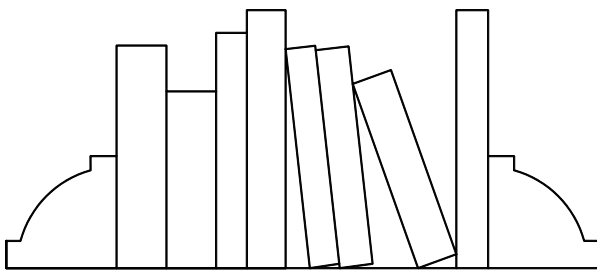


# Air Resources

## Lecture Outline:

13. GLOBAL WARMING
  - A. Not a Hypothesis Anymore!
  - B. Introduction to Global Warming
  - C. Carbon Dioxide
  - D. Other Greenhouse Gases
  - E. Amount and Consequences of Global Warming
  - F. Coping with Global Warming



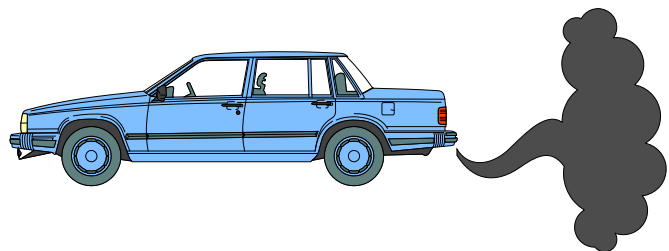
## Learning Objectives:

*When you are finished with this unit you should be able to:*

1. Define global warming.
2. Describe how the greenhouse gases maintain heat in the atmosphere.
3. List the different greenhouse gases and evaluate their contribution to present and future global warming.
4. Describe the most significant possible impacts of future global warming.
5. Decide if global warming is real or not.
6. Describe the different national and international efforts to cope with global warming.

## Terms You Should Know:

- ❖ Global warming
- ❖ Greenhouse Earth
- ❖ Infrared radiation
- ❖ Greenhouse gases
- ❖ IPCC
- ❖ FCCC
- ❖ Kyoto Protocol
- ❖ Climate Change Action Plan
- ❖ Carbon sequestration



## Reading Assignment:

Brennan and Withgott:  
Chapter 18; pages 493-525.

## 13. GLOBAL WARMING

### A. NOT A HYPOTHESIS ANYMORE!

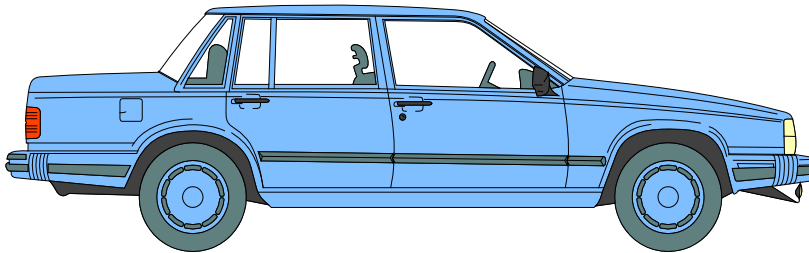
- In the last 10 years the evidence has become overwhelming that global warming is here
- 
- BUSINESS has bought into global warming
  - 
  - 
  - insurance losses are mounting

### B. INTRODUCTION TO GLOBAL WARMING

- 

#### 1. Greenhouse Earth

Why does the interior of your car sitting in the sun get hot?



sunlight in

light energy is converted to heat energy in the form of infrared radiation

infrared radiation can not escape through closed windows

–

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**Global scale:**

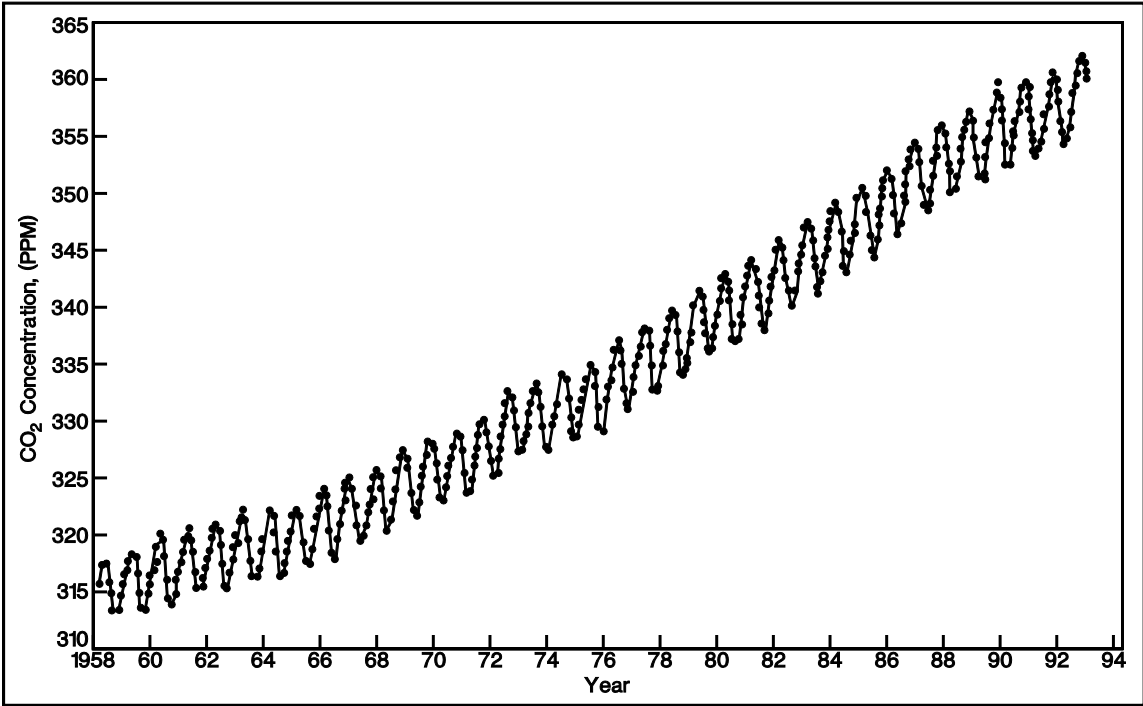
CO<sub>2</sub>, H<sub>2</sub>O vapor, and trace gasses are called **GREENHOUSE GASES**

because they absorb and trap heat

- Our climate depends on greenhouse gases
  - a change in the amount of greenhouse gases in the atmosphere will change the temperature
  - 
  - ✓ 3 - 5° C cooler
  - ✓ CO<sub>2</sub> concentrations were 60% lower

**C. CARBON DIOXIDE**

- CO<sub>2</sub> levels in the atmosphere have been increasing



- 
- Currently, enough fossil fuels are burned to increase the CO<sub>2</sub> concentration of the atmosphere by 3 ppm each year
-

- 
- The burning of forests add CO<sub>2</sub> (should actually serve as a sink)

## D. OTHER GREENHOUSE GASES

- Gases that absorb infrared radiation and add to the insulating effect of CO<sub>2</sub>

### 1. Water Vapor

-

### 2. Methane (CH<sub>4</sub>)

-

- concentration has doubled since the industrial revolution (ice cores)
- although increasing, methane has a minimal impact compared to CO<sub>2</sub>

### 3. Nitrous Oxides

- levels are increasing

#### **Sources:**

✓

✓

✓

- will last 170 years before breakdown in the atmosphere

-

-

### 4. Chlorofluorocarbons and Other Halocarbons

-

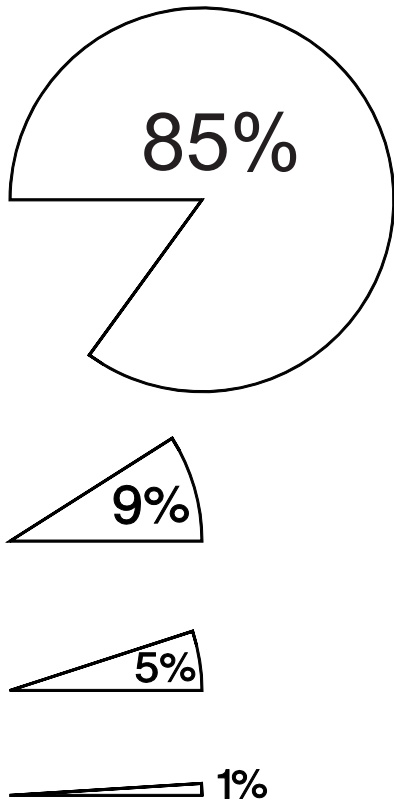
-

- on a molecule basis CFCs have 1,000X the capacity for absorbing infrared radiation of CO<sub>2</sub>

-

-

Greenhouse gases released by the USA:



New Theory:

Humans Changed Climate in the Past

-

-

## E. AMOUNT AND CONSEQUENCES OF GLOBAL WARMING

- Difficult to predict
- Use models
- If greenhouse gases double

- got an ice age with a temperature drop of 5°C

#### IMPACTS:

–

–

–

–

#### Sea level—2 factors:

–

- melting of glaciers and icefields

•

- Enough water in icecaps to raise sea level 240 feet
- In 100 years, sea level could rise 3 to 12 feet

## F. COPING WITH GLOBAL WARMING

### 1. Is it real?

- Must look at trends (> 40 years) because of mini cycles
- 
- Ice Age Theories
  - some say we are moving toward an ice age
- Theory A:
  - increasing temperature →
  - increasing precipitation →

–

- Theory B:

"The Day After Tomorrow"

- if large quantities of fresh water melts into the Atlantic from Arctic and Greenland glaciers →

- ✓

- ✓

- ✓

- ✓ if current shuts down, may get much colder temperatures in Europe, North America

- ✓ more northern snowfall

- ✓

## 2. Consequences in the USA

- Average temperature will increase 5–9°F (100 years)

- 

- 

- Drought could decrease crop yields in the Midwest

- High CO<sub>2</sub> concentrations could enhance crop growth

- 

- Greater temperature extremes →

–

–

- Altered forest ecosystems
- 
- Barrier islands disappear
- 
- Loss of coastal wetlands and real estate due to rising sea level
- 

### 3. Dealing with Global Warming

- 
- The effects will last a long time
- 
- The harmful and beneficial impacts of climate change are not spread evenly
- Many actions are controversial

–

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#### **Difficult issues:**

- SCIENCE

–

- ECONOMICS

–

–

- POLITICS

–



–

- ETHICS

–

–

–

#### 2012 – A Tipping Point?

- Warmest spring on record for 47 of the 48 contiguous states (exception: Washington)
- Wild 2012 weather

–

–

#### 4. Main Culprits (CO<sub>2</sub>)

##### A. Electricity Generation

–

–

–

##### B. Transportation

–

–

–

#### 5. Global Warming Solutions

##### A. Prevention

- cut fossil fuel use

- 
- 
- shift to renewable energy resources
- transfer new technologies to developing countries
- 
- use more sustainable forestry and agriculture systems
- 
- slow population growth

#### B. Clean-up

- remove CO<sub>2</sub> from smokestack and vehicle emissions
  - 
  - sequester CO<sub>2</sub> deep underground
  - sequester CO<sub>2</sub> in soil
    - ✓
    - ✓
  - sequester CO<sub>2</sub> in the deep ocean
  - use animal feeds that reduce methane emissions by belching cows
- CORNUCOPIAN VIEW
    - do nothing
    - may never happen anyway—where is the proof!
    - if problem occurs:
    - if problem occurs:

## 6. International Efforts

- International Panel on Climate Change (IPCC) was formed in 1988
  -
  
- In 1992, 150 countries signed the Framework Convention on Climate Change (FCCC) — aimed at stabilizing greenhouse gas levels low enough to prevent climate change
  - 
  -
  
- FCCC formulated Kyoto Protocol in 1997
  - greenhouse gas emission levels for HDCs for 2008–2012
  - 
  -

### KYOTO PROTOCOL

- Treaty took effect in 2005 without USA support
- Signed by nations responsible for 55% of greenhouse gas emissions

How are we doing?

Country	Required change	Observed change
Germany		
UK		
Japan		
USA		

## 7. USA Efforts

- 1993—Climate Change Action Plan

—

- USA greenhouse gas emissions increased 22% from 1990 to 2009