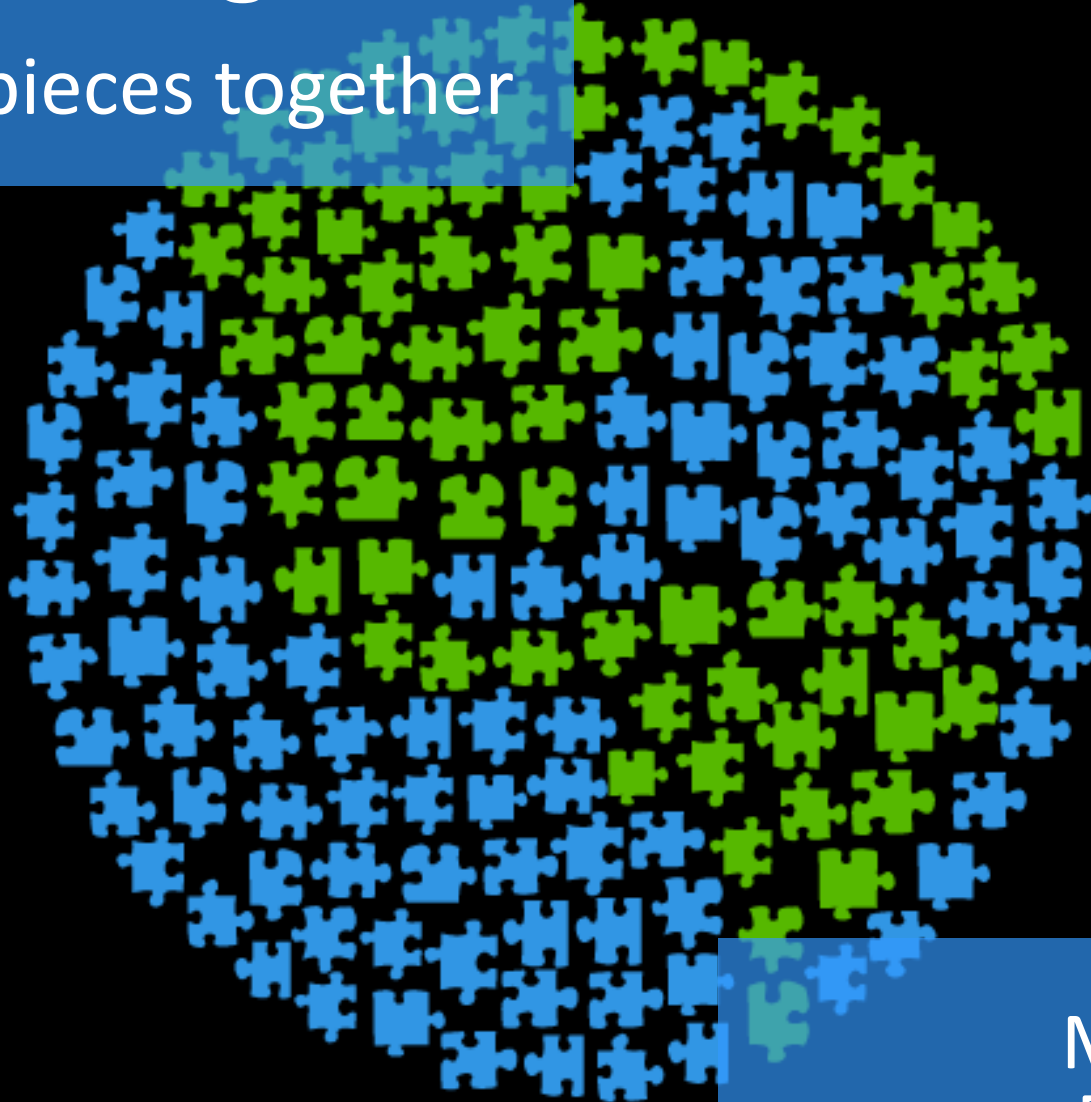


# Climate Change: Fitting the pieces together



Presented by:

**Mehmet R.  
DERINDAG**



# Outline

- What changes climate?
- Is it real?
- How do we know?
- Why should we care?
- How sure are scientists?
- What next—what can we do?

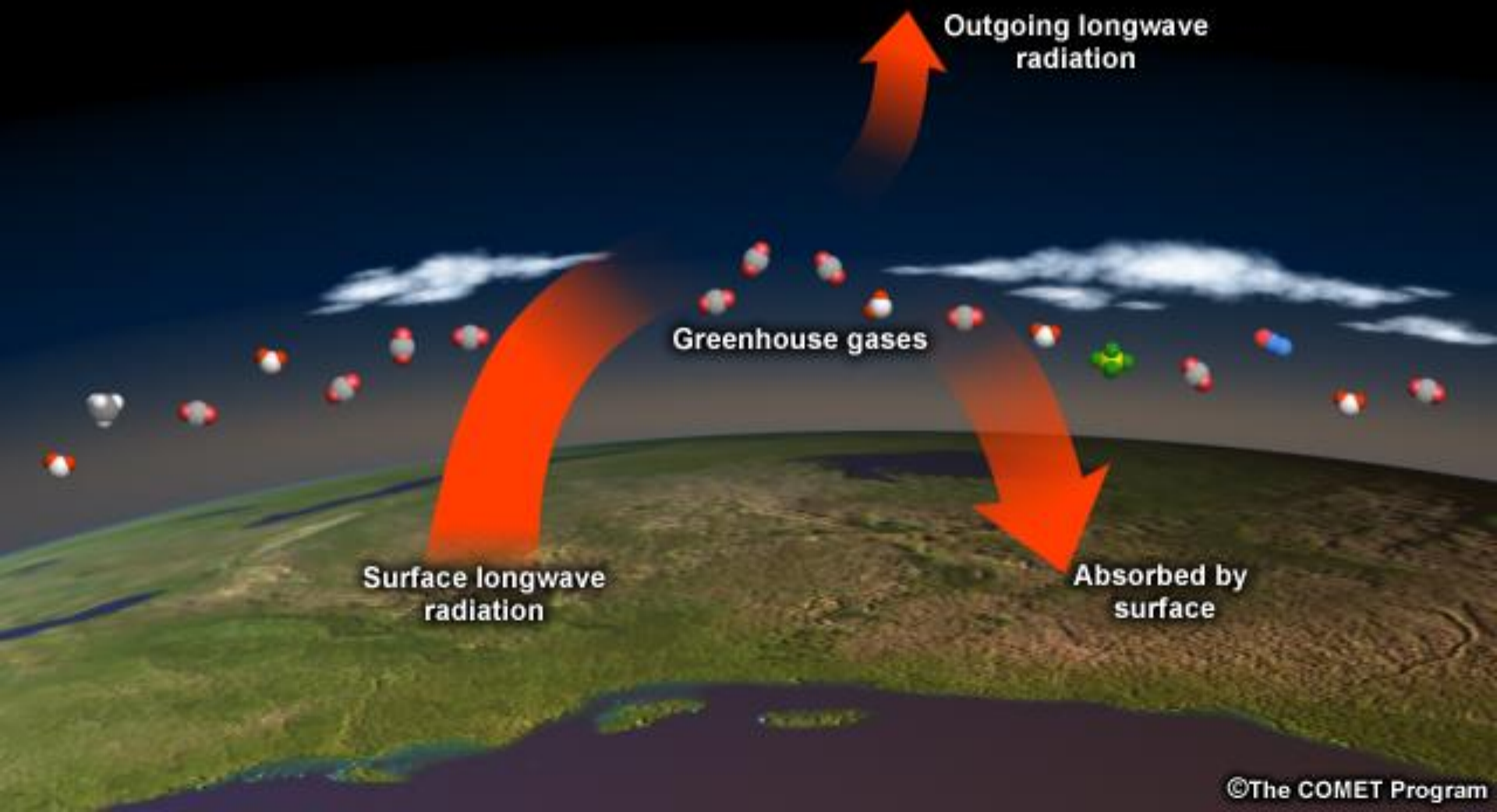


# What changes climate?

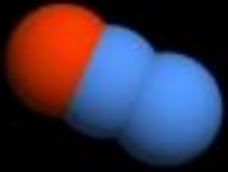
- Changes in:
  - Sun's output
  - Earth's orbit
  - Drifting continents
  - Volcanic eruptions
  - Greenhouse gases



# Increasing greenhouse gases trap more heat



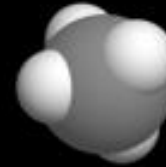
# Greenhouse gases



Nitrous oxide



Carbon dioxide



Methane



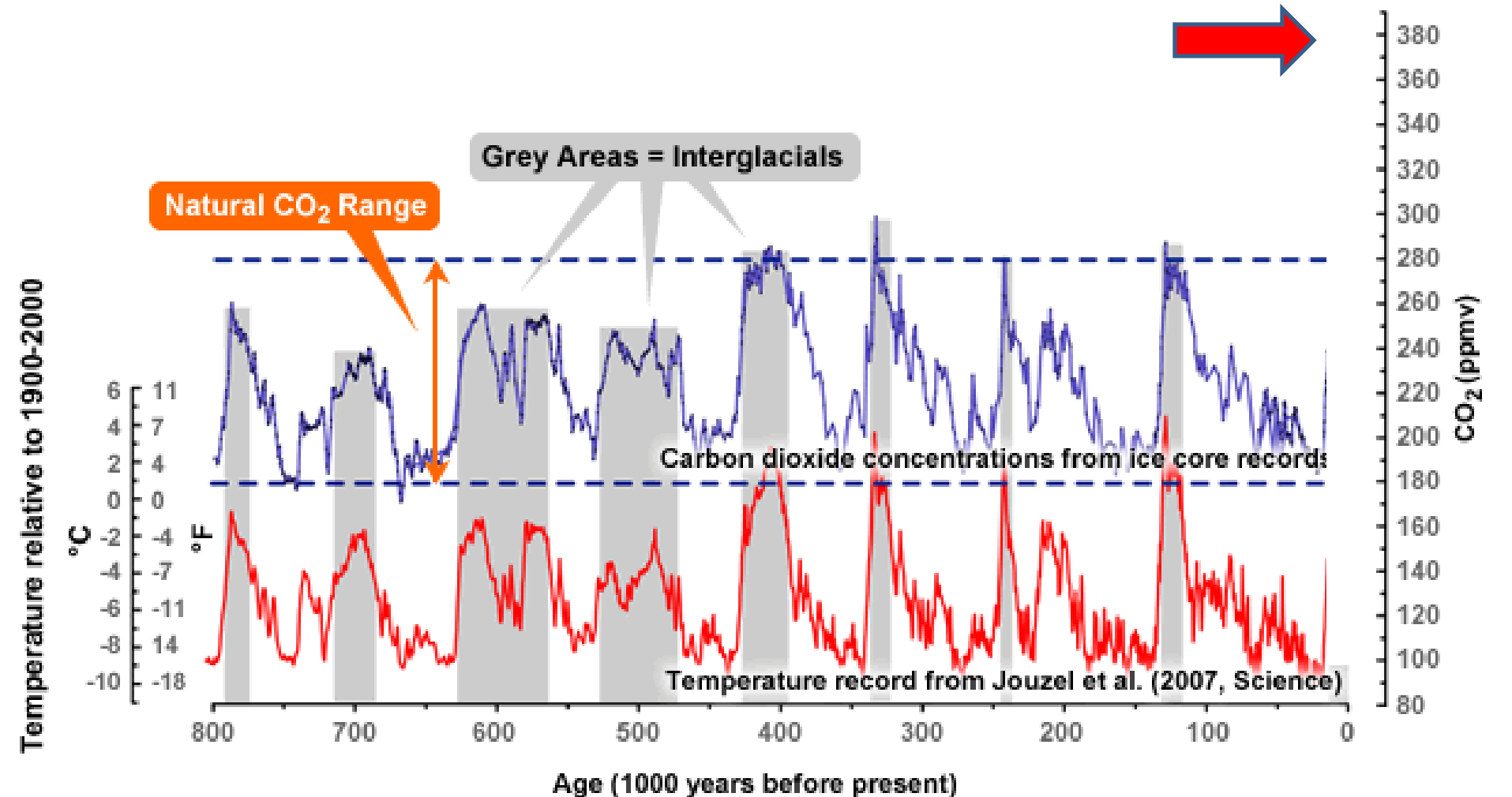
Water



Sulfur hexafluoride



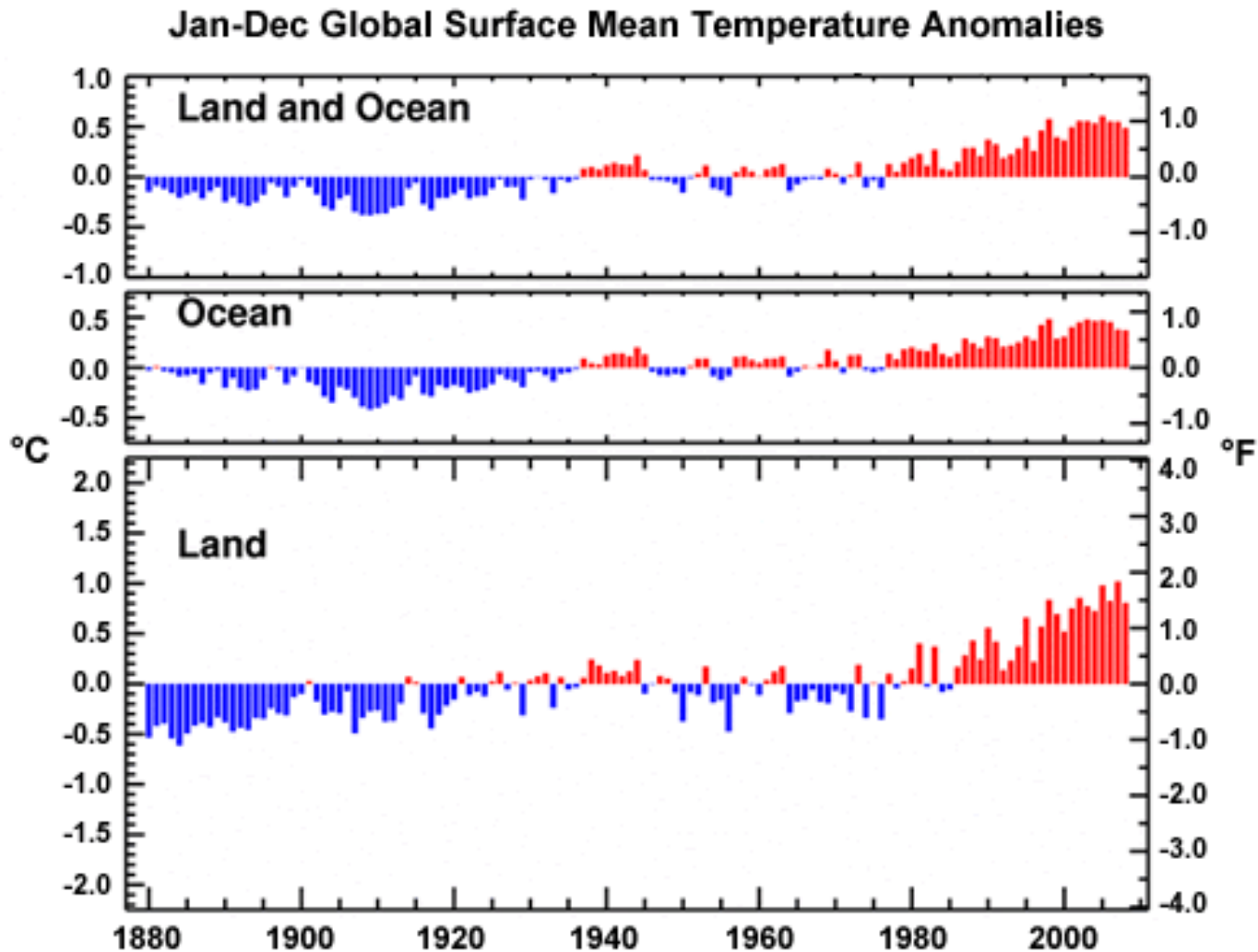
# Could the warming be natural?



Courtesy of Dieter Luthi

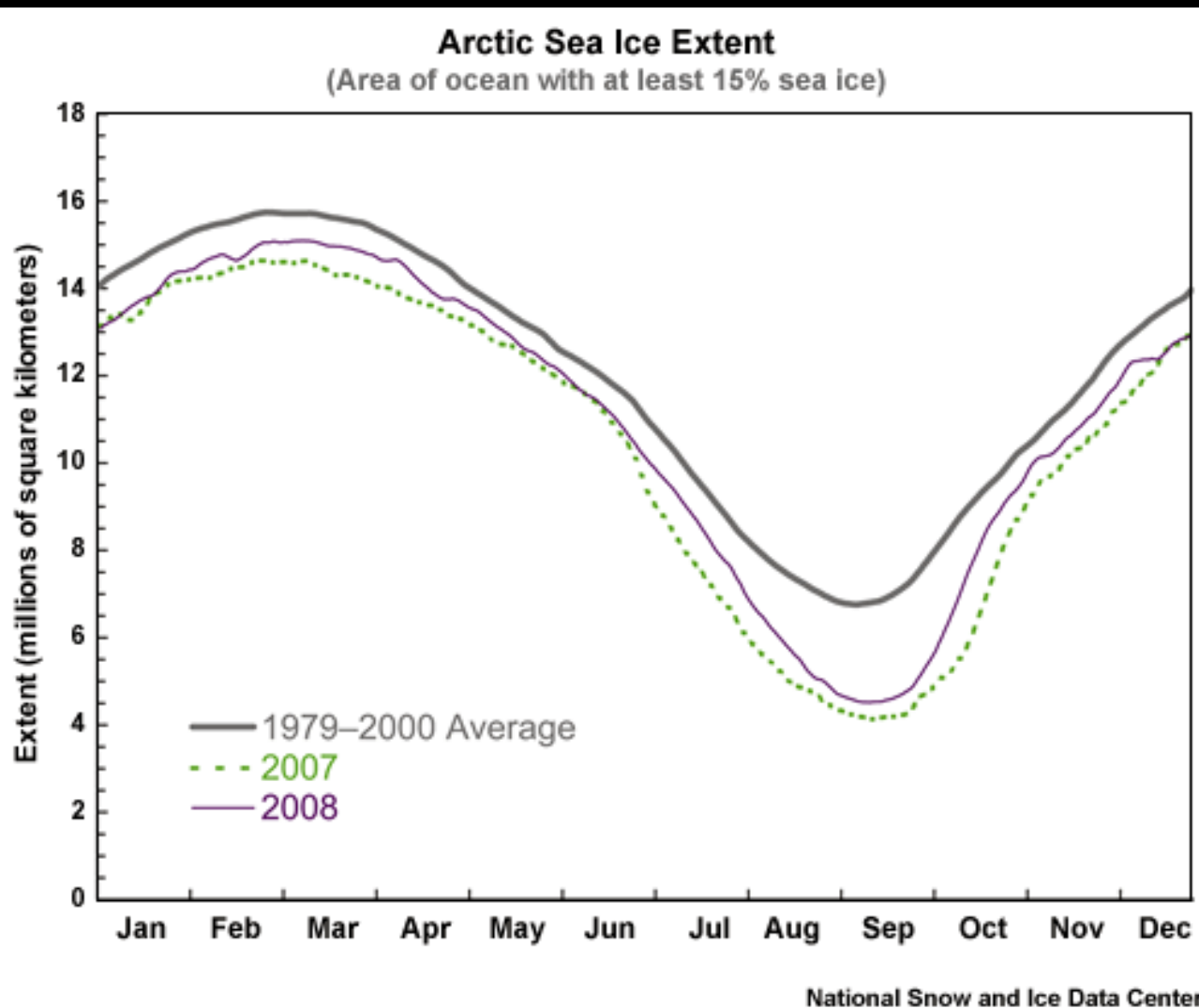


# Is it real?





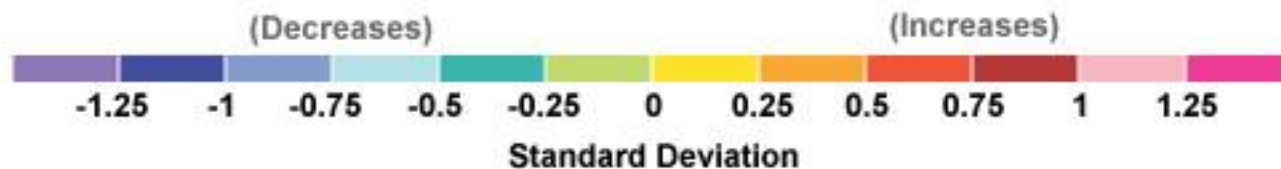
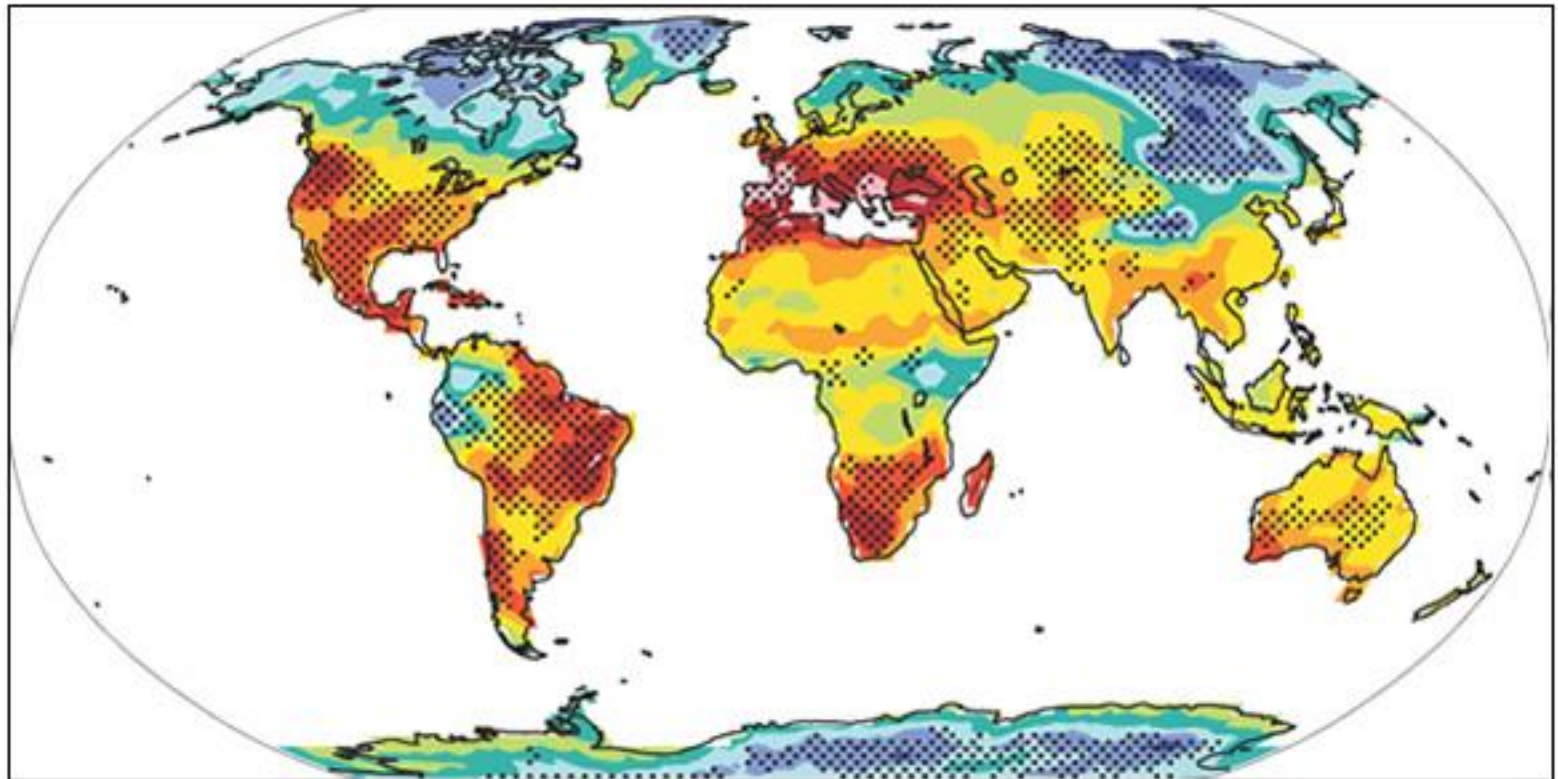
# Effects: Snow and ice



Lisa McKeon, USGS

# Effects on precipitation

Multi-model Simulation of Changes in Dry Days  
Years 2080-2099 Minus Years 1980-1999 (middle emissions scenario)



# Effects on ecosystems





# How do we know?



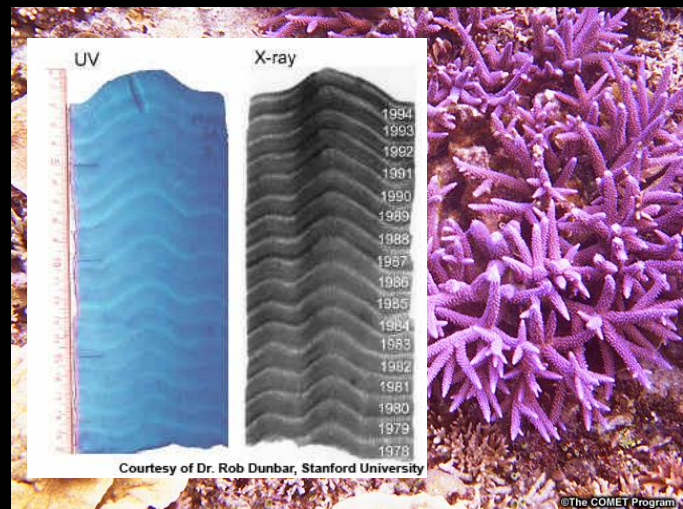
©UCAR / NCU



National Science Foundation, photo by Emily Stone



National Science Foundation, photo by Steve Roof



Courtesy of Dr. Rob Dunbar, Stanford University

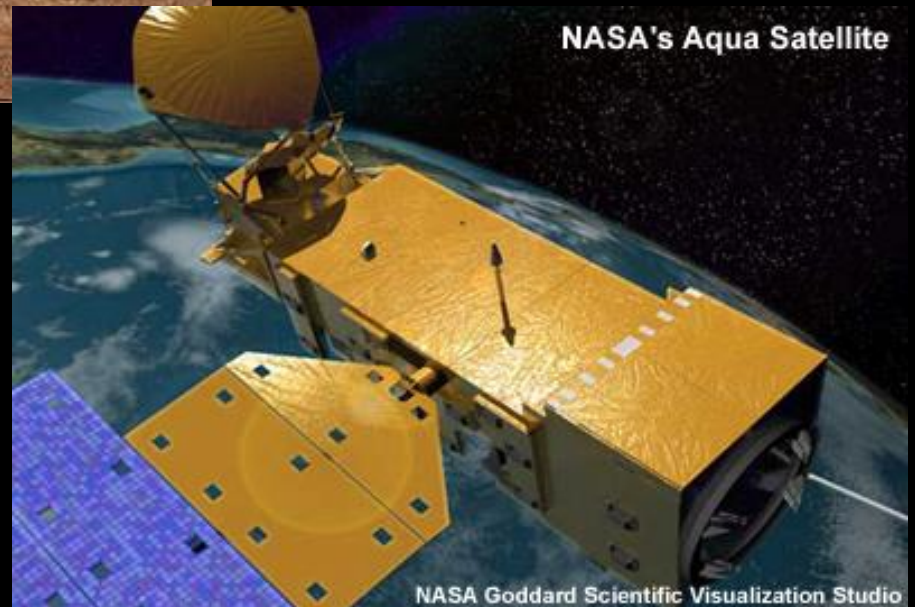
©The COMET Program

# Present day observations

U.S. Climate Reference Network Station

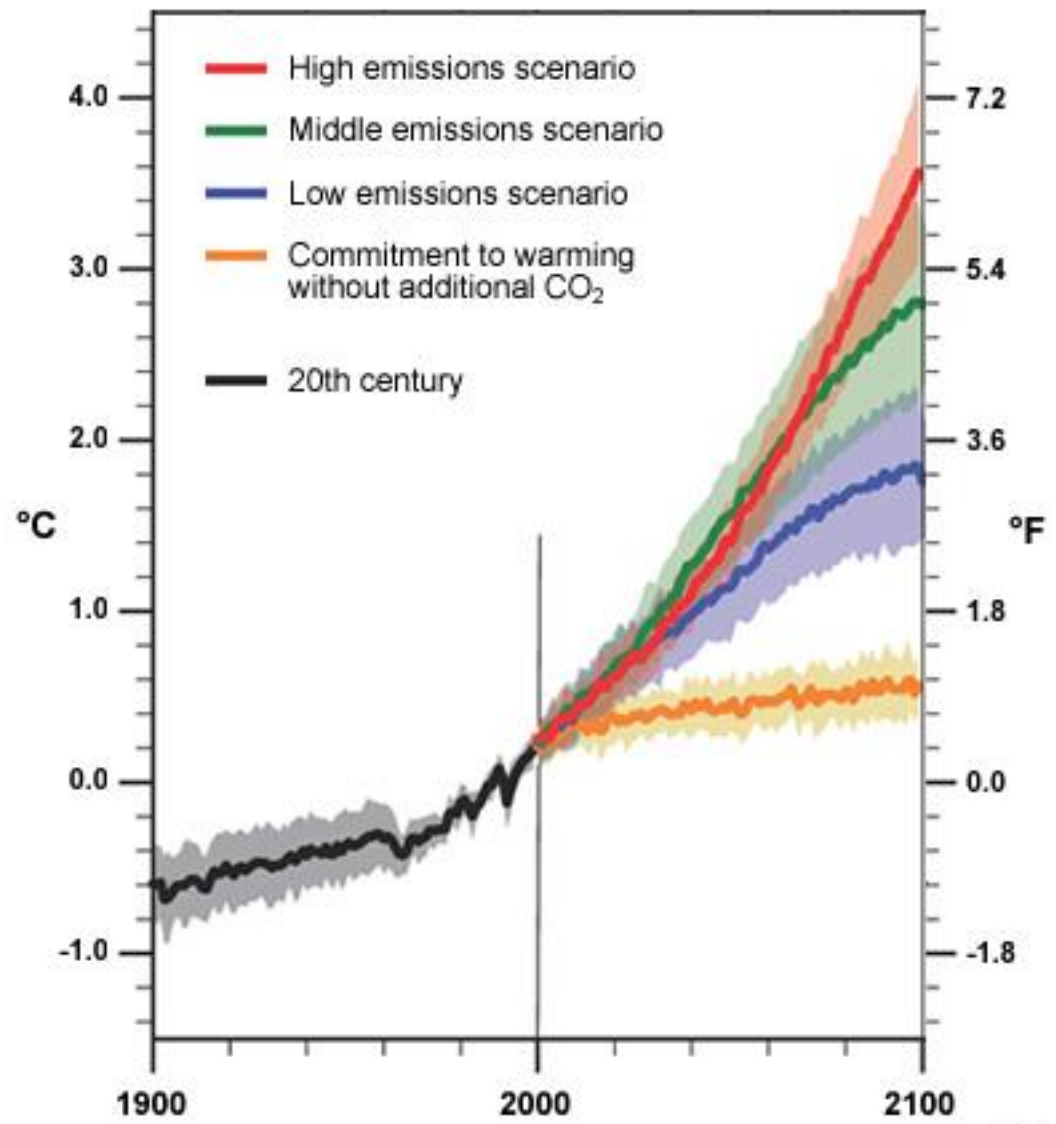


NASA's Aqua Satellite

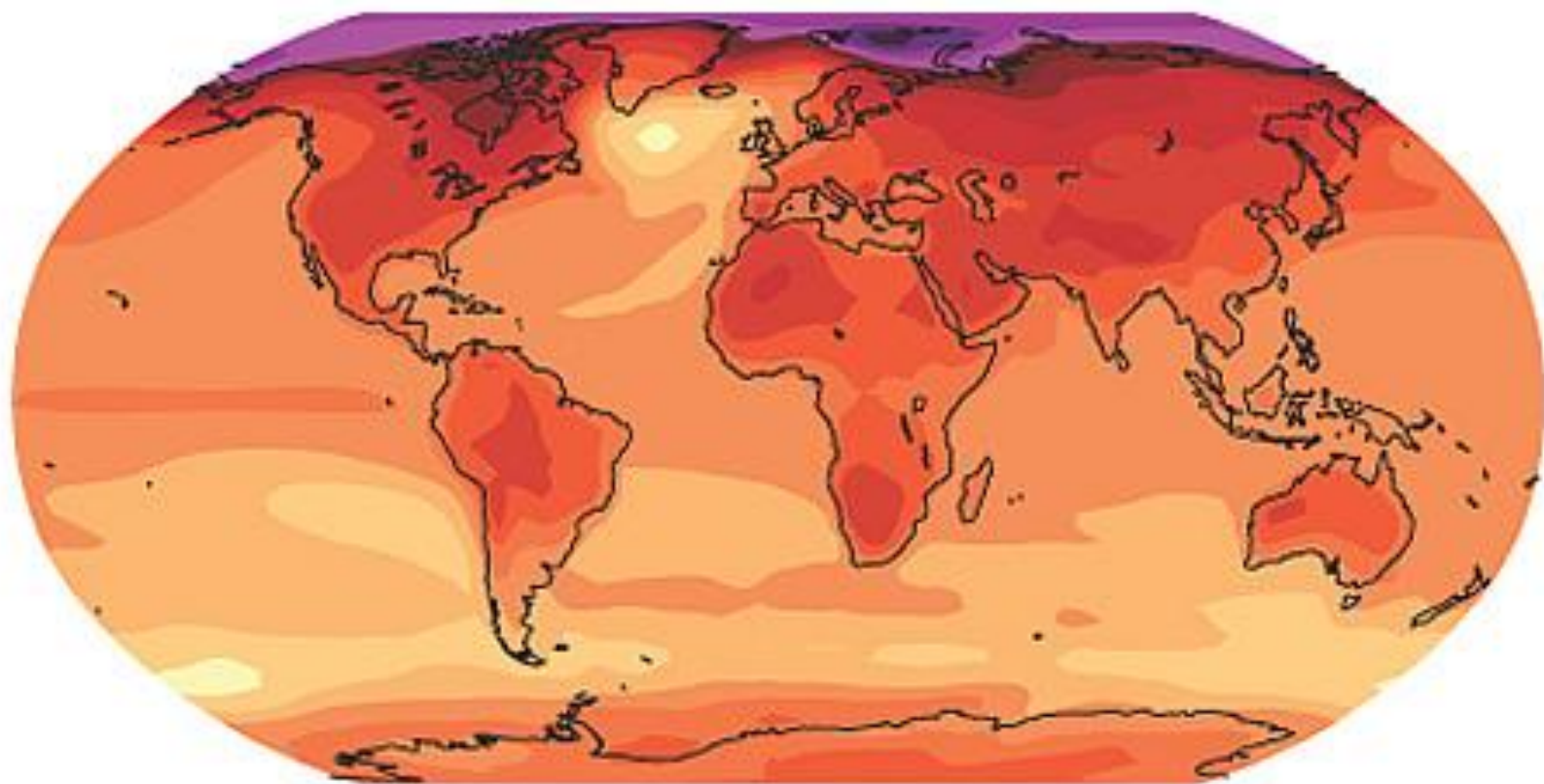


NASA Goddard Scientific Visualization Studio

# Temperature Increases for Various Emission Scenarios



## Projected Temperature Increases Middle Emissions Scenario, 2080 - 2099



°F

0

1.8

3.6

5.4

7.2

9

10.8

12.6



°C

0

1

2

3

4

5

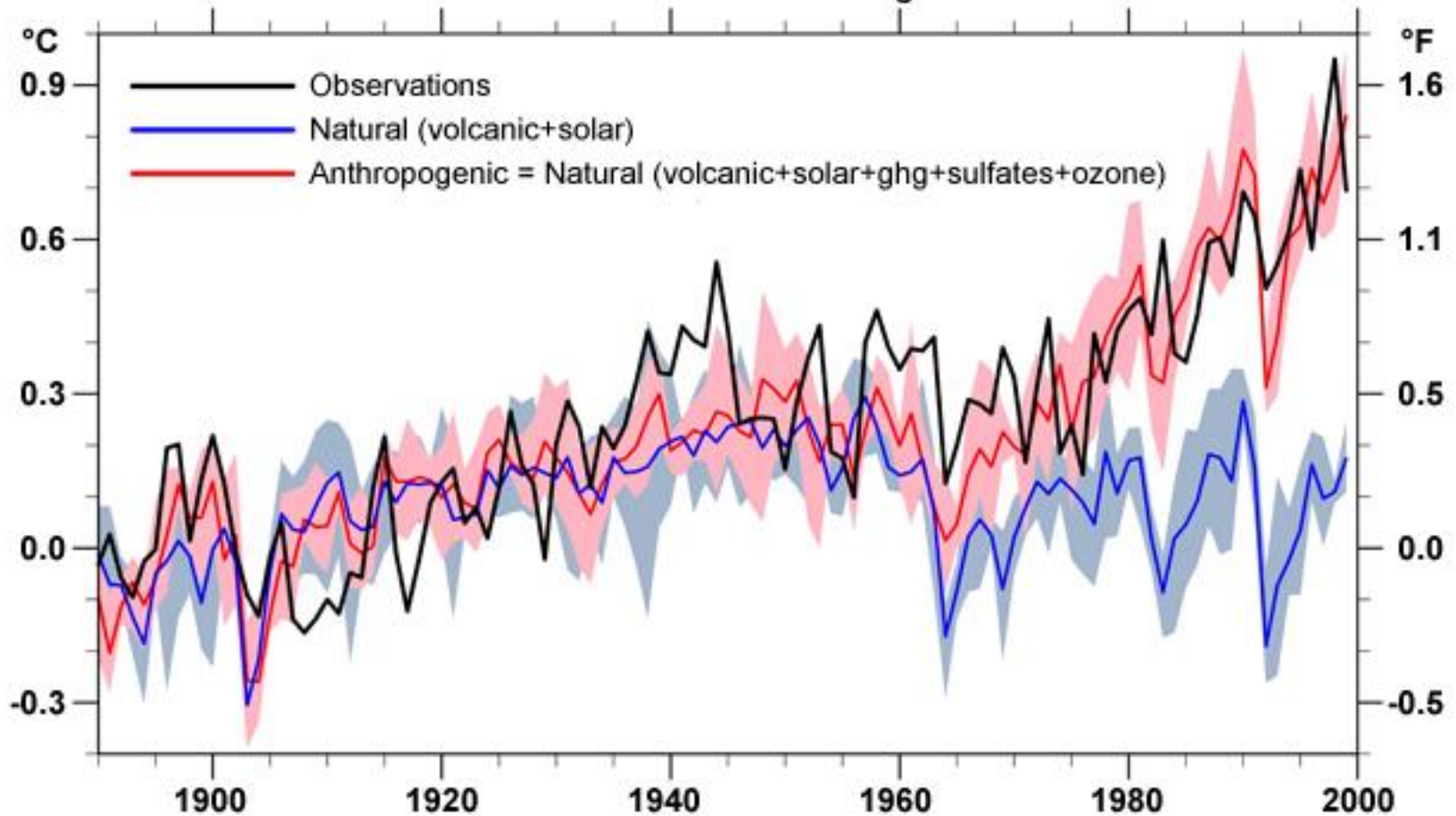
6

7

IPCC

# Climate Model Runs With/Without Greenhouse Gases

Global Temperature Anomalies  
from 1890-1919 average

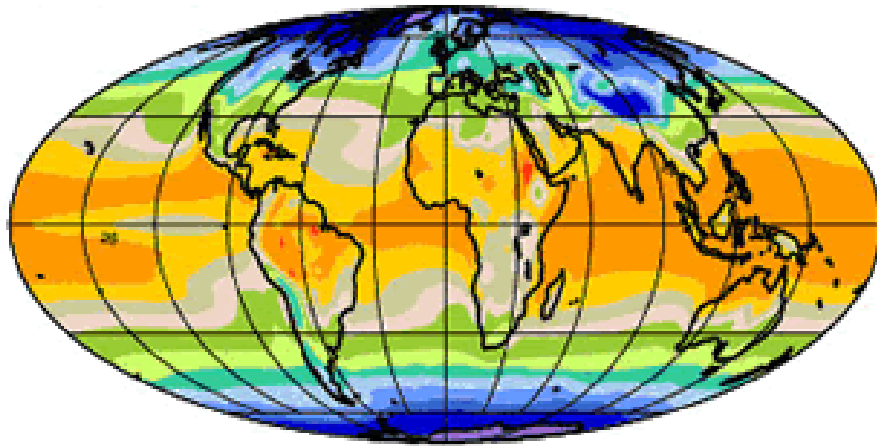




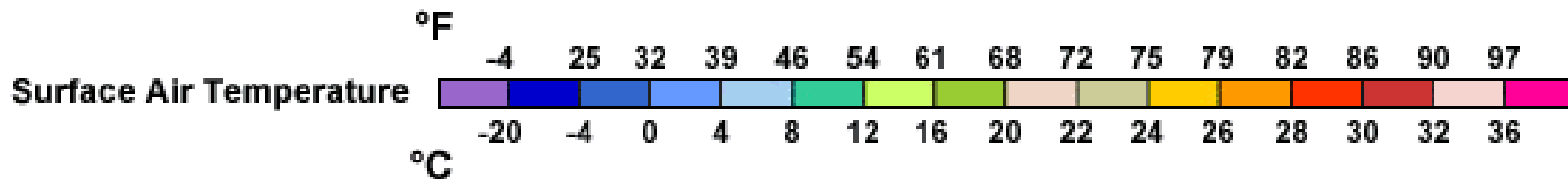
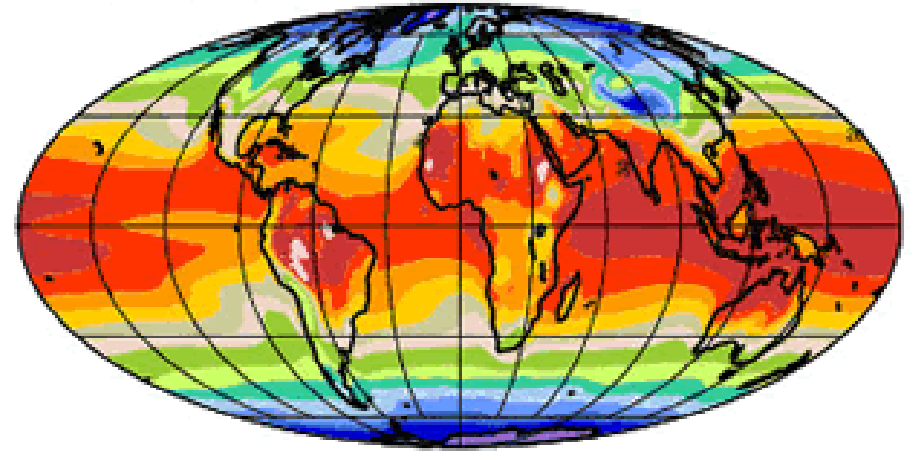


# Why should we care?

**Present Day**  
(1990s)



**Possible Future**  
(2090s)





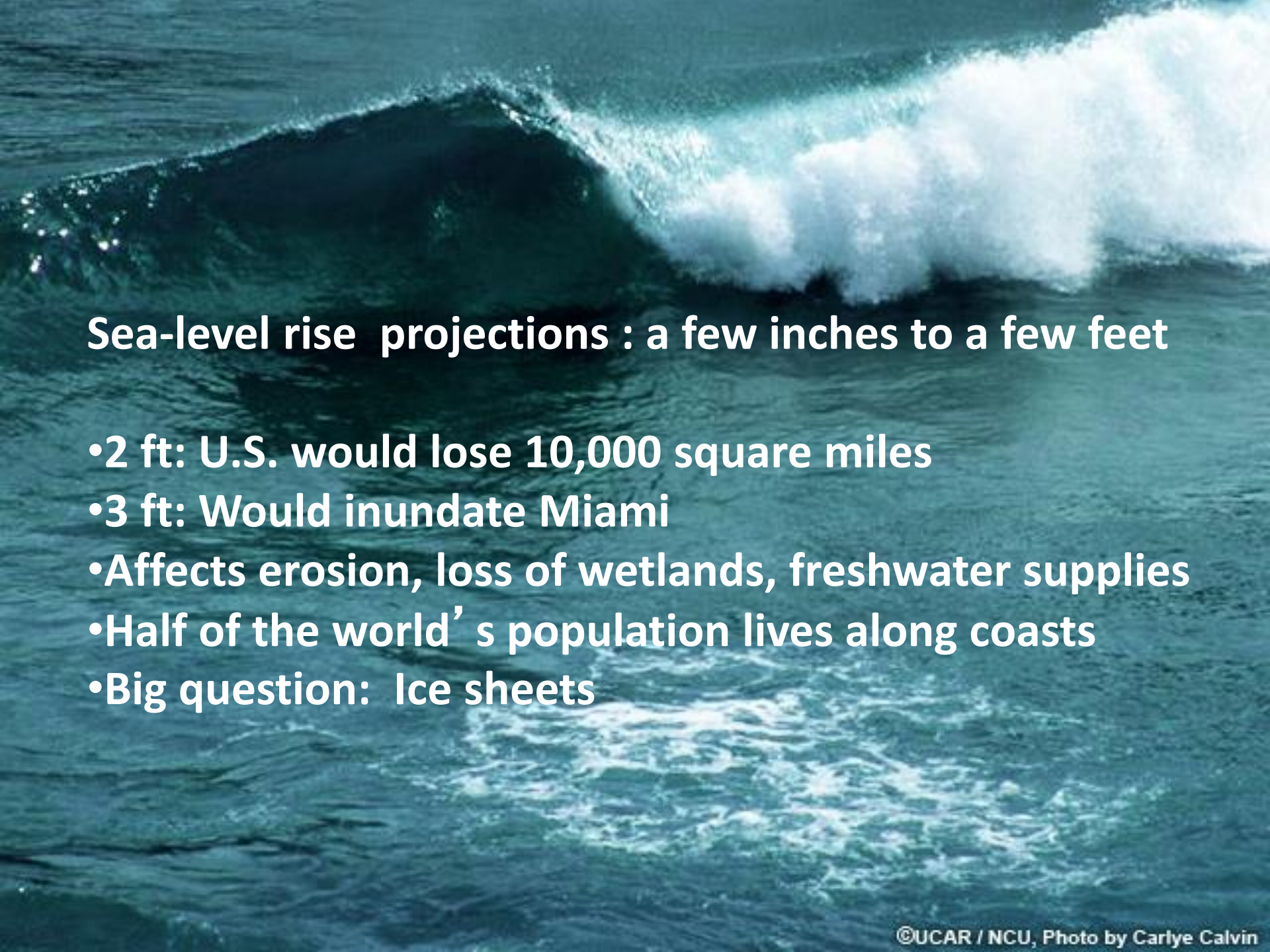
U.K.: Train rails buckle

Germany: Lowest river levels  
this century

France: >14,000  
deaths

Switzerland: Melting  
glaciers, avalanches

Portugal: Forest fires



## **Sea-level rise projections : a few inches to a few feet**

- 2 ft: U.S. would lose 10,000 square miles**
- 3 ft: Would inundate Miami**
- Affects erosion, loss of wetlands, freshwater supplies**
- Half of the world's population lives along coasts**
- Big question: Ice sheets**





# How sure are scientists?



What don't we know?

- Is there some critical piece of the about climate process we don't understand?
- How and when will our fossil fuel use change?
- Will future , yet-to-be-discovered technologies mitigate the problem?
- How will changing economics, global population, and political processes affect our ability to tackle the problem?

# The IPCC



Courtesy of Kevin Trenberth / NCAR

# 2007 Conclusions

- Warming of the climate system is **unequivocal**
- **Very high confidence** that global average net effect of human activities since 1750 one of warming
- Human-caused warming over last 30 years has **likely** had a visible influence on many physical and biological systems
- Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21<sup>st</sup> century that would **very likely** be larger than those observed during the 20<sup>th</sup> century.”

# Consensus?

- **Do we know enough about the drivers of climate to know what causes change?**
- **Are we underestimating the Earth system's complexity ?**
- **Can models accurately simulate the complex climate system?**
- **Are there processes that will limit warming naturally?**

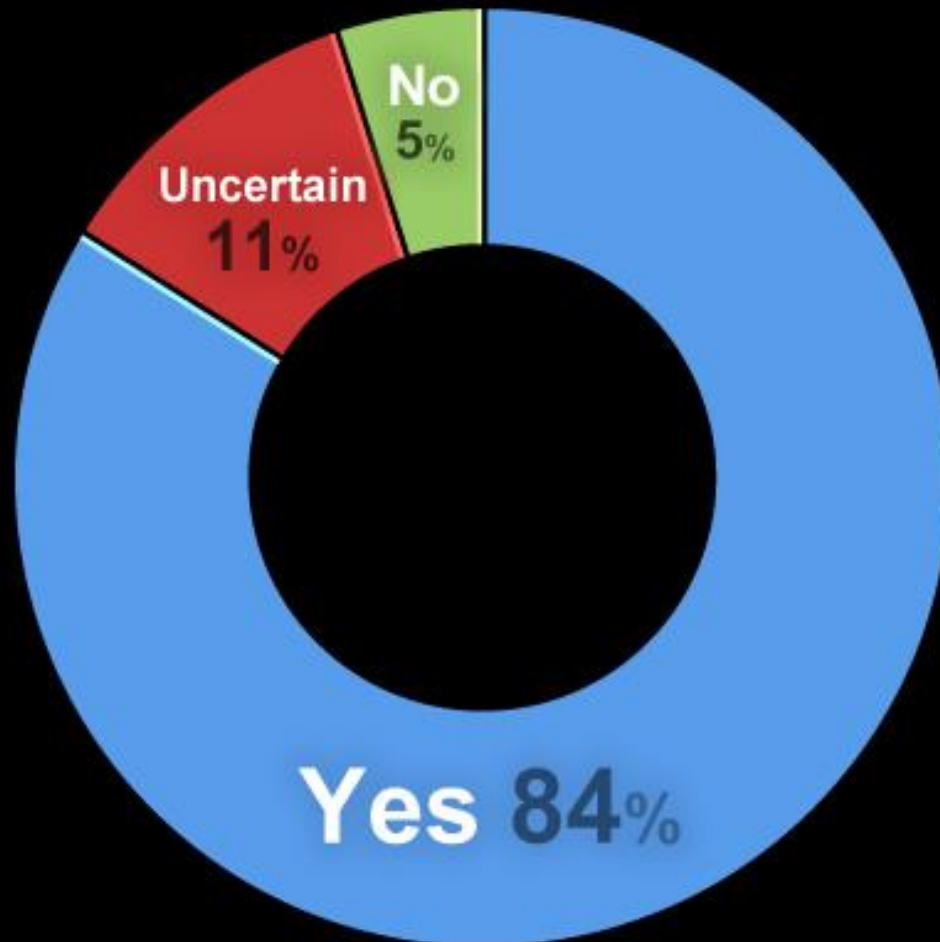


# On the other hand...

- Arctic sea ice melting faster than predicted.
- Fossil fuel emissions exceeded most IPCC projections.
- Are assumptions about global energy use are too optimistic?
- How quickly can developing countries reduce GHG emissions?
- Calculations don't include unexpected melting in Greenland and Antarctica.

# What do climate scientists really think?

Climate Scientists: Are humans responsible for observed warming?

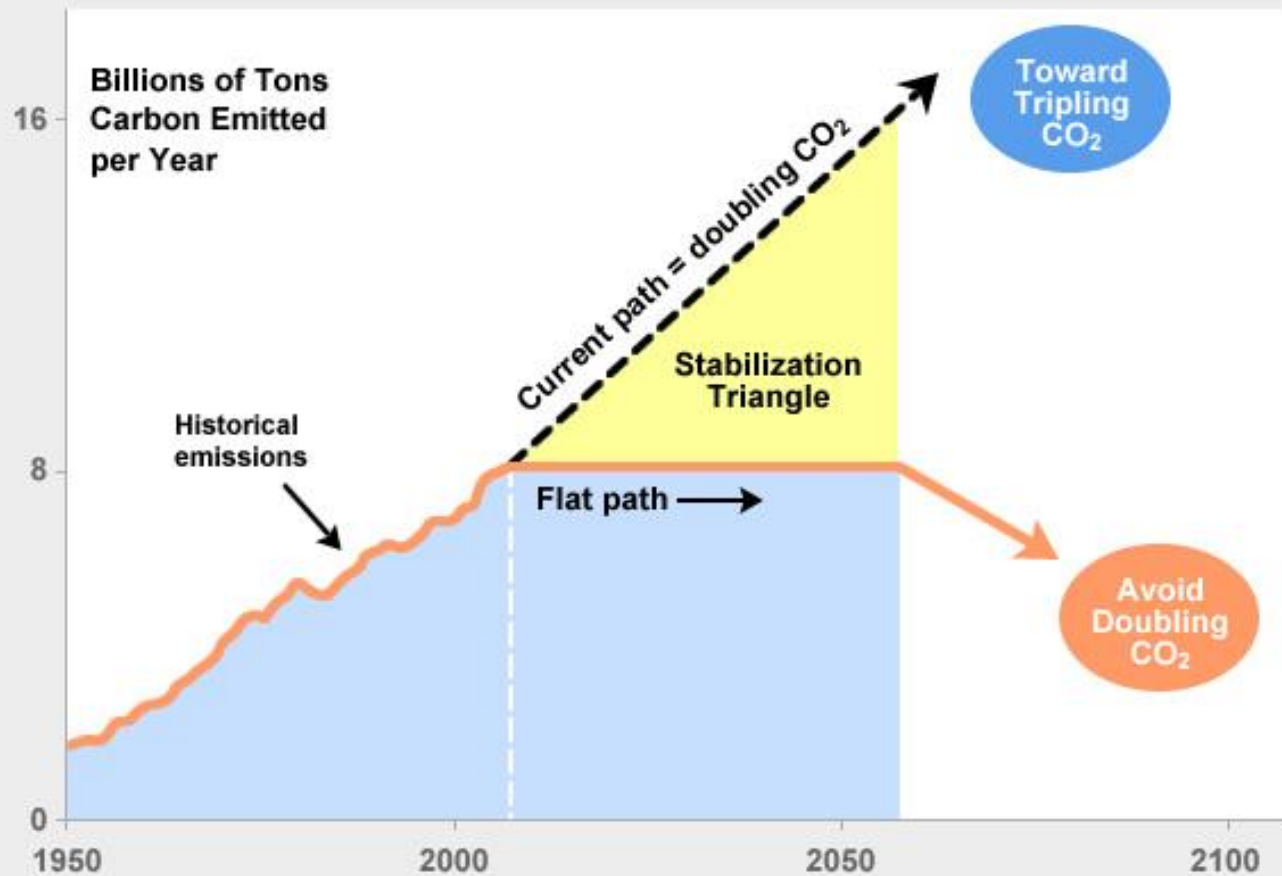


# Be an educated consumer

- IPCC AR4 Synthesis Report  
(<http://www.ipcc.ch/ipccreports/ar4-syr.htm>)
- Other organizations:
  - NAS (<http://dels.nas.edu/climatechange/>)
  - US CCSP (<http://www.climate-science.gov/>)
- Look for contrasting opinions
- Evaluate the source

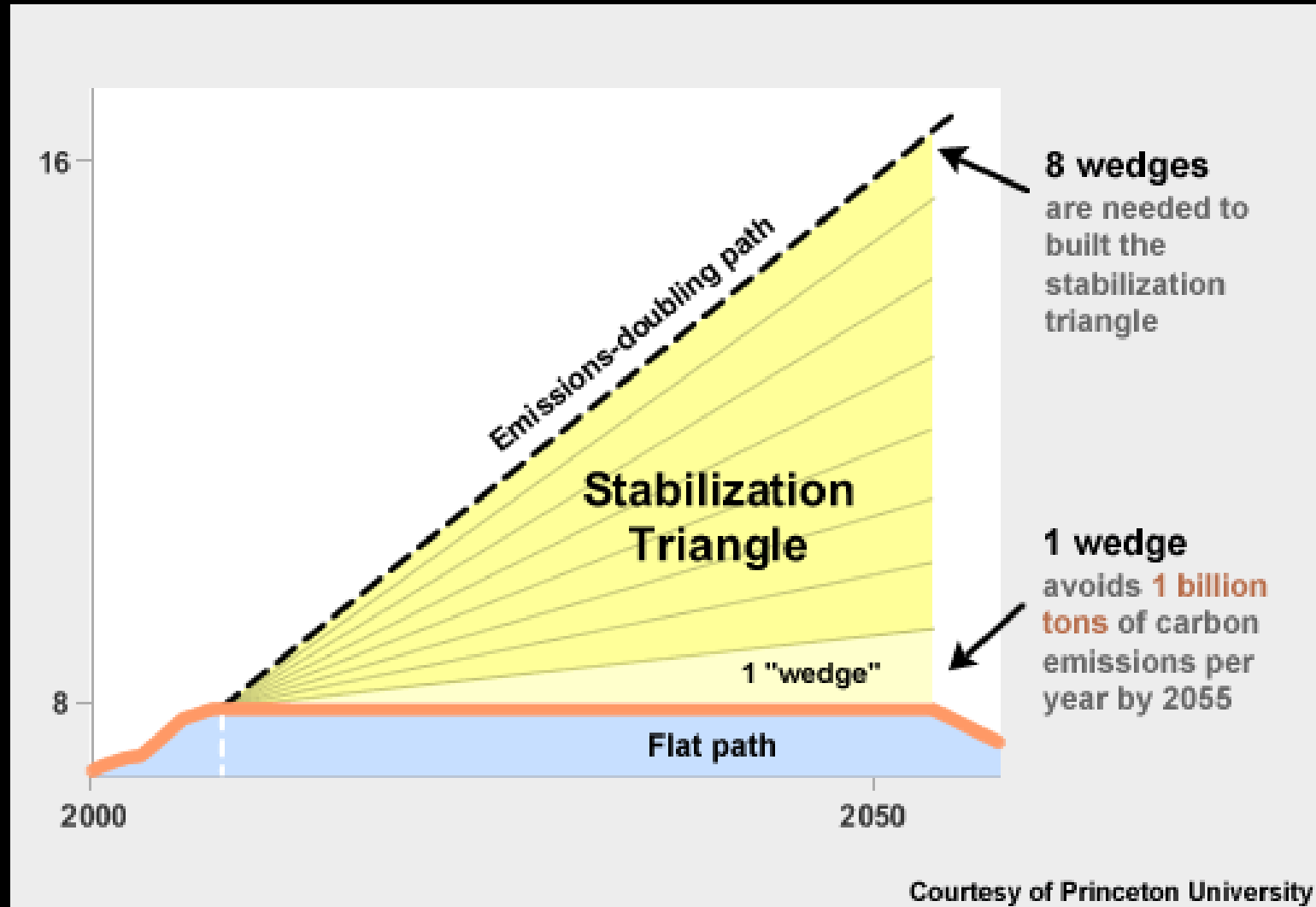


# What next—what can we do?





# What next—what can we do?



- ▶ Produce more fuel-efficient vehicles
- ▶ Reduce vehicle use
- ▶ Improve energy-efficiency in buildings
- ▶ Develop carbon capture and storage processes
- ▶ Triple nuclear power
- ▶ Increase solar power
- ▶ Decrease deforestation/plant forests
- ▶ Improve soil carbon management strategies


# Individual actions



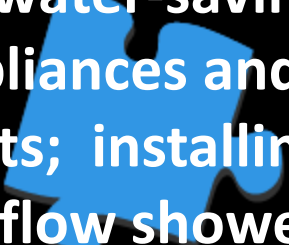
Use mass transit, bike, walk, roller skate



Tune up your furnace



Unplug appliances or plug into a power strip and switch it off



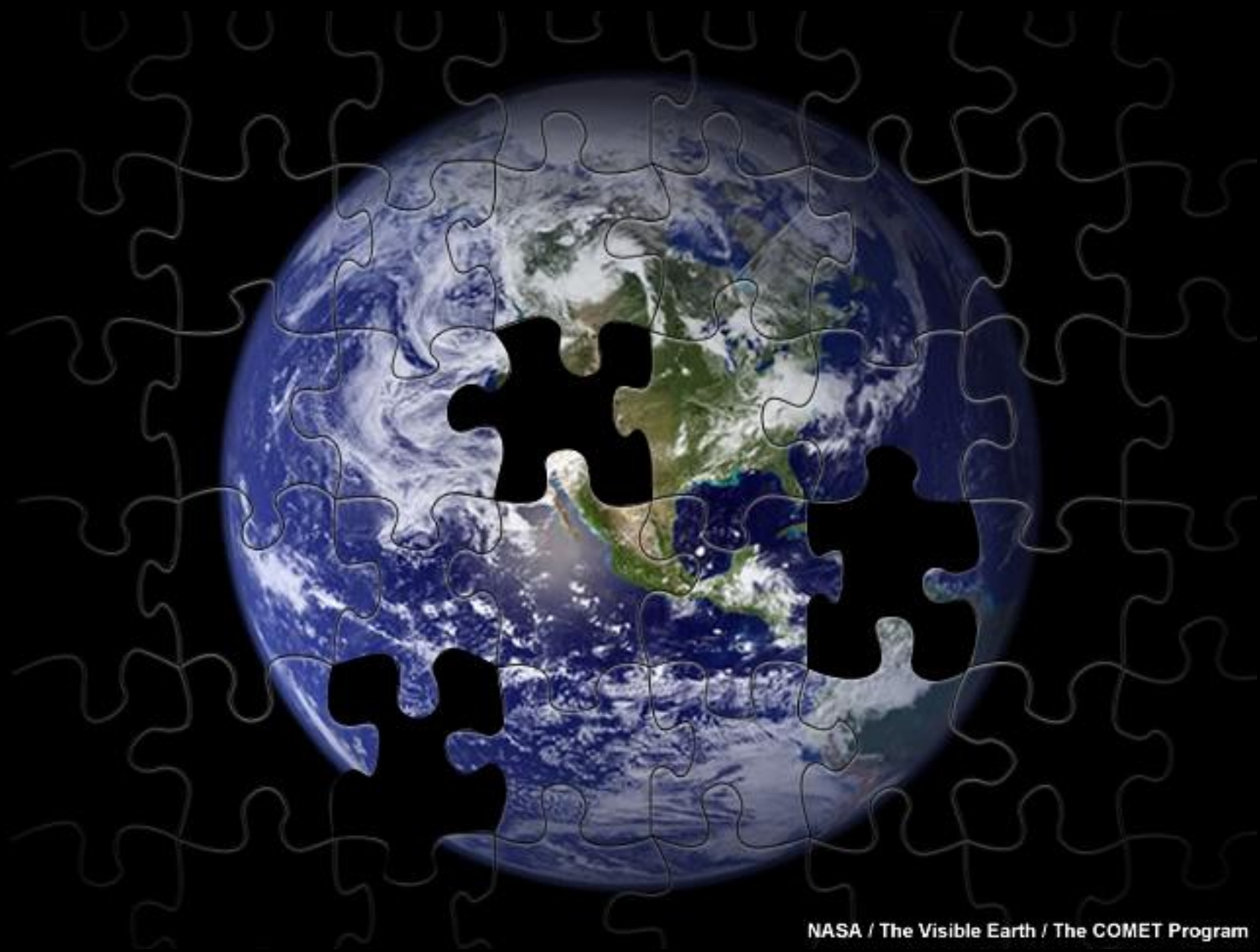
Buy water-saving appliances and toilets; installing low-flow shower heads



Caulk, weatherstrip, insulate, and replace old windows



Buy products with a U.S. EPA Energy Star label



NASA / The Visible Earth / The COMET Program