Review For Exam 5

GEOL 1347/1350: Introduction To Meteorology

Exam 5

Online Test on Blackboard

Website: https://uh.edu/blackboard/

Cover:

L6 (Humidity, Condensation, and Clouds-I);

L11 (Air Pressure & Winds-II);

L13 (Atmospheric Circulation-II);

L17 (Hurricanes);

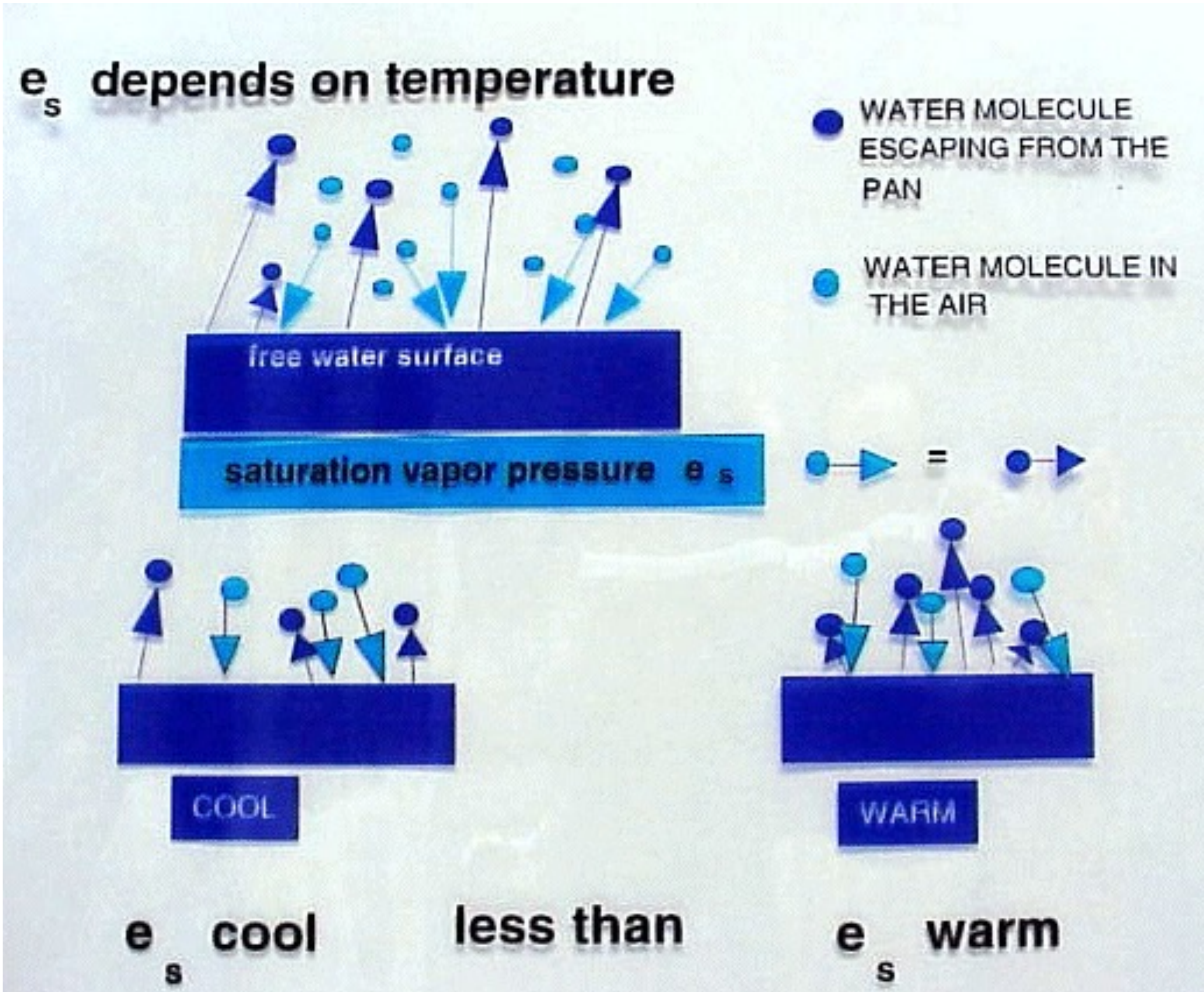
L18 (Light, Color, & Atmospheric Optics)

- The test is close book and close notes.
- There are 25 multiple choice questions.
- Time limit is 80 mins.
- Once started, the test must be completed in one sitting. Do not leave test before clicking save and submit.
- The test will save and submit automatically when the time expires.
- Please take the test during 1pm-2:30pm on Apr 27.
- You can use a scientific calculator.

Vapor pressure - e

- Air molecules all contribute to pressure p
- Each subset of molecules (e.g., N_2, O_2, H_2O) exerts a partial pressure
- The vapor pressure, e, is the pressure exerted by water vapor molecules in the air
  - similar to atmospheric pressure, but due only to the water vapor molecules
  - 2-30 mb common at surface
  - the larger the vapor pressure is, the more water vapor molecules in the atmosphere

Saturation vapor pressure e_s depends upon temperature
higher temperature, higher e_s,
more water vapor that the air can hold



Specific Humidity - q

- Ratio of mass of water to total mass of air in a unit volume
- Invariant to change in volume

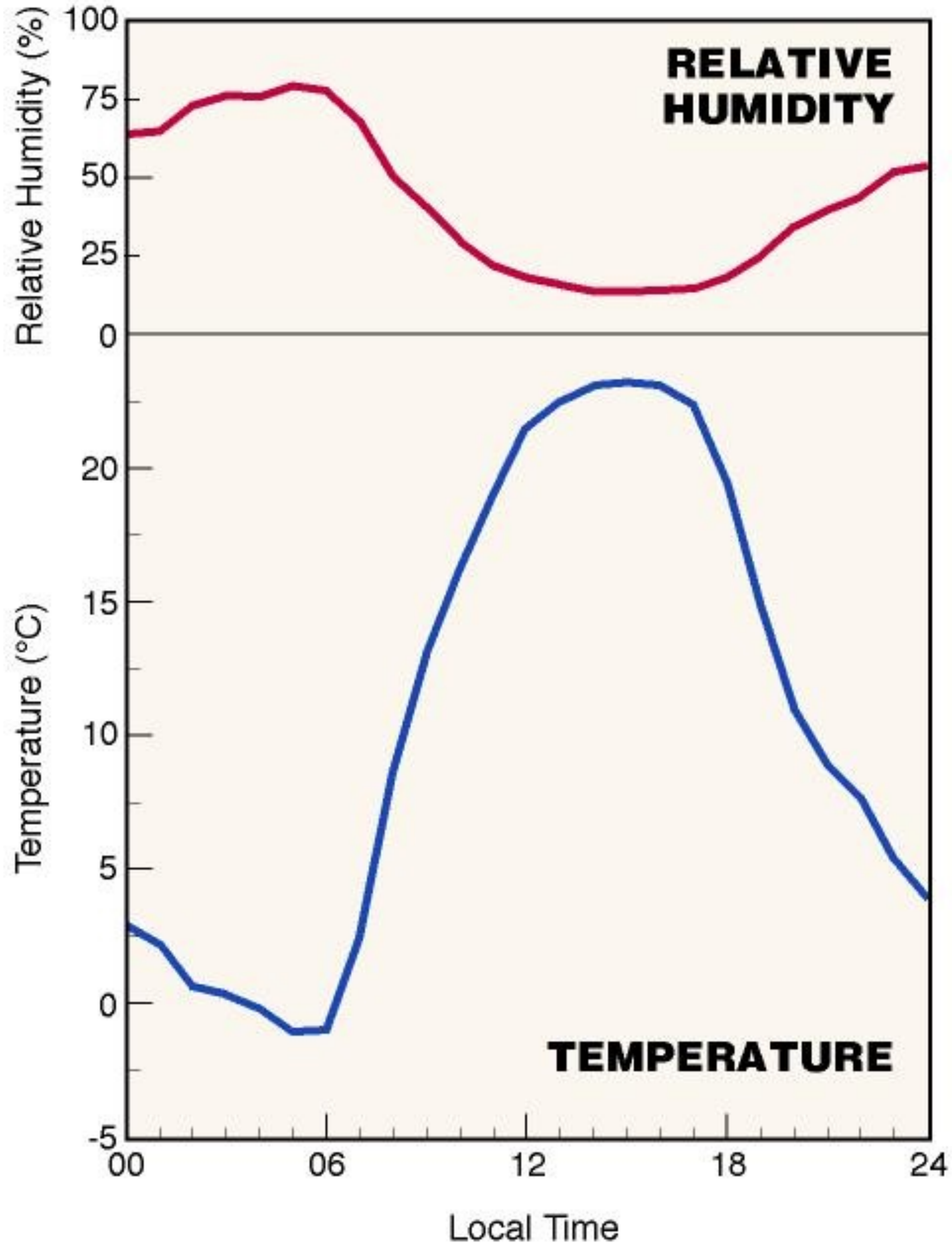
Since q is on the order of 10^{-3} g_v/g_a, we prefer to use g_v/kg_a

q values normally range from 1 to 20 g_v/kg_a and decreases with increasing height

Change of relative humidity in a day

What time of the day when relative humidity is usually high ?

As the air cools during the night, the relative humidity increases. The highest relative humidity occurs in the early morning, during the coolest part of the day.



Dew Point Temperature - T_d

- Temperature to which air must be cooled (at constant pressure and constant water vapor content) to become saturated.
- When $T=T_d$, $e_s(T_d) = e$, $q_s(T_d) = q$, $r_s(T_d) = r$
- T_d is less or equal to T
- Unlike relative humidity which is a measure of how near the air is to being saturated, dew point temperature is a measure of its actual moisture content. *The higher the dew point, the more water vapor in the air.*

- Dew point depression: $T- T_d$
- The larger the dew point depression is, the drier the air is, or the air is farther away from saturation

Coriolis Force (*CF*)

- **Apparent force due to the rotation of the earth**

- **Magnitude depends on latitude and the speed of the air parcel**

The higher the latitude, the larger the Coriolis force

Zero at the equator, and maximum at the poles

The faster air moves, the larger the Coriolis force

- **Causes the parcel to deflect**

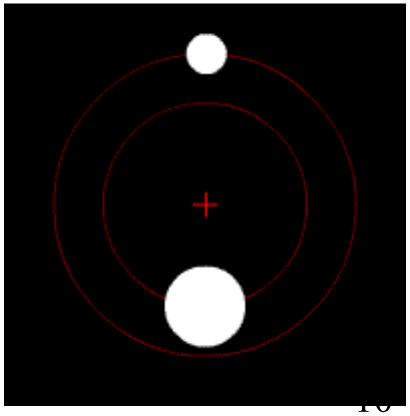
to the right of its intended path in the northern hemisphere

to the left of its intended path in the southern hemisphere.

Only influence wind direction, no effect on wind speed !

Centrifugal Force

- Magnitude CENTF = mV^2/R
  - m is the mass
  - R the radius of curvature of the curved path
  - V is the speed of the air parcel
- Direction
  - Pointing away from the center of the curve
  - **The faster the speed and the tighter the curve of the path traveled (i.e., the smaller R), the larger the centrifugal force.**



Frictional Force

- Frictional drag of the ground slows wind down.

$$FF = -kV$$

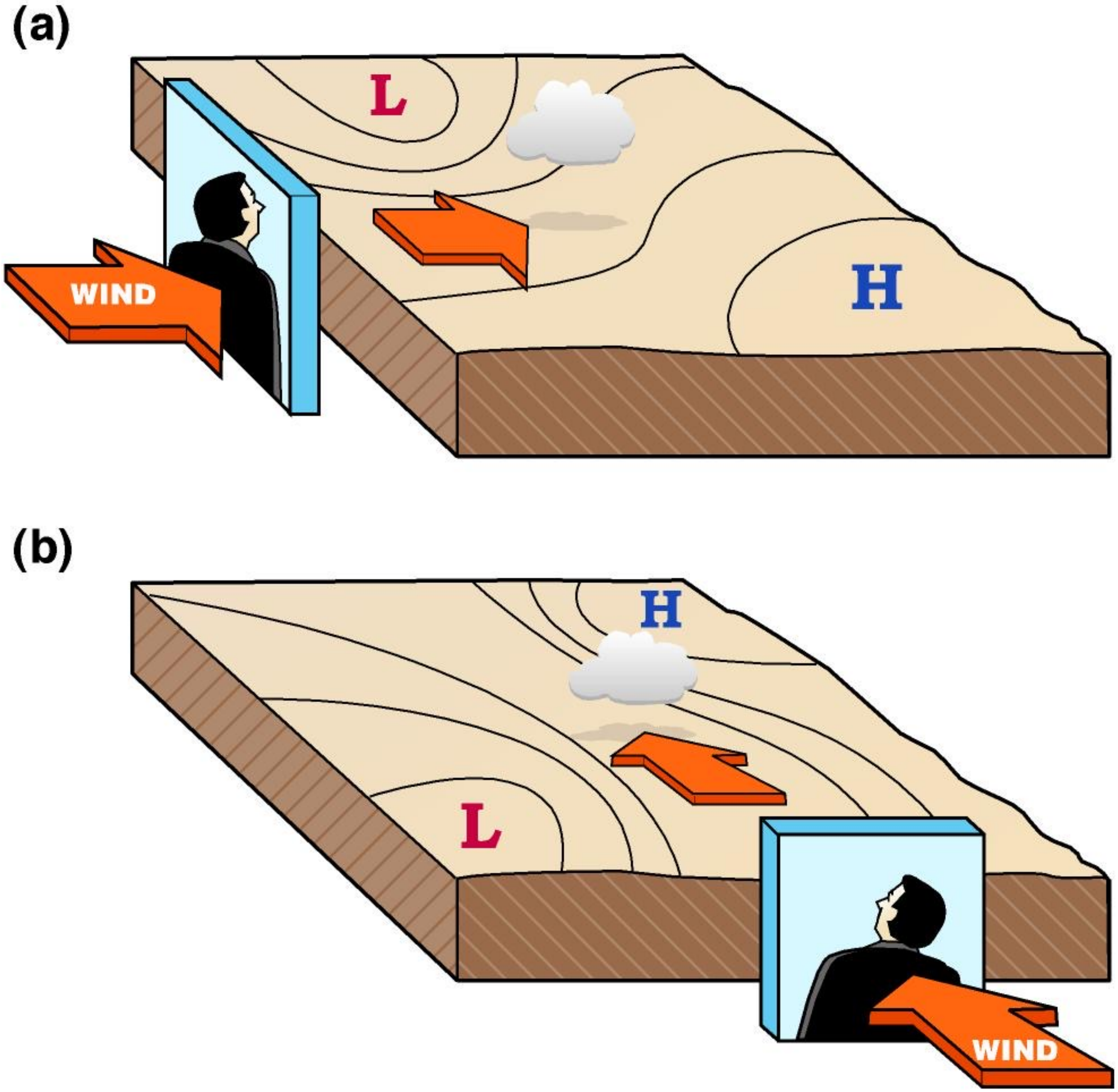
  - Magnitude
    - Depends upon the speed of the air parcel (V)
    - Depends upon the roughness of the earth’s surface (k)
  - Direction
    - Always acts in the direction opposite to the movement of the air parcel (minus sign emphasizes this)
  - Important in the friction layer (planetary boundary layer)
    - ~lowest 1000 m of the atmosphere

Geostrophic Wind

Geostrophic balance - the most fundamental horizontal force balance when the pressure gradient force is counter balanced by the Coriolis force

PGF + CF = 0

The resulting wind is called Geostrophic wind. Geostrophic wind is good approximation to winds above earth's surface



Buys Ballot's Law:

Stand with your back towards the wind (upper-level wind), low pressure is on your left and high pressure on your right.

A rotating earth break the single cell into Three Cells

Hadley cell (thermal direct)

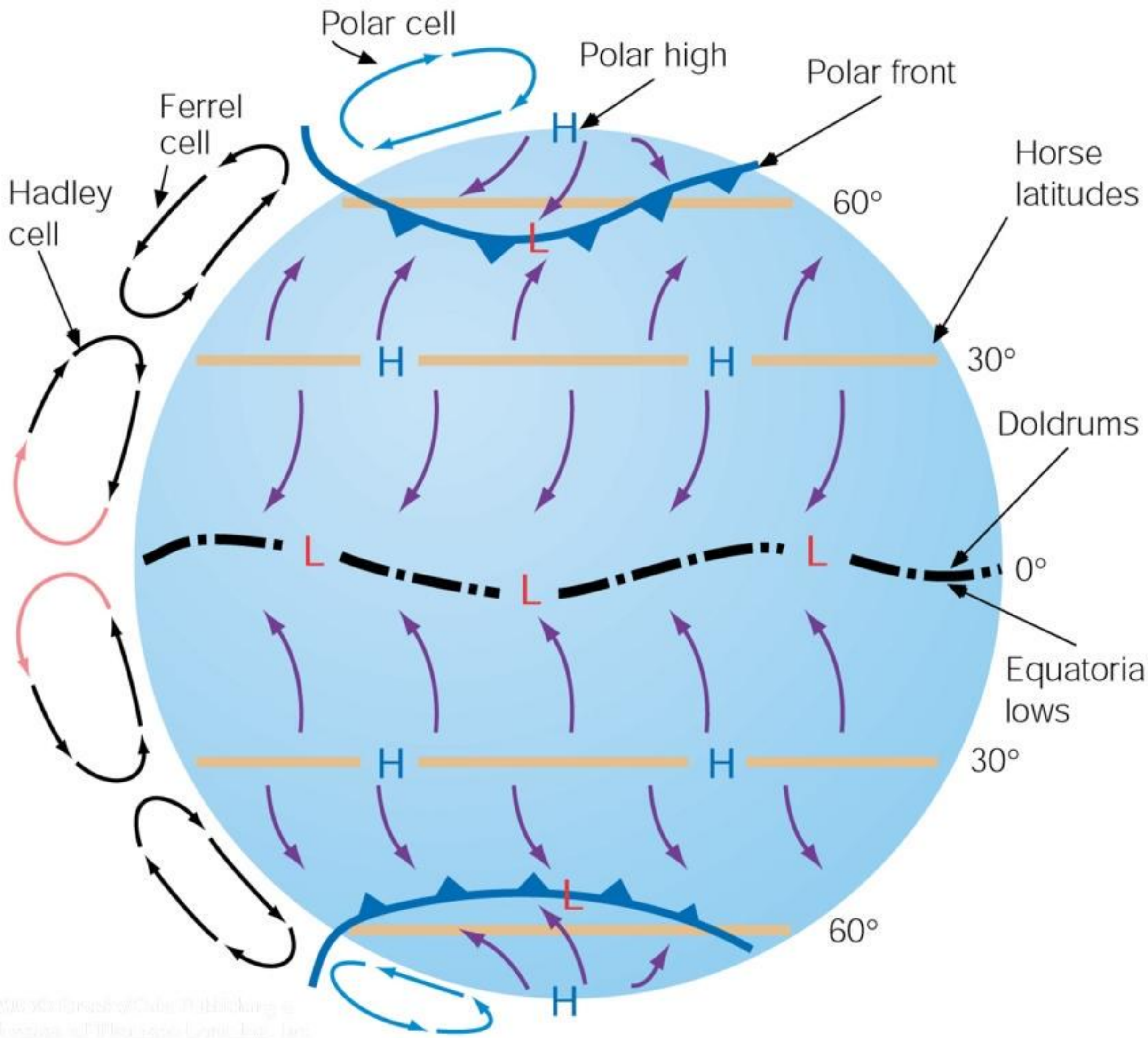
Air rises near equator and descends near 30° where a belt of high pressure is found (subtropical high)

Polar Cell (thermal direct)

Cold air moving southward from the pole rises when it reaches the ***polar front*** near 60°. The rising air aloft returns to the north where it sinks back to the pole.

Ferrel Cell (thermal indirect)

A reverse circulation between the Hadley and Polar Cell (between 30° and 60°) that carries air northward near the surface and southward aloft



Wind patterns in the three-cell model

Weak winds near

equatorial region and 30° latitude belt

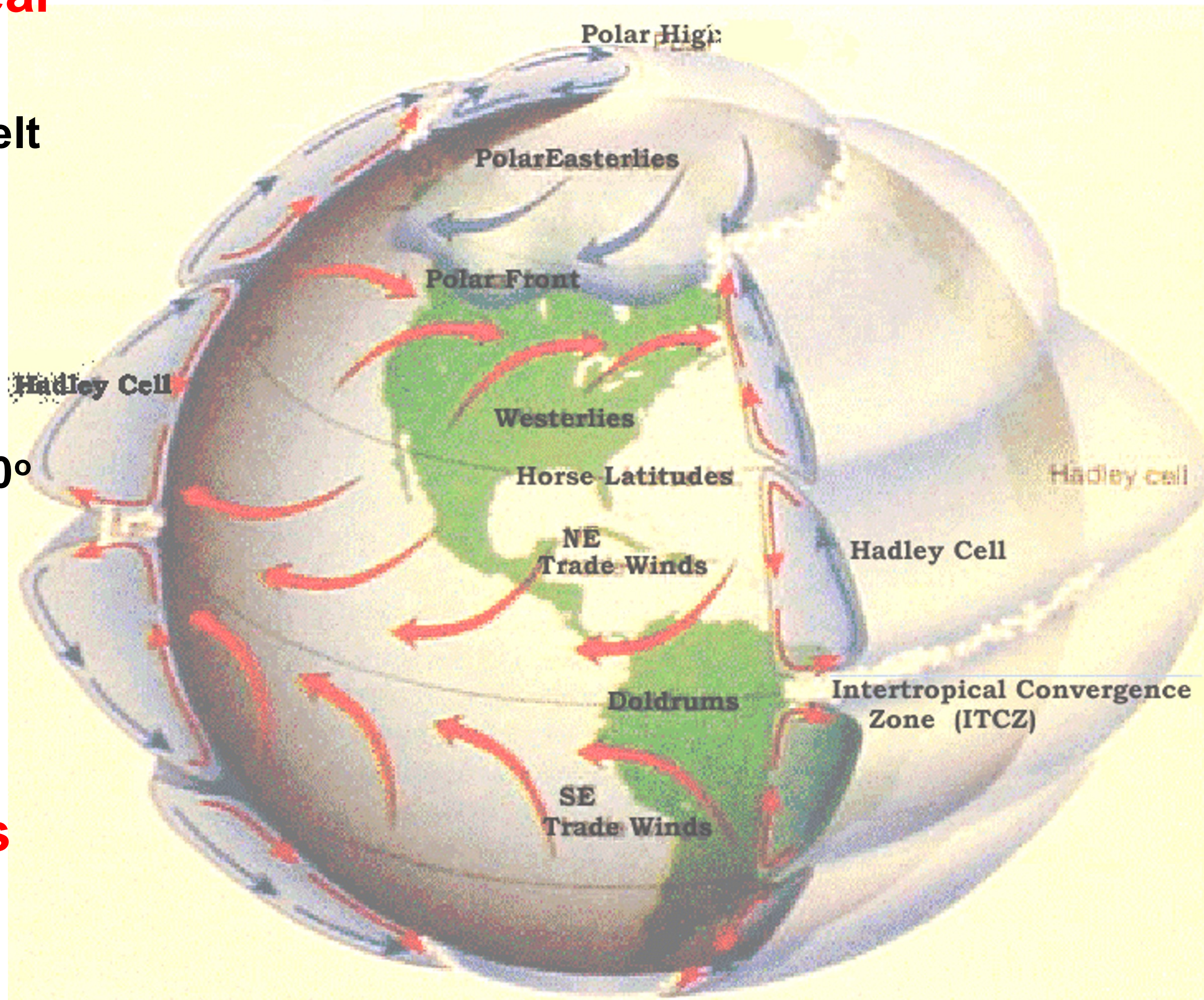
Easterly winds dominate

from equator to 30° (*Trade winds*)

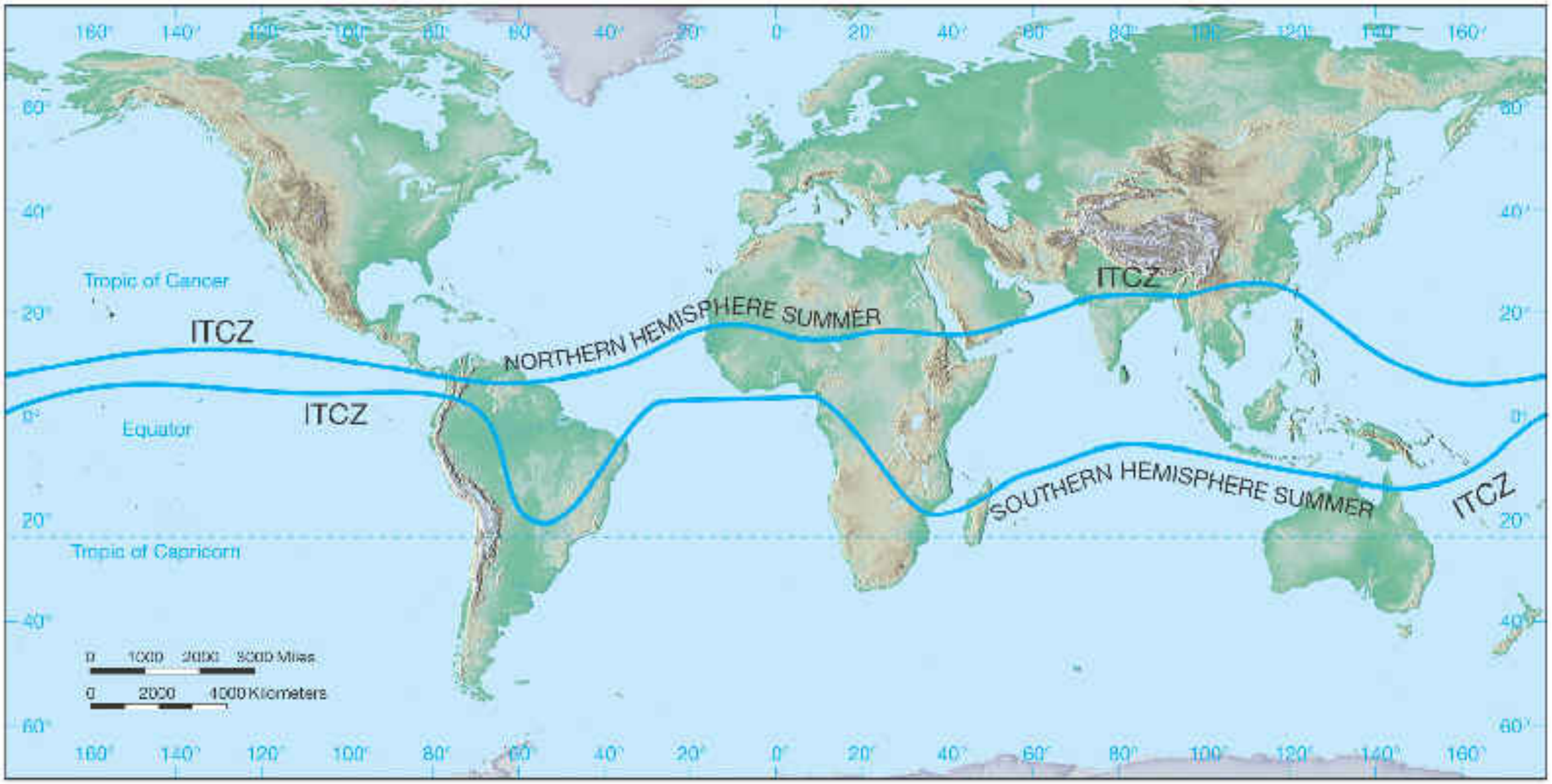
from pole to 60° (*Polar easterly*)

Westerly winds predominate

between 30 to 60° (mid-latitude)

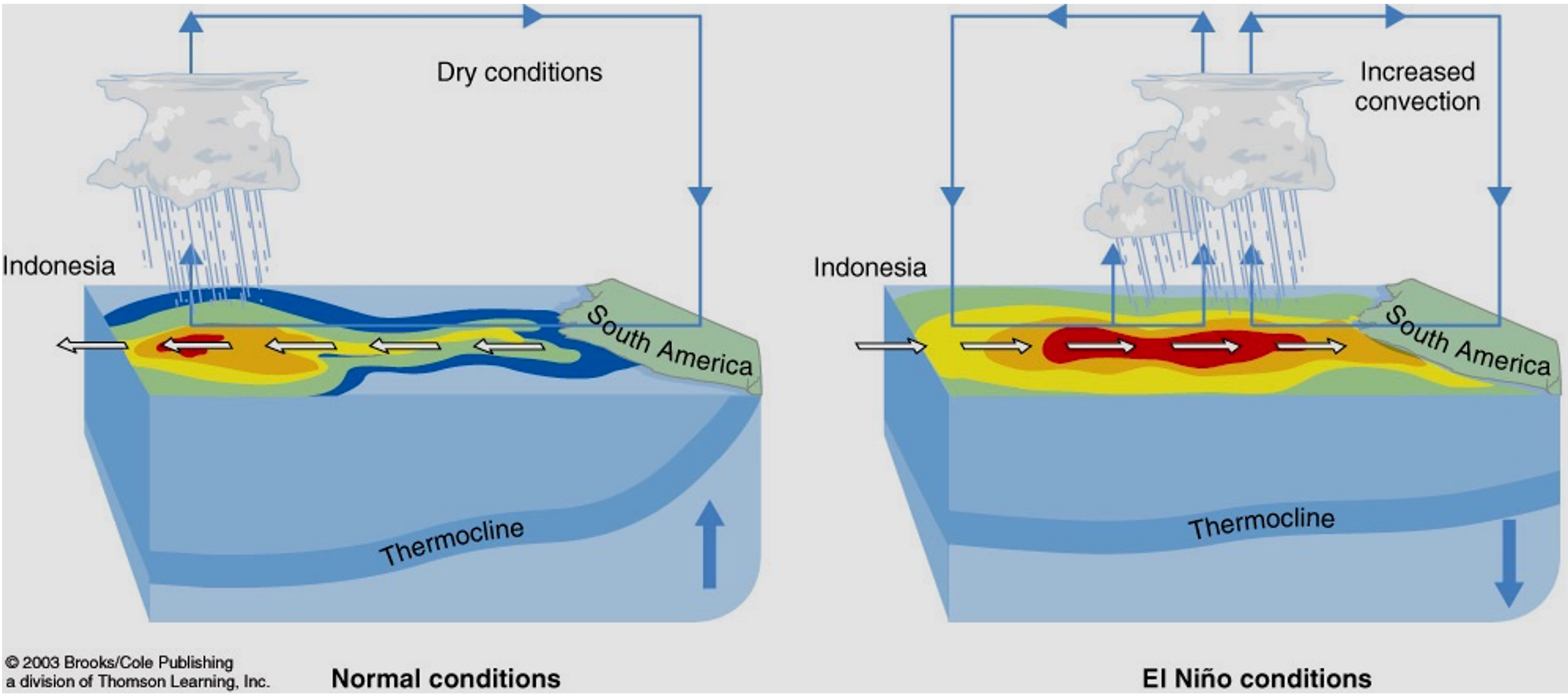


Intertropical Convergence Zone (ITCZ)



- **ITCZ moves back and forth across equator following the sun's zenith point.**
- **Variation in the ITCZ locations affect rainfall in the tropics.**
- **ITCZ shifts toward south in January and toward north in July.**

El Nino


Dry conditions
Indonesia
South America
Thermocline
Increased convection
Indonesia
South America
Thermocline
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Normal conditions
El Niño conditions

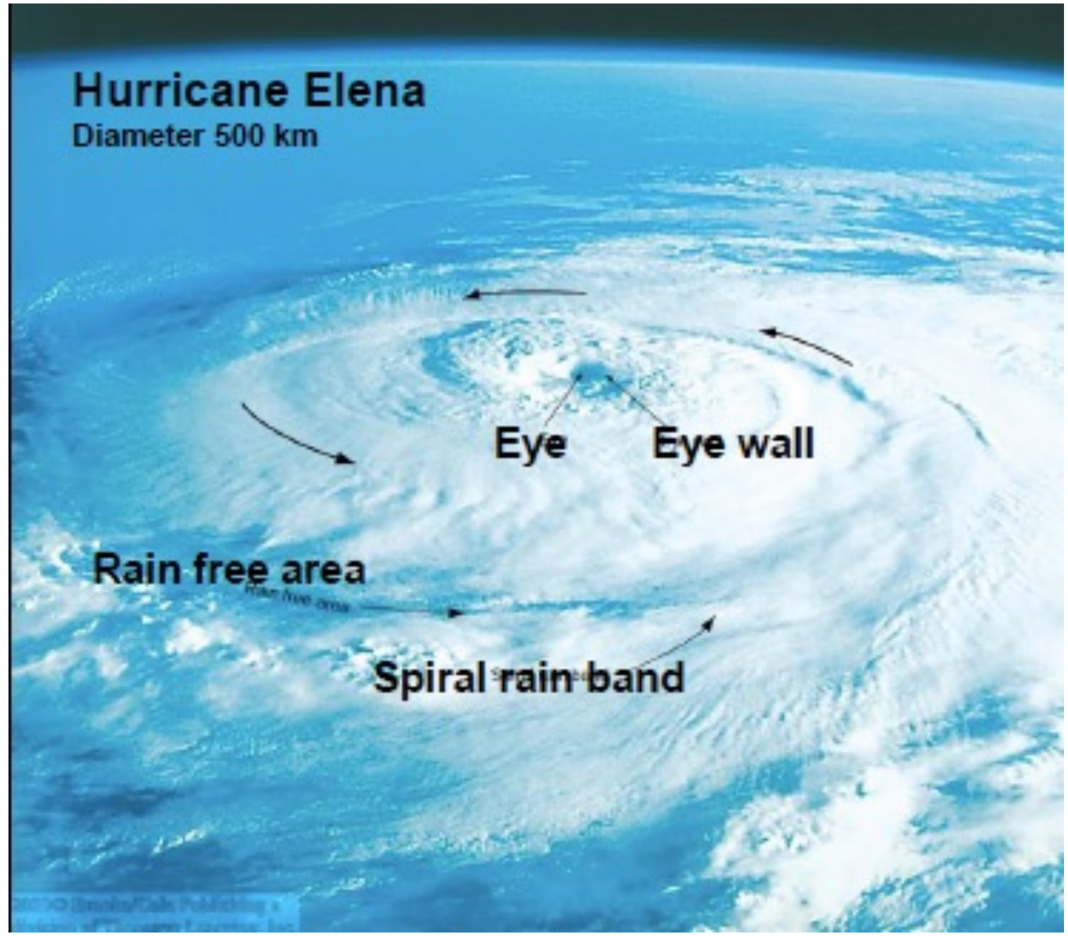
Anatomy of a Hurricane

- **Hurricane** is an intense storm of tropical origin, with sustained winds exceeding 64 knots (74 mi/hr), which forms over the warm northern Atlantic and eastern North Pacific oceans.

- In the western North Pacific, it is called typhoon, in India a cyclone, and in Australia a tropical cyclone. By international agreement, tropical cyclone is the general term for all hurricane-type storms that originate over tropical waters.

Anatomy of a Hurricane

- **Diameter - 500 km**
- **Eye - 40 km; Area of broken clouds at the center; Winds are light**
- **Surface Air Pressure - 955 mb**
- **Surface winds increase in speed as they blow counterclockwise and inward toward this center (NH).**
- **Adjacent to the eye is the eyewall, a ring of intense thunderstorms that whirl around the storm's center and may extend upward to almost 18 km.**
- **Within the eyewall, we find the heaviest precipitation and the strongest winds.**



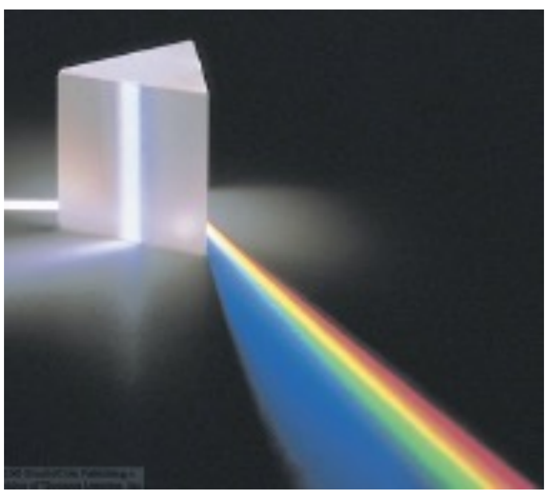
Aerosol Scattering

- Refraction depends on wavelength

1. Refraction bends short wavelengths (e.g. blue) more than long wavelengths (e.g. red).
2. Examples for refraction:

   --- Dispersion of white light into individual colors through a glass/ice crystal prism

   --- Refraction of starlight by the atmosphere



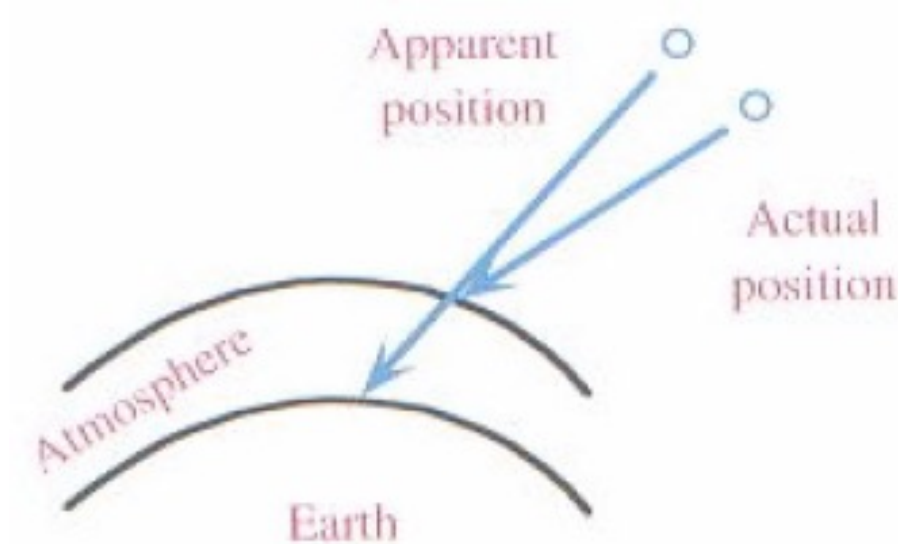
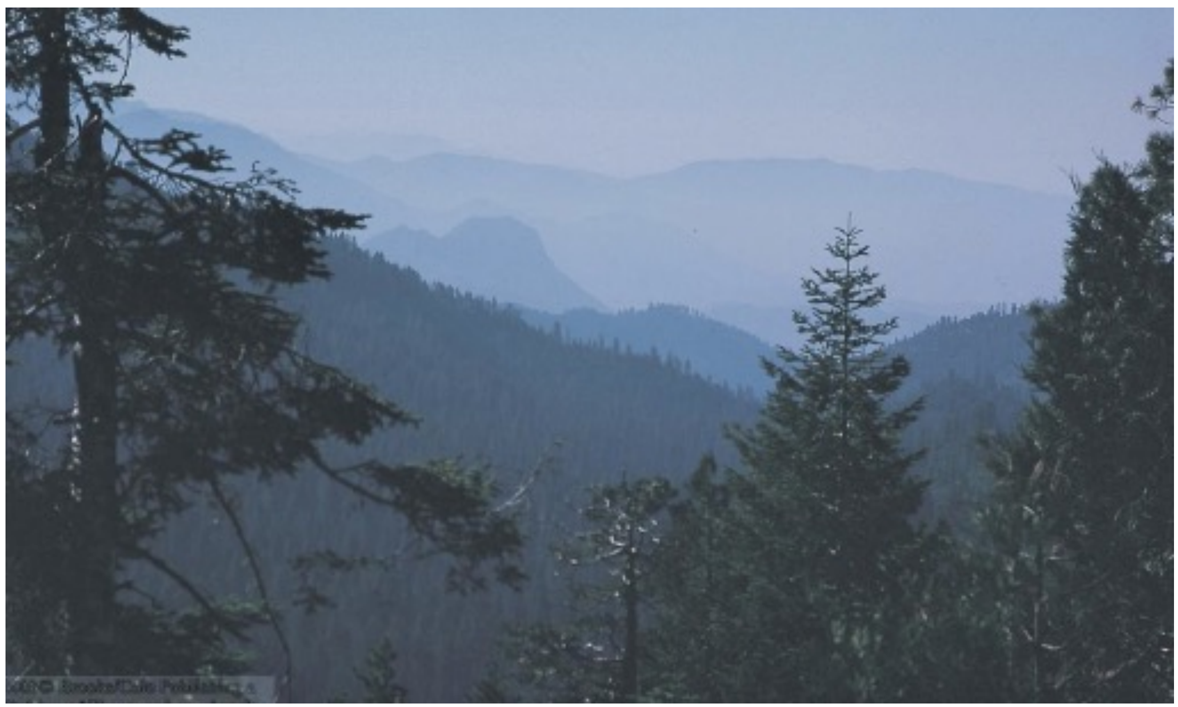


Figure 7.13. Refraction of starlight by the atmosphere makes stars appear to be where they are not.

Scattering

- **Rayleigh Scattering**
- **The selective scattering of blue light by air molecules and very small particles can make distant mountains appear blue.**



The blue ridge mountains in Virginia.