Energy and the Earth
AOSC 200

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

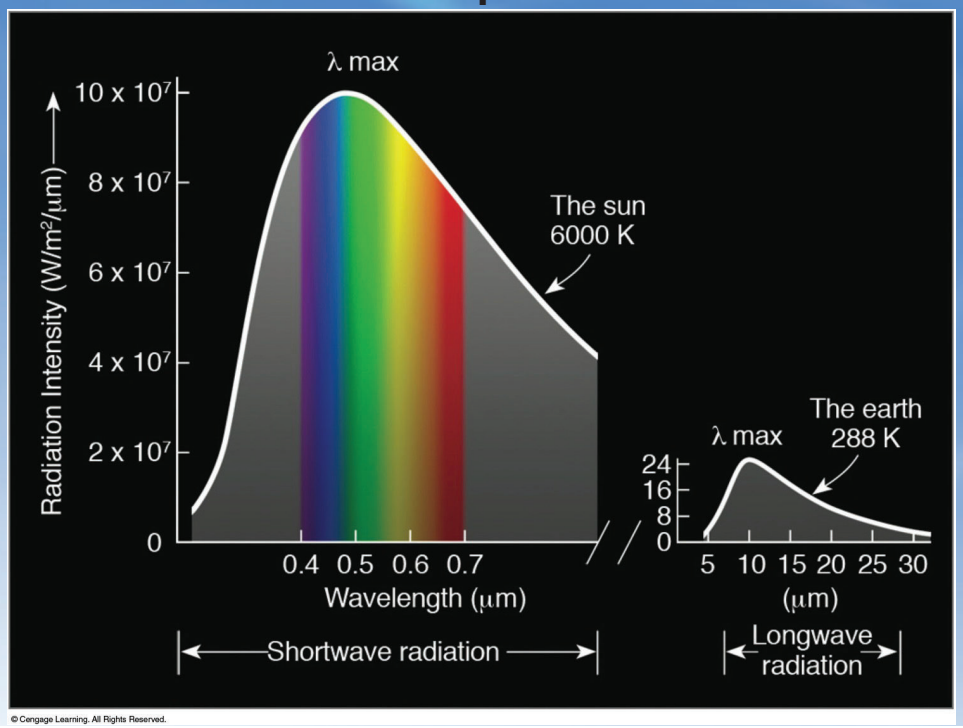
Topics for today:

- **Energy absorption**
- **Radiative Equilibirum**

Lecture 08

Sep 19 2019

Solar Spectrum



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)

Fig 2.10: *Essentials of Meteorology*

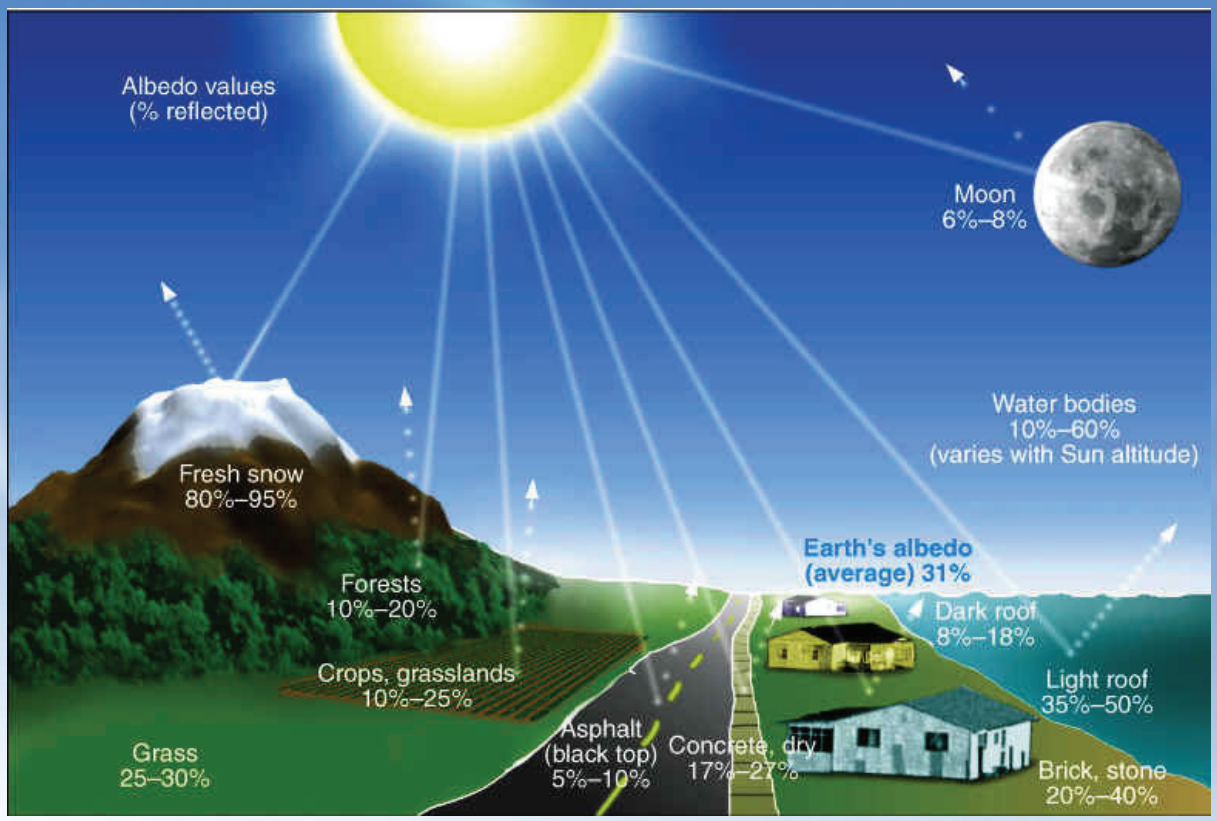
Energy Transfer: Radiation

Radiative Heat – heating due to electromagnetic radiation (waves of energy that move through space

Can be:

- **Absorbed**
- **Reflected**
- **Scattered**

Fig 4.4 ***Weather: A Concise Introduction***



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%

Reflection: Albedo

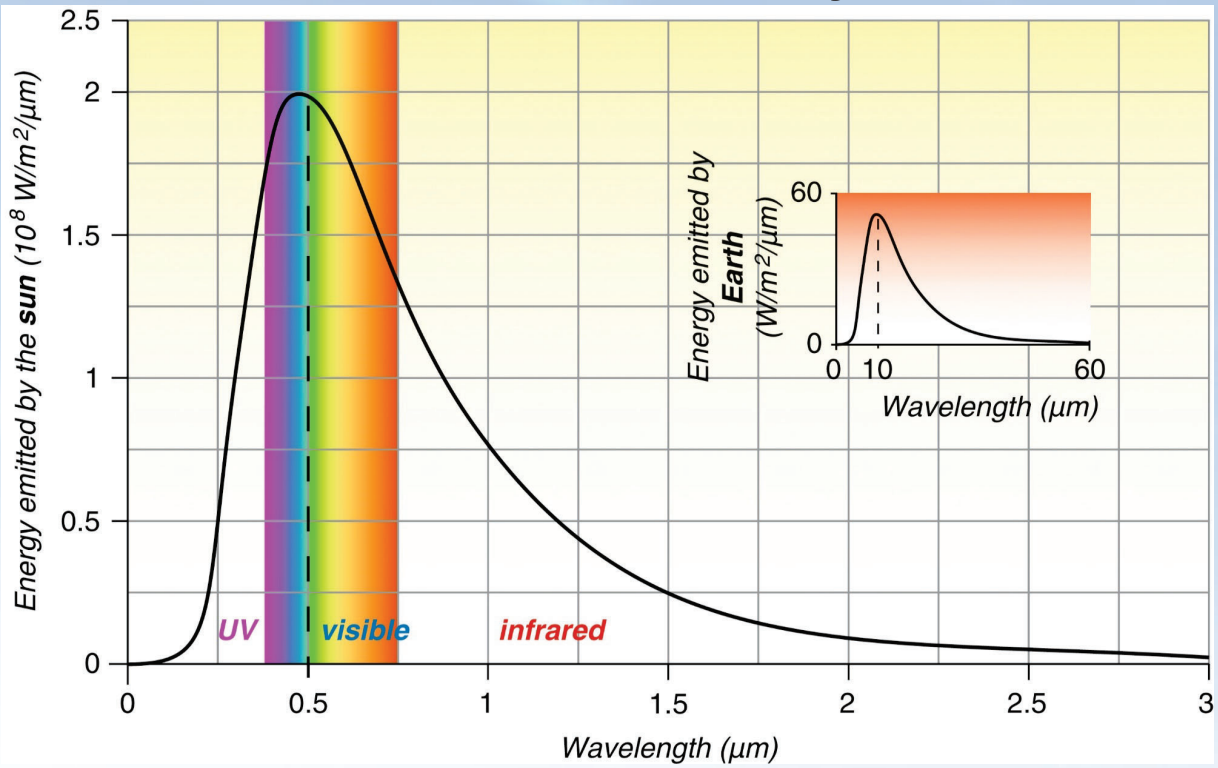
TABLE 2.2 Typical Albedo of Various Surfaces

SURFACE	ALBEDO (PERCENT)
Fresh snow	75 to 95
Clouds (thick)	60 to 90
Clouds (thin)	30 to 50
Venus	78
Ice	30 to 40
Sand	15 to 45
Earth and atmosphere	30
Mars	17
Grassy field	10 to 30
Dry, plowed field	5 to 20
Water	10*
Forest	3 to 10
Moon	7

*Daily average.

What color is the sky?

What color is the sky?



N_2 and O_2 are really good at scattering shorter wavelengths

What color is the sky?

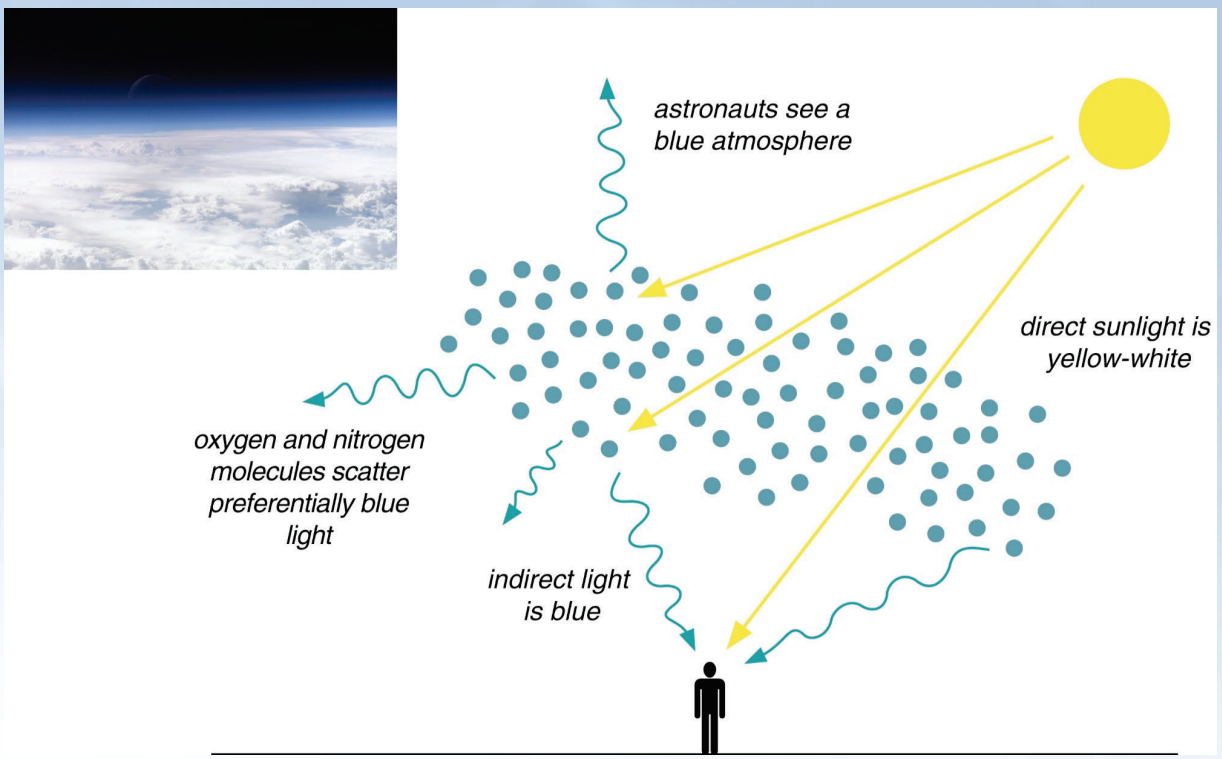


Fig 4.2.1 ***Weather: A Concise Introduction***

What color is the sky?

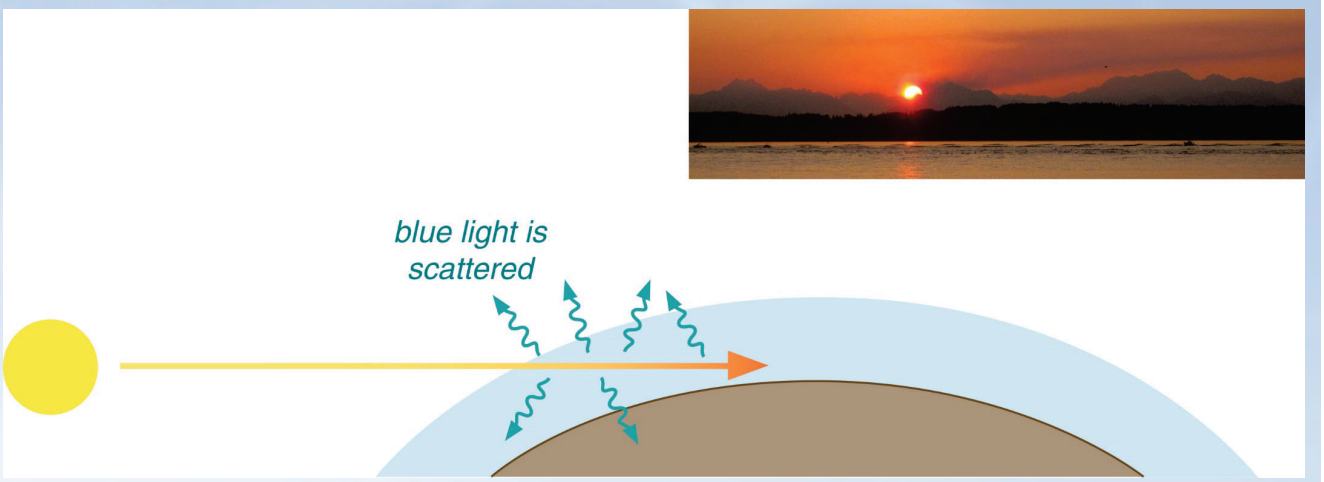
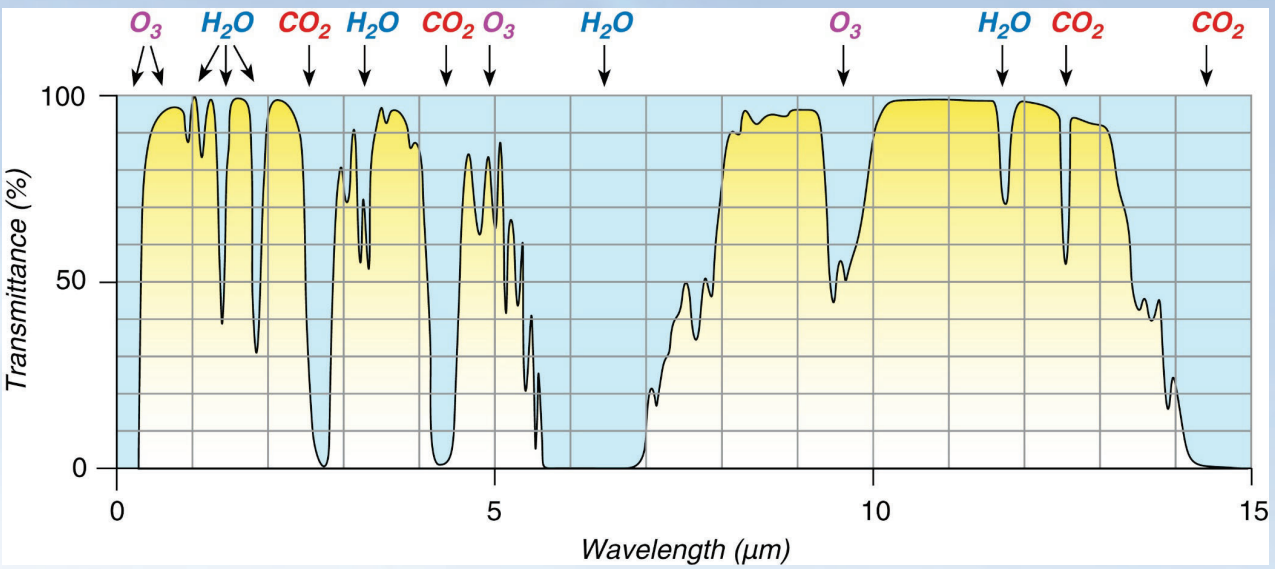


Fig 4.2.2 ***Weather: A Concise Introduction***

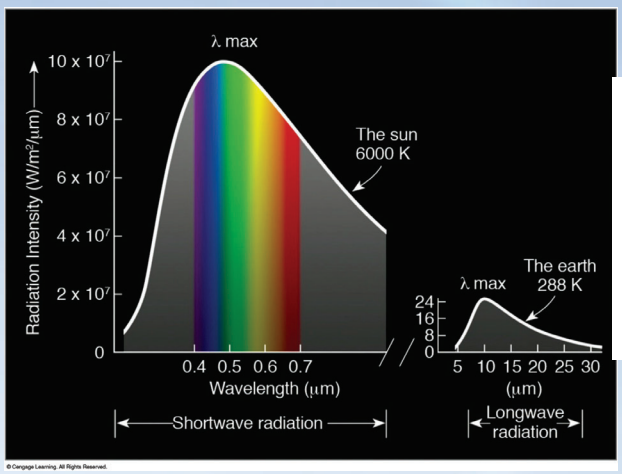
How does energy interact with the atmosphere?



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

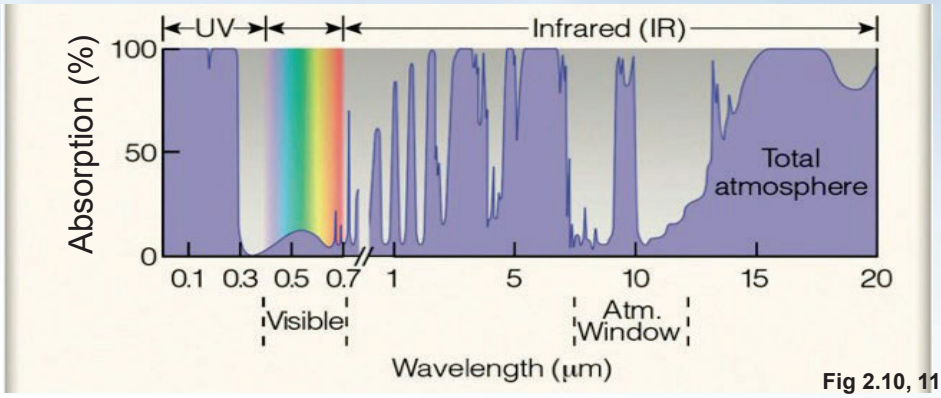
Fig 4.6 ***Weather: A Concise Introduction***

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

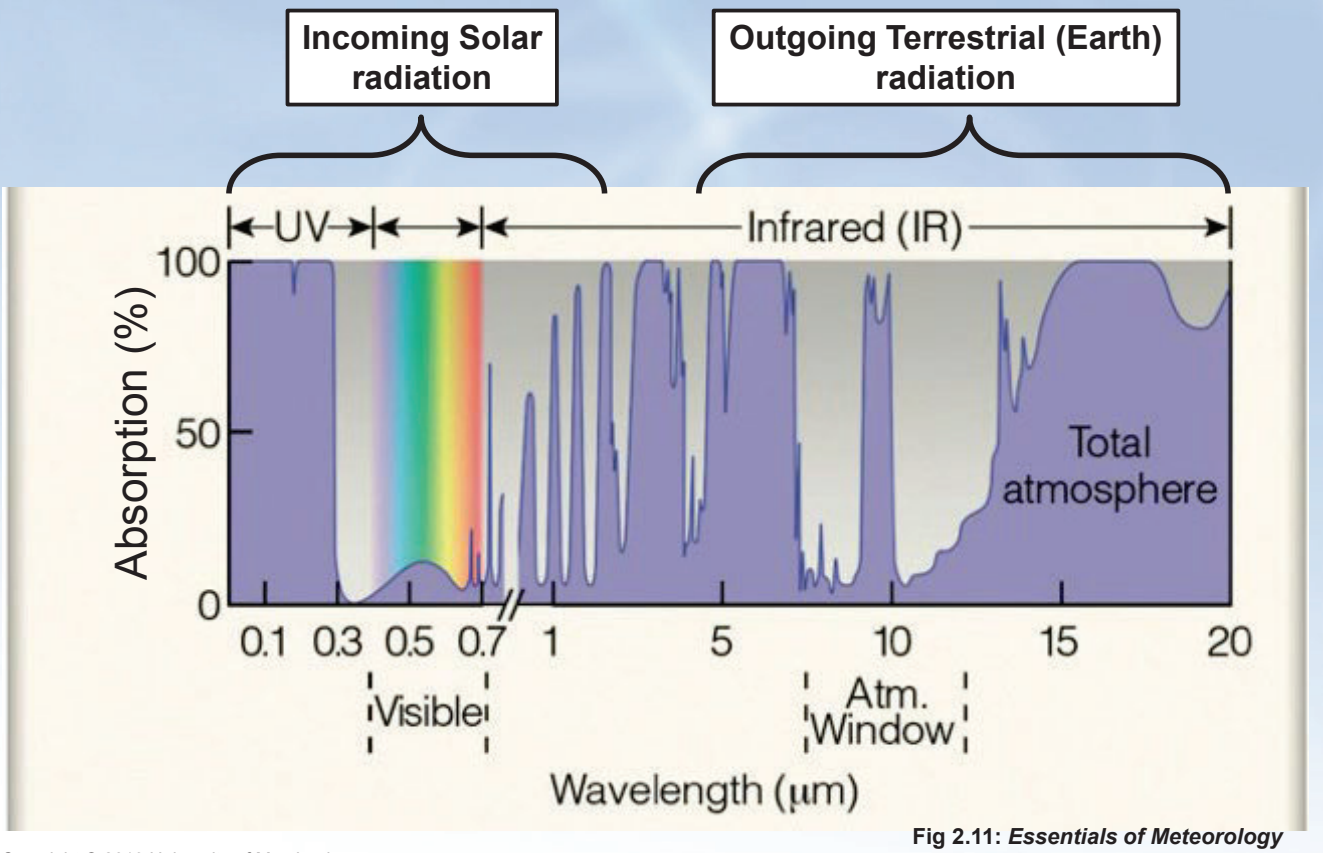


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption

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

Example, at 0.1 μm the atmosphere absorbs 100% of the incoming radiation from the sun.

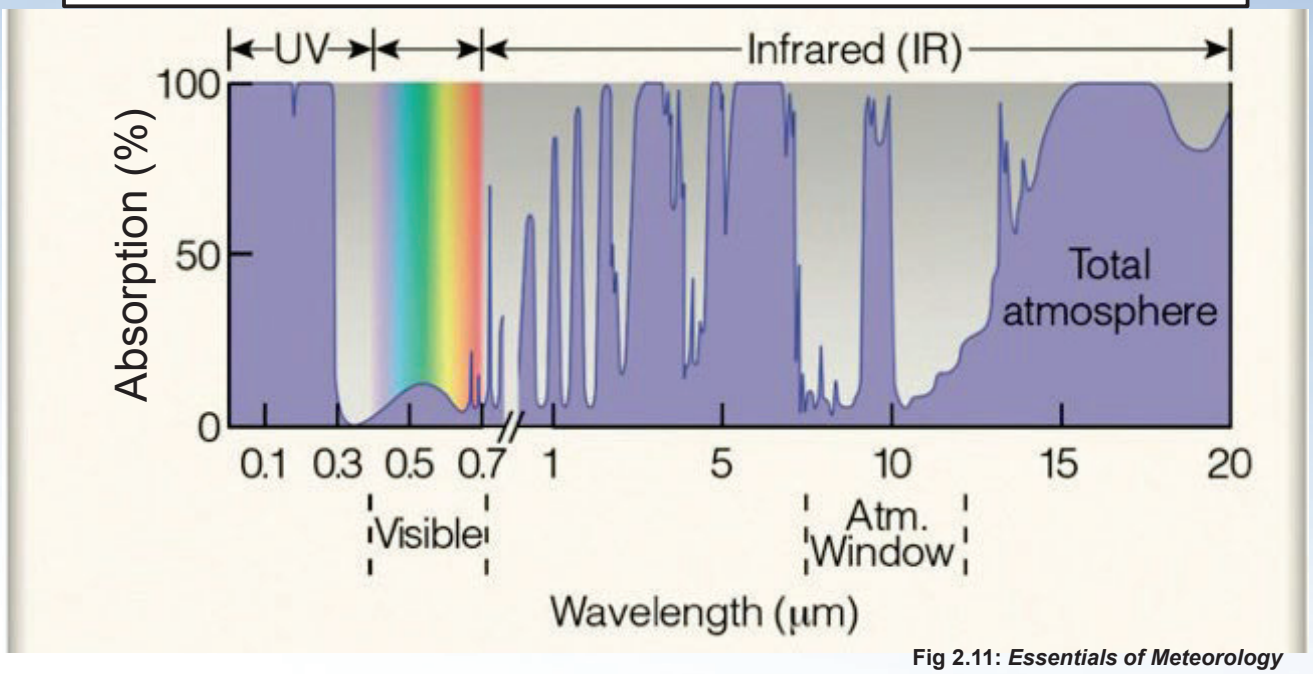


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from O_2 and O_3

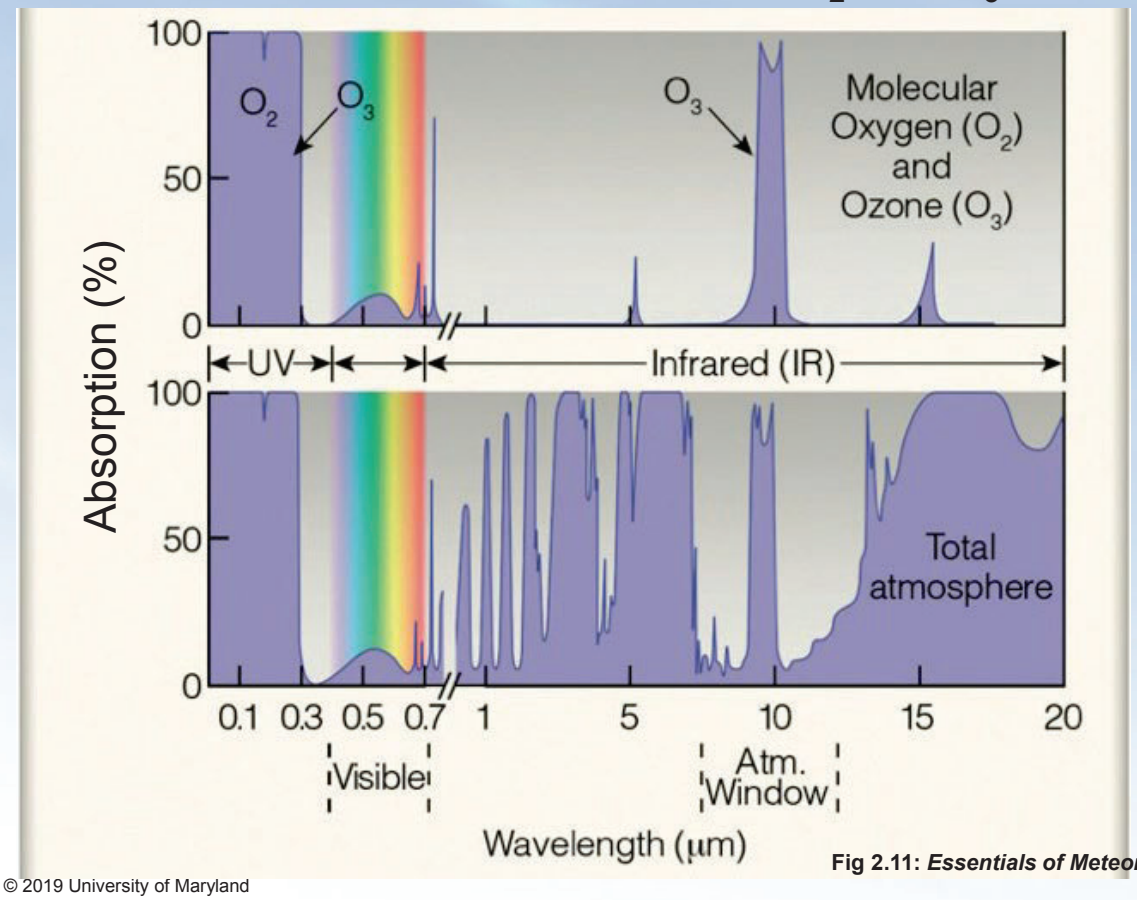


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from CH_4

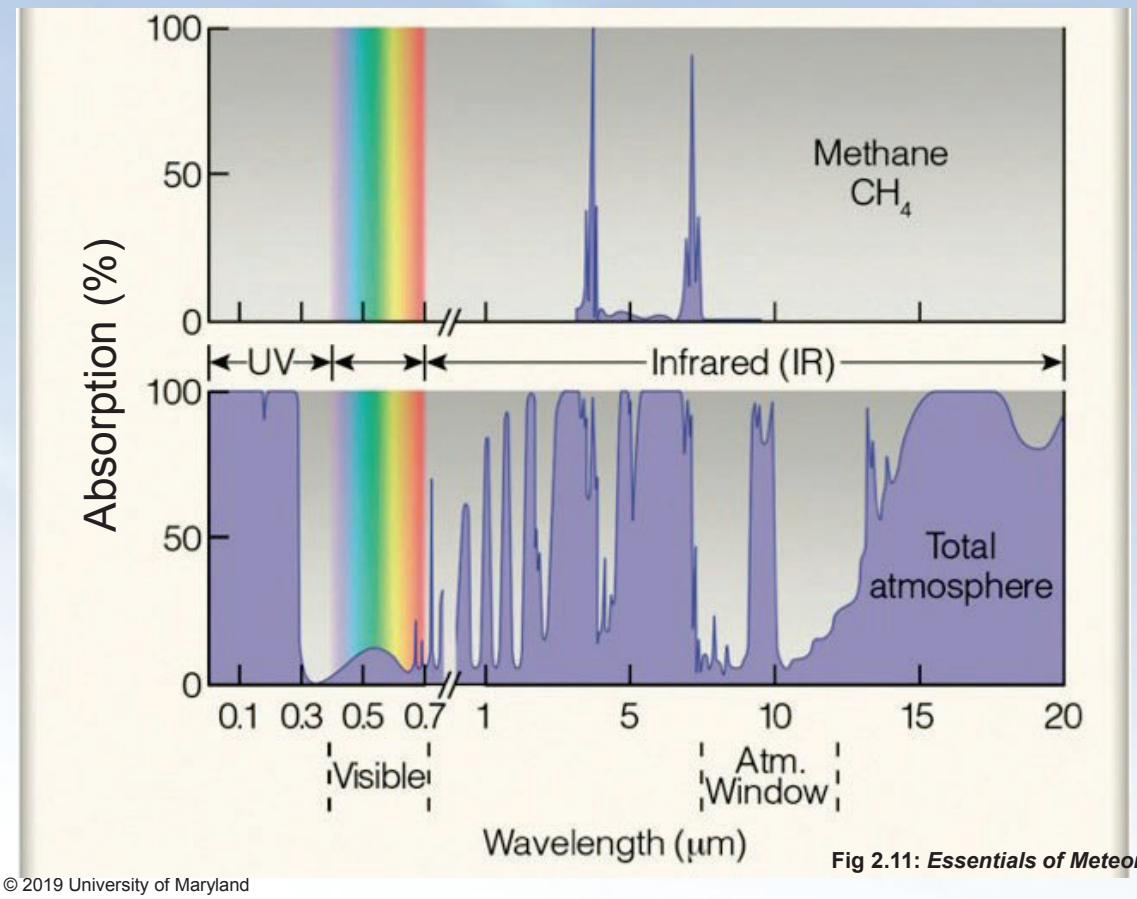


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from N_2O

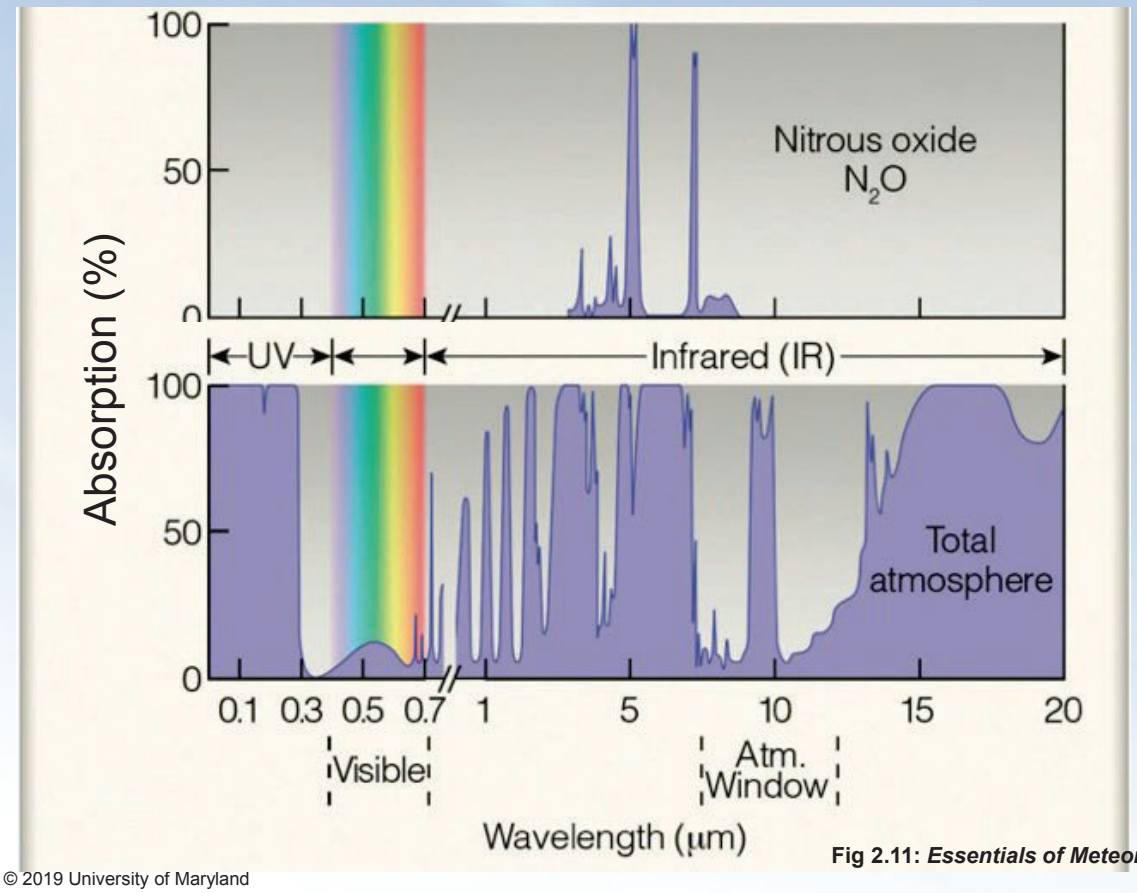


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from CO_2

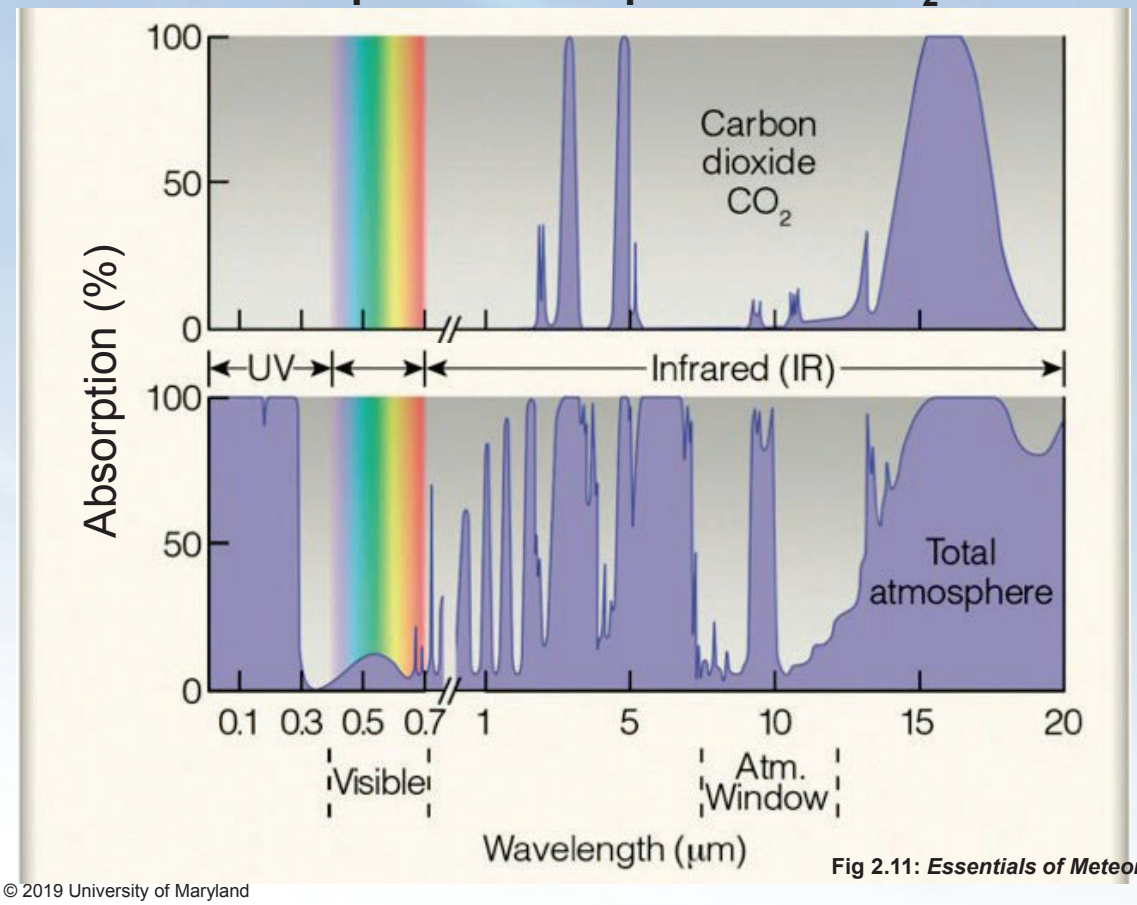


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from H_2O

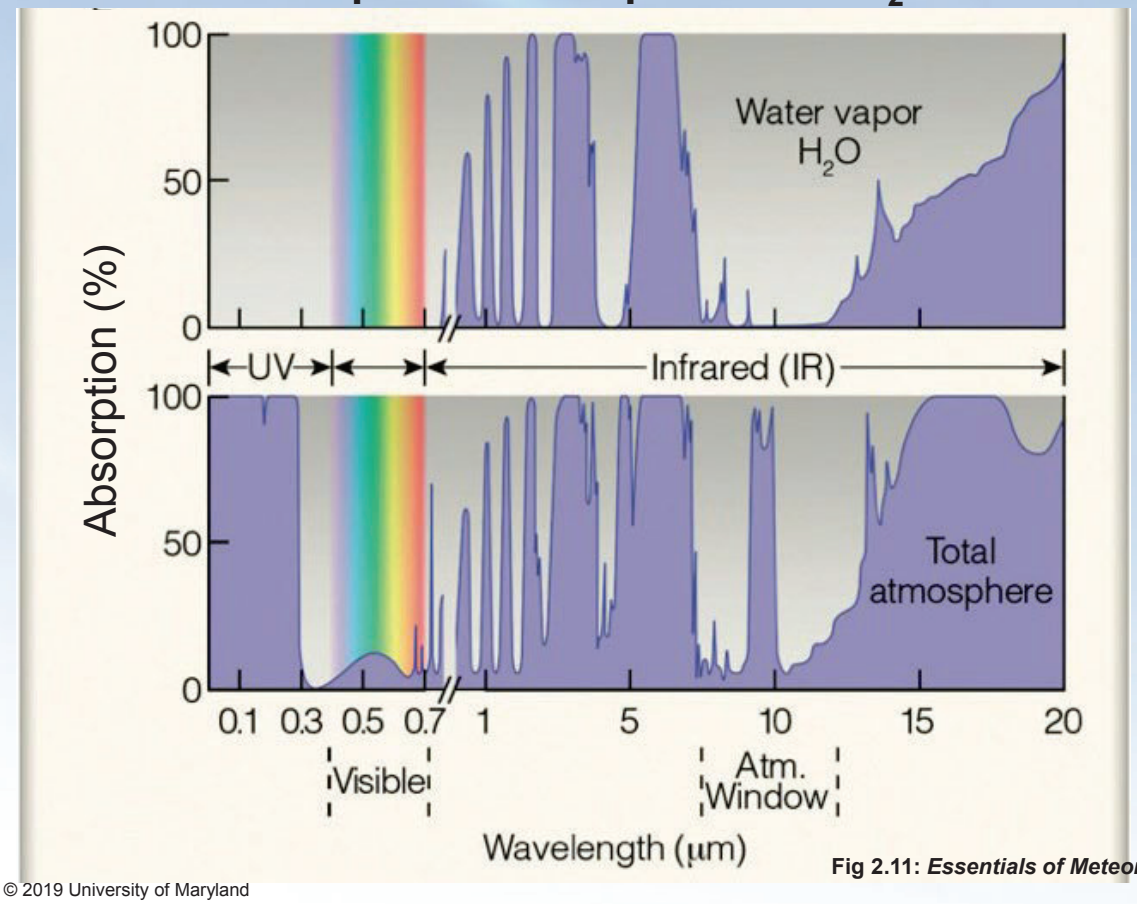


Fig 2.11: ***Essentials of Meteorology***

Earth without the Greenhouse Effect

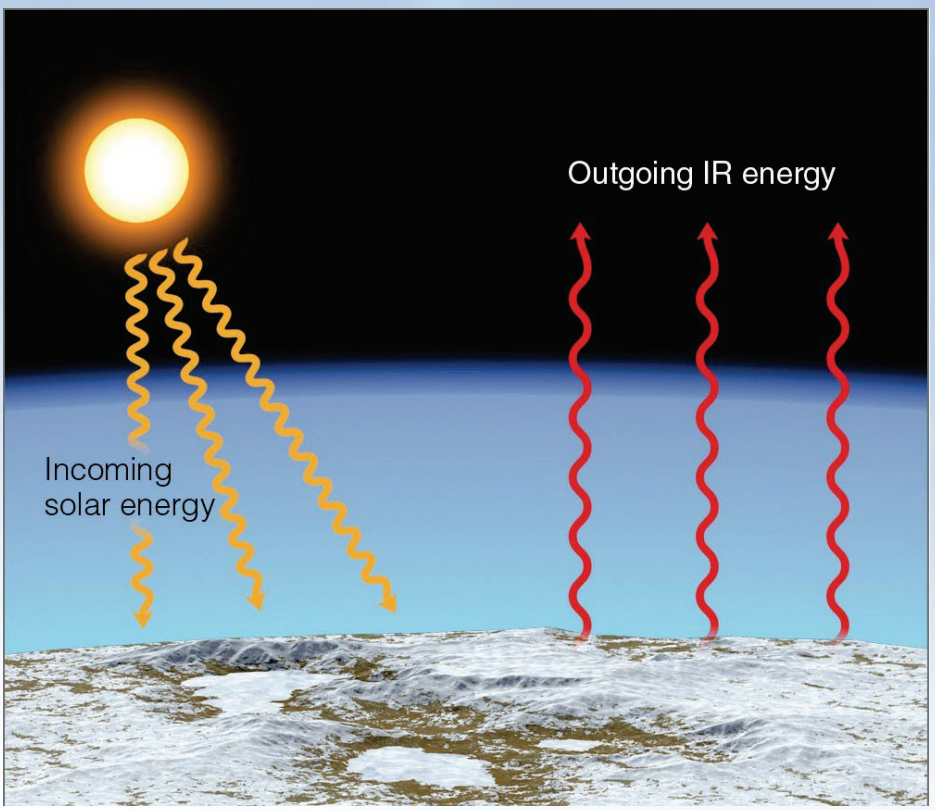


Fig 2.12a: ***Essentials of Meteorology***

Earth with the Greenhouse Effect

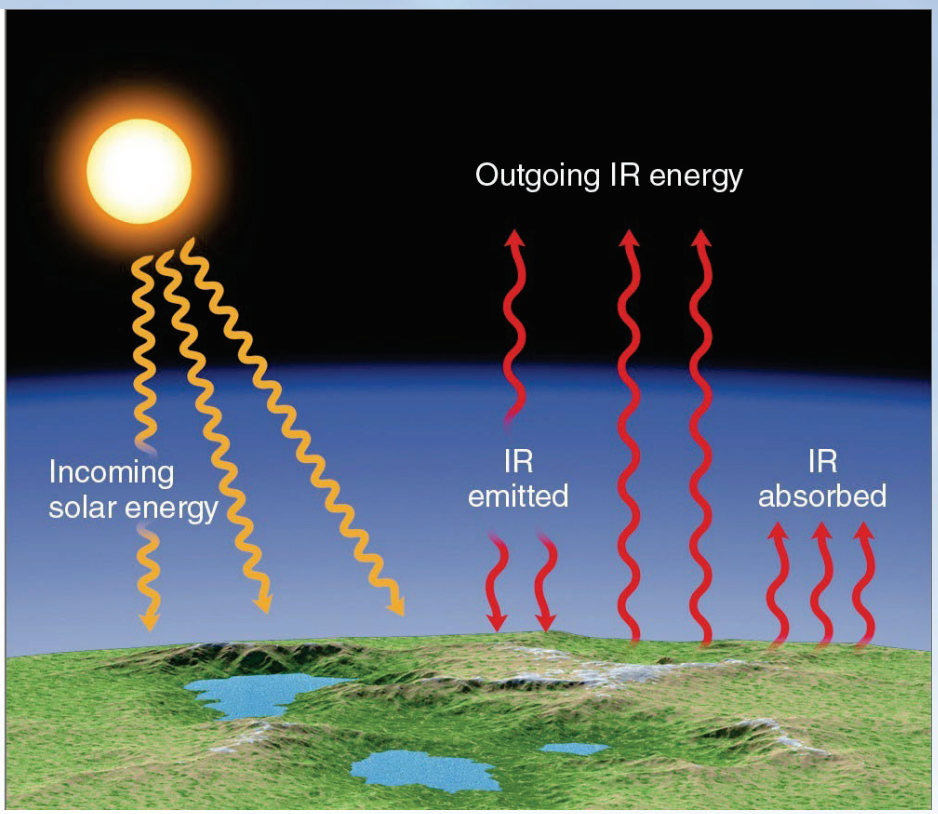
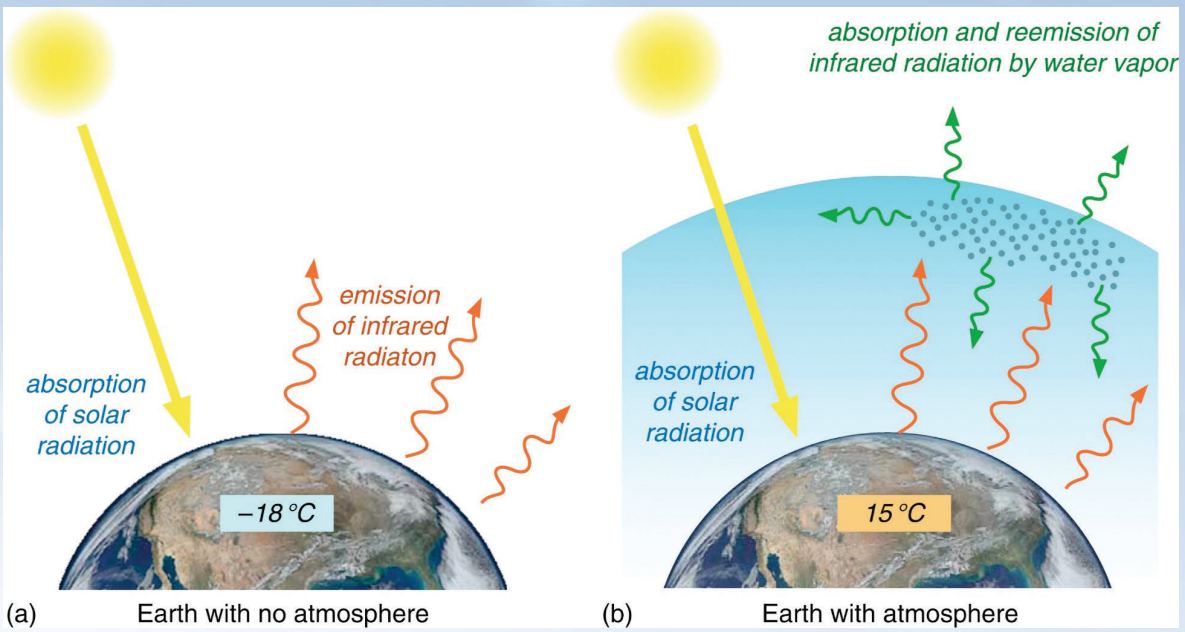


Fig 2.12b: ***Essentials of Meteorology***

Earth with the Greenhouse Effect



What happens when the "blanket gets too thick?

Fig 4.7: ***Weather: A Concise Introduction***

Energy Budget cont.

We've discussed the composition of the atmosphere

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How energy is transferred throughout the atmosphere

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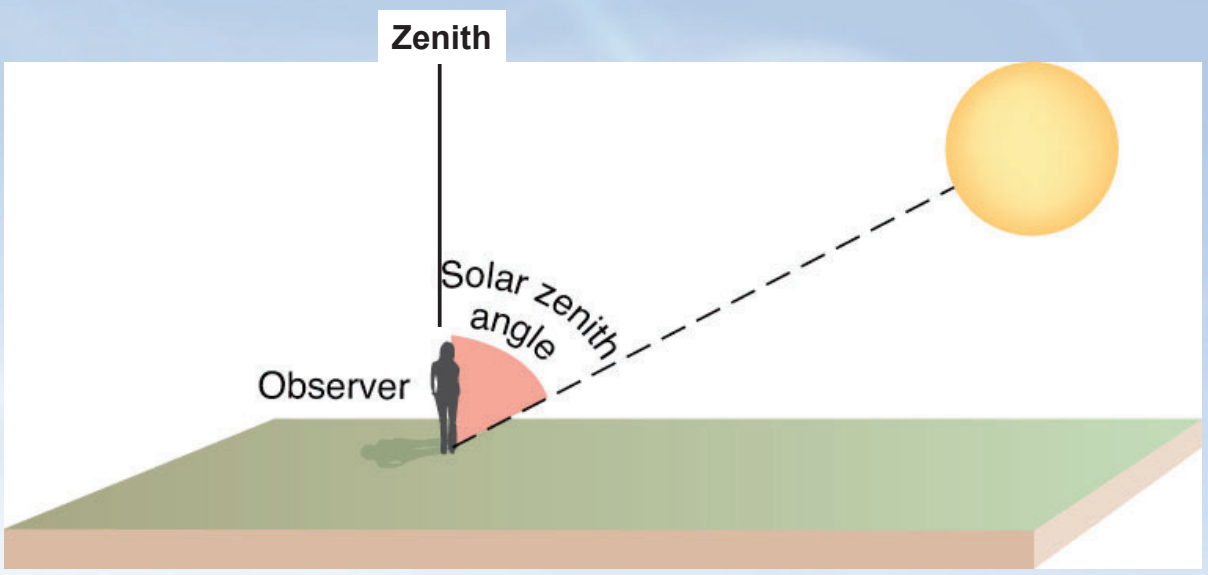
Now we'll discuss how composition and the seasons affects surface temperature

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

Solar Zenith Angle

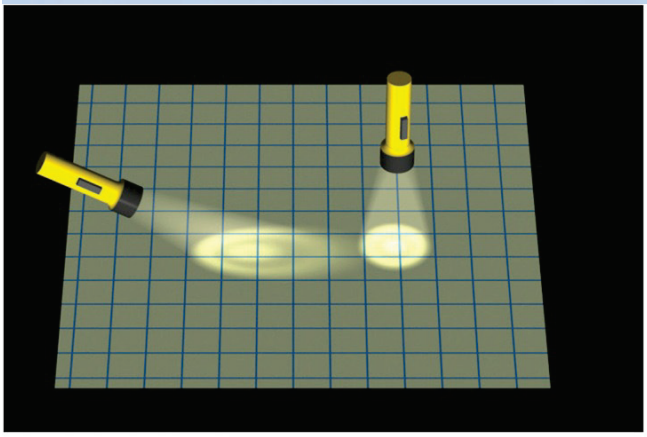


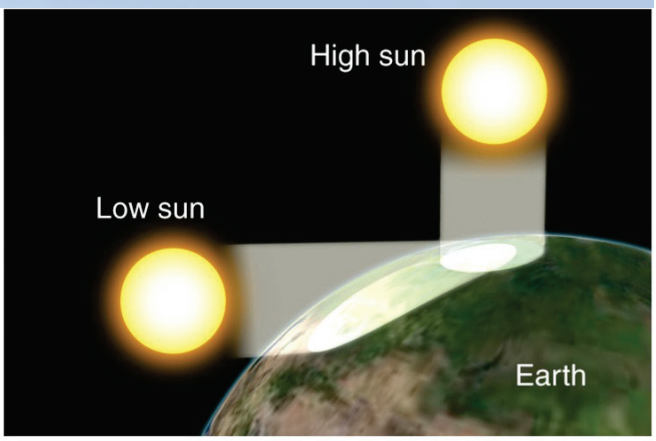
Zenith – the point directly over your head

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

Fig 2-13 *Meteorology: Understanding the Atmosphere*

Solar Zenith Angle



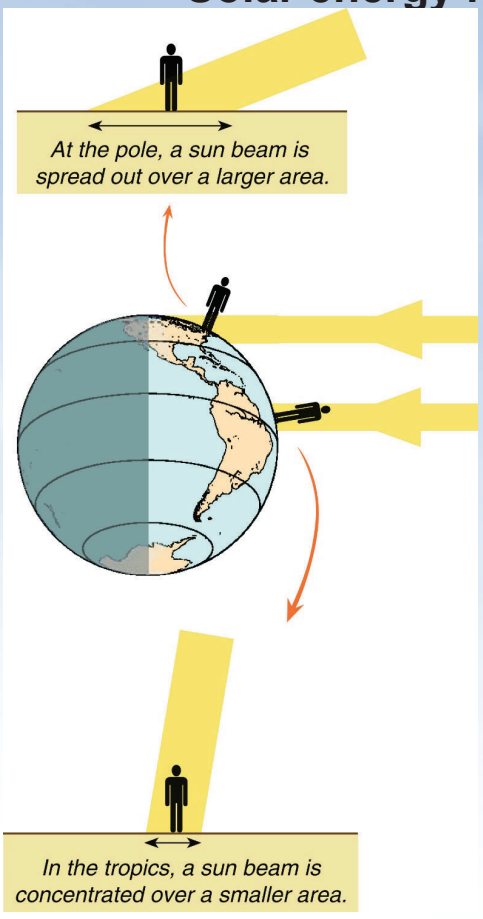


The intensity of light reaching the surface decreases as the sun lowers in the sky

As SZA ↑ Intensity ↓

Fig 2.21: *Essentials of Meteorology*

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 4.8: *Weather: A Concise Introduction*

Solar energy reaching the Earth's surface

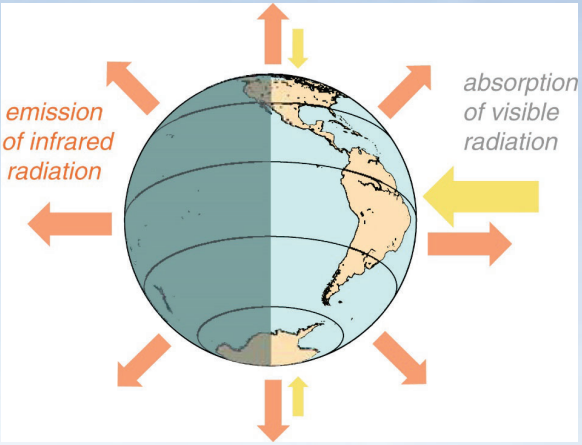


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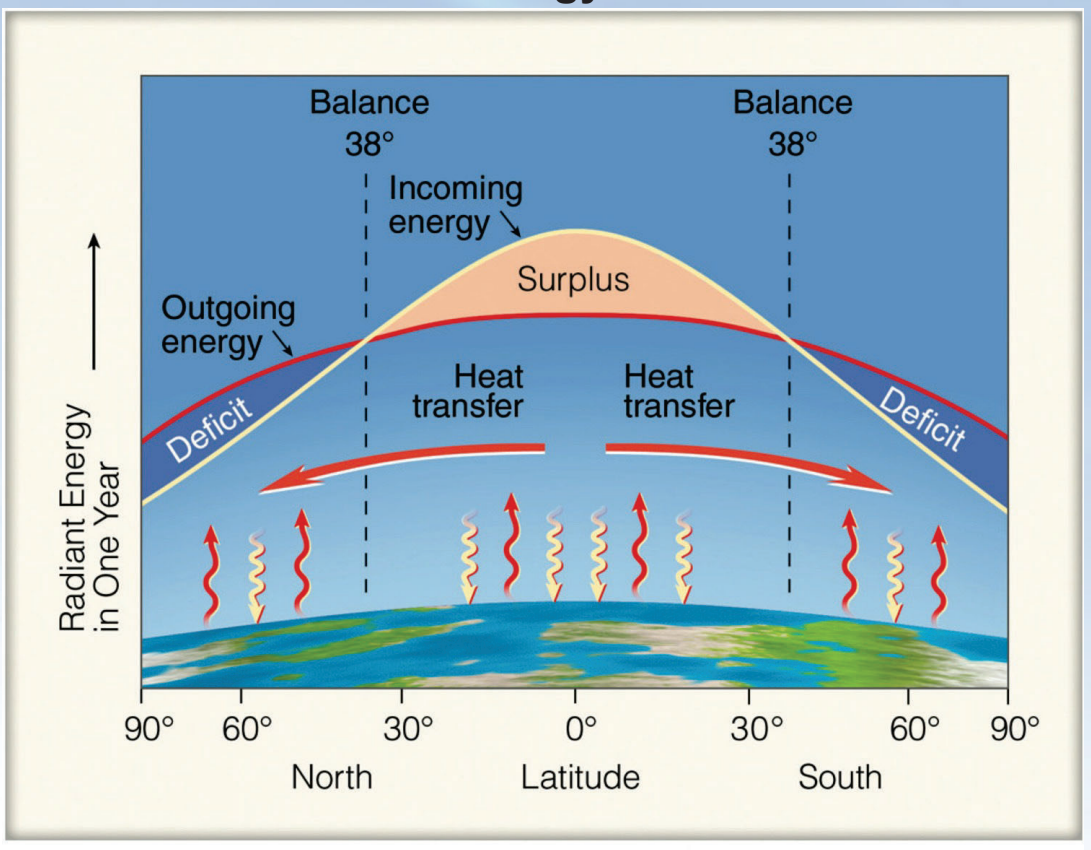
Fig 4.9: ***Weather: A Concise Introduction***

Global Energy Balance



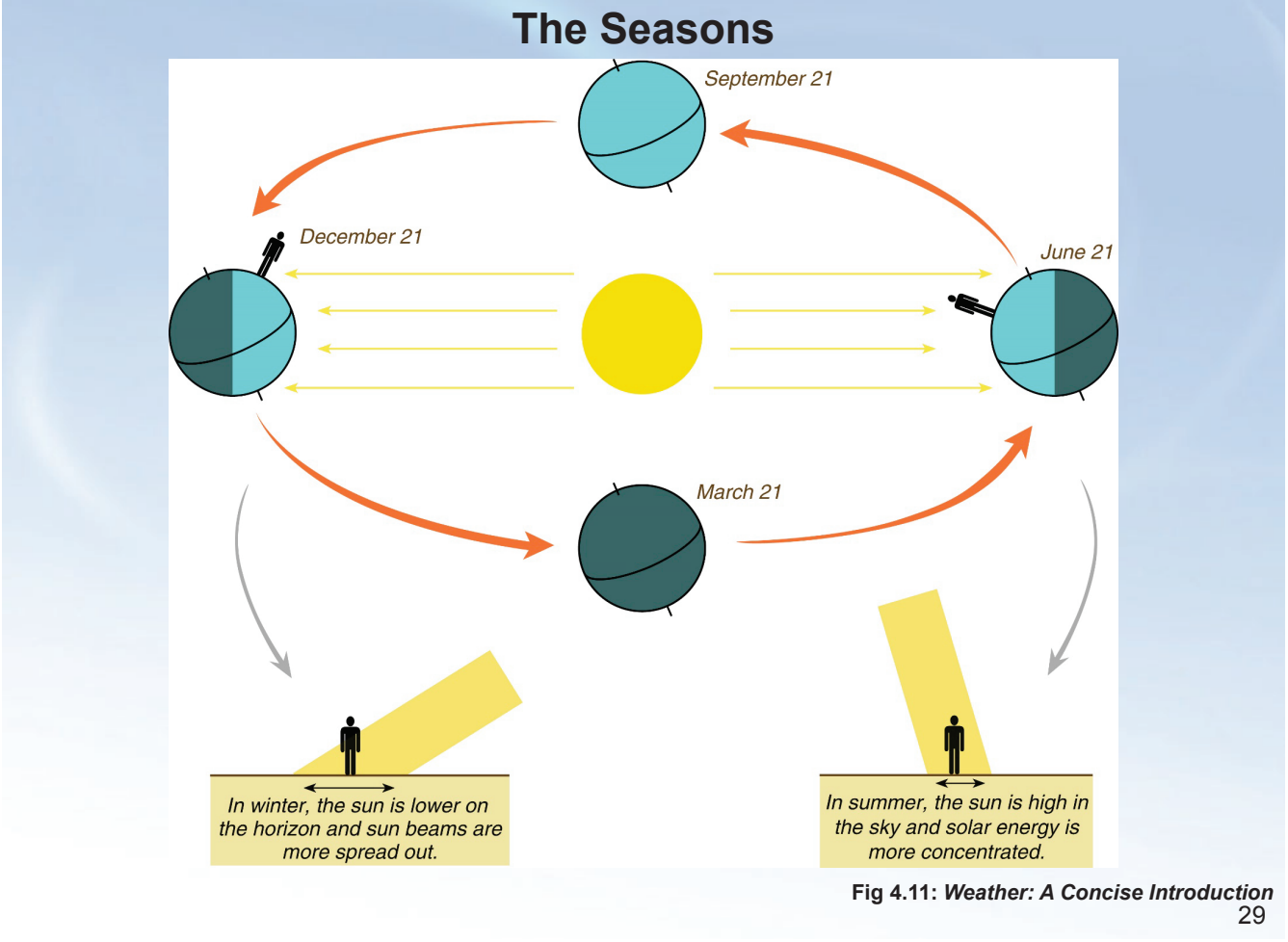


Fig 4.11: ***Weather: A Concise Introduction***