Atmospheric Composition  
AOSC 200  
Tim Canty

Class Web Site:  http://www.atmos.umd.edu/~tcanty/aosc200

Topics for today:

• Satellite Observations  
• Early Atmosphere  
• Current Atmosphere  
  • Permanent Gases  
  • Variable Gases

Lecture 05  
Sep 10 2019

Satellite Imagery: Infrared (heat)

This is a “false color” image. The lighter the color, the colder the temperature.  
What does this tell us about clouds?
Satellite Imagery: Infrared (heat)

This is a “false color” image. The lighter the color, the colder the temperature.

What does this tell us about clouds?
Can you think of a limitation of the infrared image?

Satellite Imagery: Water Vapor

This is a “false color” image. Water vapor absorbs and emits energy.
You can tune an instrument to only “see” the wavelengths where water vapor absorbs and emits energy.
### Atmospheric Composition
(What are you breathing?)

<table>
<thead>
<tr>
<th>TABLE 1.1 Composition of the Atmosphere near the Earth's Surface</th>
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<tbody>
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<td><strong>PERMANENT GASES</strong></td>
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<tr>
<td>Gas</td>
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<tr>
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</tr>
<tr>
<td>Nitrogen</td>
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*For CO<sub>2</sub>, 400 parts per million means that out of every million air molecules, 400 are CO<sub>2</sub> molecules.

**Stratospheric values at altitudes between 11 km and 50 km are about 5 to 12 ppm.
Early Earth’s Atmosphere

As Earth formed it was very hot. Any water would have evaporated. So, where did the water come from?

After the oceans formed, CO$_2$ dissolved into the water, sea creatures used CO$_2$, water, and sunlight to create carbohydrates. This led to the creation of.....
Early Earth’s Atmosphere

After the oceans formed, CO₂ dissolved into the water, sea creatures used CO₂, water, and sunlight to create carbohydrates. This lead to the creation of ….. Oxygen!!!!

The increase in atmospheric oxygen led to one of the greatest environmental disasters ever!!!

The “Oxygen Catastrophy”

Oxygen is toxic to cells (even ours). The build of atmospheric oxygen wiped out anaerobic bacteria ~4 billion years ago.

Endosymbiotic Theory - Lynn Margulis (1967)

Atmospheric Composition
(What are you breathing?)

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99.96% of the atmosphere “permanent gases”
TABLE 1.1 Composition of the Atmosphere near the Earth's Surface

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**Stratospheric values at altitudes between 11 km and 50 km are about 5 to 12 ppm.

These gases control the chemistry of the atmosphere “variable gases” or “trace gases”

Carbon Dioxide (CO₂) Cycle

One of the most talked about Greenhouse Gases.

Some CO₂ is produced naturally

Some CO₂ produced by human activity (anthropogenic)

Once in the air, some CO₂:
- stays there
- goes into ocean
- goes into land

CO₂ stays in the air for ~200yrs
Carbon Dioxide (CO₂)


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**Recent Science**

OCEAN ACIDIFICATION

How will changes in ocean chemistry affect marine life?

CO₂ absorbed from the atmosphere

\[
\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{CO}_3^{2-} \rightarrow 2\text{HCO}_3^-
\]

Carbon dioxide + water + carbonate ion \rightarrow 2 bicarbonate ions

Consumption of carbonate ions impedes calcification

http://www.pmel.noaa.gov/co2/story/Ocean+Acidification

“There has been a 30% increase in the acidity of the ocean since 1700, and we now expect that by 2100, it will have become a 100% increase. This constitutes a rate of change in ocean chemistry that is 10 times anything scientists can document over the last 50 million years.”

http://newswatch.nationalgeographic.com/2014/09/02/ocean-acidification-from-domestic-to-international/
Carbon Dioxide (CO₂) Cycle

Currently, there are more sources than sinks.

As a consequence, CO₂ in the air is rising.

This rise is correlated with the rise in temperatures…

... but more on that in future lectures

Currently, few ways to reduce CO₂

https://directory.eoportal.org/web/eoportal/satellite-missions/o/oco-2

Methane Sources and Sinks

http://www.giss.nasa.gov/research/features/200409_methane/
Methane Sources and Sinks

Methane is mainly lost by chemical reactions in the atmosphere

The carbon in methane eventually becomes $\text{CO}_2$

http://www.giss.nasa.gov/research/features/200409_methane/

Nitrous Oxide ($\text{N}_2\text{O}$)

http://rstb.royalsocietypublishing.org/content/367/1593/1157
Nitrous Oxide (N$_2$O)

Nitrous Oxide is mainly lost by chemical reactions in the stratosphere

- Cattle and feedlots
- Industry
- Atmosphere
- Biomass burning

http://rstb.royalsocietypublishing.org/content/367/1593/1157

Aerosols (really tiny!!!!!)

- Smog
- Smoke from fires
- Sea salt
- Viruses
- Bacteria
- Dust storms
- Beach sand
- Human hair

Fig 1-10  Meteorology: Understanding the Atmosphere
Aerosols (really tiny particles!!!!)

Main sources: oceans (sea salt), erosion, fires, volcanoes, and human activity

Can be harmful to human health