Temperature
AOSC 200

Tim Canty

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

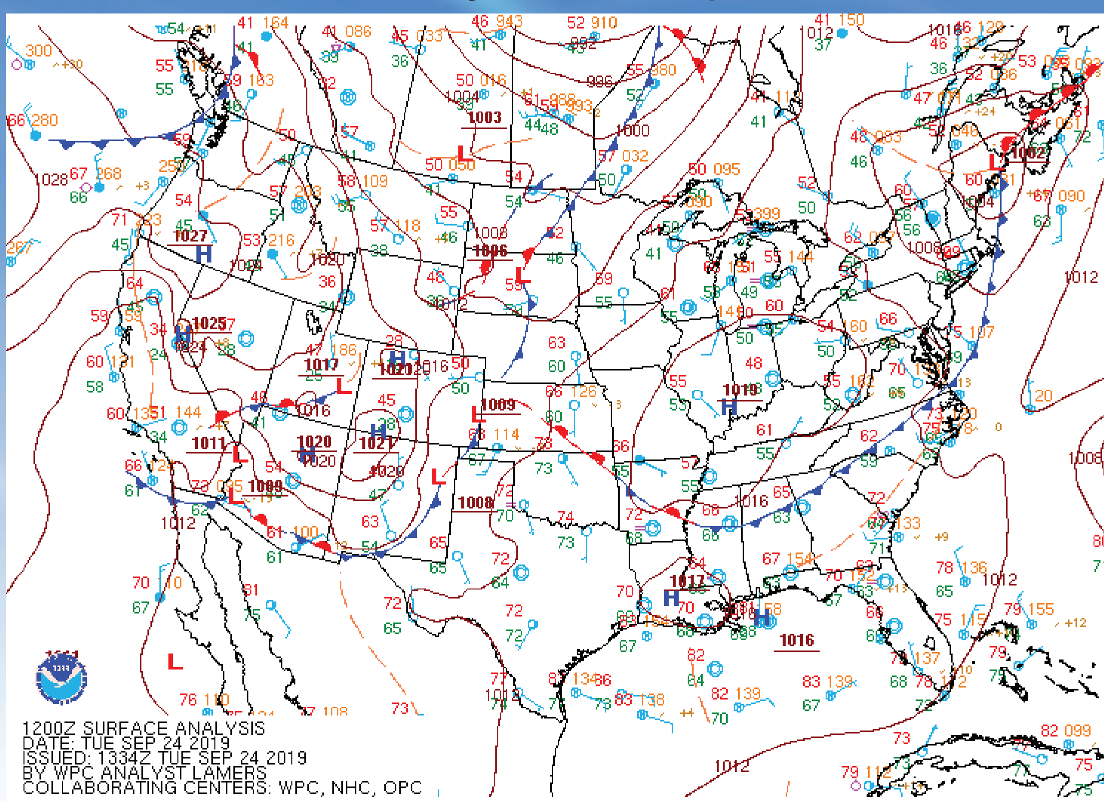
Topics for today:

- **Daily Temperatures**
- **Role of clouds, latitude, land/water**

Lecture 09

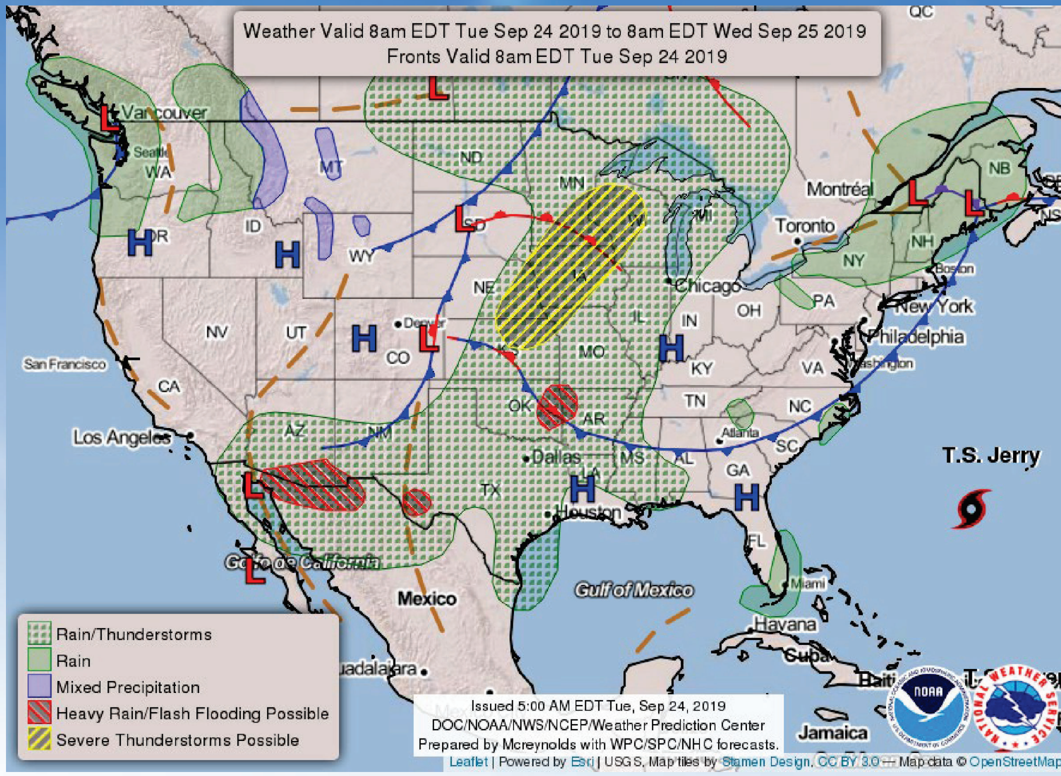
Sep 24 2019

Today's Weather Map



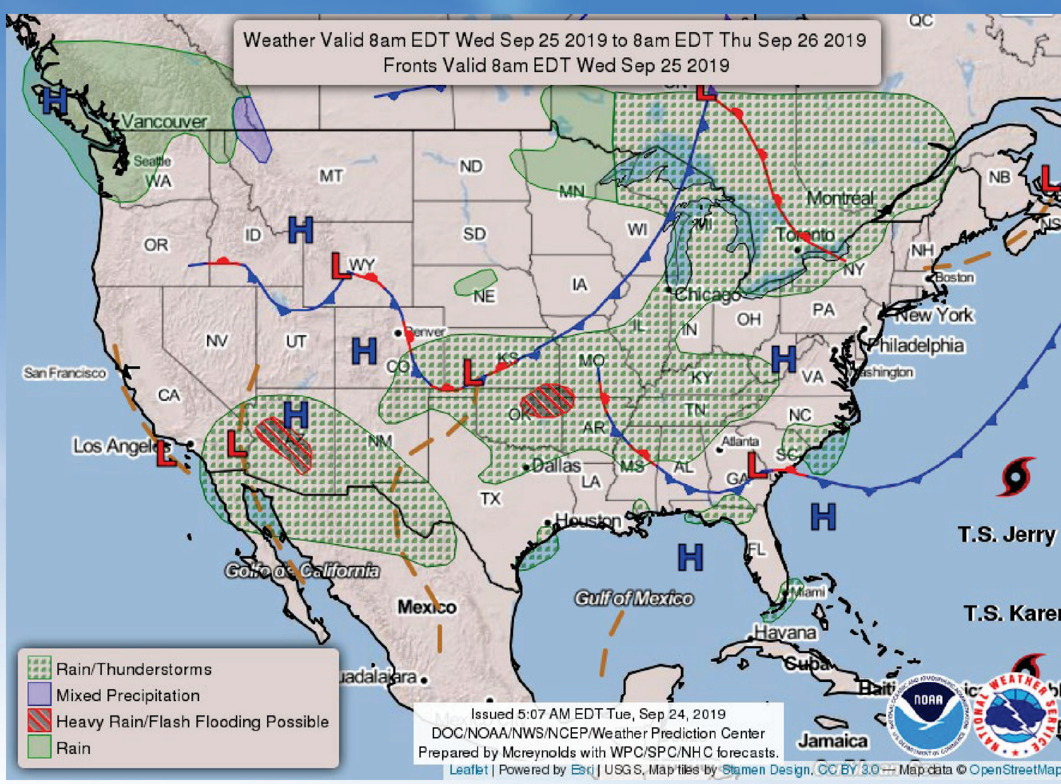
http://www.wpc.ncep.noaa.gov/sfc/namussfcwbg.gif

Today's Forecast



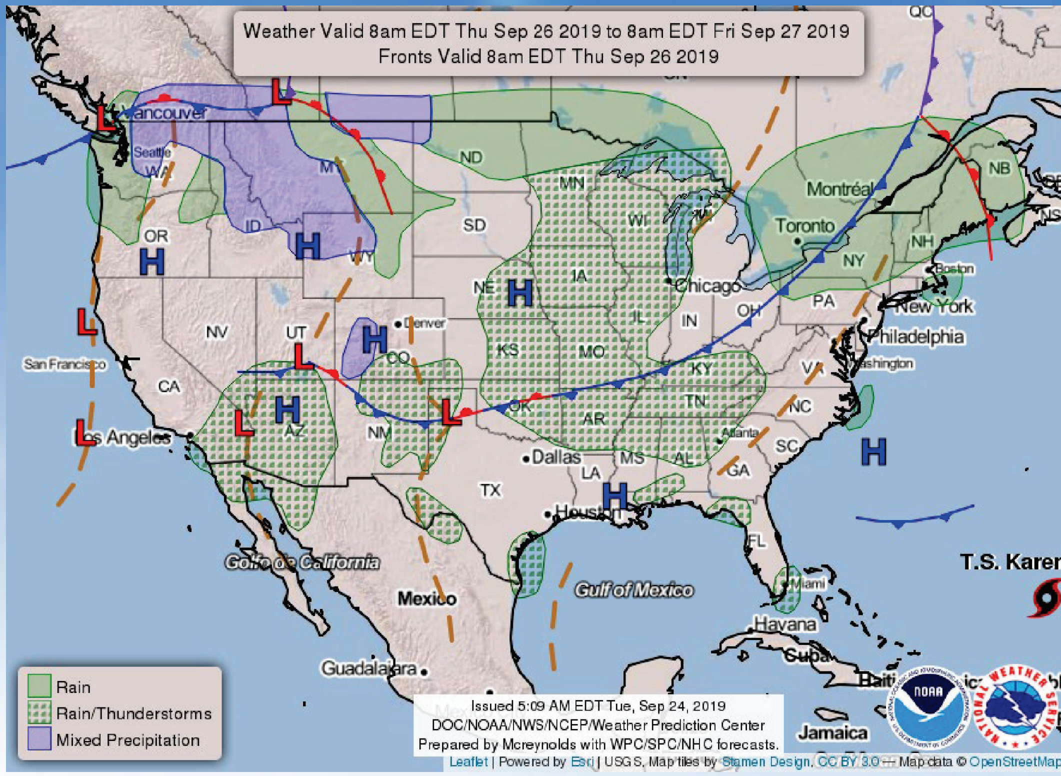
http://www.wpc.ncep.noaa.gov/national_forecast/natfcst.php

Tomorrow's Forecast



http://www.wpc.ncep.noaa.gov/national_forecast/natfcst.php

Thursday's Forecast



http://www.wpc.ncep.noaa.gov/national_forecast/natfcst.php

Why is the sky blue?

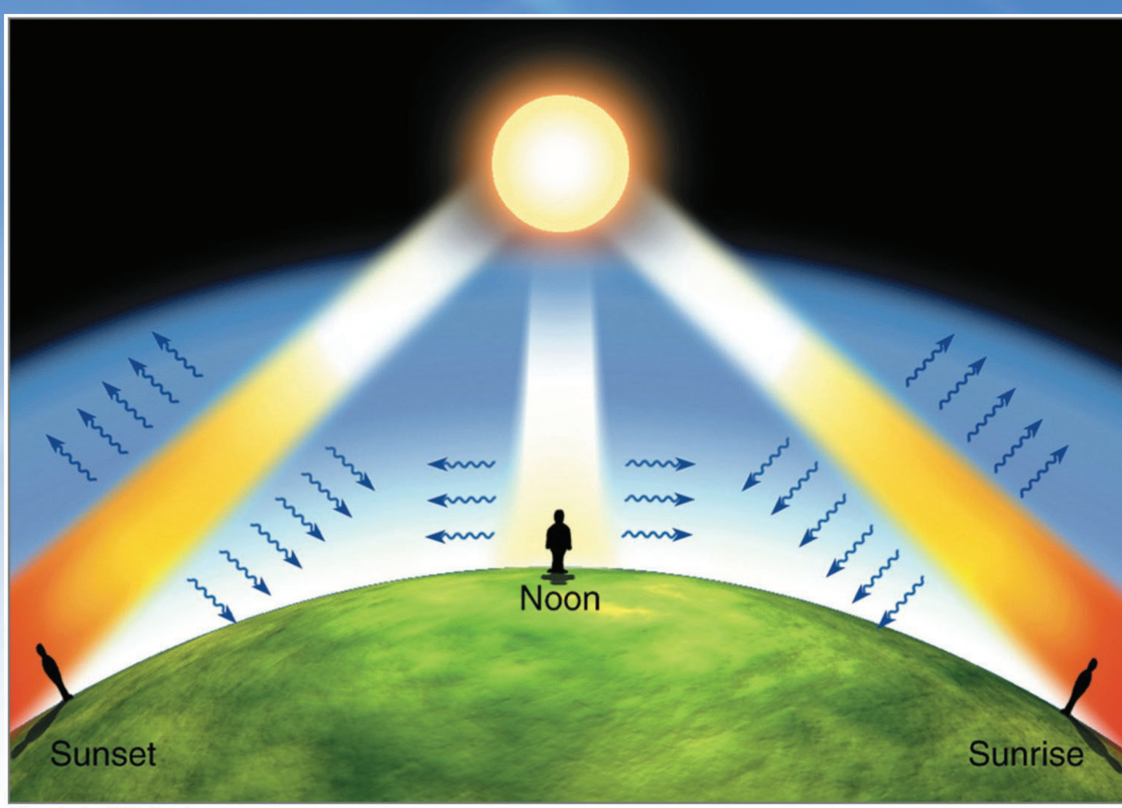
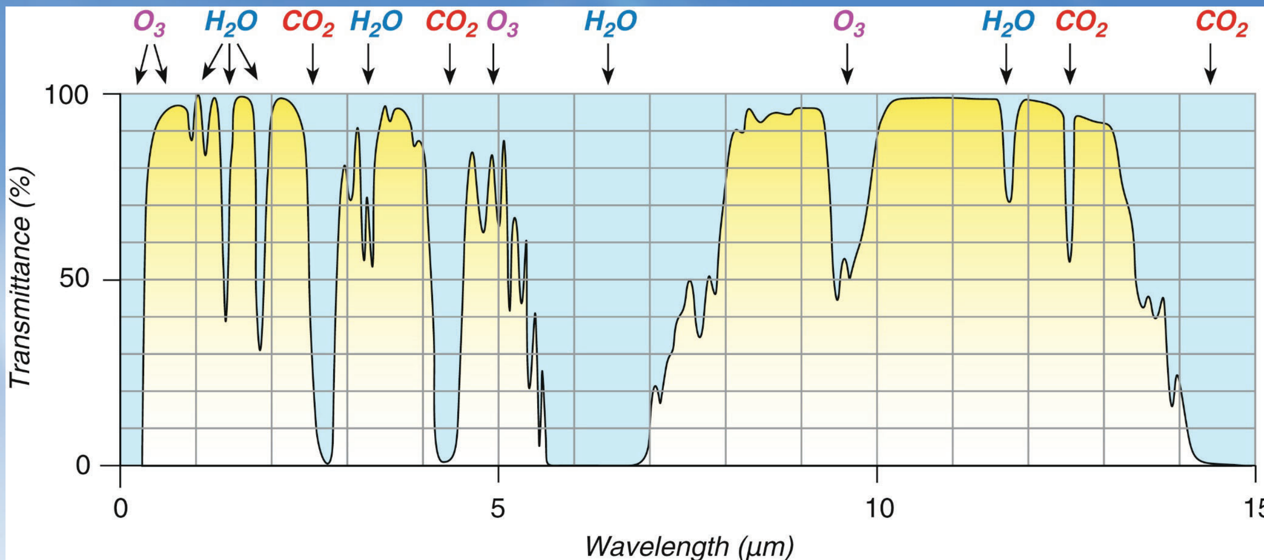


Fig 2.15: *Essentials of Meteorology*

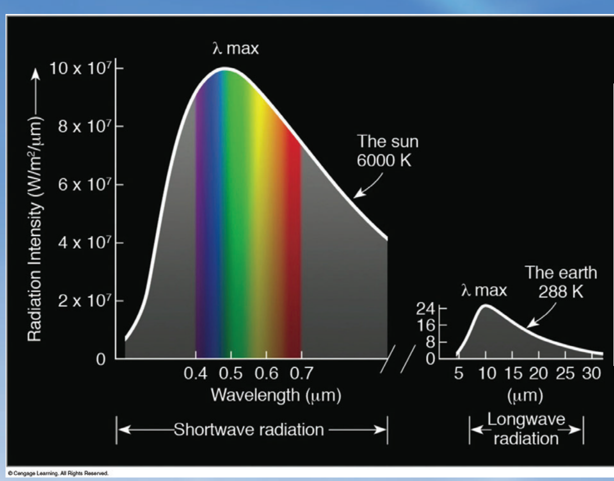
How does energy interact with the atmosphere?



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

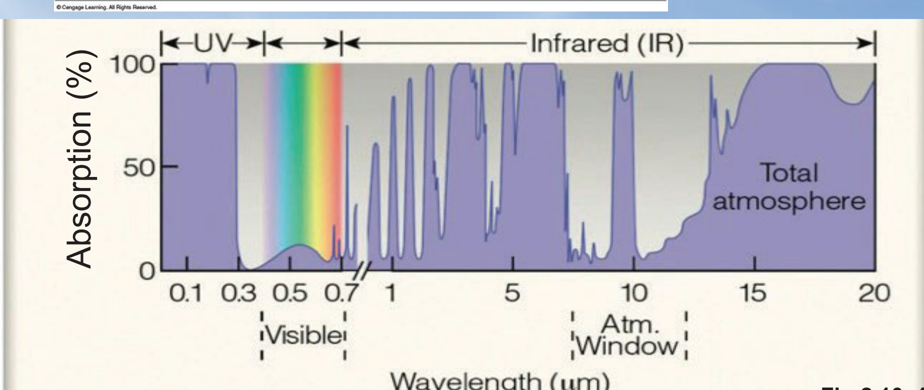
Fig 4.6 ***Weather: A Concise Introduction***

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

Incoming Solar radiation

Outgoing Terrestrial (Earth) radiation

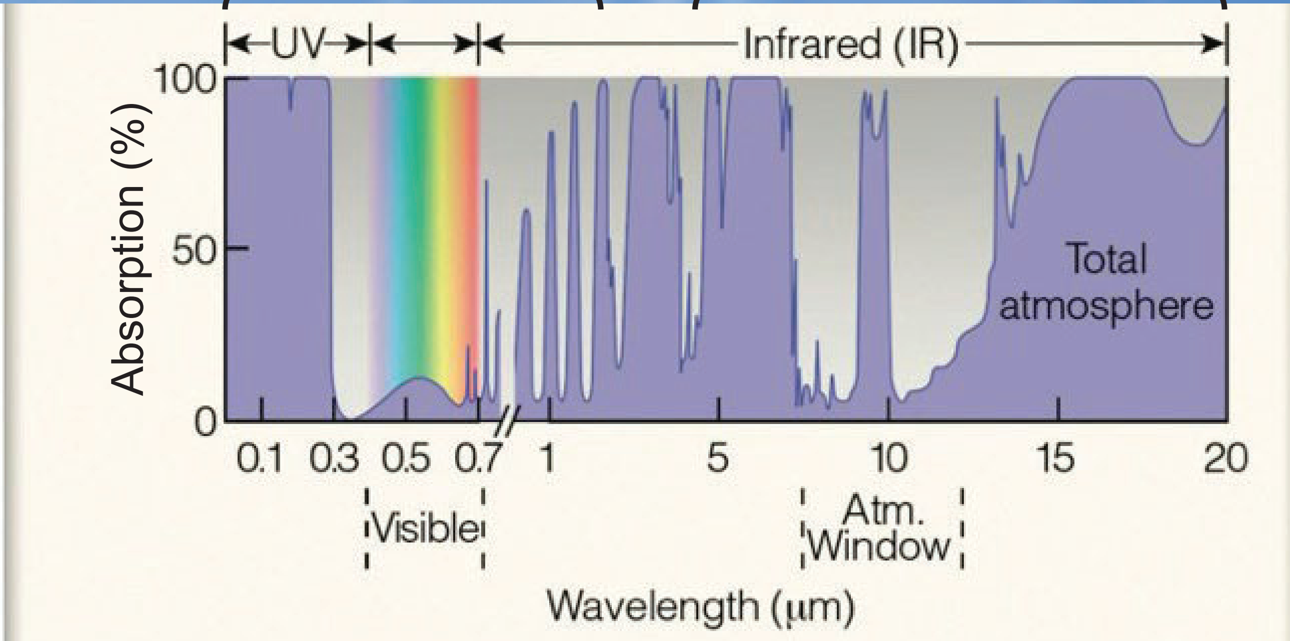


Fig 2.11: ***Essentials of Meteorology***

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.

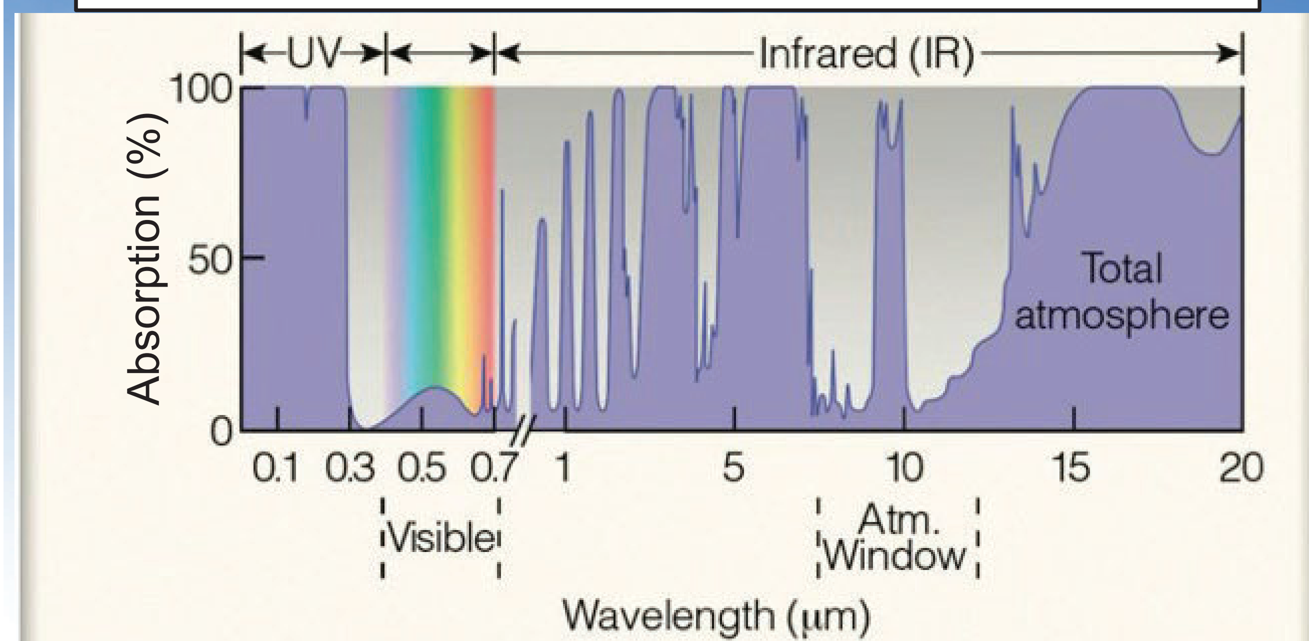


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from O_2 and O_3

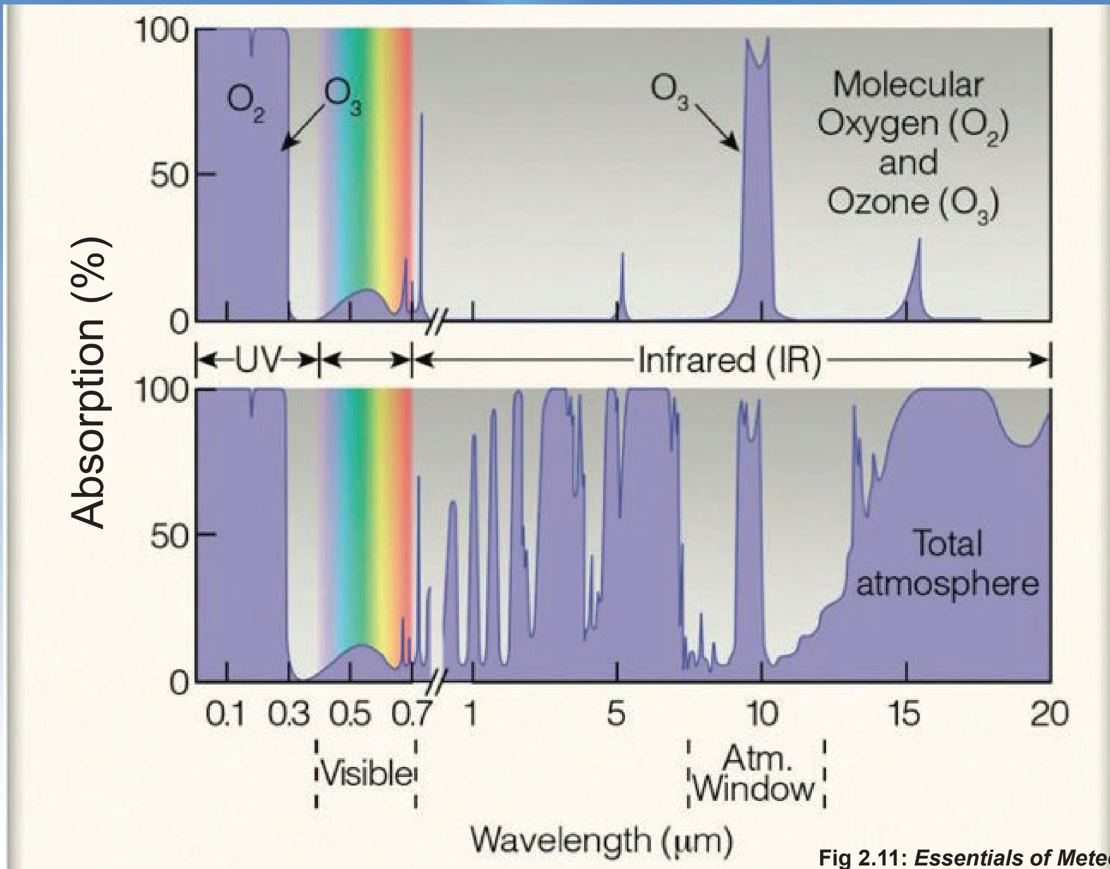


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from CH_4

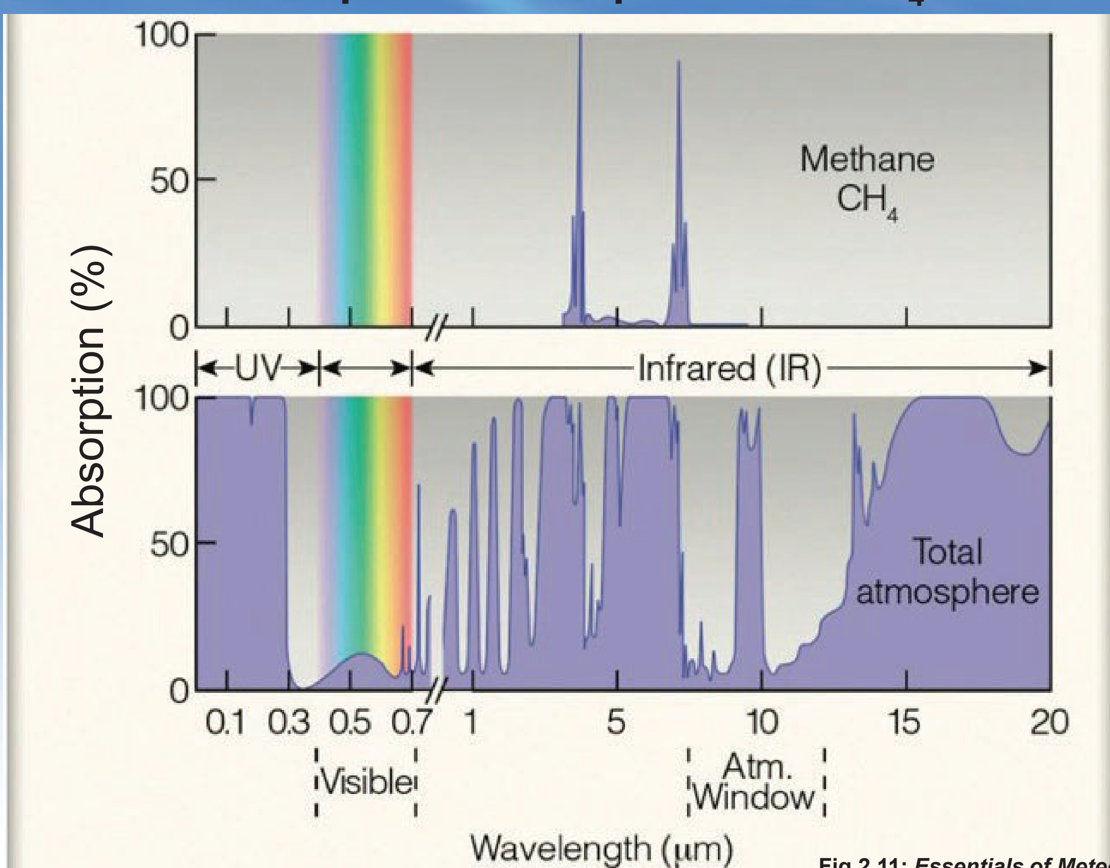


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from N_2O

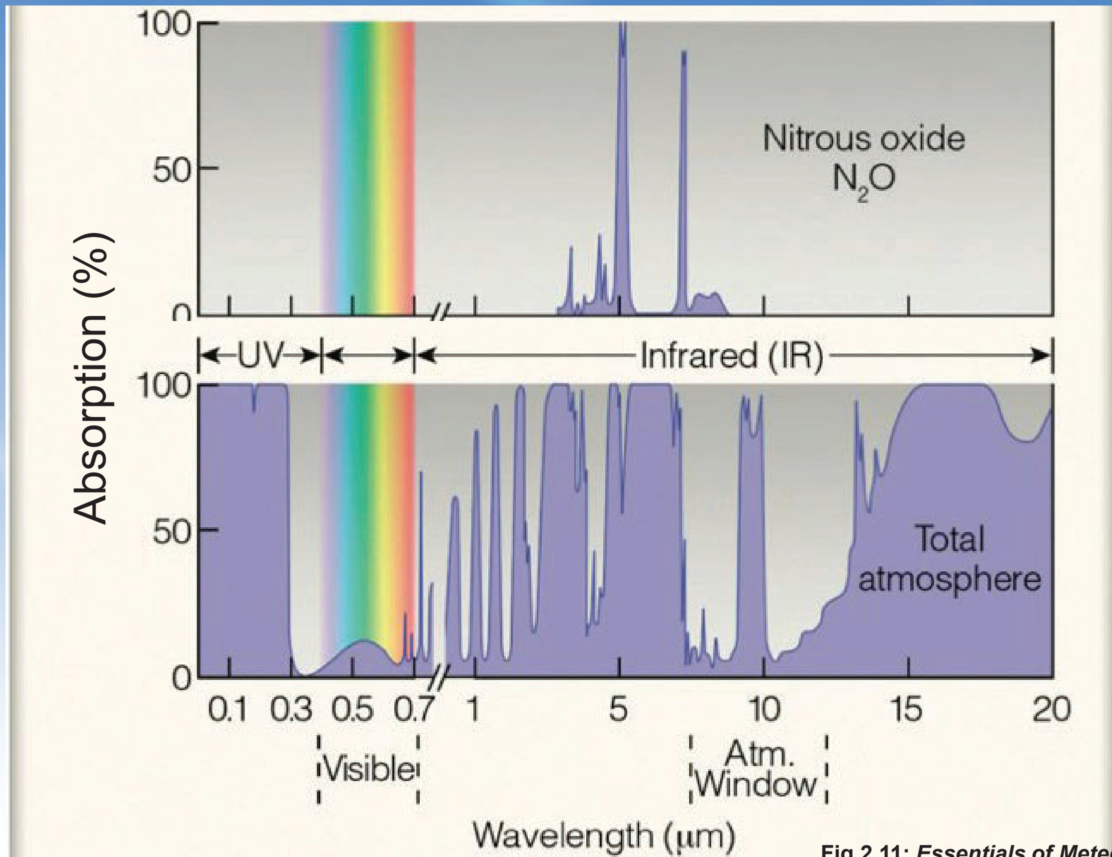


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from CO_2

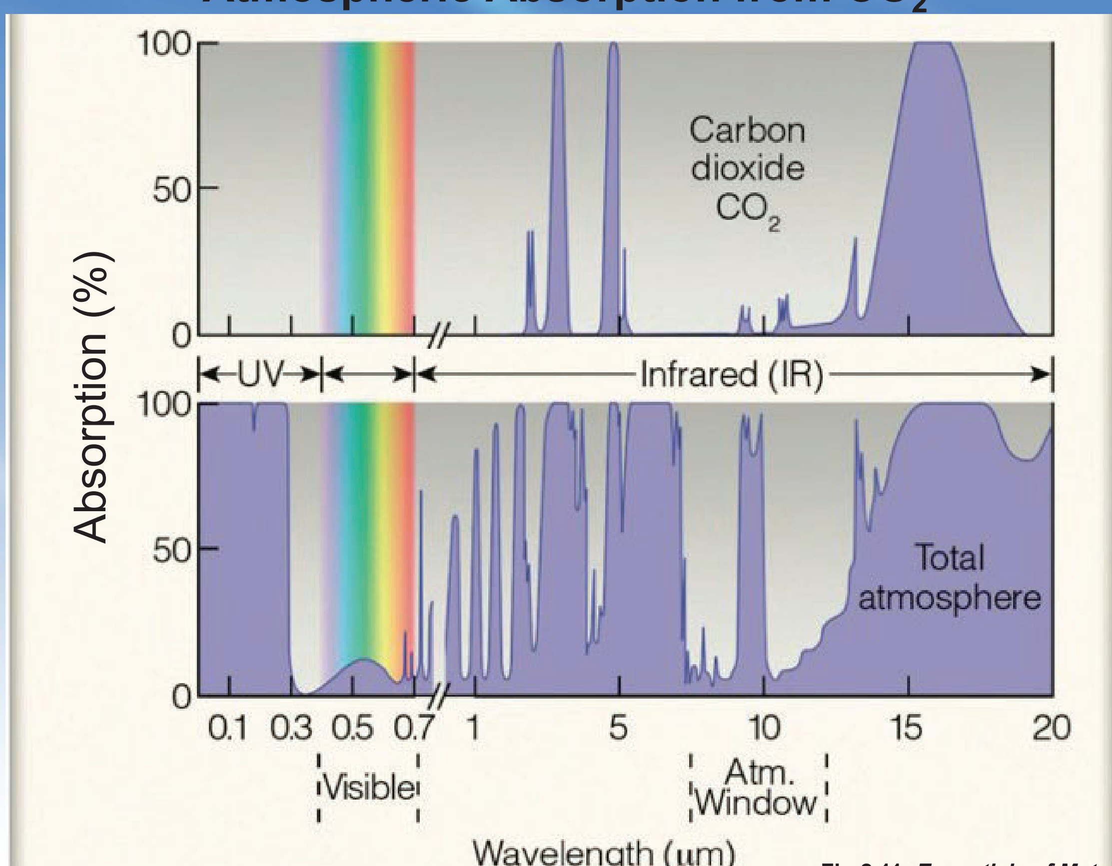


Fig 2.11: ***Essentials of Meteorology***

Atmospheric Absorption from H_2O

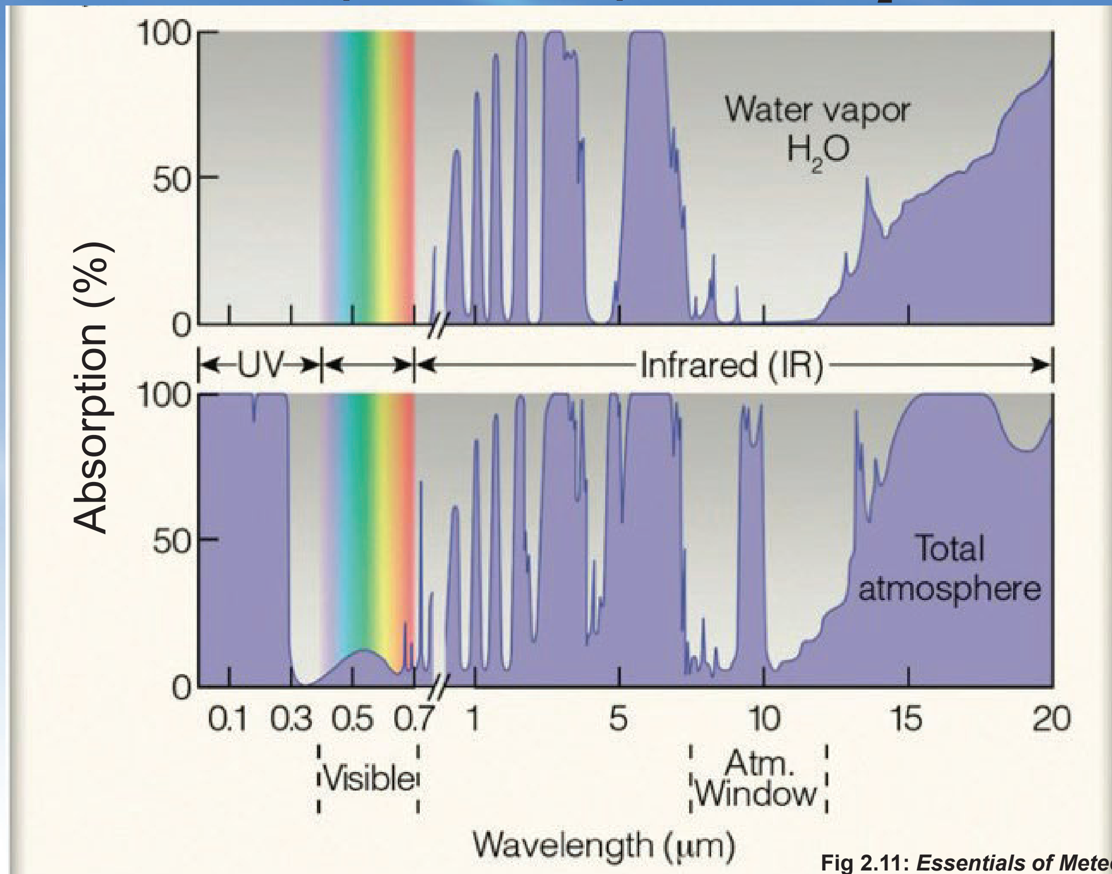


Fig 2.11: ***Essentials of Meteorology***

Earth without the Greenhouse Effect

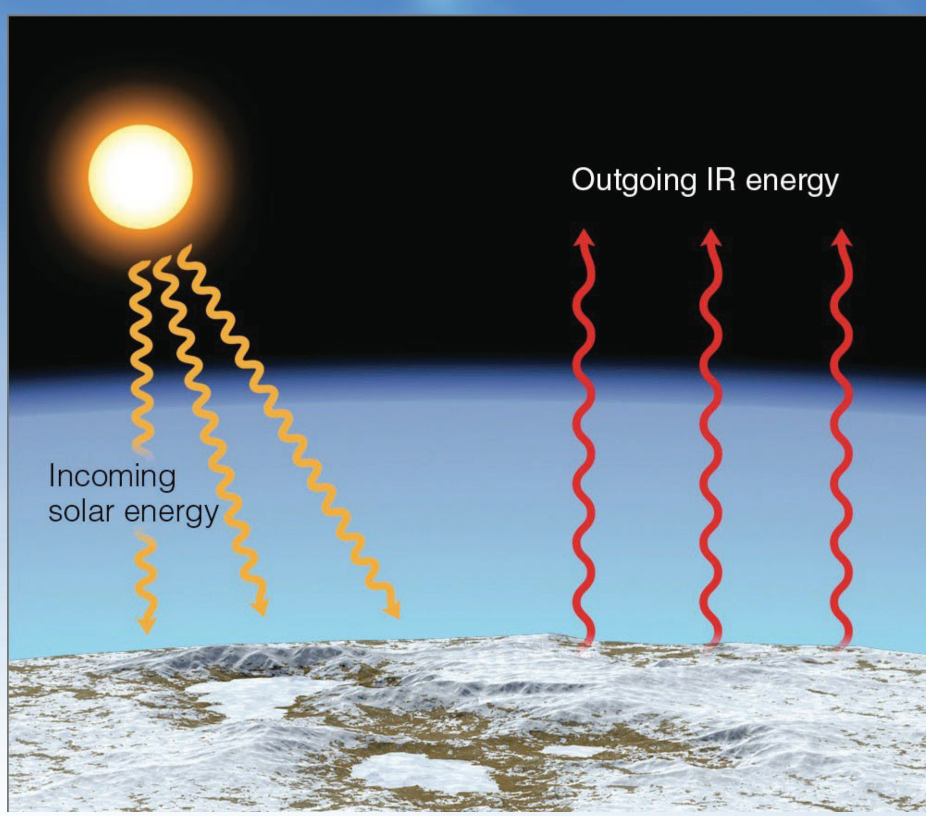


Fig 2.12a: ***Essentials of Meteorology***

Earth with the Greenhouse Effect

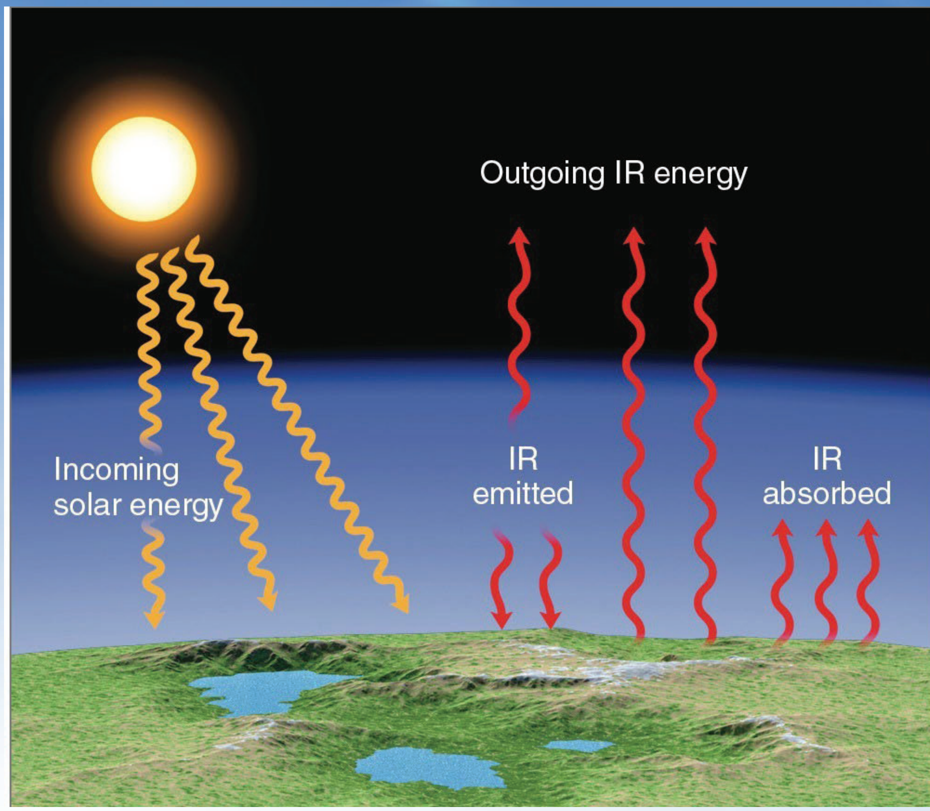
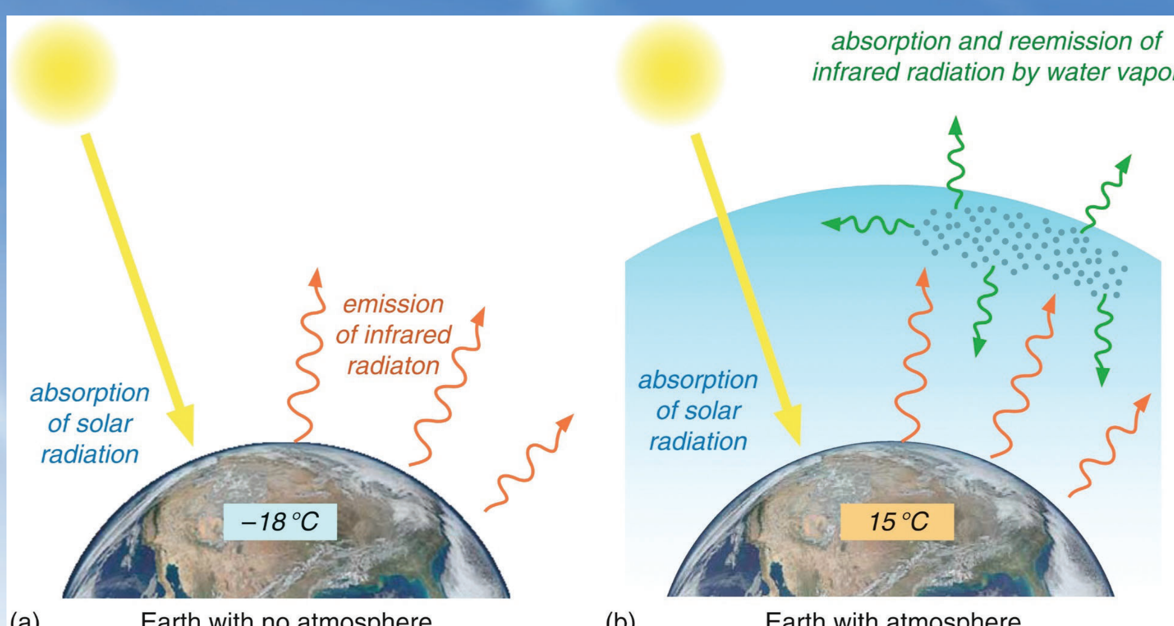


Fig 2.12b: ***Essentials of Meteorology***

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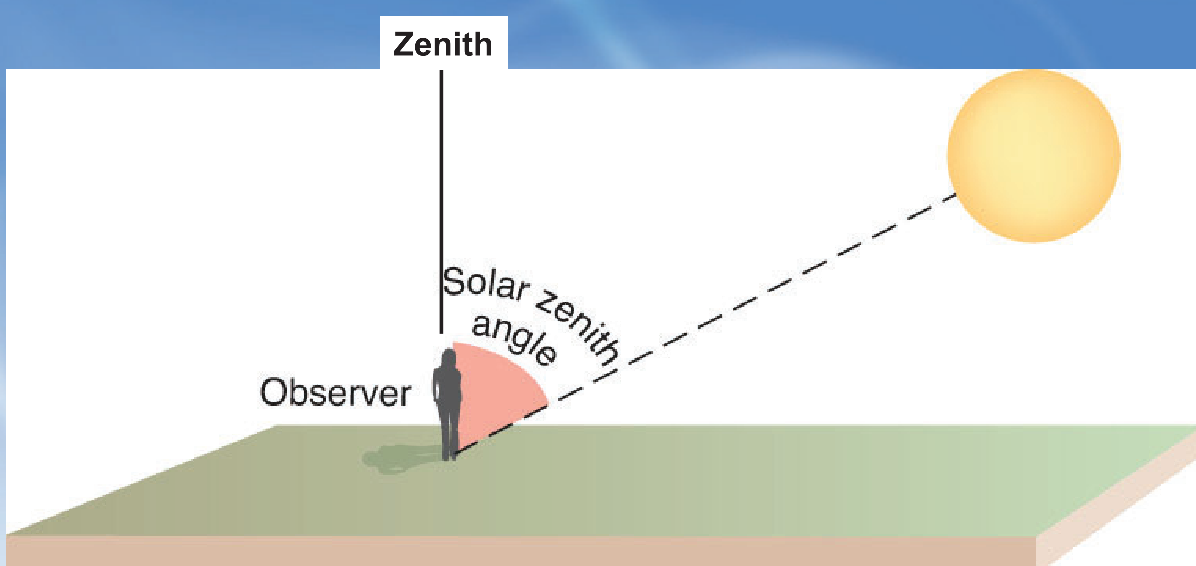
Now we'll discuss how composition and the seasons affects surface temperature

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

Solar Zenith Angle

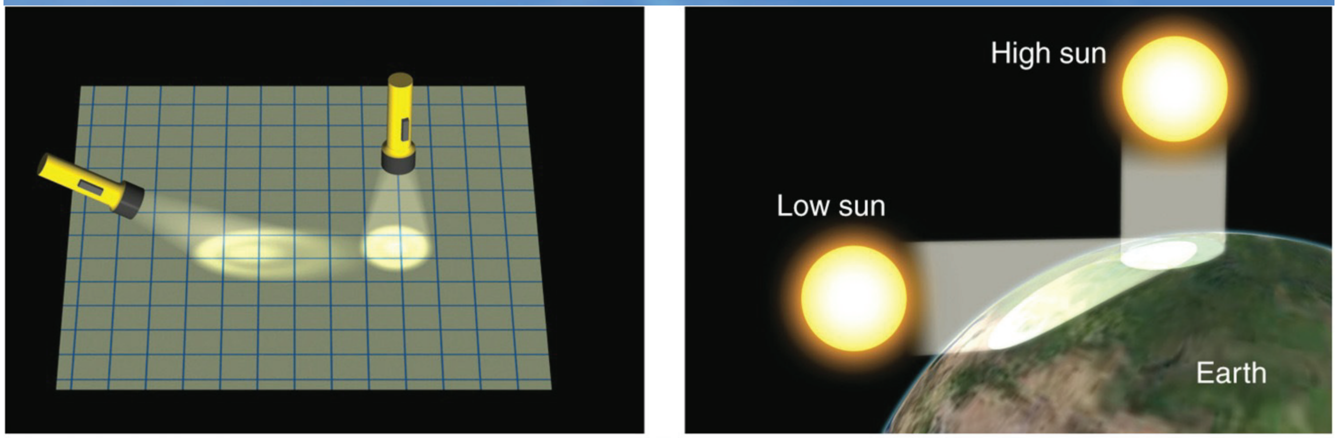


Zenith – the point directly over your head

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

Fig 2-13 *Meteorology: Understanding the Atmosphere*

Solar Zenith Angle

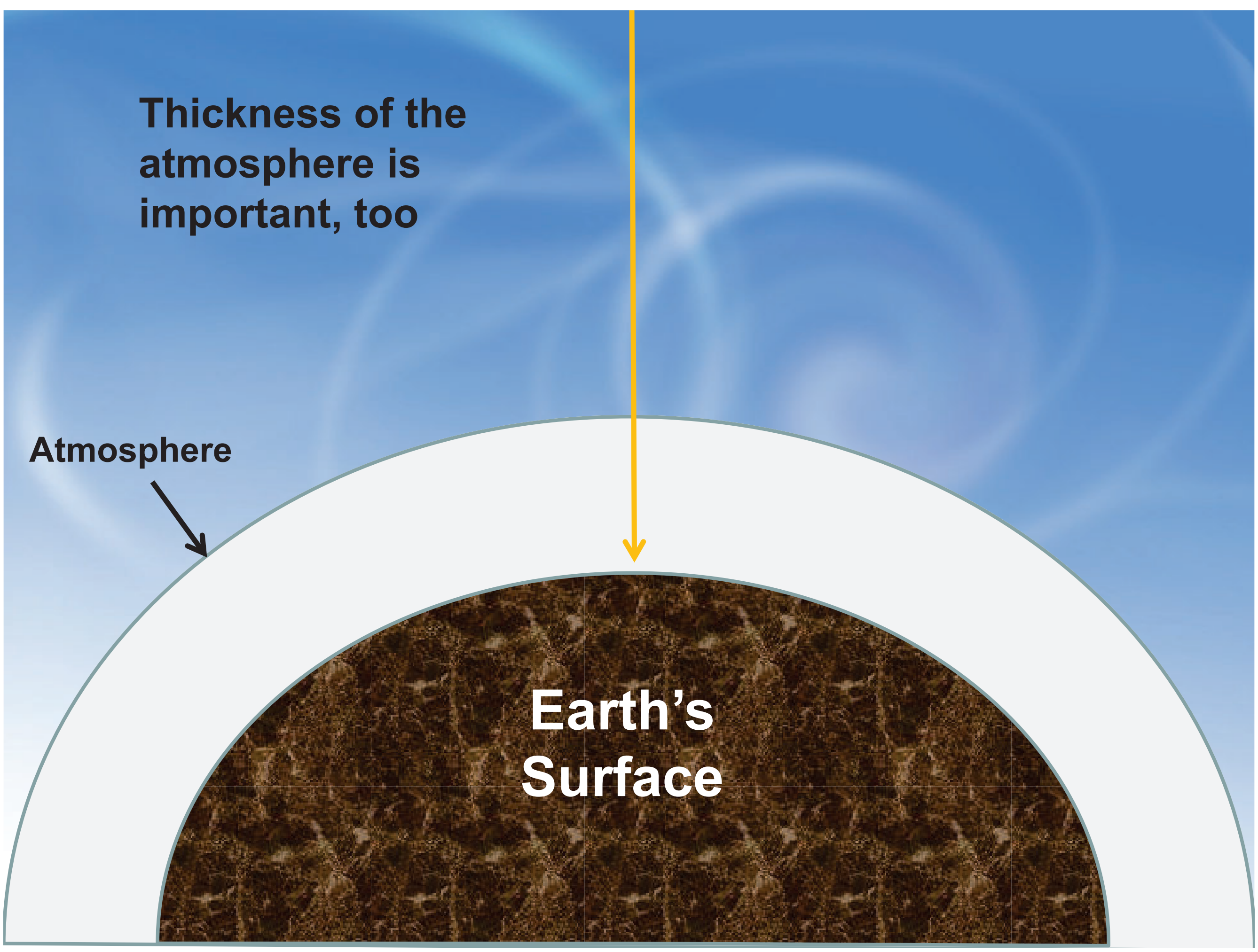


The intensity of light reaching the surface decreases as the sun lowers in the sky

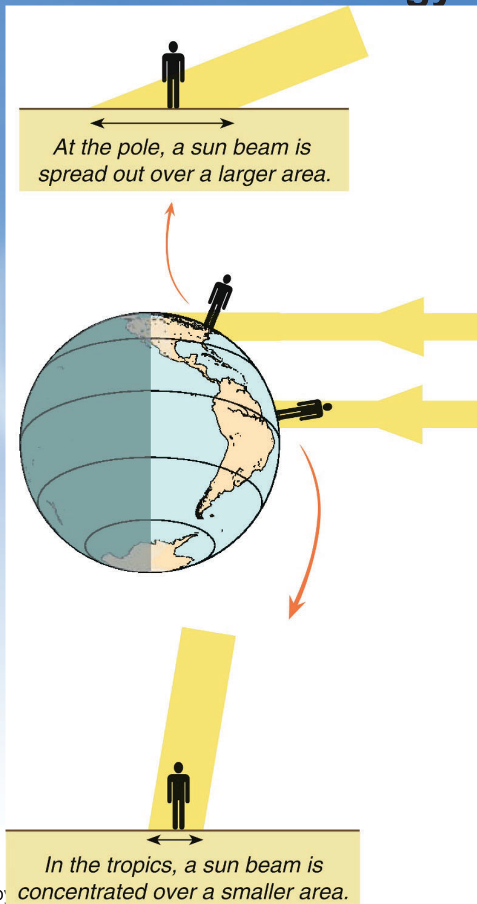
As SZA ↑ Intensity ↓

Fig 2.21: ***Essentials of Meteorology***

Thickness of the atmosphere is important, too



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

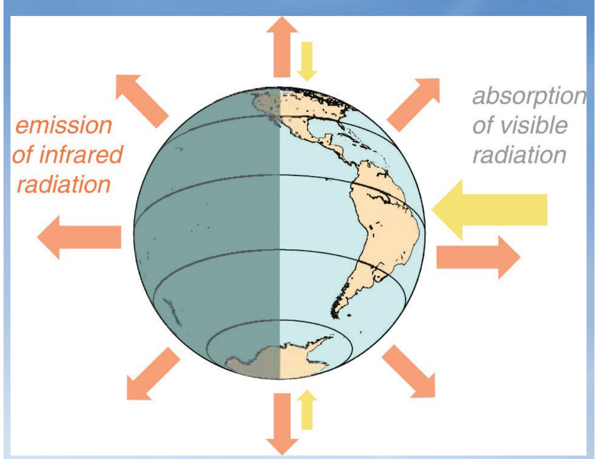


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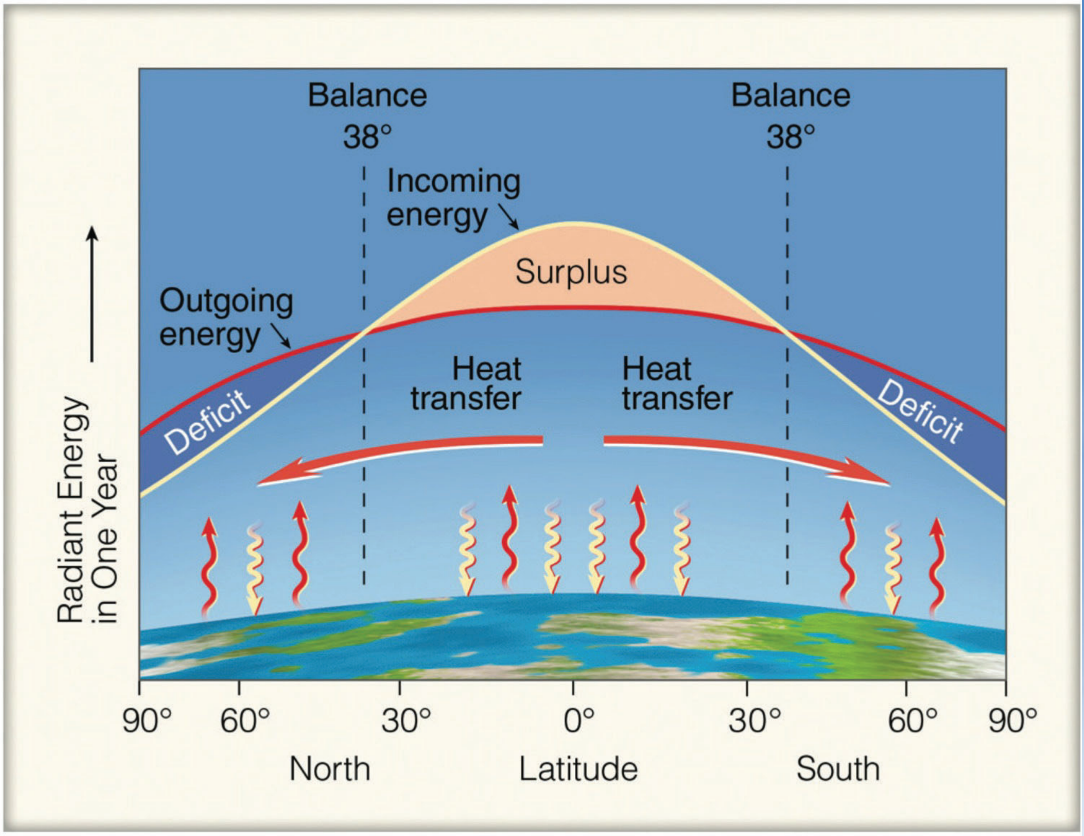
Fig 4.9: ***Weather: A Concise Introduction***

Global Energy Balance



The Seasons

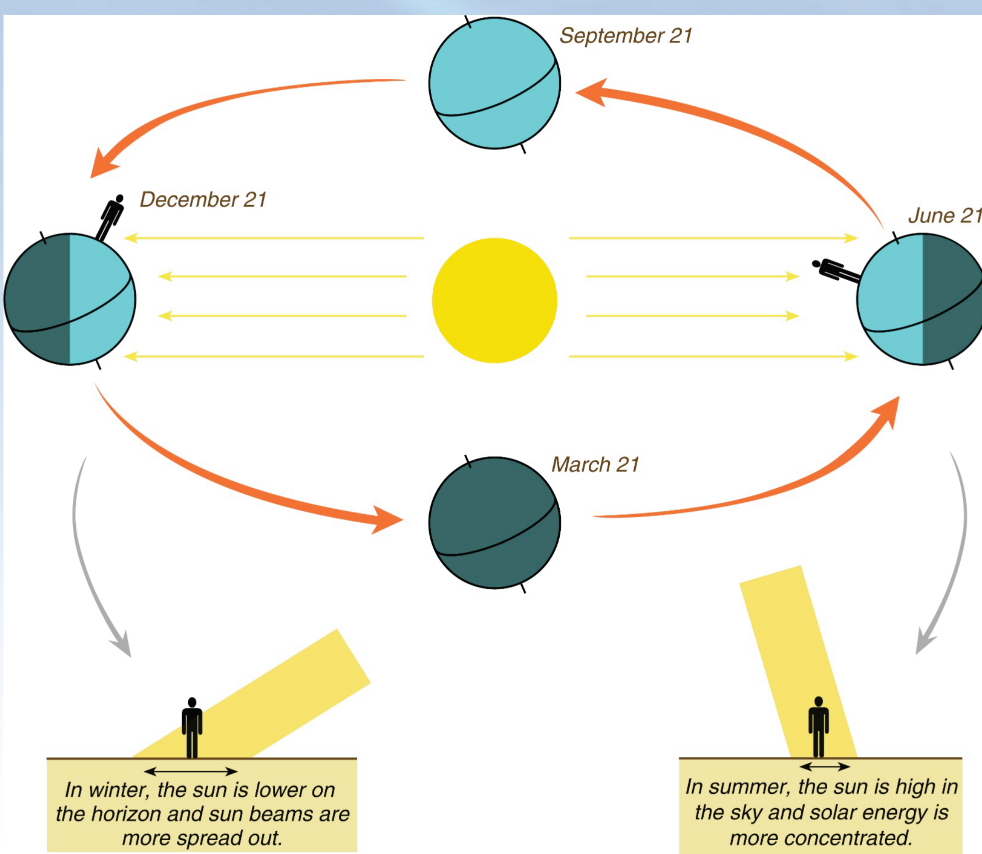


Fig 4.11: *Weather: A Concise Introduction*

The Seasons

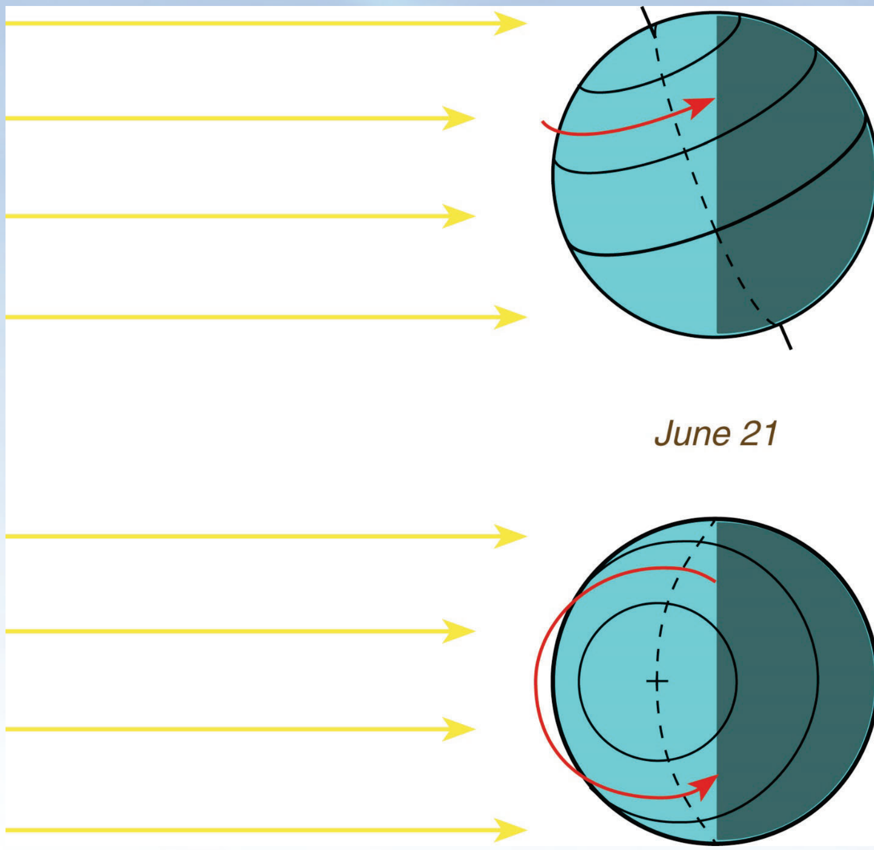


Fig 4.12: *Weather: A Concise Introduction*

Daily Temperatures

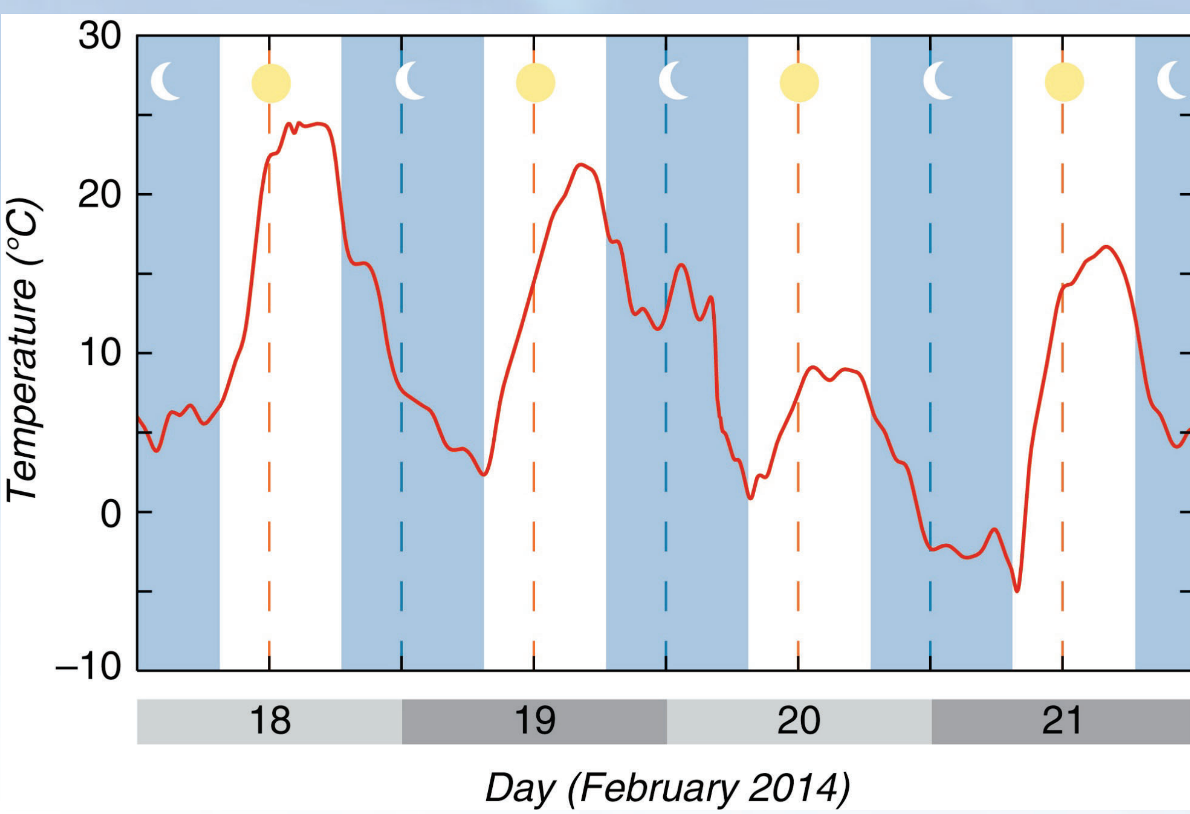
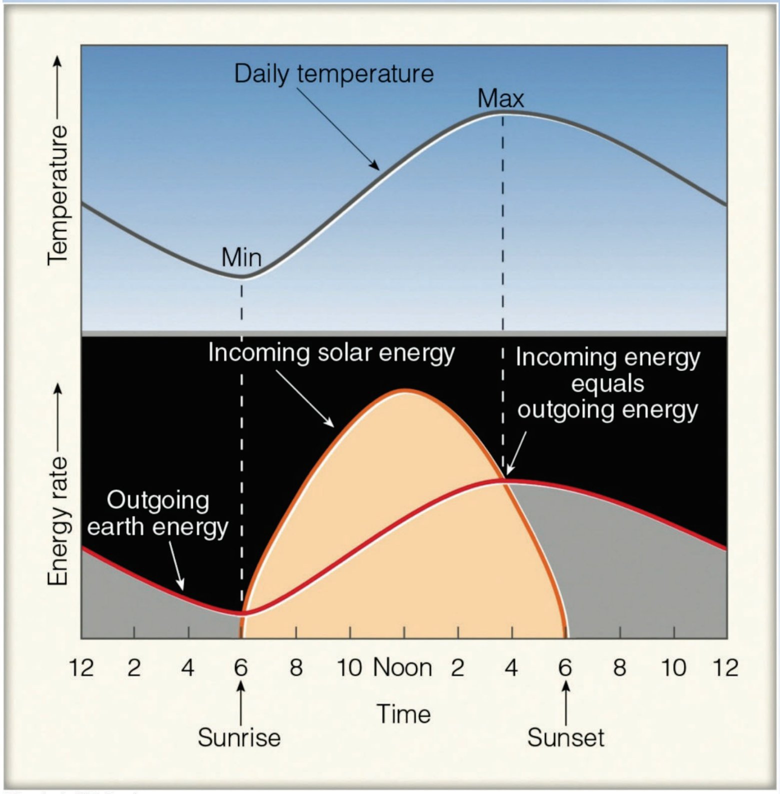


Fig 4.13: *Weather: A Concise Introduction*

Daily Temperatures



Solar energy is most intense at noon.

Suns rays are more "focused" at noon.

Solar radiation (incoming radiation) greater than surface radiation (outgoing radiation) until later in afternoon.

Lowest temperature occurs shortly after sunrise when outgoing radiation is greater than incoming.

Fig 3.2: ***Essentials of Meteorology***

Air temperature data

- **Daily mean temperature determined two ways**
  1. **average of max. and min. temperatures for the day**
  2. **average of 24 hourly temperatures**
- **Daily temperature range – difference between max. and min. temperatures**
- **Monthly mean temperature – average of daily mean for the month**
- **Annual mean temperature – average of monthly means**
- **Annual temperature range – difference between coldest monthly mean and warmest monthly mean**

Daytime Temperatures

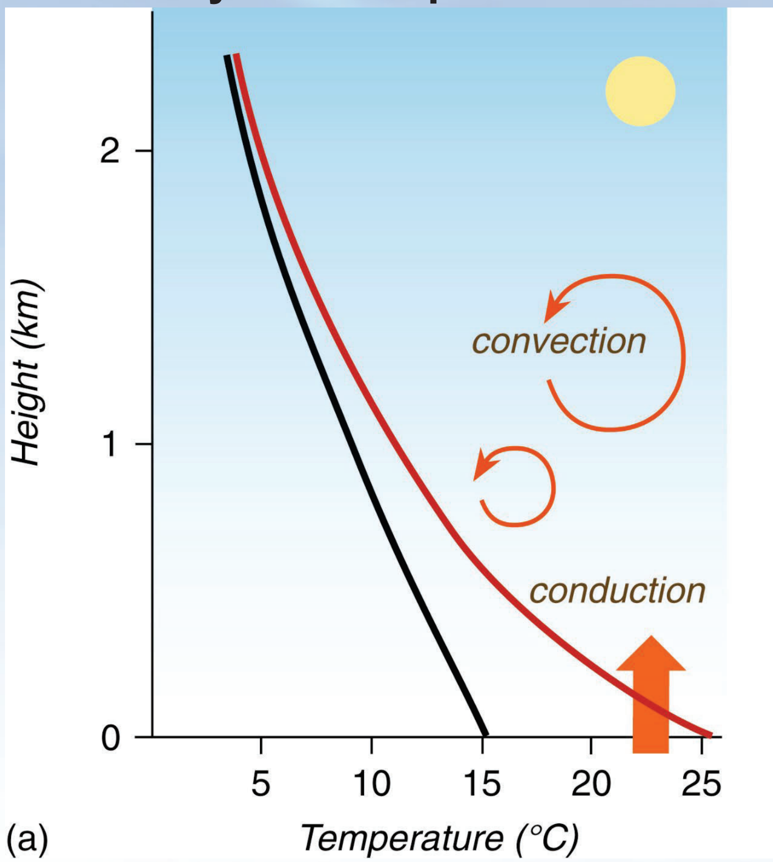
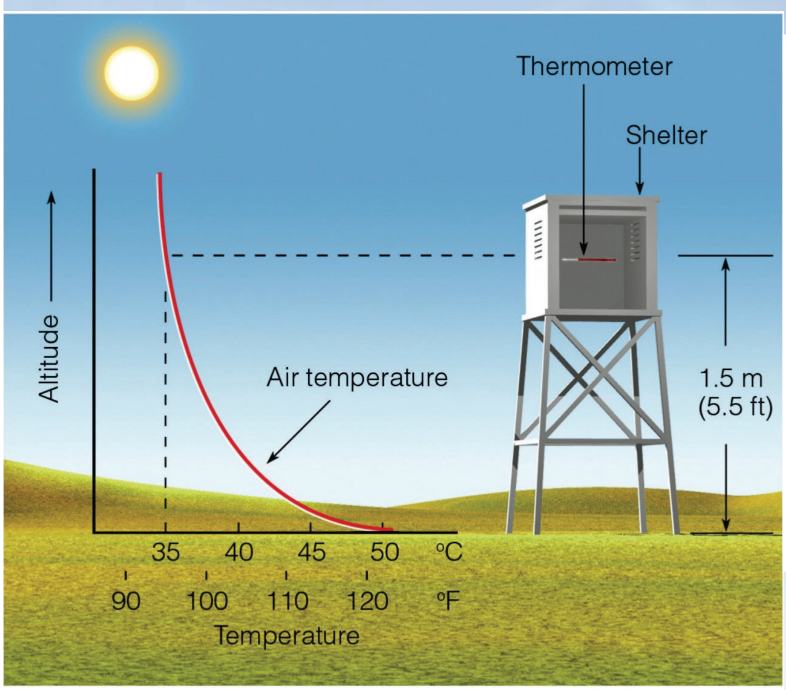


Fig 4.14: *Weather: A Concise Introduction*

Daytime Temperatures



As the sun rises, the ground warms.

Air in contact with ground warms, too.

On calm days, air above the surface is cooler

On windy days, the air is mixed so the difference in temperature between the surface and air above is smaller

Fig 3.1: *Essentials of Meteorology*

Nighttime Temperatures

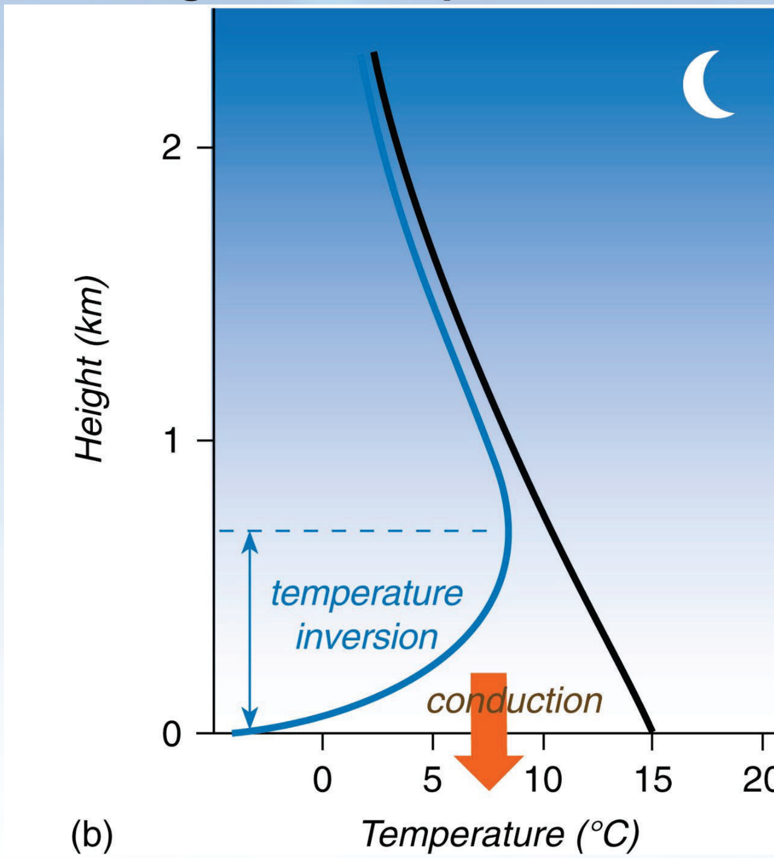
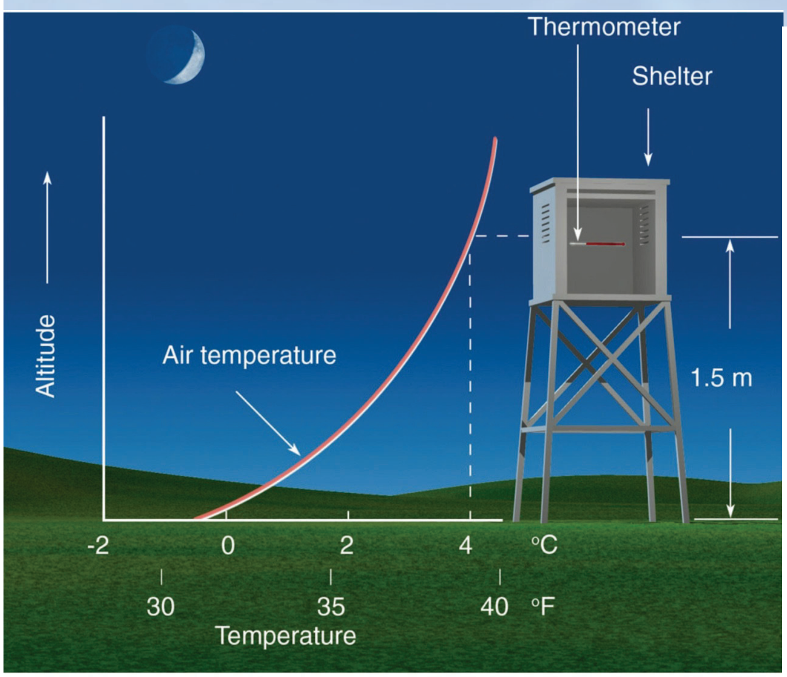


Fig 4.14: ***Weather: A Concise Introduction***

Nighttime Temperatures



As the sun sets, the ground cools by radiating it's heat to space

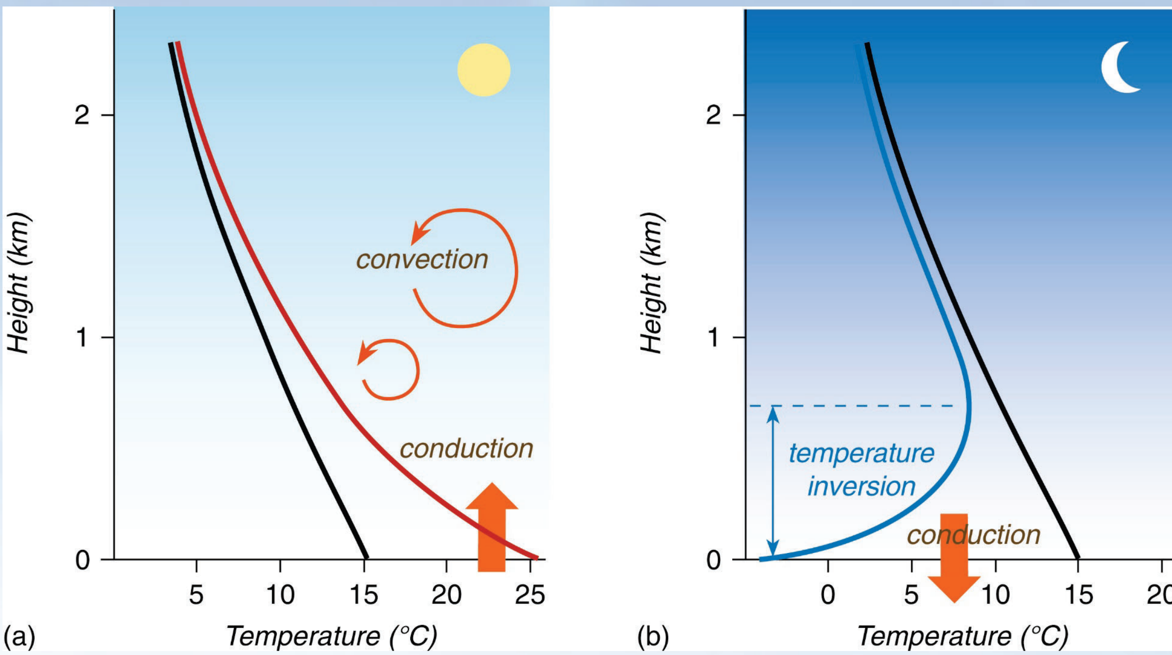
Air radiates some heat to the ground and the ground radiates this heat away, too.

As the night progresses, the ground and the air just above the surface cool more rapidly than the air above.

Increase in temperature above the ground is called a "radiation inversion"

Fig 3.5: ***Essentials of Meteorology***

Daily Temperatures



Daily temperature changes are largest near the surface

Fig 4.14: ***Weather: A Concise Introduction***

Role of Clouds

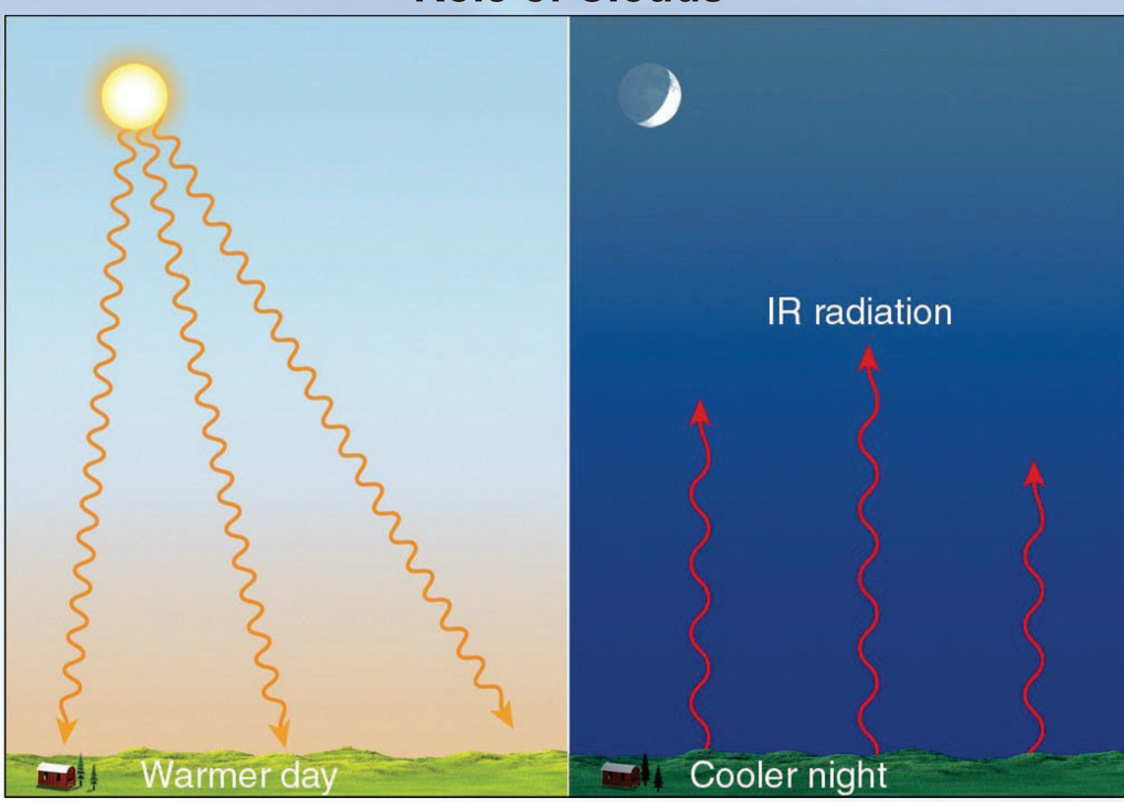
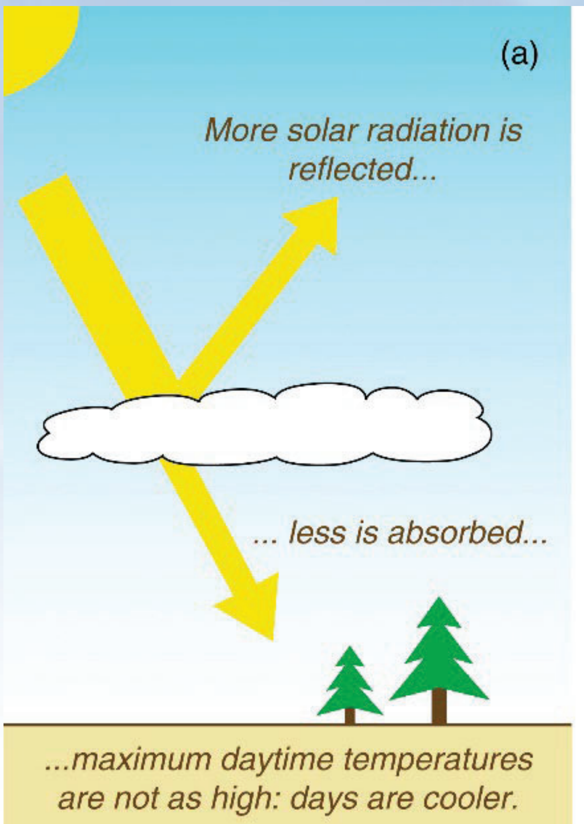


Fig 3.14: ***Essentials of Meteorology***

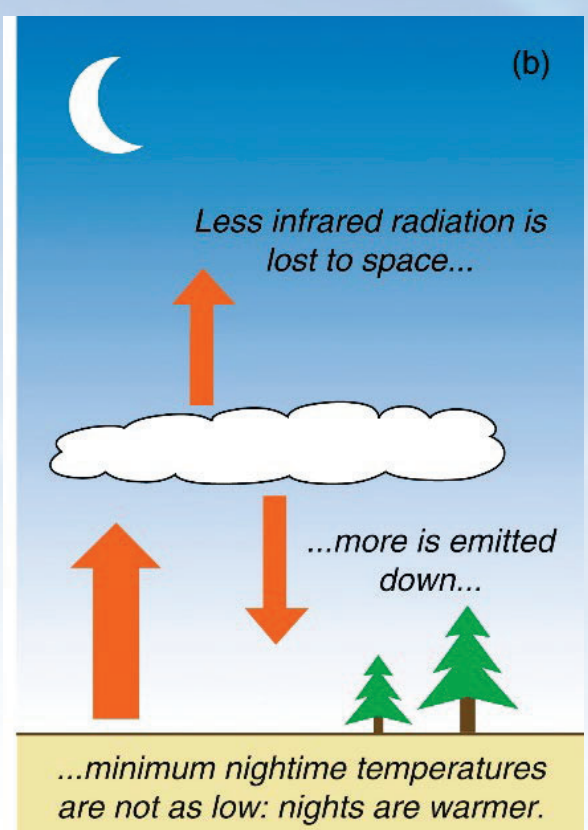
Daytime Temperatures: Clouds



Clouds have a high albedo and will reflect incoming solar radiation

Fig 4.15: ***Weather: A Concise Introduction***

Nighttime Temperatures: Clouds



Clouds prevent heat from surface from going out to space

Fig 4.15: ***Weather: A Concise Introduction***

Temperature: Cloud Influence

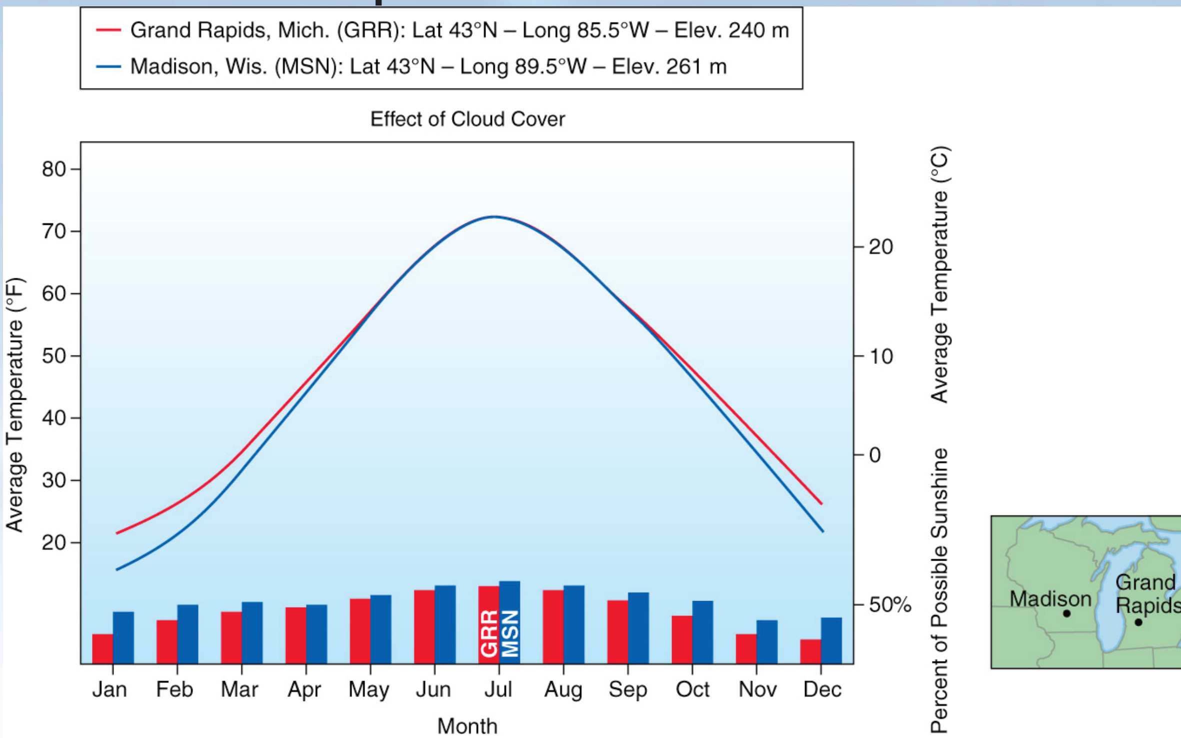


Fig 3-14 *Meteorology: Understanding the Atmosphere*

Temperature: Latitude Variations

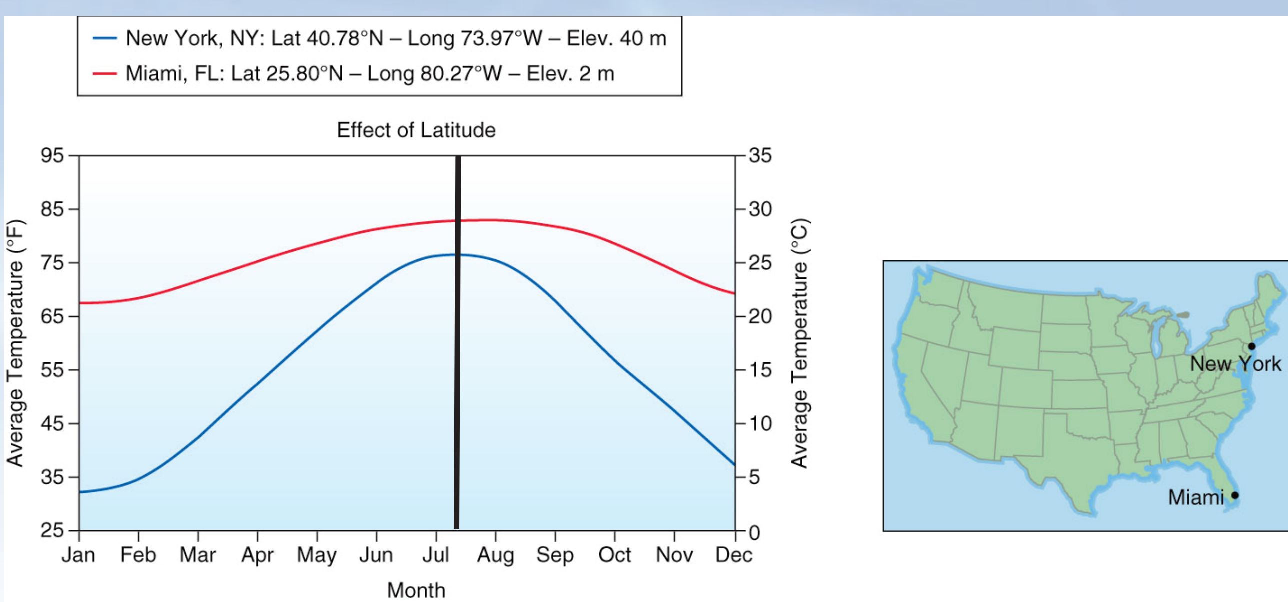


Fig 3-6 *Meteorology: Understanding the Atmosphere*

Temperature: Latitude Variations

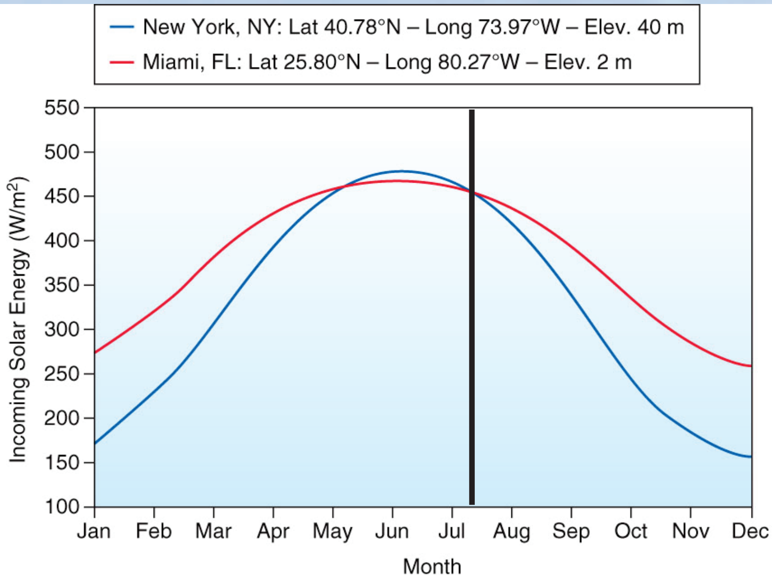
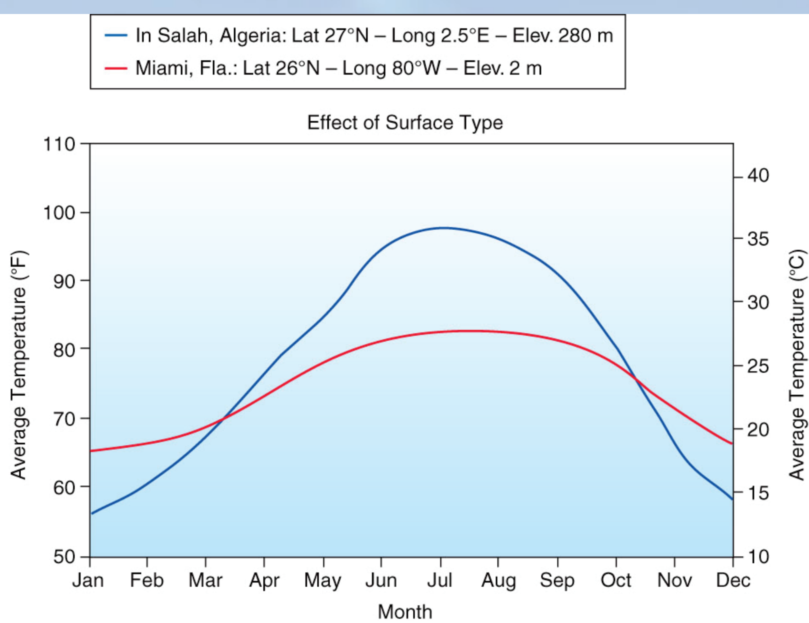


Fig 3-6 *Meteorology: Understanding the Atmosphere*

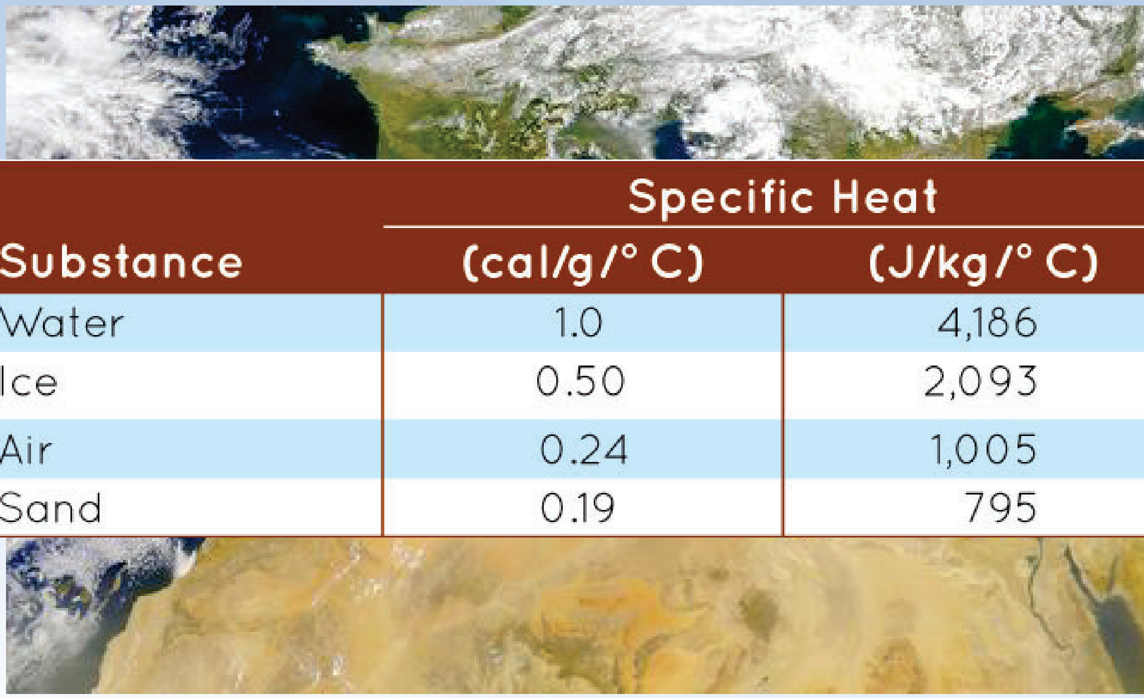
Temperature: Surface Variations



Both cities are around the same latitude

Fig 3-8 *Meteorology: Understanding the Atmosphere*

Temperature: Surface Variations

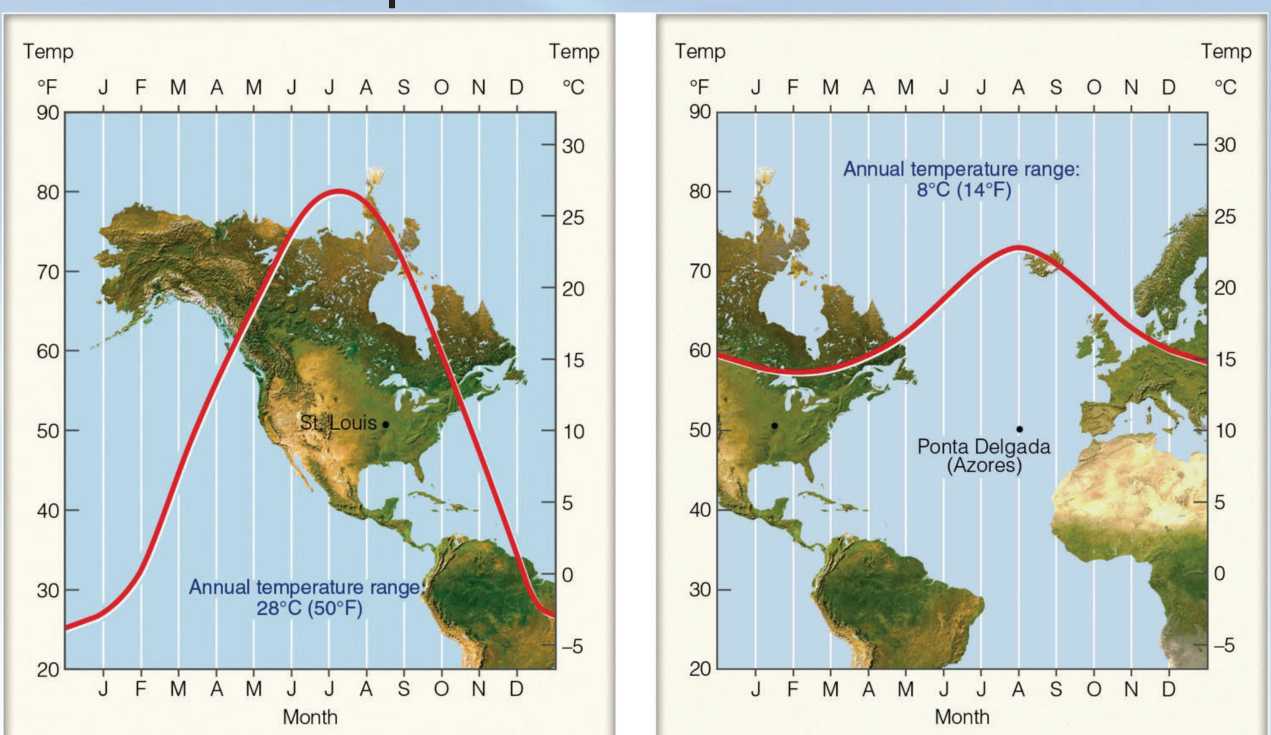


Substance	Specific Heat (cal/g/° C)	Specific Heat (J/kg/° C)
Water	1.0	4,186
Ice	0.50	2,093
Air	0.24	1,005
Sand	0.19	795

C_p = heat capacity or "specific heat"

SeaWiFS Project, NASA/Goddard Space Flight Center, ORBIMAGE

Temperature: Surface Variations



(a) St. Louis, Missouri, 39°N

(b) Ponta Delgada, Azores, 38°N

Fig 3.17: *Essentials of Meteorology*

Average Temperature

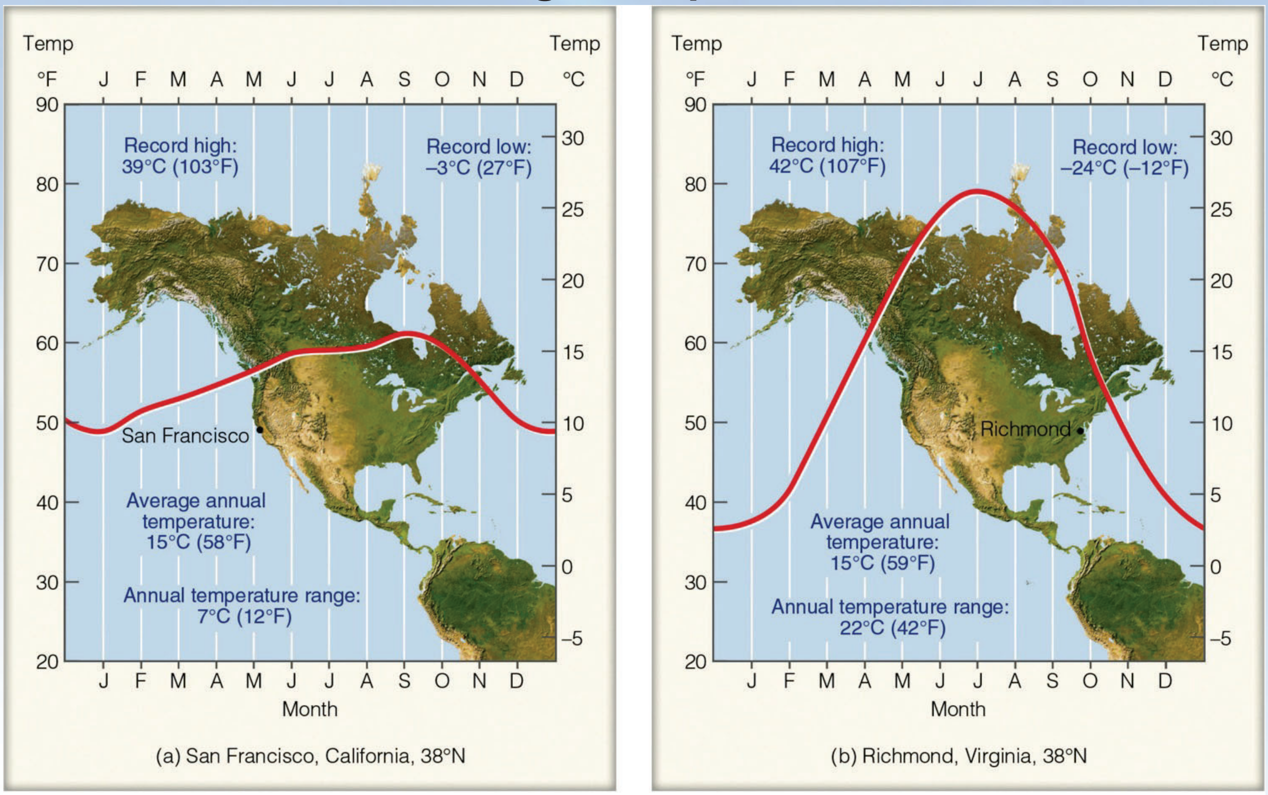


Fig 3.17: ***Essentials of Meteorology***