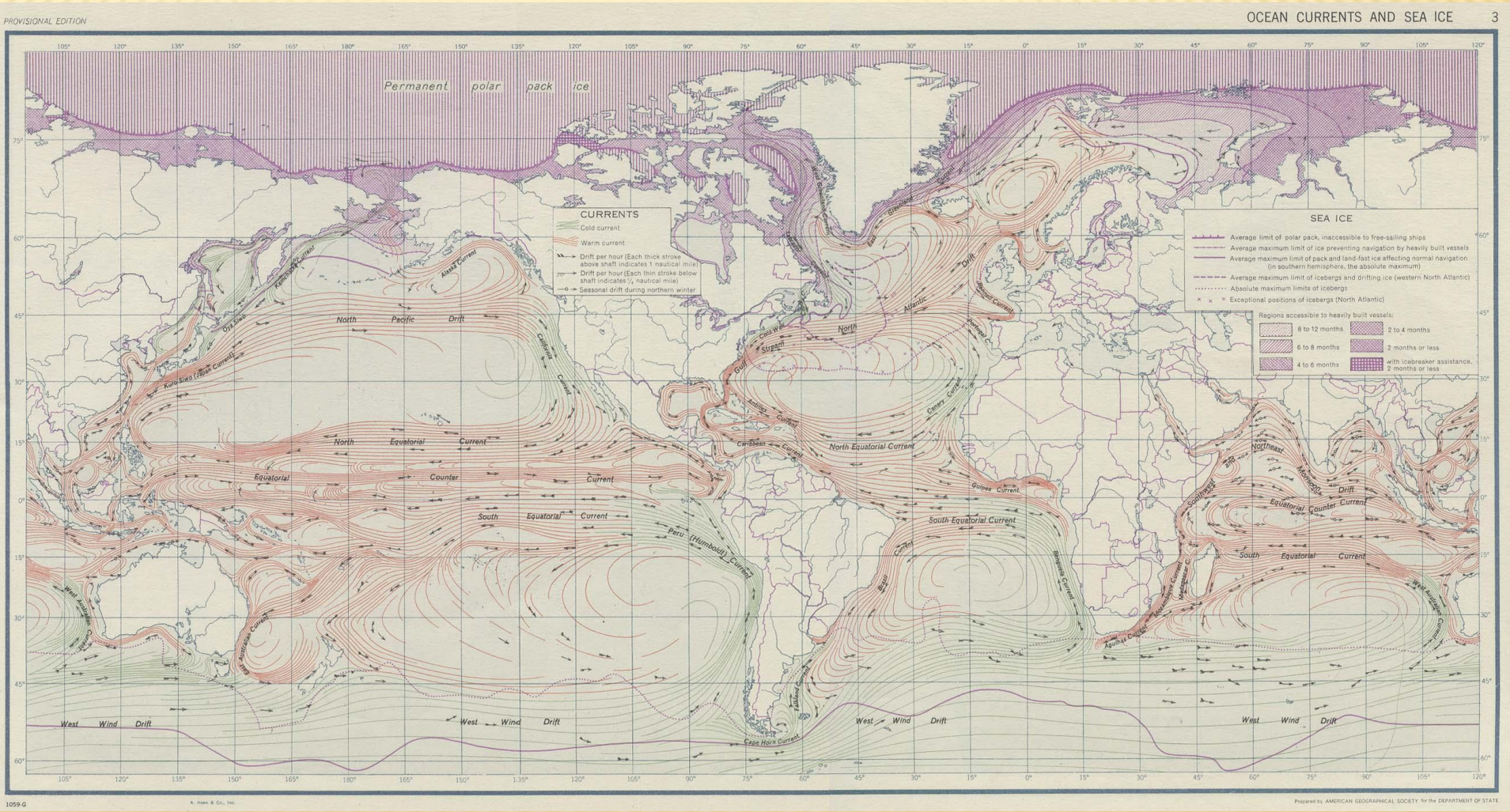
- The atmosphere is one part of the heat engine of the earth.
- Solar radiation on the globe results in more at the equator less at the poles
- Convective currents move heat from warm to cool.
- Because the earth rotates, Coriolis force breaks up this flow
- The result is the tropical, temperate, and polar winds



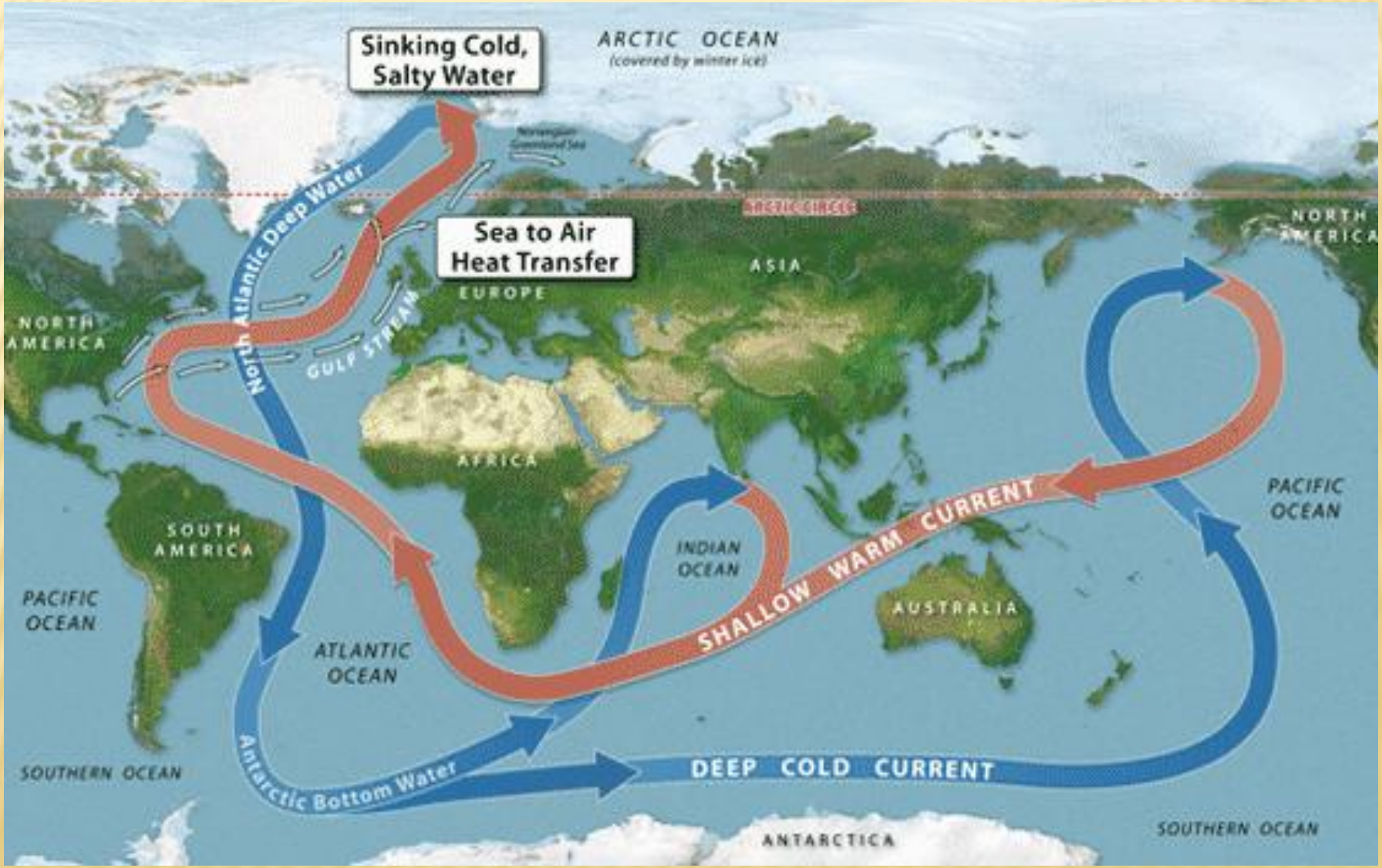


OCEAN CURRENTS AFFECT CLIMATE

- Wind currents and ocean heating then create the great ocean currents

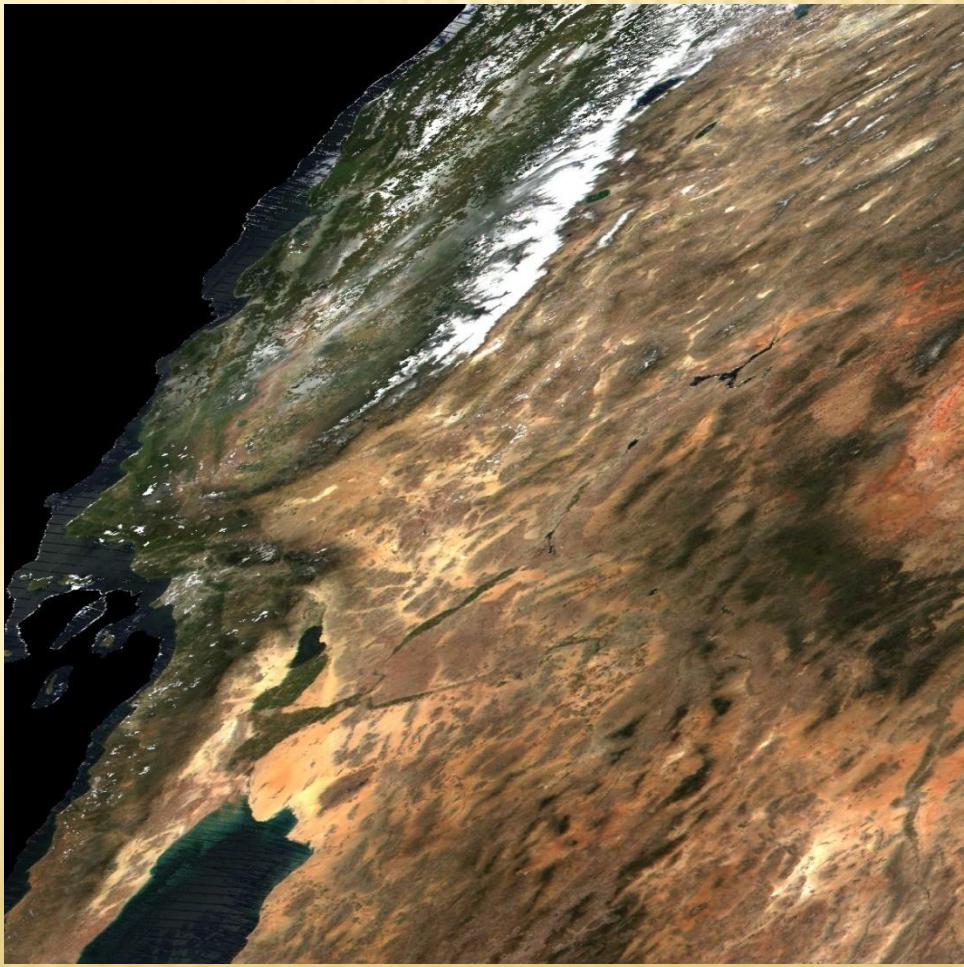


GLOBAL OCEAN CONVEYOR BELT



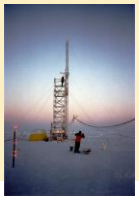
LAND SURFACE AFFECTS CLIMATE

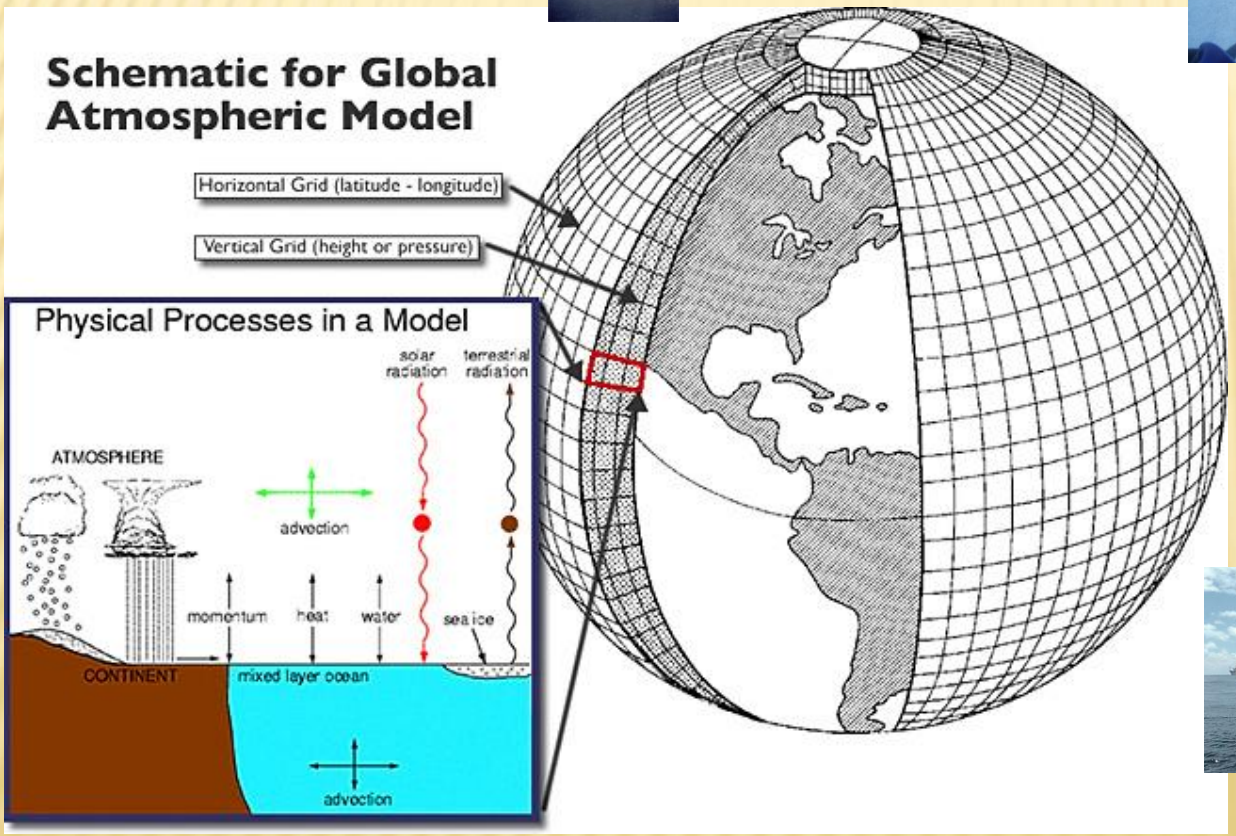
- Vegetation, configuration of continents, geomorphology
- Surface topography
- Albedo: ice, vegetation
- Gas exchange (water, CO_2, etc)
- Land use change is very important



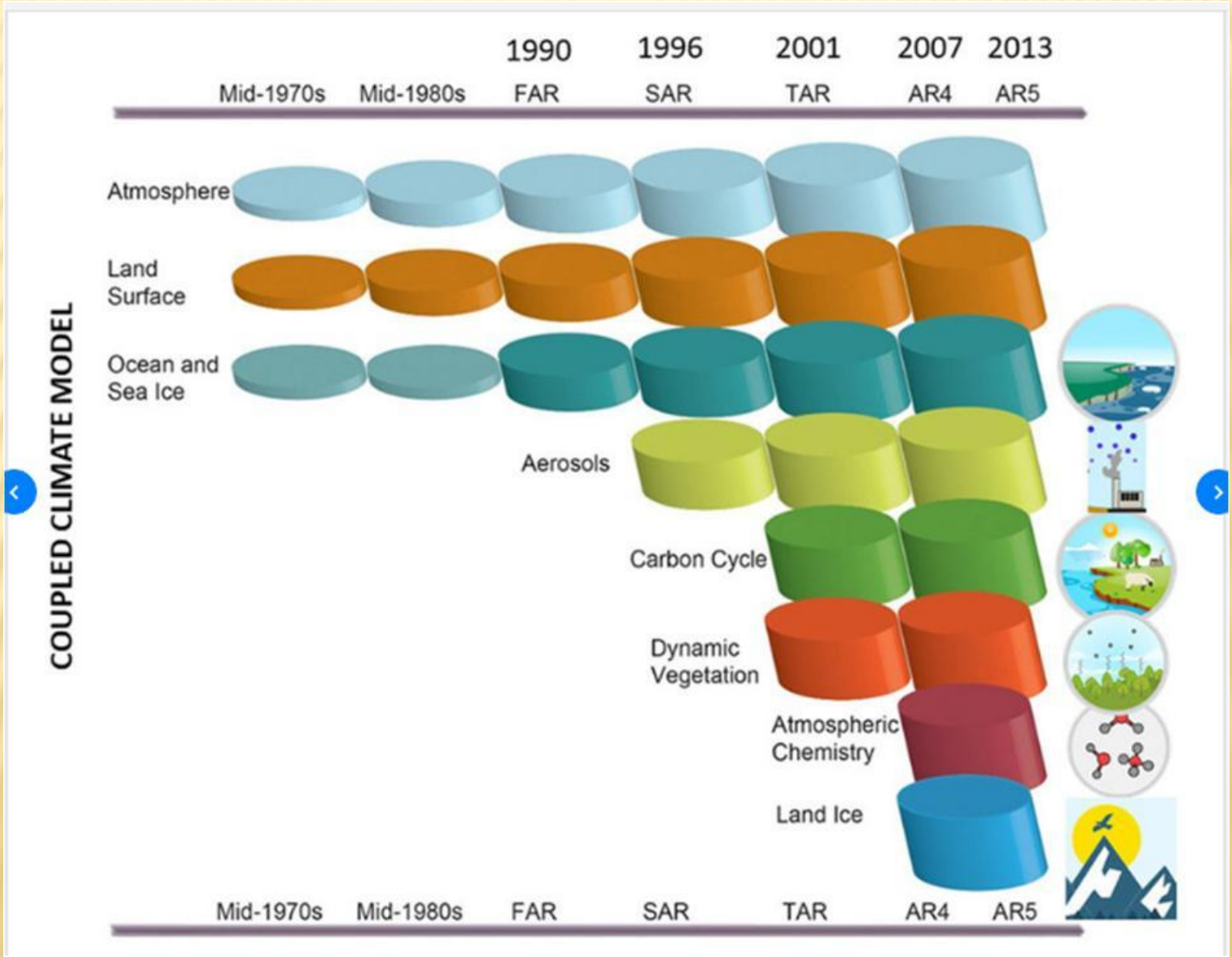
MODIS Northern Mexico, southwest US.
Composite of data from April 14 - 22, 2000.

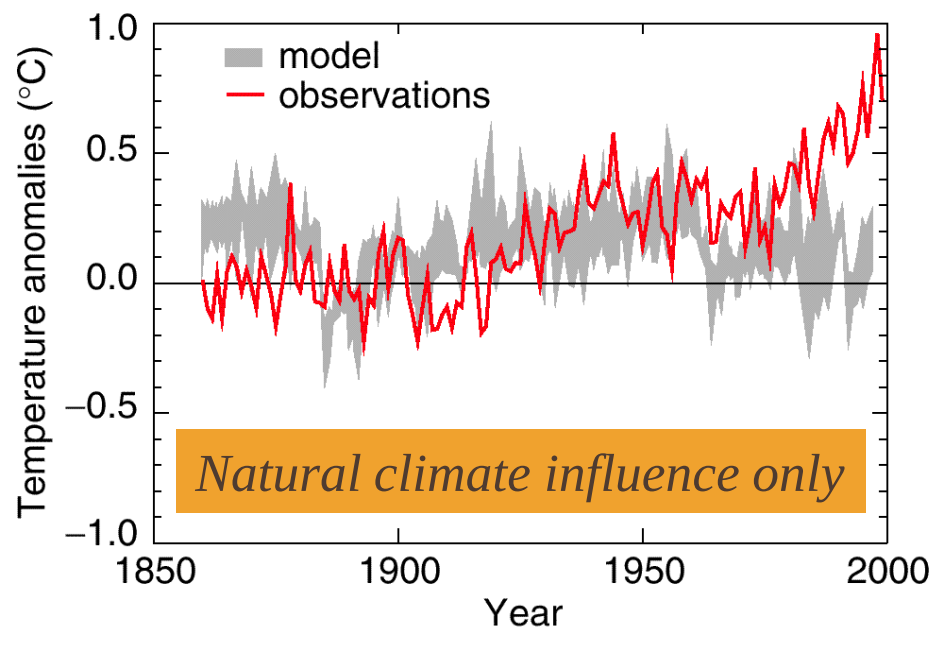
CLIMATE MODELS: INTEGRATING EARTH'S PROCESSES FOR FORECASTING

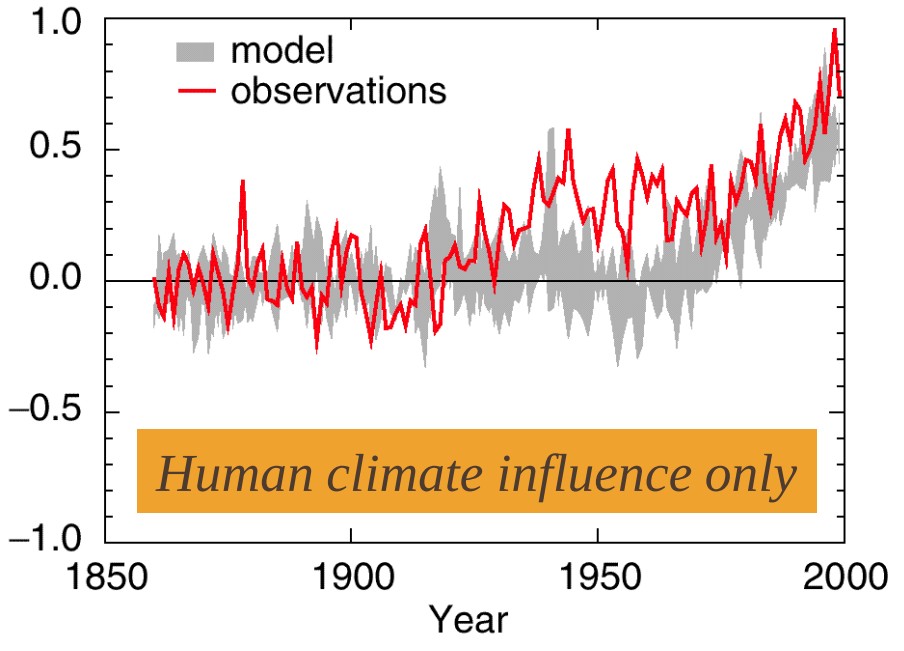




EVOLUTION OF CLIMATE MODELS



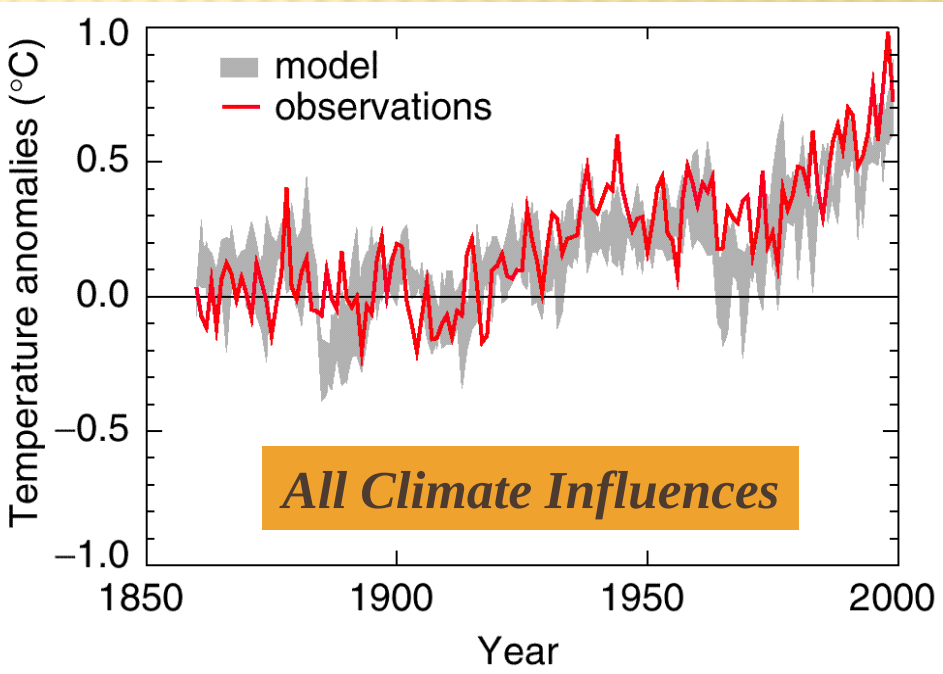




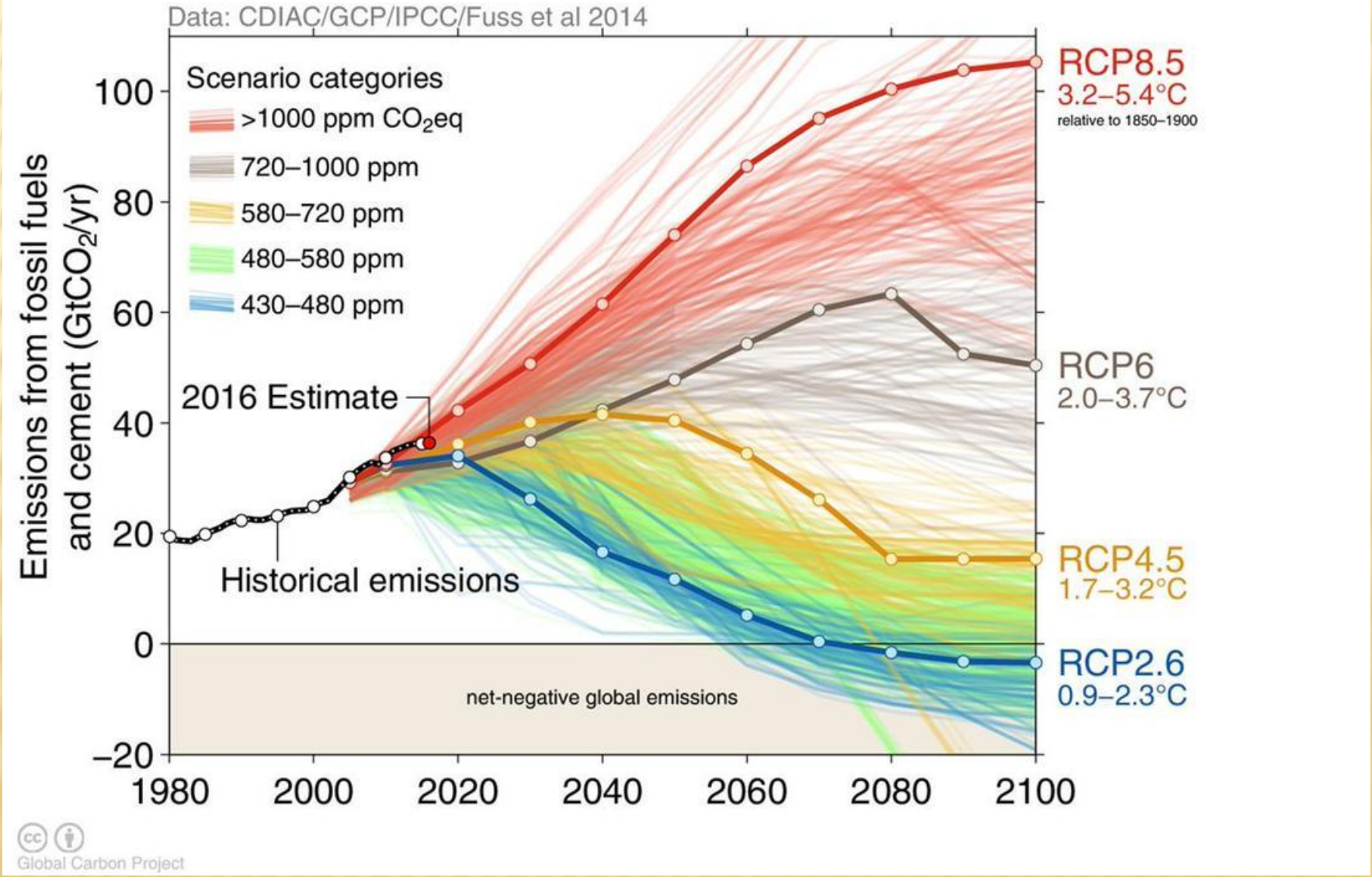
Gaining perspective through climate modeling

Observational record best matched when natural climate influences (solar variation and volcanic activity) and increases in CO2 concentrations are both included.

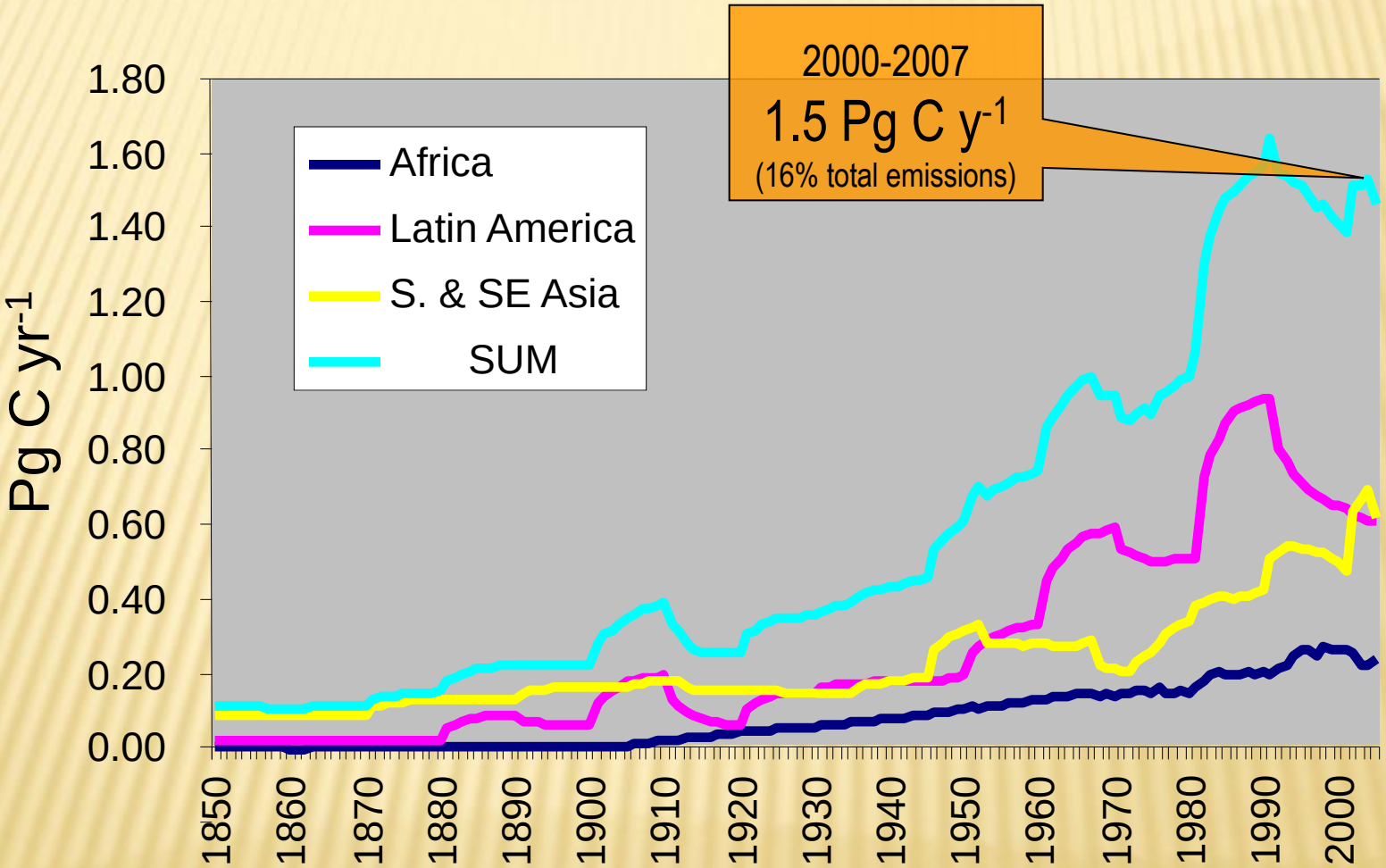
Source: IPCC, 2001



GHG EMISSIONS: IPCC SCENARIOS AND HISTORICAL



HISTORICAL EMISSIONS FROM LAND USE CHANGE



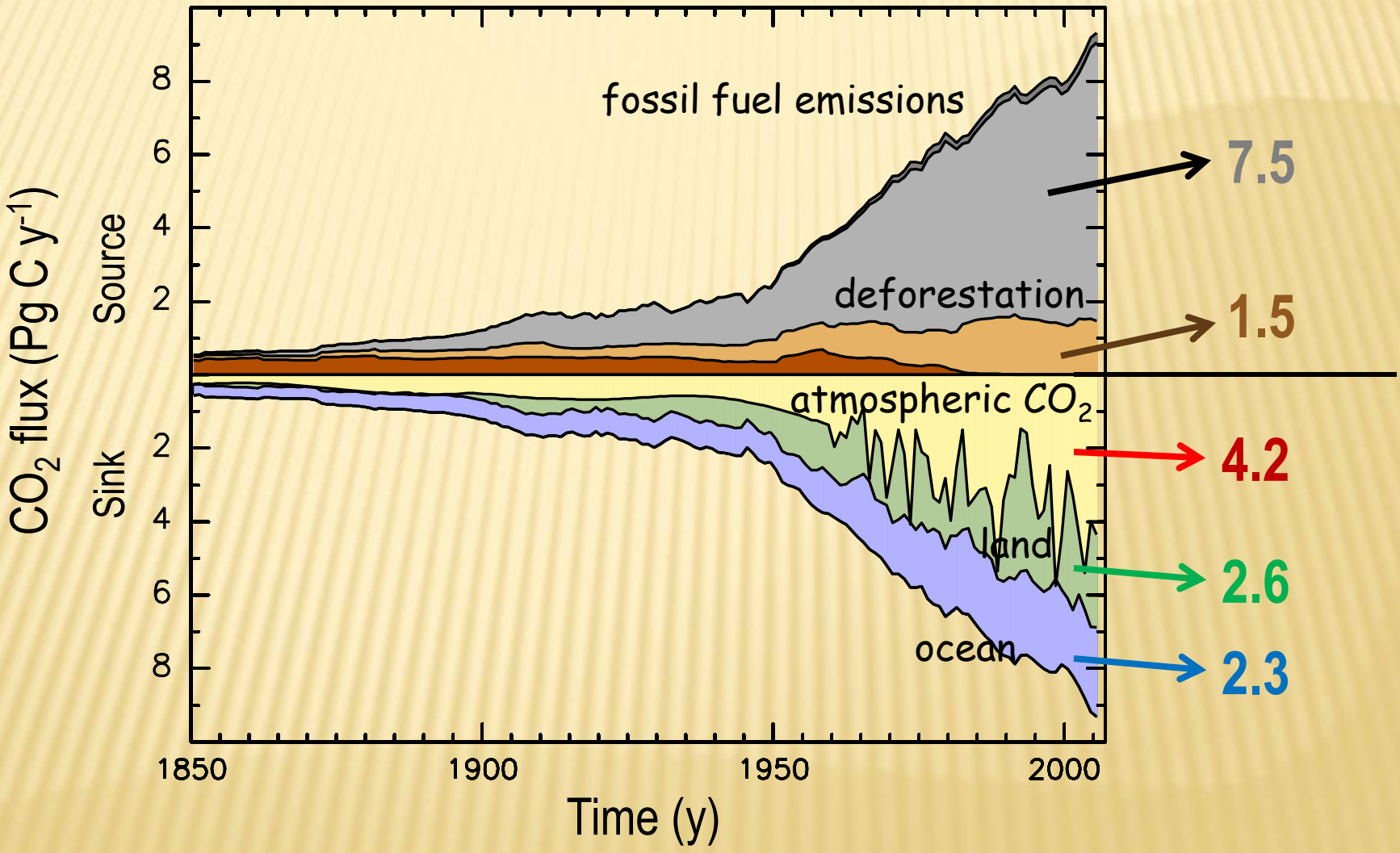
R.A. Houghton, unpublished

NATURAL CO2 SINKS

Natural CO_2 sinks absorb 55% of all anthropogenic carbon emissions slowing down climate change significantly.

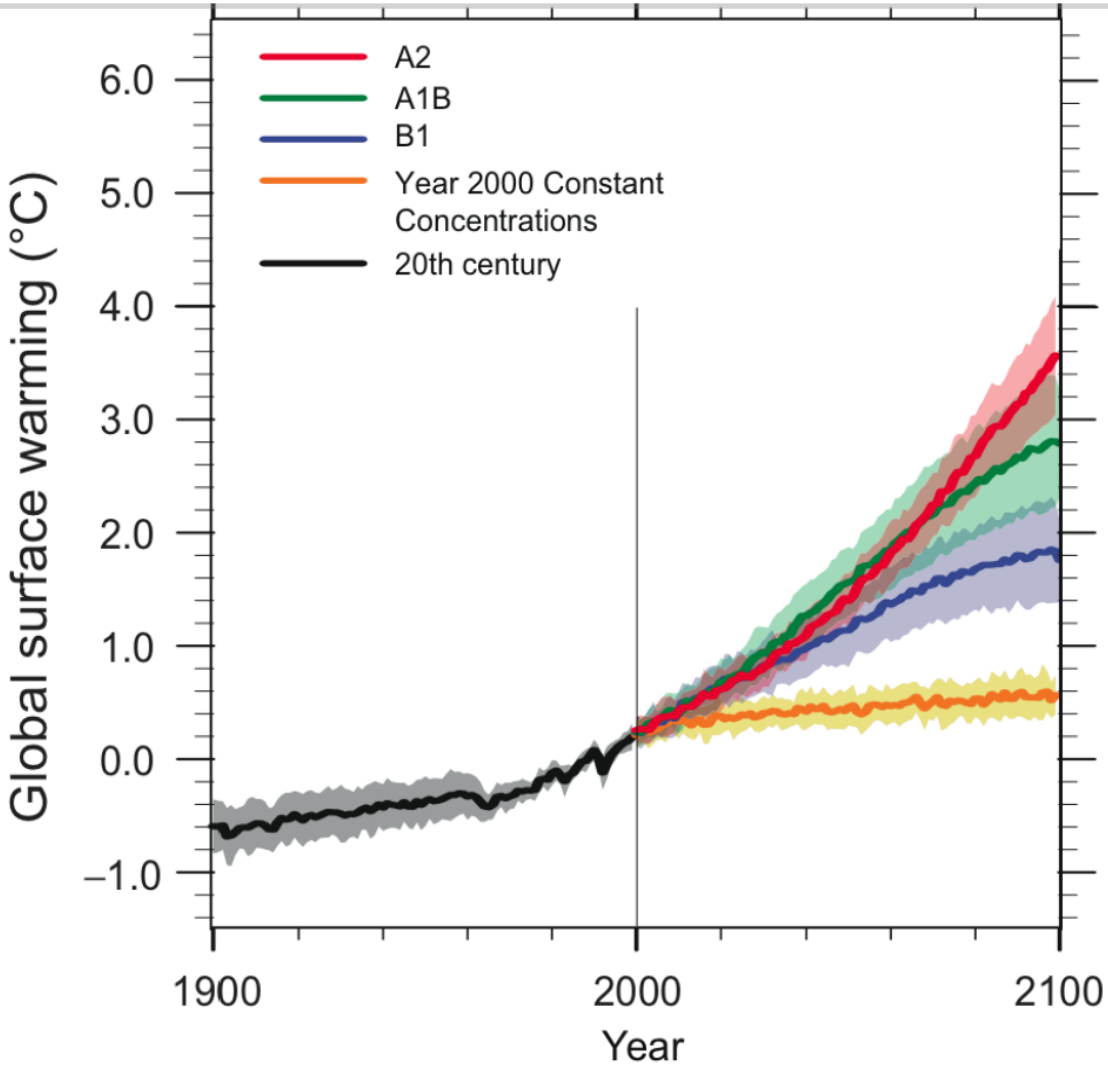
They are in effect a huge subsidy to the global economy worth **half a trillion US$** annually if an equivalent sink had to be created using other climate mitigation options (based on the cost of carbon in the EU-ETS).

HUMAN PERTURBATION OF THE GLOBAL CARBON BUDGET



Global Carbon Project (2008)

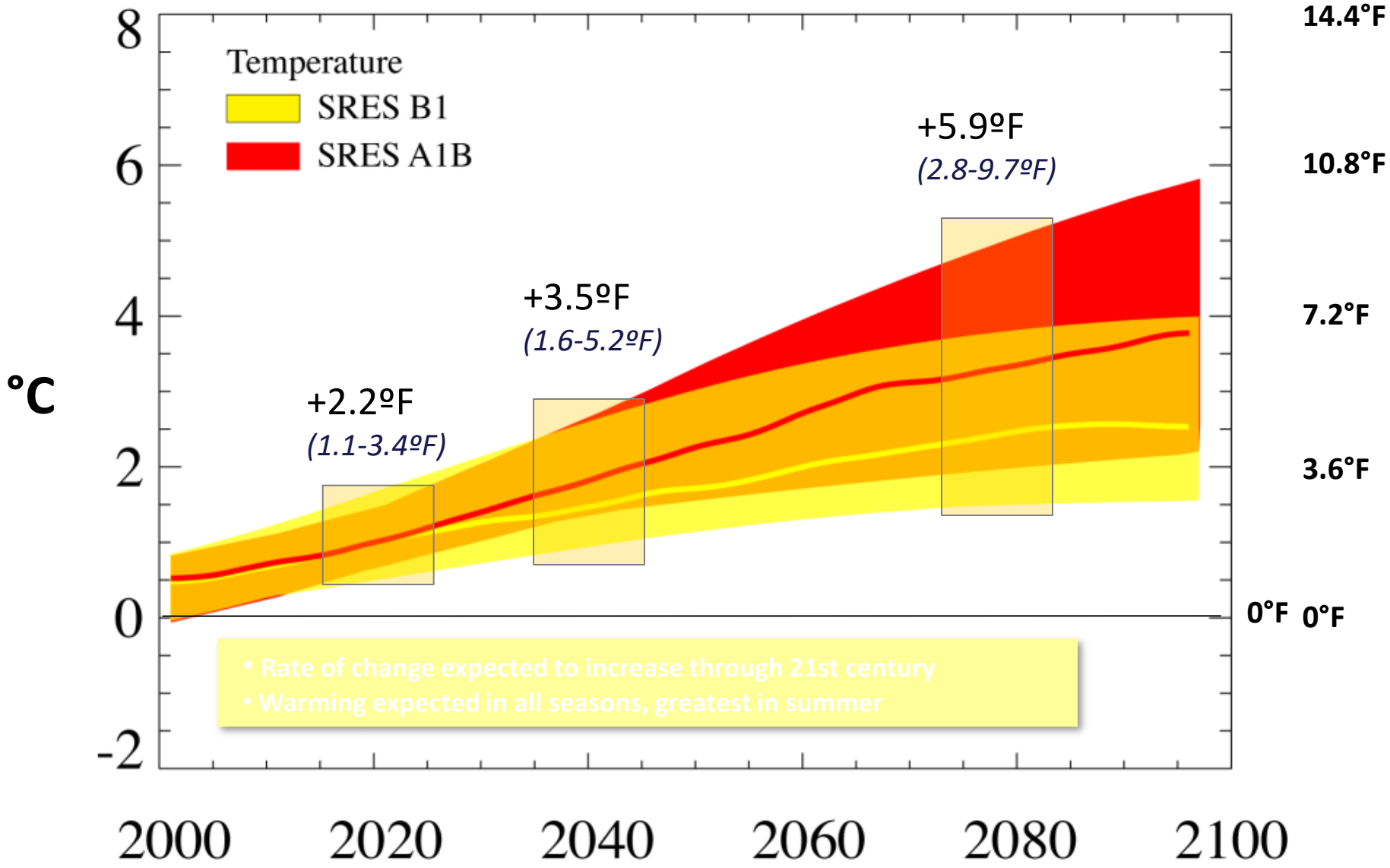
Projected 21st Century Global Warming



IPCC "best estimate" range of global-scale warming by the 2090s: 3.2° F-7.2° F

Warming in the next few decades largely driven by current and near-term atmospheric GHG oncentrations

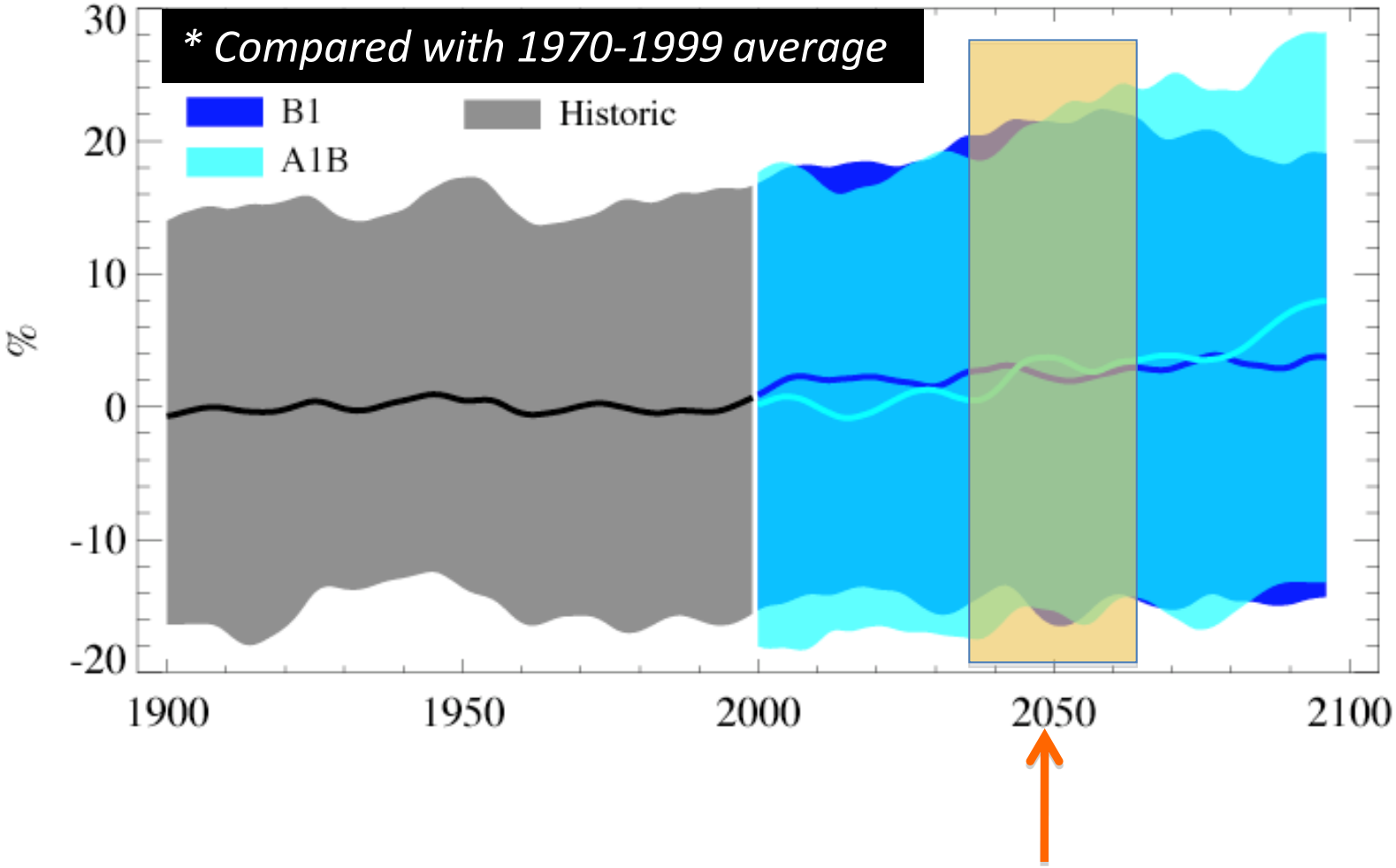
PROJECTED INCREASES IN PNW TEMP



*Changes relative to 1970-1999 average

Mote and Salathé, 2009

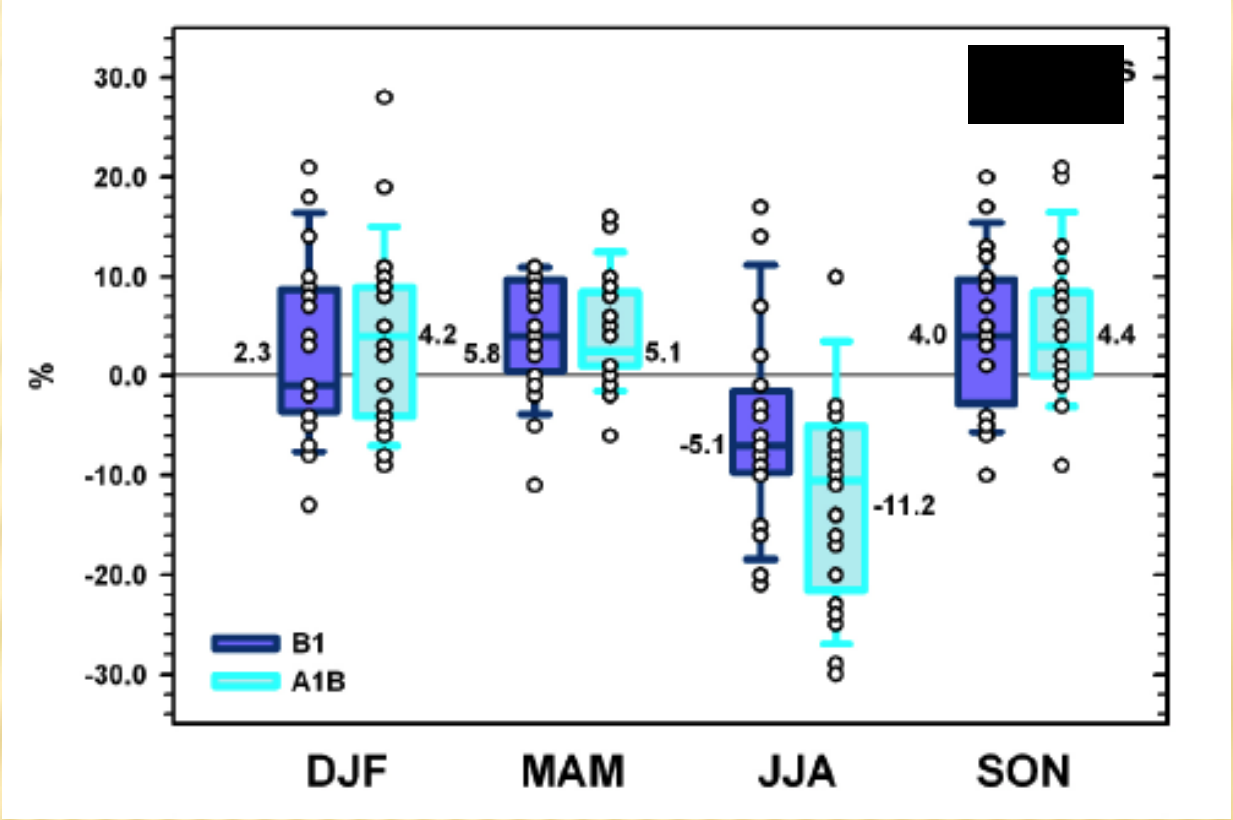
Projected Changes in Annual Precipitation



What about seasonal changes in precipitation?

Mote and Salathé, 2009

Seasonal Changes Projected for Precipitation

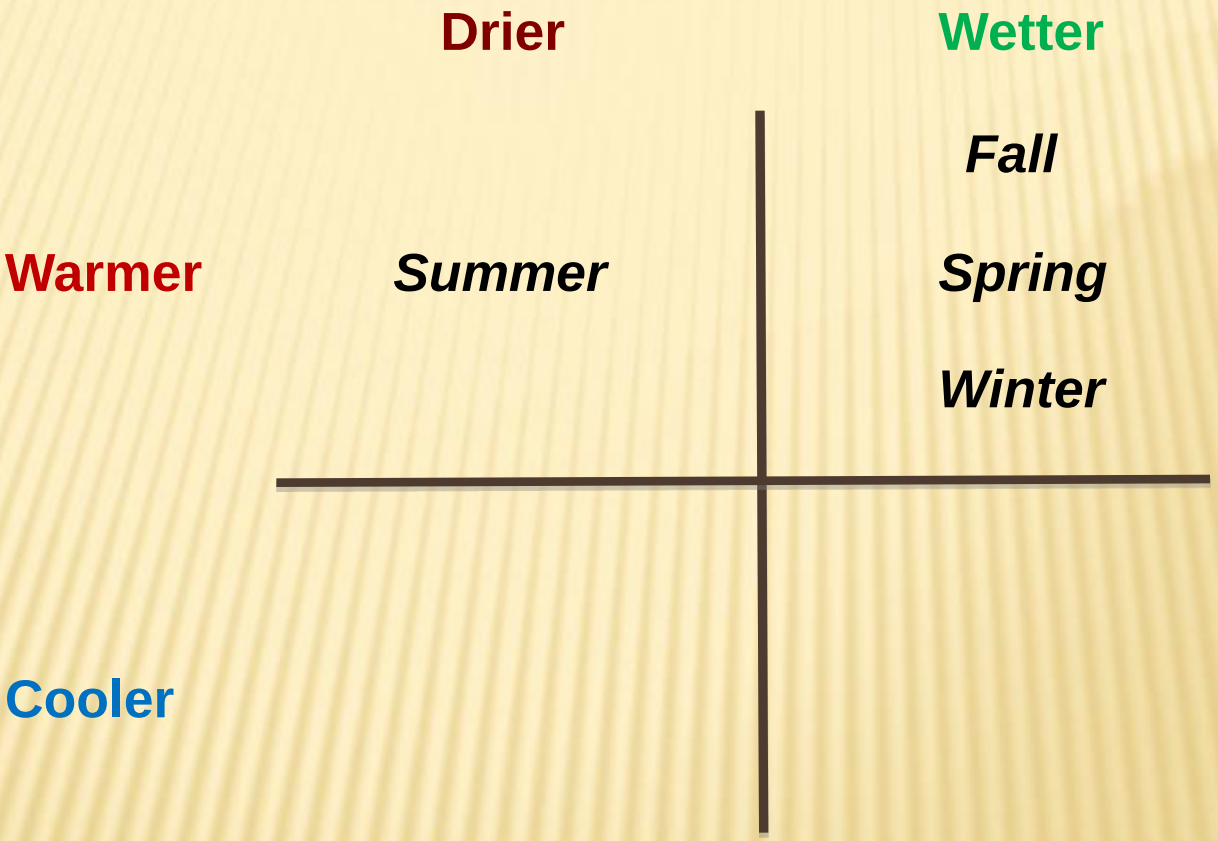


Wetter winters, springs and falls, but drier summers by mid 21st C

*Changes relative to 1970-1999 mean

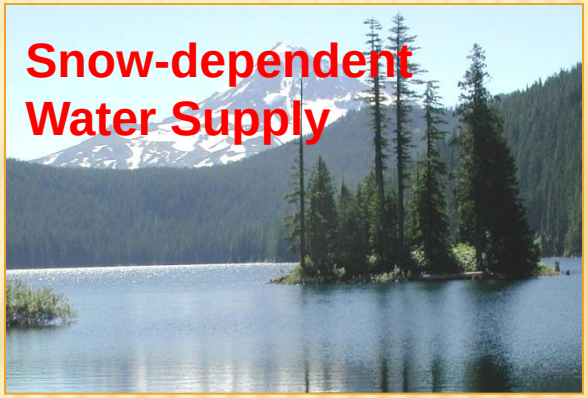
Mote and Salathé, 2009

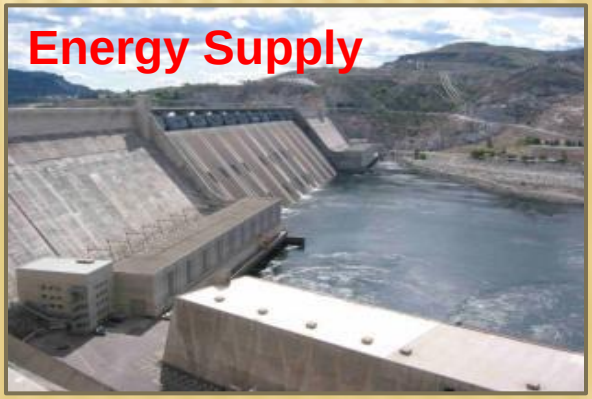
Seasonal matrix of projections



How will this projection of future climate affect Puget Sound's natural resources?

IMPACTS ON LOCAL KEY SECTORS





Human Health

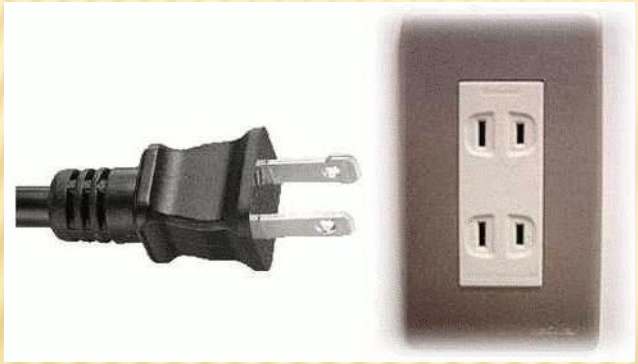
- In Washington, climate change will lead to **larger numbers of heat-related deaths** due mainly to hotter summers. For example in greater Seattle, a medium climate change scenario projects **101 additional deaths for people over 45 by 2025** and **another 50% increase by 2045**

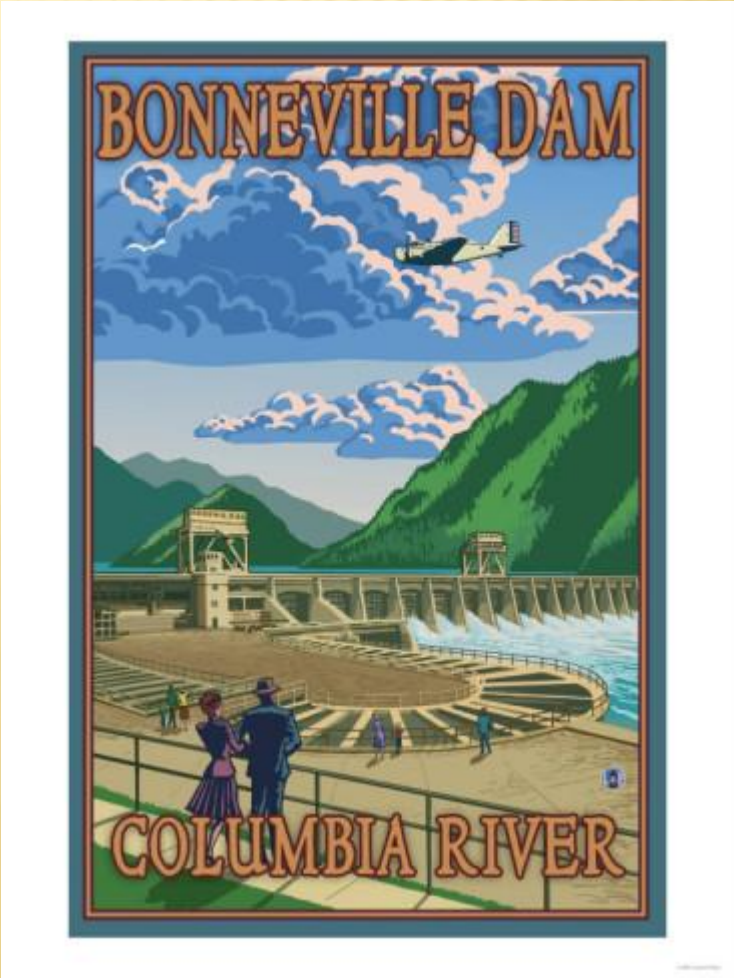
- Other impacts include:
  - **Dust and smoke** from fires
  - **Smog** (ground ozone)
  - **Disease vectors** (e.g. West Nile)

- Climate change can also be a **mental health** issue, due to **heat stress**, **disaster trauma**, and **fear and uncertainty**

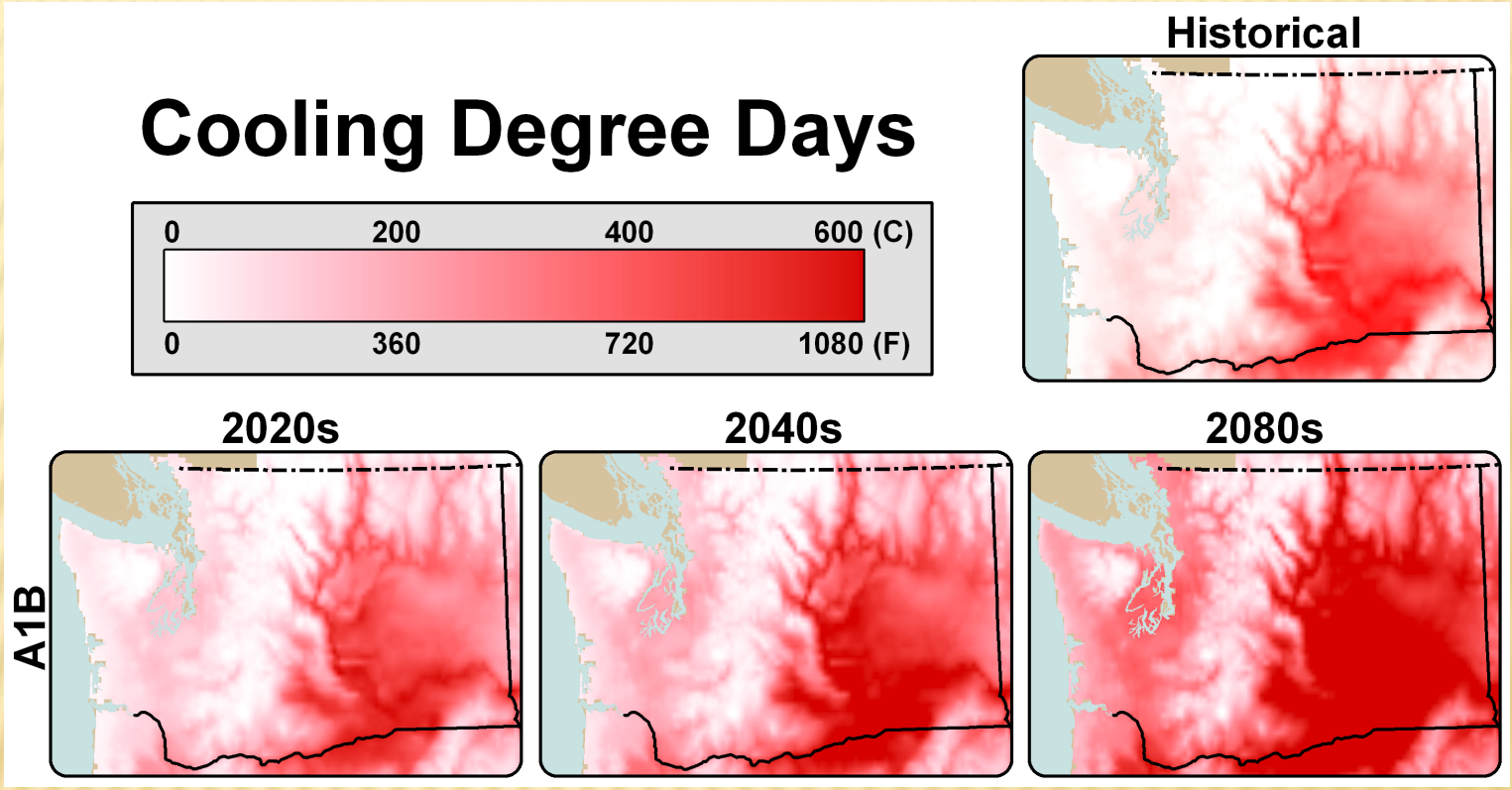
Jackson et al. 2009

Energy Demands





Demand for Cooling

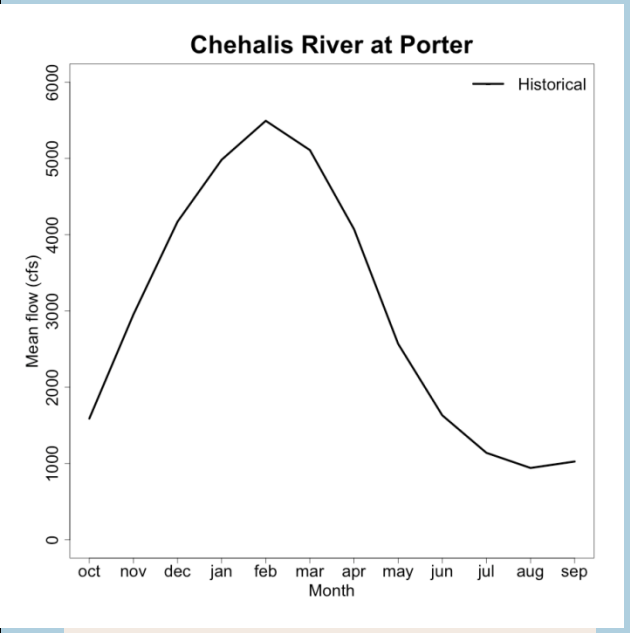


- Warmer temperatures in the summer will boost energy demands for AC
- Especially brutal in eastern WA
- Summer months are both hotter and drier

Impacts to Water Resources

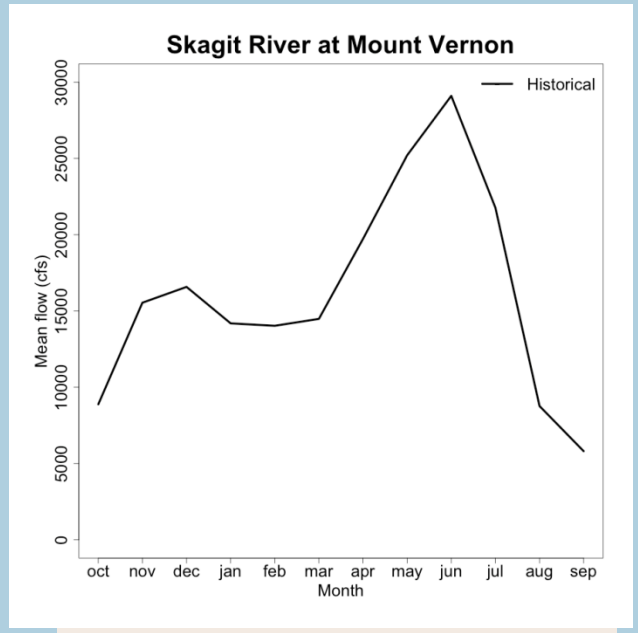
Three types of basins

rain-dominant



average monthly streamflow peaks in fall/winter

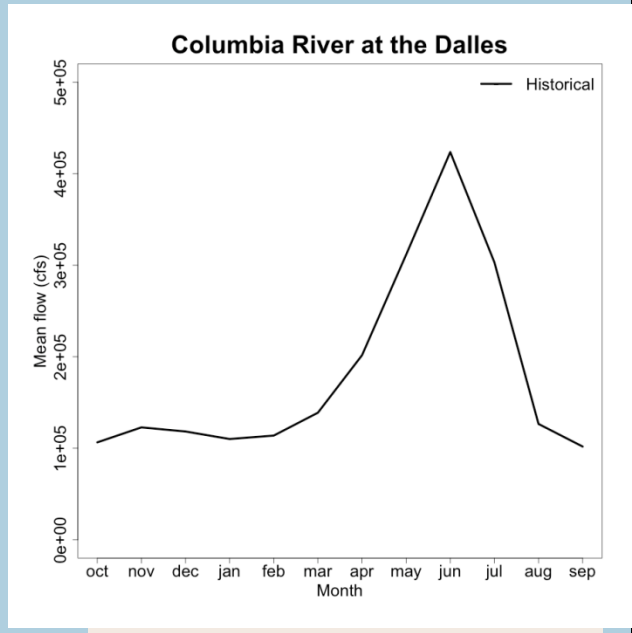
"transient" – double peaked



early winter rainfall

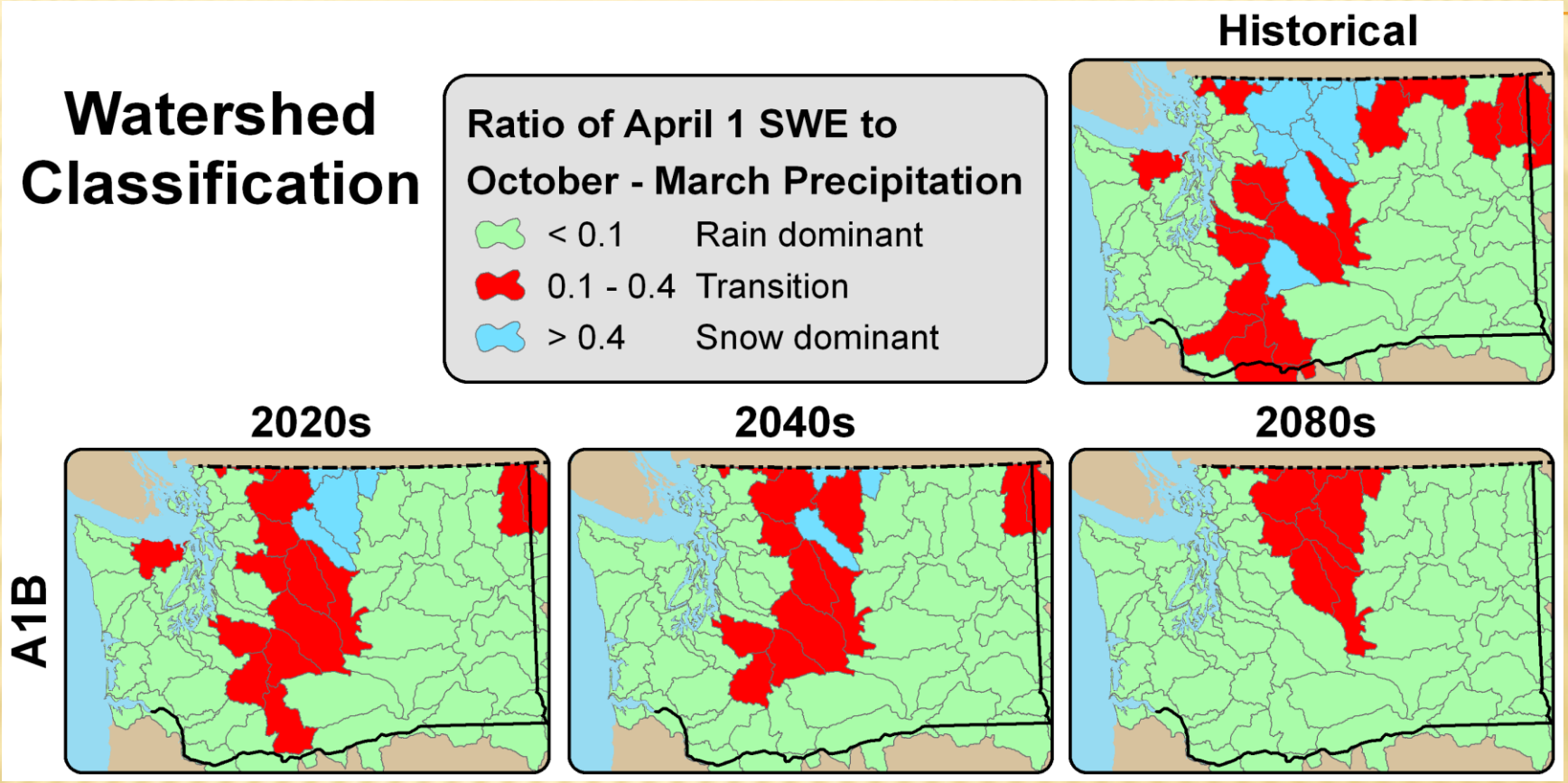
spring peak snowmelt

snowmelt-dominant



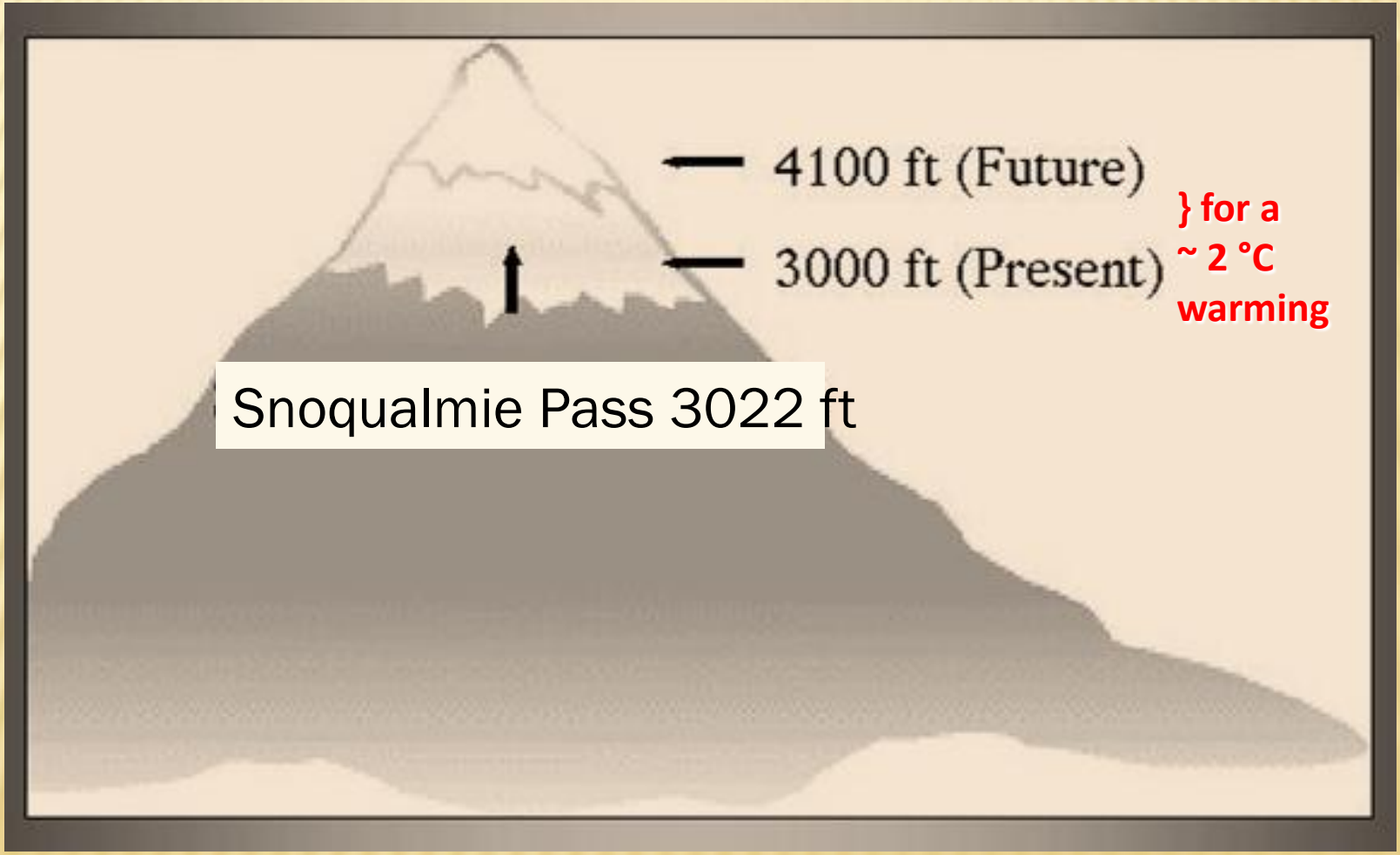
average monthly streamflow peaks in late spring/early summer

DRAMATIC SHIFTS IN SNOWMELT SYSTEMS



- Snowmelt basins shift to transient behavior
- Transient basins become rainfall dominant

A CLEAR IMPACT OF CLIMATE WARMING: LESS SNOW



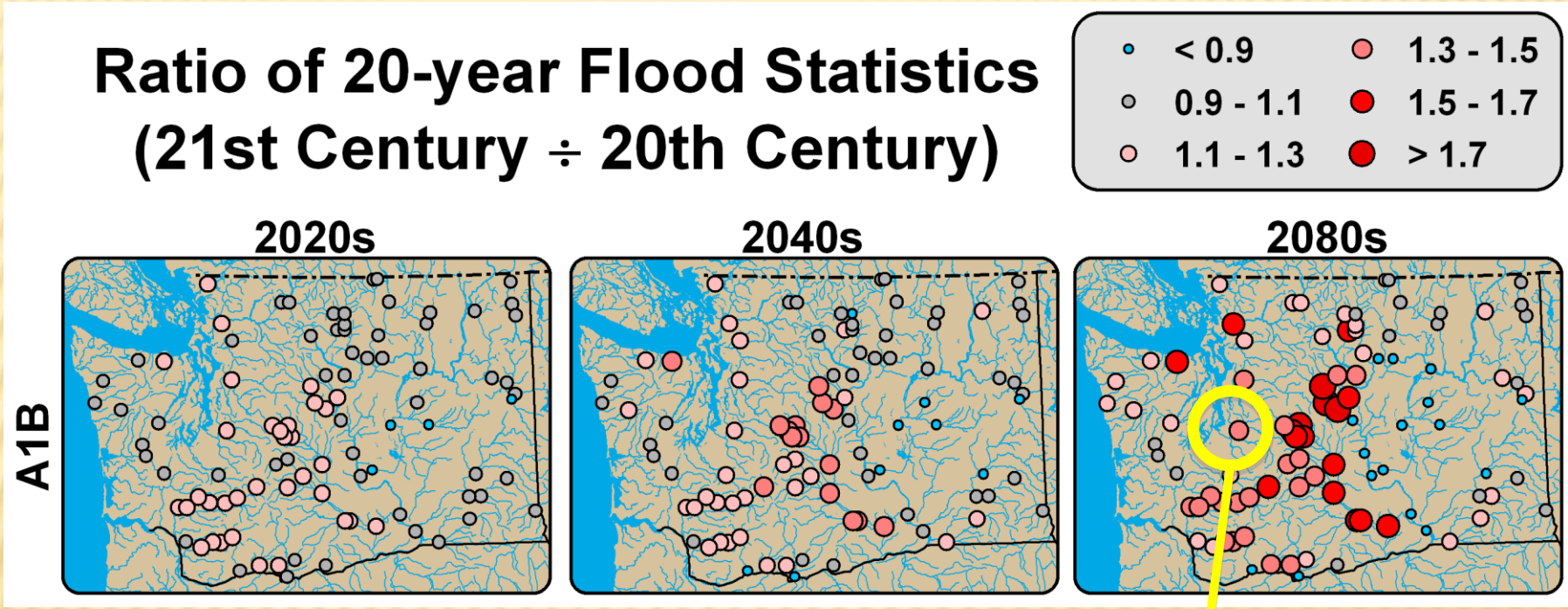
Why Focus on Hydrologic Extremes?

Many natural systems are quite robust under "normal" conditions, but have the potential to be profoundly impacted by hydrologic extreme events.

Image source: Seattle PI – Chehalis flood Jan. 8, 2009

Image source: Harley Soltes/Seattle Times

Shifts in Flood Magnitudes



Mantua et al. 2010

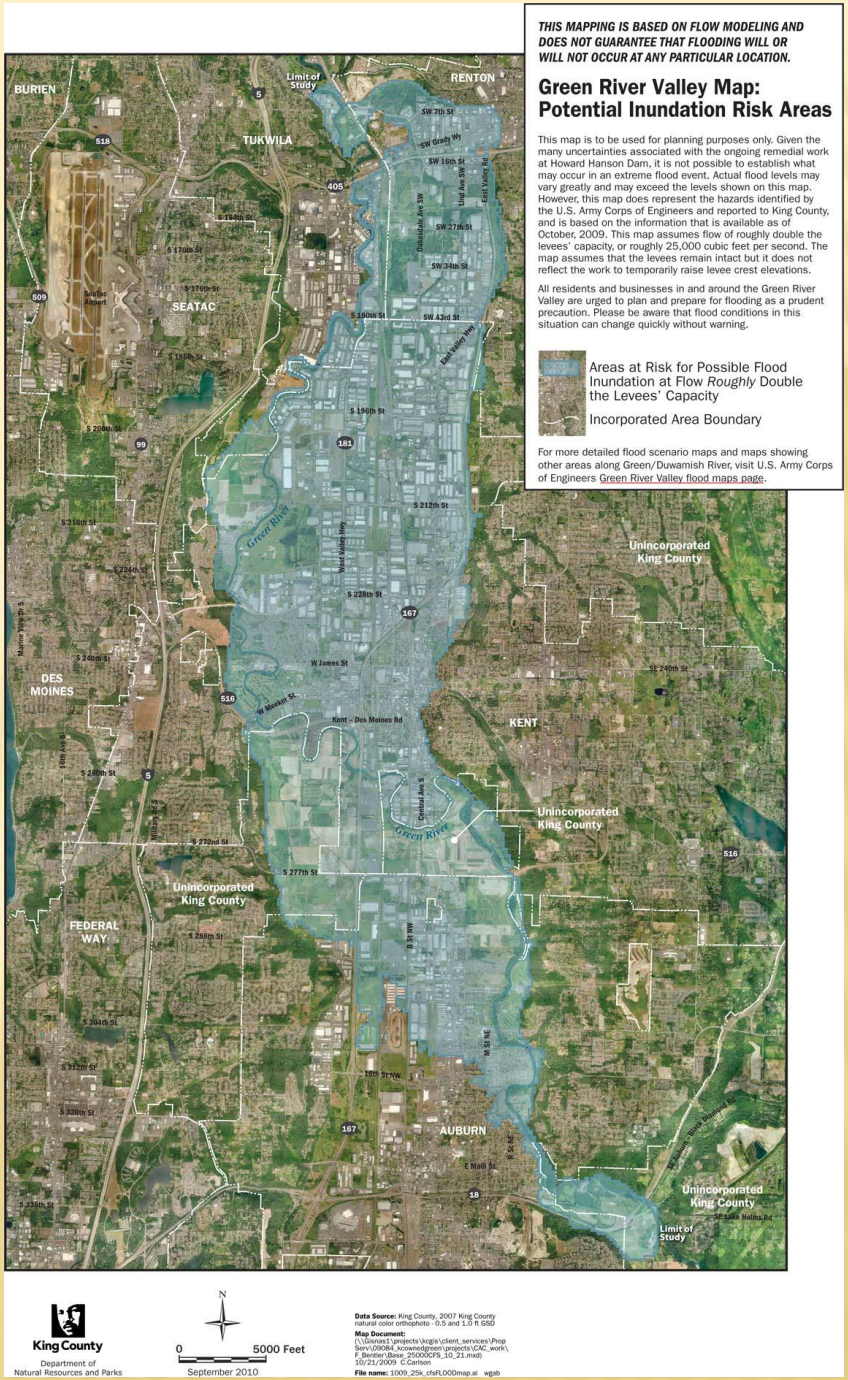
Harmful to salmon habitat

Hydropower operations

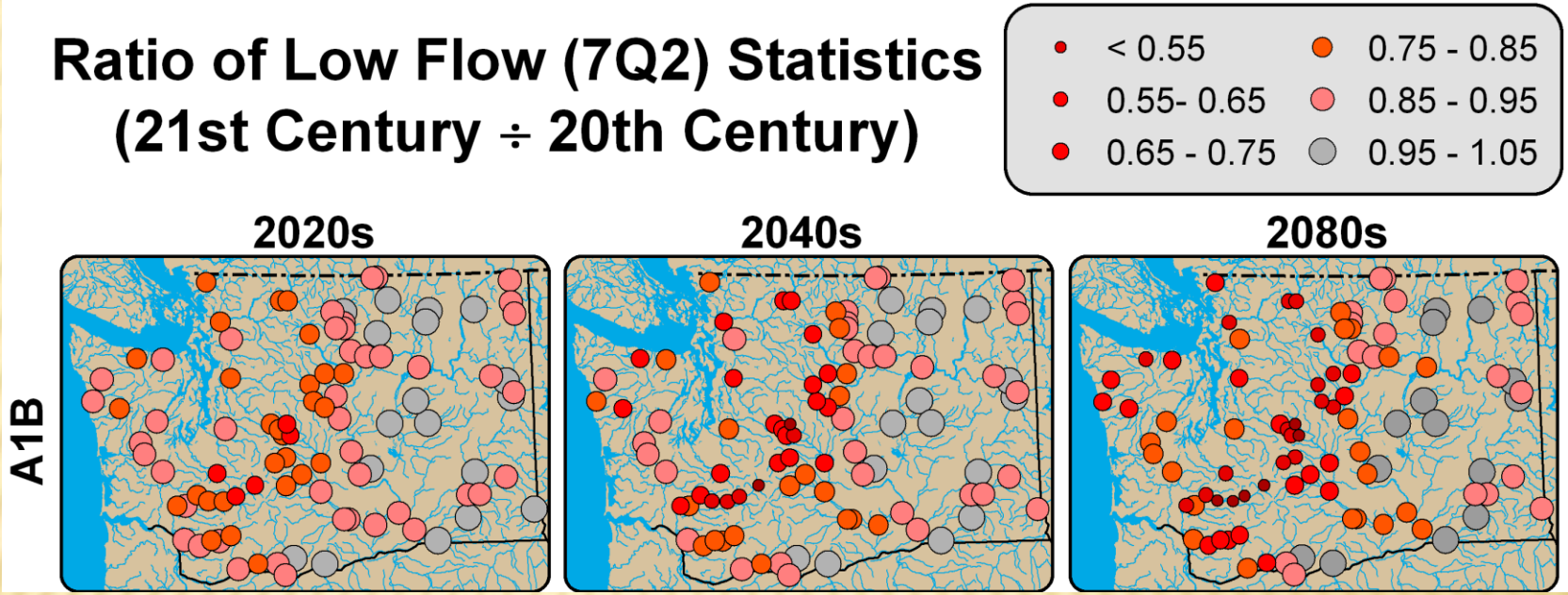
Urban stormwater systems

Green River

All good plans start with an idea of what we need to prepare for



More Severe Summertime Low Flows



Barriers for migrating fish

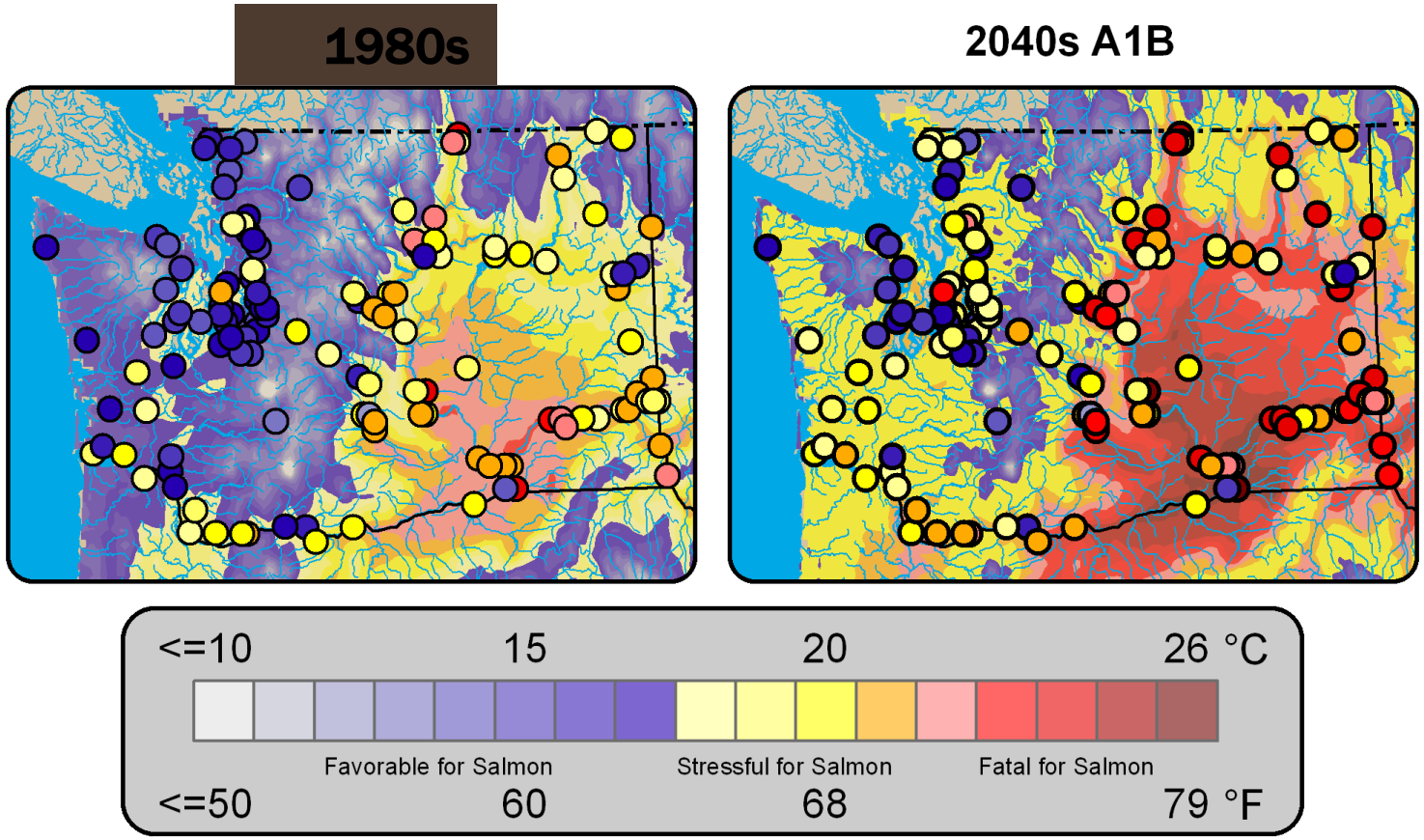
Lower water levels during high energy demands

Mantua et al. 2010

Low Flow and Temperature Impacts to Fish

Temperature/ Disease Related Fish Kill in the Klamath River in 2002

Projected summer water temperatures

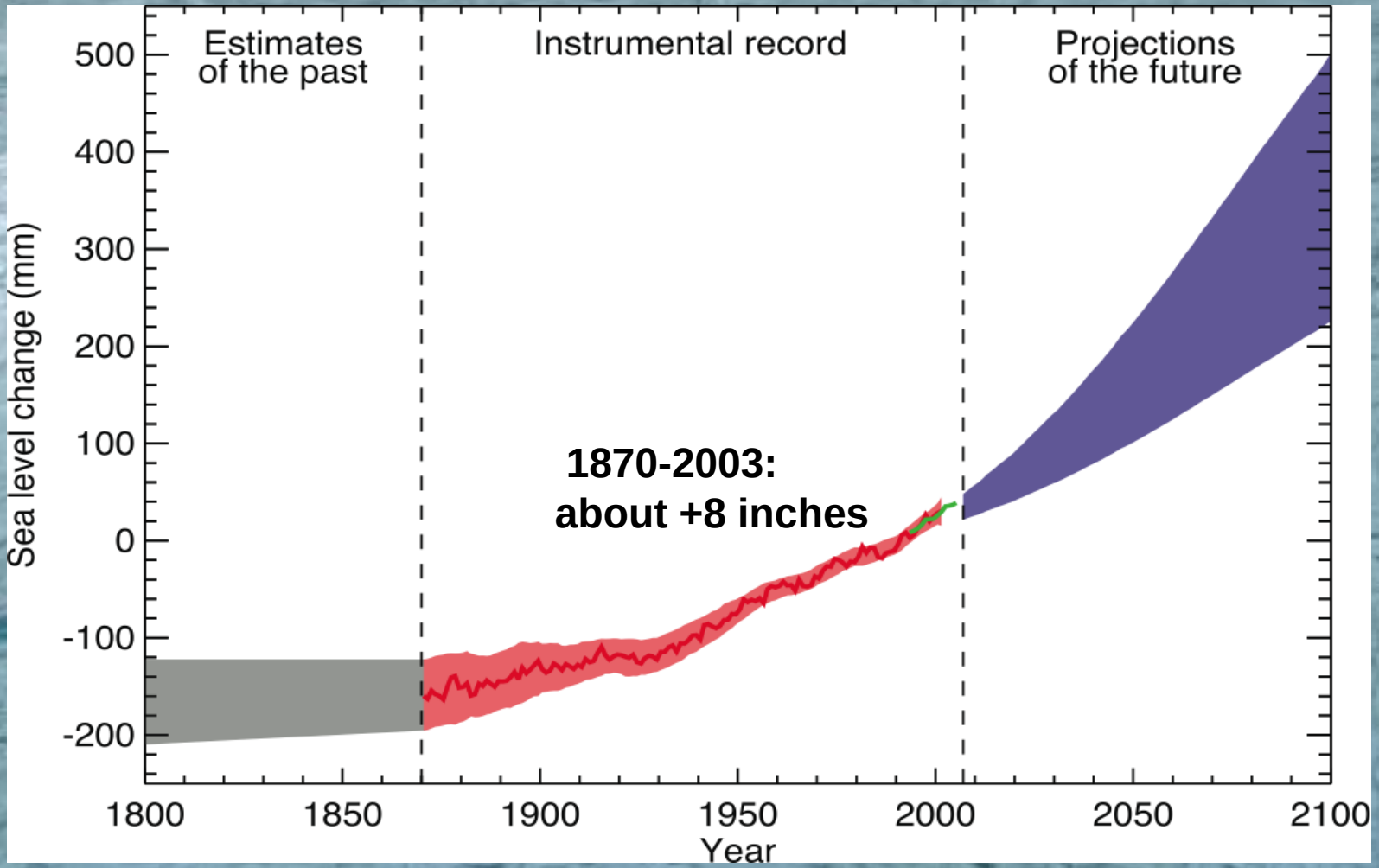


BY THE END OF THE 21ST CENTURY:
WESTERN WASHINGTON'S "MARITIME" = TODAY'S INTERIOR COLUMBIA BASIN
INTERIOR COLUMBIA BASIN = CURRENT CENTRAL VALLEY IN CALIFORNIA

Marine Impacts

Image source: armageddon o

PROJECTED GLOBAL SEA LEVEL RISE



18.9 inches

8.3 inches

Changes are relative to the 1980-1999 mean

Figure source: IPCC 2007

SEA LEVEL RISE (SLR) IN THE PNW

Major determinants:

- Global SLR driven by the melting of land-based ice
- Global SLR driven by the thermal expansion of the ocean
- Local tectonic processes *(subsidence and uplift)*
- Atmospheric dynamics, i.e., wind-driven “pile-up” of waves along the coast

WASHINGTON STATE SEA LEVEL RISE

Sea Level Rise Projections for Washington, Oregon, and northern California (relative to year 2000)		
Year	**Projection (in inches)**	**Range (in inches)**
2030	+2.6	-2 to +9
2050	+6.5	-1 to +19
2100	+24	+4 to +56

- Sea level rose about 7 inches prior to 2000.
- Two-thirds of the rise is caused by the melting of land ice
- Sea level rise interacts with geologic changes such as subduction and post-glacial rebound
- Sea level rise will magnify storm damage by interacting with increased wave height, storm surges and high tide events
- The health of coastal wetlands will depend on the interaction of sea level rise, sedimentation, and inland migration

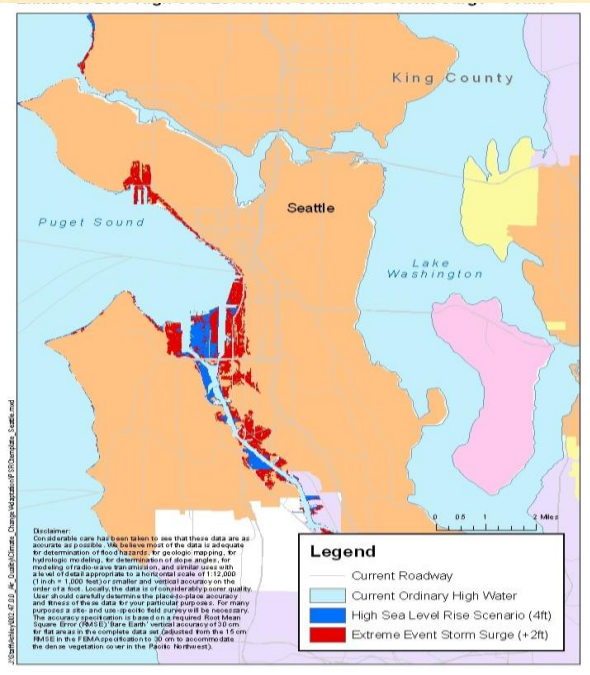
GEOMORPHIC RESPONSE

Influence of sea levels depends on:

- Rate of sea level rise
- Frequency/character of storms/events
- Landform (rocky, spit, bluff, marsh, delta)
- Ability of landform to shift laterally
- Availability of sediment

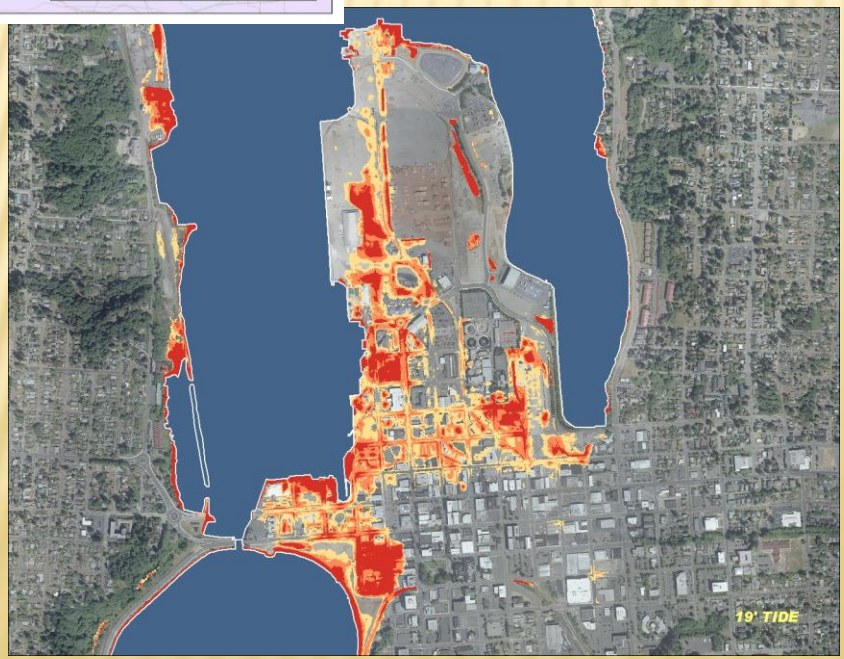
Slide courtesy of Hugh Shipman, WA Dept. of Ecology

Sea level rise in Puget Sound region



2100 High SLR Scenario + Storm Surge - Seattle

2100 Medium SLR Olympia – 13”



High Tide - January 2010

West Seattle, WA

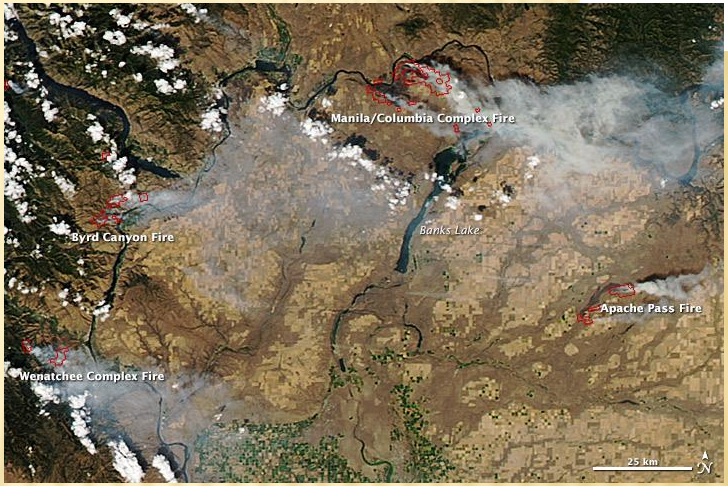
Port Orchard, WA

Impacts on PNW Forests

- Changes in tree species distributions
- Changes in productivity
- Increased insect damage
- Increased forest fire risk
- "Stress complexes" (e.g., drought, fire, insects) will be strong agents of landscape change by midcentury.

Mountain pine beetle

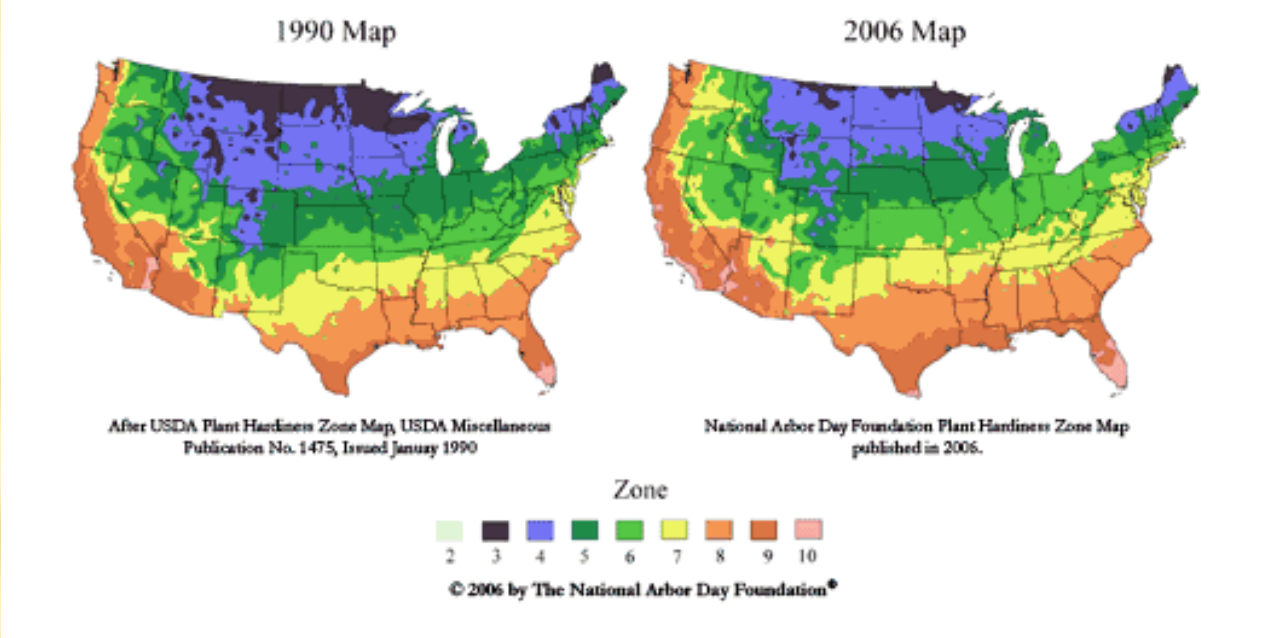
Sept. 10, 2012



IMPACTS TO PNW AGRICULTURE

- High temperatures and heat waves can affect productivity of crops and livestock
- Higher CO2 levels can promote growth of some crops
- Increase risks from weeds, pests and diseases
  - Exotic species
  - More generations/year
- Less water available for irrigation and more evaporation

Shift in Plant Hardiness Zones
National Arbor Day Foundation



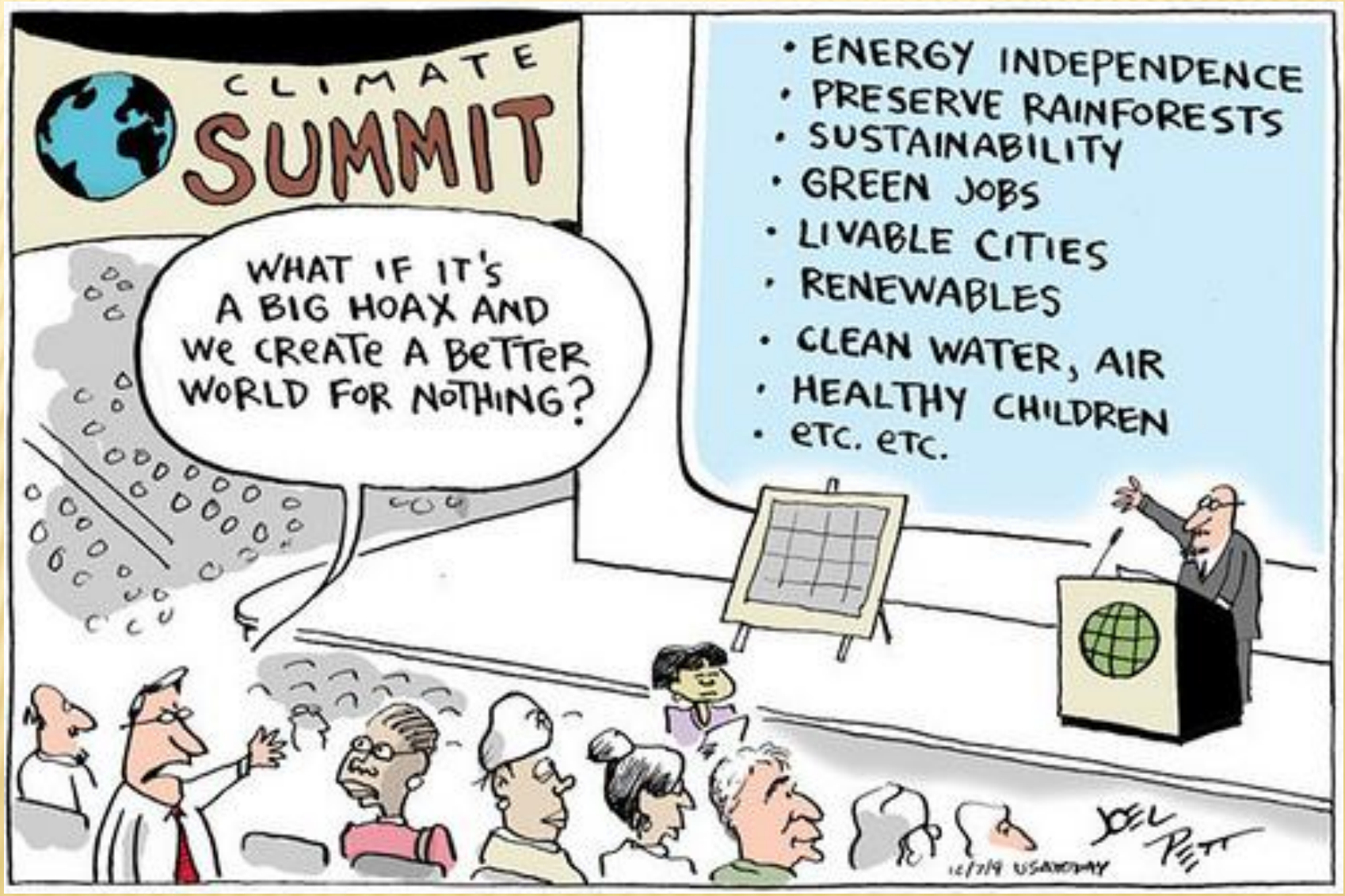
Potential Economic Costs in Washington
If no additional actions are taken to reduce greenhouse gas emissions
(million dollars per year)

	2020	2040
Lost Natural Water Storage	$7,150	$11,100
Increased health-related costs	$1,300	$2,200
Reduced salmon populations	$531	$1,400
Increased energy costs (reduced hydro supply, higher energy demand)	$222	$623
Increased wildland fire costs	$102	$208
Lost recreation opportunities	$75	$210
Increased coastal and storm damage	$72	$150
Reduced food production	$35	$64
Impacts to Forestry of Beetle Kill	$31	$28.7
Total increased costs	**$9,000**	**$15,900**

By 2020 total cost expected to reach $3,166 per household each year

Source: University of Oregon, Climate Leadership Initiative

ADAPTATION
- INCREASE RESILIENCE TO A CHANGING CLIMATE



ADAPTATION
- INCREASE RESILIENCE TO A CHANGING CLIMATE

Key principles

- Adaptation does not replace GHG reductions
  - We have to stabilize emissions to protect our future
- Current emissions will change the climate for decades
  - We must adapt to changes already in the pipeline
- Design for future changes, not for historical record
  - "End of Stationarity" = the past no longer predicts the future
- CC makes existing problems worse
  - Look for solutions that include climate resiliency
- CC adds new implications
  - We must anticipate a future that will look different
- Sometimes we may have to adapt to adaptation
  - Some solutions create new problems

ADAPTATION
- INCREASE RESILIENCE TO A CHANGING CLIMATE

Examples:

- Protect human health from heat, smoke, disease vectors
- Protect infrastructure from flooding and SLR
- Treat forests for wildfires and increase home protection
- Improve water management and protect thermal refugia
- Increase resilient habitat for sensitive species
- Restore wetlands and allow for coastal wetland retreat
- Modernize land use regulations to address impacts
- Design for future changes, not for historical record
  - "End of Stationarity" = the past no longer predicts the future

A PUBLIC HEALTH RESPONSE

- **Risk management planning for a increasing uncertainty**
- **Improved response to disease and air quality events**
- **Build resilience into water supply infrastructure**
- **Prepare for emerging threats: more tropical diseases, extreme weather events**

CHANGING ENERGY IMPACTS

- **Invest in conservation and a diverse renewable energy portfolio**
  - **Reducing GHG emissions is also energy adaptation**
- **Increase contingency planning for extreme weather**
  - **Heat waves and extreme storms**

RESTORATION TO MITIGATE LOW FLOWS AND STREAM TEMPERATURES

- Increase access to side channels and refugia
- Reforest riparian zones to increase shading and reduce warmer water temperatures
- Restore watershed processes to increase summer inflows of cool groundwater

PLANNING FOR INCREASED SURFACE WATER AND IMPROVING WATER QUALITY

Pervious paving, storm water swales & green roofs

reduce stormwater flows and clean runoff

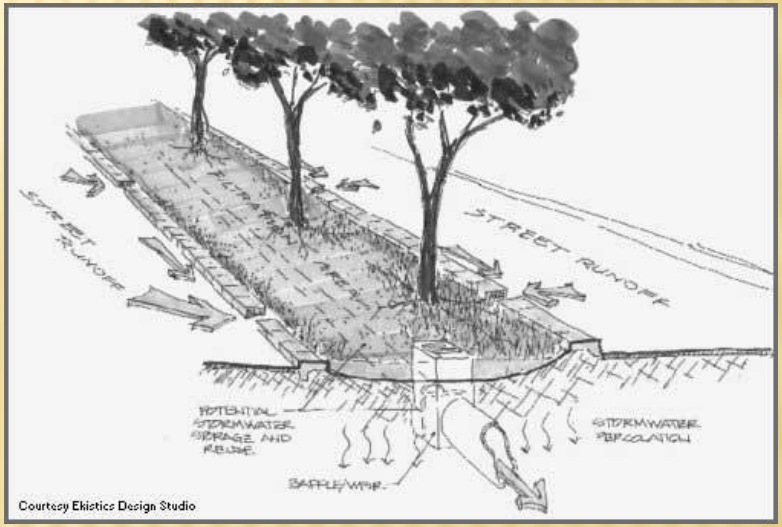


Image source: Bay Soundings

A NATURAL WORLD ON THE MOVE

- Migration corridors needed for mobile species
- Habitat resiliency for heat and floods
- How do we help vegetation to shift when the climate changes more quickly than plants can grow?
- Protecting isolated habitats
  - Vernal pools, mountain tops

INCREASED THREATS TO OUR COASTS

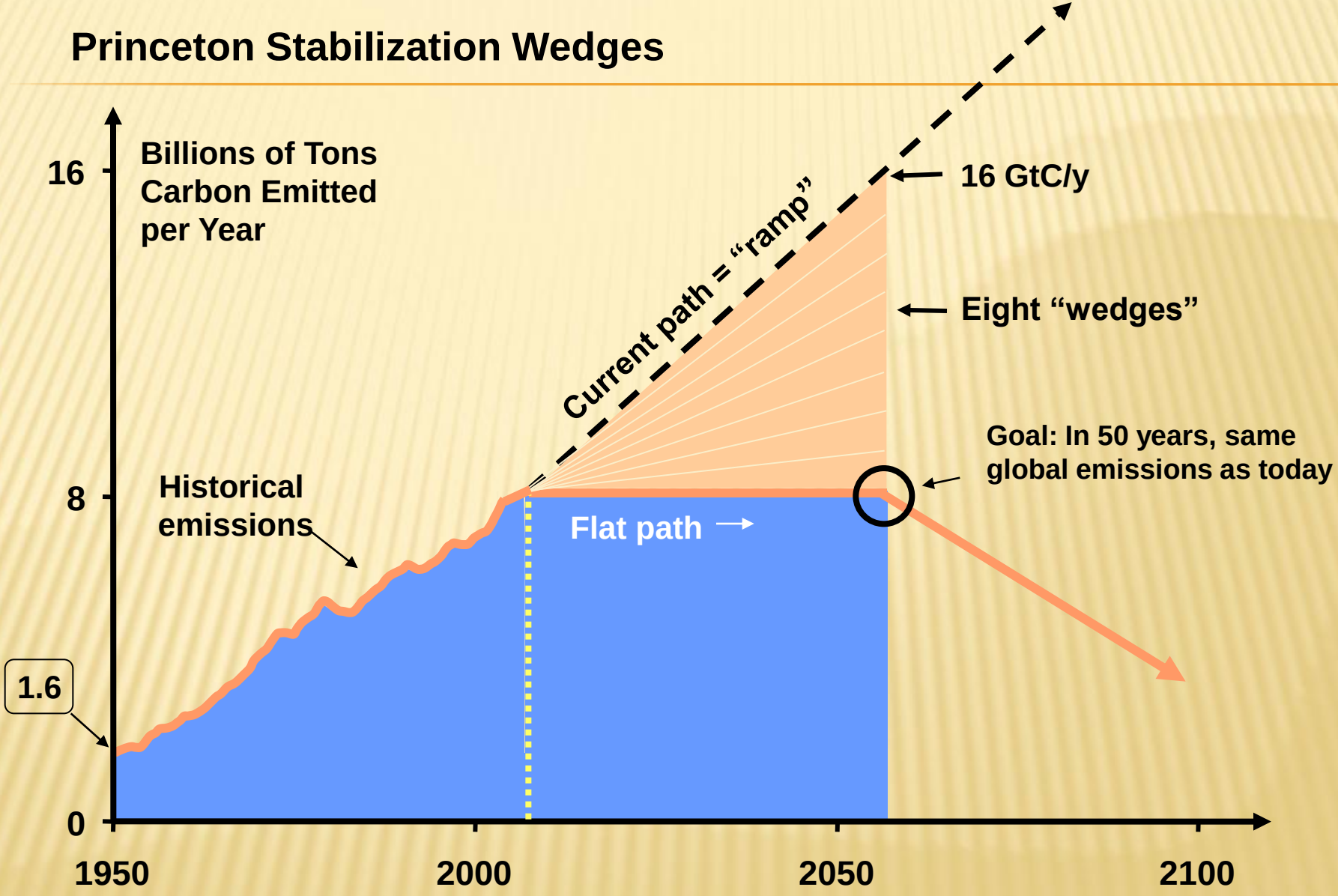
- **Planning for extreme events:**
  - **SLR + storm surge + spring tides + higher waves**
- **Urban zoning and flood risk – improved standards**
  - **Where to retreat and where to defend?**
- **Coastal wetland migration**
  - **Creating inland corridors for estuaries**

PROTECTING OUR WORKING LANDS

- **Forest treatments to reduce wildfire hazard**
  - **Thinning and control burns**
  - **Homeowner education: urban-wildland interface**
- **Responding to exotic and expanding pests**
  - **Biological controls and IPM**
  - **Addressing increased pesticide use**
- **Planning for changing species assemblages**
  - **Managing shifting forest biomes**
  - **More resilient crops – heat, water, pest stress**

HOW TO REDUCE CARBON EMISSIONS?

Princeton Stabilization Wedges

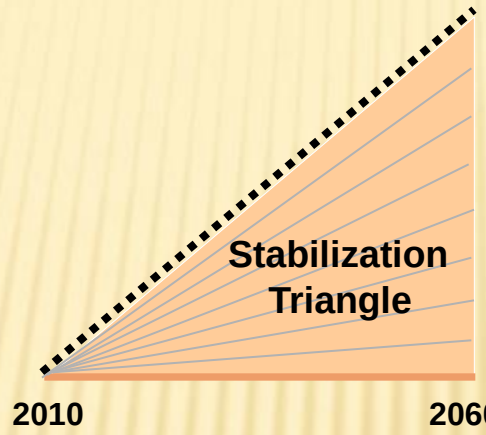


http://cmi.princeton.edu/wedges/

15 Wedge Strategies in 4 Categories

Energy Efficiency & Conservation
- Electricity
- Tranportation
- Buildings

Fossil Fuel-Based Strategies
- Carbon capture and storage
- Fuel switching (coal→natural gas)



Nuclear Power

Renewables & Biostorage
- Wind
- Solar
- Biofuels
- Natural sequestration

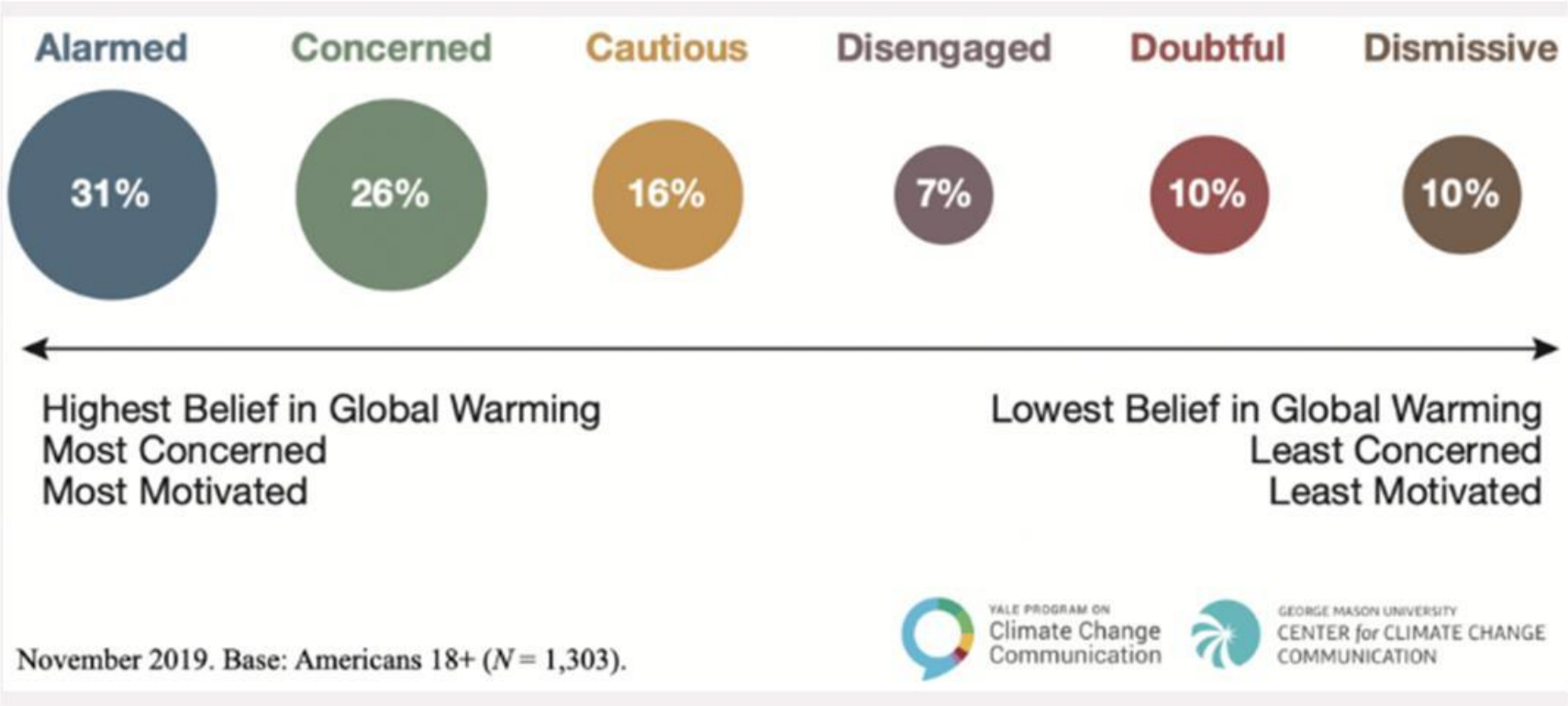
Similar ideas built into the "Green New Deal"

ECONOMIC TOOLS

- Carbon Pricing
  - Carbon tax
    - currently in effect in B.C.
  - Carbon cap-and-trade
    - currently in effect in California and Europe
- Tax subsides
  - Remove fossil fuel subsidies
  - Tax breaks for conservation or renewables
- Carbon offsets
  - Put economic value on natural sequestration
    - e.g. soil, wetlands forests

CLIMATE CHANGE ATTITUDES

- "Six Americas" project
  - Yale Project on Climate Change Communication
  - November 2019 report



WHAT KEEPS US FROM TAKING ACTION?

- Barriers to accepting and acting on climate change
  - Anxiety – too scary, triggers avoidance
  - Lack of control / helplessness – nothing I do matters
  - Distant – not a problem right now, far in the future
  - Uncertainty – don't understand, not sure who's right
  - Mistrust – don't believe the experts or leaders
  - Social comparison – what do our peers believe?
  - Undervaluing risk – people exaggerate, it can't be that bad
  - Perceived control – too big a problem, I can't change it
  - Habit and avoidance – trust the status quo

Report of the American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change

http://www.apa.org/science/about/publications/climate-change.aspx

CHANGING ATTITUDES – MOVING TO ACTION

- Connect to people's personal experience
  - What impacts do they see?
- Connect to landscapes people care about
- Connect to current events – it's happening now
  - Record heat, storms, rainfall are all climate signals
- Gather knowledge, listen to the science consensus
- Identify vested interests
  - Stakeholders in the status quo resist change
- We need to create a new paradigm for our future
- Teach, and learn from, our youth
  - Together we create their future
- We need to work together
  - Support one another
- What you do is important
  - Action is needed now