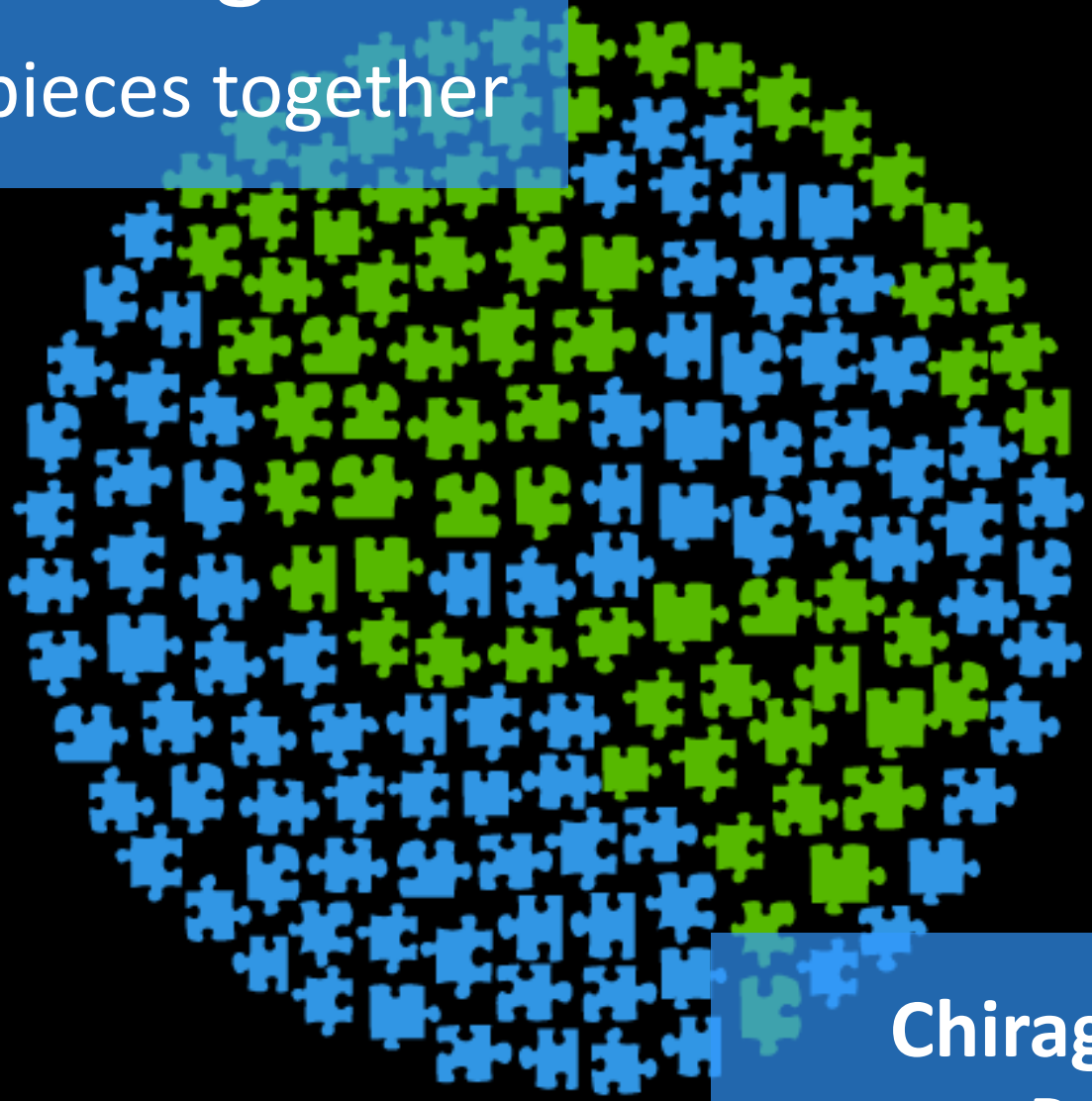
Climate Change:

Fitting the pieces together



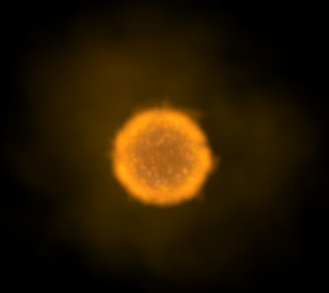
Chirag Bhimani

Dy. Envi. Engg.

Outline

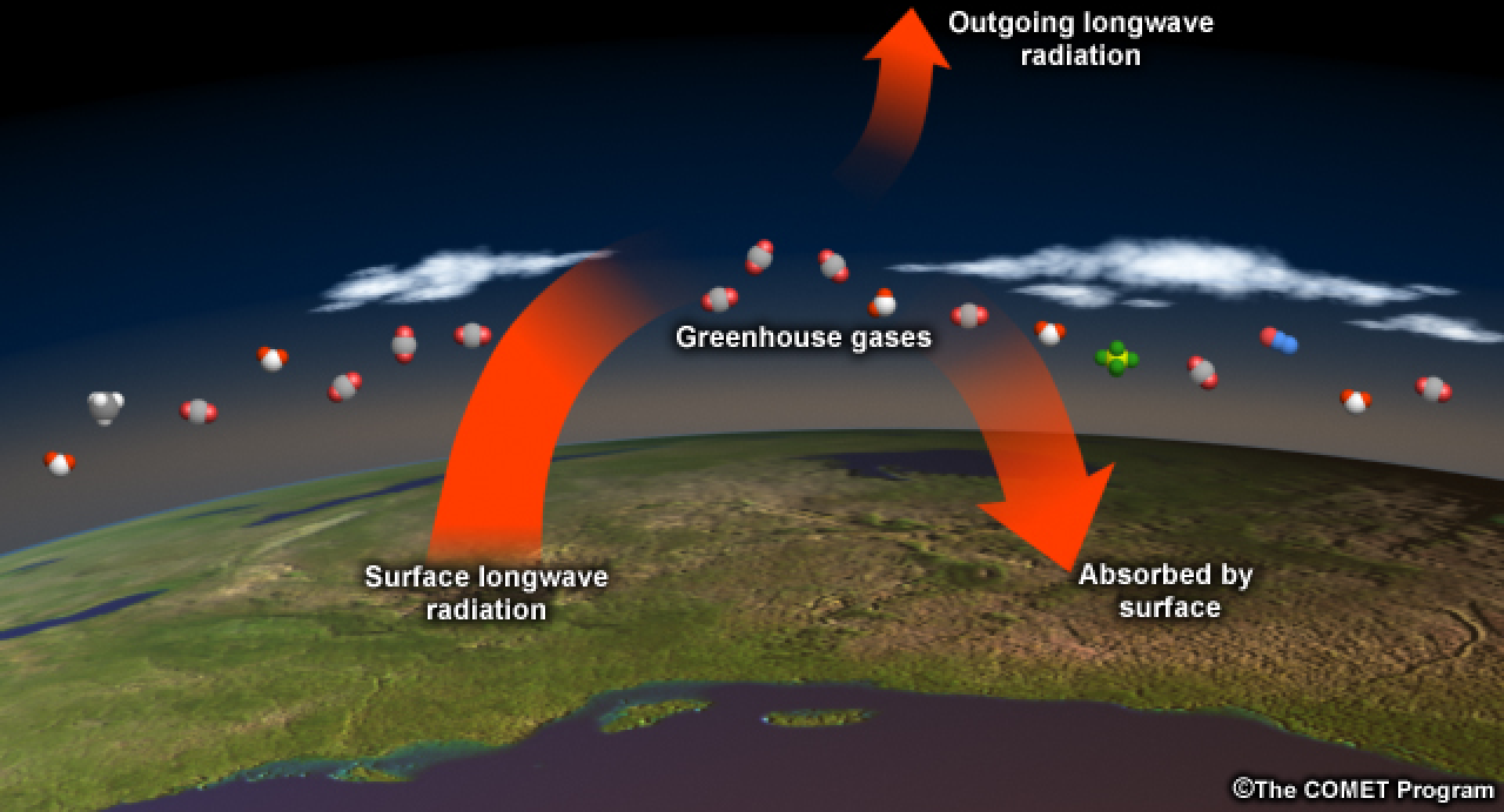
- What changes climate?
- Is it real?
- How do we know?
- Why should we care?
- How sure are scientists?
- What next—what can we do?

What changes climate?

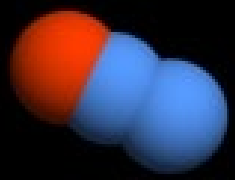


- Changes in:
  - Sun's output
  - Earth's orbit
  - Drifting continents
  - Volcanic eruptions
  - Greenhouse gases

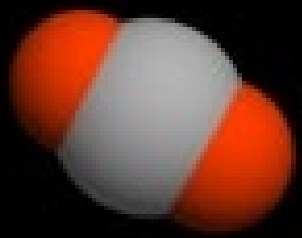
Increasing greenhouse gases trap more heat



Greenhouse gases

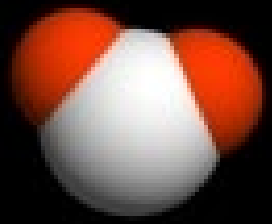


Nitrous oxide



Carbon dioxide

Methane

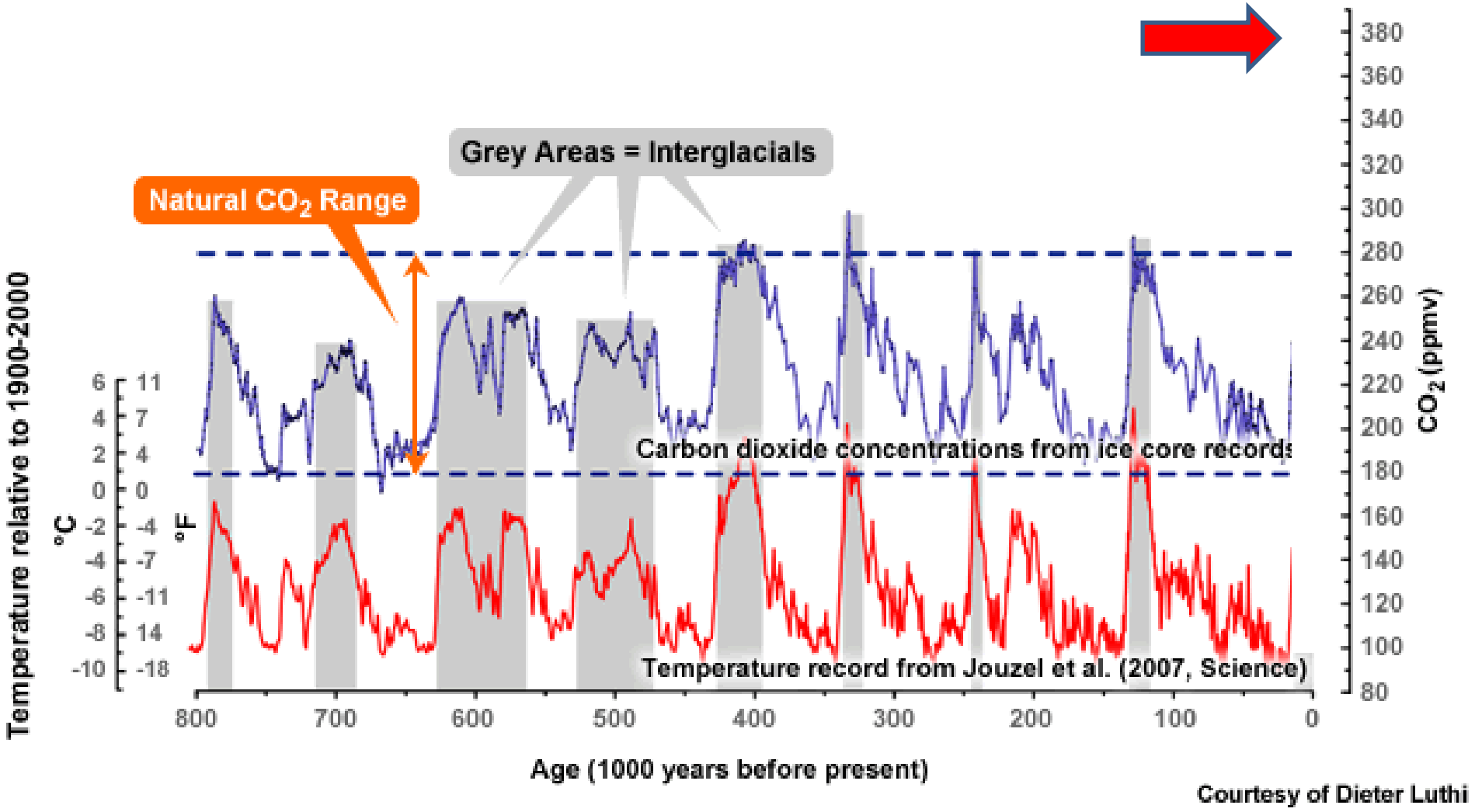


Water

Sulfur hexafluoride

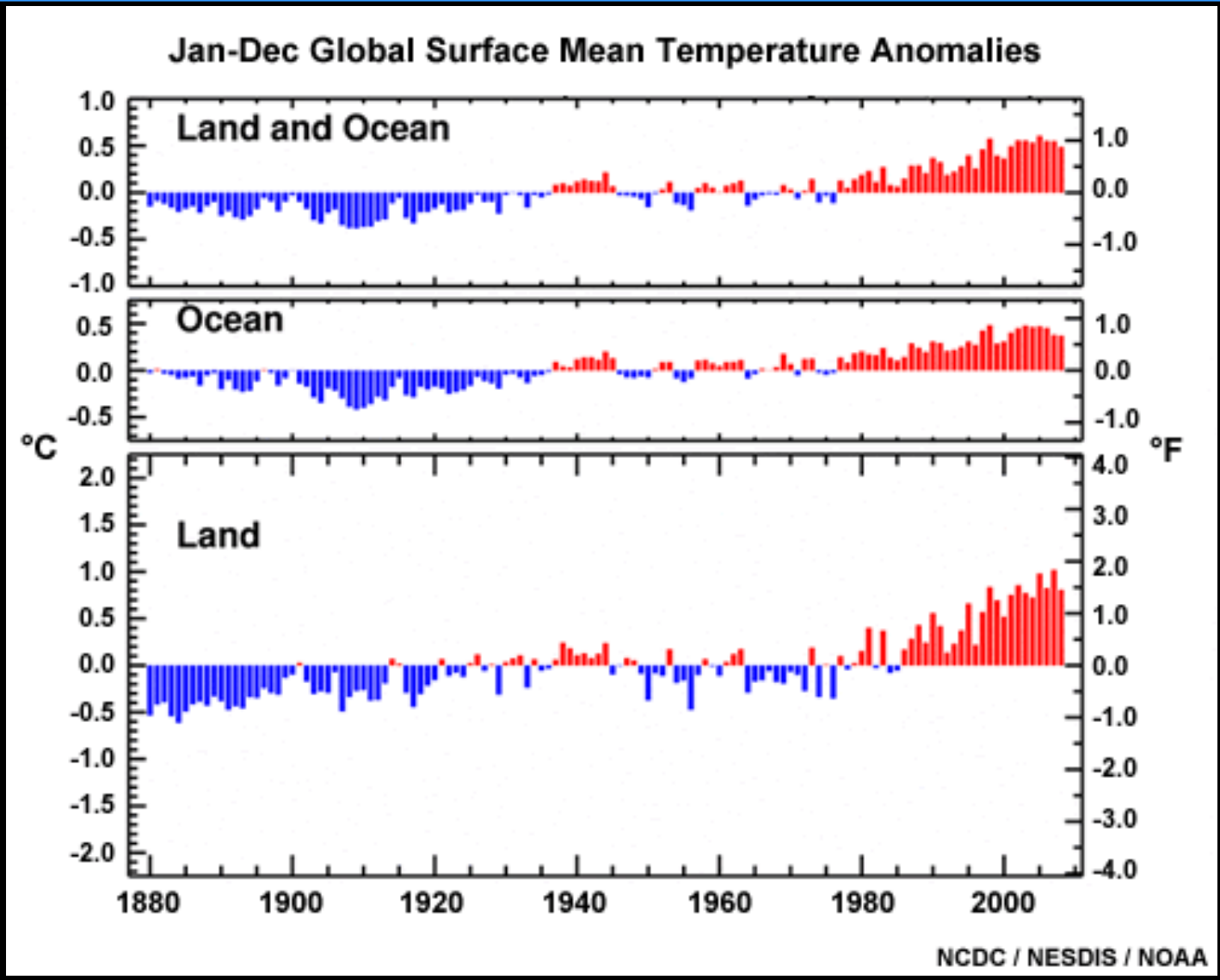

©UCAR / NCU

Could the warming be natural?

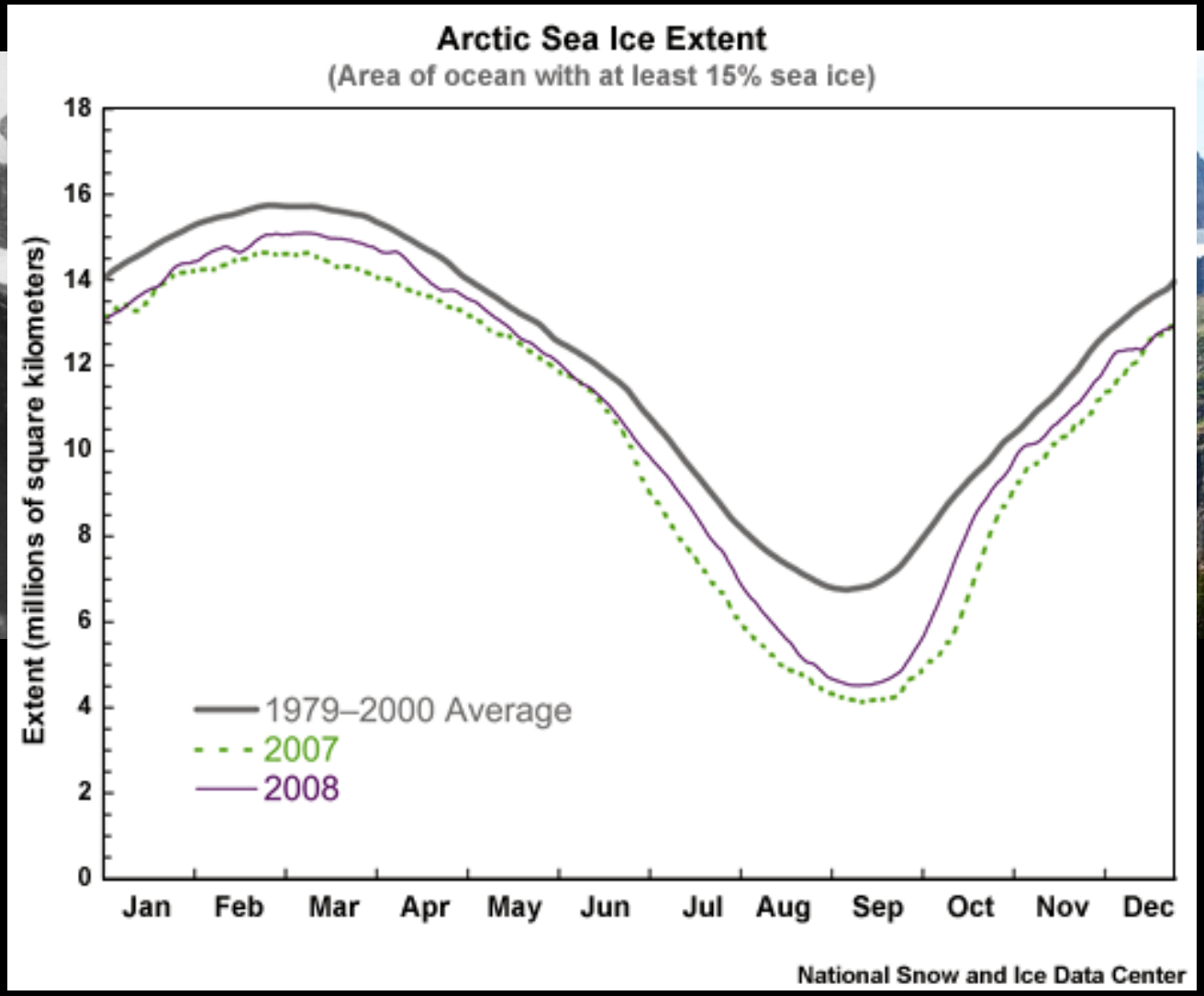


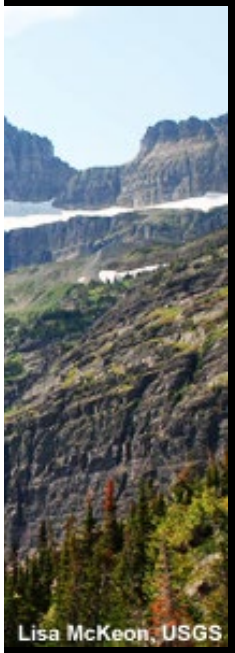
Courtesy of Dieter Luthi

Is it real?

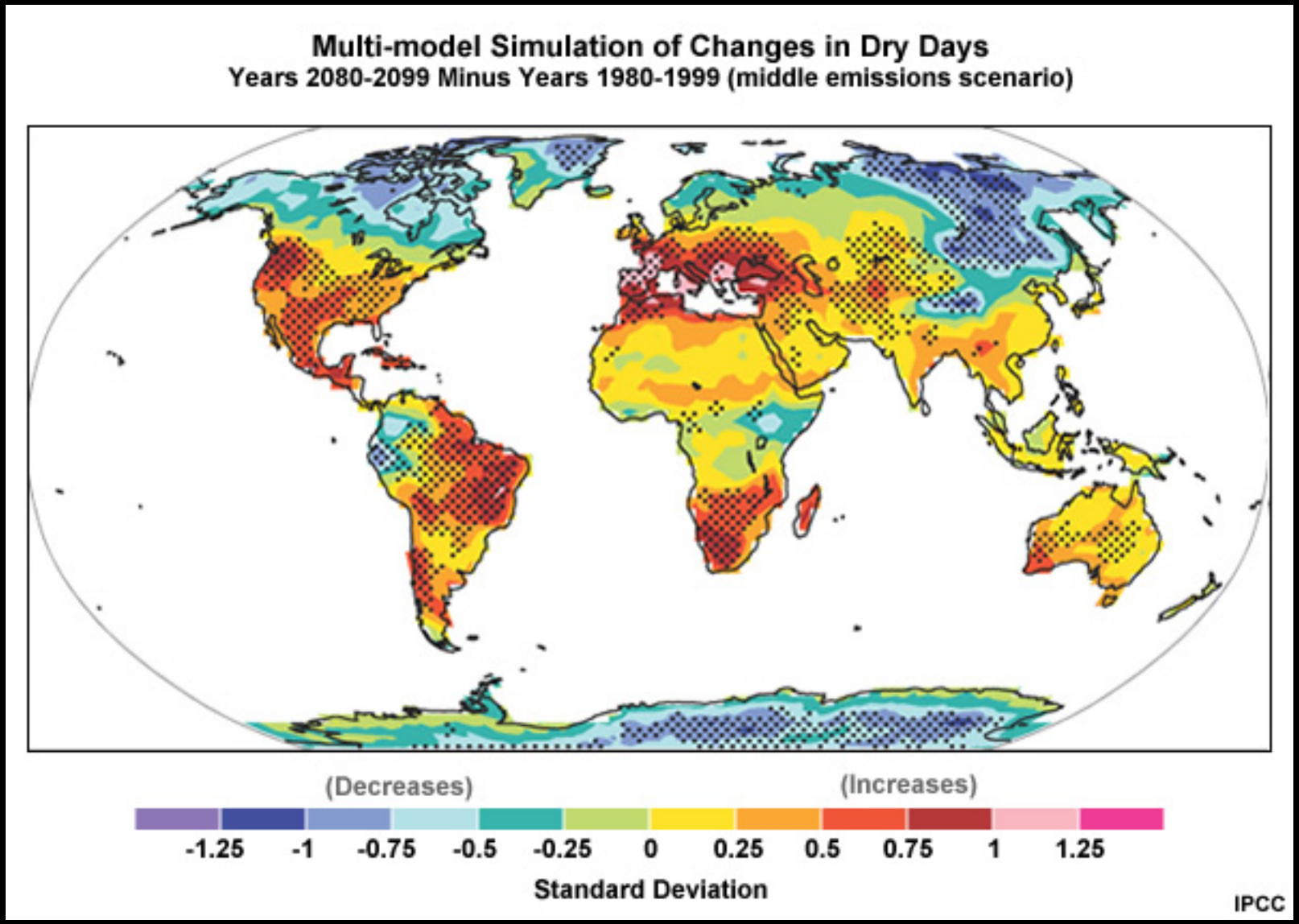

Jan-Dec Global Surface Mean Temperature Anomalies
Land and Ocean
Ocean
Land
°C
°F
1.0
0.5
0.0
-0.5
-1.0
2.0
1.5
-1.5
-2.0
4.0
3.0
2.0
-3.0
-4.0
1880
1900
1920
1940
1960
1980
2000
NCDC / NESDIS / NOAA

Effects: Snow and ice



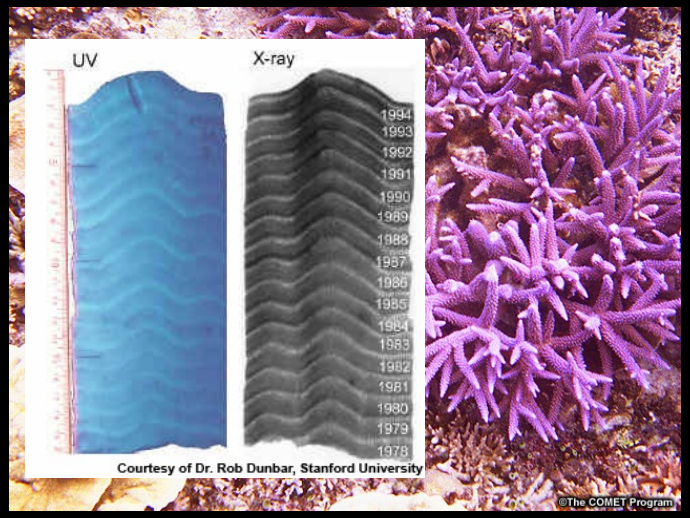


Effects on precipitation

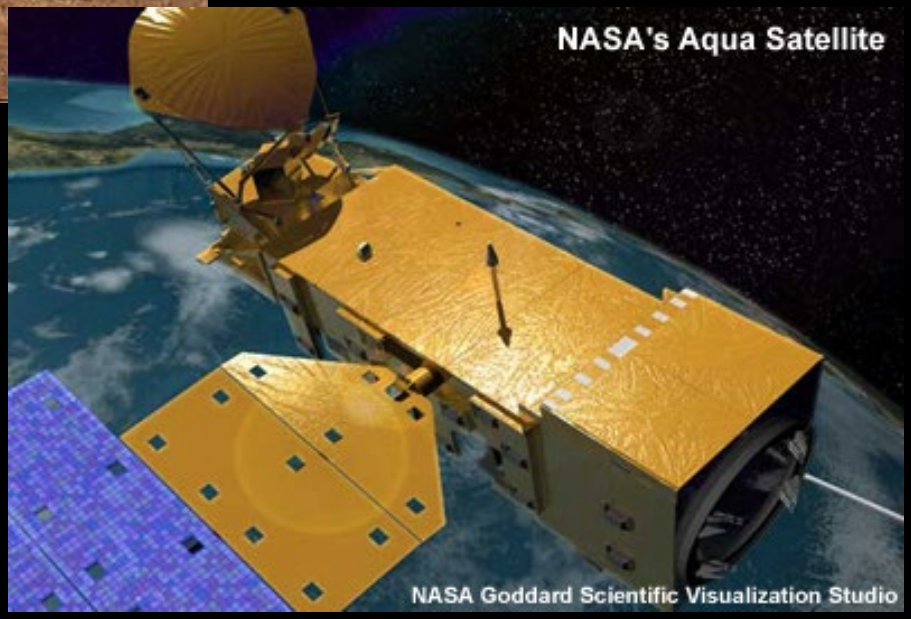


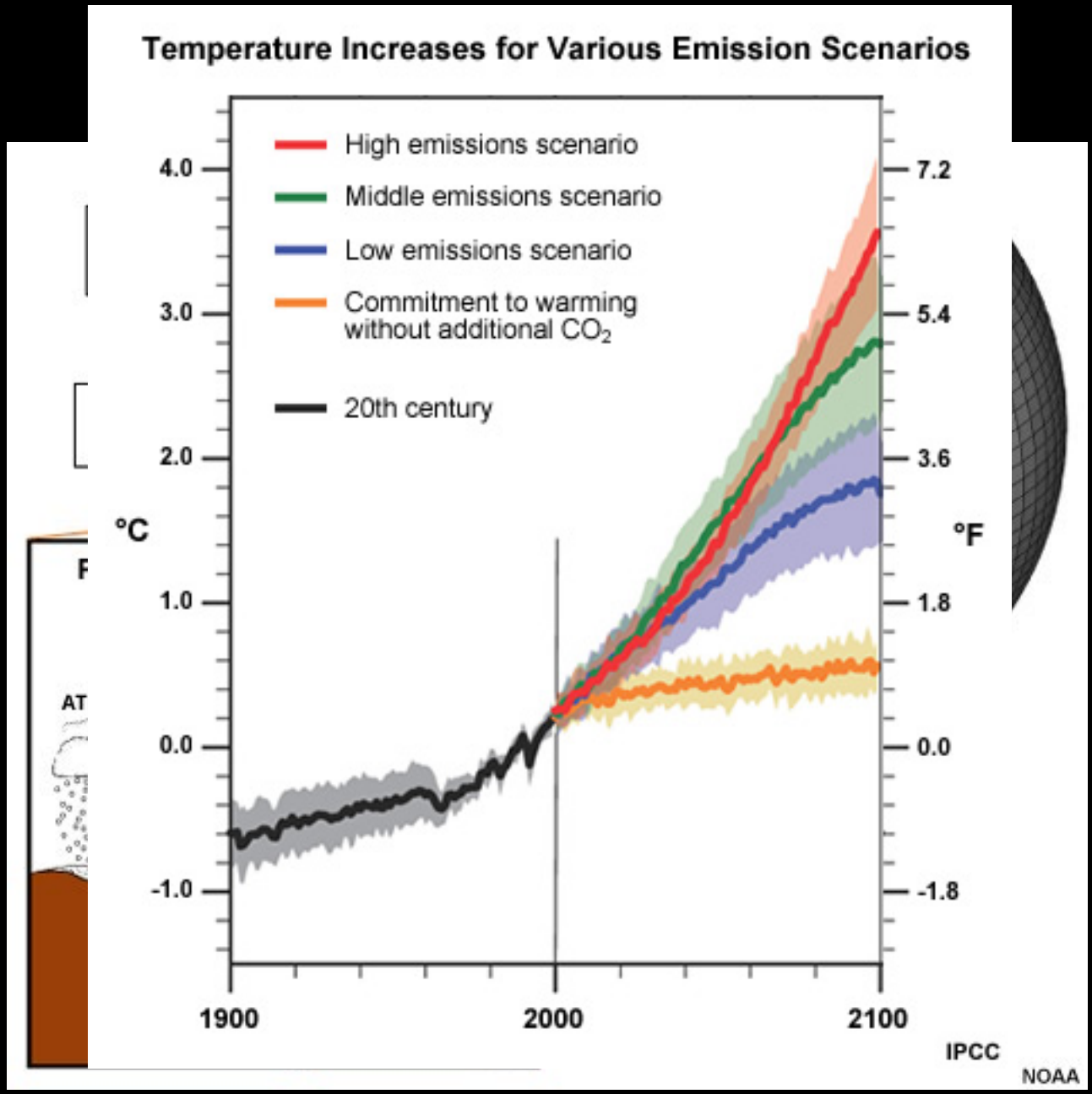
Effects on ecosystems

How do we know?

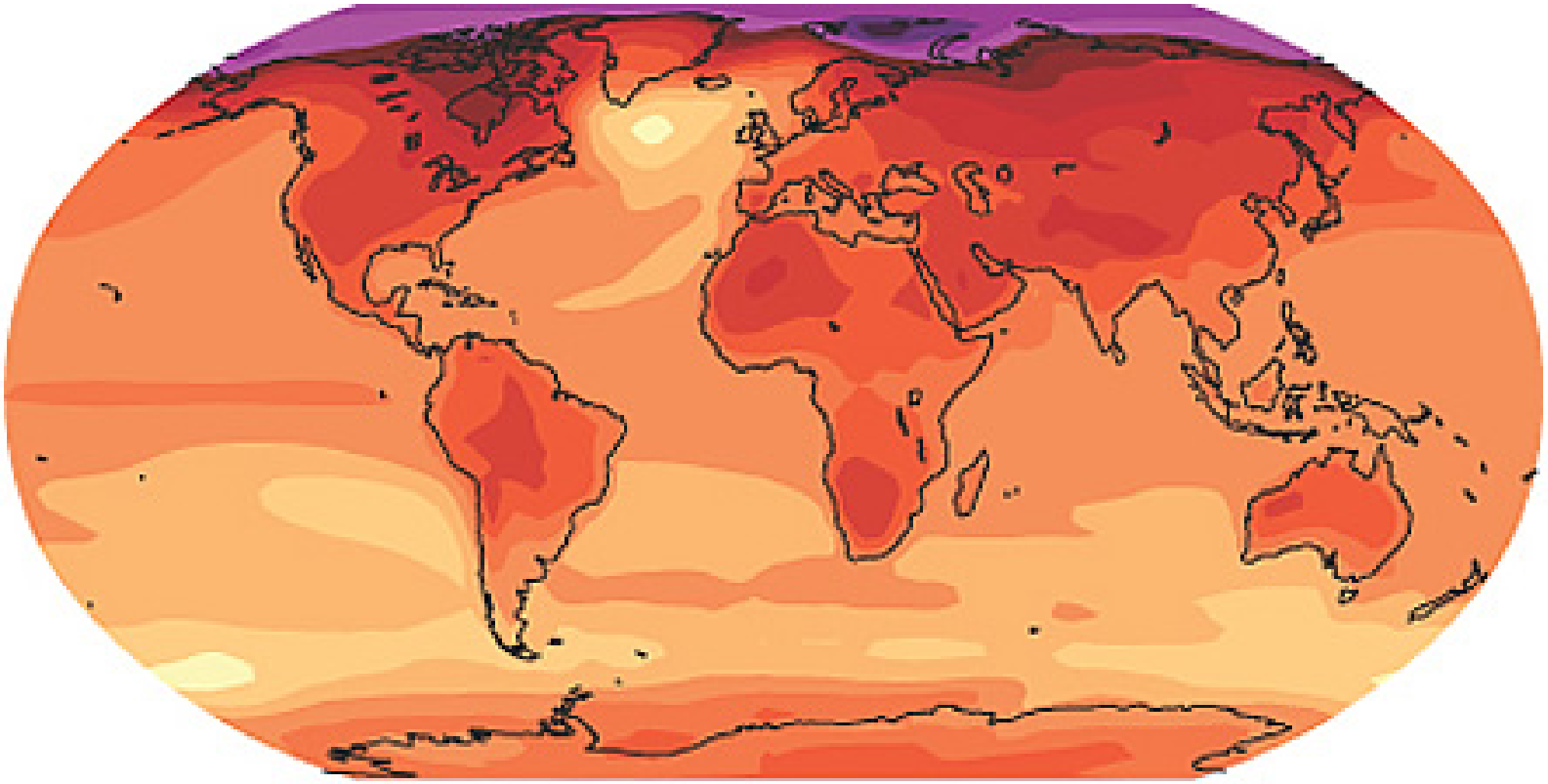


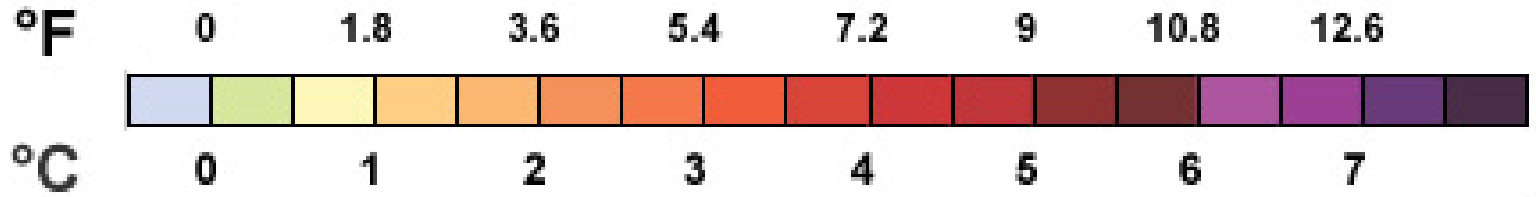
Present day observations



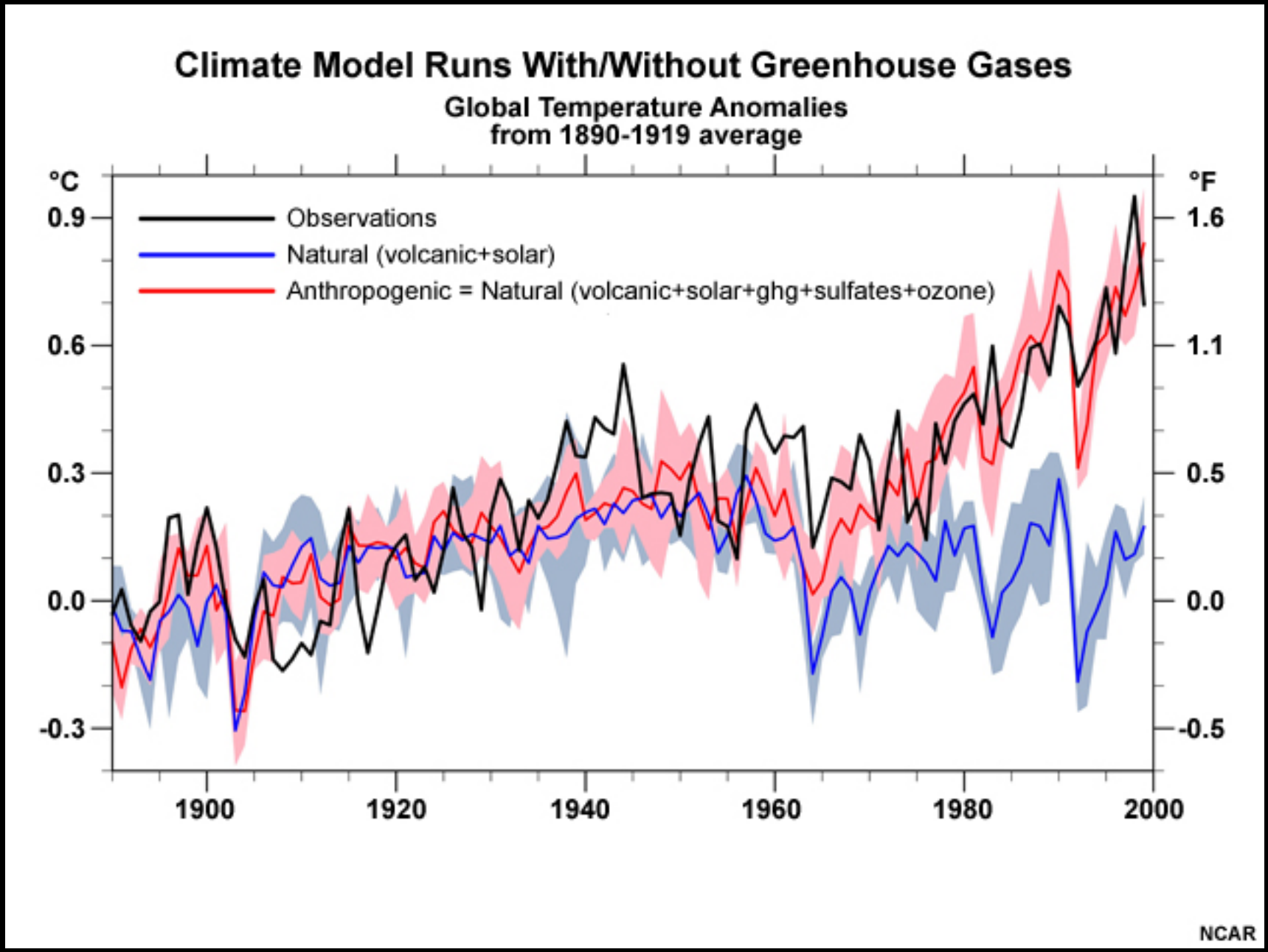

Temperature Increases for Various Emission Scenarios
High emissions scenario
Middle emissions scenario
Low emissions scenario
Commitment to warming without additional CO_2
20th century
°C
°F
4.0
3.0
2.0
1.0
0.0
-1.0
7.2
5.4
3.6
1.8
0.0
-1.8
1900
2000
2100
IPCC
NOAA

Projected Temperature Increases
Middle Emissions Scenario, 2080 - 2099

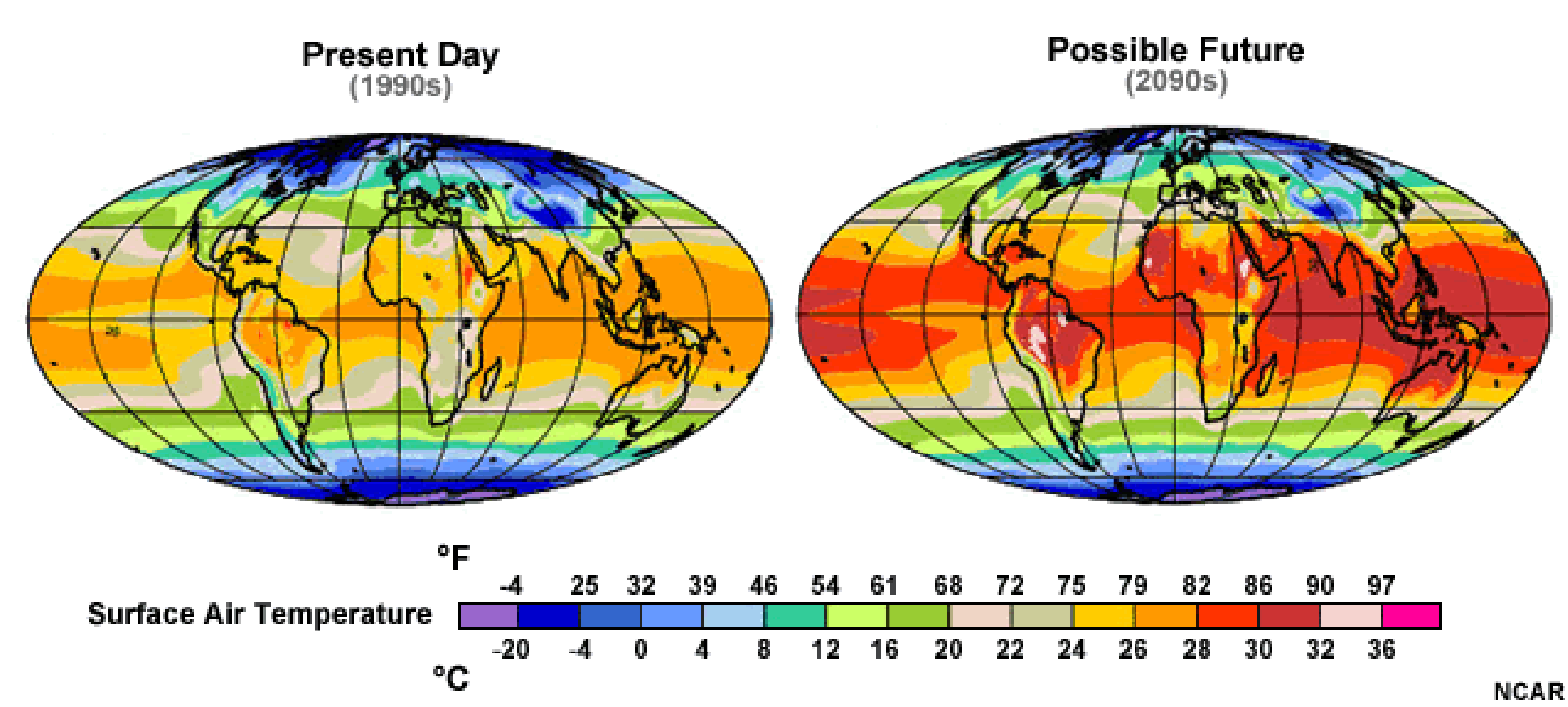


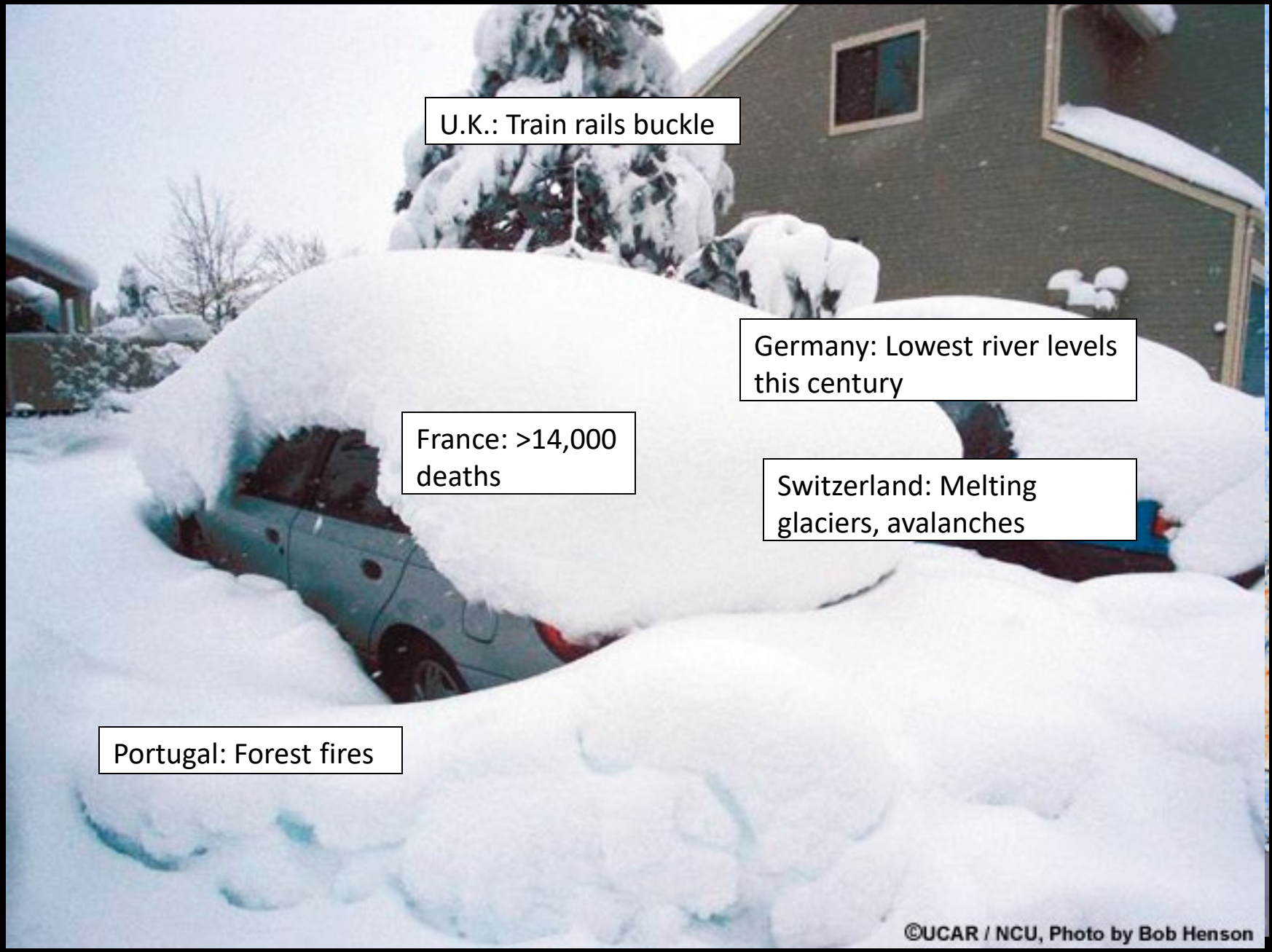


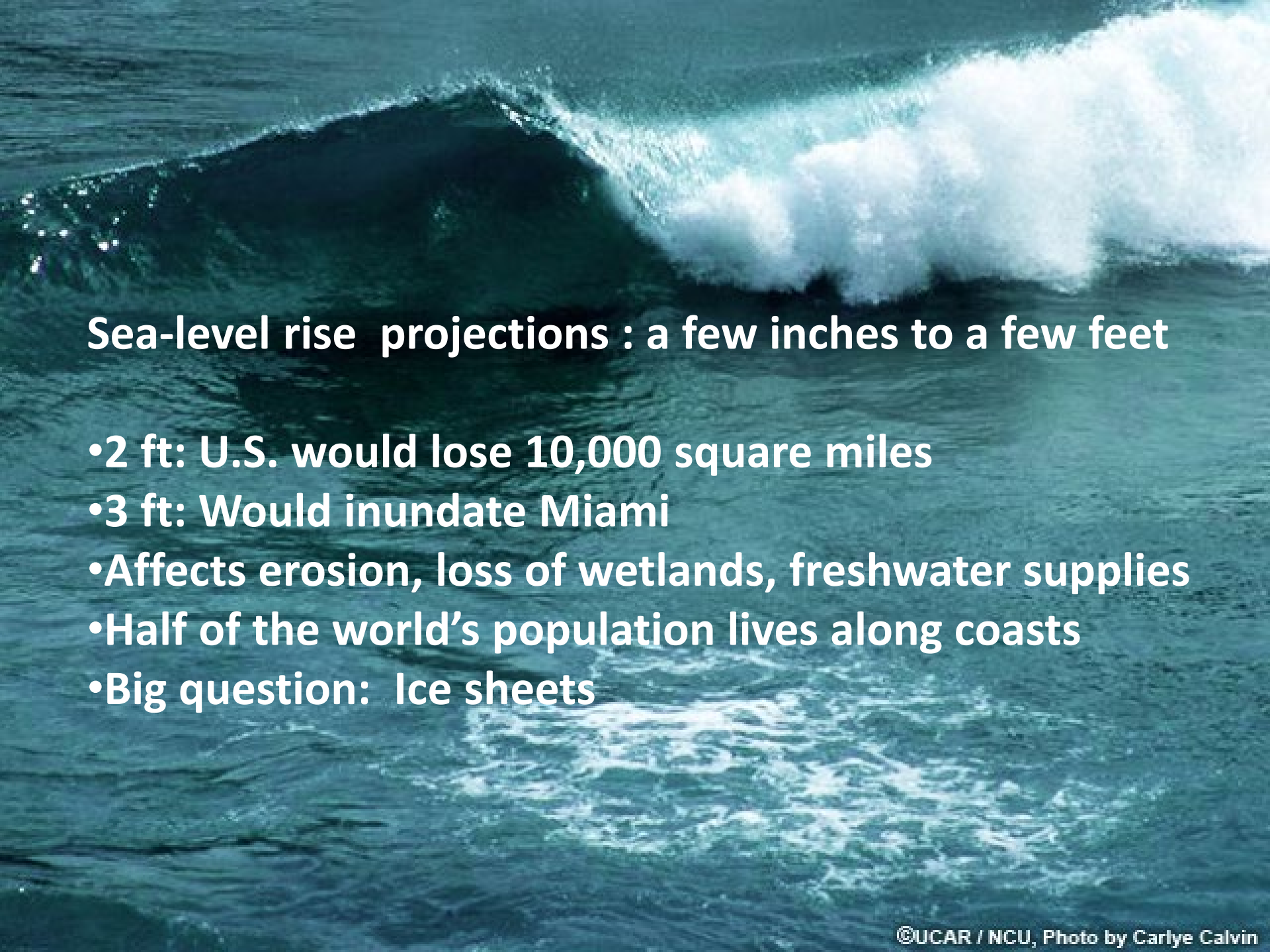
IPCC


Climate Model Runs With/Without Greenhouse Gases
Global Temperature Anomalies
from 1890-1919 average
°C
°F
0.9
0.6
0.3
0.0
-0.3
1.6
1.1
0.5
0.0
-0.5
Observations
Natural (volcanic+solar)
Anthropogenic = Natural (volcanic+solar+ghg+sulfates+ozone)
1900
1920
1940
1960
1980
2000
NCAR

Why should we care?




U.K.: Train rails buckle
Germany: Lowest river levels this century
France: >14,000 deaths
Switzerland: Melting glaciers, avalanches
Portugal: Forest fires
©UCAR / NCU, Photo by Bob Henson



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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CDC / James Gathany


Photo courtesy of USDA NRCS


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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

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 21st century that would **very likely** be larger than those observed during the 20th century."

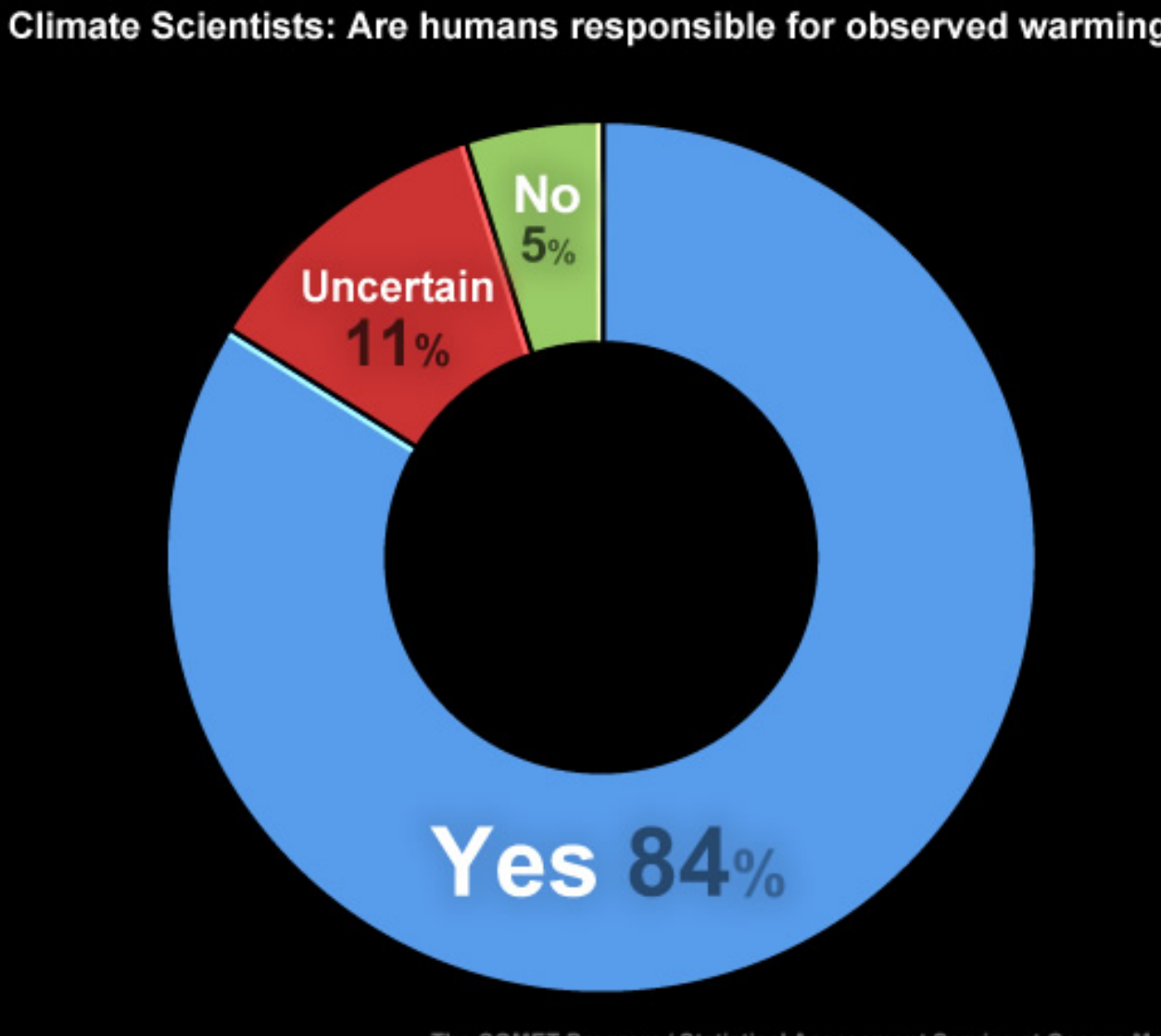
Consensus?

- **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?**

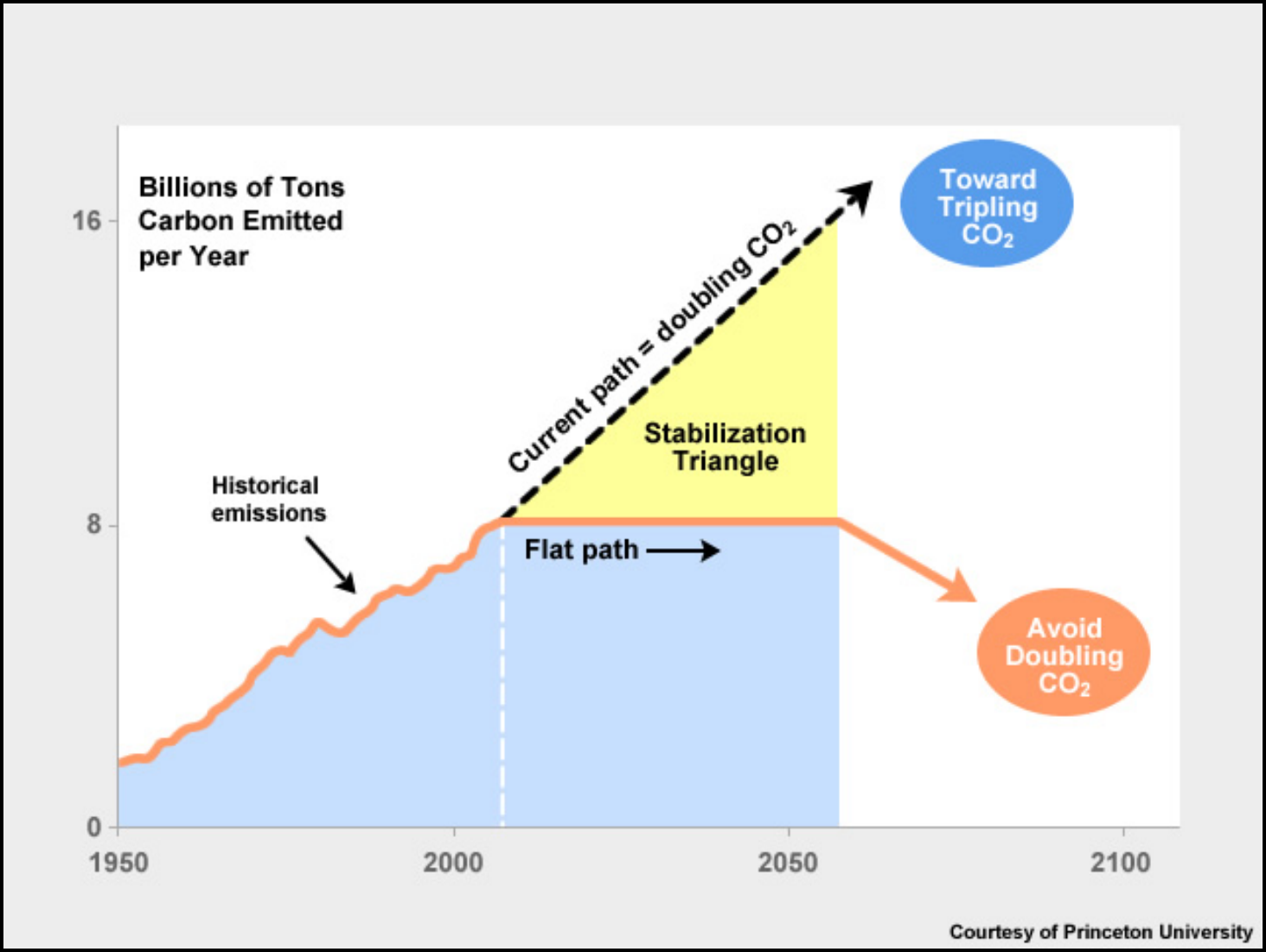
On the other hand…

- 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.

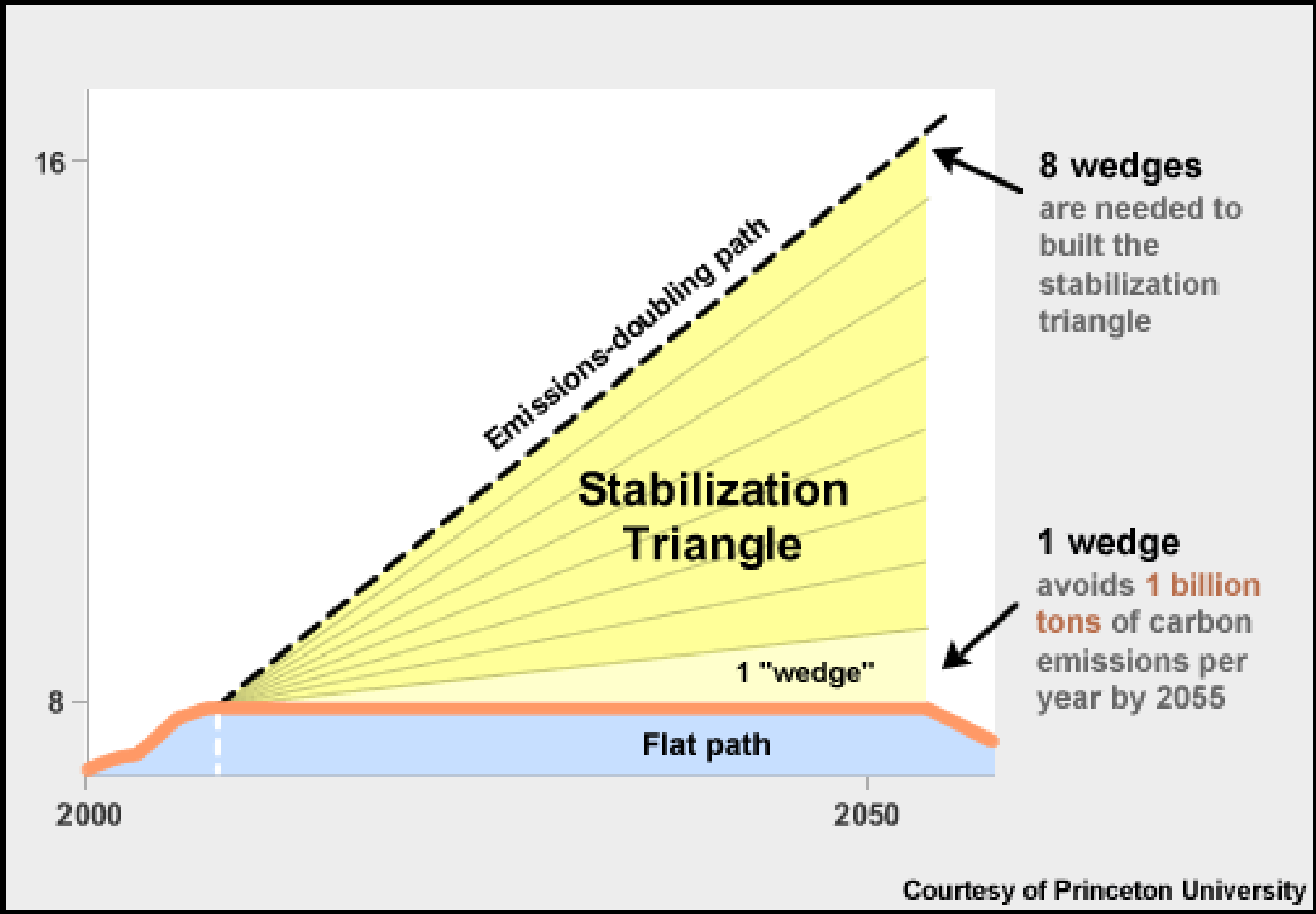
What do climate scientists really think?



What next—what can we do?

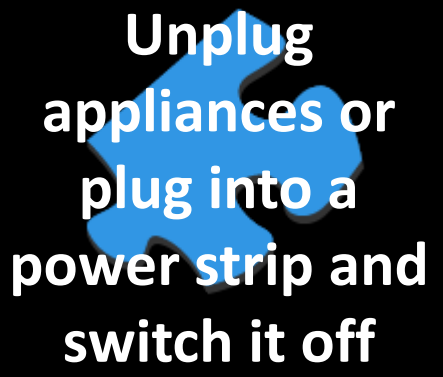


What next—what can we do?



- 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




NASA / The Visible Earth / The COMET Program