Topic 12A:
Climate Change, Part I

Online Lecture:
The Greenhouse Effect & Global Warming

- Climate vs. Weather
- Electromagnetic Waves and The Greenhouse Effect
- Global Warming & Carbon Dioxide
Climate

- **Weather**: what will happen today or this afternoon
- **Climate**: conditions will be warm or cool on most days, how much rain will fall during a season

  - Global Warming is an example of *Climate Change*
    - more warm days, fewer cool days (every day is not going to be warm)
    - won’t matter most of the time, but during extreme conditions (e.g., very hot days) the small boost in temperature could have large consequences

  - Climates do not necessarily change slowly. Instead, they often “flip” from one “setting” (e.g., warm) to another “setting” (e.g., cold), like a light switch.
    - are we destabilizing the nice climate that we have now?
The Electromagnetic Spectrum

There are many kinds of EM Waves.
Each kind behaves differently with matter.
Most are invisible to us, but they can still "burn" us.

<table>
<thead>
<tr>
<th>Gamma Rays</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Rays</td>
</tr>
<tr>
<td>Ultraviolet “Light”</td>
</tr>
<tr>
<td>Visible Light</td>
</tr>
<tr>
<td>Infrared “Light”</td>
</tr>
<tr>
<td>Microwaves, RADAR</td>
</tr>
<tr>
<td>TV</td>
</tr>
<tr>
<td>Radio</td>
</tr>
</tbody>
</table>
Objects Emitting EM Waves

Objects must be very **HOT** to emit visible light.

All objects emit infrared “light,” even cold ones. (e.g., dew)

Hotter = send away *more* EM waves (“heat,” energy)
Greenhouses & How They Work

Glass lets visible light pass through, but absorbs infrared “light”

The warmer the car seat & window get, the more heat they emit (“send away”) as infrared light.

Seat gets heat from both Sun & window.
Thank You, Greenhouse Effect

- Like a window, “greenhouse gases” in the atmosphere let visible light from the Sun pass through.

- Greenhouse gases absorb infrared “light” emitted by the Earth, so the air becomes warmer.

- Once the atmosphere has gotten warm enough, it emits lots of infrared “light” too, sending some off into space and the rest back down to the Earth, warming it.

If there were no “greenhouse effect,” the Earth would be a big ball of ice
Global Warming is Happening: an observation

How much does ocean temperature change during El Niño’s?

Do El Niño’s have a large or small effect on our climate?

≈1900

0.8°C
Global Warming II: Melting Ice at the Poles

Antarctica

North Pole
Global Warming III: More Melting Ice

Melting Glaciers

Grinnell Glacier 1850-1981

1850 1937 1968 1981
Global Warming IV: Sea-Level Rise & More

Coral Atoll: They really notice it.

species behavior (e.g., coming out of hibernation, growing leaves): happening *earlier* in the spring

species which prefer "warm" conditions are spreading towards the Poles and up mountains

about 1 ft
Carbon Dioxide Measurements from Ice

Human activities are causing carbon dioxide and other greenhouse gases to increase at an accelerating rate.

[Graph showing CO2 levels from 1750 to 2000, with a sharp increase after the Industrial Revolution.]

Industrial Revolution begins

CO2 level (parts per million)

1750 1800 1900 2000

Year

Natural record

Instrument record
Why is the World Getting Warmer?

○ **Current, Best Theory:**
  We are significantly **enhancing** the GE by burning lots of fossil fuels (like *oil* & *coal*) which adds **carbon dioxide** to the atmosphere.

○ Carbon dioxide in the atmosphere is going up dramatically owing to human activities – *up by 30%+

---

Why does the curve go up and down a little bit each year?

Direct Measurements (since 1950s)
Temperature & CO₂ went up & down together in the past.

We’ve added the same amount of CO₂ that entered the atmosphere at the end of the last ice age.

More CO₂ when warmer.

There should be even *more* of our CO₂ in the atmosphere. *The ocean* absorbs about half (48%) of our pollution.