Climate Change

This is home we need to take care of it.

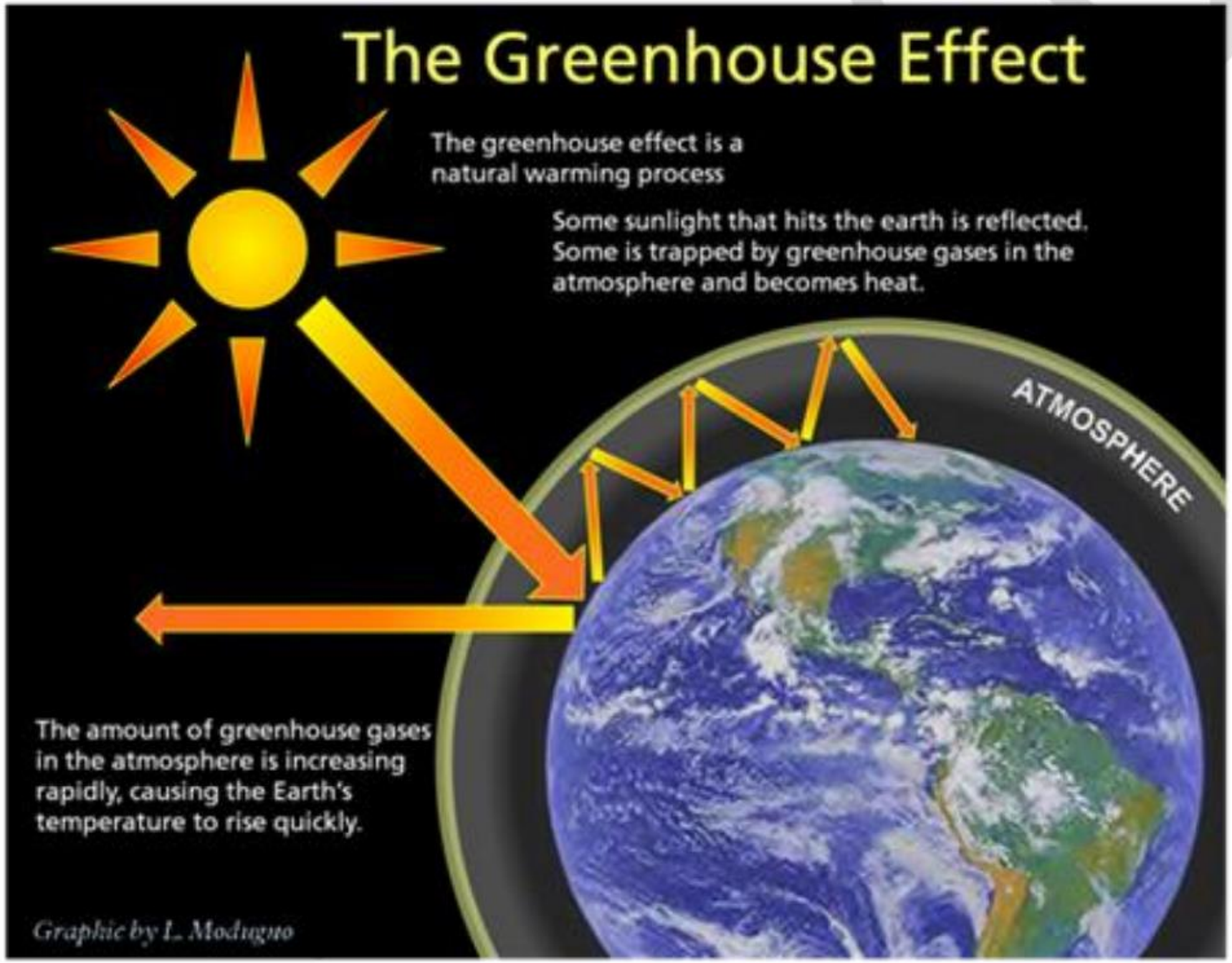
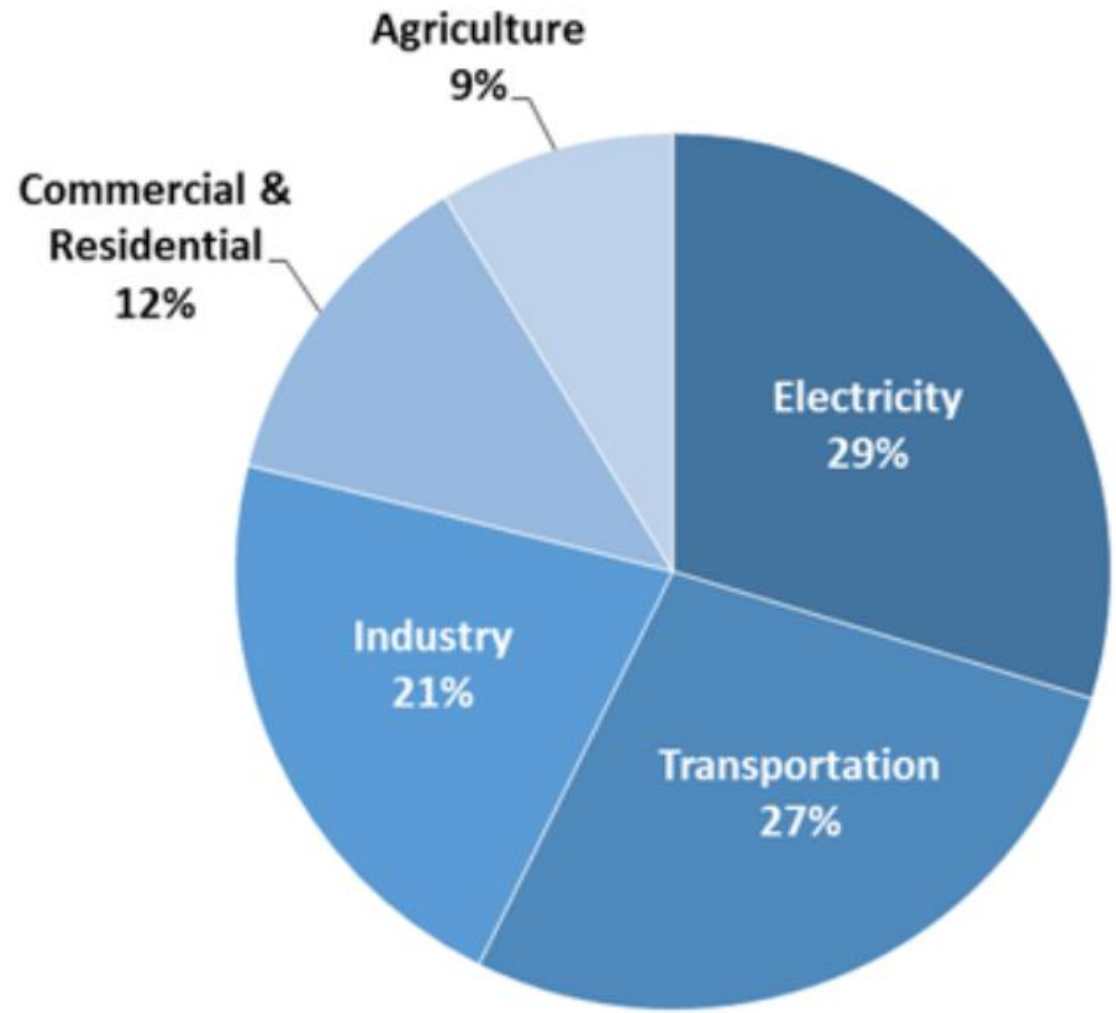
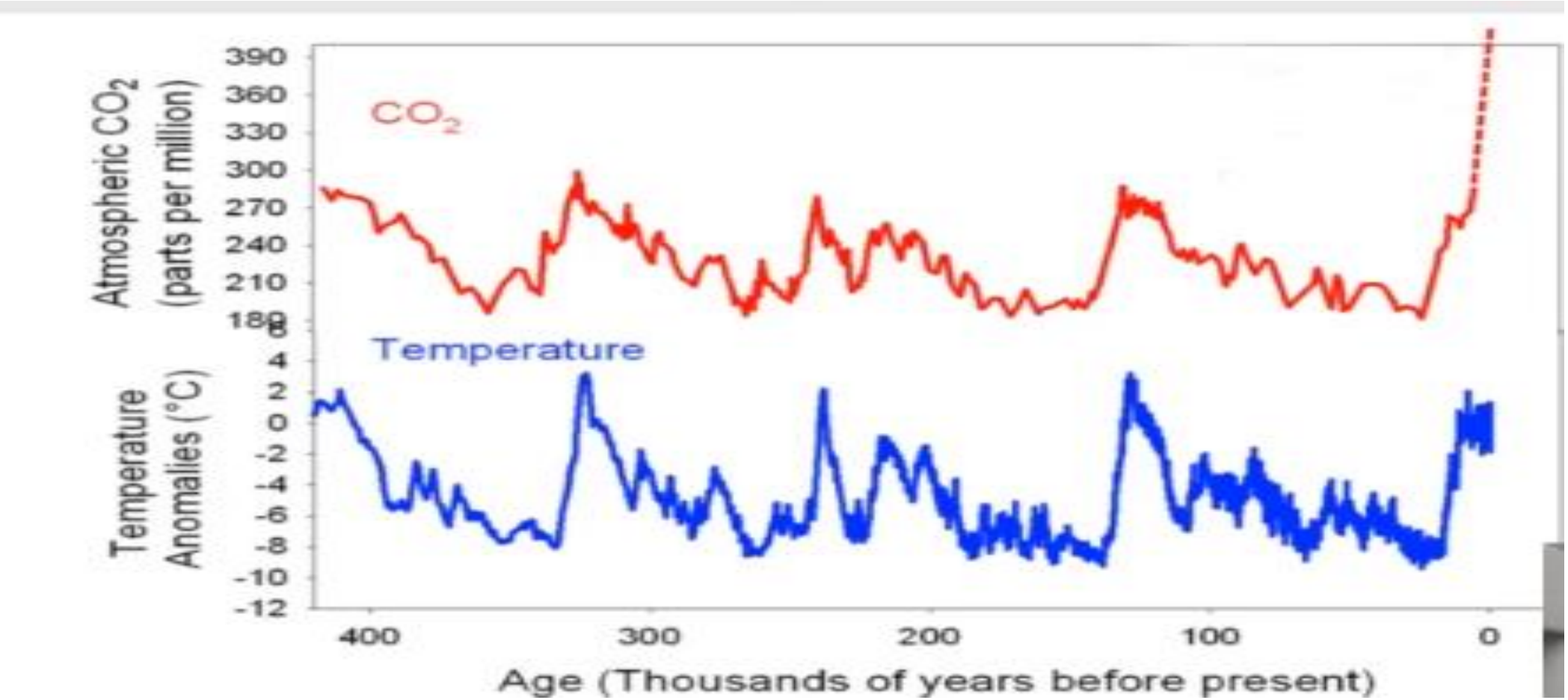


FIGURE 1.1 The greenhouse gas effect. Credit: Modugno, Pace, and Lidor, 2015.

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2015



Carbon Dioxide Concentration & Temperature Are Linked



Climate versus Weather

Weather varies minute to minute, hour to hour, day to day, month to month, and season to season.

It might be colder in a minute, in the next hour, tomorrow, next month or next winter.

Climate varies over a longer term – maybe half your life time.

It is warmer now than when you were a child. Storms are worse now than when you were a child. Droughts may last for 35 years. Miami may be under sea water soon.

What is Climate

Climate is the aggregated pattern of weather, meaning averages, extremes, timing, spatial distribution of…

- hot & cold
- cloudy & clear
- humid & dry
- drizzles & downpours
- snowfall, snowpack, & snowmelt
- blizzards, tornadoes, & typhoons

Climate change means altered patterns.

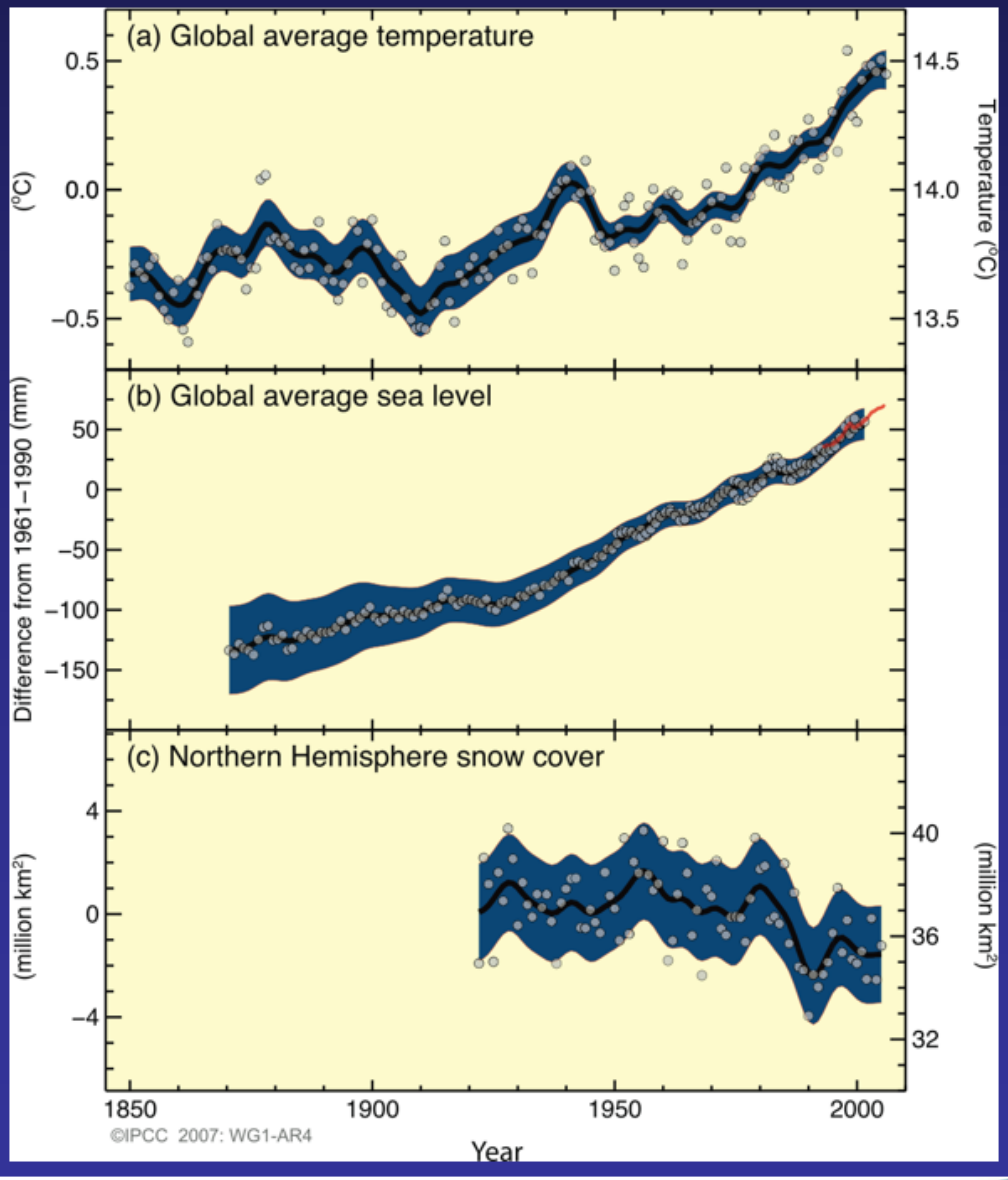
Global average temperature is just one measure of the state of the global climate as expressed in these patterns.

Small temperature changes → big changes in the patterns

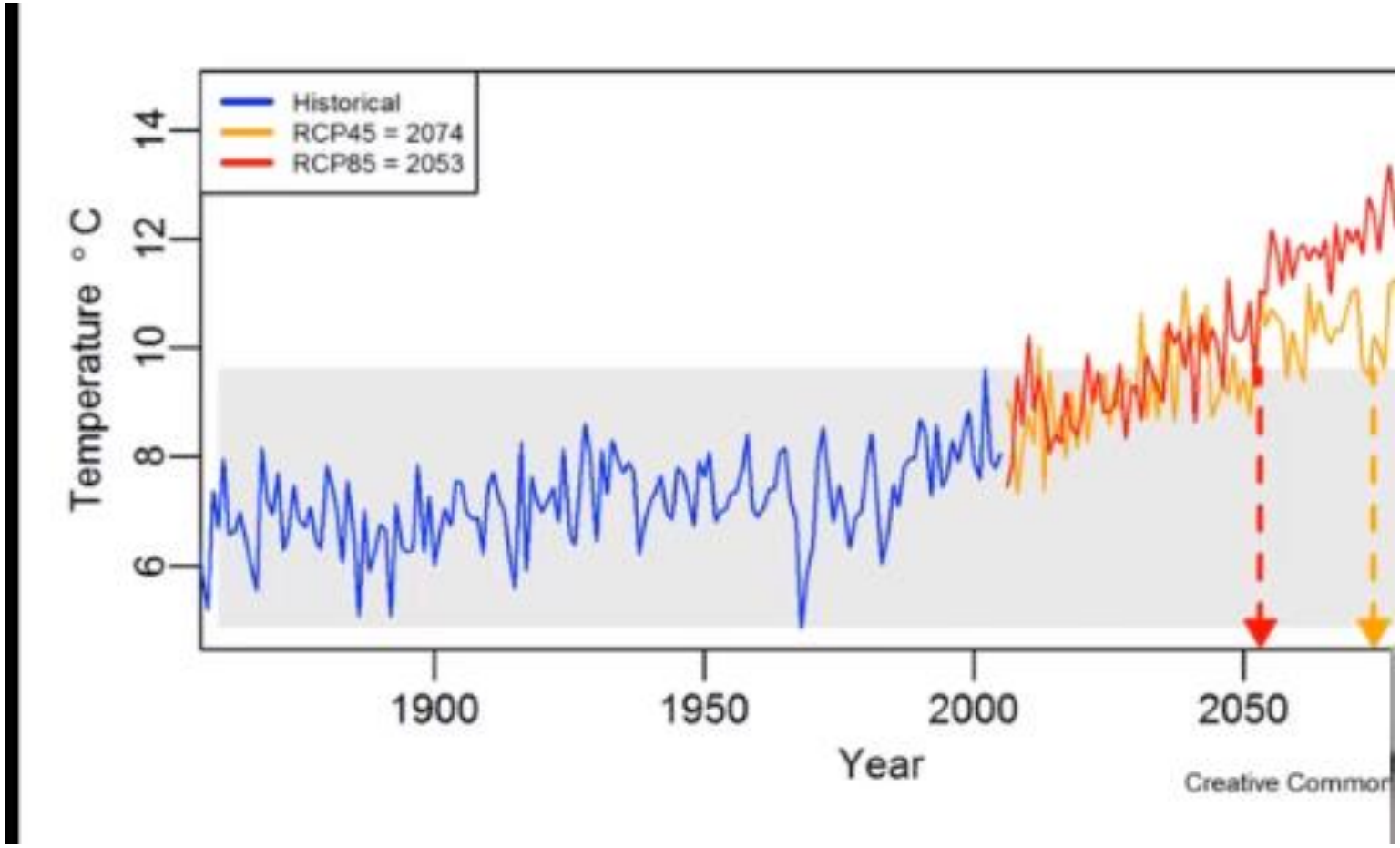
(after Holdren NCES, 2008)

Historic record of global climate change

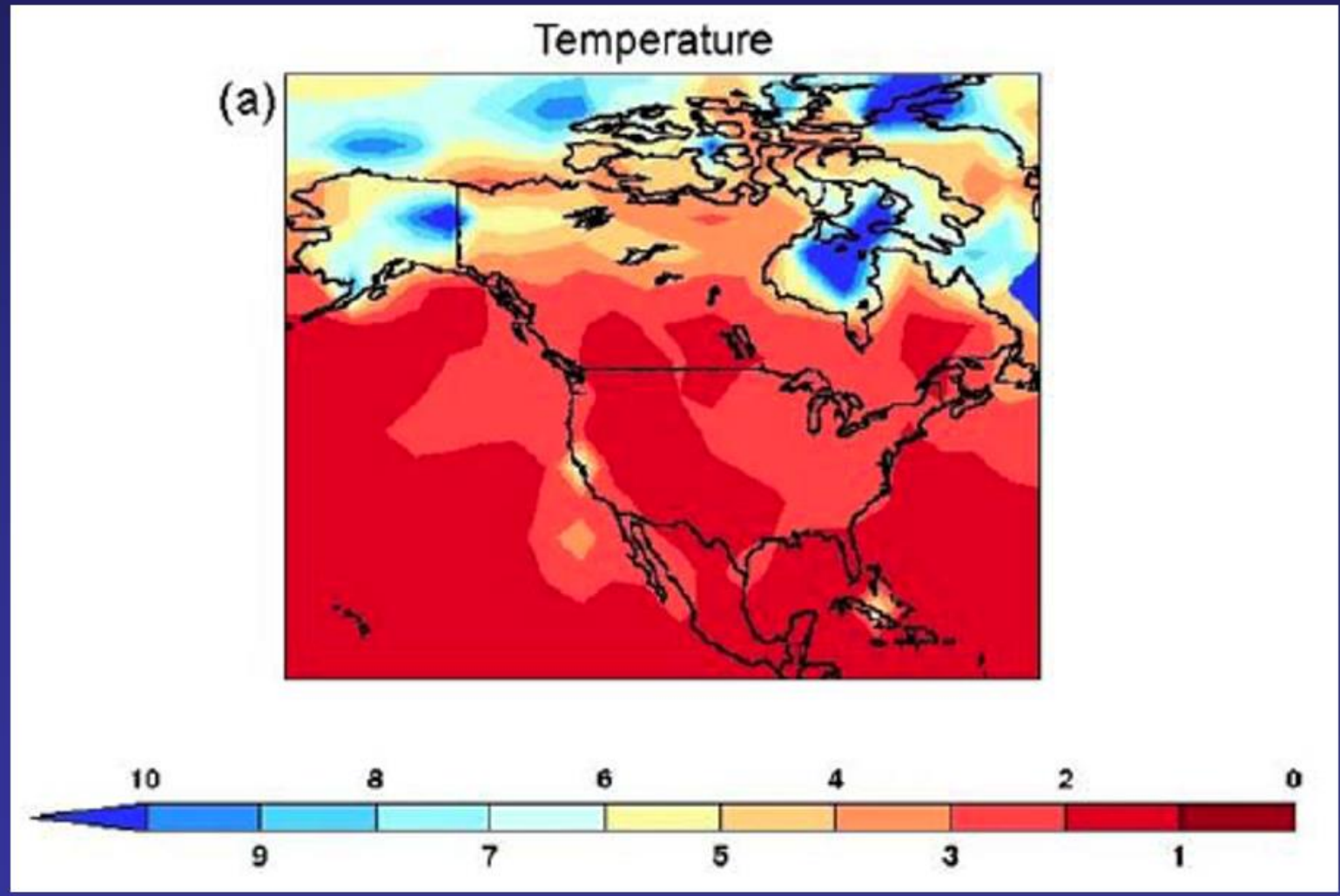
Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.



Future Temperatures are going to be higher

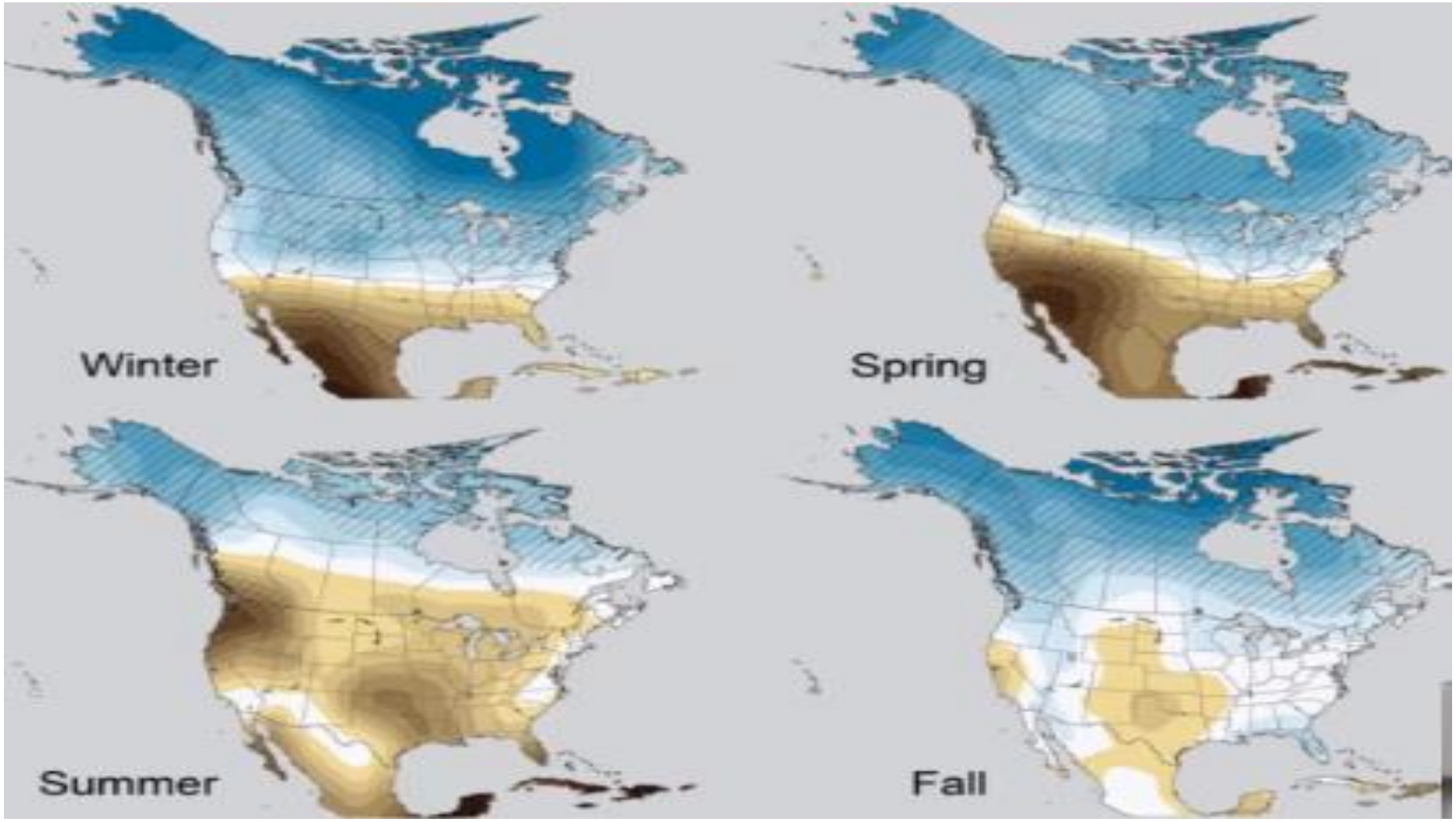


Projected increase in occurrence of extremely rare hot days (a 1 in-20 year event)

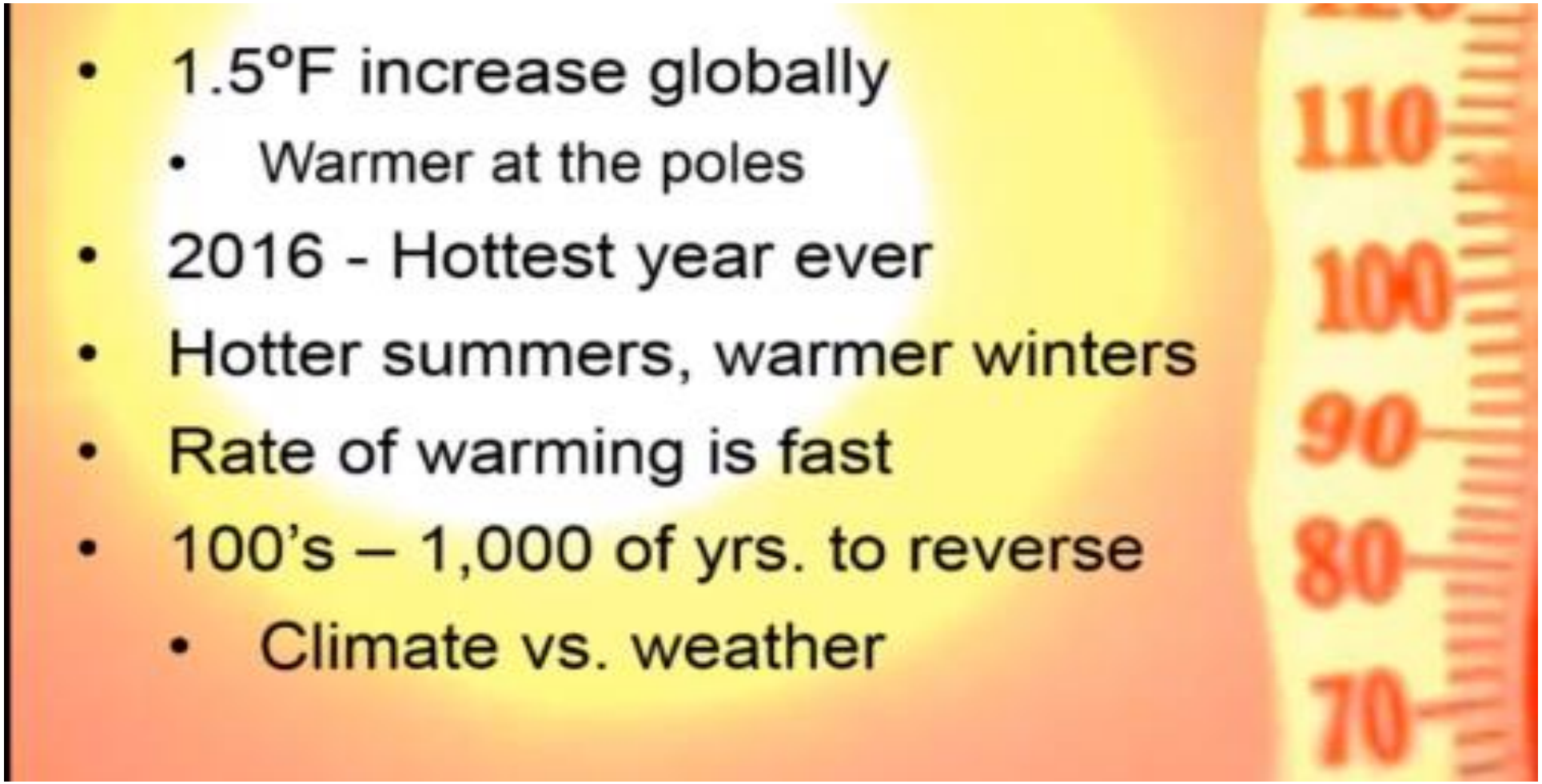


(from Wehner 2005)

Future Precipitation Patterns Are Going To Change Dramatically By End Of Century



This is Climate Change Not Weather



Take away message

Climate Change is real.

We are the cause of it.

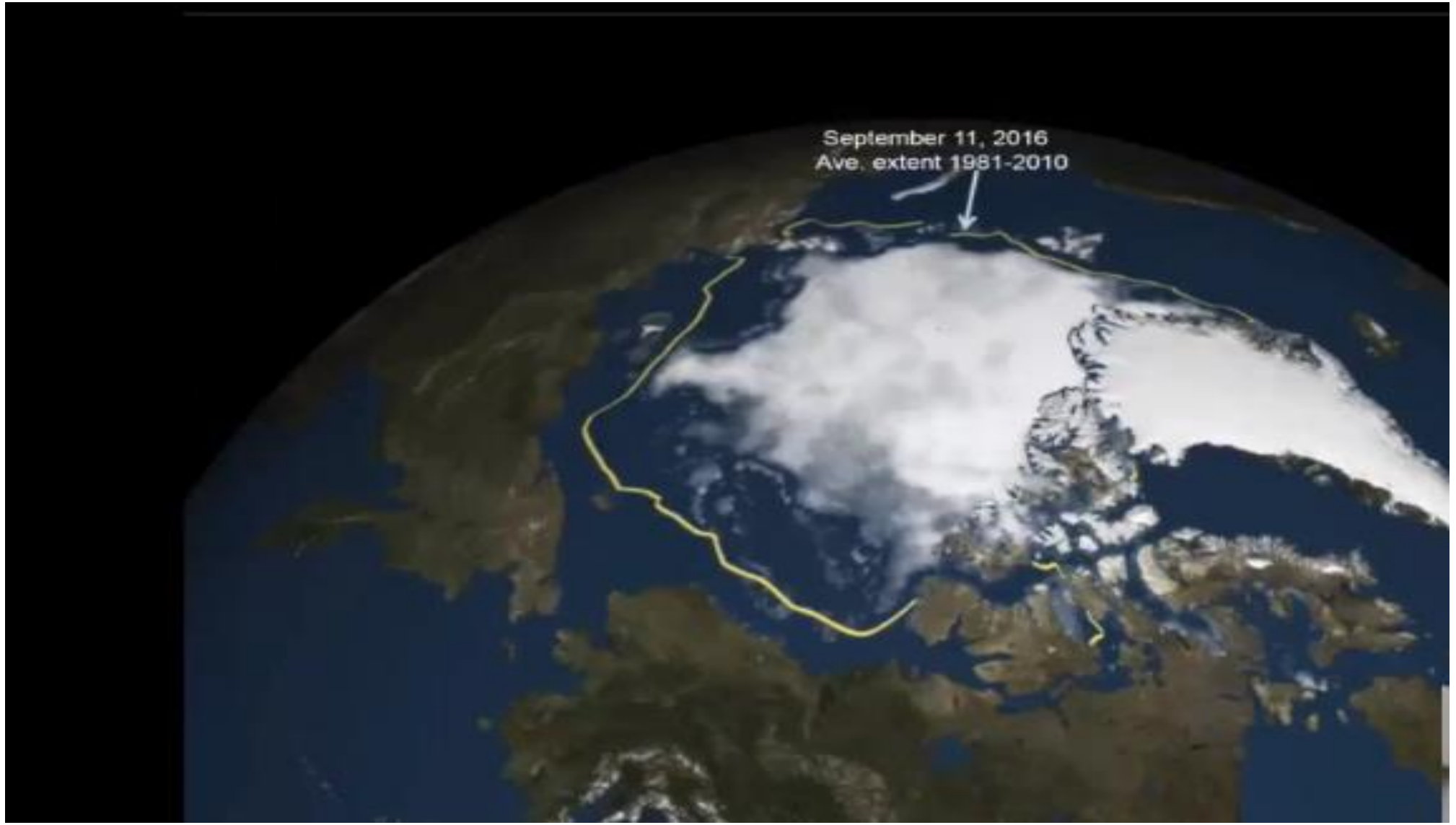
It is happening fast.

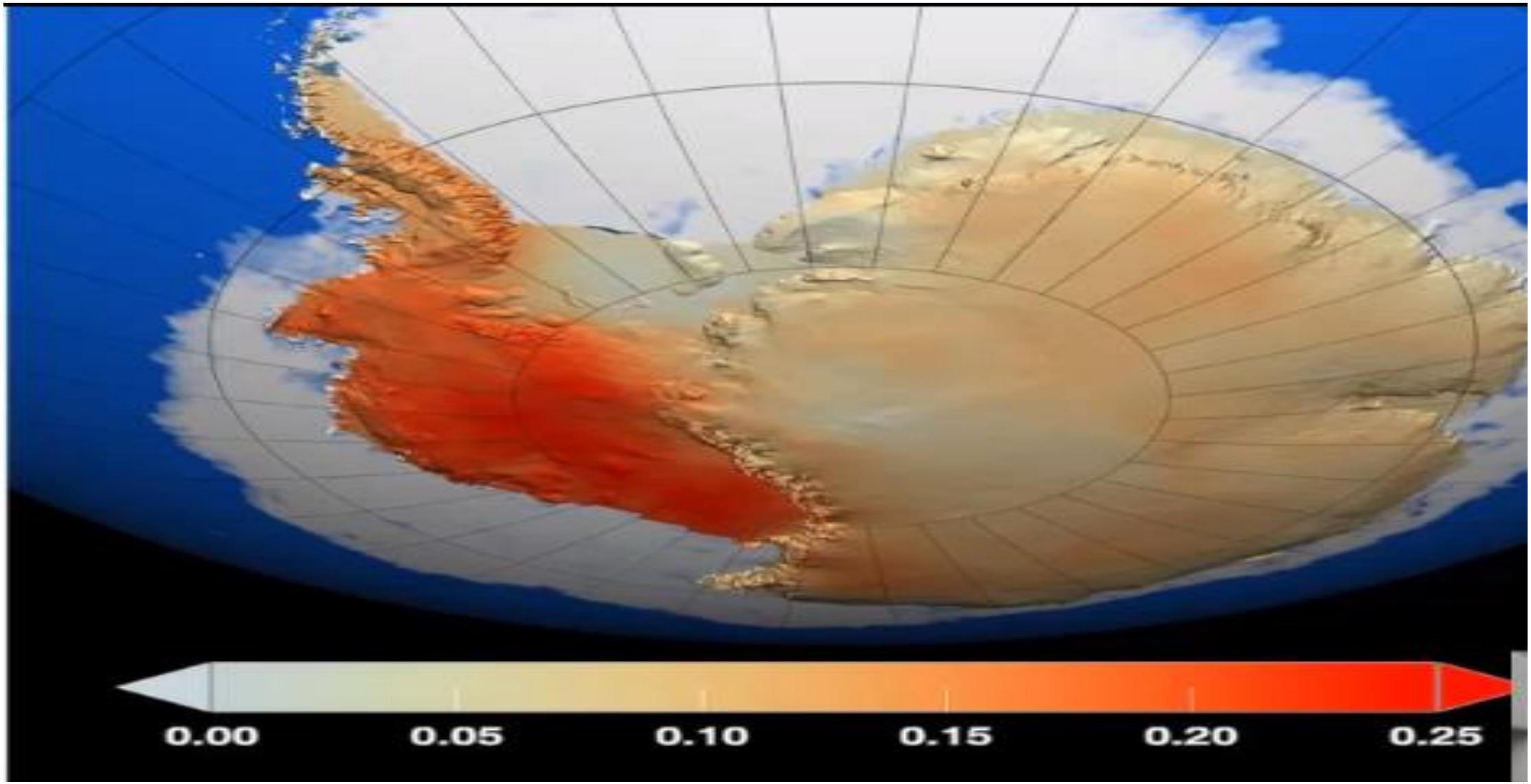
It will get worse with business as usual.

We can impact this outcome.

Is there really evidence of Climate Change?

Columbia Glacier, Alaska, has retreated by 6.5 km (4 miles) between 2009 (left) and 2015 (right) (Credit: James Balog and the Extreme Ice Survey)

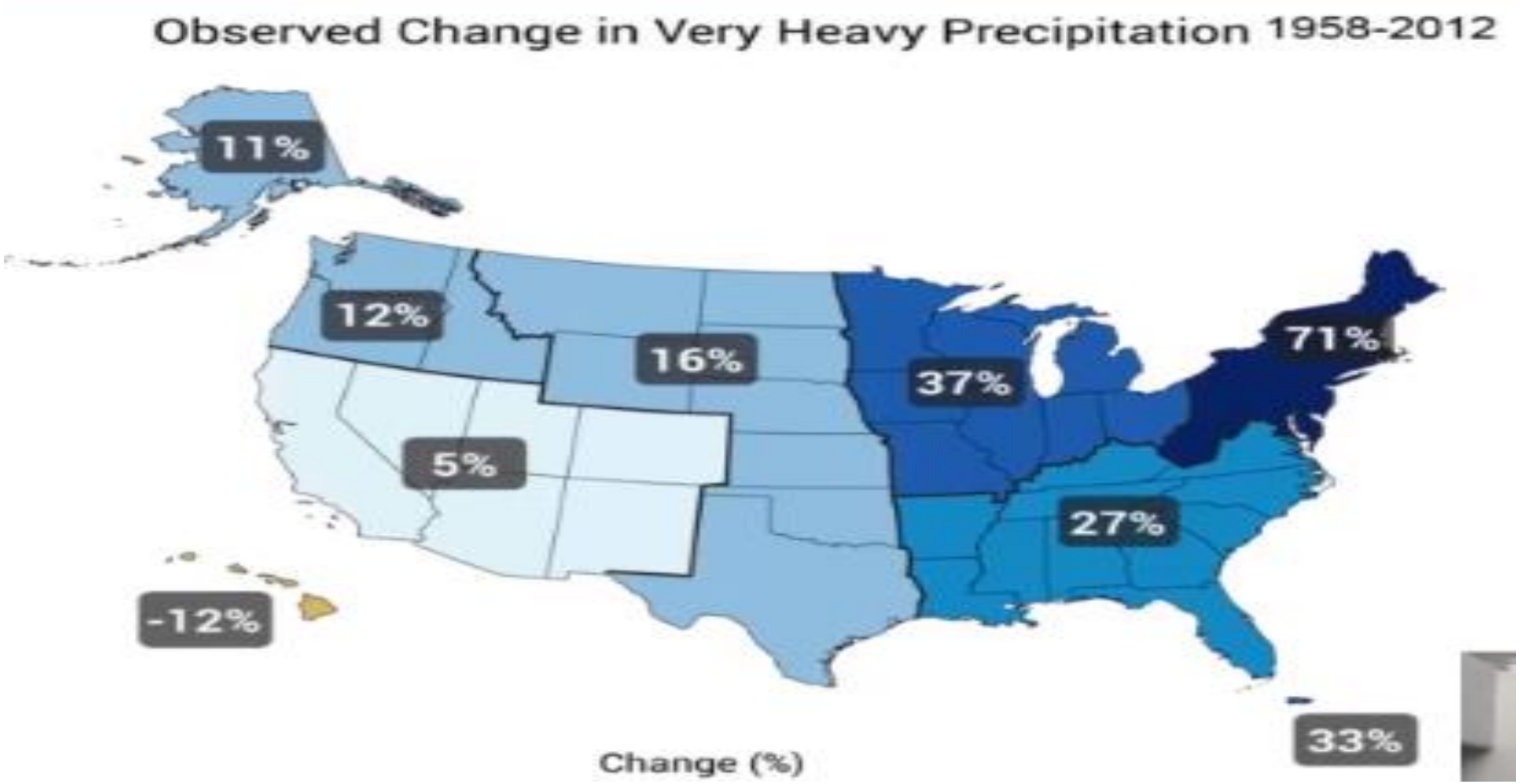

September 11, 2016
Ave. extent 1981-2010


0.00
0.05
0.10
0.15
0.20
0.25

More Evidence: Warm Ocean Waters

Longer “summers”

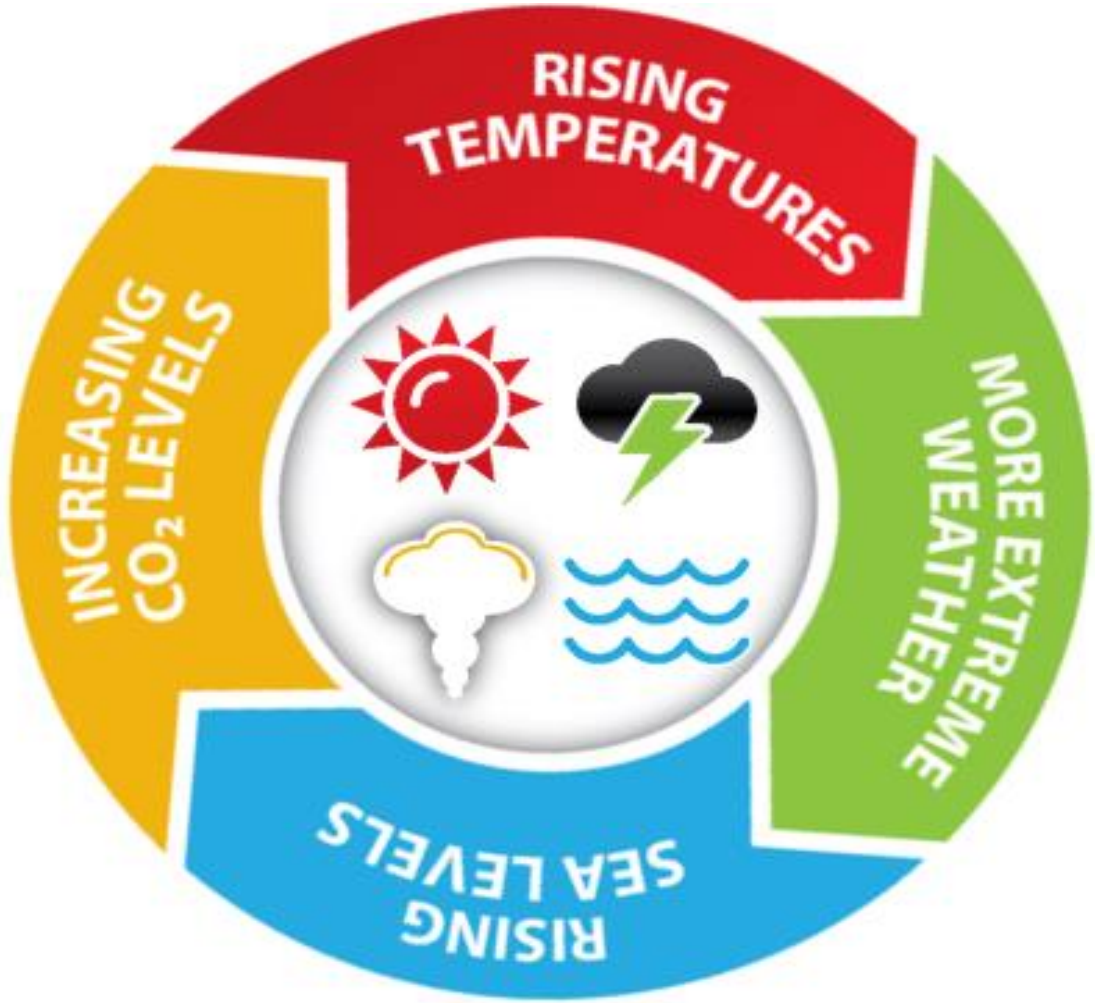
More "Downpours"



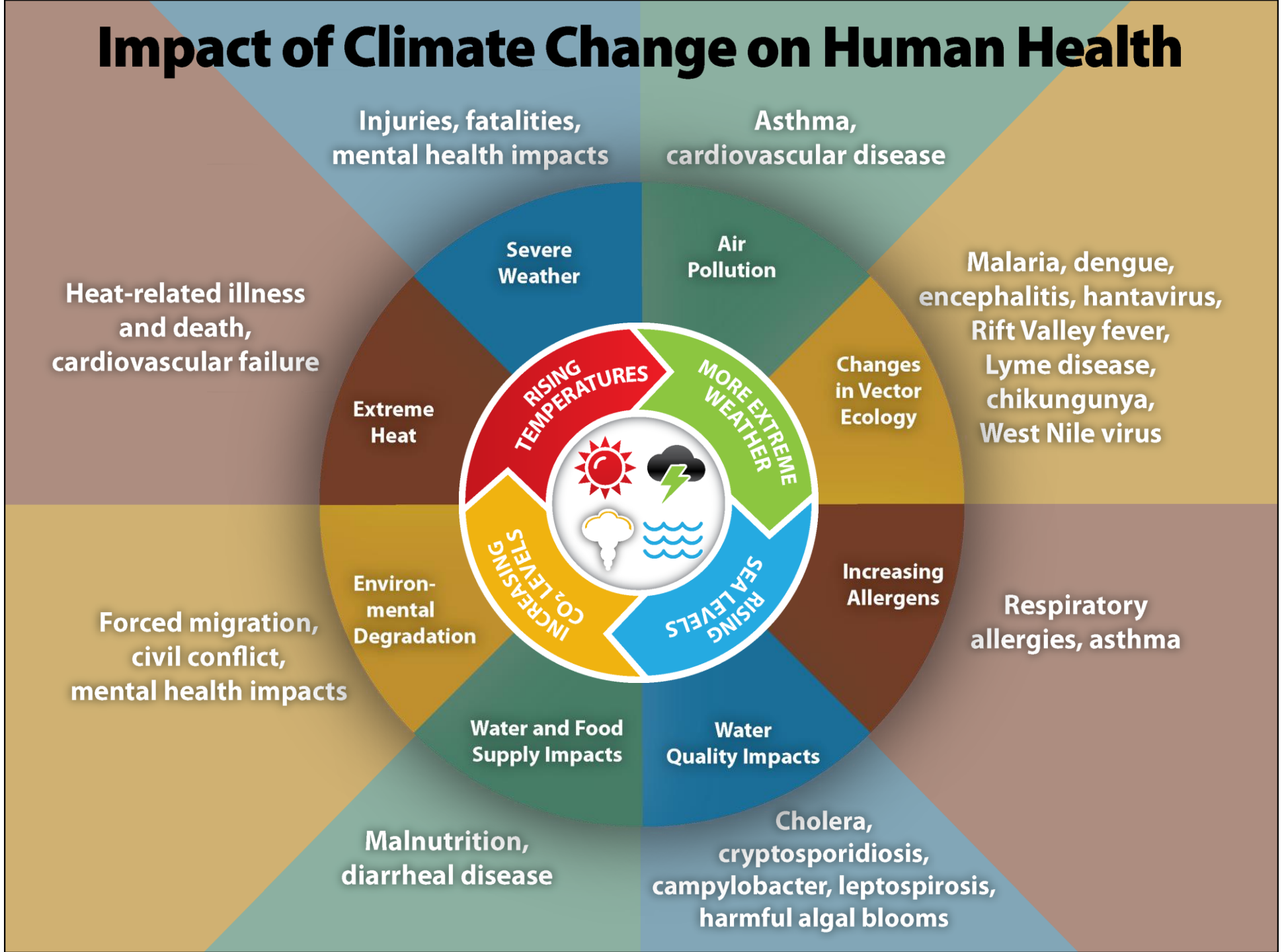
Take Home message

The evidence is everywhere we look.

How does climate change effect global health?


RISING TEMPERATURES
MORE EXTREME WEATHER
RISING SEA LEVELS
INCREASING CO_2 LEVELS

Impact of Climate Change on Human Health



We can already see the impact on health.

- Warmer winters are becoming more frequent and are occurring in more northern areas : Incredible increase in Lyme Disease.

- Periods of excessive heat are more frequent : 7,415 deaths attributed to excessive heat from 1999-2010.

- Extreme precipitation is increasing : 51% of water born diseases occur after extreme precipitation.

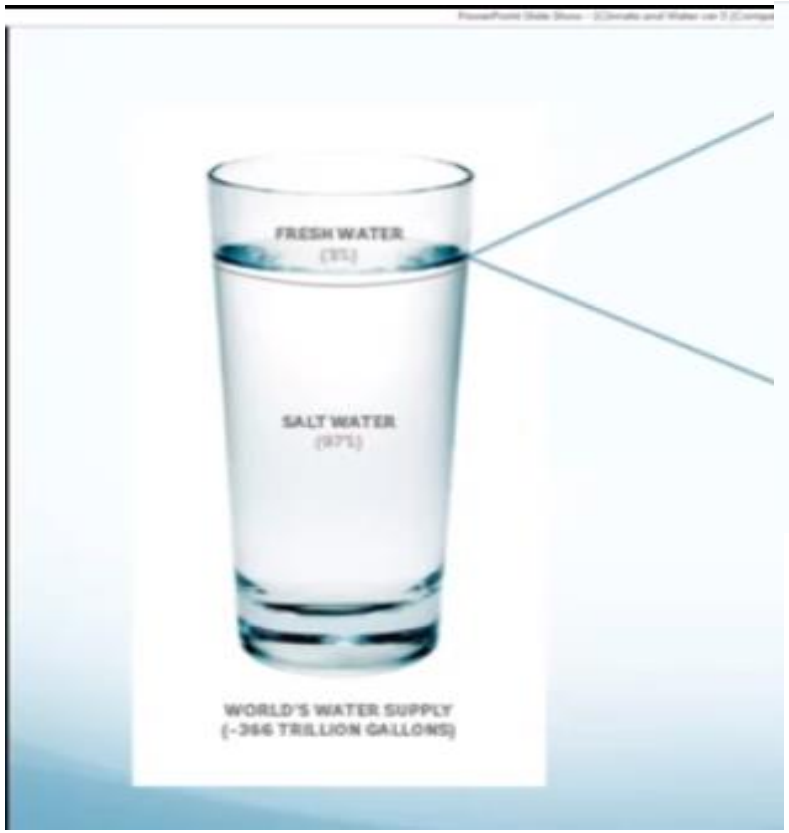
Take Home Message

- Climate Change is a major issue for public health because the changes impact the very quality of life and in extreme situations can result in death.

- For example floods, droughts, extreme temperatures, water quality, food security.

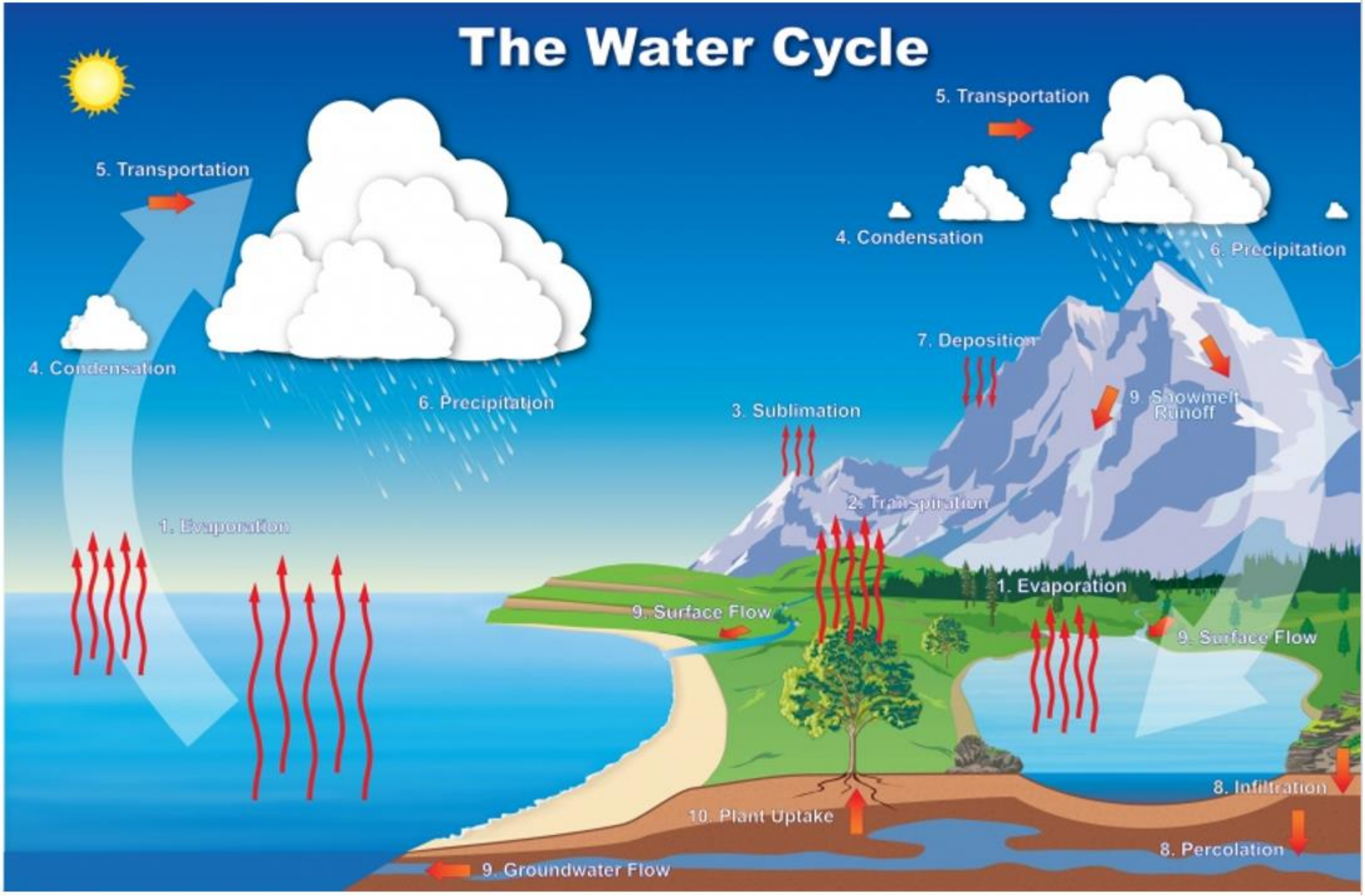
- We may not notice one change on a particular day or season but they add up to a dangerous pattern. That pattern is becoming the new norm.

How will water cycles be impacted by climate change?



Icecaps & glaciers 68.7%
Ground Water 30.1%
Other 0.9%

Surface Water 0.3%
Lakes 87%
Swamps 11%
Rivers 2%


The Water Cycle
5. Transportation
4. Condensation
6. Precipitation
5. Transportation
4. Condensation
6. Precipitation
7. Deposition
9. Snowmelt Runoff
3. Sublimation
2. Transpiration
1. Evaporation
9. Surface Flow
1. Evaporation
9. Surface Flow
8. Infiltration
10. Plant Uptake
8. Percolation
9. Groundwater Flow

Projected Precipitation Change by Season

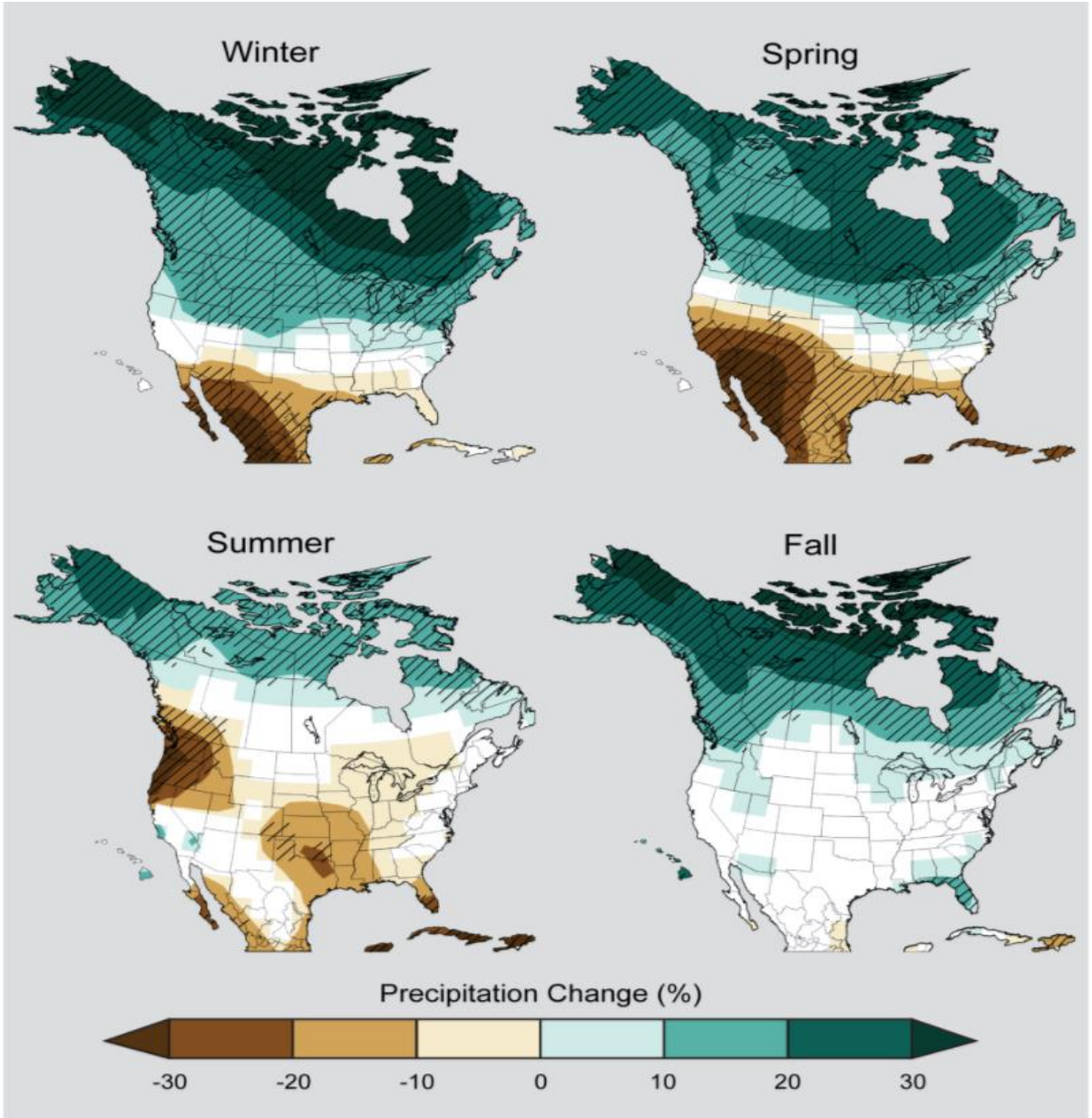
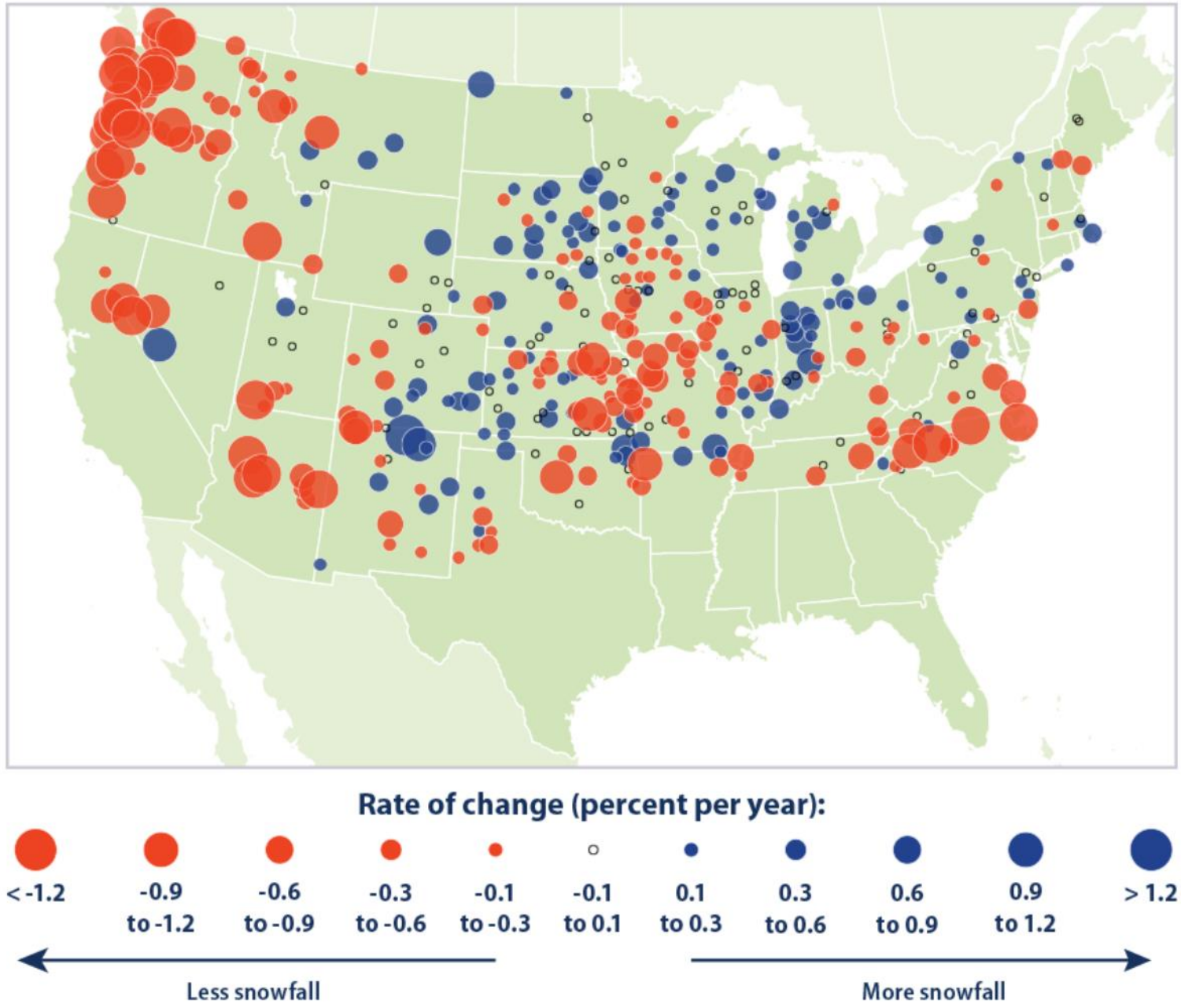


Figure 1. Change in Total Snowfall in the Contiguous 48 States, 1930–2007



Water Quality

Take home message

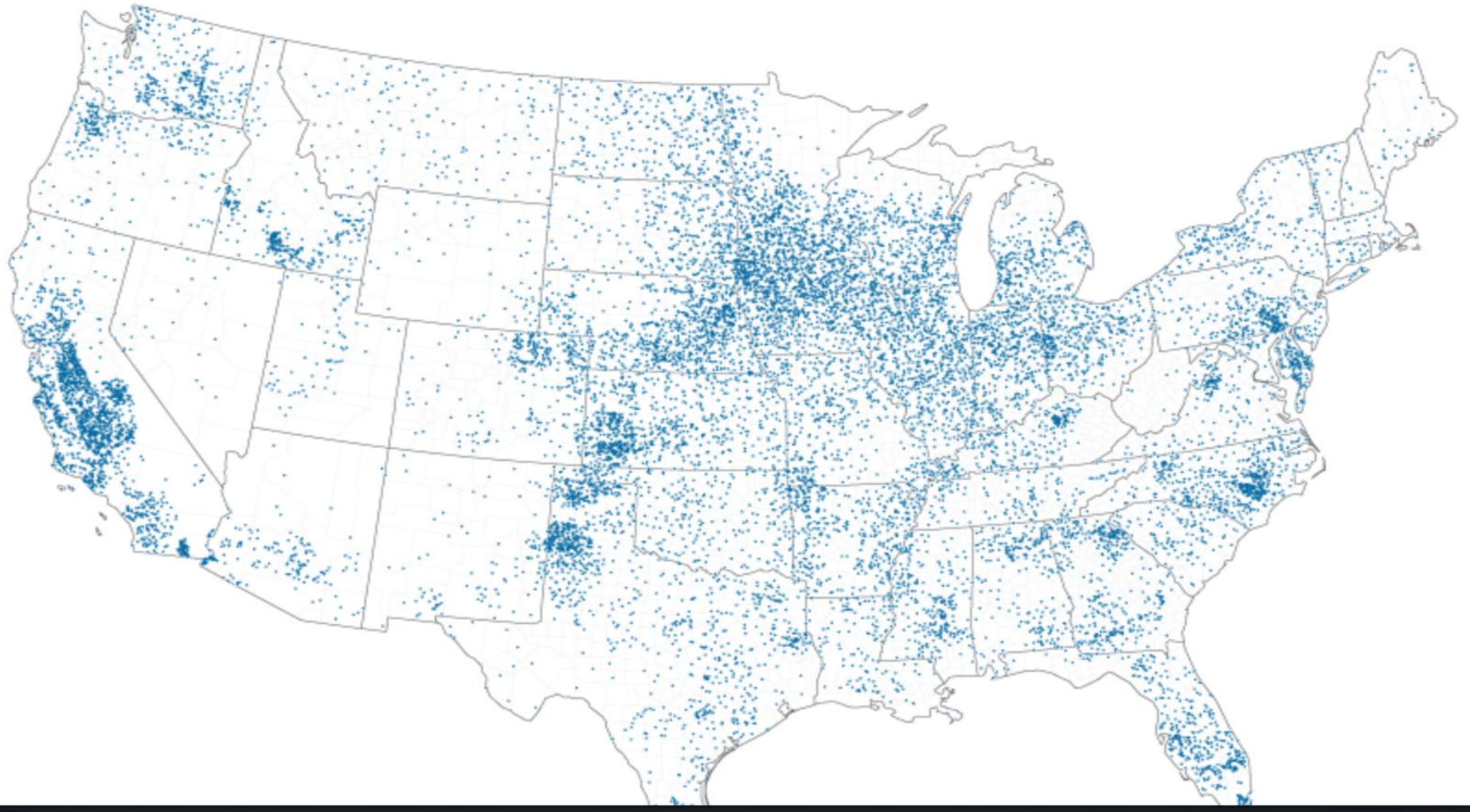
- **Climate change will have wide-ranging impacts on our water resources:**
- Quality of drinking water,
- Agriculture and food security,
- Energy production,
- Recreational activities,
- Infrastructure,
- Forest fires And much more.

How will climate change impact our food supply?

We have a lot to lose from:

Extreme weather
Too much Greenhouse Gas
Floods and droughts
Ocean Acidification
High temperature stress
New pests

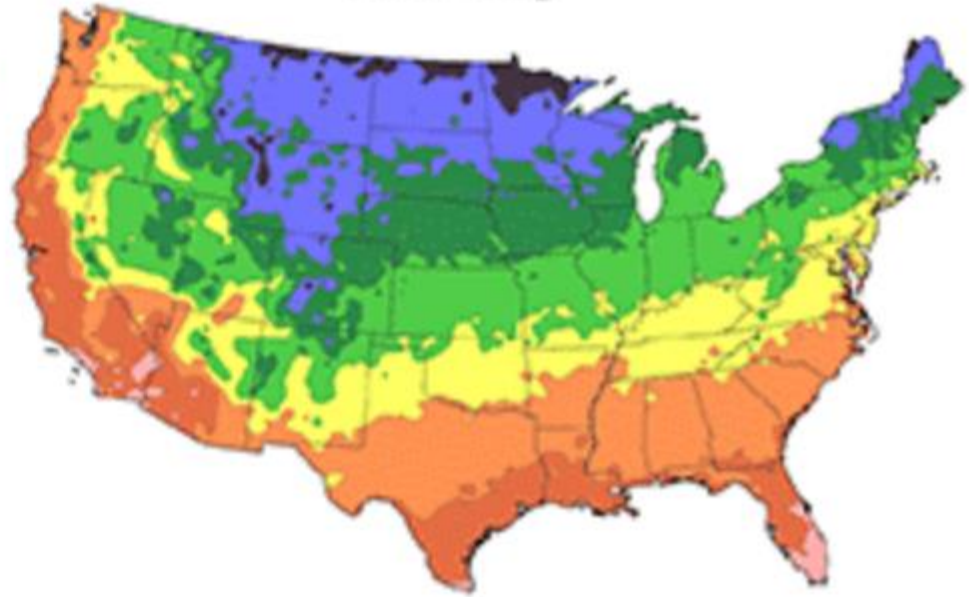
Market Value of Agricultural Products Sold



1990 Map

After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990.

2015 Map



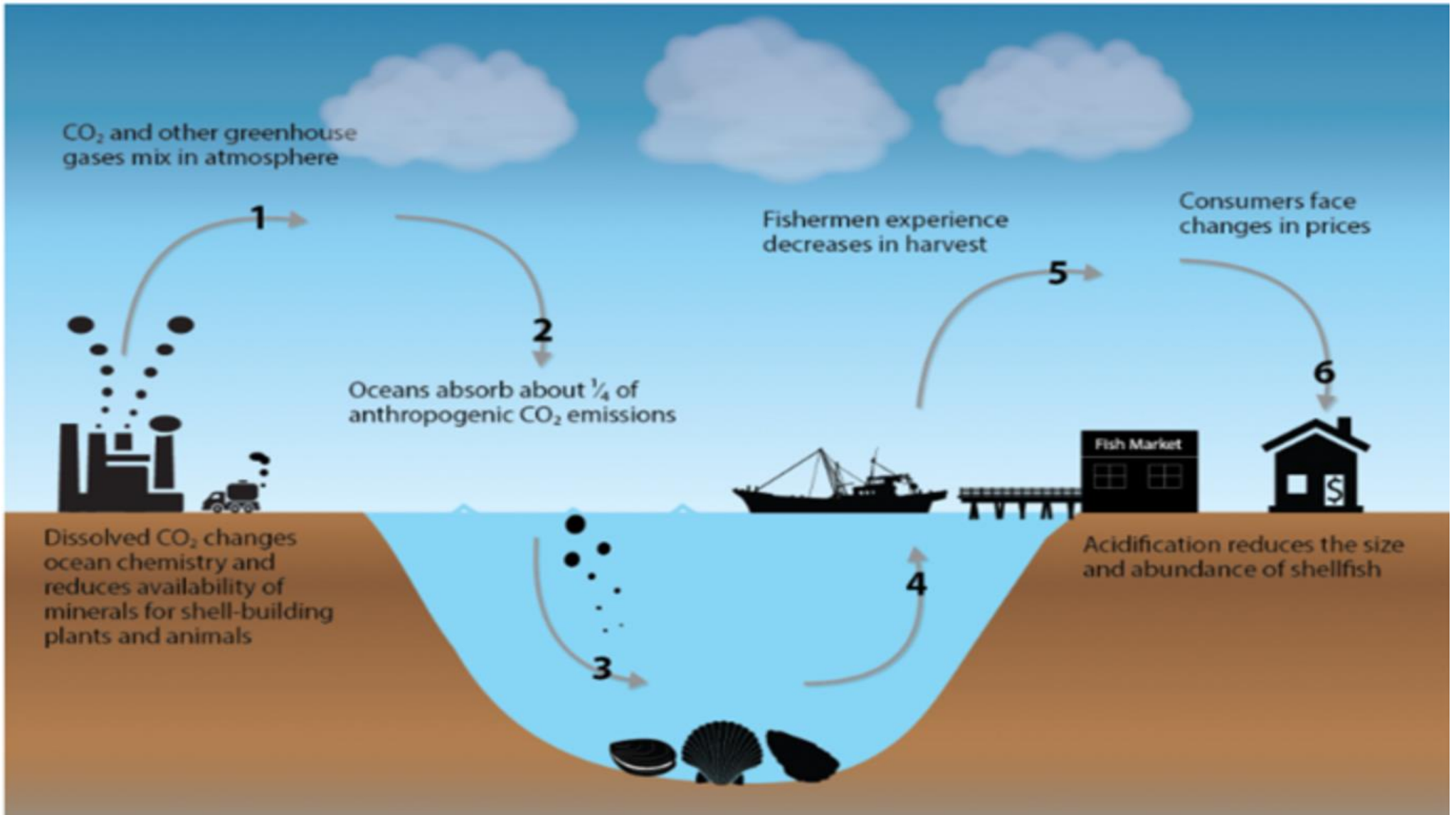
Arbor Day Foundation Plant Hardiness Zone Map published in 2015.

Zone

Farm to Table

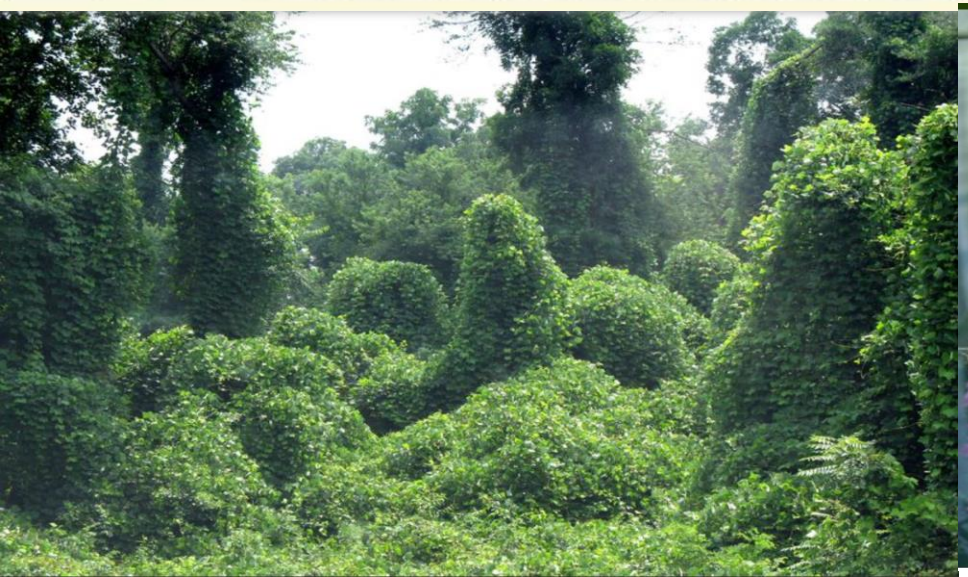
The Potential Interactions of Rising CO_2 and Climate Change on Food Safety and Nutrition

Ocean acidification impacts harvest of shellfish



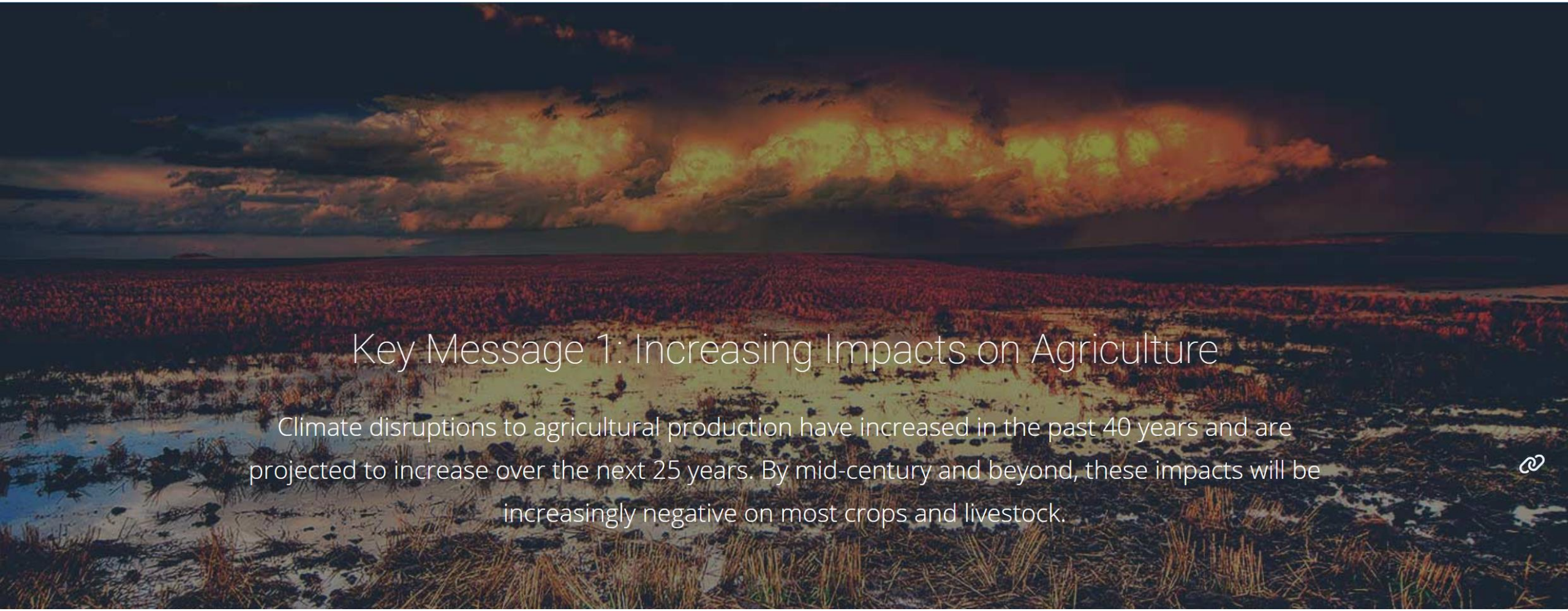
New Pests and Invasives

Asian Longhorned Beetle



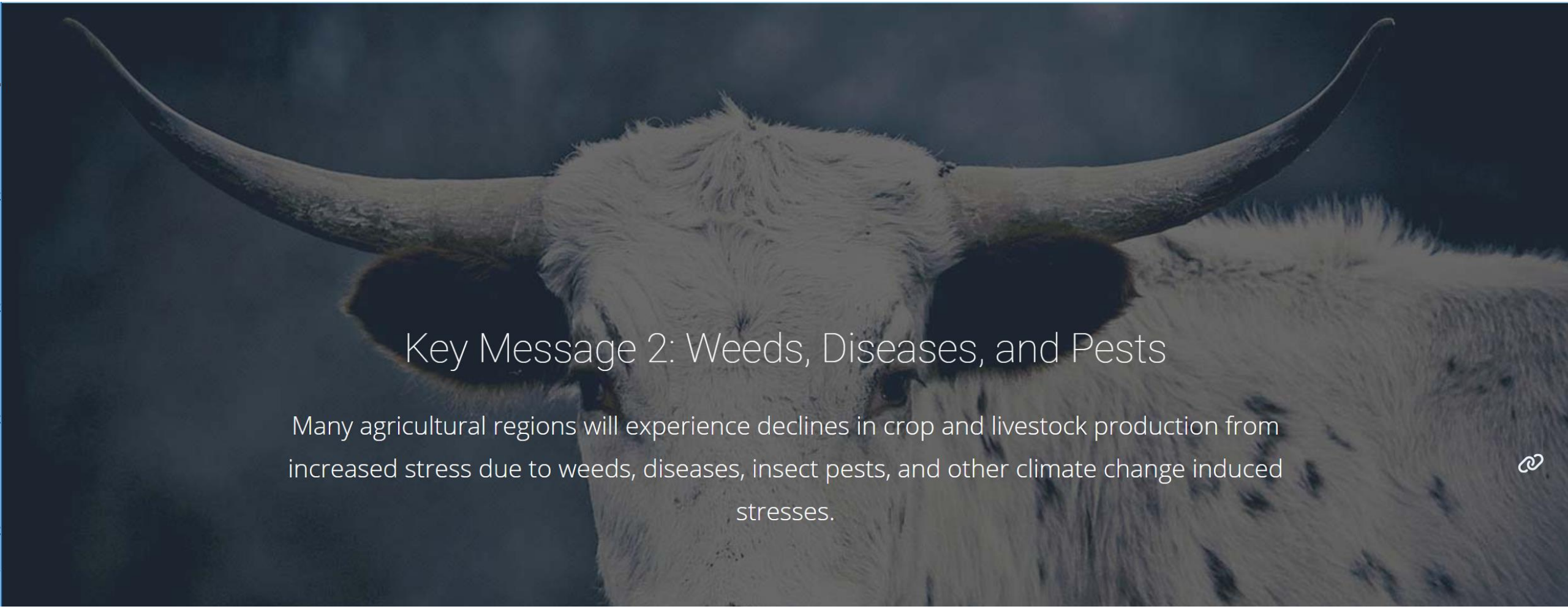
Hemlock Woolly Adelgid

Nun Moth



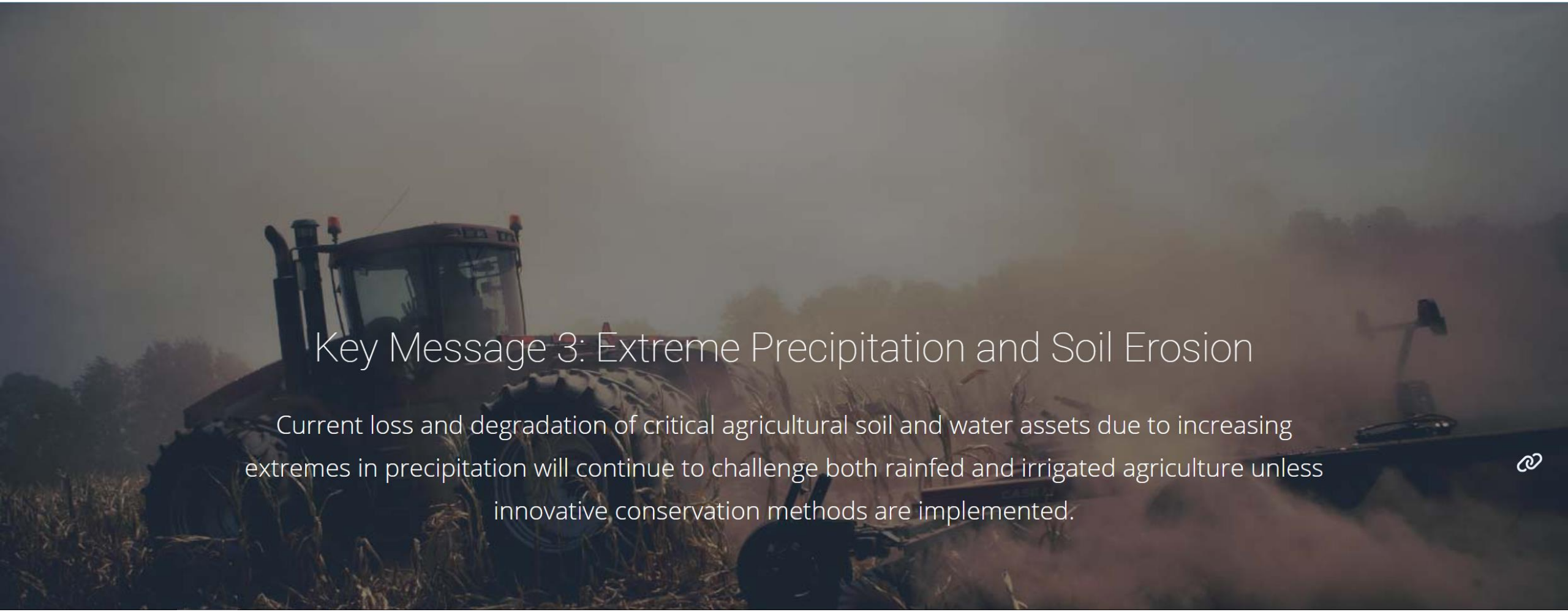
Key Message 1: Increasing Impacts on Agriculture

Climate disruptions to agricultural production have increased in the past 40 years and are projected to increase over the next 25 years. By mid-century and beyond, these impacts will be increasingly negative on most crops and livestock.



Key Message 2: Weeds, Diseases, and Pests

Many agricultural regions will experience declines in crop and livestock production from increased stress due to weeds, diseases, insect pests, and other climate change induced stresses.



Key Message 3: Extreme Precipitation and Soil Erosion

Current loss and degradation of critical agricultural soil and water assets due to increasing extremes in precipitation will continue to challenge both rainfed and irrigated agriculture unless innovative conservation methods are implemented.

Key Message 4: Heat and Drought Damage

The rising incidence of weather extremes will have increasingly negative impacts on crop and livestock productivity because critical thresholds are already being exceeded.

Key Message 5: Rate of Adaptation

Agriculture has been able to adapt to recent changes in climate; however, increased innovation will be needed to ensure the rate of adaptation of agriculture and the associated socioeconomic system can keep pace with climate change over the next 25 years.

Key Message 6: Food Security

Climate change effects on agriculture will have consequences for food security, both in the U.S. and globally, through changes in crop yields and food prices and effects on food processing, storage, transportation, and retailing. Adaptation measures can help delay and reduce some of these impacts.

Questions and Discussion

Key references

- *IPCC Third Assessment Report: The Scientific Basis* (WG1, 2001).

NRC Reports:

- *Climate Change Science: An Analysis of Some Key Questions (2001).*
- *Global Environmental Change: Research Pathways for the Next Decade (1999).*
- *U.S. Climate Modeling Reports (1998, 2001).*
- *Abrupt Climate Change: Inevitable Surprises (2002)*
- *The Atmospheric Sciences: Entering the Twenty-First Century (1998).*
- *Making Climate Forecasts Matter (1999).*
- *A Climate Services Vision (2001).*
- Other planning documents, e.g., *CLIVAR Science Plan.*