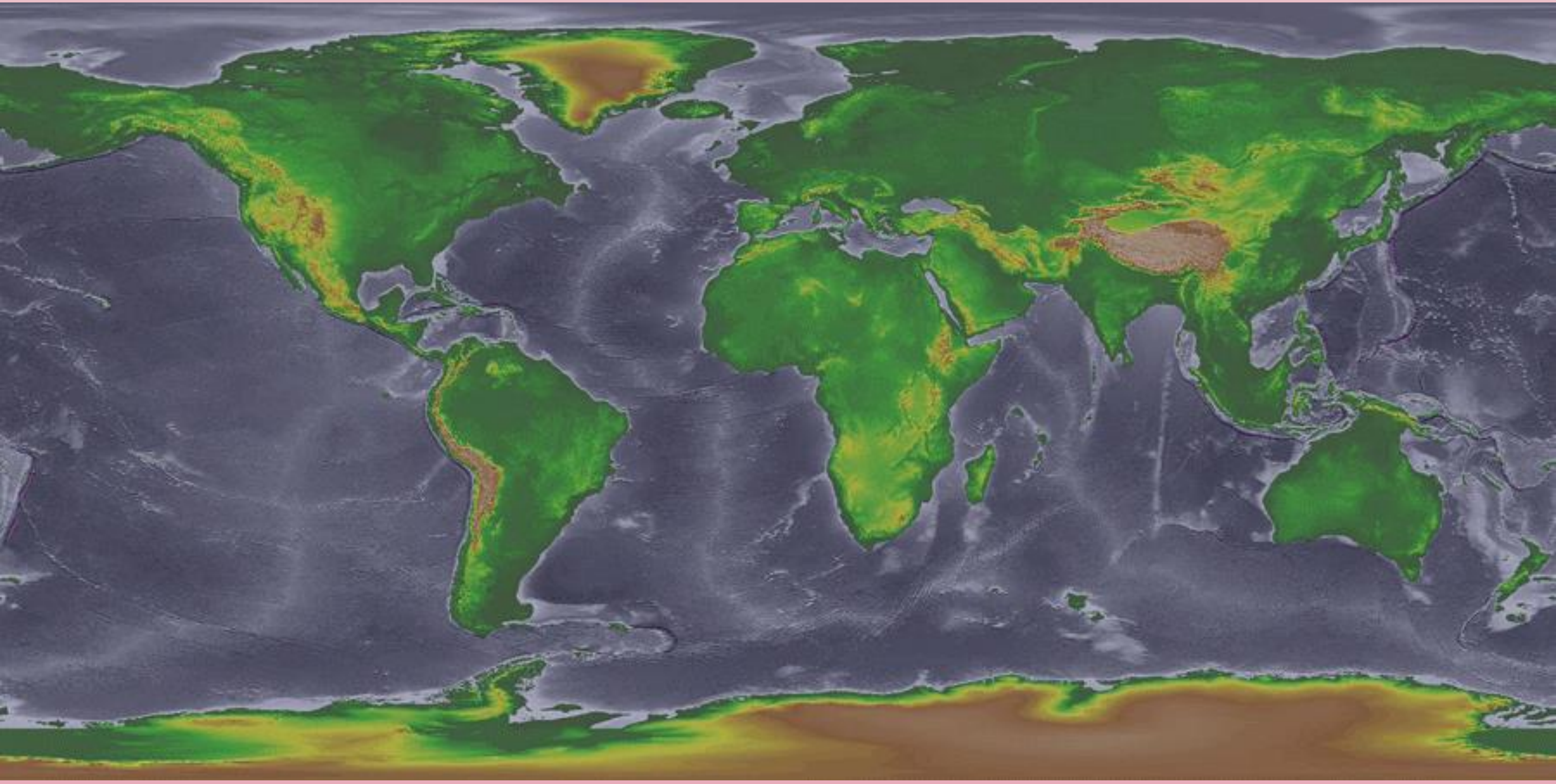
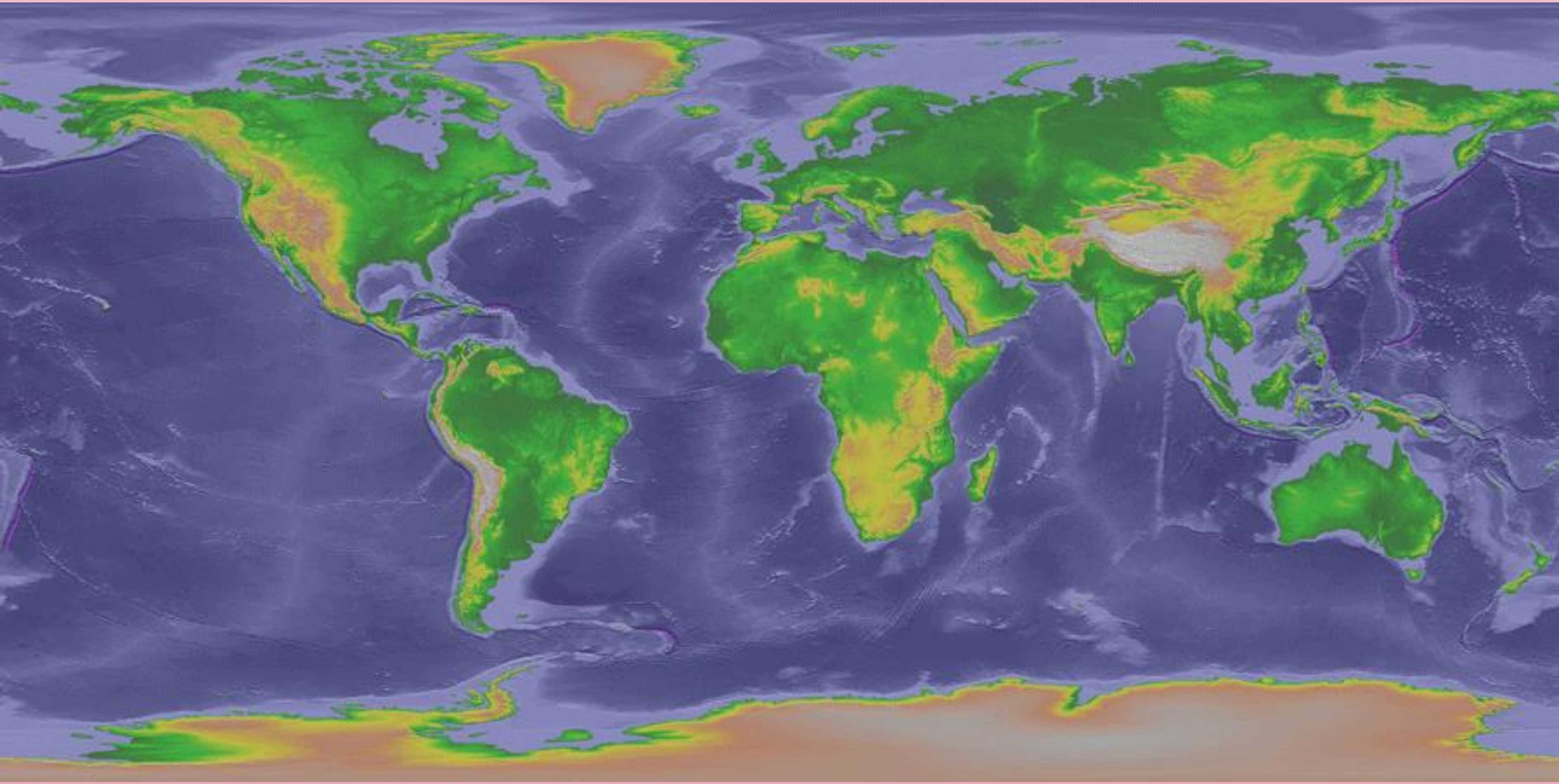


What do you see….



What do you see now….

Less land?!?!?

Chapter 19
Global Change

Global Change

- **Global change-** any chemical, biological or physical property change of the planet.

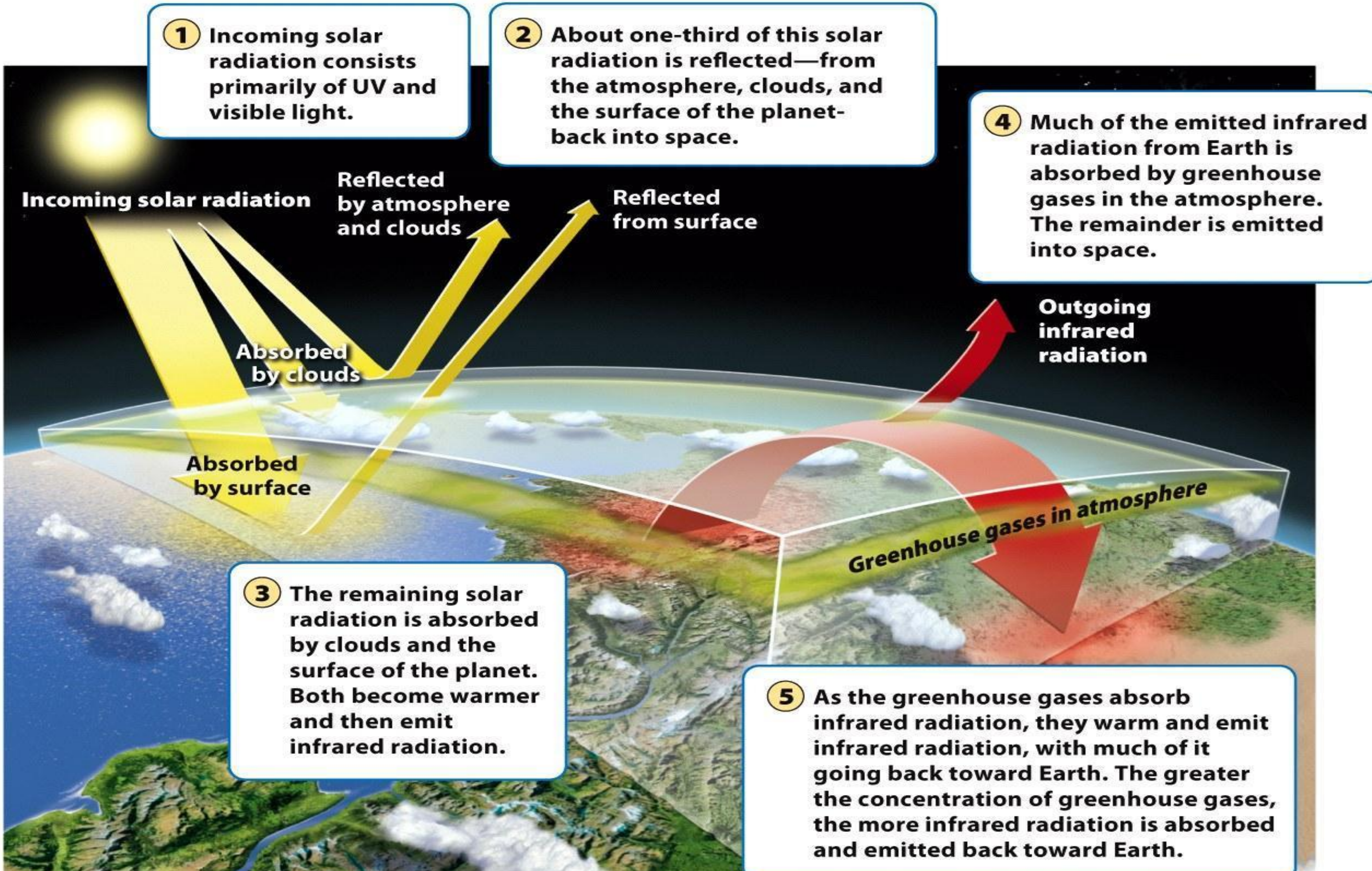
Examples: include cold temperatures causing ice ages.

- **Global climate change-** changes in the climate of the Earth.
- **Global warming-** one aspect of climate change, the warming of the oceans, land masses and atmosphere of the Earth.

The Greenhouse Effect

- When radiation from the sun hits the atmosphere, 1/3 is reflected back.
- Some of the UV radiation is absorbed by the ozone layer and strikes the Earth where it is converted into low-energy infrared radiation.
- The infrared radiation then goes back toward the atmosphere where it is absorbed by greenhouse gasses that radiate most of it back to the Earth.

- Greatest contributor is Carbon Dioxide



On average, Earth is about 60*F, w/o atmosphere it would be 0*F

About 30% of solar energy is reflected back into space, 70% absorbs by Earth

(Earth's oceans and land masses eventually radiate heat back out in the form of infrared radiation).

Greenhouse Gases

-Water vapor

-Carbon dioxide

-Nitrous oxide

-Methane

-Chlorofluorocarbons (CFC's)

ex. aerosols (ozone depleters, tried to be banned by Montreal Protocol, highest warming potential to carbon dioxide

TABLE 19.1 The major greenhouse gases

The major greenhouse gases differ in their ability to absorb infrared radiation and the duration of time that they stay in the atmosphere. The units "ppm" are parts per million.

Greenhouse gas	Concentration in 2010	Global warming potential (over 100 years)	Duration in the atmosphere
Water vapor	Variable with temperature	<1	9 days
Carbon dioxide	390 ppm	1	Highly variable (ranging from years to hundreds of years)
Methane	1.8 ppm	25	12 years
Nitrous oxide	0.3 ppm	300	114 years
Chlorofluorocarbons	0.9 ppm	1,600 to 13,000	55 to >500 years

Source: Data on concentration are from the National Oceanic and Atmospheric Administration. www.esrl.noaa.gov/gmd/aggi. Data on global warming potential are from the United Nations Framework Convention on Climate Change.

Table 19.1
Environmental Science

Natural Greenhouse Gases

- **Volcanic eruptions-** mainly carbon dioxide; *causes a cooling of Earth*
- **Methane** – from decomposition
- **Nitrous oxide-** from denitrification
- **Water vapor** – heating of water cycle *(greenhouse gas most responsible for trapping the most outgoing infrared radiation)*

- *W/o human activities, greenhouse warming is detrimental to sea life due to the warming and changing of pH levels*

Anthropogenic Causes of Greenhouse Gases

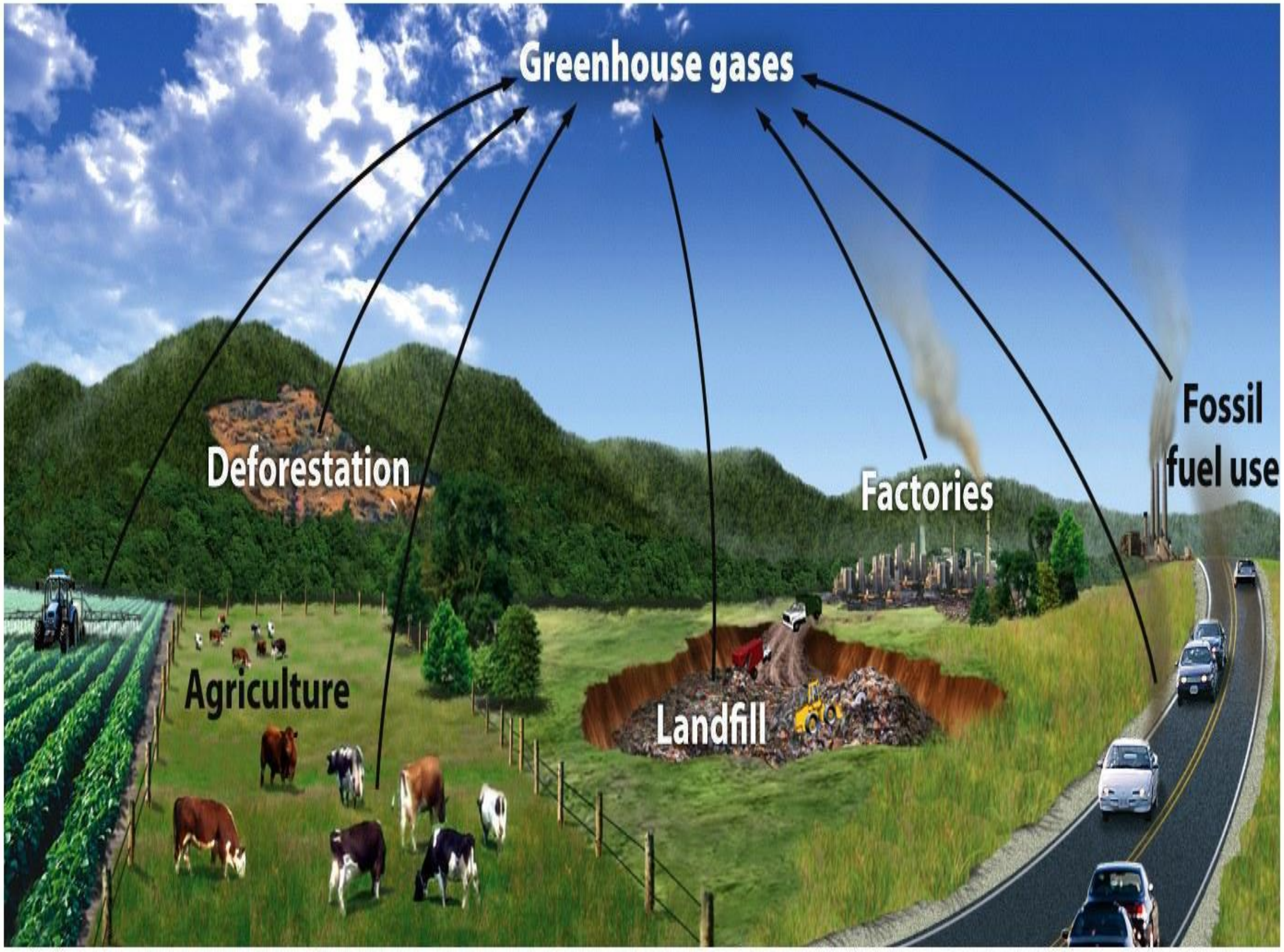
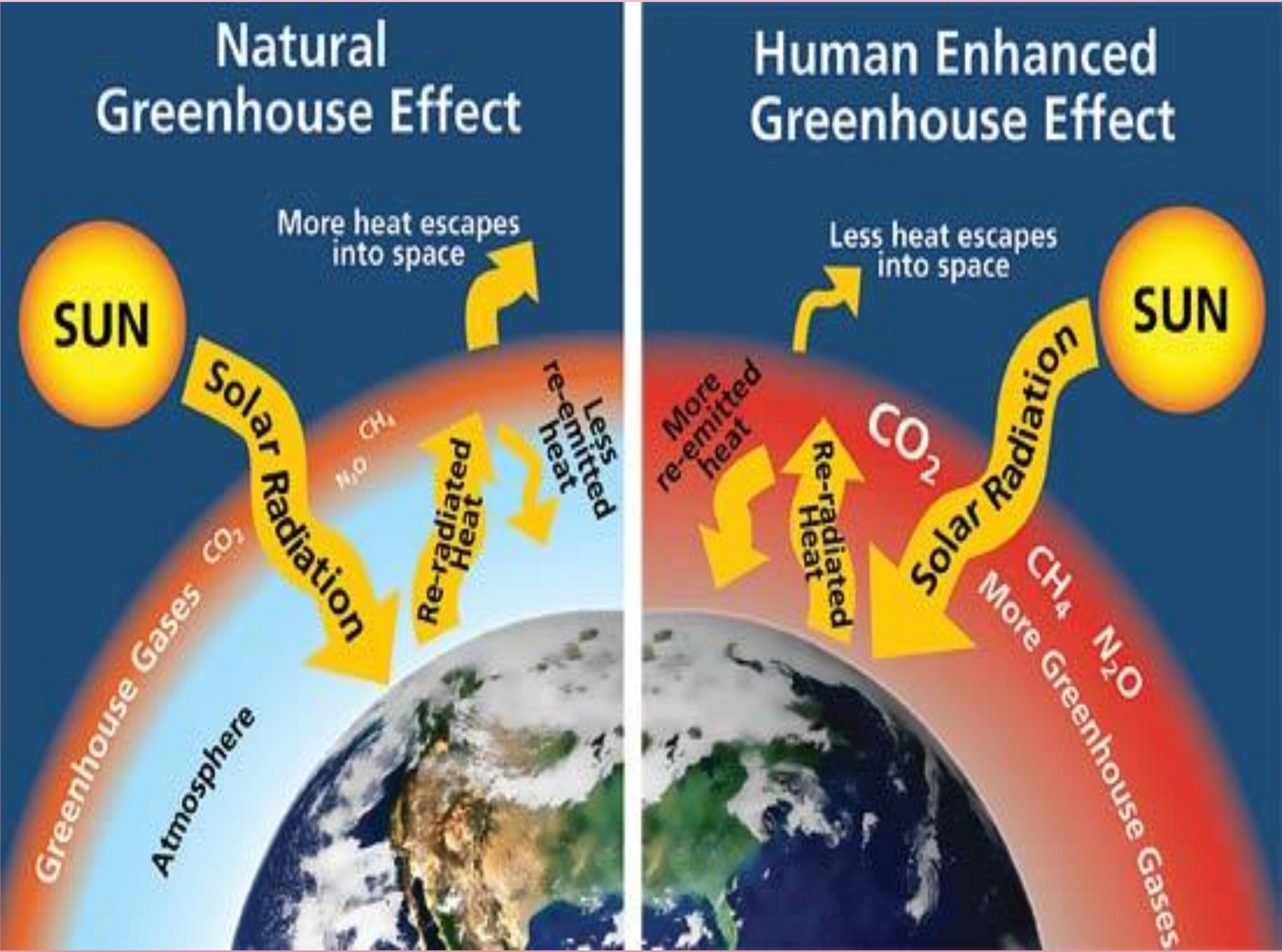


Figure 19.5
Environmental Science

- Burning of fossil fuels
- Agricultural practices
-Deforestation
- Landfills
- Industrial production- (CFC's are an example)


Natural
Greenhouse Effect
More heat escapes
into space
SUN
Solar Radiation
Re-radiated Heat
Less re-emitted heat
CH_4
N_2O
CO_2
Greenhouse Gases
Atmosphere
Human Enhanced
Greenhouse Effect
Less heat escapes
into space
SUN
More re-emitted heat
Re-radiated Heat
CO_2
Solar Radiation
CH_4
N_2O
More Greenhouse Gases

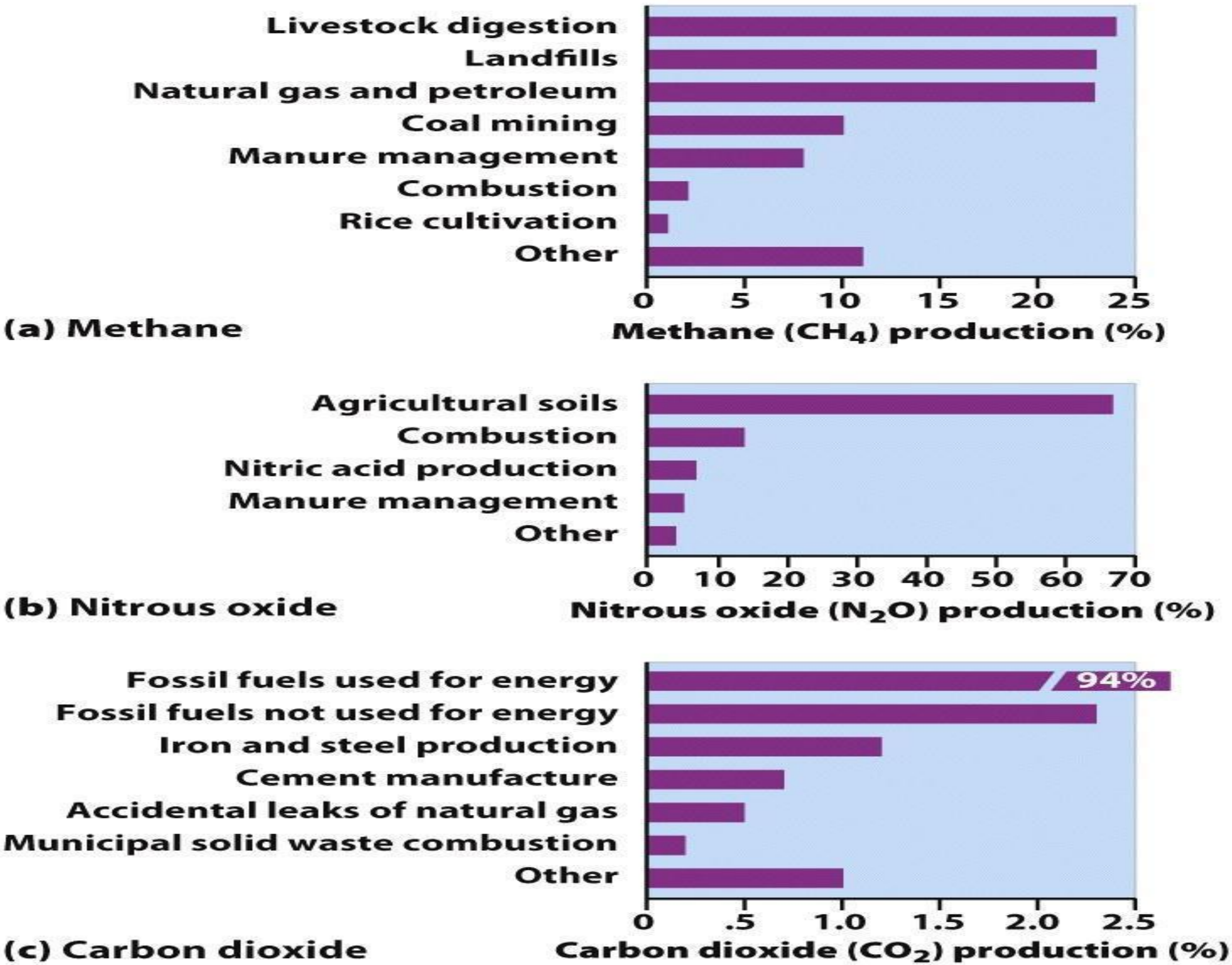


Figure 19.6
Environmental Science

Increasing CO_2 Concentrations

- David Keeling began measuring CO_2 in 1958.

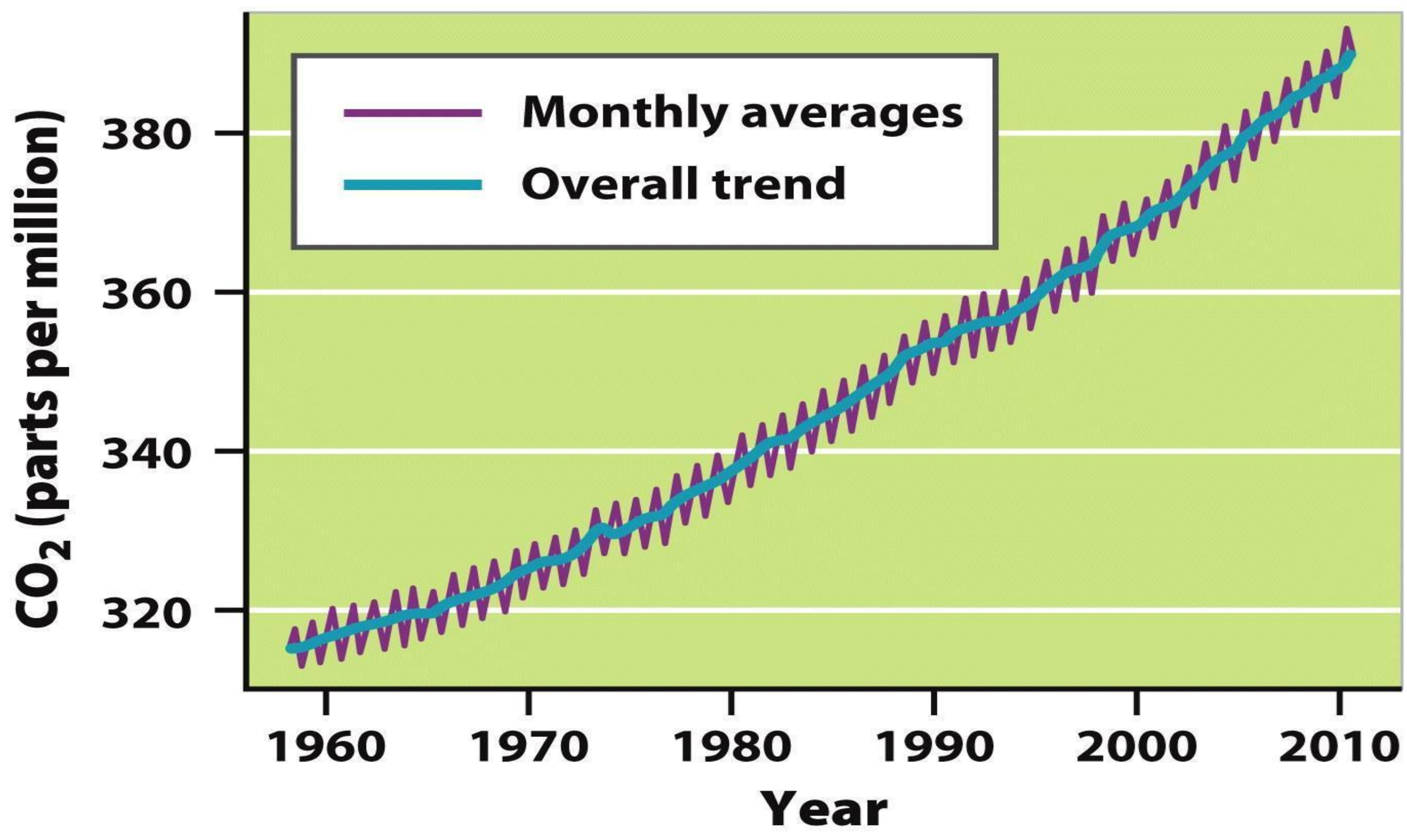
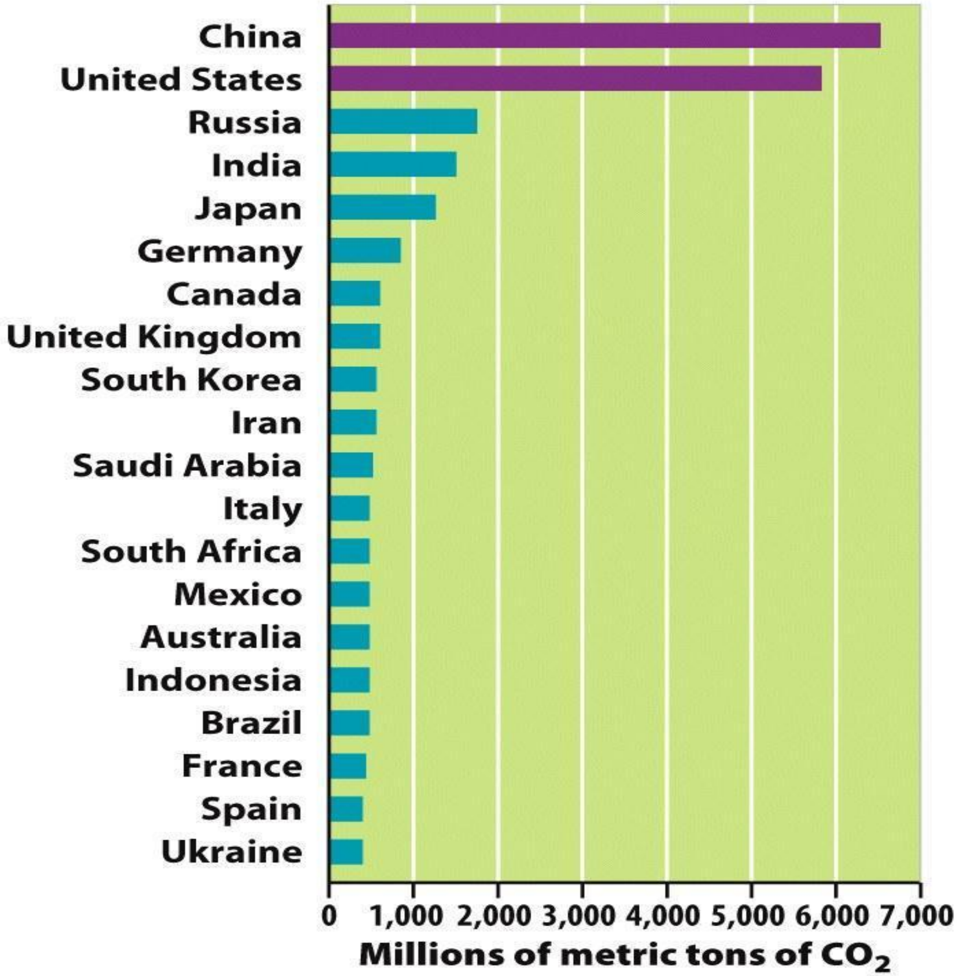


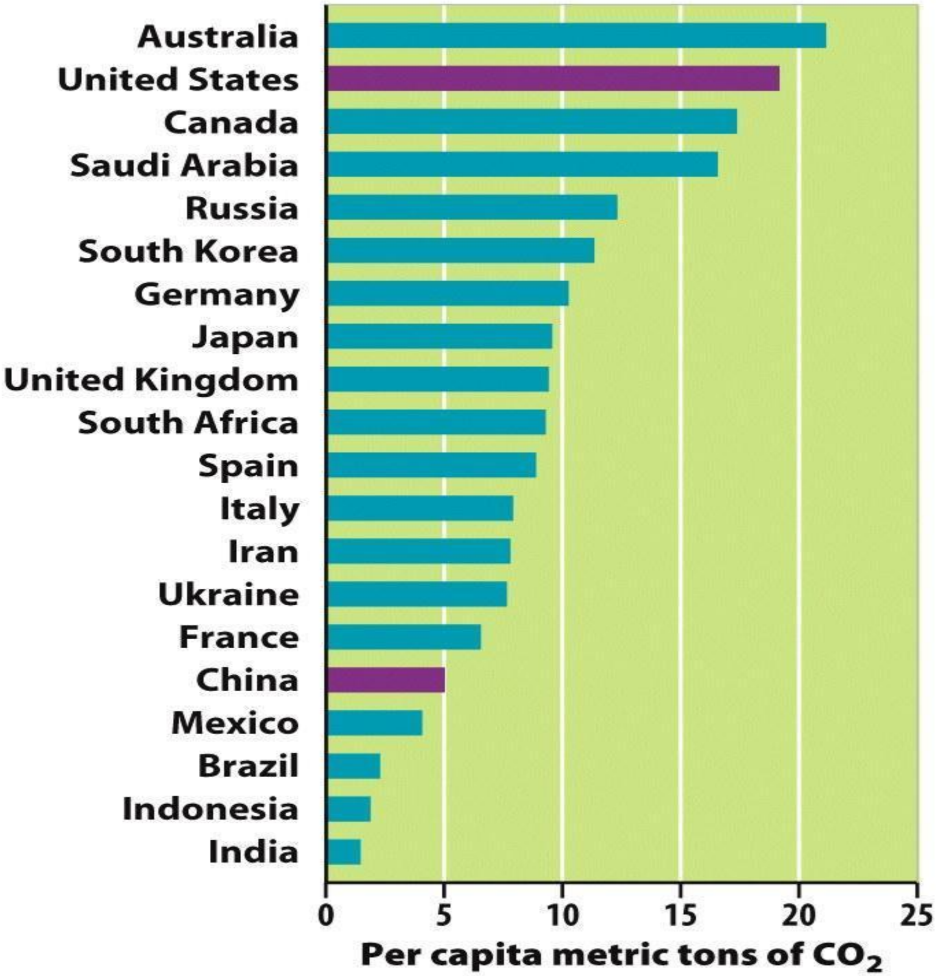
Figure 19.7
Environmental Science

Emissions from the Developed and Developing World

(largest contributors are developed and rapidly developing) nations



Total amt of carbon dioxide produced by a country

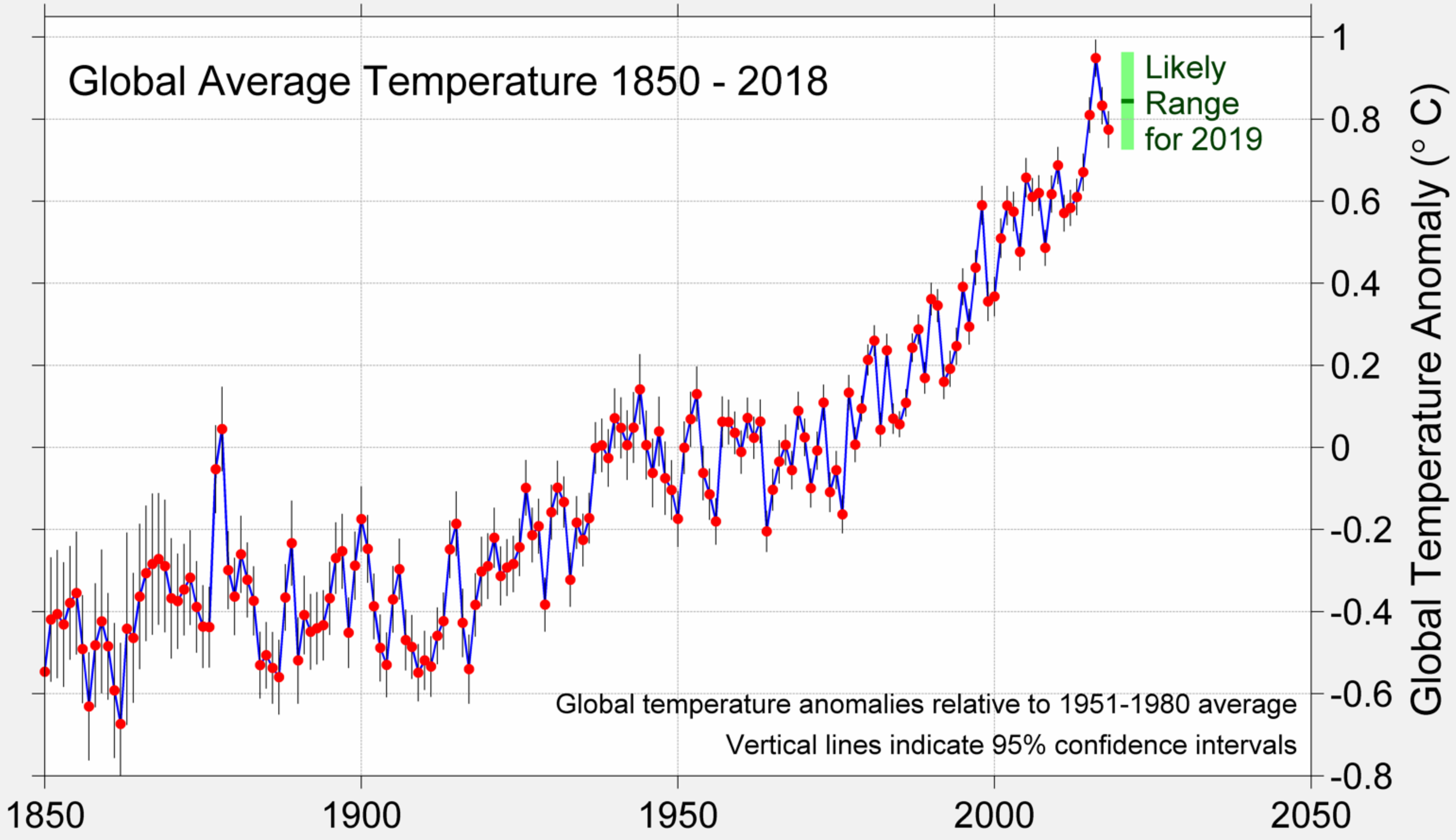


(Per individual use vs. total population)

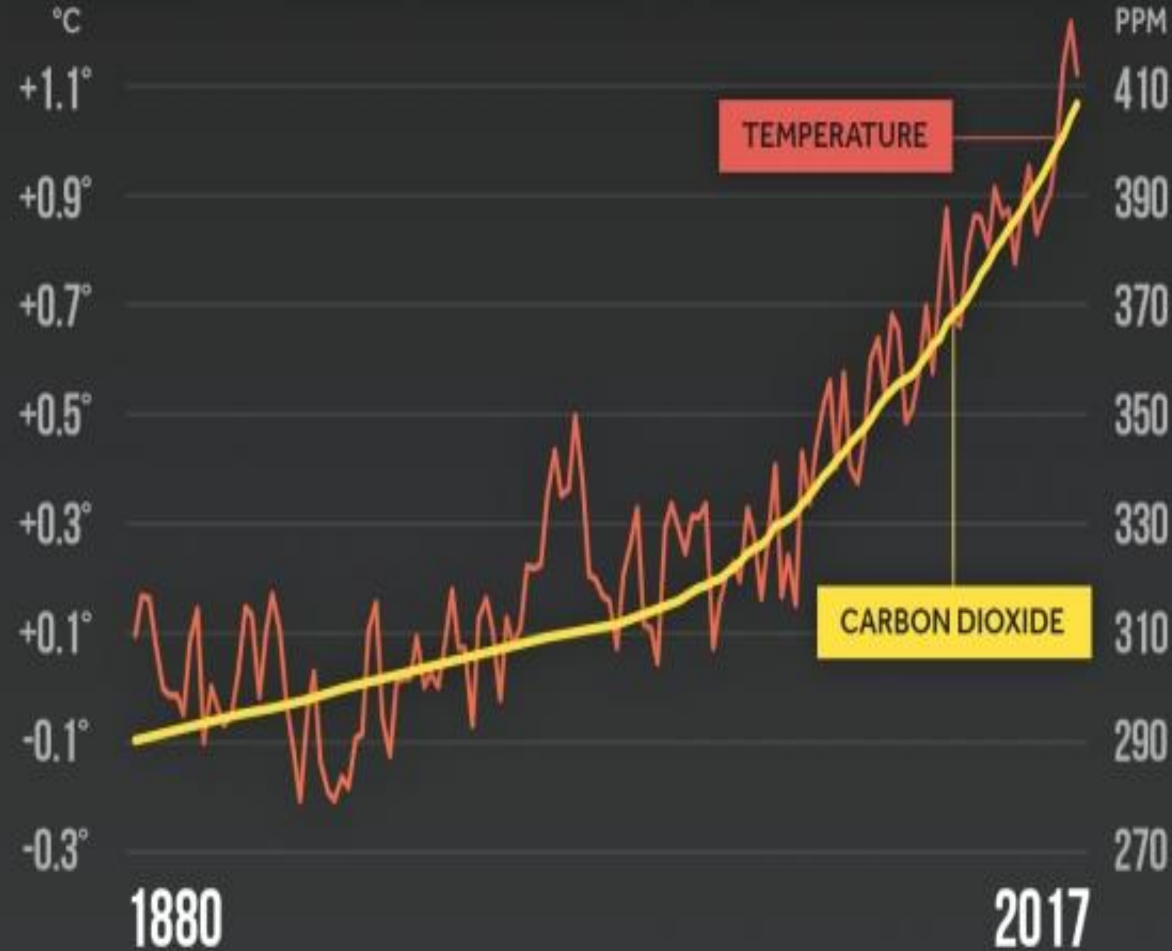
Figure 19.8
Environmental Science

Global Temperatures since 1850

- Since 1880 temperatures have increased 0.8°C (1.4*F).



GLOBAL TEMPERATURE & CARBON DIOXIDE



Global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910)
Source: NASA GISS, NOAA NCEI, ESRL

CLIMATE CENTRAL

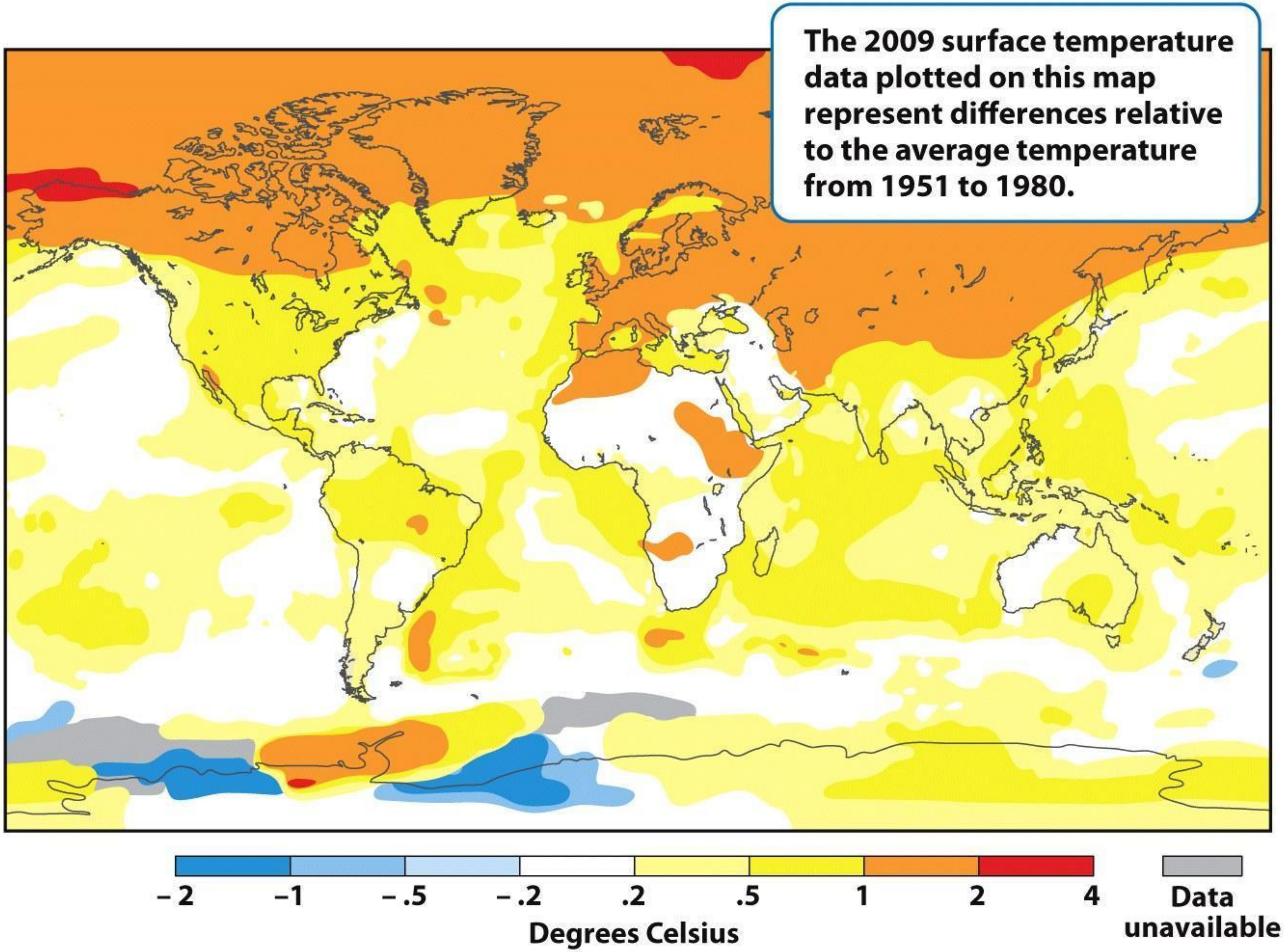


Figure 19.10
Environmental Science

Temperatures and Greenhouse Gas Concentrations in Past 400,000 Years

- No one was around thousands of years ago to measure temperatures so we use other indirect measurements. Some of these are
  - **Changes in species compositions** (preserved over millions of years)
  - **Chemical analyses of ice** (formation of *ice cores* based on air bubbles that trap greenhouse gases – measure concentration levels)

Figure 19.12a

Figure 19.12b

Historic Carbon Dioxide concentrations

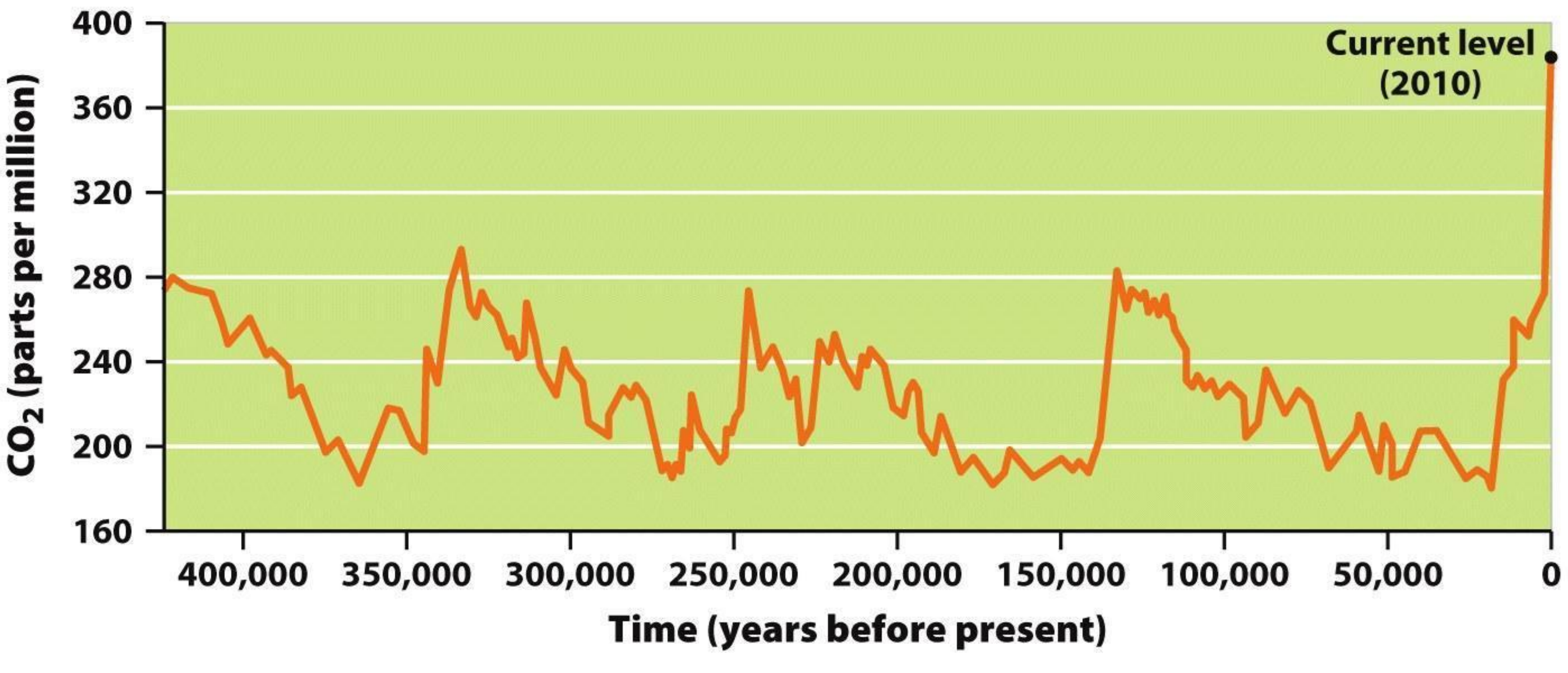
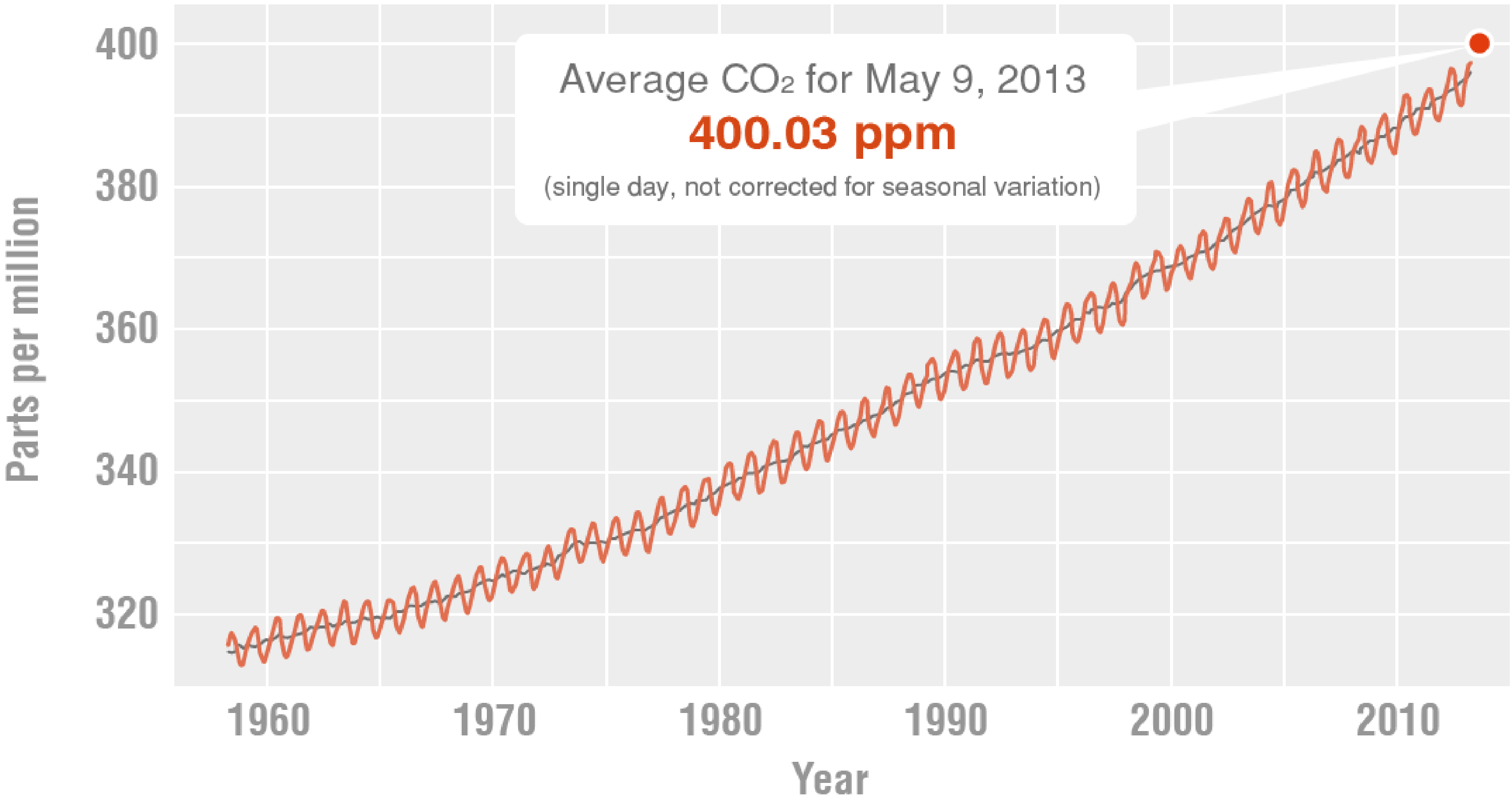


Figure 19.13
Environmental Science

More than 400,000 years of Carbon Dioxide concentrations never exceeded 300ppm. After 1950, concentrations sharply increased to their current level of 390ppm

Carbon Dioxide Concentration



Credit: NOAA/Scripps Institution of Oceanography

Increase use of fossil fuels after the 1950's and still rising

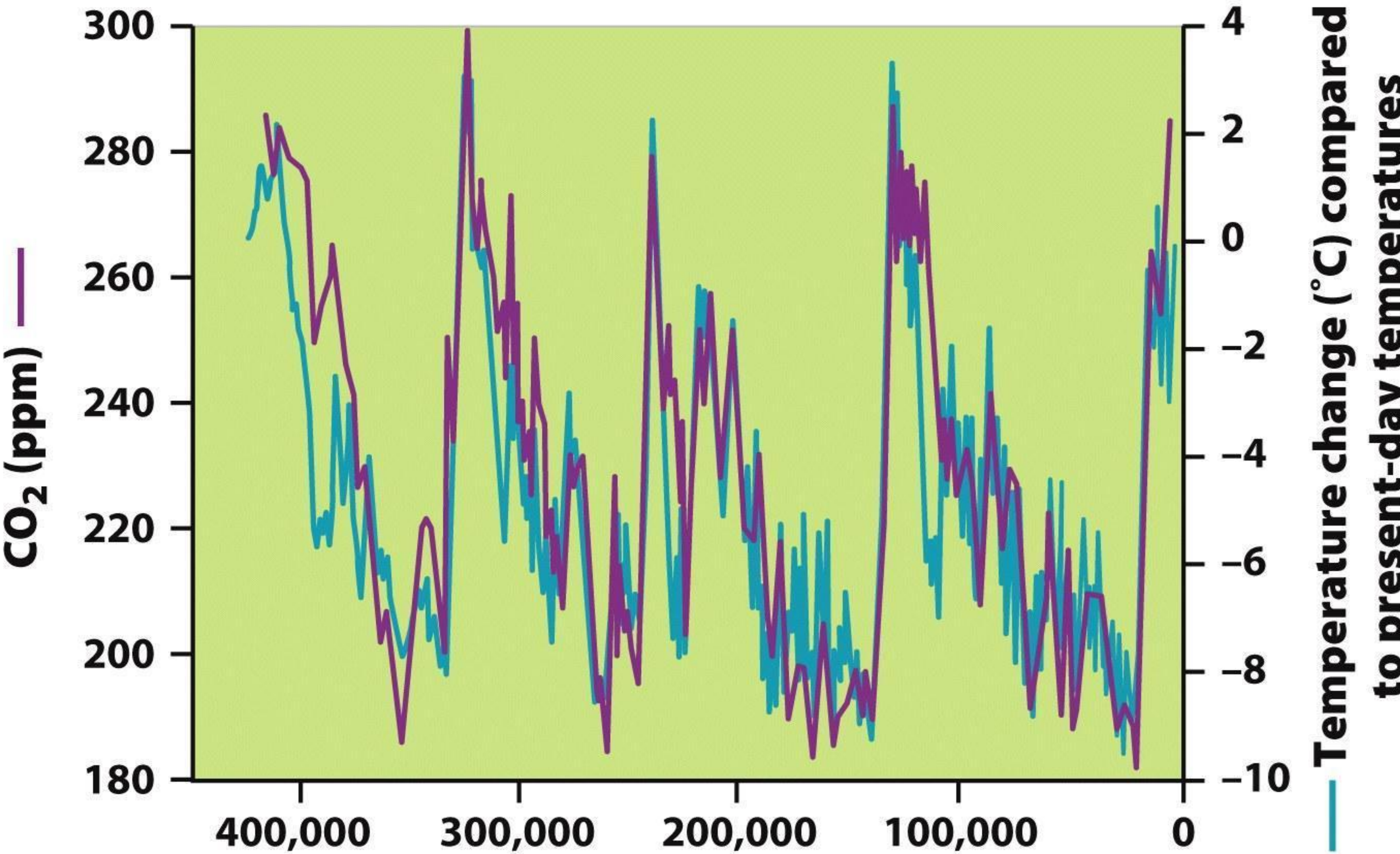


Figure 19.15
Environmental Science

Predications of increase in global temps by 2100

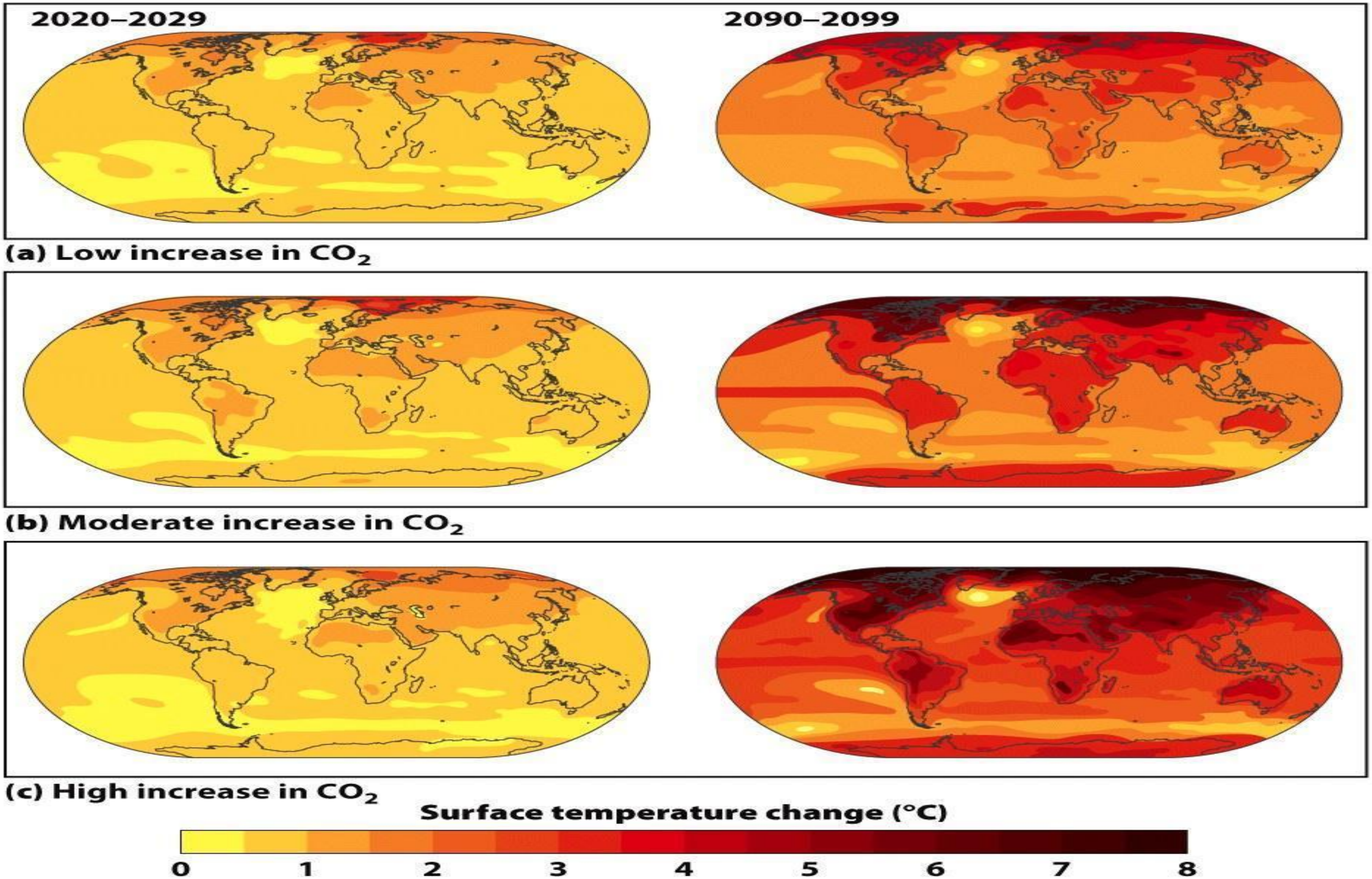
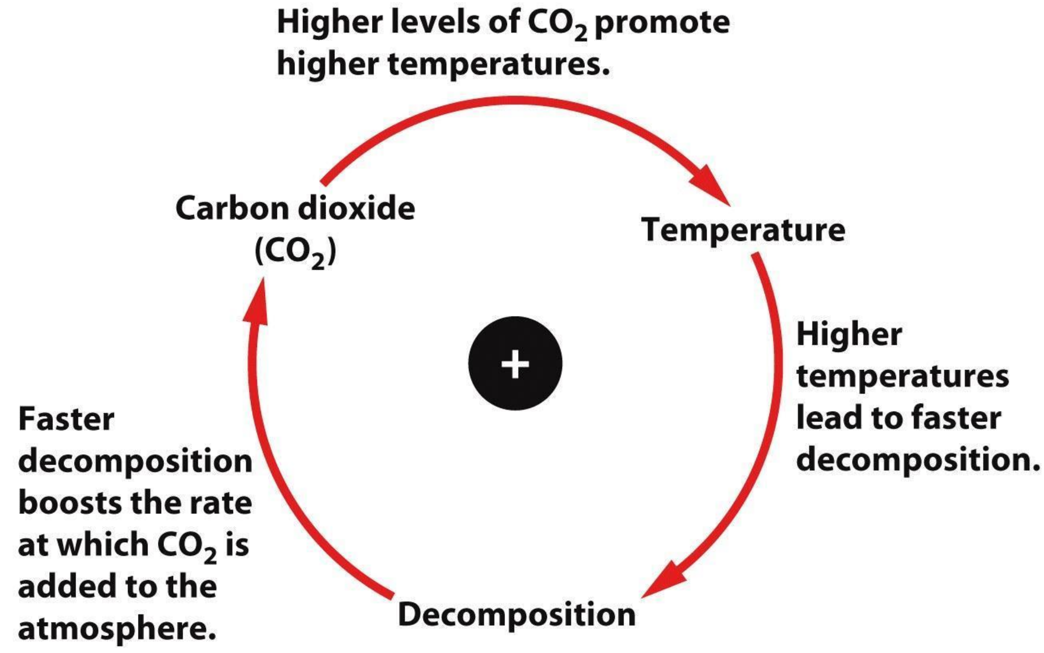


Figure 19.17
Environmental Science

Putting It Together

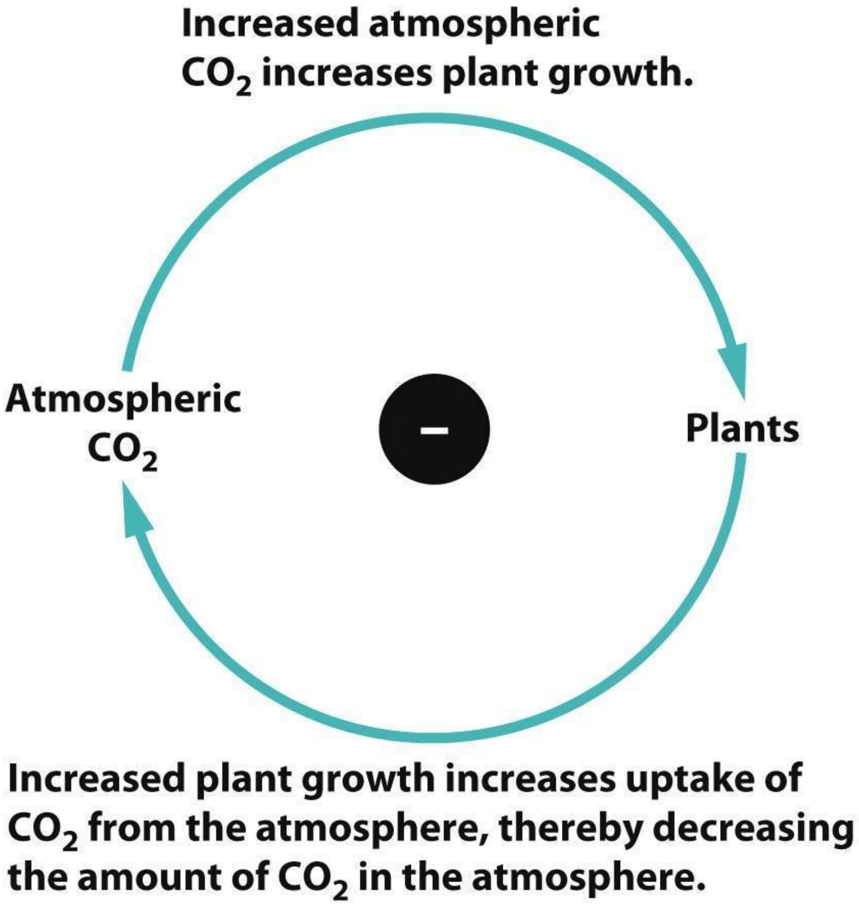
- We know that an increase in CO_2 in the atmosphere causes a greater capacity for warming through the greenhouse effect.
- When the Earth experiences higher temperatures, the oceans warm and cannot contain as much CO_2 gas and, as a result, they release CO_2 into the atmosphere.

Feedbacks



Positive feedback system

Figure 19.18a
Environmental Science



Negative feedback system

Figure 19.18b
Environmental Science

Consequences to the Environment Because of Global Warming

- Melting of polar ice caps, Greenland and Antarctica
- Melting of many glaciers around the world *(could reduce seasonal water drinking supplies)*
- Melting of permafrost
- Rising of sea levels due to the melting of glaciers and ice sheets and as water warms it expands
- Heat waves
- Cold spells
- Change in precipitation patterns
- Increase in storm intensity
- Shift in ocean currents

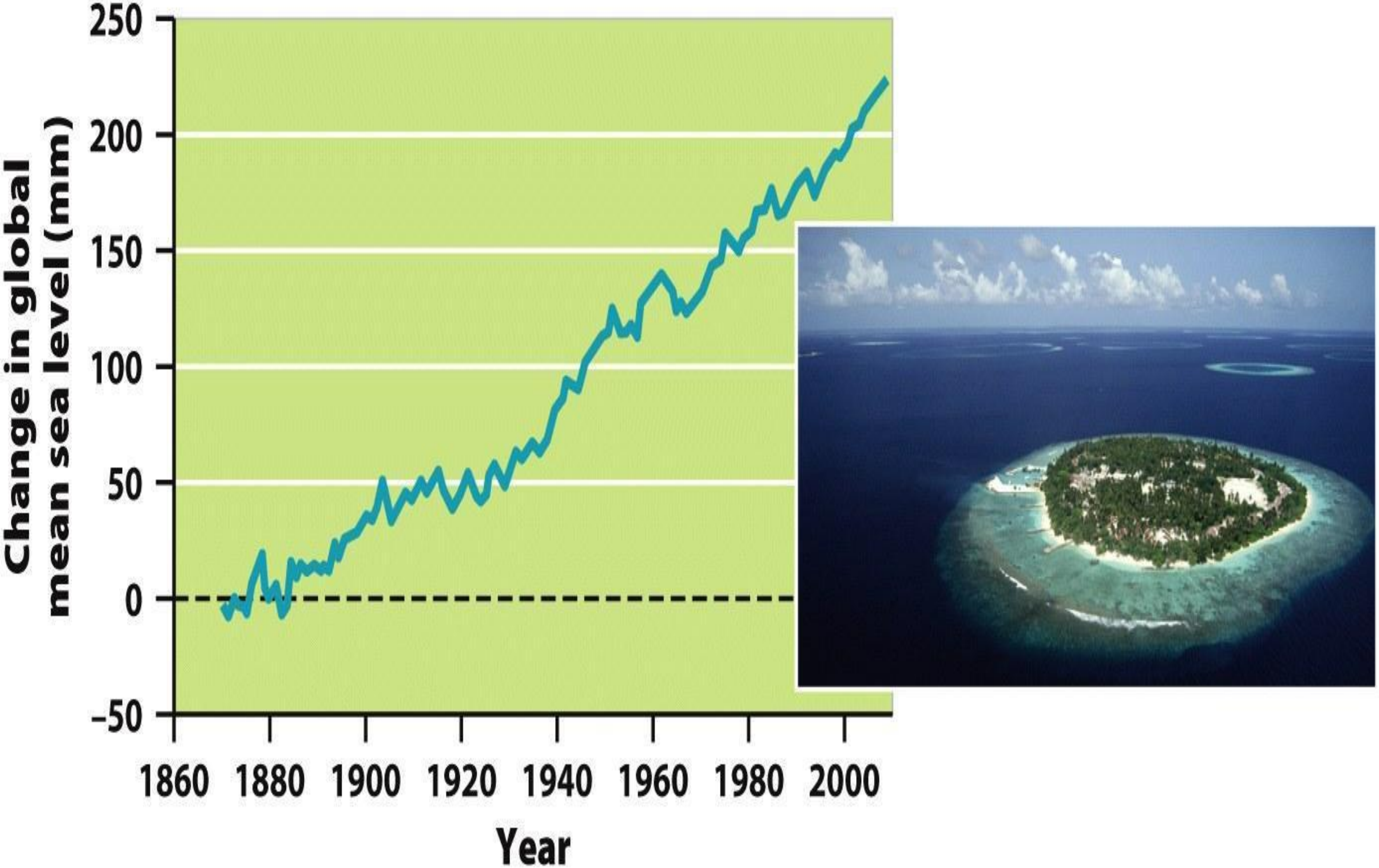
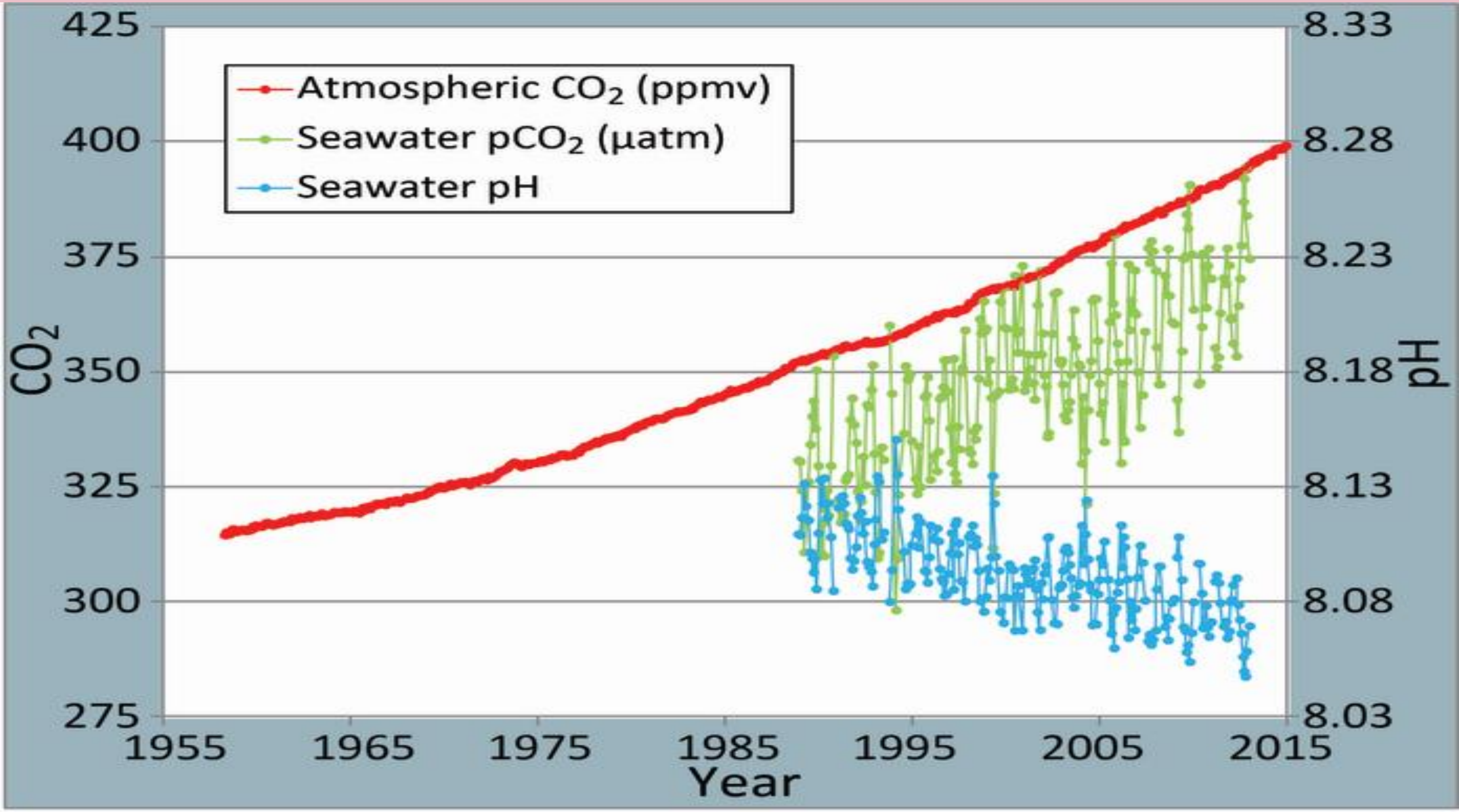


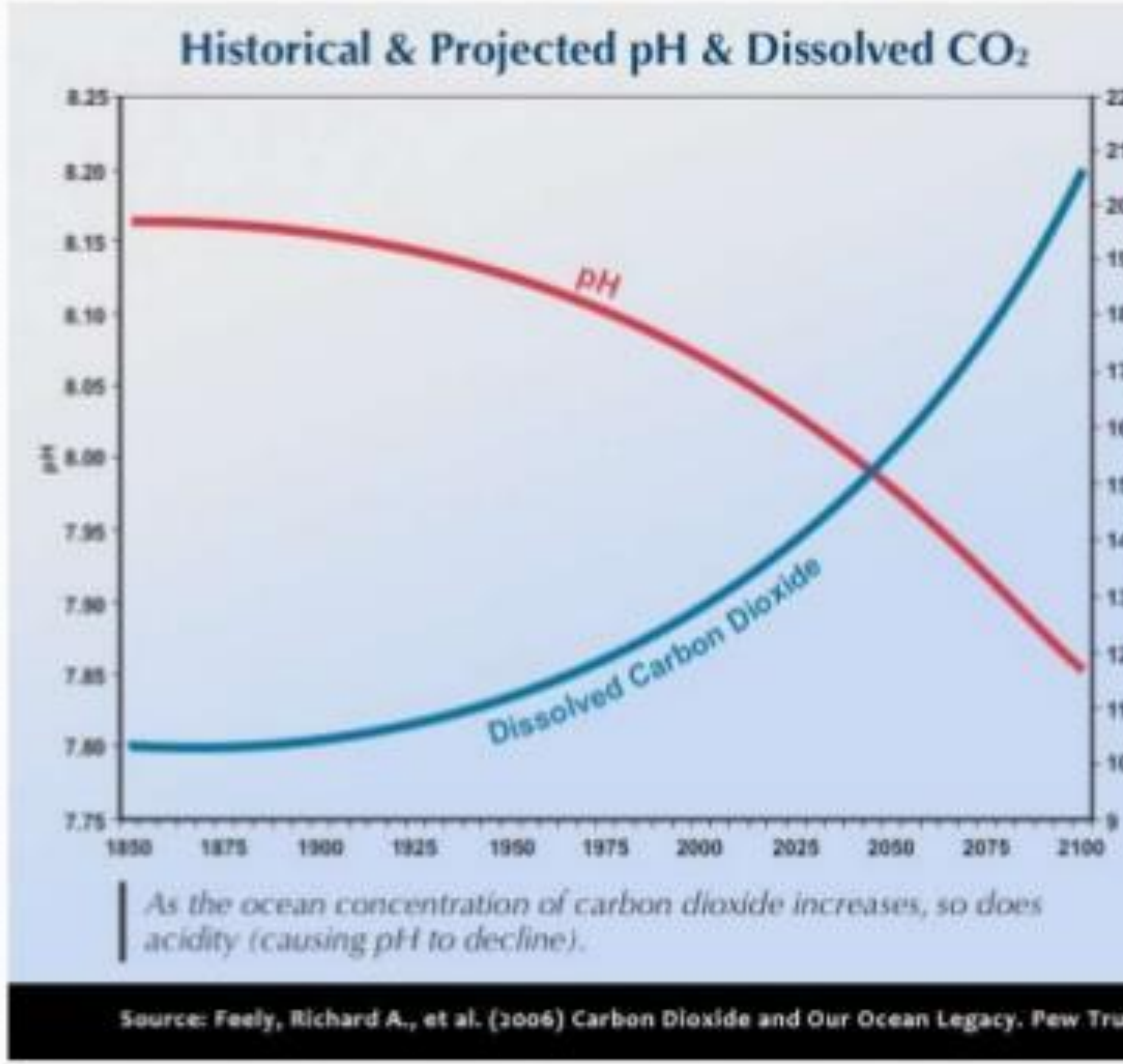
Figure 19.20
Environmental Science



This graph shows the correlation between rising levels of carbon dioxide (CO_2) in the atmosphere at Mauna Loa with rising CO_2 levels in the nearby ocean at Station Aloha.
As more CO_2 accumulates in the ocean, the pH of the ocean decreases. (modified after R. A. Feely, Bulletin of the American Meteorological Society, July 2008).

What happens when CO_2 goes into the ocean?

- ~30% of the CO_2 emitted into the atmosphere dissolves into the ocean
- When CO_2 dissolves into water, it forms an acid
- The pH of the ocean has dropped 30% since the industrial revolution



Consequences to Living Organisms

- Wild plants and animals can be affected. The growing season for plants has changed and animals have the potential to be harmed if they can't move to better climates.
  - *Beef cattle produce the most greenhouse gas emitted of all livestock*

- Humans may have to relocate, some diseases like those carried by mosquitoes could increase and there could be economic consequences.

The Controversy of Climate Change

- **The fundamental basis of climate change-** that greenhouse gas concentrations are increasing and that this will lead to global warming is not in dispute among the vast majority of scientists.
- What is unclear is how much world temperatures will increase for a given change in greenhouse gases, because that depends on the different feedback loops.

TABLE 19.2 The 2007 assessment of global change by the Intergovernmental Panel on Climate Change (IPCC)

The scientists considered the likelihood that specific changes have occurred, the likelihood that humans contributed to the change, and the likelihood that current trends will continue.

Definitions: More likely than not = more than 50% certain; Likely = more than 60% certain; Very likely = more than 90% certain; Virtually certain = more than 99% certain.

Phenomenon and direction of trend	Likelihood that trend occurred in late 20th century (typically post-1960)	Likelihood of a human contribution to observed trend	Likelihood of future trends based on projections for 21st century from *Special Report on Emissions Scenarios*
Warmer and fewer cold days and nights over most land areas	Very likely	Likely	Virtually certain
Warmer and more frequent hot days and nights over most land areas	Very likely	Likely (nights)	Virtually certain
Warm spells/heat waves. Frequency increases over most land areas	Likely	More likely than not	Very likely
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	Likely	More likely than not	Very likely
Area affected by droughts increases	Likely in many regions since 1970s	More likely than not	Likely
Intense tropical cyclone activity increases	Likely in some regions since 1970	More likely than not	Likely
Increased incidence of extreme high sea level (excludes tsunamis)	Likely	More likely than not	Likely

Table 19.2
Environmental Science

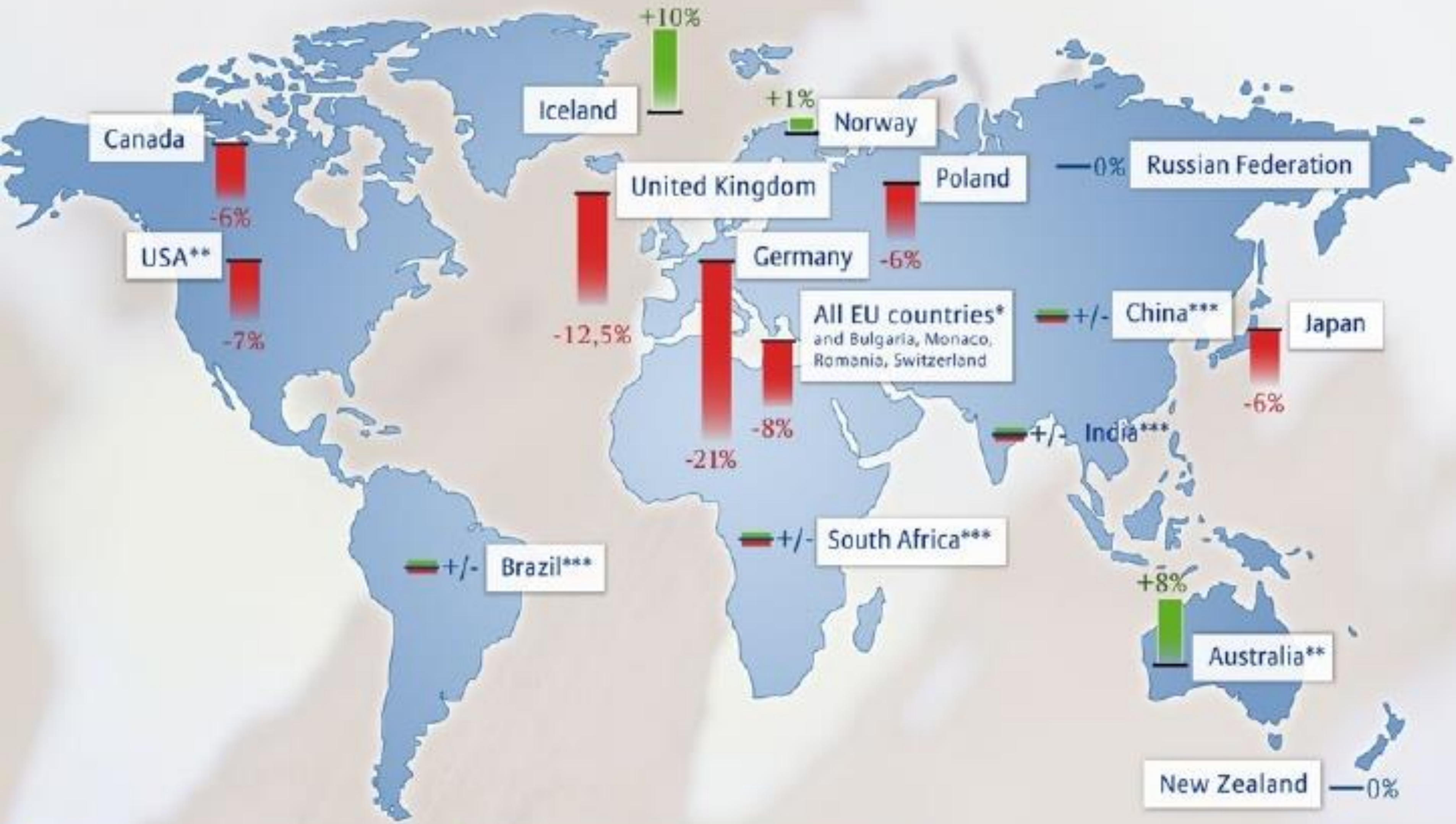
The Kyoto Protocol

- In 1997, representatives of the nations of the world went to Kyoto, Japan to discuss how best to control the emissions contributing to global warming.
- The agreement was that **emissions of greenhouse gases from all industrialized countries will be reduced to 5.2% below their 1990 levels by 2012**.

- *Developing nations did not have emission limits imposed by the protocol.*

CO_2 Reduction

Emission Targets for Selected Countries (Kyoto Protocol)



Where to reduce emissions until 2012

Where an increase of emissions is permitted until 2012

* The EU countries have redistributed their reductions commitments in a so-called burden-sharing commitment.

** The USA and Australia have not ratified the protocol.

*** No restrictions under the Kyoto Protocol

Problems

- Some delayed in signing up to Kyoto such as Russia who signed in 2004
- Some still have not. Australia the world's 2nd largest polluter per capita.
- USA initially signed but then withdrew in 2001 following GW Bush's election (USA emit 25% of world emissions)

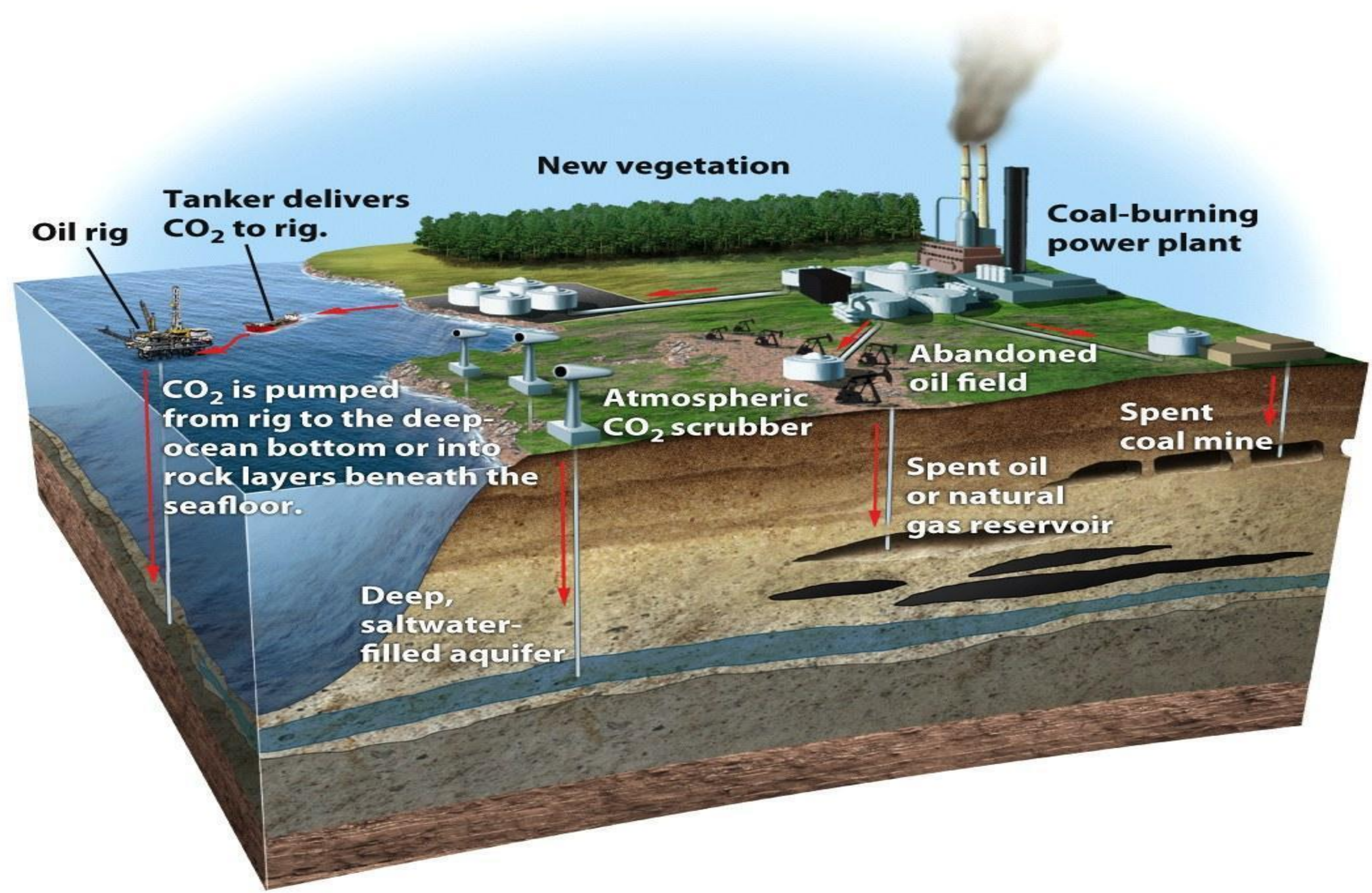
The United States hasn't become part of the agreement because it considers a problem the fact that several major developing nations, including India and China, are not required to reduce emissions under the agreement.

UK Government Response

- Set targets to reduce emissions by 30% by 2020 and 60% by 2050
- Pass laws on carbon reduction targets
- Invest in green technology creating 100,00 new jobs
- Create a $20 billion World Bank Fund to help poorer countries

Carbon Sequestration

- An approach involving taking emitted CO_2 out of the atmosphere.
- Some **methods** include storing carbon in agricultural soils or retiring agricultural land and allowing it to become pasture or forest.
- Researchers are looking at cost-effective ways of capturing CO_2 from the air, from coal-burning power stations, and from other emission sources.
- This **captured CO_2 would be compressed and pumped into abandoned oil wells or the deep ocean.**



To help reduce the amount of carbon dioxide that ends up in the atmosphere, efforts are being made to capture carbon at its source and either to convert it into plant biomass and soil carbon or to pump it down into the ground or the deep sea.