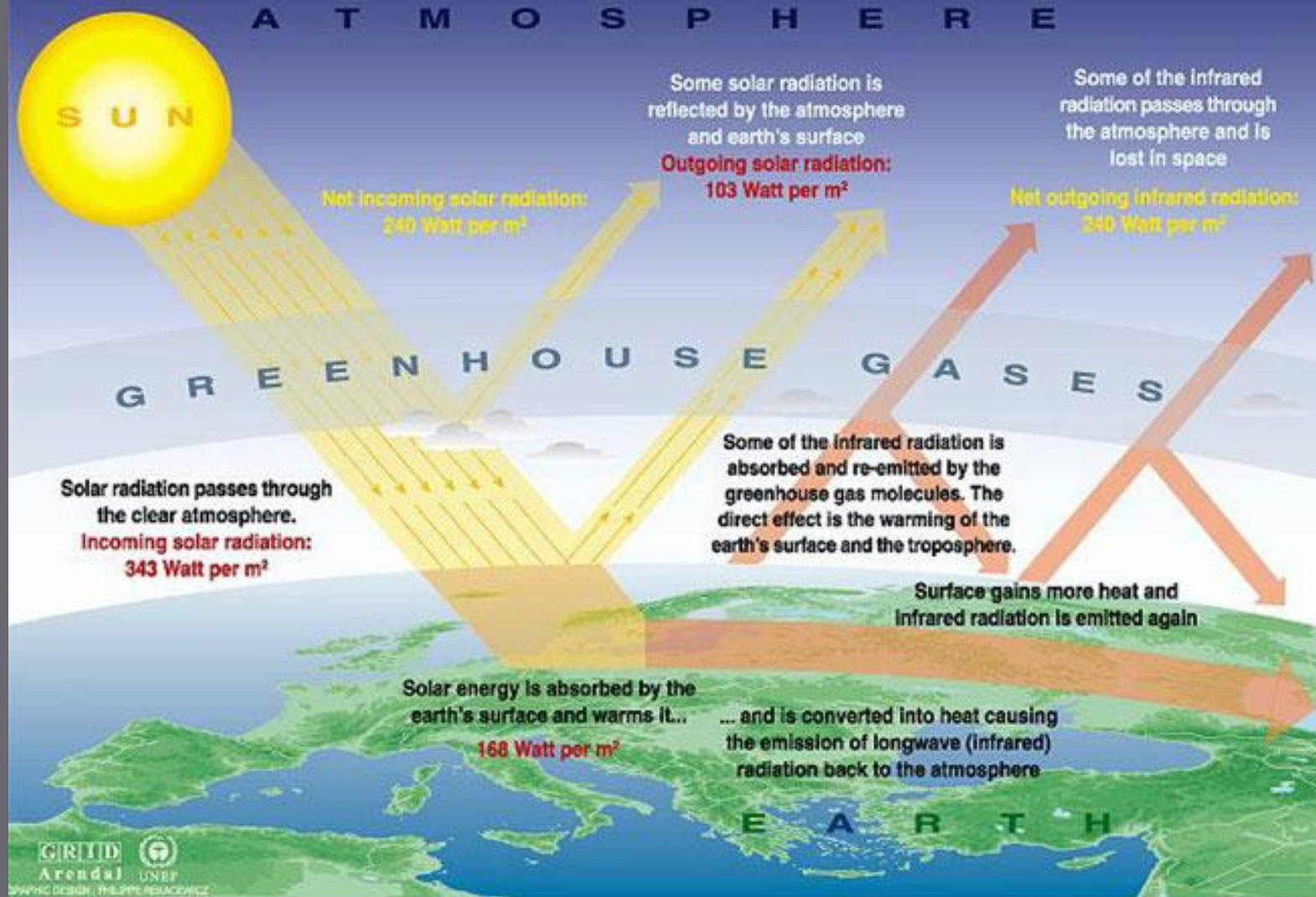


# The Greenhouse effect



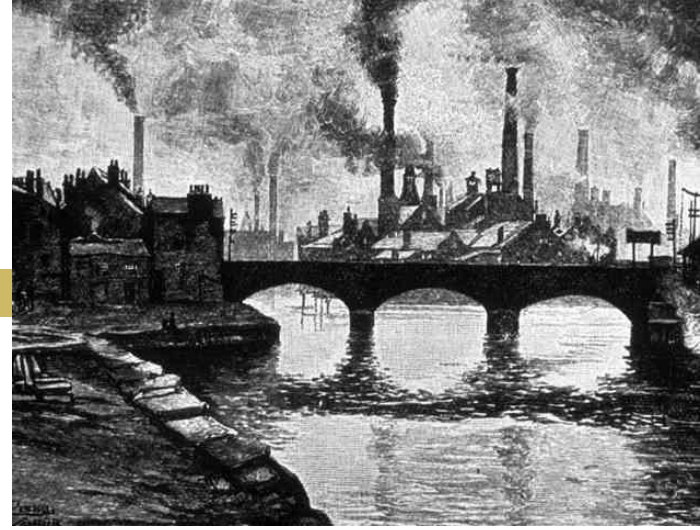
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

## INTRO TO GREENHOUSE GAS EMISSIONS

# Weather vs. Climate

- **“Climate is what we expect, weather is what we get.”**  
– Mark Twain
- Weather refers to the day-to-day changes in temperature, precipitation, etc. at a specific location
- Climate refers to the average of these variables over long time periods
- Individual weather events, especially extreme events, do not prove (or disprove) climate change

# Climate Science History



- 1824 – French physicist, Fourier, notices warming in relation to atmosphere
- By 1900 “greenhouse effect” studied in reference to CO<sub>2</sub>
  - ▣ First analysis done on human-made carbon emissions and Earth’s temperature
- Several hypotheses tested and rejected:
  - ▣ Changes in Earth’s orbit
  - ▣ Ice age theory
  - ▣ Sunspots

# Climate Science History

- 1979 – US National Academy of Sciences finds it “highly credible” that CO<sub>2</sub> capable of causing dangerous levels of warming
- Early 80’s scientific consensus grows
- 1988 – The UN creates the Intergovernmental Panel on Climate Change (IPCC)
- 1992 – Earth Summit in Rio de Janeiro (signed by HW Bush)
- 1997 – Kyoto Protocol sets emissions reductions – US does not act
- 2010 – Obama administration acknowledges need for climate legislation – none

# What are Global Warming Gases?

- There are 6 greenhouse gases that contribute to global warming:
  - Carbon Dioxide (CO<sub>2</sub>)
  - Methane (CH<sub>4</sub>)
  - Nitrous Oxide (N<sub>2</sub>O)
  - Hydrofluorocarbons (HFC)
  - Perfluorocarbons (PFC)
  - Sulphur Hexafluoride (SF<sub>6</sub>)

# What are Global Warming Gases?

□ There are 6 greenhouse gases that contribute to global warming:

- Carbon Dioxide ( $\text{CO}_2$ )
- Methane ( $\text{CH}_4$ )
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- Sulphur Hexafluoride ( $\text{SF}_6$ )

BUT... They are not created equal: each one is capable of capturing different amounts of heat from the sun's energy – this amount is its “Global Warming Potential”

# What are Global Warming Gases?

## Gases

- Carbon Dioxide ( $\text{CO}_2$ ) – is the most plentiful of the gases and holds the least amount of heat energy. That is why it is used as the standard against which all else is measured.
- Example:
  - 1 ton of Methane ( $\text{CH}_4$ ) = 21 tons of Carbon Dioxide ( $\text{CO}_2$ )
  - Therefore the Global Warming Potential of Methane is 21
  - This is why we say “1 ton of Methane = 21 tons of carbon dioxide **equivalent**”.

# What are Global Warming Gases?

## Gases

- Carbon Dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)
- Nitrous Oxide (N<sub>2</sub>O)
- Hydrofluorocarbons (HFC)
- Perfluorocarbons (PFC)
- Sulphur Hexafluoride (SF<sub>6</sub>)

## Global Warming Potentials

- 1 (it's the standard)
- 21 times more powerful than CO<sub>2</sub>
- 310 times more powerful than CO<sub>2</sub>
- Up to 12,000 x CO<sub>2</sub>
- Up to 12,000 x CO<sub>2</sub>
- 23,000 x CO<sub>2</sub>

CO<sub>2</sub> is used as the standard – measured in Metric Tons of Carbon Dioxide Equivalent (MTCDE)



# What are Global Warming Gases?

Example:

When burned, fossil fuels create a large amount of CO<sub>2</sub>, a little CH<sub>4</sub> and tiny amount of N<sub>2</sub>O. Measuring the gasoline used by a vehicle fleet would look something like:

**Gas    Amount (metric tons)    Multiplied by    Global Warming Potential    =    MTCDE**

CO<sub>2</sub>            10,000            X            1            =            10,000

CH<sub>4</sub>            10            X            21            =            210

N<sub>2</sub>O            0.1            X            310            =            31

+

This number is the total emissions

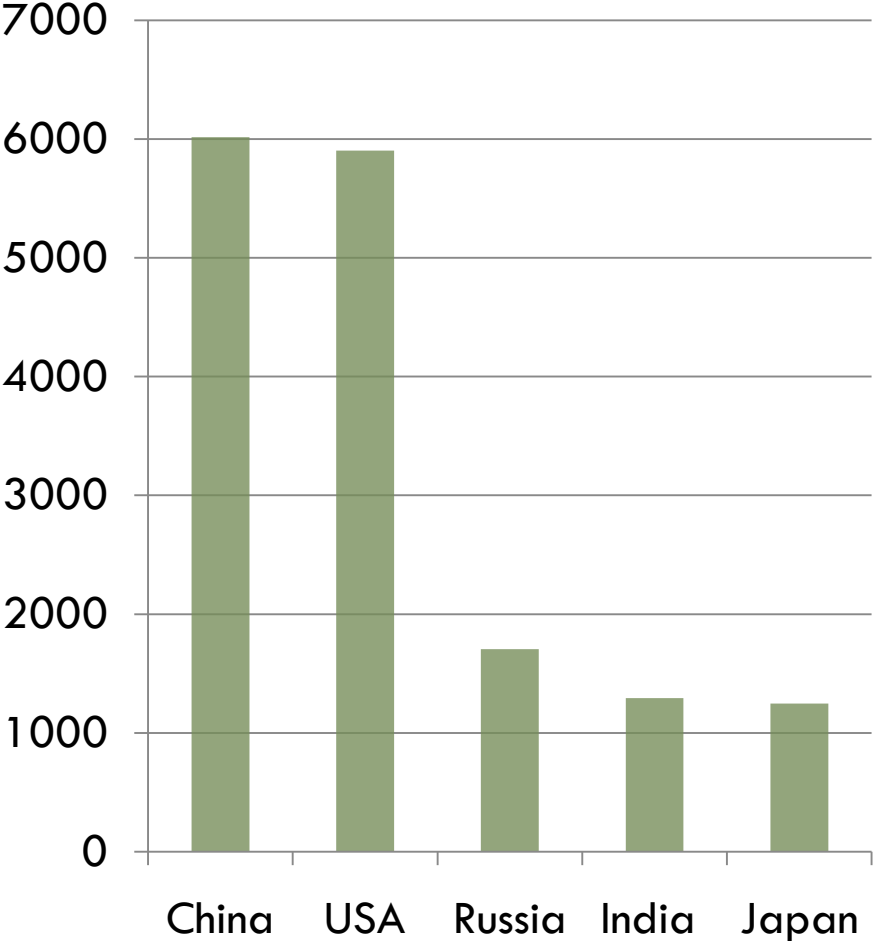


10,241 MTCDE

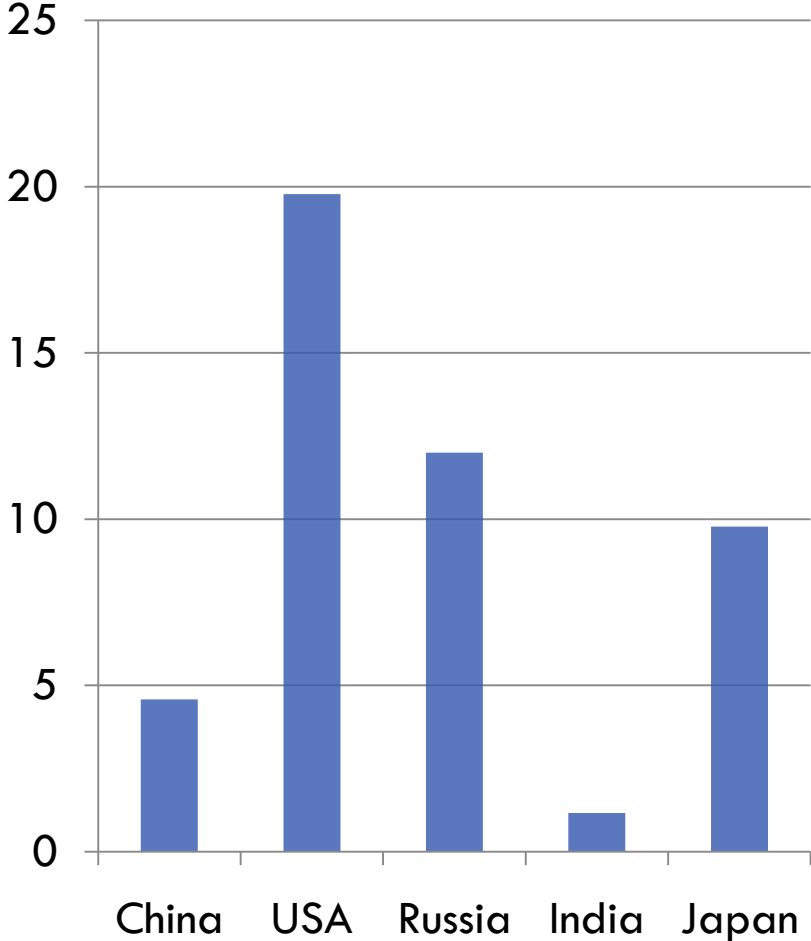
(Metric Tons of Carbon Dioxide Equivalent)

# Global Carbon Emissions

**Total Emissions by Country  
(Millions of Metric Tons)**

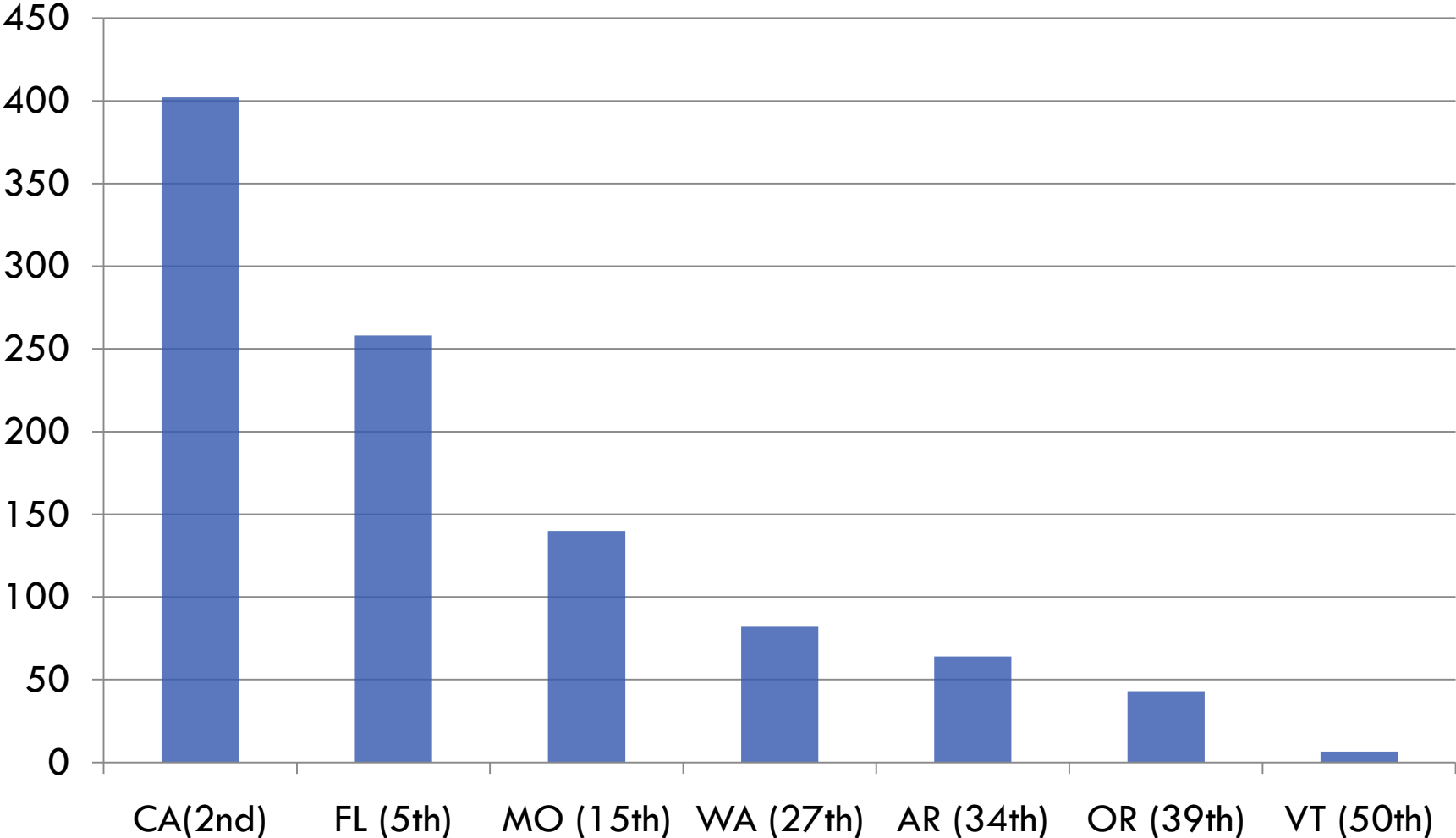


**Emissions per capita  
(Metric Tons)**



# U.S. Carbon Emissions

Emissions by State (Rank) in Millions of Metric Tons



# Impacts for Washington State

For additional information on this topic see the University of Washington Climate Impacts Group:  
<http://cses.washington.edu/cig/>

# Expected Regional Changes

Climate Impacts  
Group

NOAA

International  
Panel on Climate  
Change

NASA

Hydrology Data  
Specific to  
Thurston County

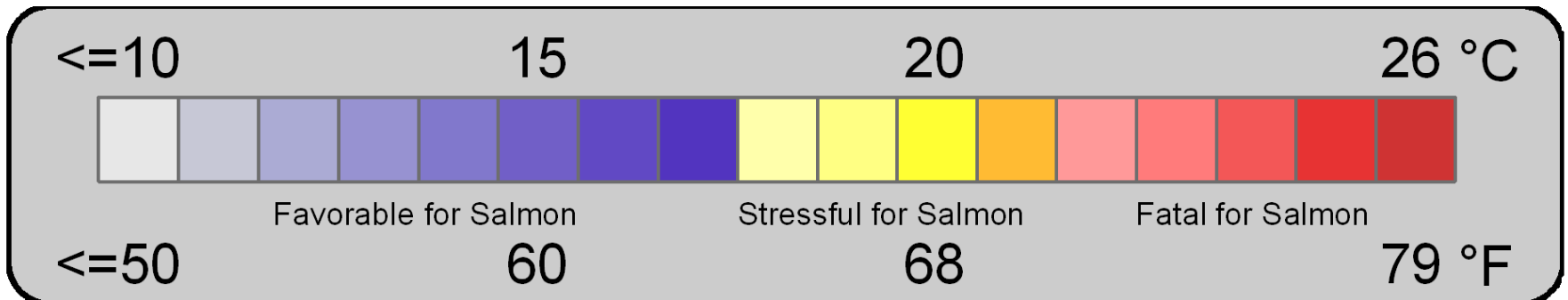
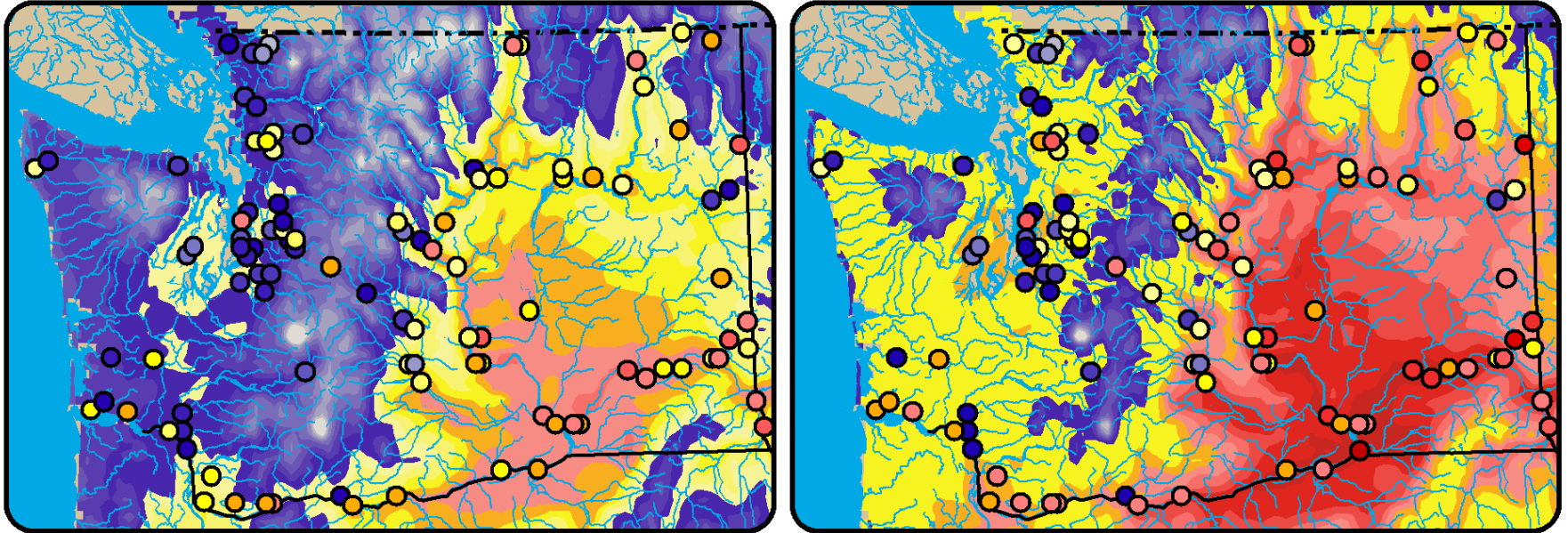
- ❑ Decreased mountain snowpack / Earlier snowmelt
- ❑ Decreased water for irrigation, fish, and summertime hydropower production
- ❑ Increase in high snow forests - Decrease in dry forests
- ❑ Potential increases in forest fires
- ❑ Potential loss of biological diversity if environmental shifts outpace species migration rates
- ❑ Increased coastal erosion, landslides and groundwater flooding due to increased winter rainfall
- ❑ Permanent inundation, especially in south Puget Sound around Olympia

# Salmon and Aquatic Ecosystems

August Mean Surface Air Temperature and Maximum Stream Temperature

Historical (1970-1999)

2040s medium (A1B)



Compared with 1970-1999 average

# Summary

- Science suggests we must END fossil fuel dependence AND decrease the CO<sub>2</sub> already in the atmosphere within approximately 50 years
- If nothing is done WA Dept. of Commerce expects \$6.5 Billion in annual costs / loss by 2040:
  - ▣ Increased Energy costs
  - ▣ Increased Health costs
  - ▣ Reduced ability to Hunt, Fish, Ski, etc...
  - ▣ Increased Coastal and Storm Damage
  - ▣ Reduced Food Production
  - ▣ Increased Wildfire costs

QUESTIONS?

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