Topics for today:

- Energy absorption
- Radiative Equilibirum

The energy from the Sun peaks at 0.5 μm (the visible portion of the spectrum)
The energy from the Earth peaks at 10 μm (in the infrared portion)
Radiative Heat – heating due to electromagnetic radiation (waves of energy that move through space)

Can be:

- Absorbed
- Reflected
- Scattered

http://marineecology.wcp.muohio.edu/climate_projects_04/snowball_earth/web/WebpageStuff/albedo.html
Reflection: Albedo

Albedo – the percentage of radiation that is reflected off of a surface

100% means everything is reflected

Snow has an albedo of 90%

Overall, the Earth’s albedo is 30%
What color is the sky?

$N_2$ and $O_2$ are really good at scattering shorter wavelengths.
What color is the sky?

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Fig 4.2.1 Weather: A Concise Introduction

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What color is the sky?

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Fig 4.2.2 Weather: A Concise Introduction
How does energy interact with the atmosphere?

The atmosphere absorbs energy only at certain wavelengths and transmits at others. This figure shows what percentage of energy is able to travel through the atmosphere.

Fig 4.6 *Weather: A Concise Introduction*

Atmospheric Absorption

The Sun releases energy at shorter wavelengths (UV, visible, near-infrared)

The Earth releases energy at longer wavelengths (IR)

Absorption is the opposite of transmittance.

Fig 2.10, 11: *Essentials of Meteorology*
Atmospheric Absorption

This slide shows how much radiation is absorbed by the atmosphere at different wavelengths.

Example, at 0.1 \( \mu \text{m} \) the atmosphere absorbs 100\% of the incoming radiation from the sun.
Atmospheric Absorption from $O_2$ and $O_3$

Fig 2.11: Essentials of Meteorology

Absorption (%)

Atmospheric Absorption from $CH_4$

Fig 2.11: Essentials of Meteorology

Absorption (%)

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Atmospheric Absorption from $\text{N}_2\text{O}$

Absorption (%)

Atmospheric Absorption from $\text{CO}_2$

Absorption (%)

Fig 2.11: Essentials of Meteorology
Atmospheric Absorption from $\text{H}_2\text{O}$

![Image of atmospheric absorption from water vapor](image)

**Fig 2.11: Essentials of Meteorology**

Earth without the Greenhouse Effect

![Diagram showing earth without greenhouse effect](image)

**Fig 2.12a: Essentials of Meteorology**
What happens when the “blanket gets too thick?”
Energy Budget cont.

We’ve discussed the composition of the atmosphere &
How energy is transferred throughout the atmosphere

Now we’ll discuss how composition and the seasons affects surface temperature

(I know….I’m excited about this, too!!!)

Solar Zenith Angle

Zenith – the point directly over your head
Solar Zenith Angle – the angle between the sun and a point directly overhead

Fig 2-13  Meteorology: Understanding the Atmosphere
The intensity of light reaching the surface decreases as the sun lowers in the sky

As SZA ↑ Intensity ↓

Solar energy reaching the Earth’s surface

Sunlight in the tropics is more intense because the sun is higher in the sky than near the polar regions.

Less solar energy makes it through the atmosphere to the poles than the equator.

The polar regions have a higher albedo than the tropics. Why?

All of these together lead to an energy imbalance

Fig 2.21: Essentials of Meteorology

Fig 4.8: Weather: A Concise Introduction
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Global Energy Balance

In the diagram, different parts of the Earth are shown with varying energy balances at different latitudes. There are regions of surplus and deficit in energy transfer, indicating the net heat transfer between the Earth's surface and the atmosphere. The balance at 38° latitude is shown with incoming energy and outgoing energy, with a surplus in the middle and deficits on either side, illustrating the global energy balance.
The Seasons

In winter, the sun is lower on the horizon and sun beams are more spread out.

In summer, the sun is high in the sky and solar energy is more concentrated.