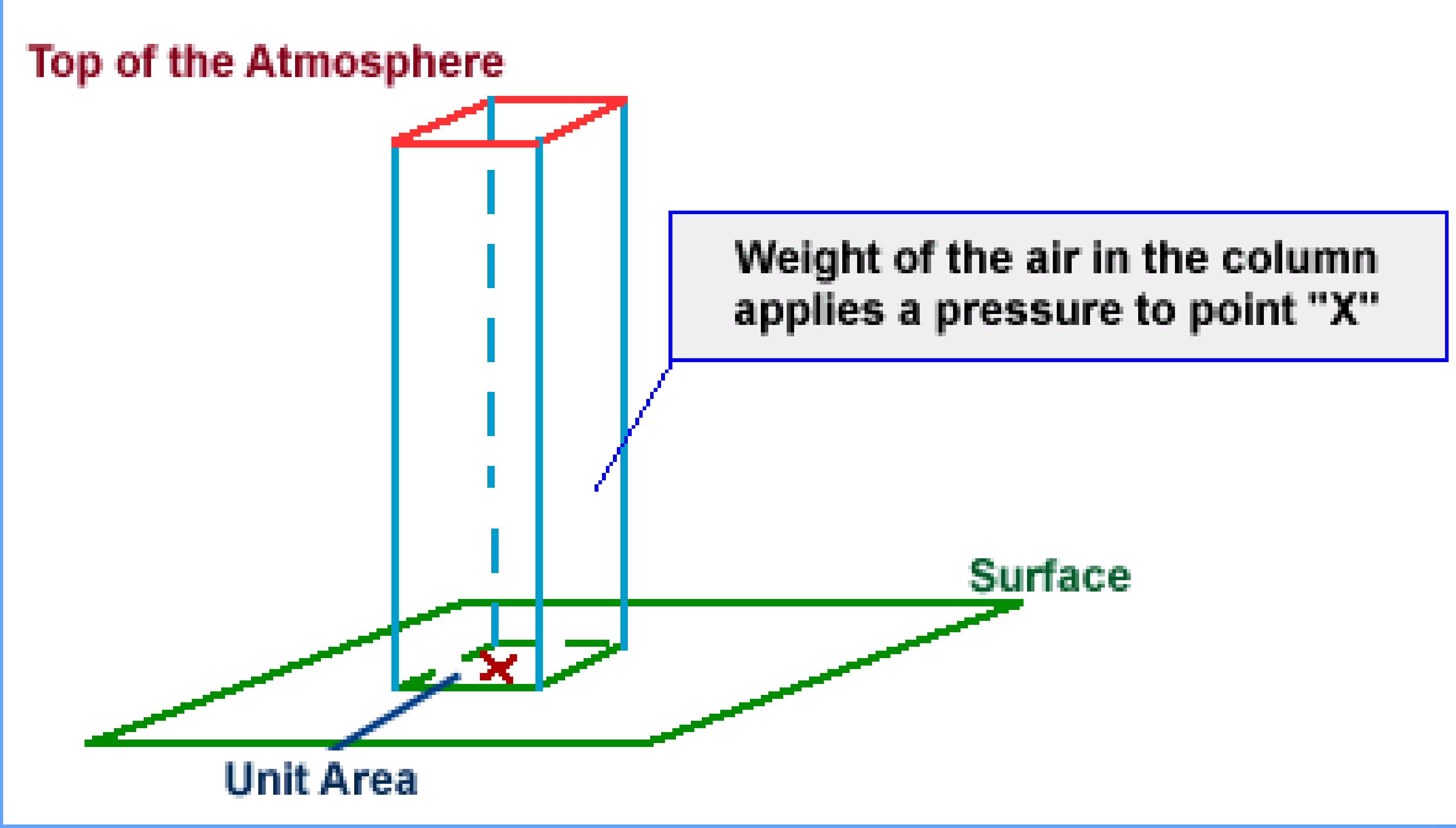
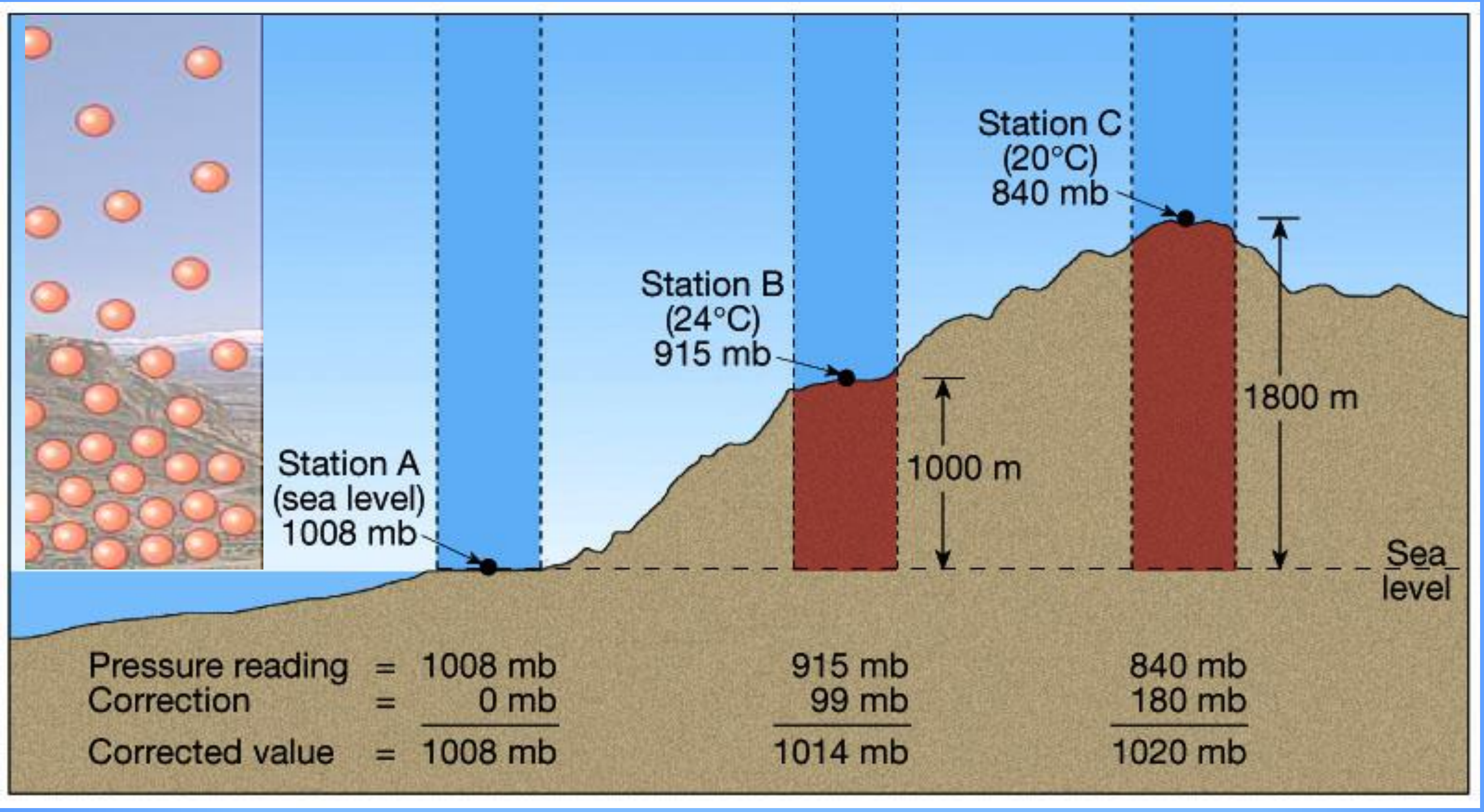
III. Air Pressure

Also referred to as *atmospheric* or *barometric* pressure

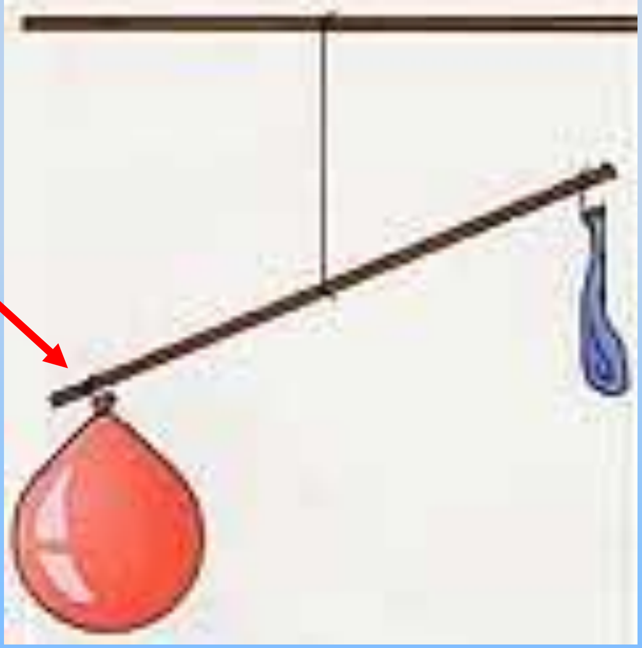


Atmospheric (Air) Pressure



A. The Cause of Air Pressure

Inflated Balloon

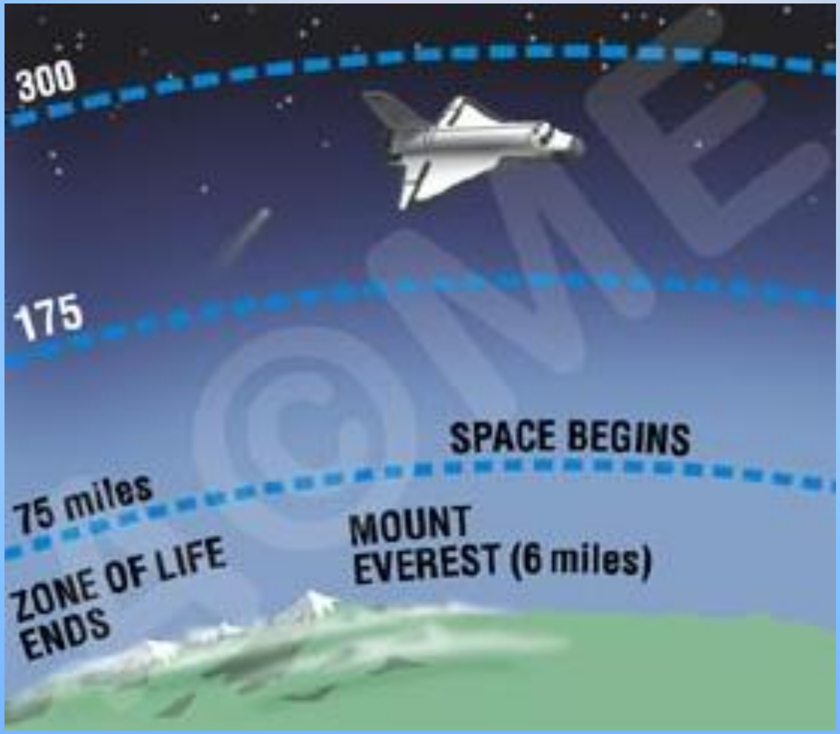


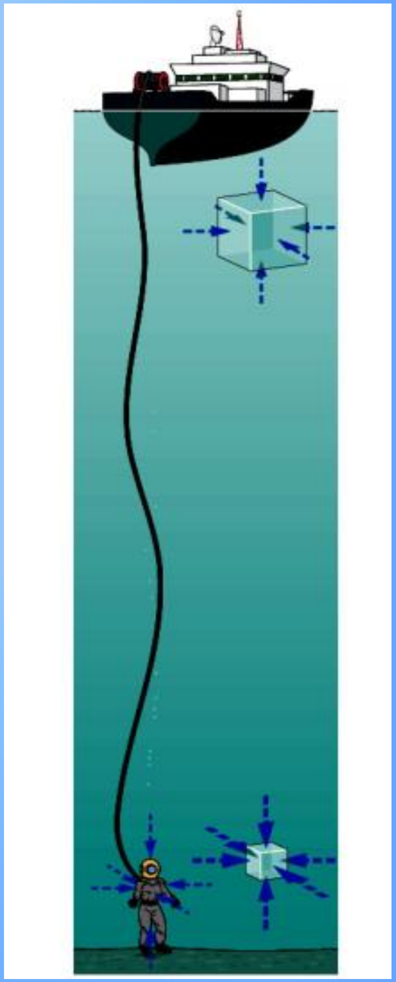
"Empty" Balloon

1. Air has ___**weight**___: A column of air measured to the "top" of the atmosphere with a cross-sectional area of one inch^2 has a weight of 14.7 pounds.

b. Pressure is defined as **a force** exerted on any plane surface.

We live at the bottom of an "ocean of air."





(1) Air pressure results from the **weight** of the air pressing down from above (as a result of gravity).

(2) Since air molecules move in all directions, air pressure is directed **equally in all directions**.

B. ***Instruments for Measuring Air Pressure***

1. Liquid – Mercury (Hg) Barometer

- Inve
  stud
- A tu
  the c
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- Merc
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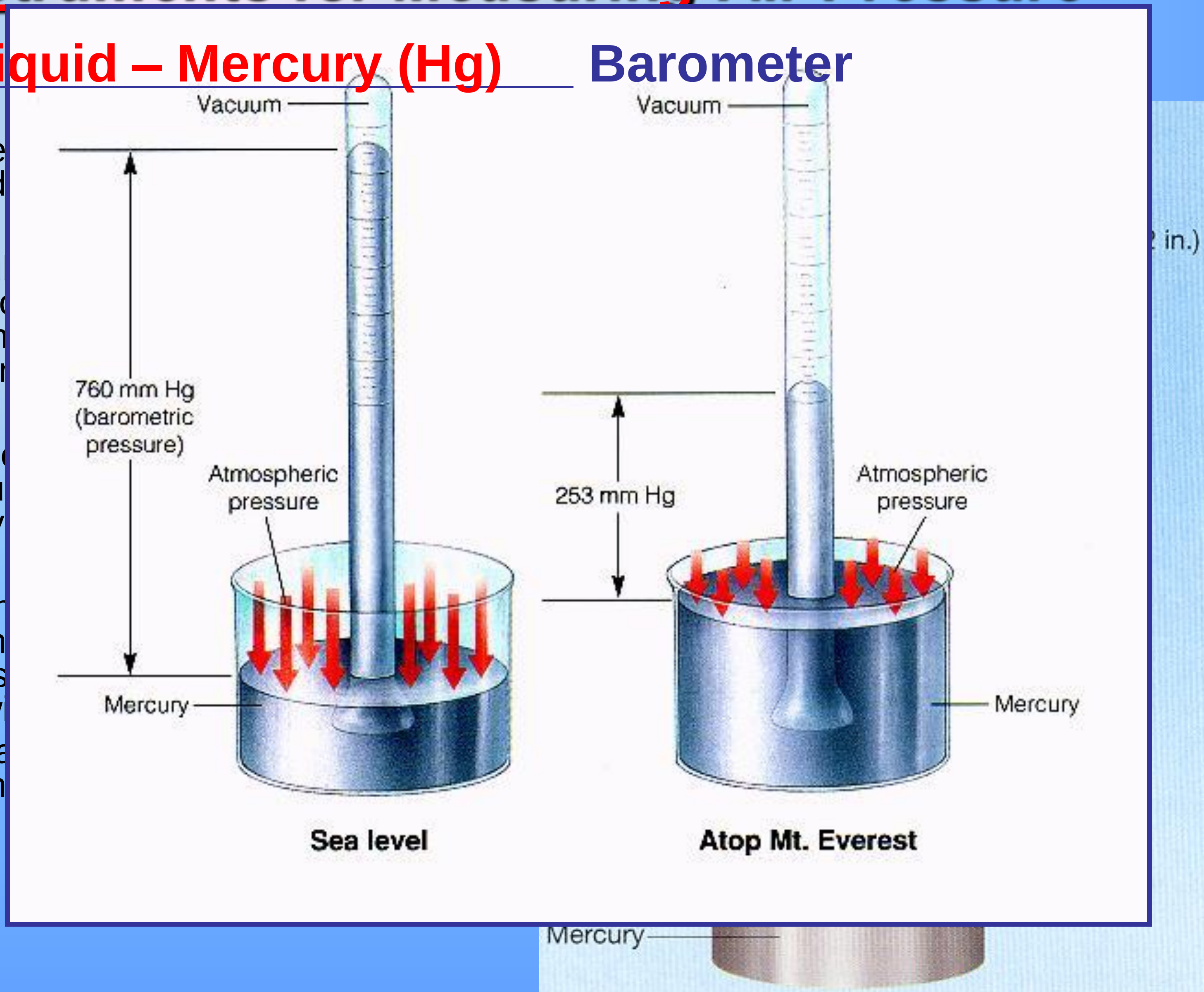
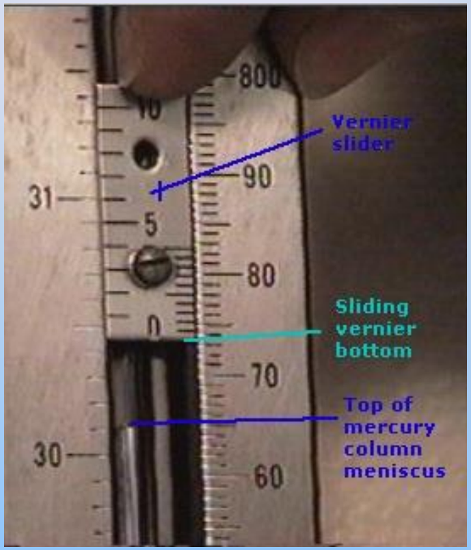
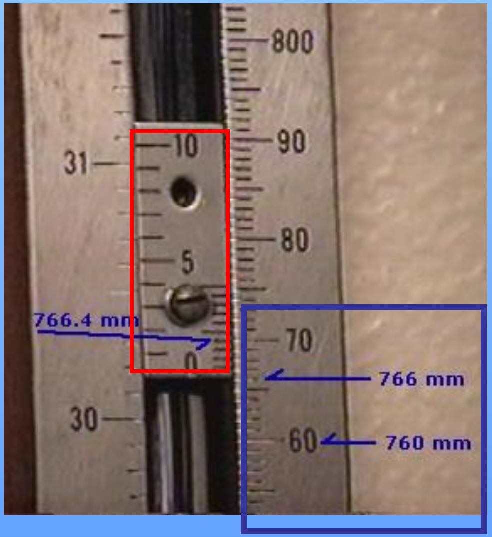
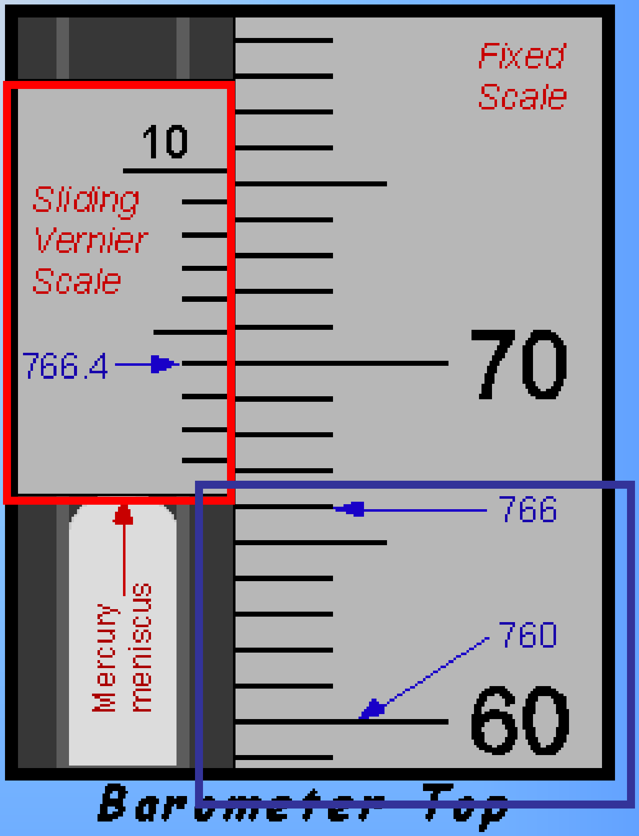


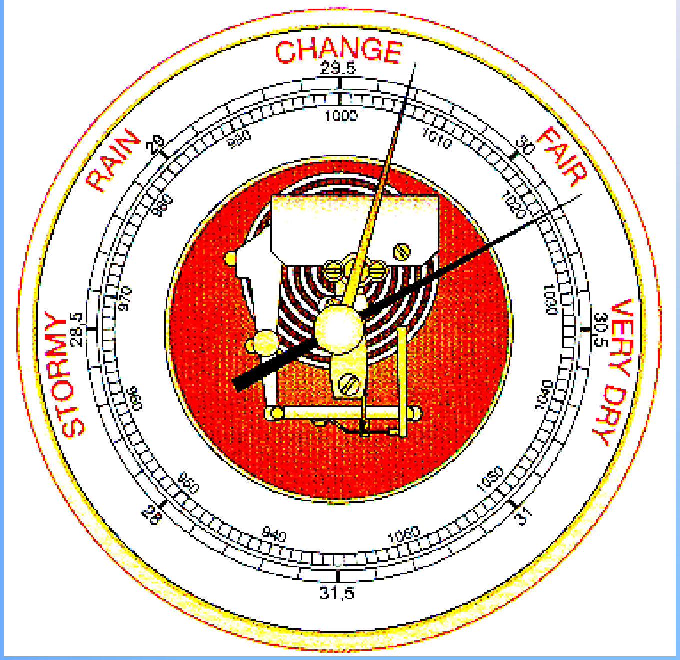
Reading a Mercury Barometer

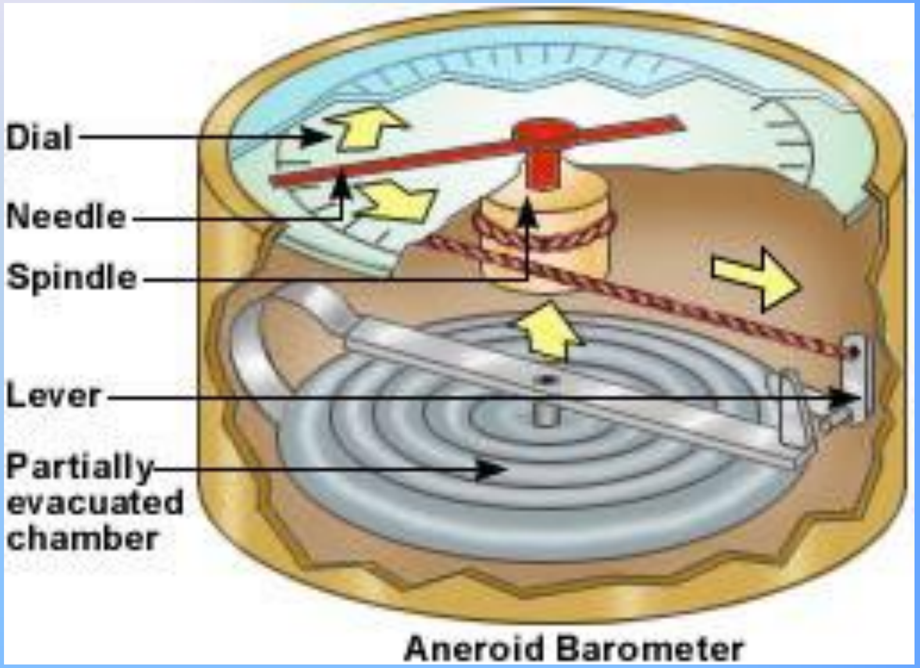






2. Aneroid Barometer





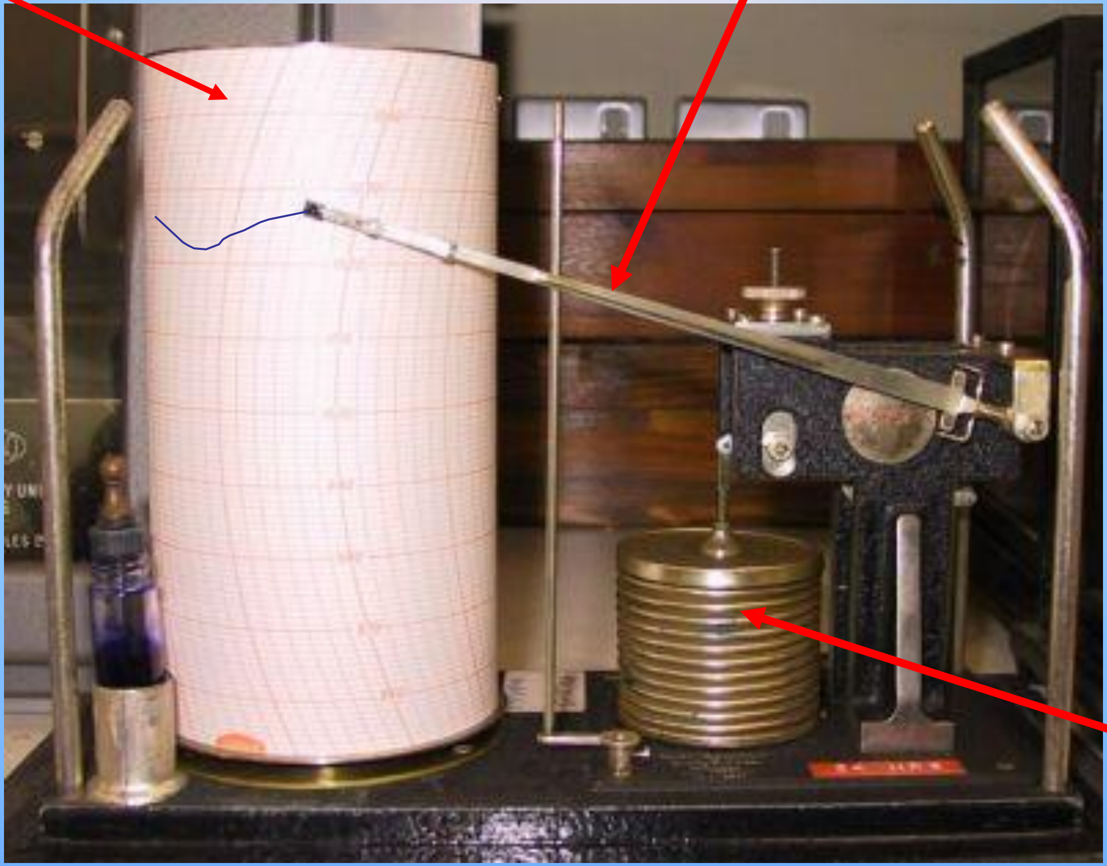
a. Working on the principal of a *spring balance*, a partially evacuated thin metal chamber compresses with an increase in pressure and expands with a pressure decrease.

b. It is prevented from collapsing by a spring which expands or contracts depending on the width of the chamber. An arm, magnified by levers detects these changes.

3. Barograph

Rotating cylinder with barogram

Pen moves up and down with pressure changes



Chamber is squeezed as air pressure increases

a. A recording aneroid barometer.

b. A pen is attached to the arm which records pressure over time.

4. Altimeter

In an airplane

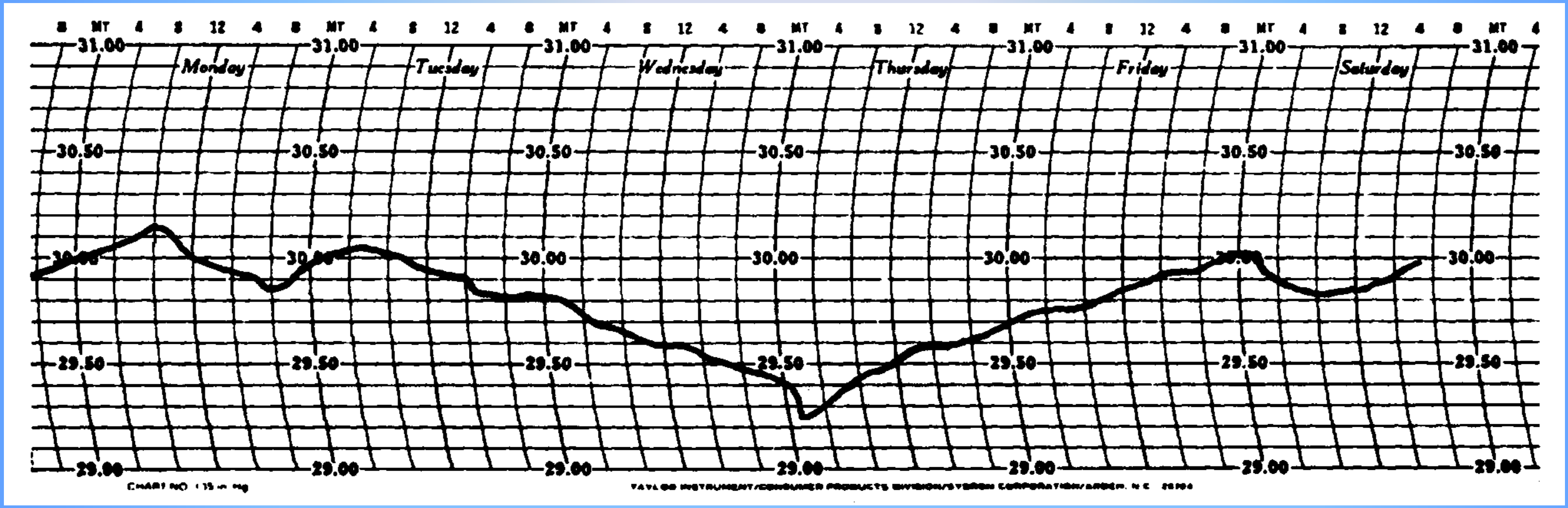
Hand-held

- An aneroid barometer that is calibrated to display __altitude__ rather than pressure.

C. Air Pressure Units

1. __Inches of Mercury__ (Hg):
   a. The height of the column of mercury in a liquid barometer (calibrated on an aneroid barometer).
   b. Not a __true unit of pressure__, but is an indicator of high or low pressure.
   c. Standard pressure at sea level is 29.92 inches of Hg (measured to the hundredth of an inch).

Barogram


Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
31.00
30.50
30.00
29.50
29.00

2. **Millibars**

a. **An actual** unit of pressure.

b. The unit of pressure used on all U.S. weather maps (since January 1940).

c. Millibars comes from to the original term for pressure "bar". Bar is from the Greek "báros" meaning weight. A millibar is 1/1000th of a bar and is the amount of force it takes to move an object weighing a gram, one centimeter, in one second. Millibar values used in meteorology range from about 950 to 1050. At sea level, standard air pressure in millibars is 1013.2. Weather maps showing the pressure at the surface are drawn using millibars.

d. Standard pressure at seal level is 1013.25 mb (measured to the nearest tenth of a millibar for the station model).

Calculating Standard Sea Level Pressure the (Pressure of One Atmosphere at Sea Level)

What air pressure did Torricelli measure at sea level??

Given:

- Density of Hg = 13.6 g/cm^3
- Acceleration due to gravity = 980.6 cm/sec^2
- Height of the column of mercury = 76 cm
- Area of column = 1.0 cm^2

Substitute for Weight

- Pressure = $\frac{\text{weight}}{\text{area}}$
- Substitute *mass x gravity* for weight.

$$\text{Pressure} = \frac{\overbrace{\textit{mass x gravity}}^{\text{weight}}}{\text{area}}$$

Find the Mass of Mercury

- The mass of Hg can be found using the equation for density.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

rewritten as:

mass = density x volume

Rewrite the Equation

- So, the equation for pressure can be rewritten substituting *density x volume* for mass.

$$\text{Pressure} = \frac{\overbrace{\textit{density x volume}}^{\textbf{Mass}}}{\text{area}} \text{ x gravity}$$

Now, Find the Volume of Hg

- Volume can be found using *height x area*.
- Substitute *height x area* for volume in the pressure equation.

$$\text{Pressure} = \text{density} \times \underbrace{\textit{height} \times \textit{area}}_{\text{volume}} \times \text{gravity}$$

Actual Units of Pressure

- While the SI unit for **pressure** is the **Newton**, (which is the force required to accelerate a 1 kg mass 1 meter per second squared) (1N = kg• m/sec^2),
- meteorologists use a smaller unit called the **dyne** (g•cm/sec^2).

- One Newton = 100,000 dynes.

Now, substitute numbers into the equation

- Pressure = density x height x gravity

$$= 13.6\ \frac{g}{cm^3} \times 76\ cm \times 980.6\ \frac{cm}{sec^2}$$

$$= 1{,}013{,}548.6\ \frac{g \times cm \times cm}{cm^3 \times sec^2}$$

Rearrange the Units

$$\text{Pressure} = 1{,}013{,}548.6 \; \frac{g \times cm \times cm}{cm^3 \times sec^2}$$

$$= \quad 1{,}013{,}548.6 \; \frac{g \bullet cm^2}{cm^3 \times sec^2}$$

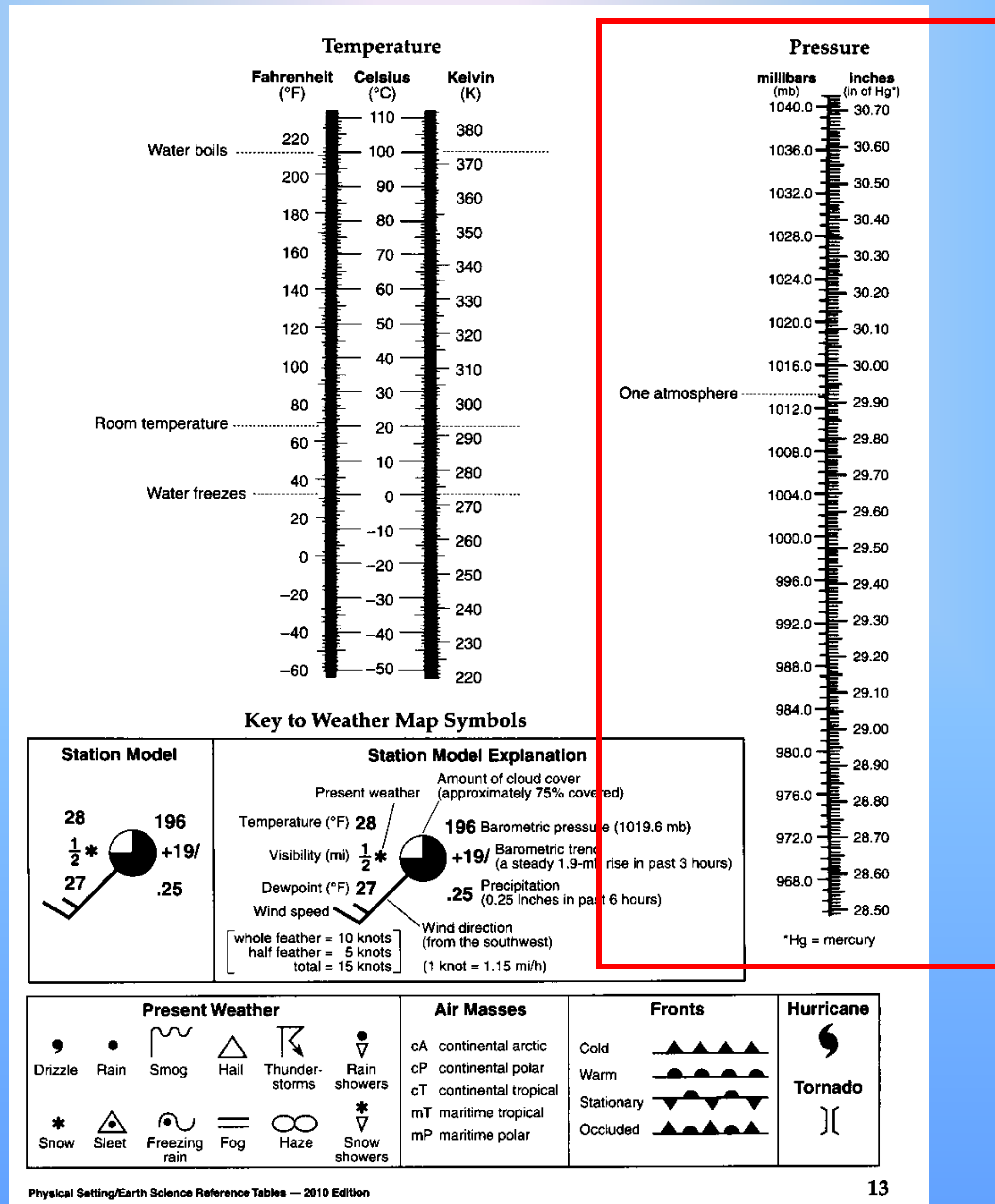
$$= \quad 1{,}013{,}548.6 \; \frac{g \bullet cm}{sec^2 \bullet cm^2}$$

Pressure at Sea Level = 1,013,548.6 dynes per cm^2

If you look up
<u>One "bar"</u> (or <u>1,000 mb</u>) =1,000,000 dynes/ cm²

- *The bar is divided into 1,000 smaller units called millibars (abbreviated as mb).*
- The bar is used because the dyne is so small and the term is clumsy.
- So <u>1,013,548.6 dynes</u> per cm^2 is precisely, standard sea level pressure <u>1,013.5 mb</u>.

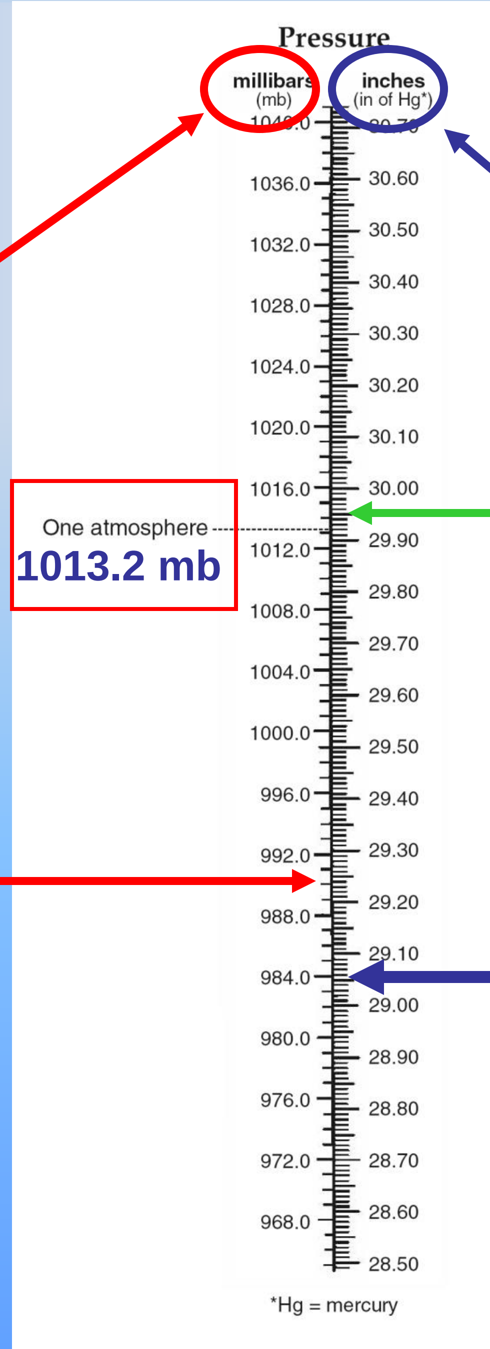
Air Pressure in the ESRT



Each increment is equal to 1.0 mb

Always express millibars to the nearest 0.1

990.0 mb



Each increment is equal to .01 inch of Hg

29.95” Hg

Always express in. of Hg to the nearest 0.01

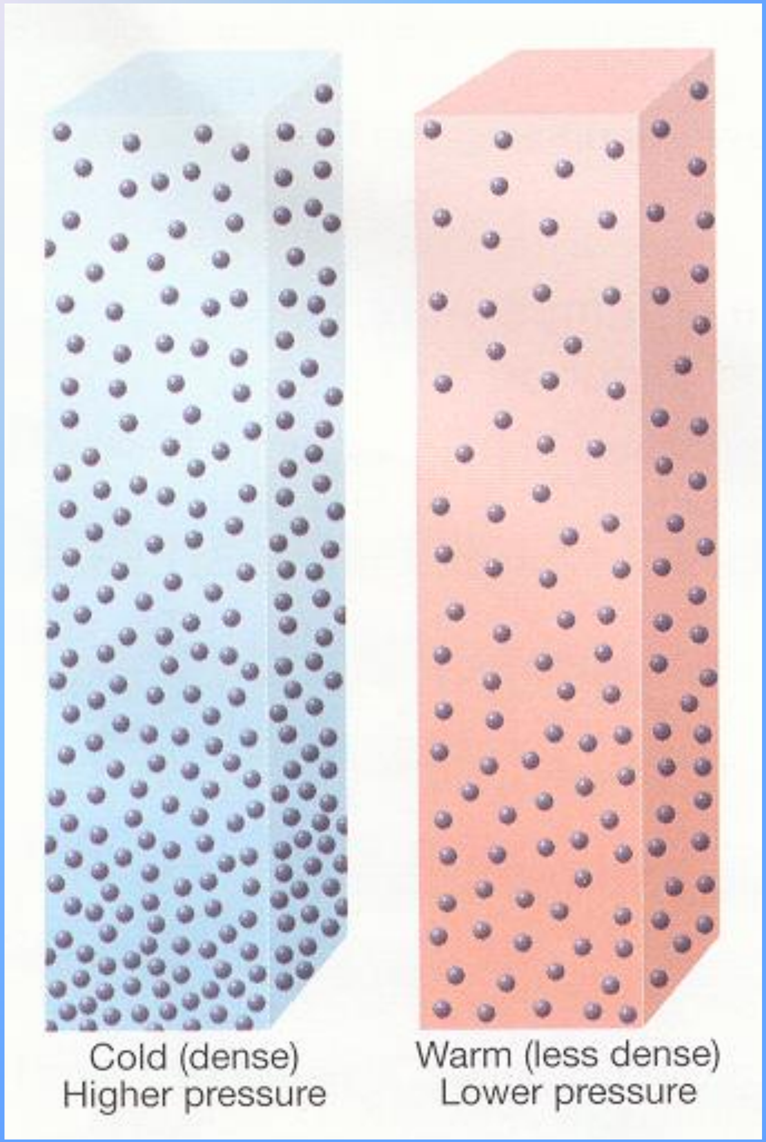
29.05 inches of Hg

- Try Air Pressure Worksheet # 1-3
- ESRT pg. 13

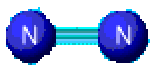
D. *Factors Affecting Air Pressure*

1. Temperature

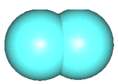
If all other factors are equal, cold __**dense**__ air exerts __**more**__ pressure than __**less**__ dense warmer air.



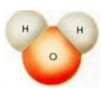
2. Humidity



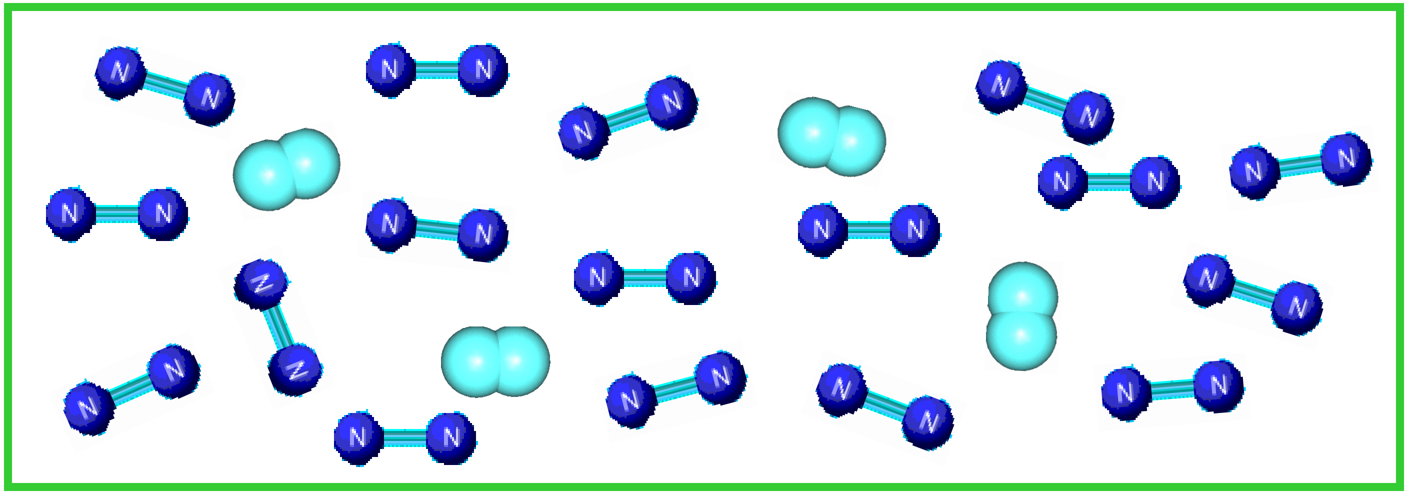
Nitrogen



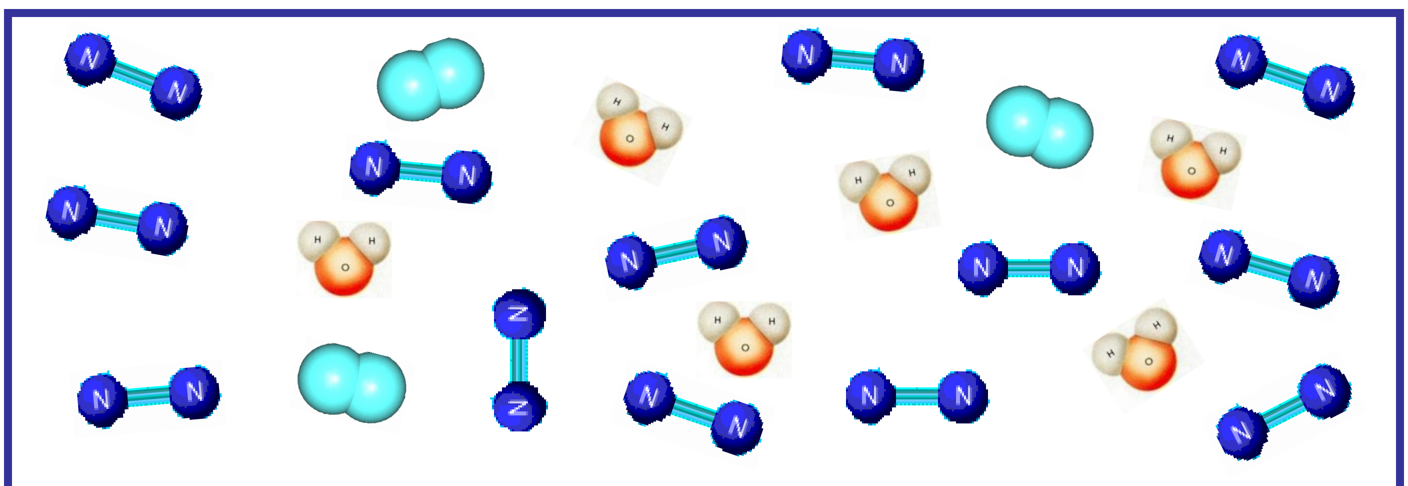
Oxygen



Water Vapor



"Dry" air is about 99 percent nitrogen and oxygen.

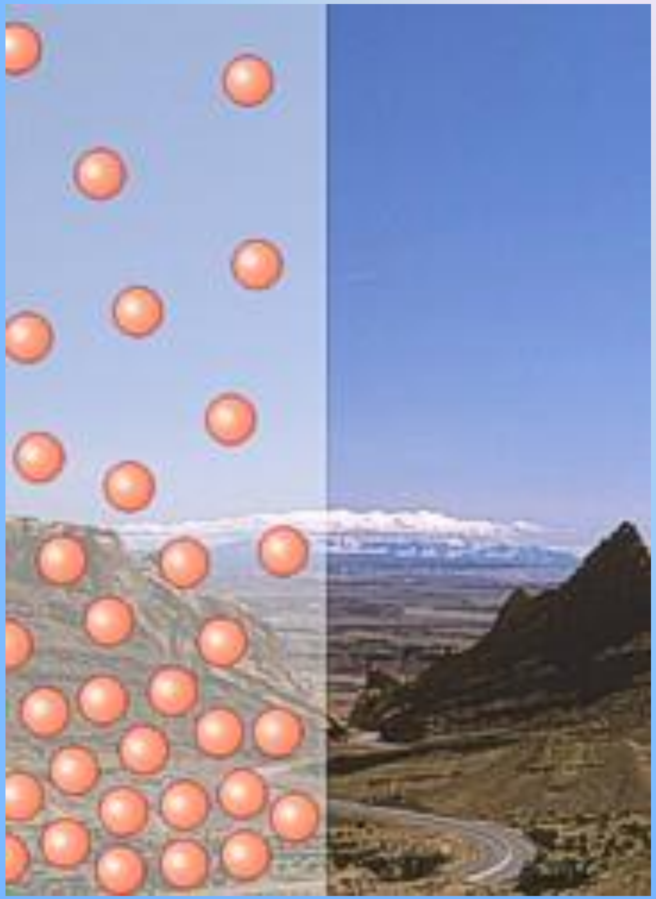


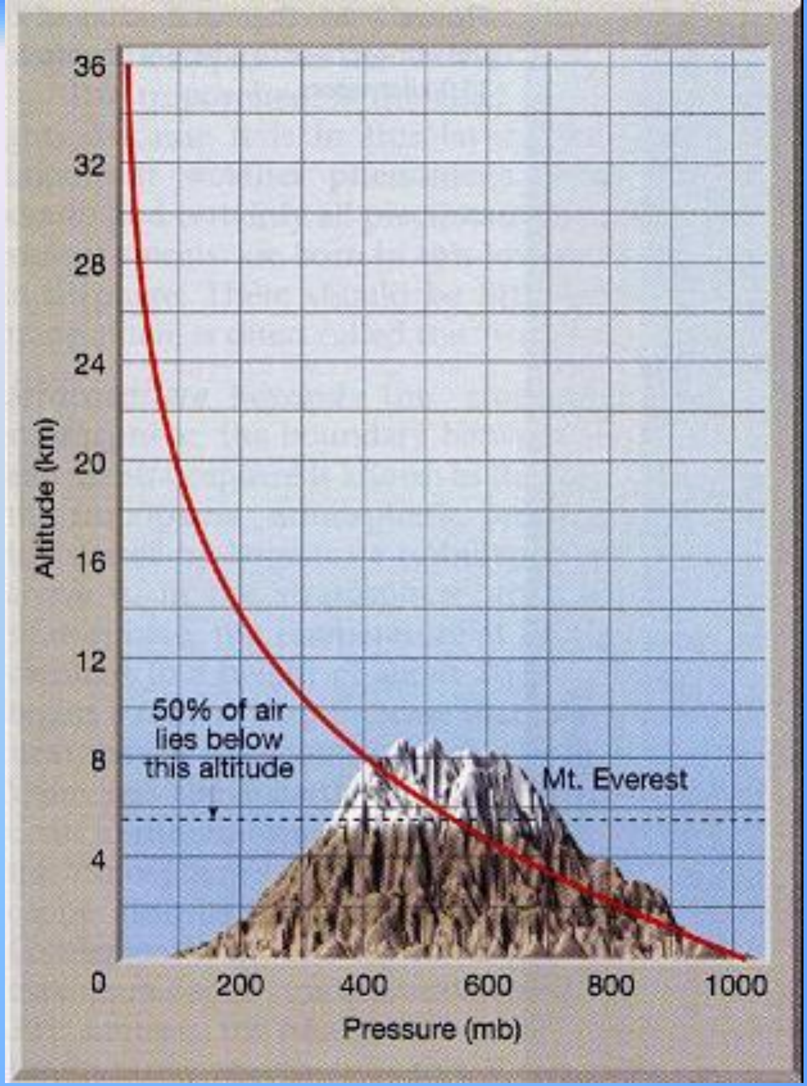
Humid air is only 97 percent oxygen and nitrogen. Lighter water vapor displaces the heavier and equal volume of nitrogen and oxygen.

Summary:
The Effect of Water Vapor on Air Pressure

1. The more water vapor air contains, the **lighter** the air is.
2. Water vapor molecules have **less** mass than the oxygen and nitrogen molecules they display.
3. As a result, humid air will have **lower** air pressure than drier air.

3. Altitude

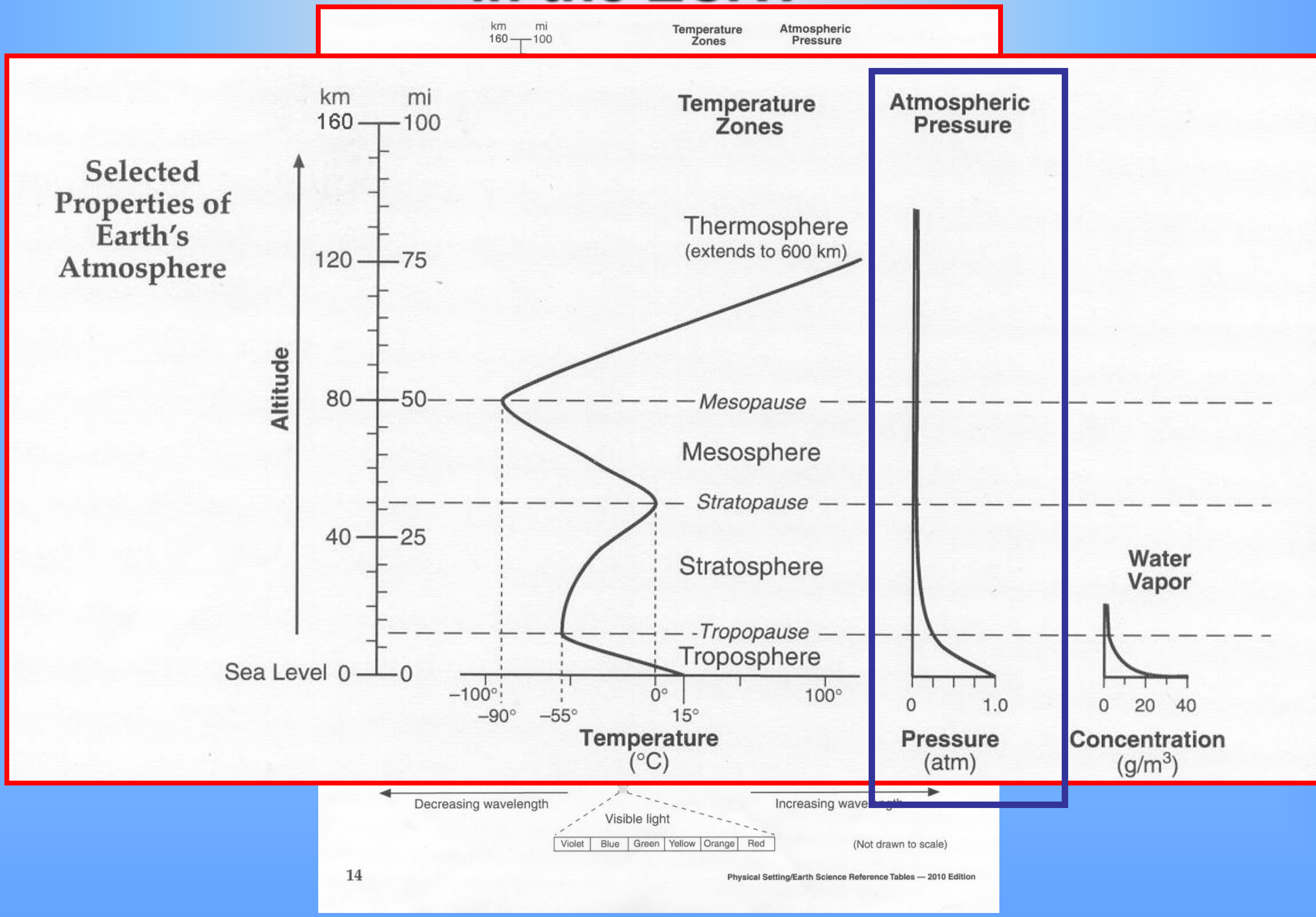




a. As altitude (elevation) increases, the density of the air __decreases__.

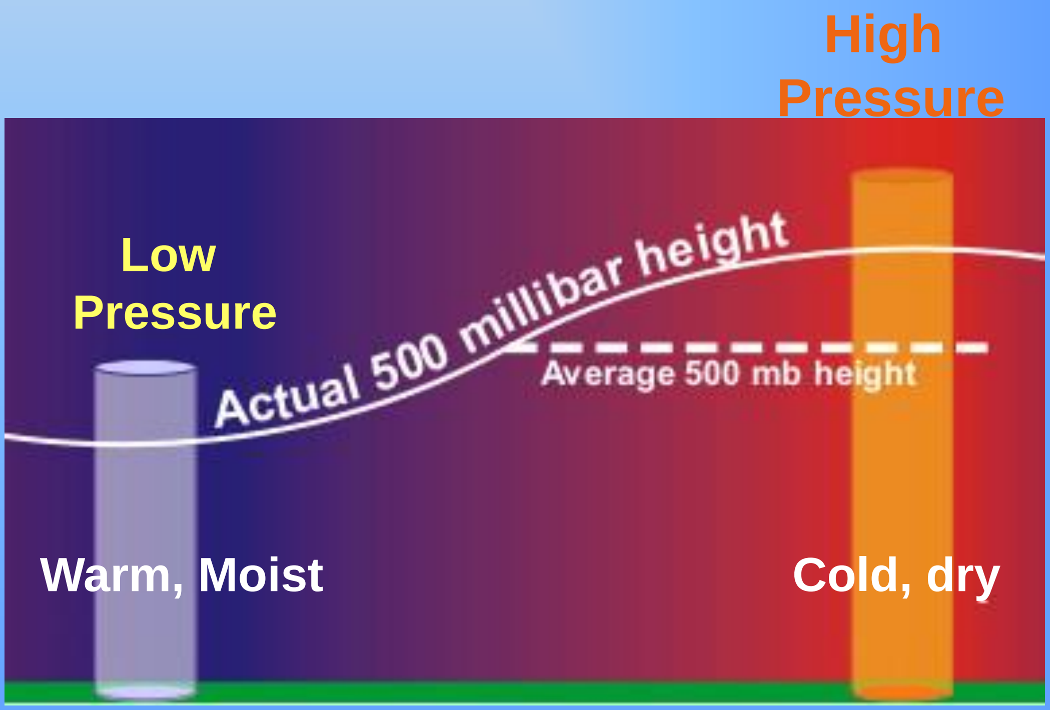
b. The lower density of the air results in a __lower__ in air pressure at high elevations.

Air Pressure Change with Altitude in the *ESRT*

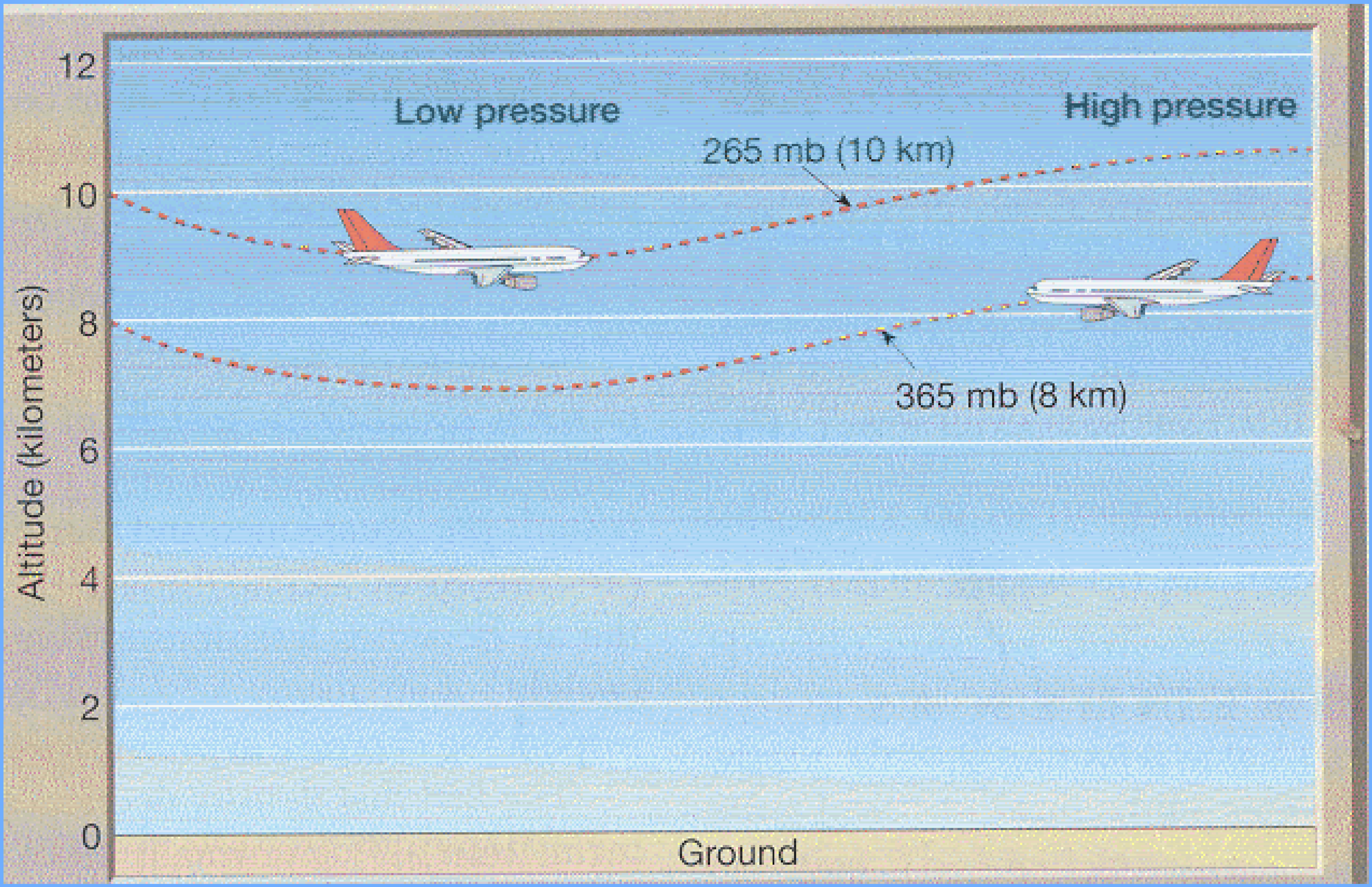


Pressure Levels Can Vary in Altitude

- Where air is less dense (warm and moist), air pressure will fall at a faster rate with altitude
- The 500 mb level shown below is reached at a lower altitude.

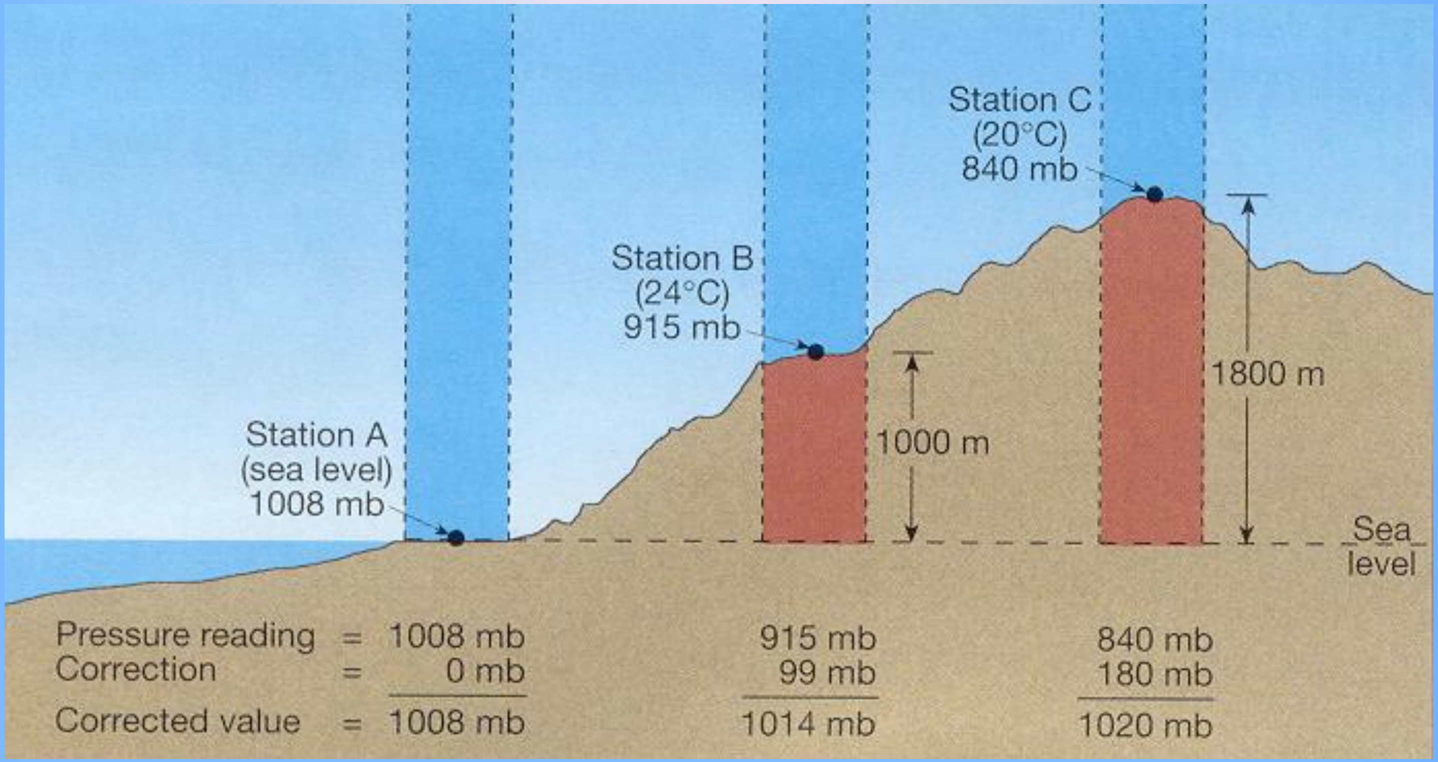


Aircraft Flight Paths



- Aircraft above 5.5 kilometers (18,000 feet) generally fly paths of constant pressure instead of constant altitude.

c. <u>Altitude</u> *Correction*



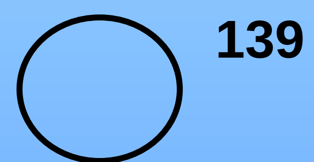
(1) **In interpreting air pressure for the purpose of weather forecasting, meteorologists are concerned with the horizontal changes across an area.**

(2) **The effect of elevation must be factored out. The corrected reading for all stations determines what their pressure would be at sea level and is related to only the weather conditions.**

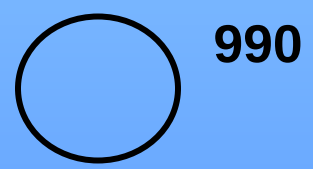
E. ***Air Pressure on Weather Maps***

1. The station model uses an encoded format of the air pressure in *millibars.*
   a. The initial 9 or 10 and the decimal point are omitted.
   b. The number is not labeled.
   c. The encoded pressure is recorded at the **upper right** of the station model.
   d. Examples:

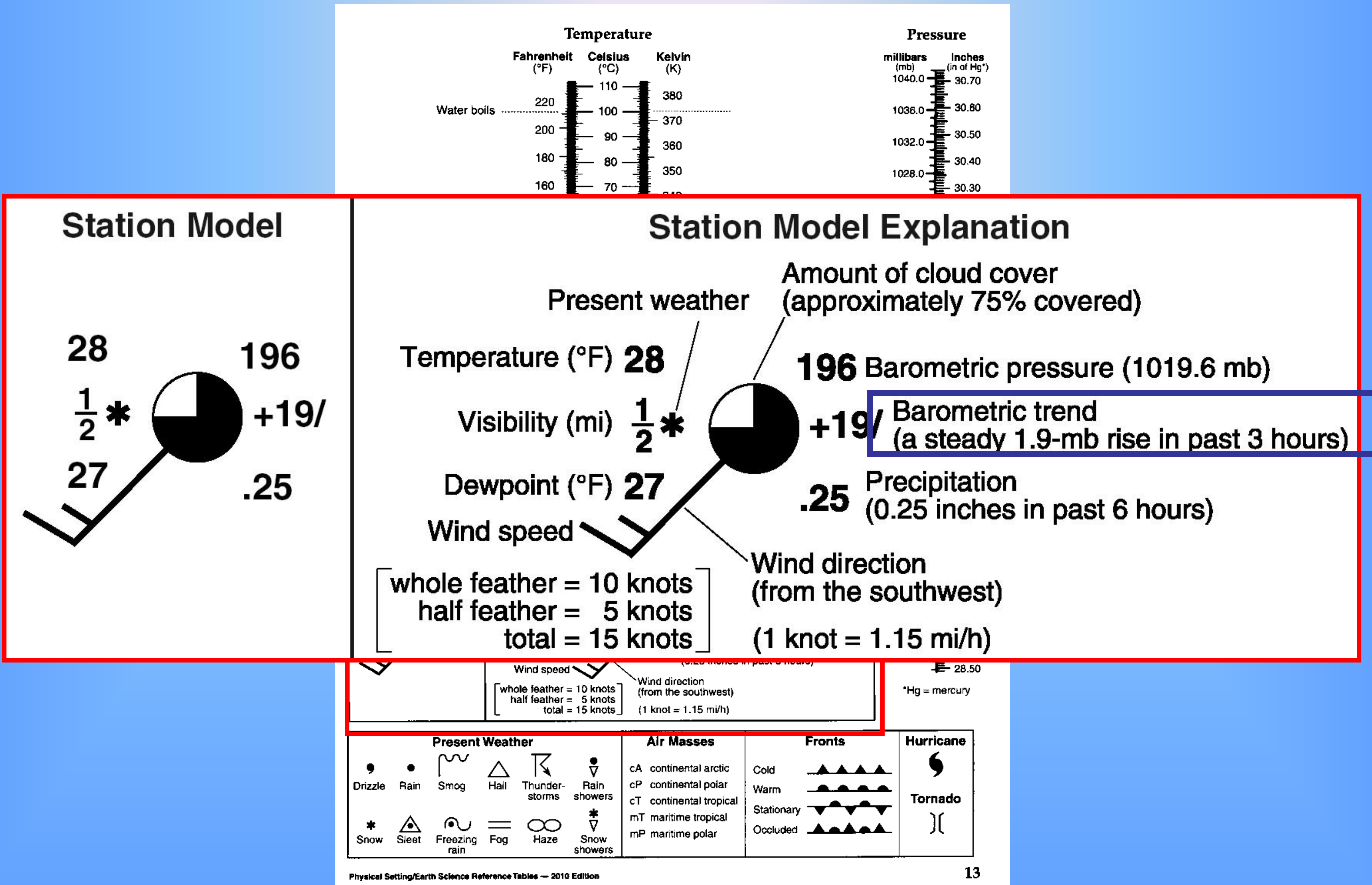
(1) 1013.9 mb



(2) 999.0 mb



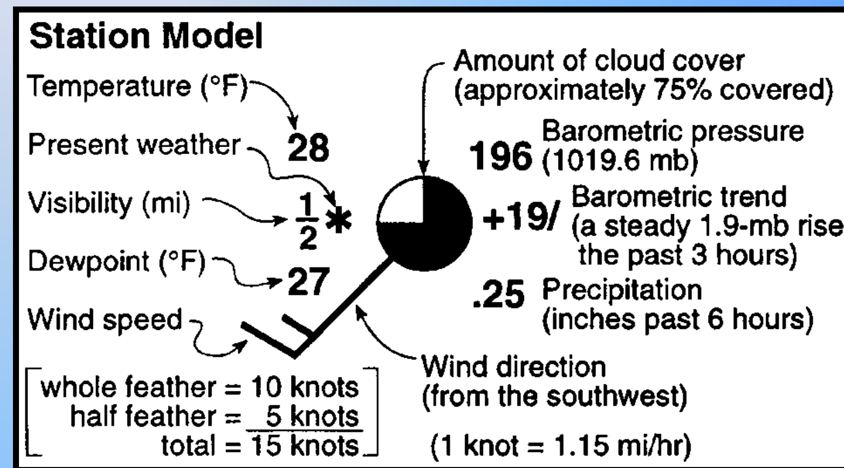
The *ESRT* Station Model



Barometric Trend

- Indicates the change in barometric pressure during the past three hours.

- Rising, then falling; same as or higher than 3 hrs ago
- Rising, then steady; or rising, then rising more slowly
- Rising steadily, or unsteadily
- Falling or steady, then rising; or rising, then rising more rapidly
- Steady; same as 3 hrs ago
- Falling, then rising; same as or lower than 3 hrs ago
- Falling, then steady; or falling, then falling more slowly
- Falling steadily, or unsteadily
- Steady or rising, then falling; or falling, then falling more rapidly



- **The current pressure is 1019.6 mb**
- **Because the pressure has been rising steadily, three hours ago the pressure was 1.9 lower.**
- **Three hours ago the air pressure was 1017.7 mb. (1019.6 mb – 1.9 mb)**

2. **Isobars**

a. Isolines connecting points of **equal** air pressure are constructed.

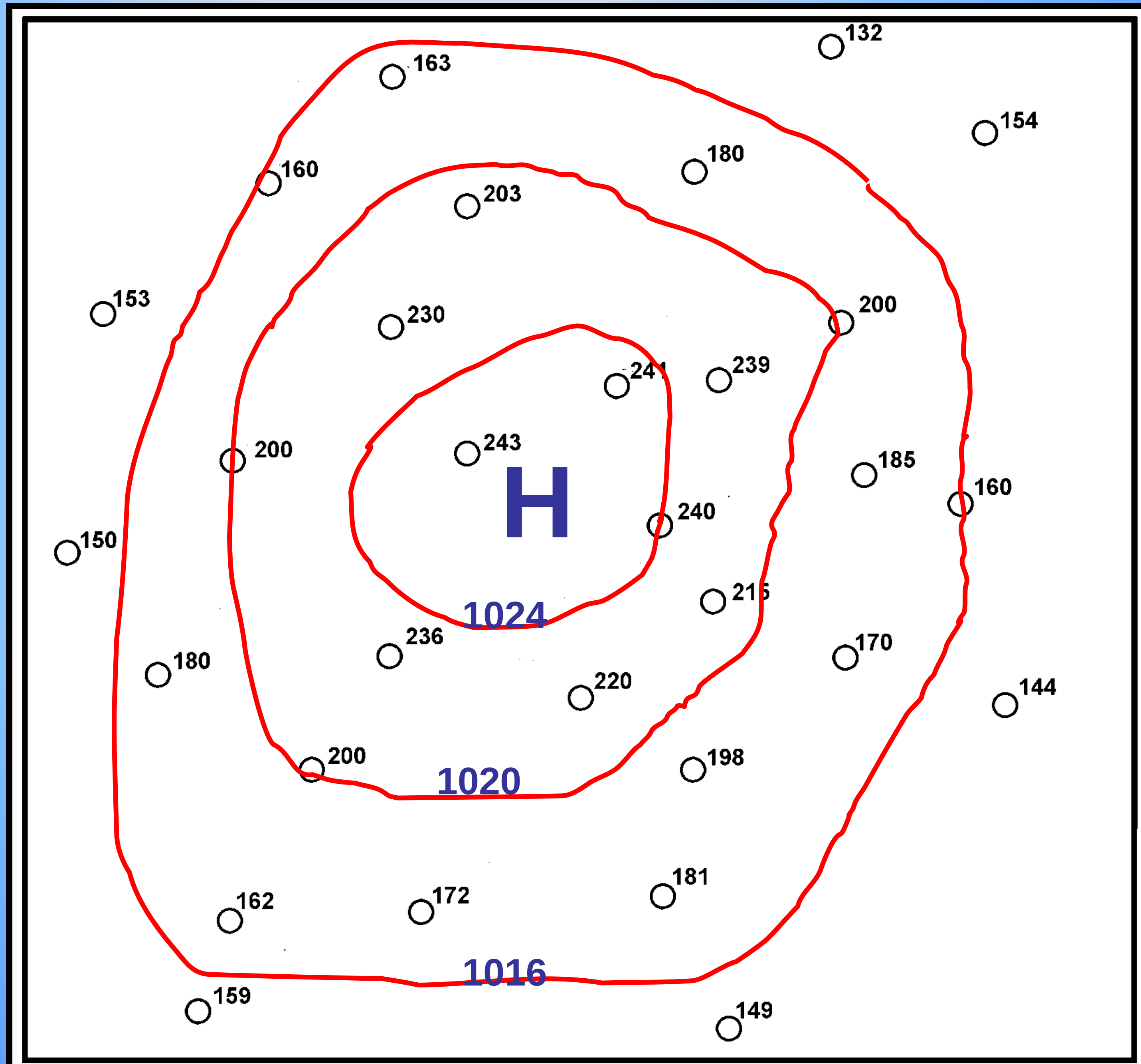
b. A **4 mb** interval is used.

c. Starts with 1000.0 mb (000 on the station model)

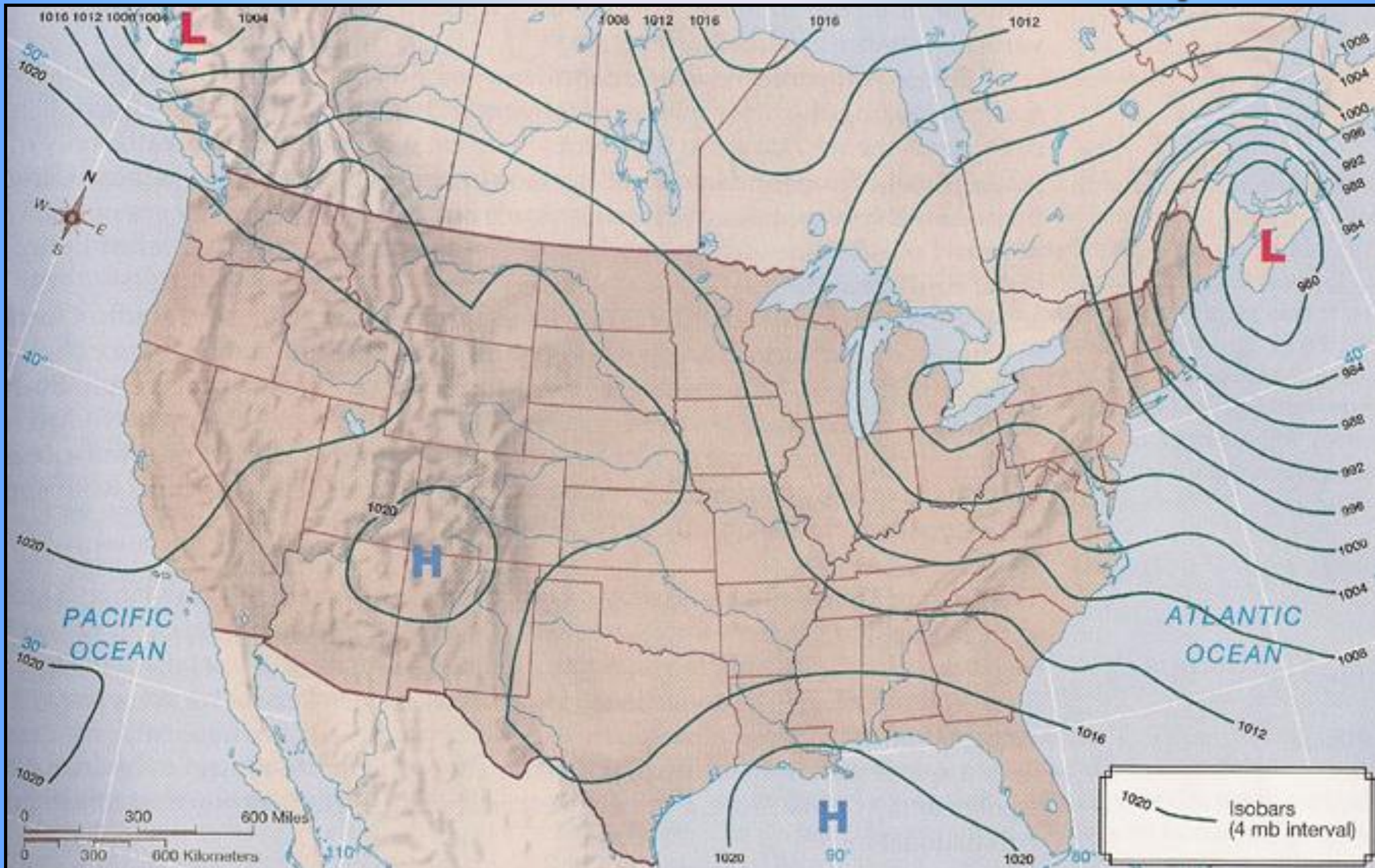
High:
1024.3 mb

Low:
1013.2 mb

1024.0 mb (240)
1020.0 mb (200)
1016.0 mb (160)

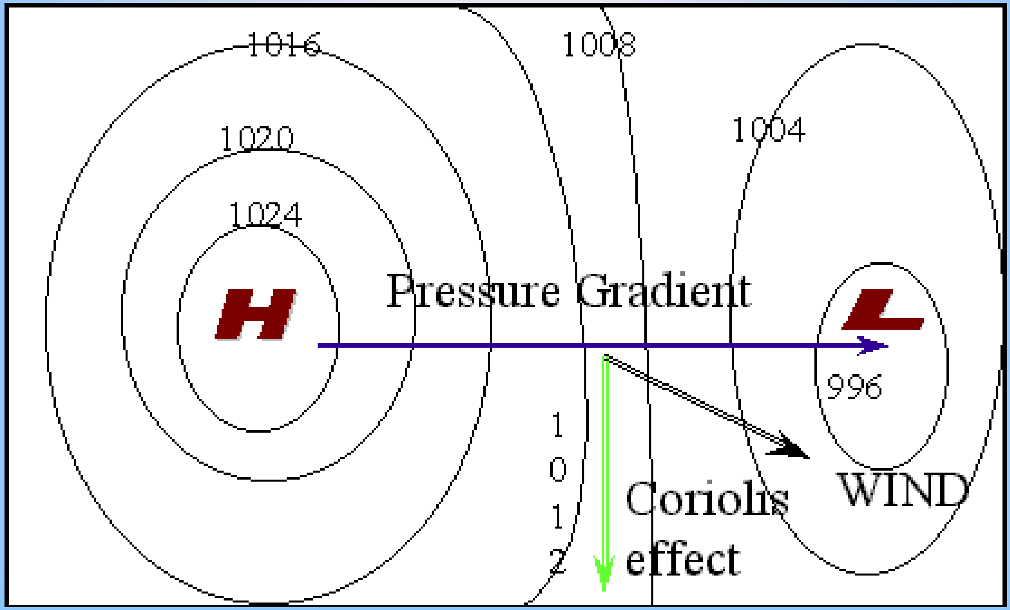


United States Isobar Map



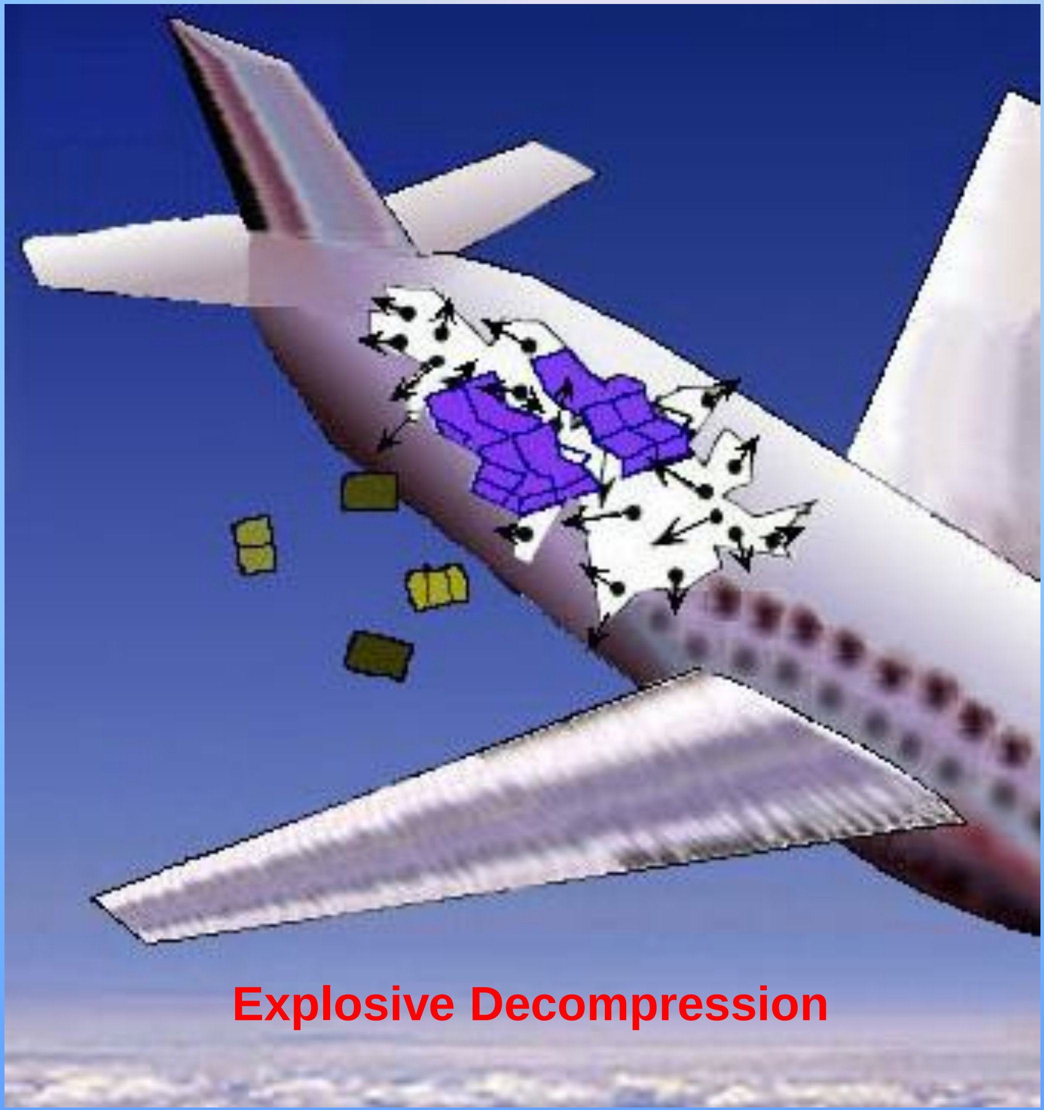
IV. Wind

A. ***What is Wind***?



1. Wind is the _horizontal movement of air____.
2. Wind is the result of horizontal differences in_air pressure_, always flowing from regions of ____high____pressure to regions of __low__pressure.
3. _Unequal_heating of Earth’s surface continually generates these pressure differences.
4. _Solar Radiation_ is the ultimate energy source for most wind.

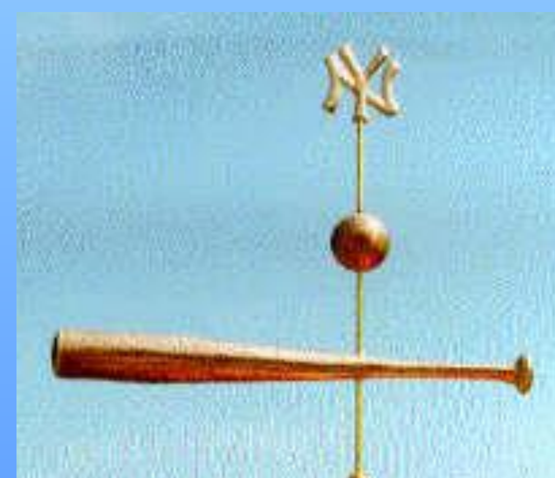
Airflow from High to Low Pressure



B. ***Measuring and Recording Wind Data***

1. Instruments to Measure Wind

a. **Wind (weather) Vanes**: Indicate wind **direction**.



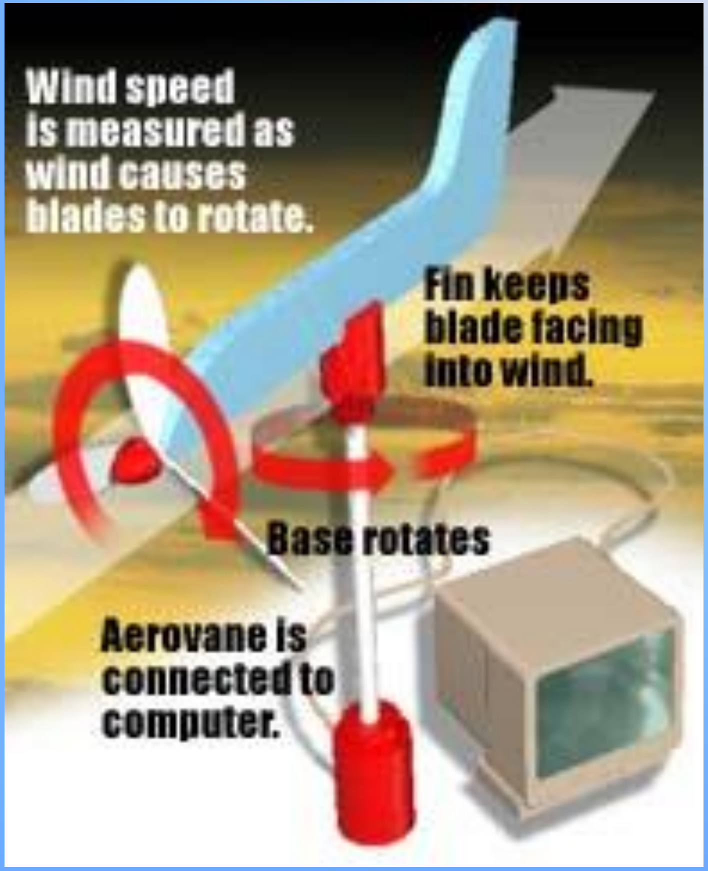
b. Anemometer

Cup Anemometers

(1) Wind ___**speed**___

(2) “Anemo” comes from the Greek word “anemos” for “wind”.

c. **Aerovane**: Combines a wind vane and anemometer into one instrument.



2. Recording Wind on Maps

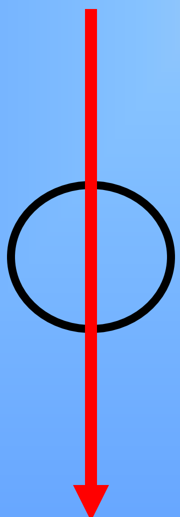
a. Wind Direction

(1) Wind is named for the direction __**from**__ *which* it is blowing.

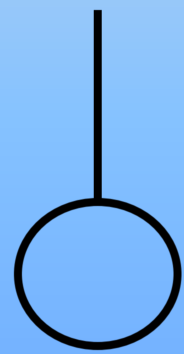
(2) A northerly wind means the wind is blowing __**north to south**__.

b. An arrow is drawn into the station model in the direction the wind is blowing but without the head of the arrow.

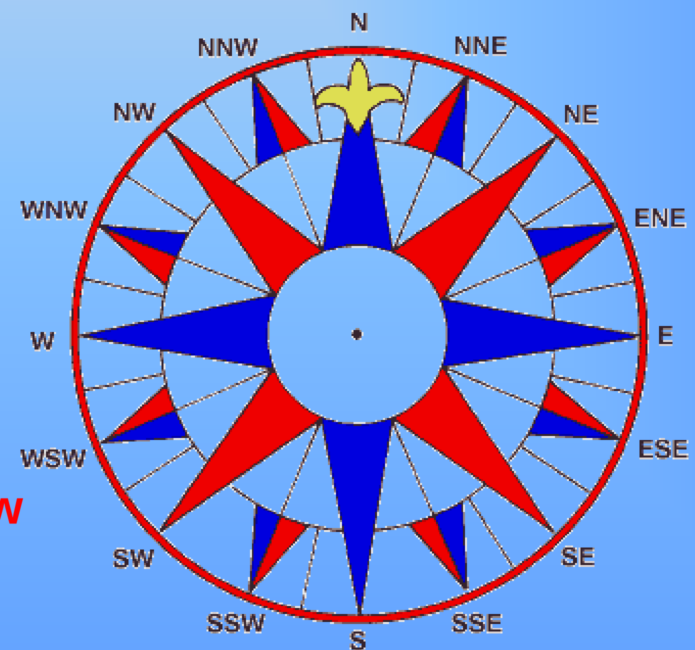
Northerly wind



Northerly Wind on a station model

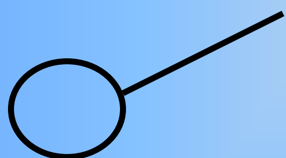


The head of the arrow Isn't drawn

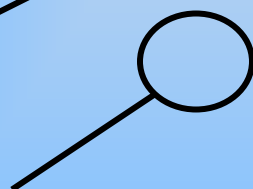


More Examples

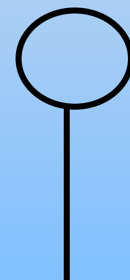
NE

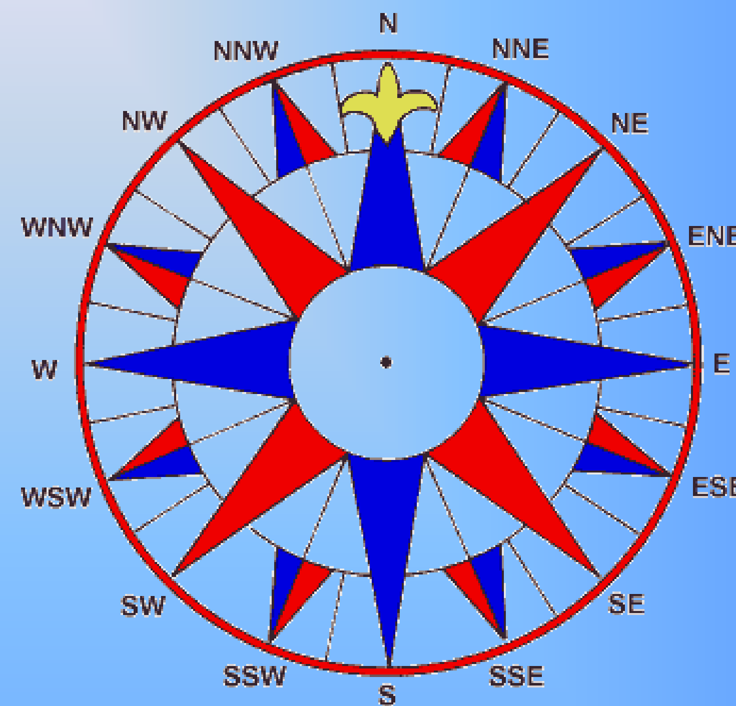


SW



S

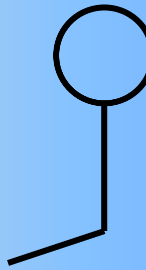


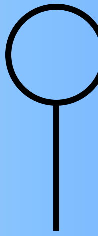


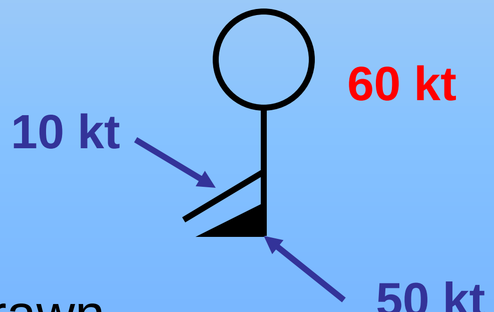
b. Wind Speed

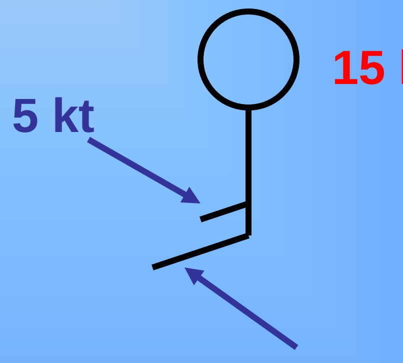
(1) **Feathers**, each representing 10 knots (12 mph) are drawn on the left side of the arrow as its “tail.” (One knot is equal to 1.15 mph.)

- (a) An arrow with no feather is equal to 1 to 2 knots.
- (b) Half a feather is equal to 5 knots
- (c) **Flag** : A triangle represents 50 knots.







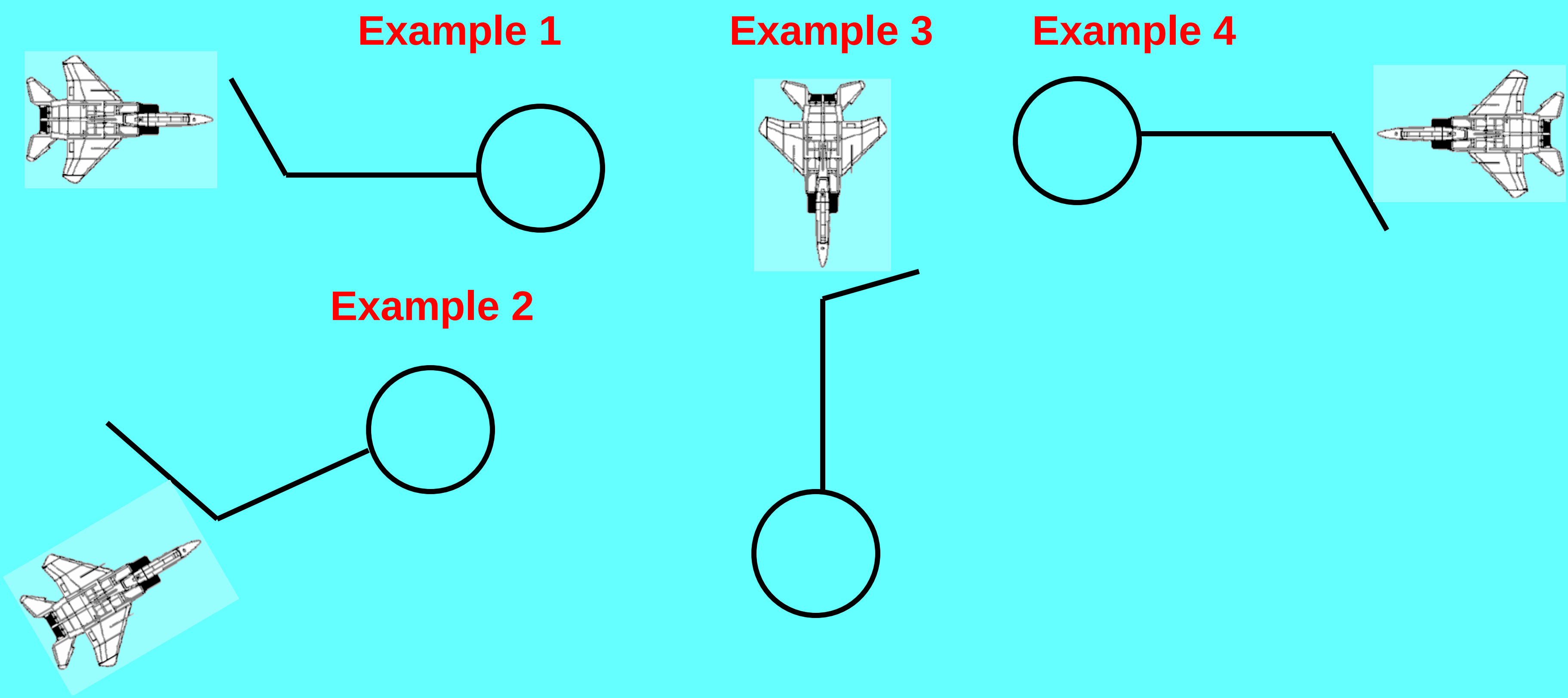


(2) **Calm**:

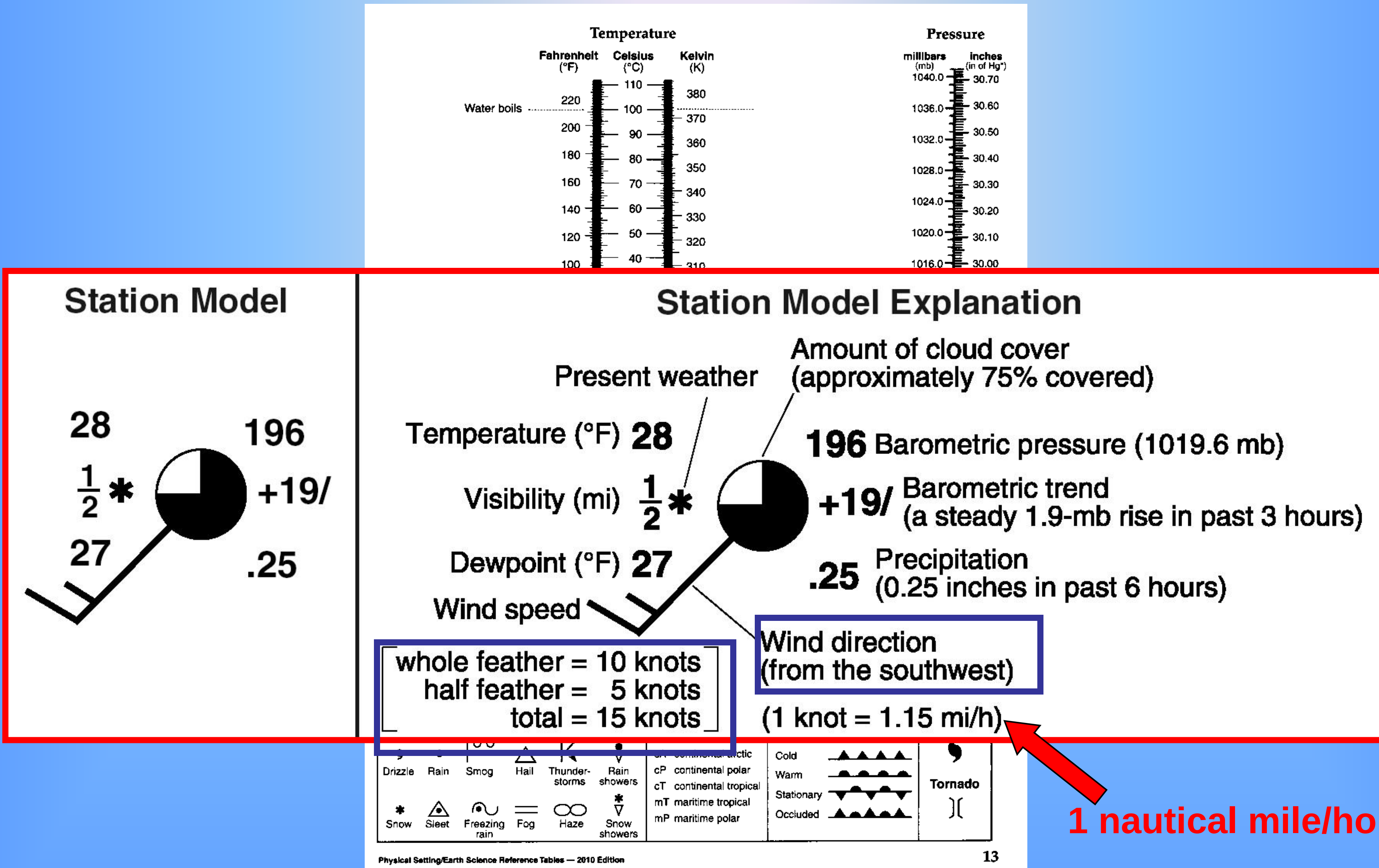
- (a) No arrow is drawn
- (b) A circle is drawn around the station model.

Identifying the Left Side of the Wind Arrow

- It’s towards the observers left side **with your back to the wind**.
- If you are flying with the wind it’s on your left.



Wind on the *ESRT* Station Model

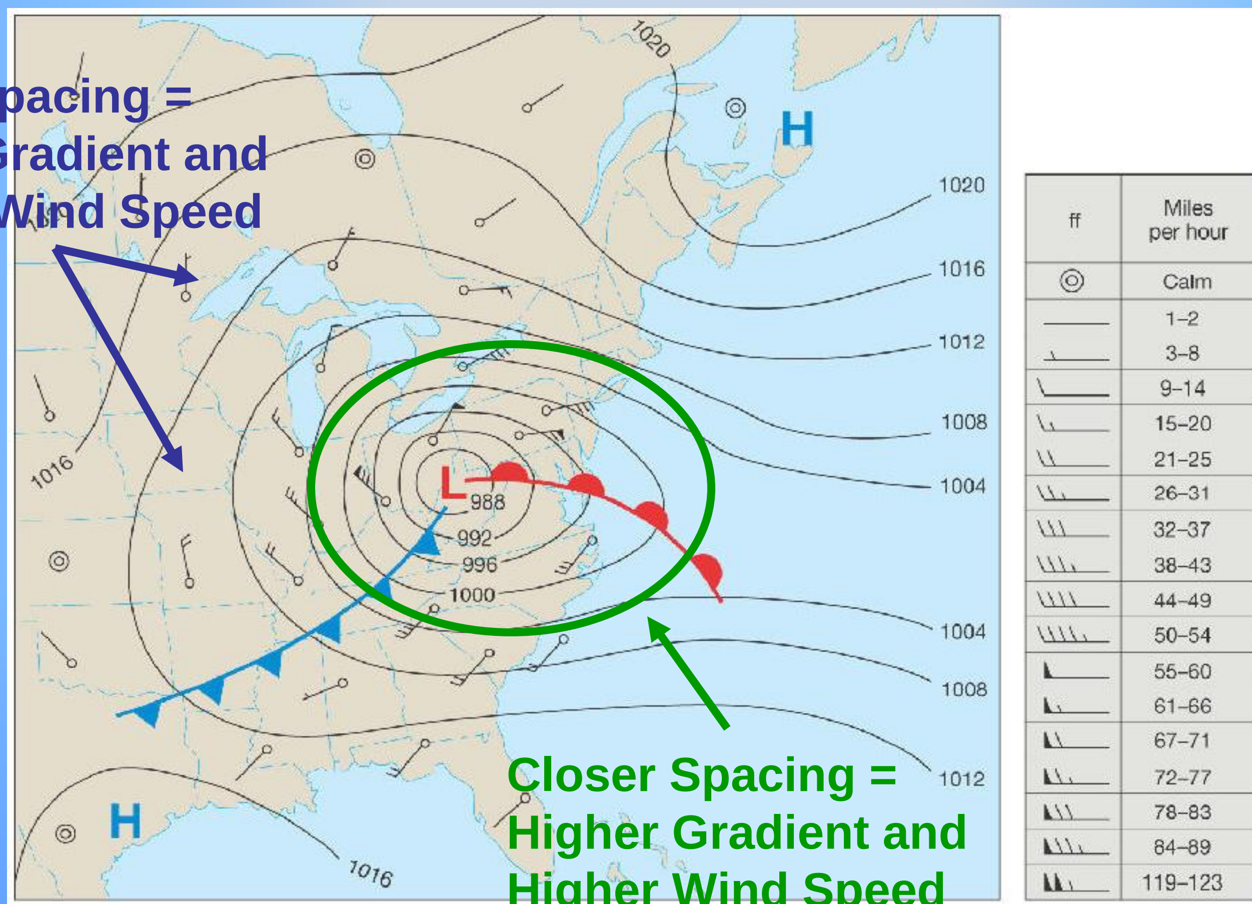


1 nautical mile/hour

C. <u>*Factors Affecting Wind*</u>

1. Pressure Gradient Force:
   a. The change in pressure over a __**distance**__.
   b. Interpreted by __**the spacing**__ of *isobars* on a weather map.

Wider Spacing = Lower Gradient and Slower Wind Speed



Closer Spacing = Higher Gradient and Higher Wind Speed

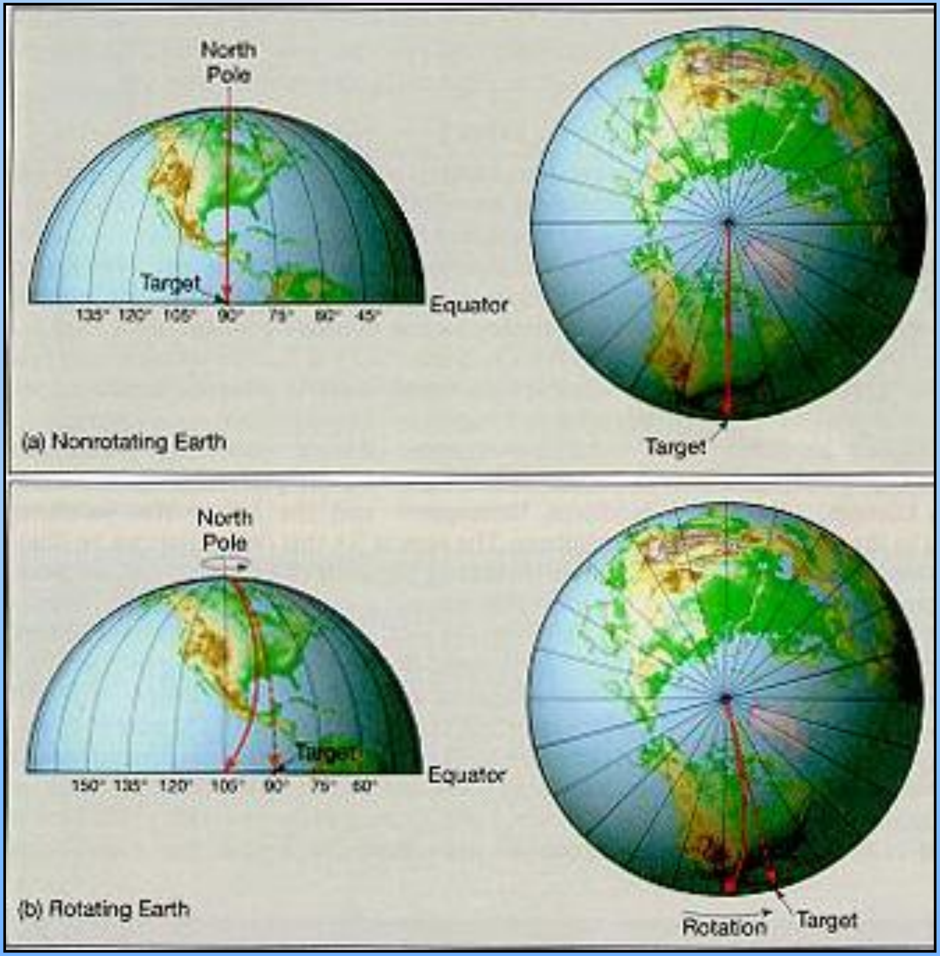
Pressure Gradient Force

c. Basic cause is the __**unequal**__ heating of Earth's land-sea surface.

d. The higher the gradient, the __**greater**__ the difference in pressure and the __**higher**__ the wind velocity.

e. Pressure gradient has __**direction**__ as well as magnitude (at right angles to the isobars)

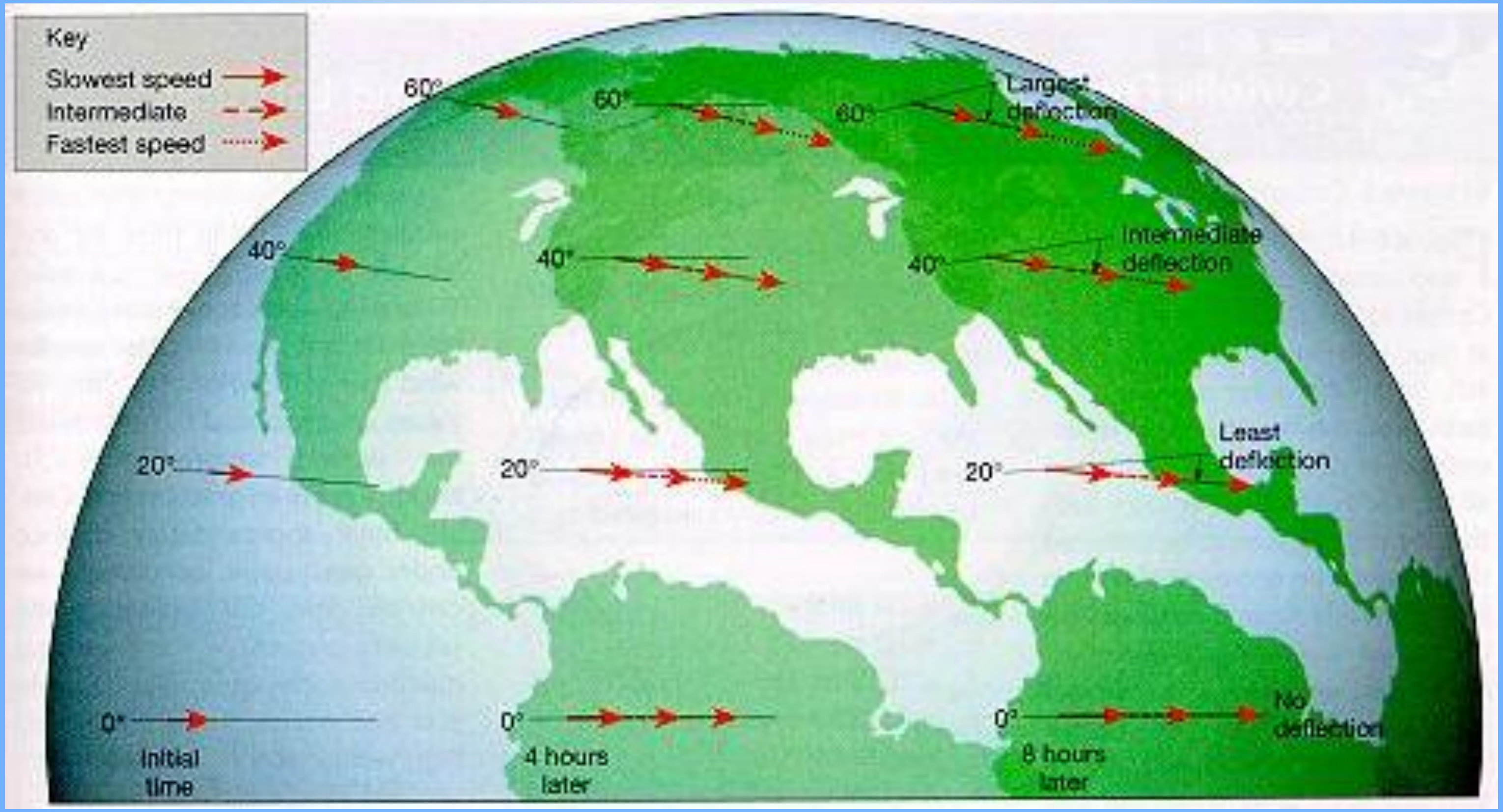
2. Coriolis Effect



a. Earth's__**rotation**__causes a deflection of winds so that they do not cross isobars at right angles.

b. Deflection is to the __**right**__ in the Northern Hemisphere and to the __**left**__ in the Southern Hemisphere

c. It's not a true force, but is an *effect* of Earth's rotation

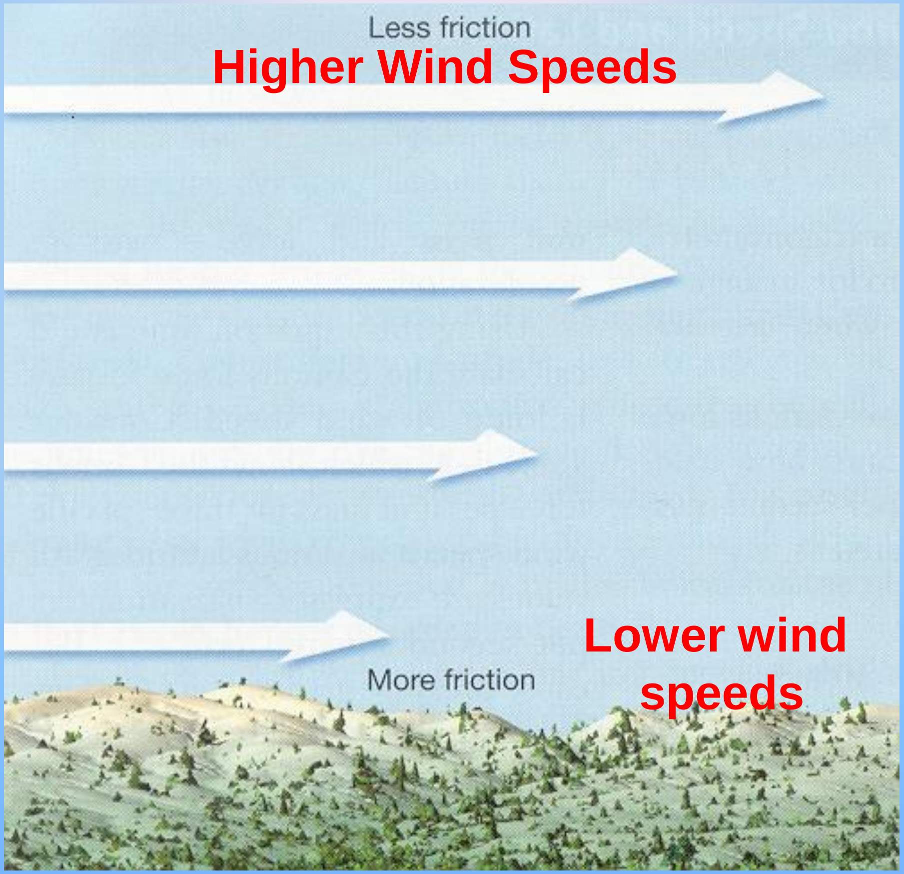


(1) Affects only the ___**direction**___ of the wind

(2) The stronger the wind, the ___**greater**___ the deflection.

(3) Strongest at the ___**poles**___ and nonexistent at the ___**equator**___.

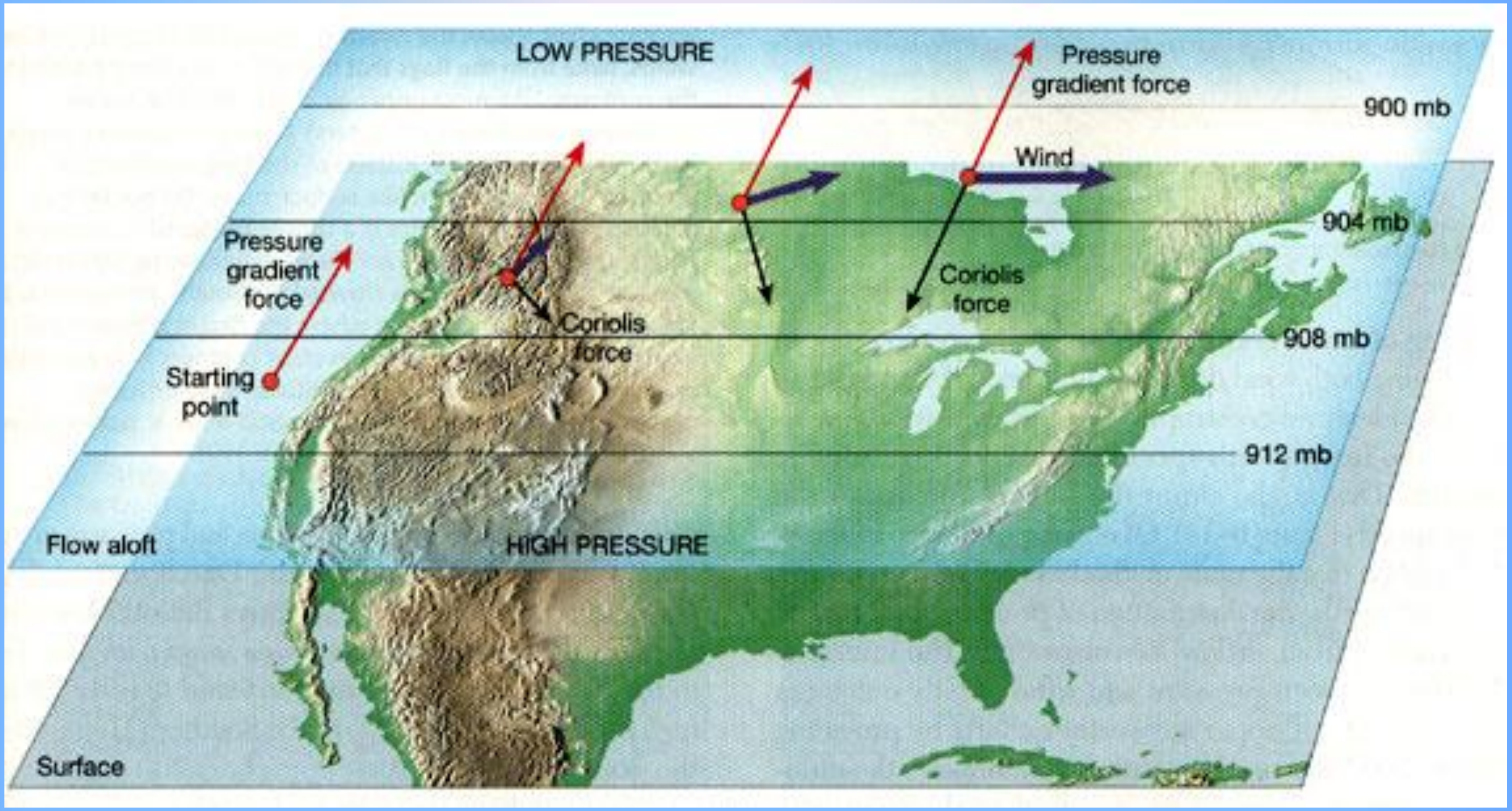
3. Friction



a. Significantly influences winds near **Earth's surface**.

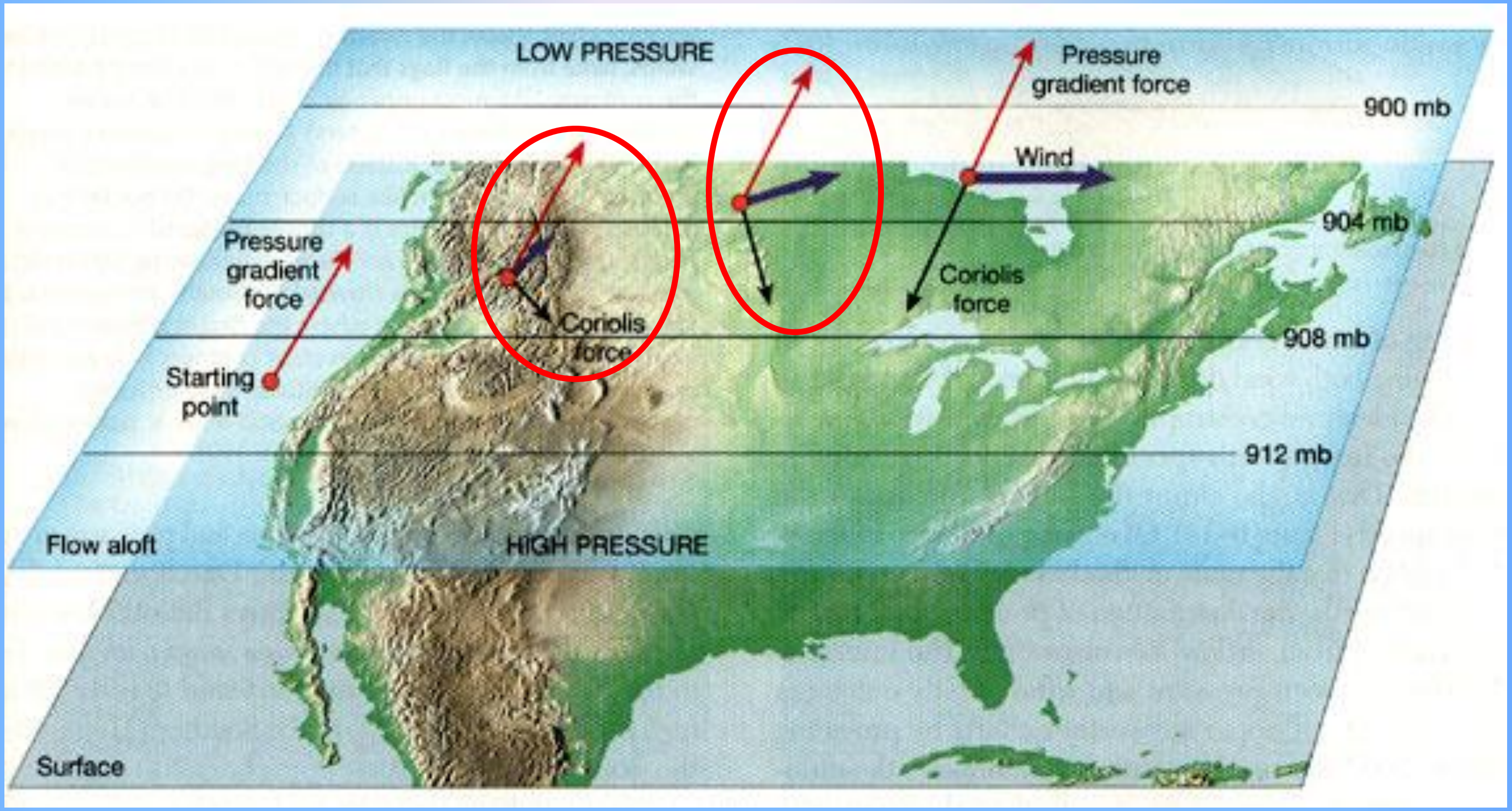
b. Prevents wind speeds from continually accelerating (opposes the pressure-gradient force).

C. Geostrophic Winds



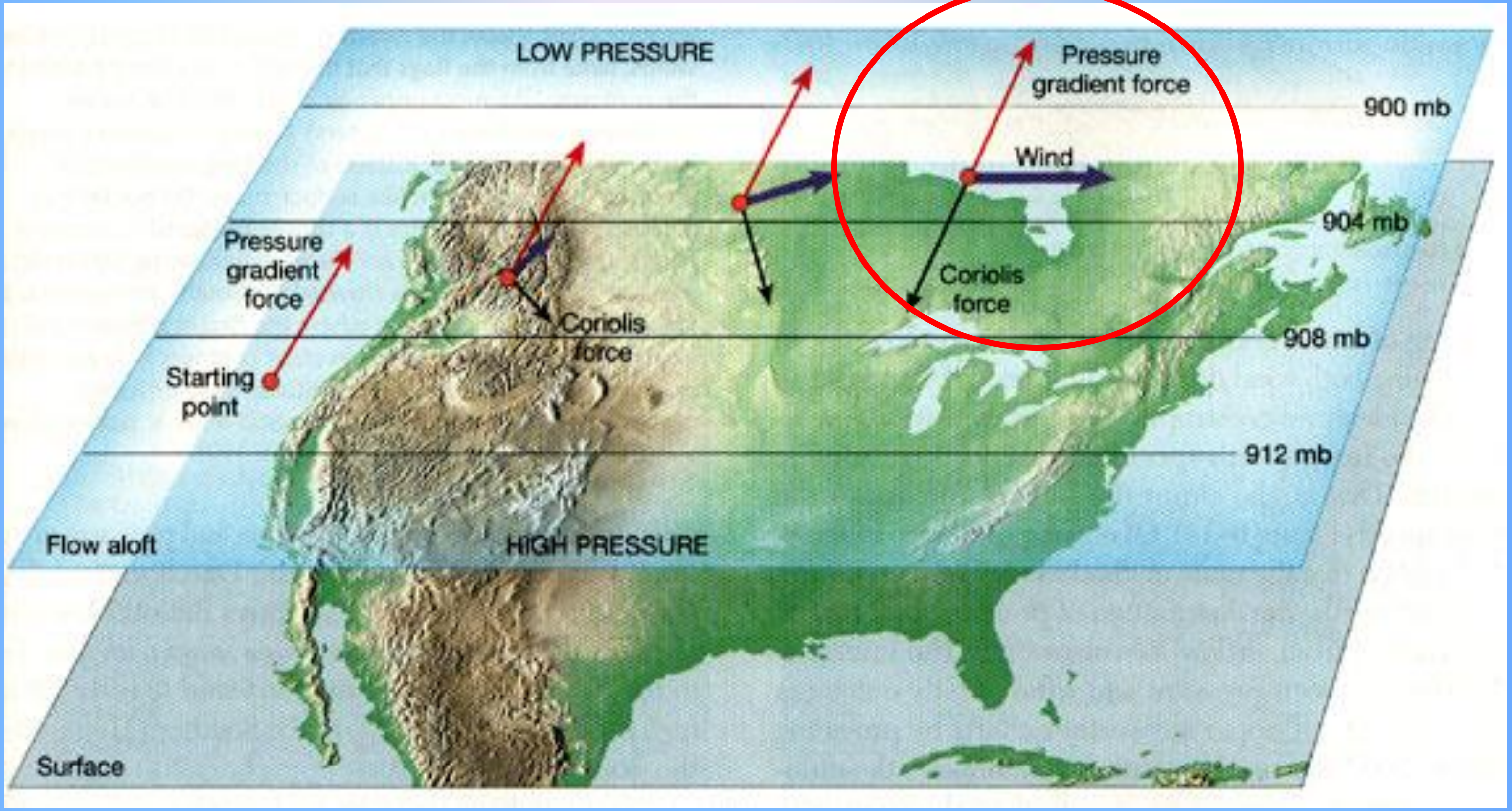
1. **Upper** level winds (above a few kilometers) flow in a straight path, parallel to isobars.
2. Velocities are proportional to the **pressure gradient** force.

D. Geostrophic Winds



3. Pressure-gradient force causes a parcel of air to accelerate towards a region of low pressure and the Coriolis force deflects winds. This deflection increases with increased wind velocity.

D. Geostrophic Winds

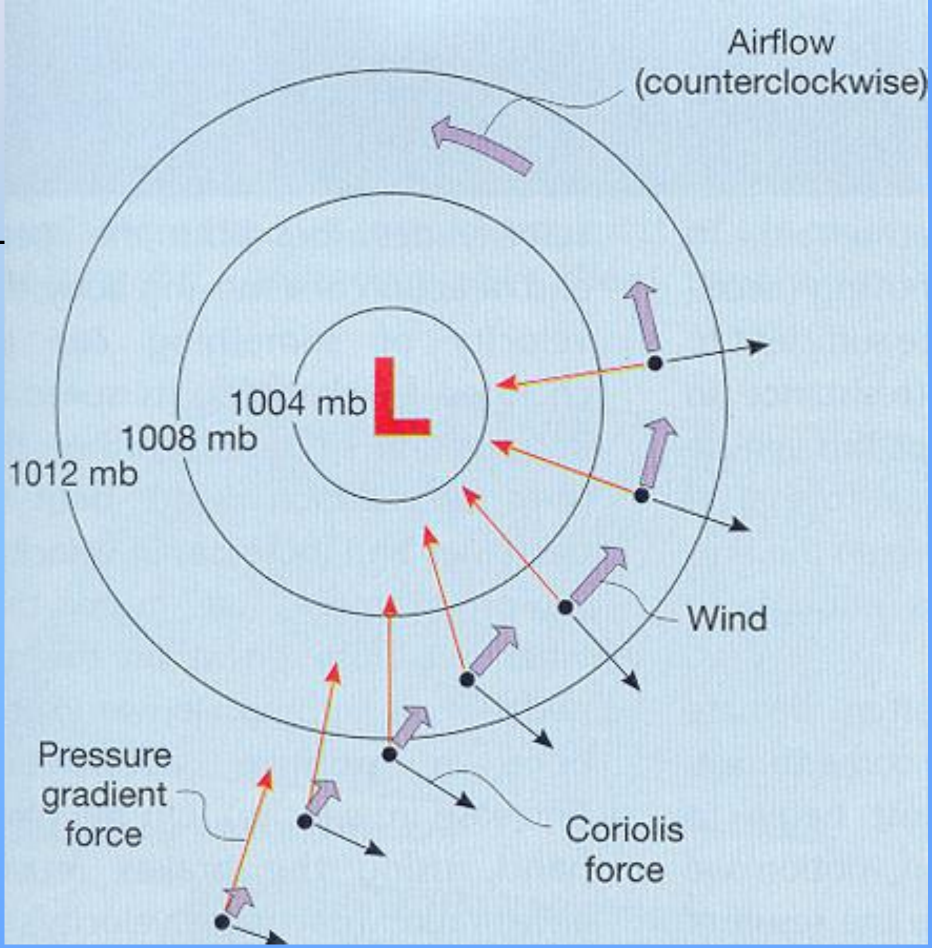


a. Eventually the wind turns so that it is flowing *parallel* to the isobars with the pressure-gradient force **balanced** by the opposing Coriolis force (called *geostrophic balance.*)

b. As long as the forces remain balanced, the wind flows parallel to the isobars at constant speed

E. *Curved Air Flow (Cyclones and Anticyclones)*

1. **Cyclone**
   a. **Low** pressure center
   b. Air flows **into the low** and **counterclockewise** in the Northern Hemisphere (clockwise in the S. Hemisphere.
   c. Air piles up in the low, **rises** and **diverges** aloft.
   d. Rising humid air cools, forming clouds.



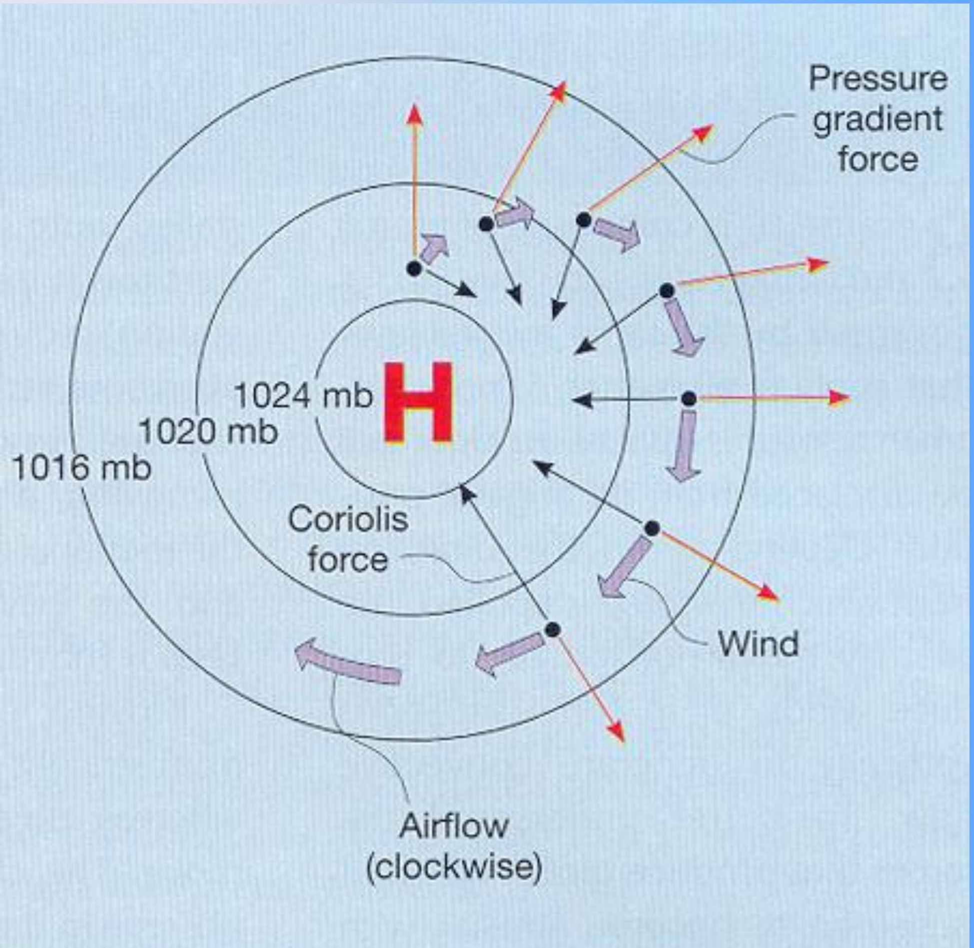
2. Anticyclone

a. High Pressure

b. Flow is out of the high and clockwise (counterclockwise in the S. hemisphere)

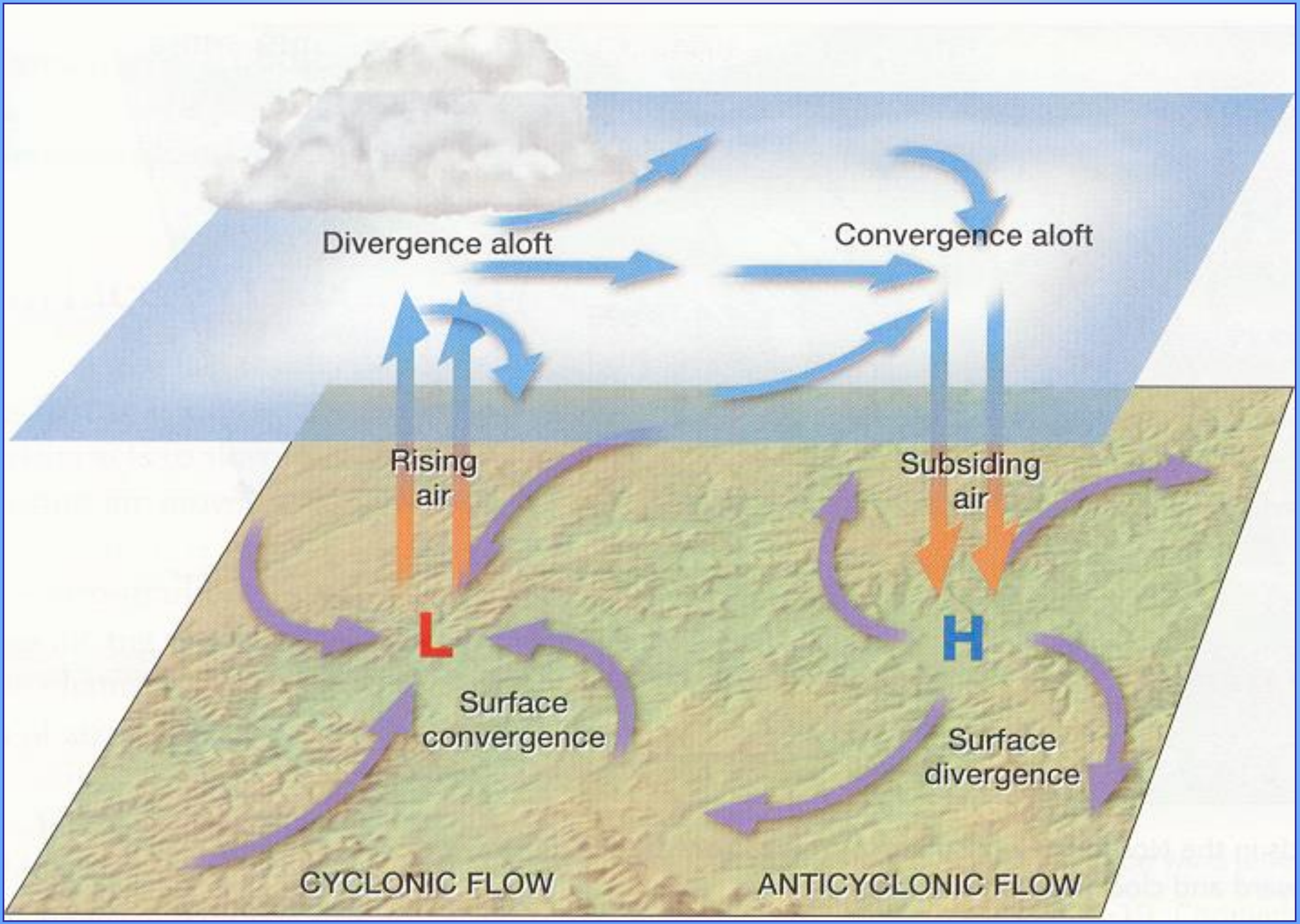
c. Outflow near the surface is accompanied by convergence aloft, and subsidence of the air column.

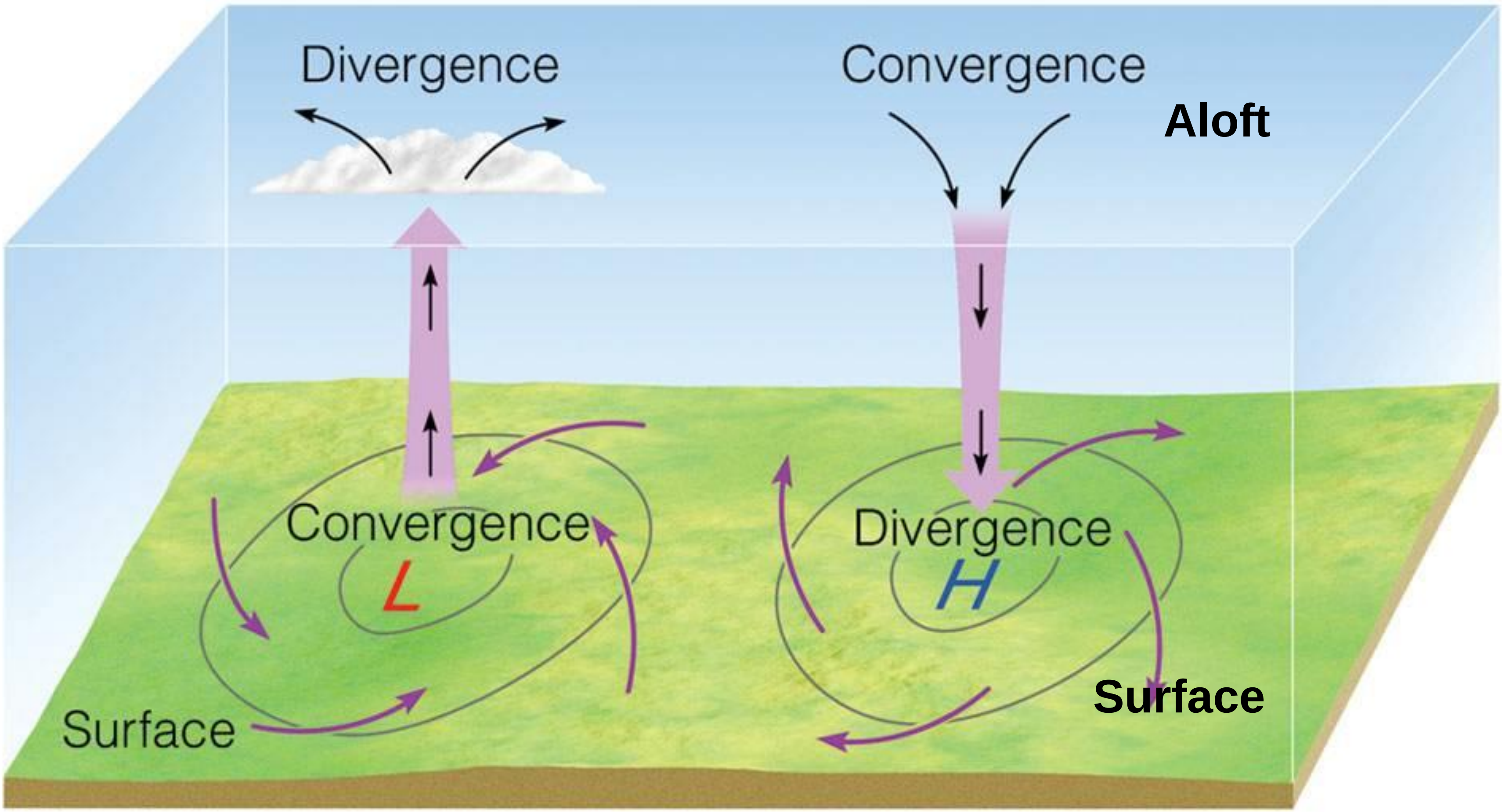
d. Sinking air compresses and becomes warmer.



(b) Anticyclonic flow (Northern hemisphere)

Airflow Associated with Surface Cyclones and Anticlones



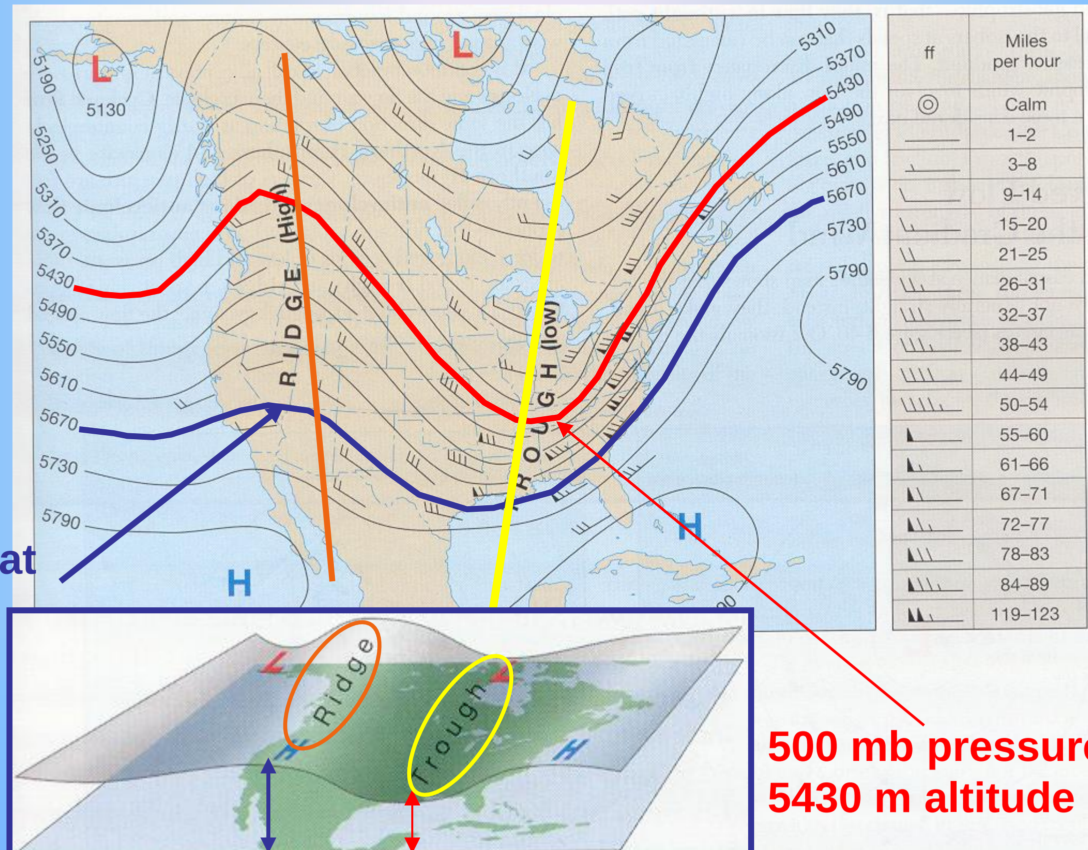

Divergence
Convergence
Aloft
Convergence
L
Divergence
H
Surface
Surface

F. High Altitude Winds Shown on Upper Level Charts

1. Upper-level maps show the __direction__ and of the __speed__ upper-air winds.

2. Maps are plotted for a selected __altitude__ using it's pressure level (e.g., 500 mb level)

3. Contours are drawn for the actual altitude in meters at which the 500 mb level is reached.



ff	Miles per hour
◎	Calm
	1–2
	3–8
	9–14
	15–20
	21–25
	26–31
	32–37
	38–43
	44–49
	50–54
	55–60
	61–66
	67–71
	72–77
	78–83
	84–89
	119–123

500 mb pressure at 5670 m altitude

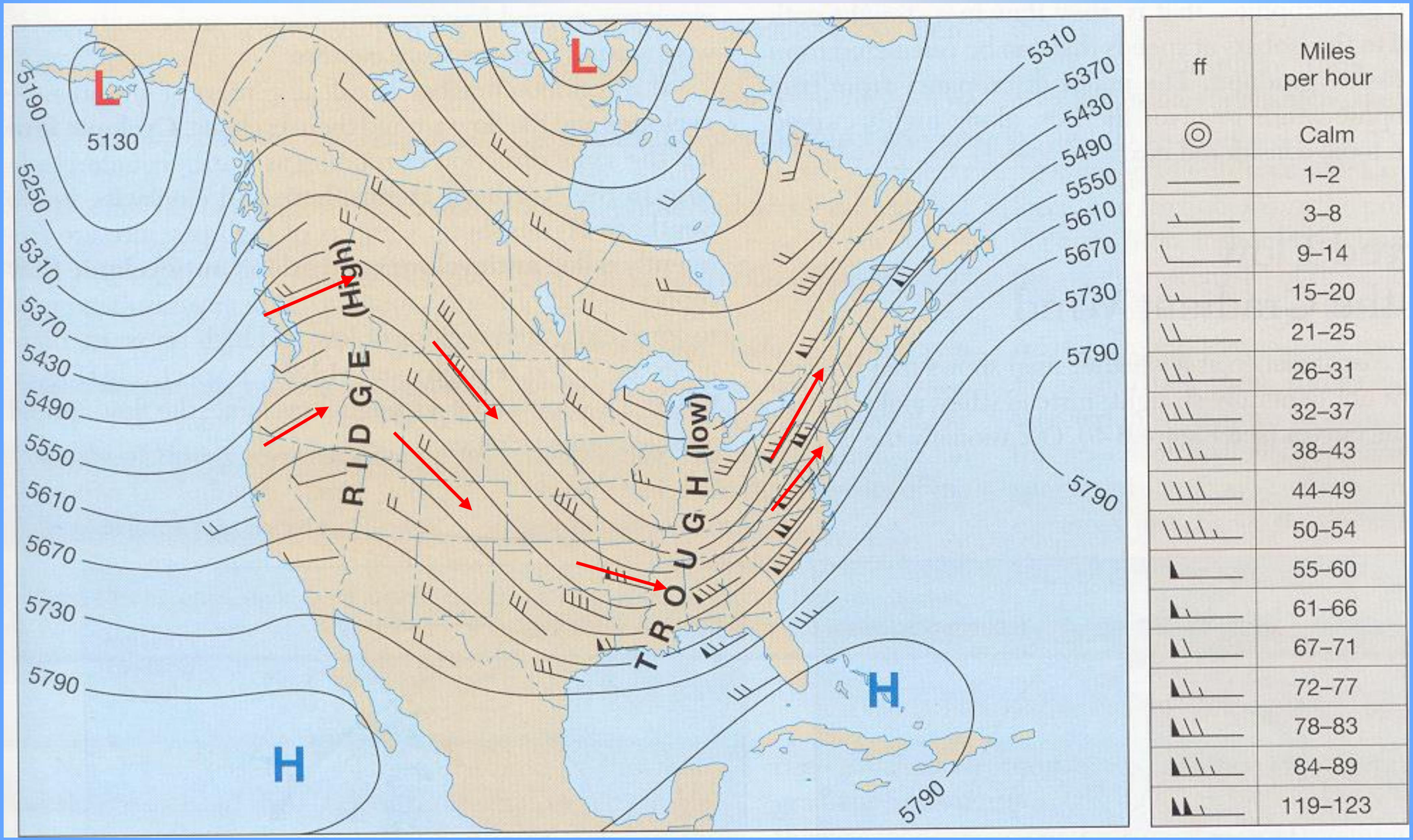
500 mb at this level

500 mb pressure at 5430 m altitude

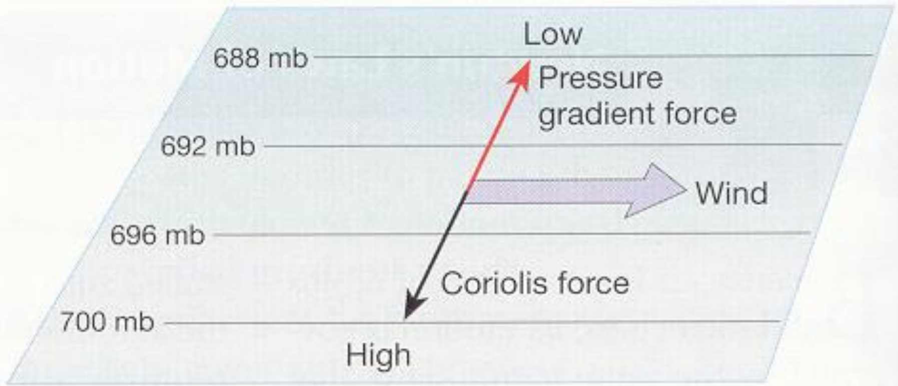
a. They will be **lower** if there is a surface low.
   (1) The contours will form elongated bends towards the south of the map.
   (2) This is referred to as an upper level **trough**.

b. Higher elevation contours indicate **higher** pressure.
   (1) The contours will form elongated bends towards the north of the map.
   (2) This is referred to as an upper level **ridge**.

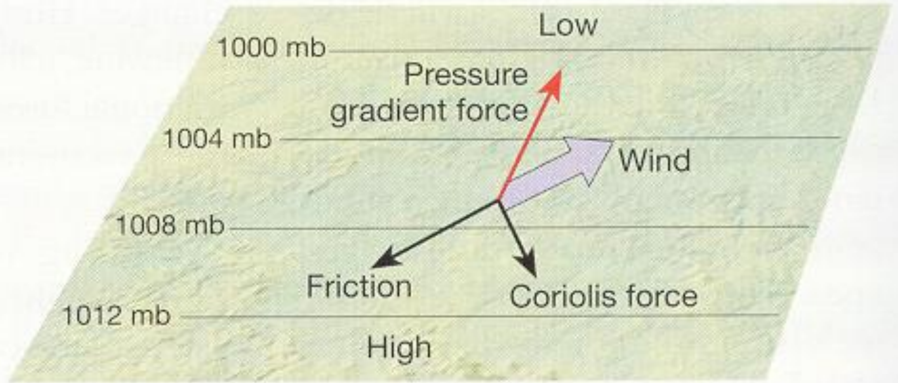
3. Upper-level winds will flow nearly **parallel** to the contours.



G. Surface Winds



(a) Upper-level wind (no friction)



(b) Surface wind (effect of friction)

1. Friction
   - A factor only within the first few kilometers of Earth's surface.
   - Friction with Earth's surface ______**reduces**______ velocity which ___**changes**_______the Coriolis force.
   - Pressure-gradient force is not affected by friction, dominates, and __**changes**______the wind direction.
   - Air flows at an __**angle**____across the isobars.

2. Smooth surface (e.g. ocean): **Reduces** friction and air crosses the isobars at and angle of about 10^o to 20^o with a speed approximately ⅔ of geostrophic flow.

- Rough topography (e.g. mountainous): Friction is **increased** and air can cross the isobars at an angle as high as 45o with wind speeds lowered by as much as 50%.

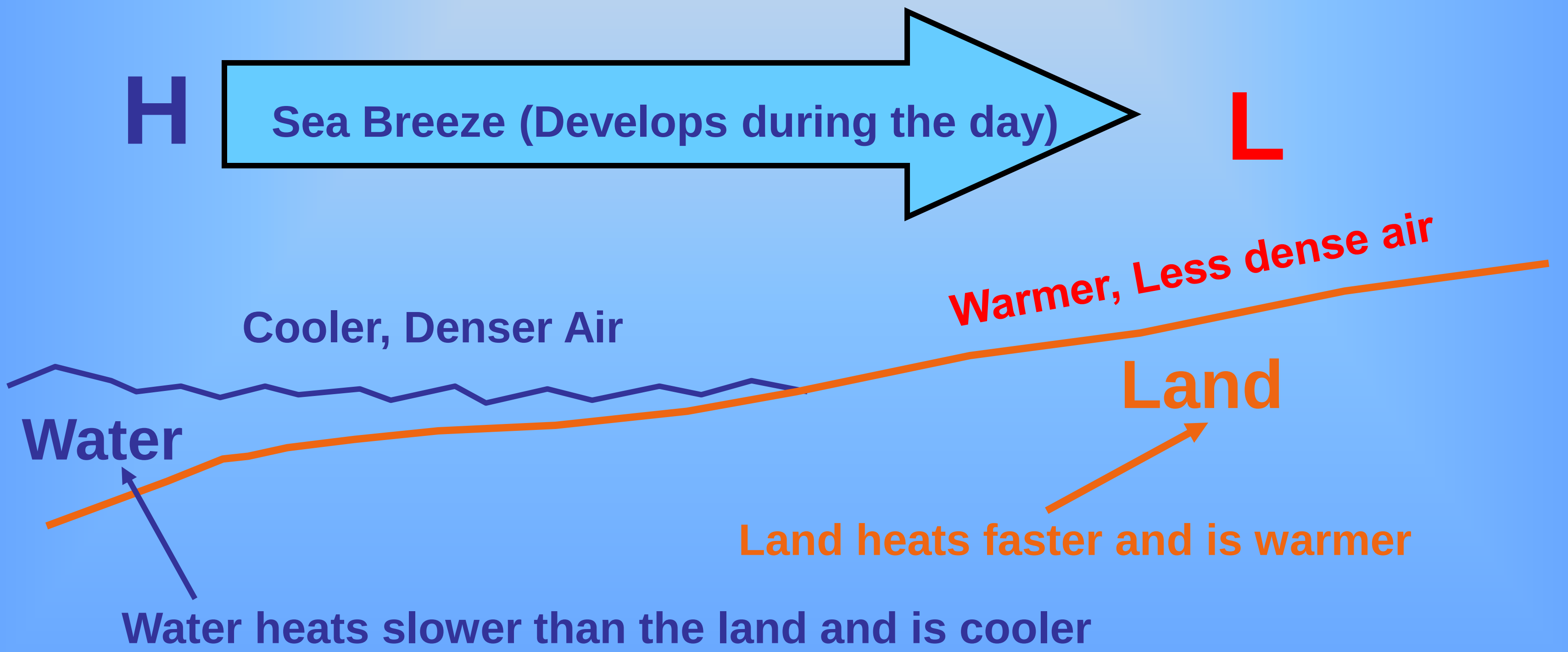
H. Local Winds

a. Land and Sea Breezes:

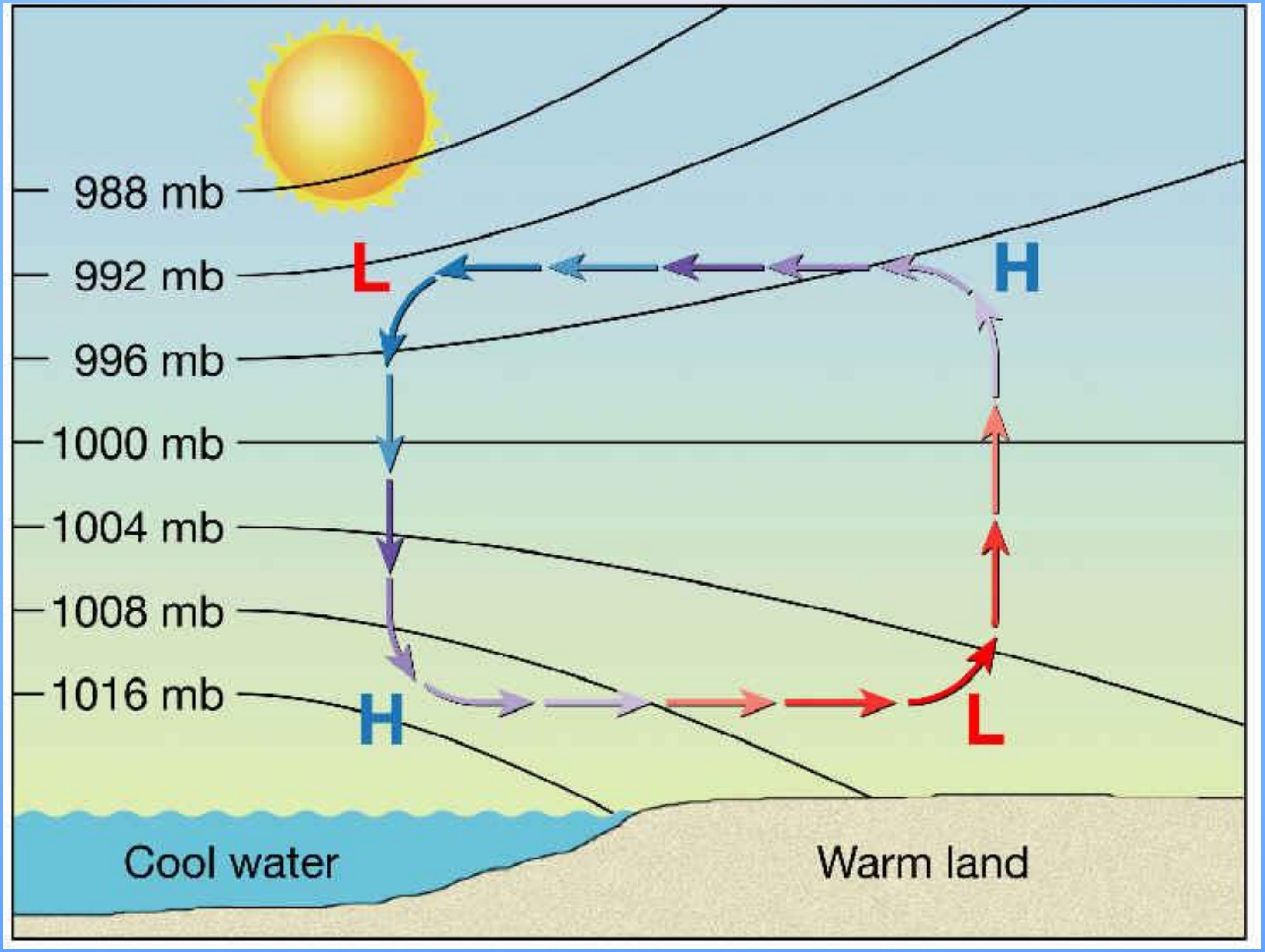
Caused by daily temperature contrast between land and water

a. Sea Breeze During the Day

By Mid-Afternoon

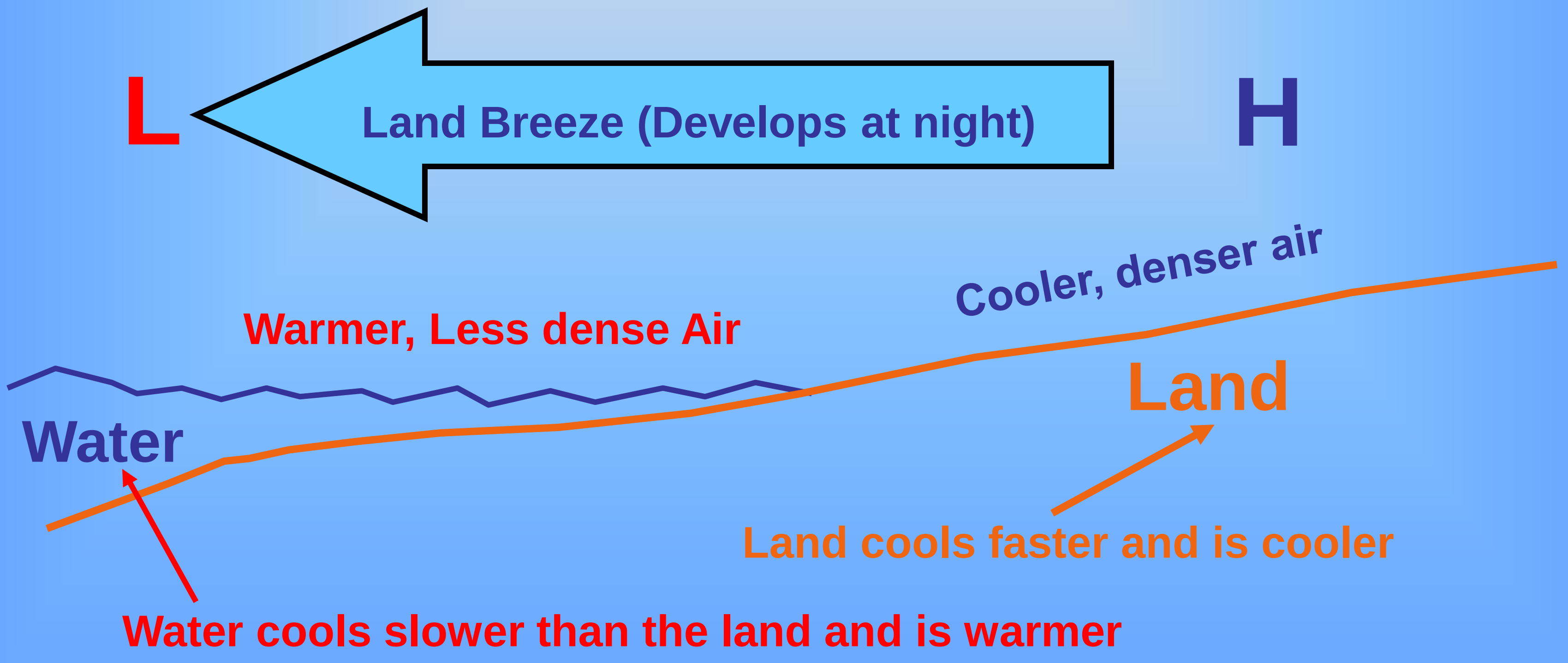


Sea Breeze Showing Horizontal and Vertical Airflow

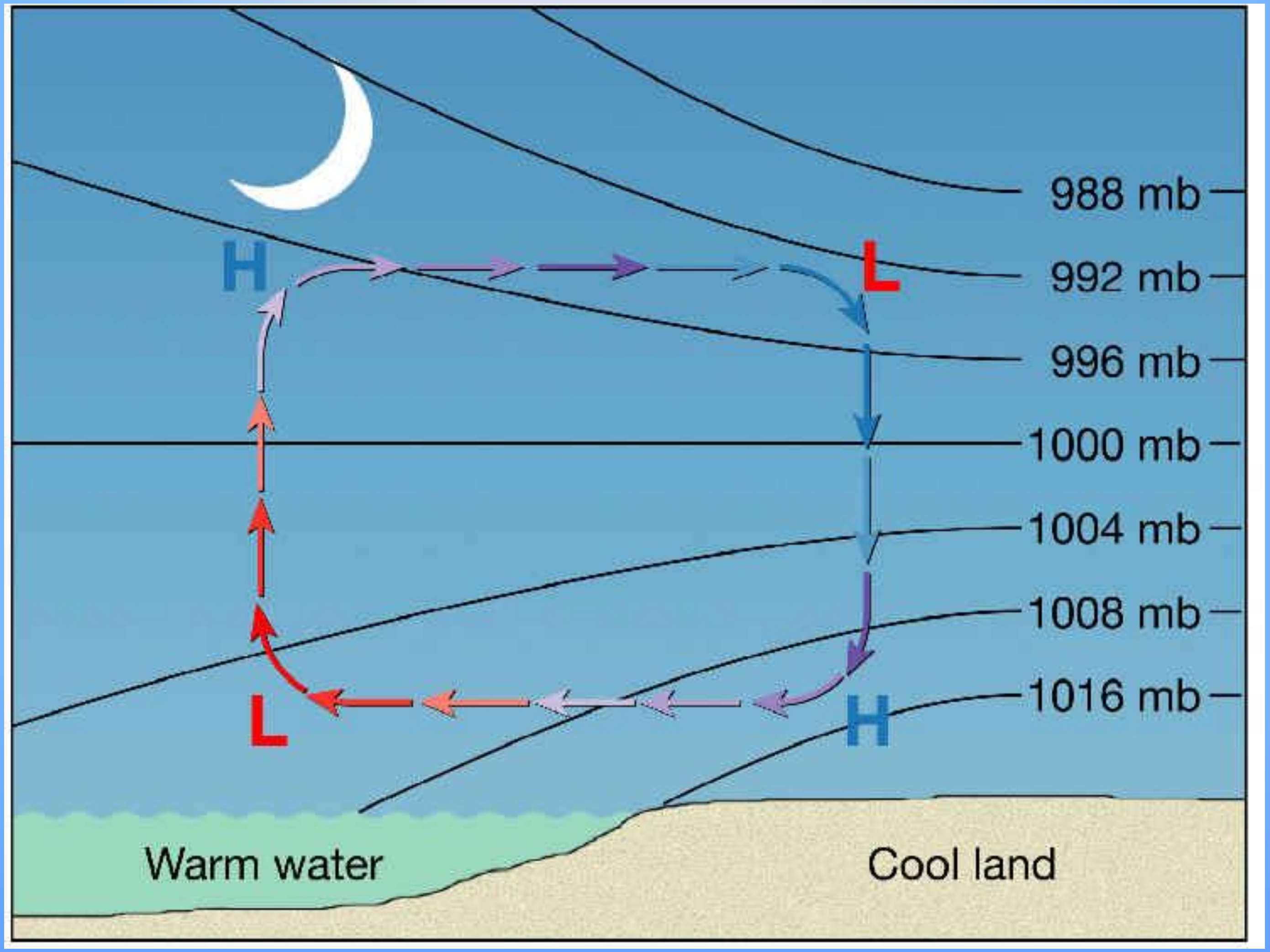


b. Land Breeze at Night

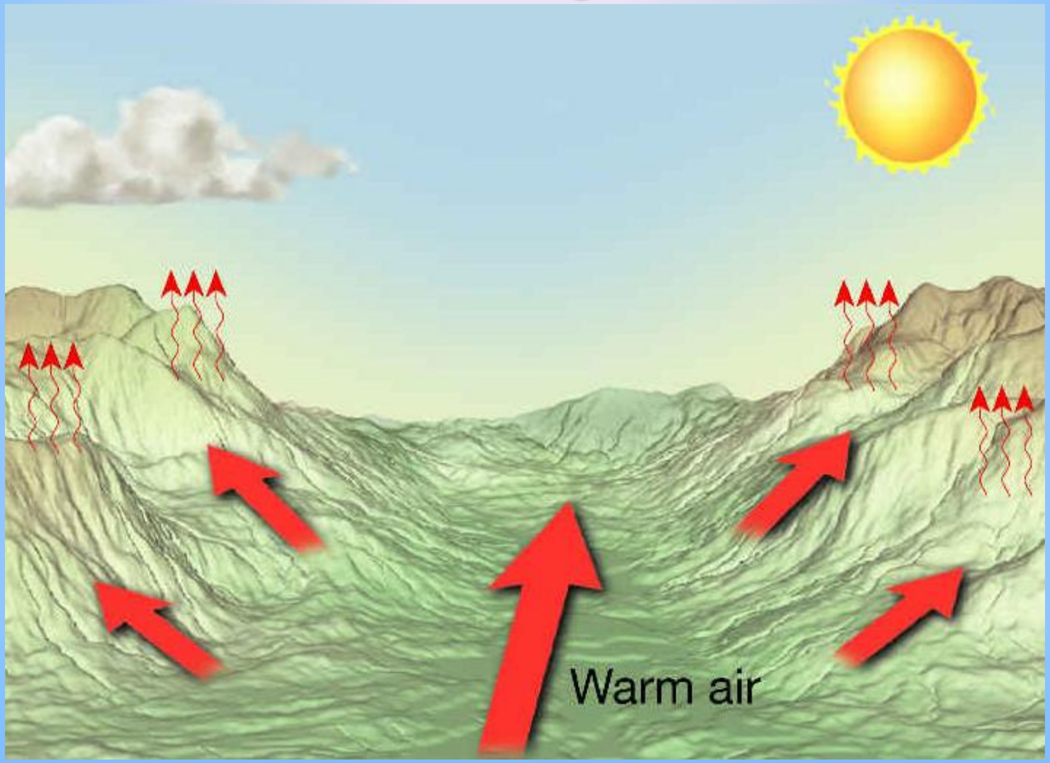
The reverse of the sea breeze forms after sunset



Land Breeze Showing Horizontal and Vertical Airflow



2. Mountain and Valley Breezes



a. ___Valley___ Breeze

(1) Heating during the day causes air___rise___.

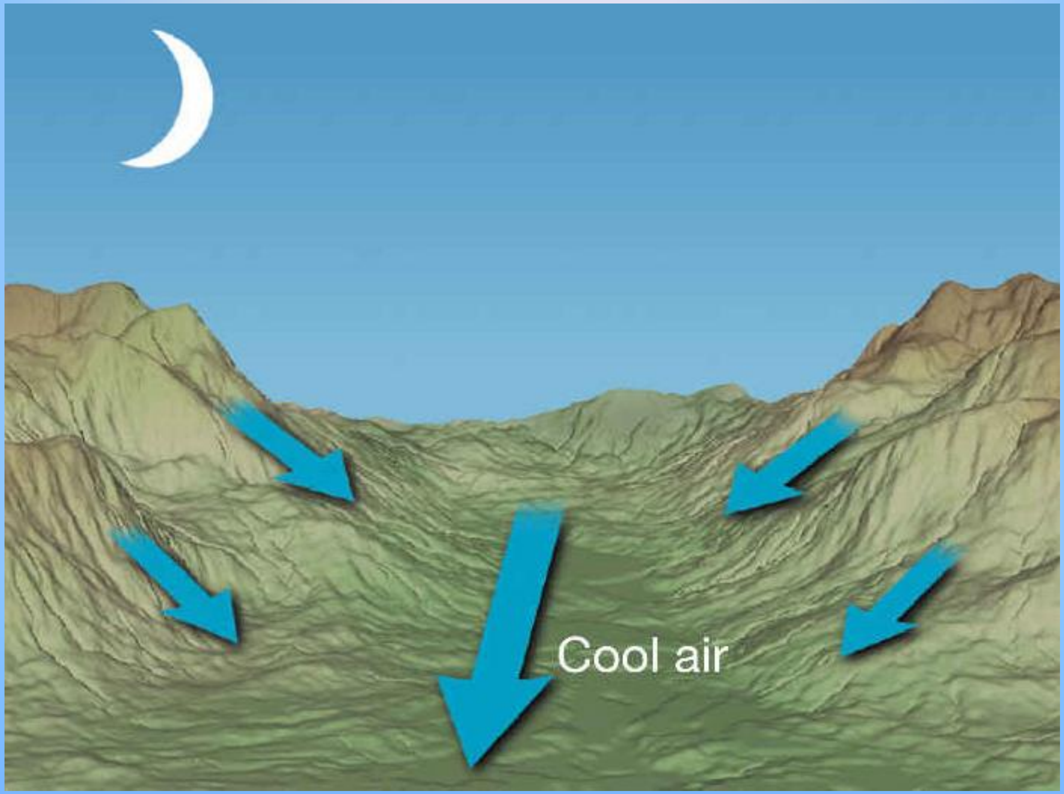
(2) Also referred to as ___thermals___.

(3) Often recognized cloud development on mountain peaks.

Valley Breeze

- Cloud development on mountain peaks from a daytime upslope (valley) breeze
- Can develop into mid-afternoon thunderstorms

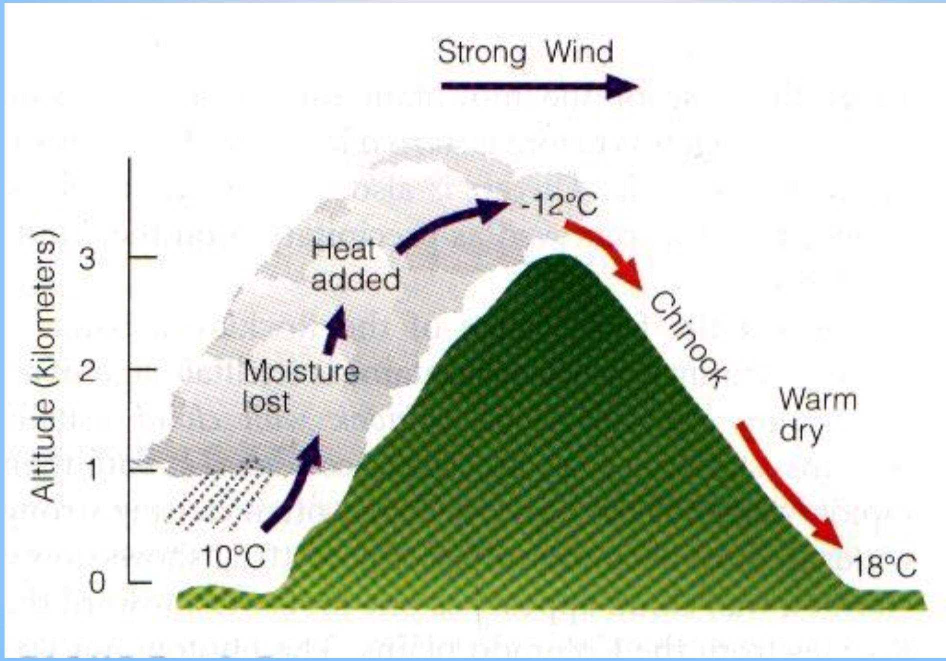
b. __Mountain__ Breeze



(1) __Cooling__ at night

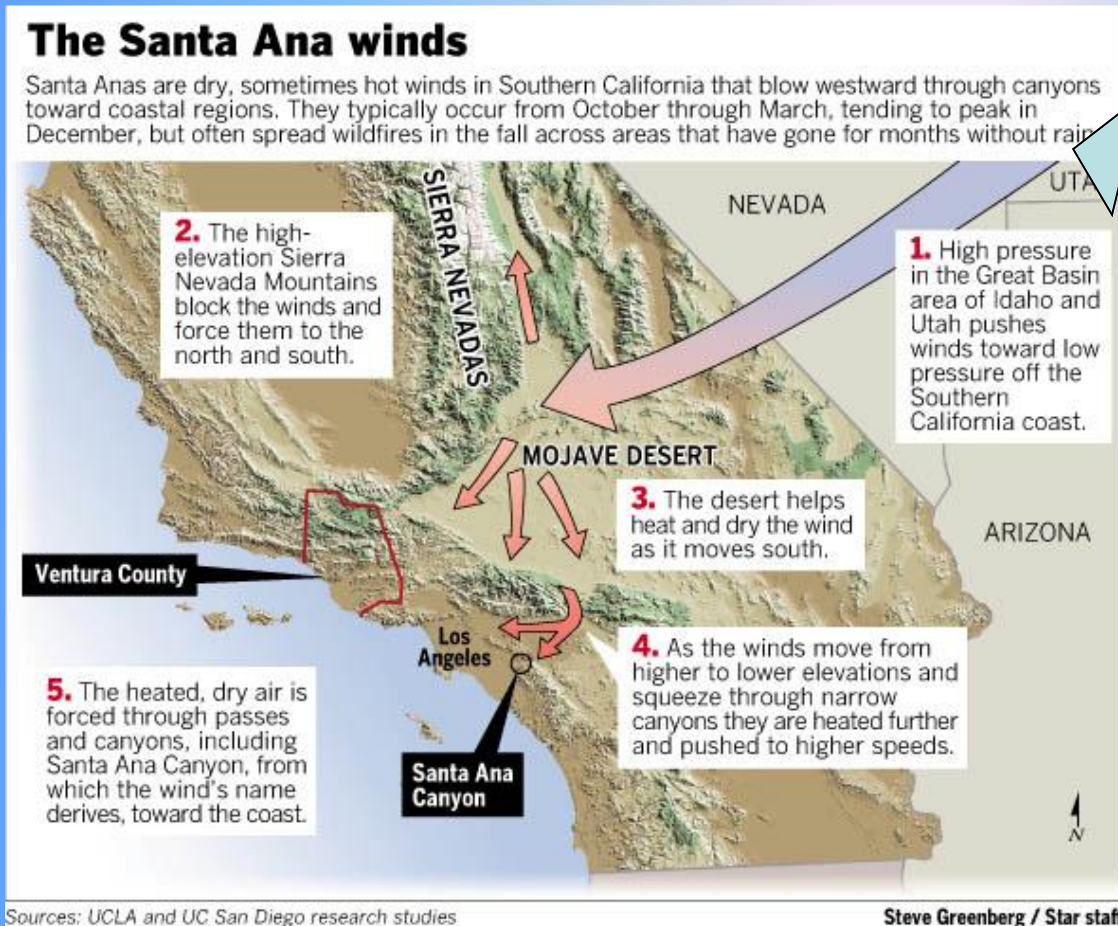
(2) __Denser__ air drains into the valley

3. Chinook (Foehn) Winds



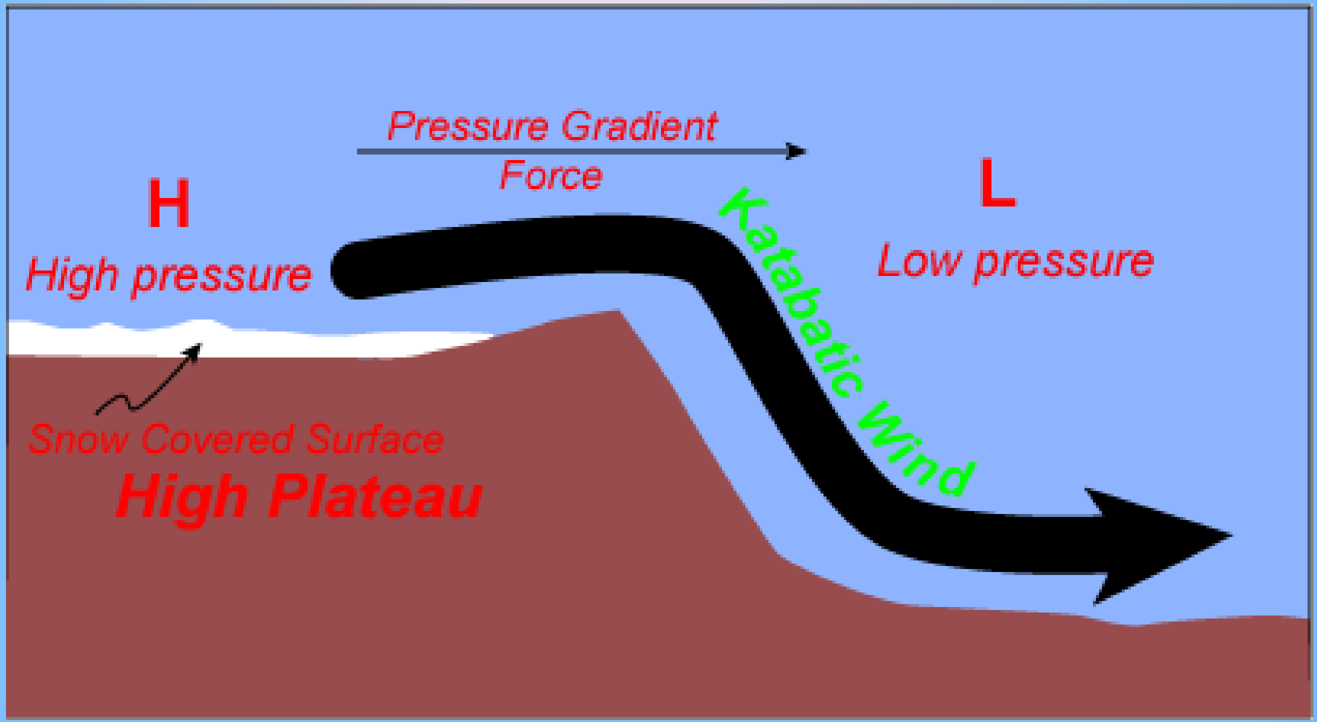
a. Strong downslope winds from mountains.
b. Caused by a significant difference in pressure on the windward side vs. the leeward side.
c. Air rises, and cools on the windward side and then heats due to compression as it descends on the leeward side
d. Can cause a temperature increase of 10 to 20 degrees Celsius in a matter of minutes.
e. Common in the Rockies (where they are called *chinooks* meaning snow-eater) and the Alps (where they are called (*foehns*).

4. Santa Ana Wind



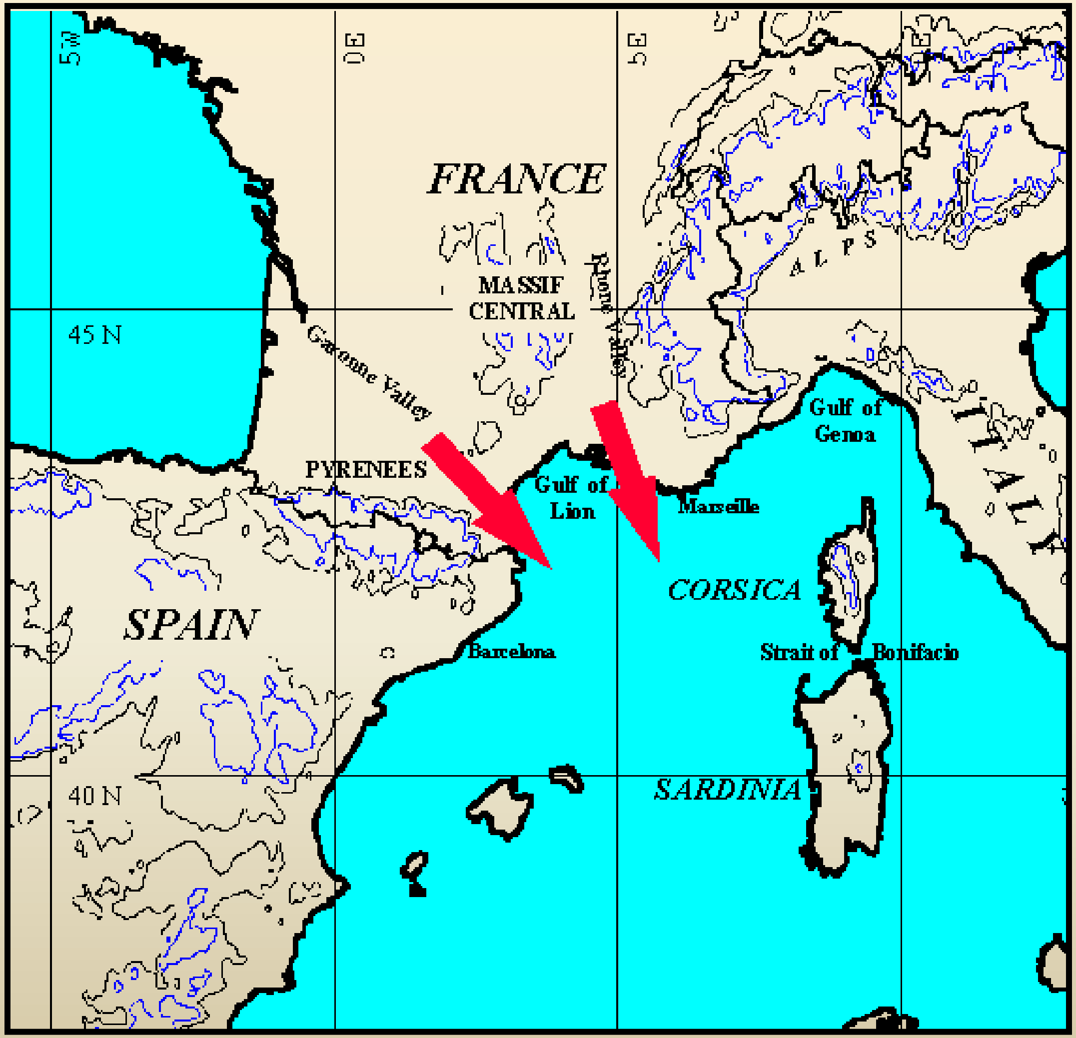
- A chinook-like wind that occurs when a strong high pressure system settles to the NE of southern California with low pressure to the SW. Clockwise flow forces desert air from Arizona and Nevada westward towards the Pacific. It is funneled through the canyons of the Coast Ranges, compresses and heat the region to temperatures that can exceed 100 degrees F.

5. Katabatic or Fall Winds

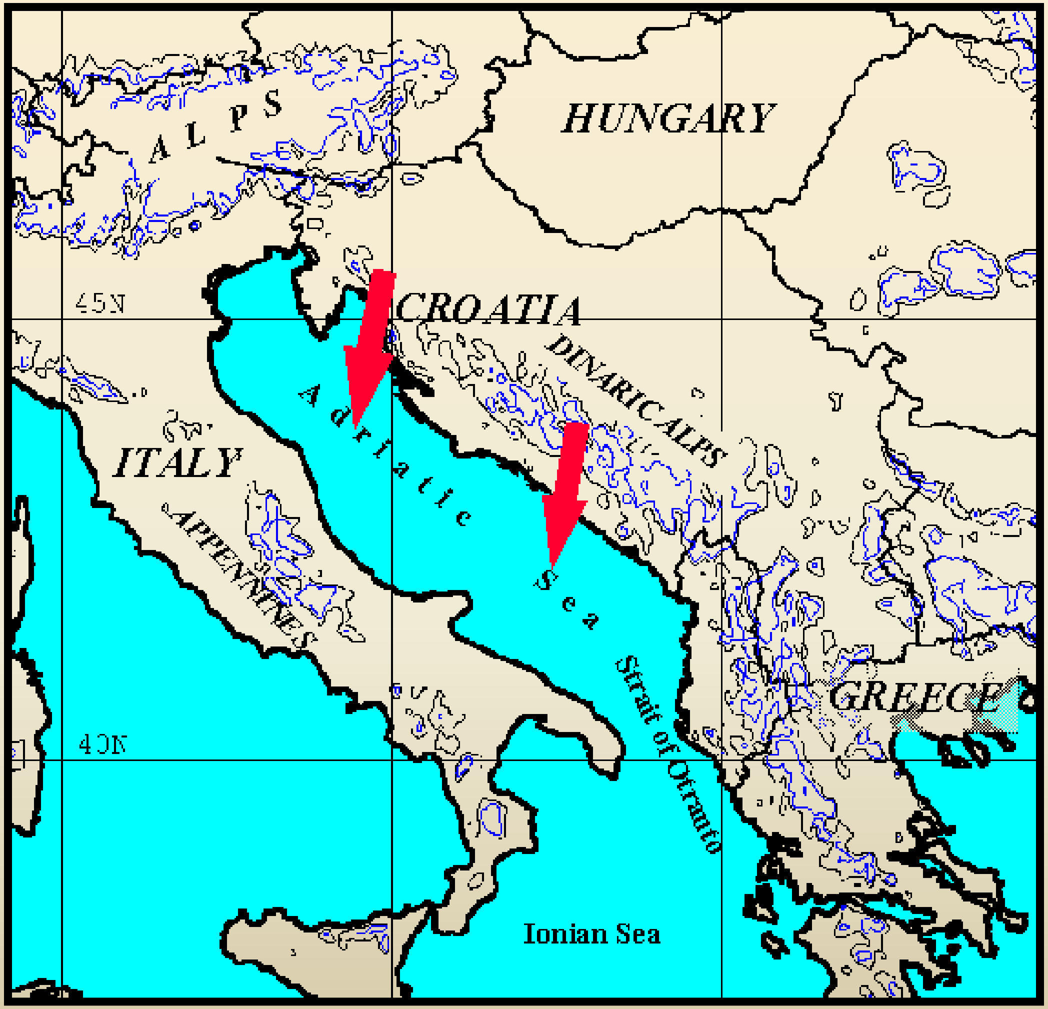


a. Cold and dense air cascades over a highland area.
b. The air does heat as it sinks but it's still colder than the air it displaces due to its very cold original temperature.
c. Occurs on ice sheets of Greenland and Antarctica.

Called a *mistral* from the French Alps to the Mediterranean Sea



Called a *bora* from the mountains of Yugoslavia to the Adriatic Sea



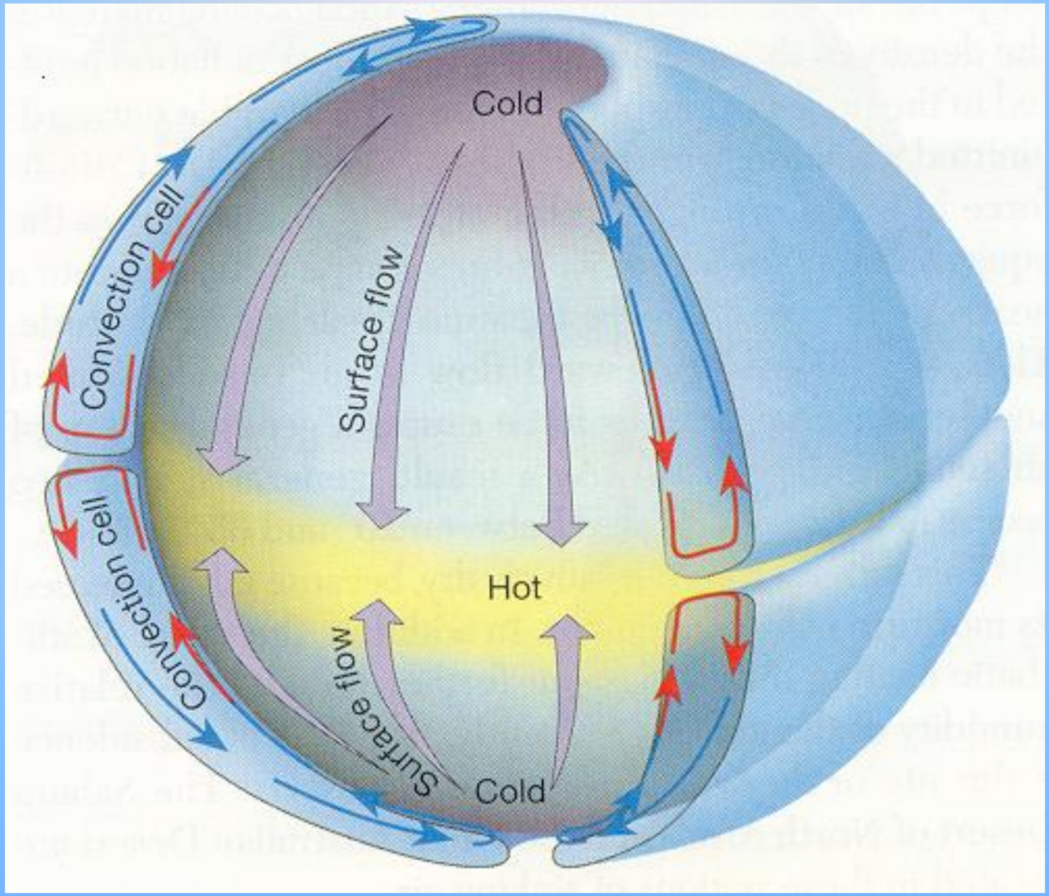
I The General Circulation of the Atmosphere

1. Large Scale Air Flow - Caused by:

a. Unequal heating by the Sun resulting in pressure differences.

b. Earth's Rotation (the Coriolis Effect)

2. A Nonrotating Earth



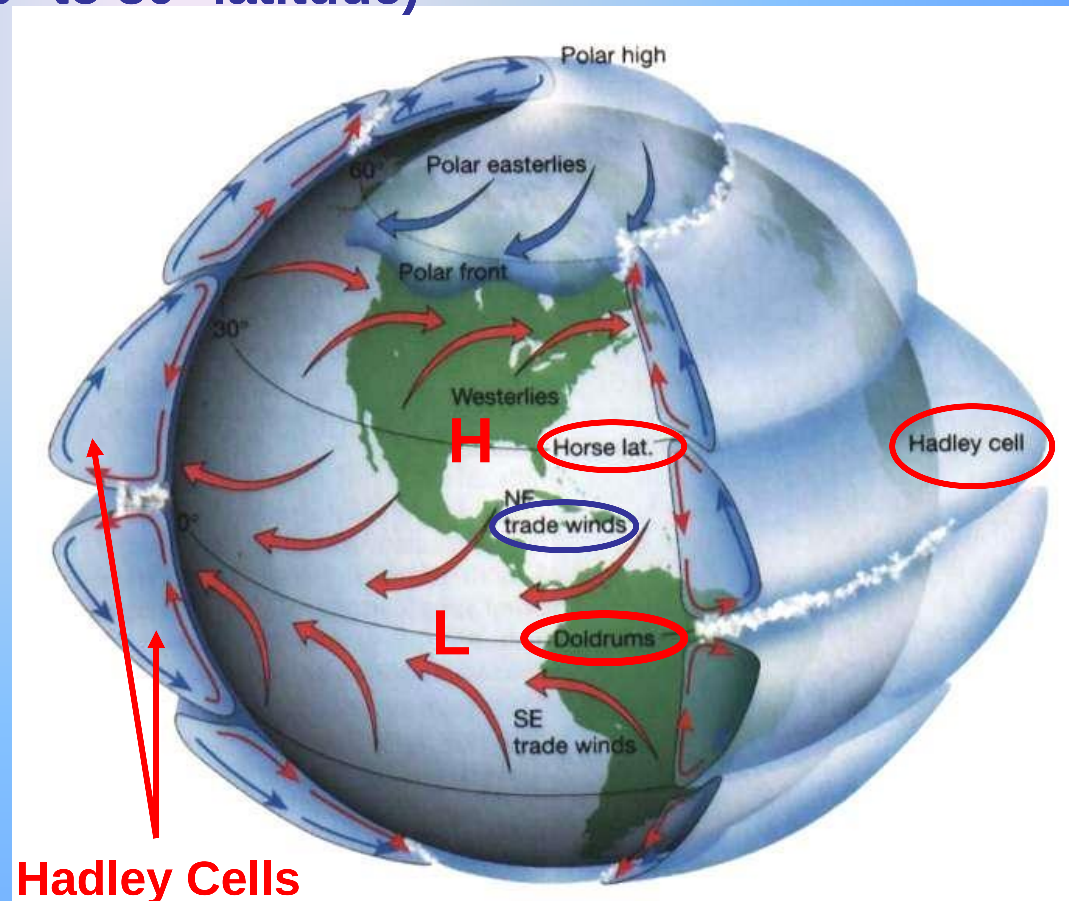
a. A simple convection system produced by unequal heating.
b. Greatest heating in__**Equatorial**__ region
c. Polar regions __**coldest**__
d. Convection cell model first proposed by George Hadley in 1735

3. The Three Cell Model for the __rotating__ Earth

a. Tropical Hadley Cell (0º to 30º latitude)

(1) Near the equator warm air rises and releases latent heat and upper flow moves poleward

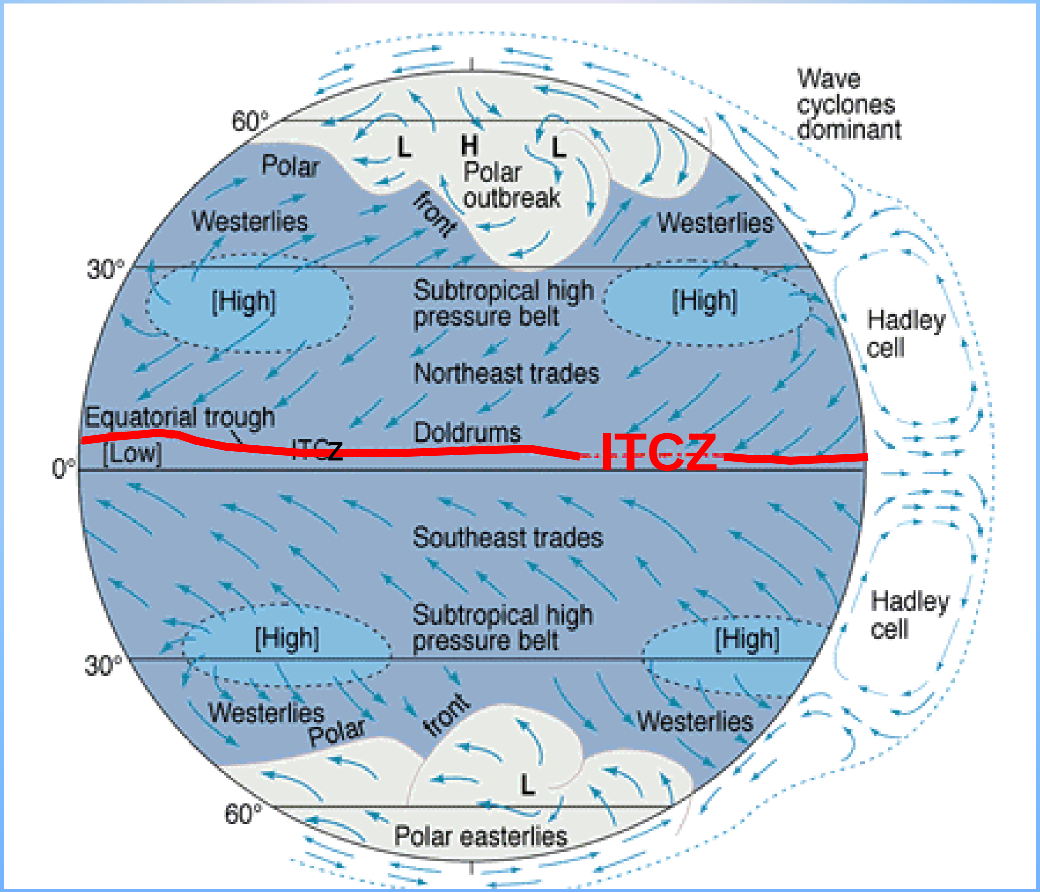
(2) Upper flow starts to descend between 20º and 35º latitude due to (1) radiational cooling and (2) increased Coriolis effect causing deflection to nearly west to east flow. This causes convergence



(3) At the surface a region of higher pressure exists at about 30º latitude. These are referred to as the *horse latitudes* due to the generally weak and variable winds.

(4) Air flows towards the equator. This equatorward flow is deflected by the Coriolis effect forming the *trade winds*

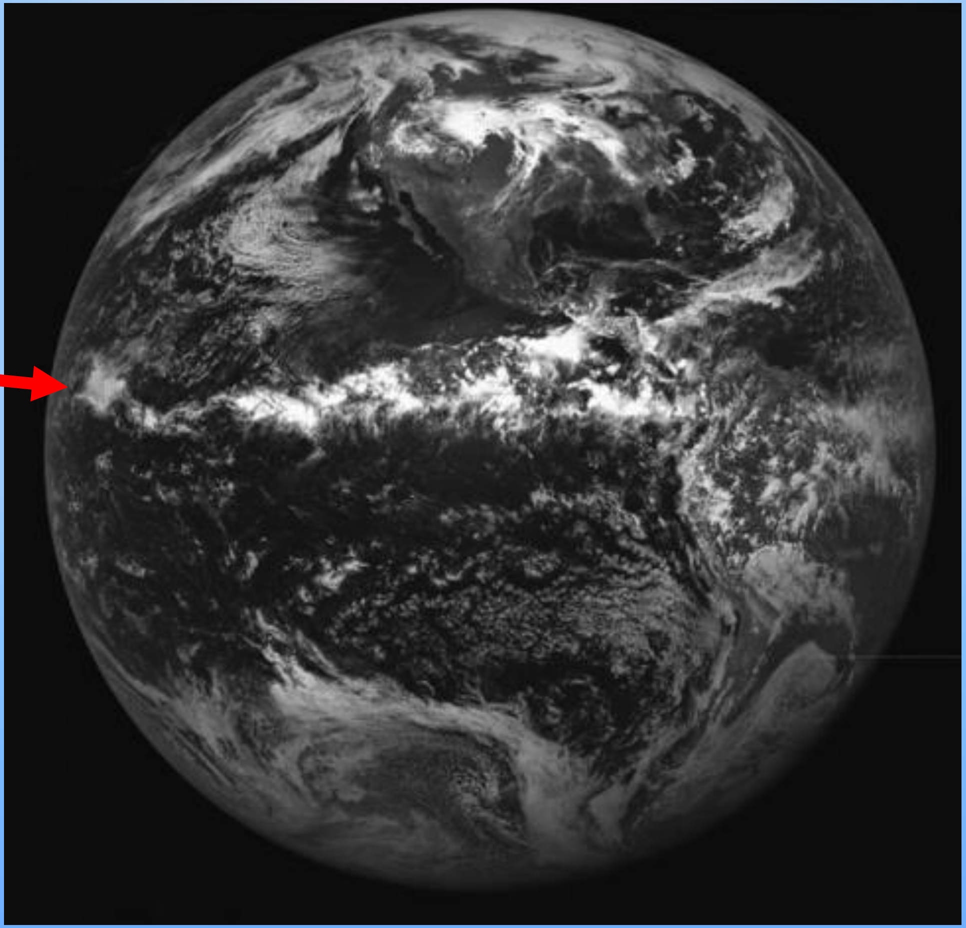
Intertropical Convergence Zone (ITCZ)



- The ITCZ is the equatorial region where the trade winds converge.
- This region has rising, hot air with abundant precipitation

Satellite Image of the ITCZ

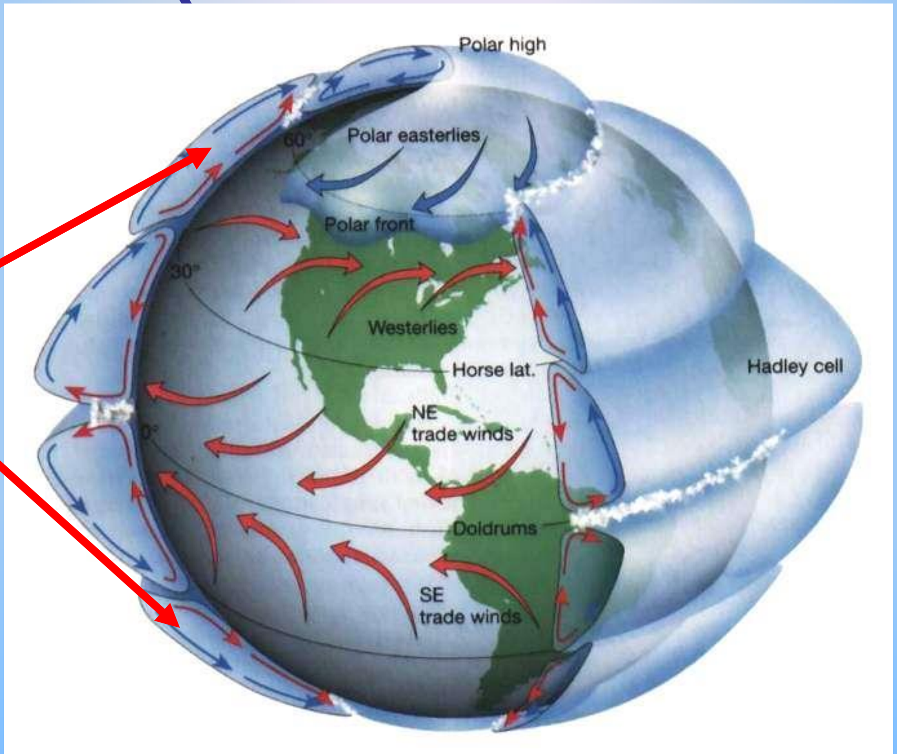
ITCZ



The ITCZ is seen as the band of clouds across the equatorial ocean and Central America

c. Ferrel Cell (mid-latitude indirect cell)

Ferrel Cells

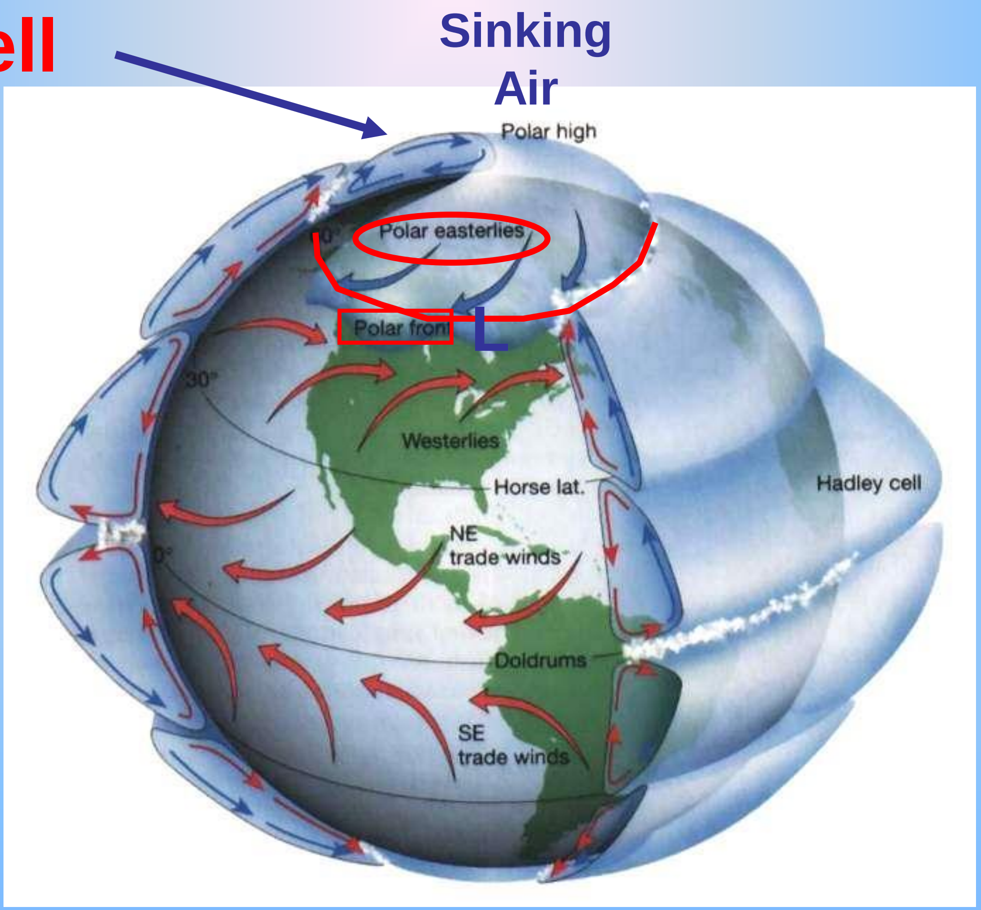


(1) Not all the air that converges at around 30º North and South latitudes (at the *subtropical high pressure zones*) moves equatorward. Some moves towards higher latitudes.

(2) Between 30º and 60º latitude the net surface flow is poleward.

(3) The Coriolis force causes winds to have a strong westerly component resulting in the *prevailing SOUTH-westerlies.*

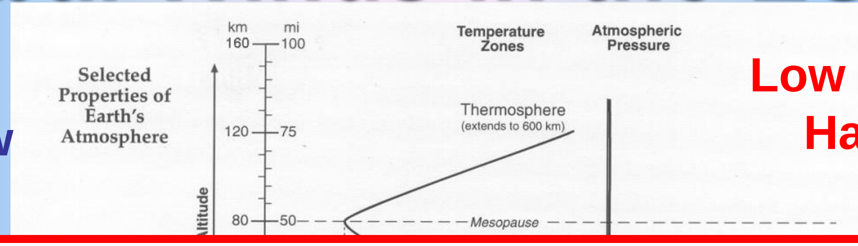
d. Polar Cell



(1) Polar regions (from about 60º north and south) and extending to each pole.
(2) Polar Easterlies: Prevailing winds are from the northeast in the Arctic and the southeast in the Antarctic.
(3) Caused by the subsidence of cold dense air at the poles.
(4) Eventually this cold polar air collides with the warmer westerly flow from the mid-latitudes resulting in the *polar front.*

Global Winds in the ESRT

Dashed arrows show surface winds

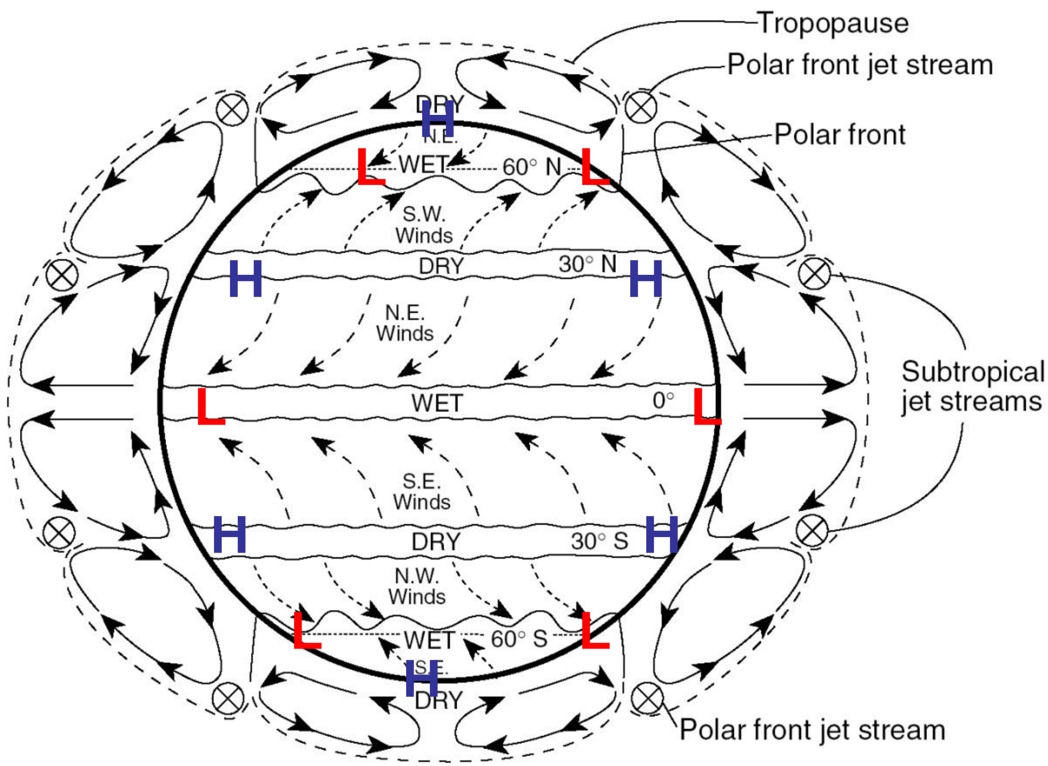


Low pressure latitudes Have rising airflow and are wet.

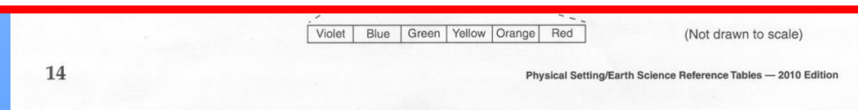
Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in the summer and southward in the winter.

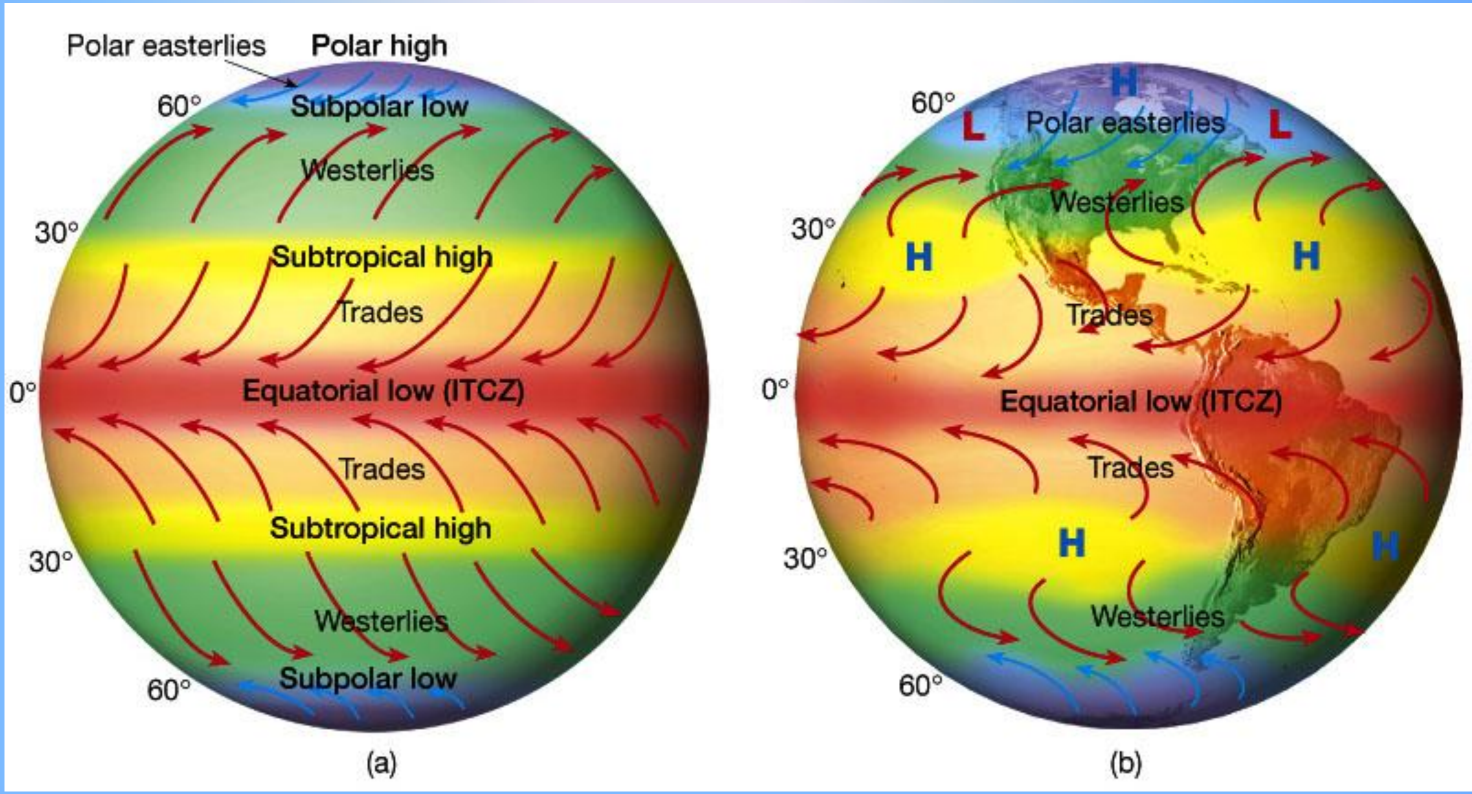
(Not drawn to scale)



High pressure latitudes have sinking airflow and are dry



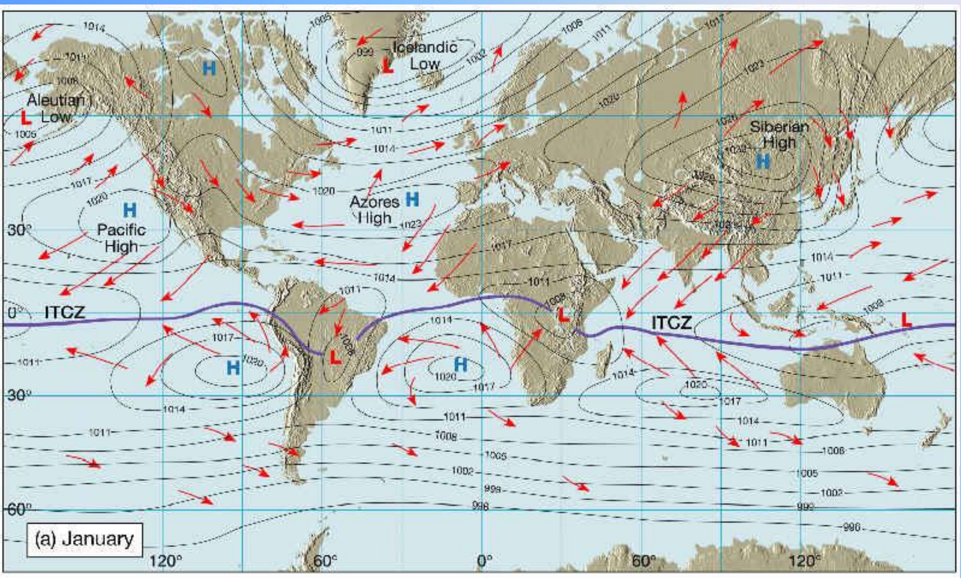
Ideal Pressure Belts vs. The "Real World"

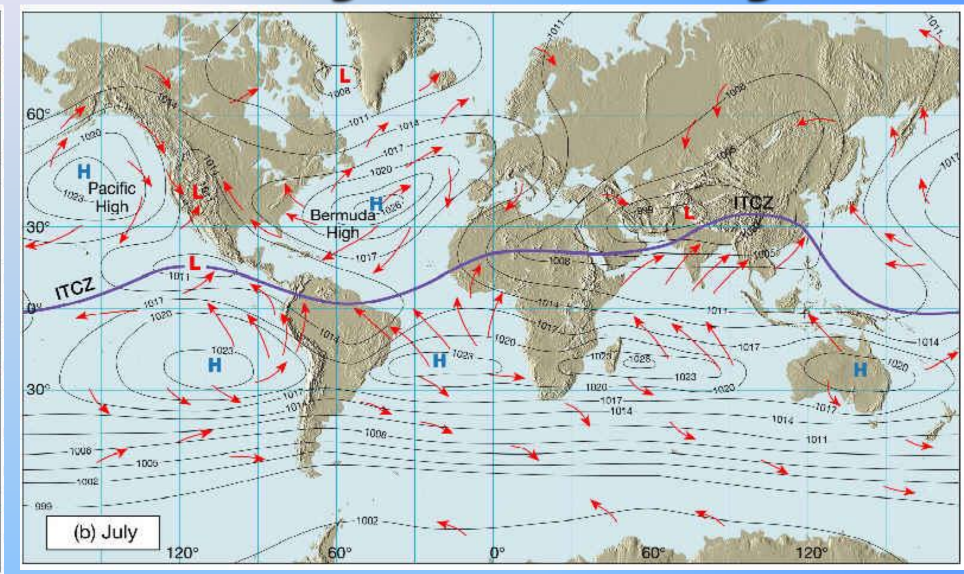


(a) An imaginary uniform Earth with idealized, continuous pressure belts.

(b) The real Earth with disruption of the zonal pattern caused by large landmasses. This causes the formation of semipermanent high and low pressure cells.

Average Surface Pressure and Global Winds for January and July





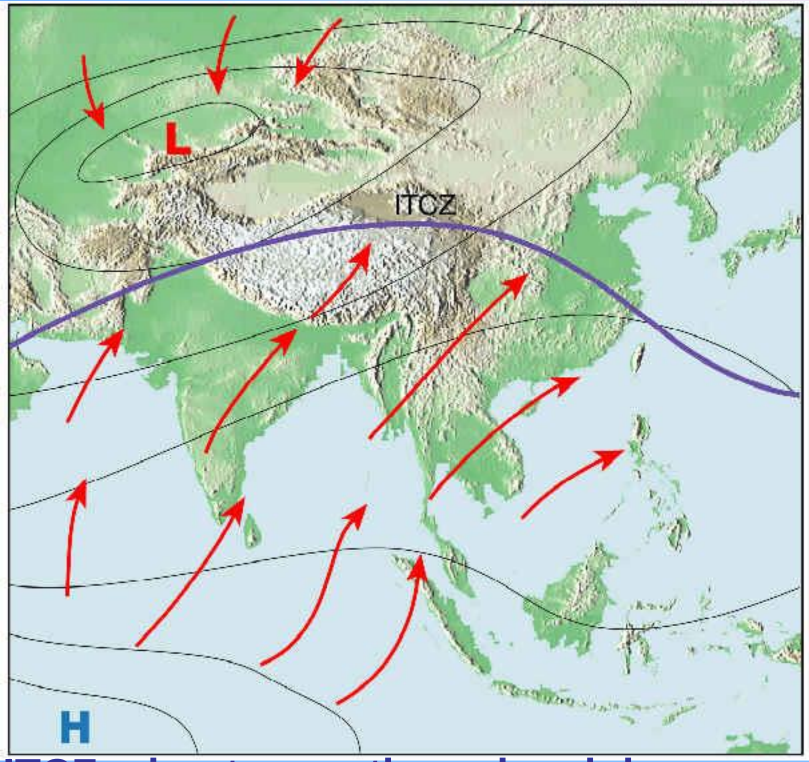
Note the change in the position of the ITCZ the semipermanent Highs

J. Monsoons

(1) **Seasonal** change in Earth's global wind circulation.

(2) Monsoon refers to a wind system that exhibits a pronounced seasonal **reversal in direction** not just a "rainy season." A monsoon could result in a dry season

3. Summer Monsoon

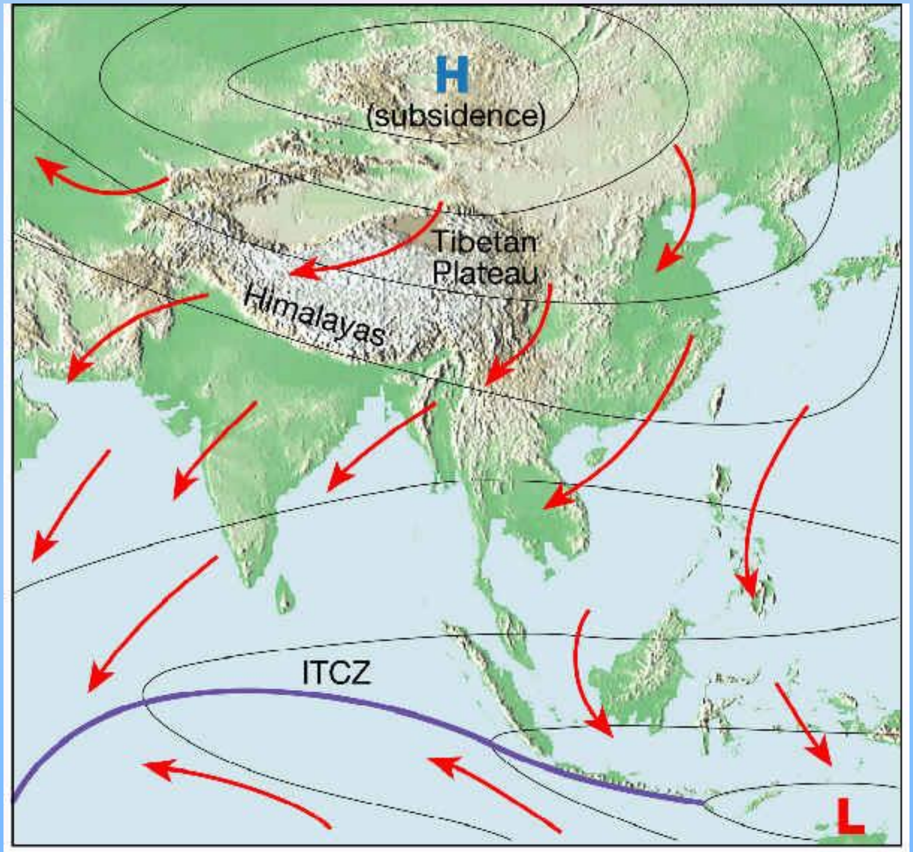


ITCZ migrates northward and draws warm Moist air onto the continent

Cherrapunji, India

a. Warm moist air blows **from the sea toward the land**
b. Results in abundant precipitation.
c. One of the world's rainiest regions is found on the slopes of the Himalayas.
   (1) Rising moist air from the Indian Ocean cools.
   (2) Cherrapunji, India once had 25 m (82.5 ft.) of rain during a four-month period during the summer monsoon.

4. Winter Monsoon

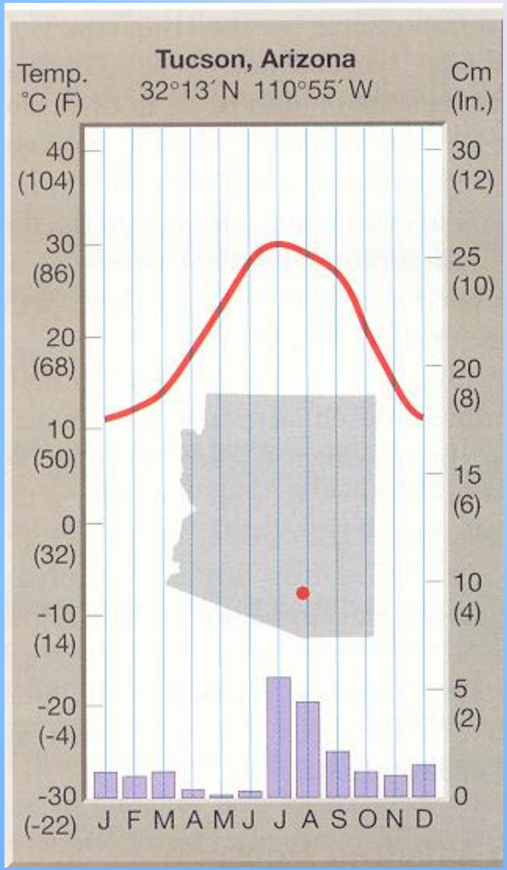


In January a strong high pressure develops over Asia and cool, dry continental air causes the winter monsoon.

a. Winds **blow off the continent**.

b. Results in a **dry** winter

The North American Monsoon



- High summer temperatures over SW United States.
- A thermal low is created that draws moisture from the Gulf of CA and the Gulf of Mexico
- Produces precipitation over SW United States and NW Mexico, mostly as thunderstorms.

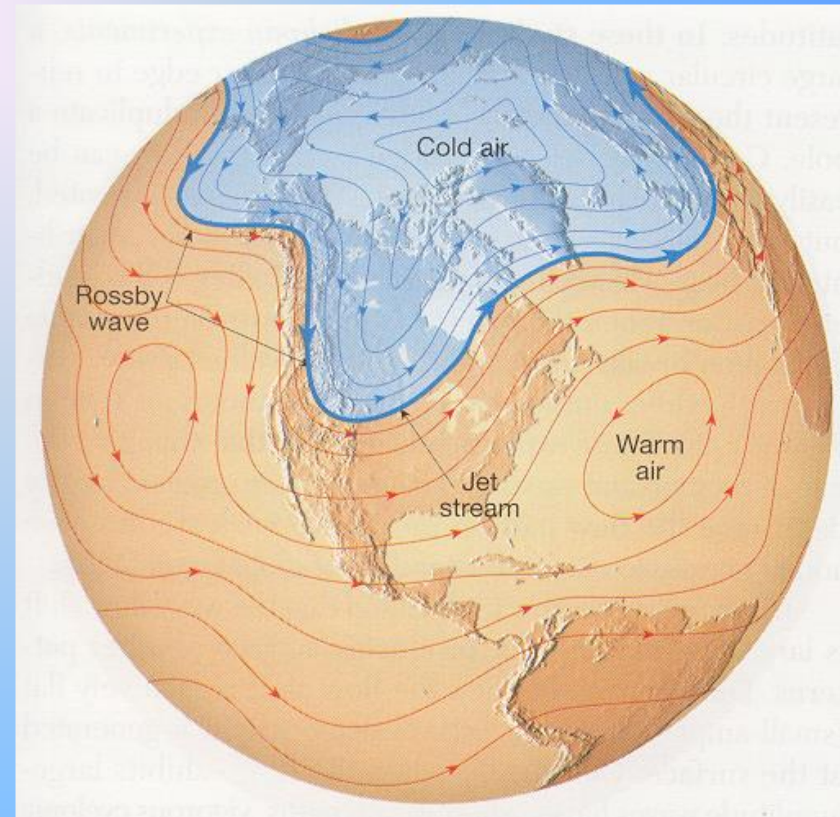
K. *Jet Streams*

1. Narrow and meandering belts of air found near the _**tropopause**_.
   a. Width varies from less than 100 km to over 500 km; 60 mi. to 300 miles
   b. Altitude is 7500 to 12,000 meters; 25,000 to 40,000 feet.
2. _**High velocity**_ winds speeds that range from 200 km/hour to 400 km/hour (120 mi/hour to 240 mi/hr)

Discovery

- Predicted as early as early as 1920 by Japanese meteorologist Wasaburo Ooishi.
- Dramatically affected American bombers during World War II.
  - On return flights tail winds increased their speeds.
  - Flying to targets they often made little headway, flying into the wind.

3. Origin



a. Large surface temperature contrasts produce large temperature gradients aloft (and higher wind speeds).
b. In winter it can be warm in Florida and near-freezing a short distance away in Georgia.
c. Polar Jet: Occurs along the polar front where large temp. contrasts are found.

Seasonal Changes in the Jet Stream

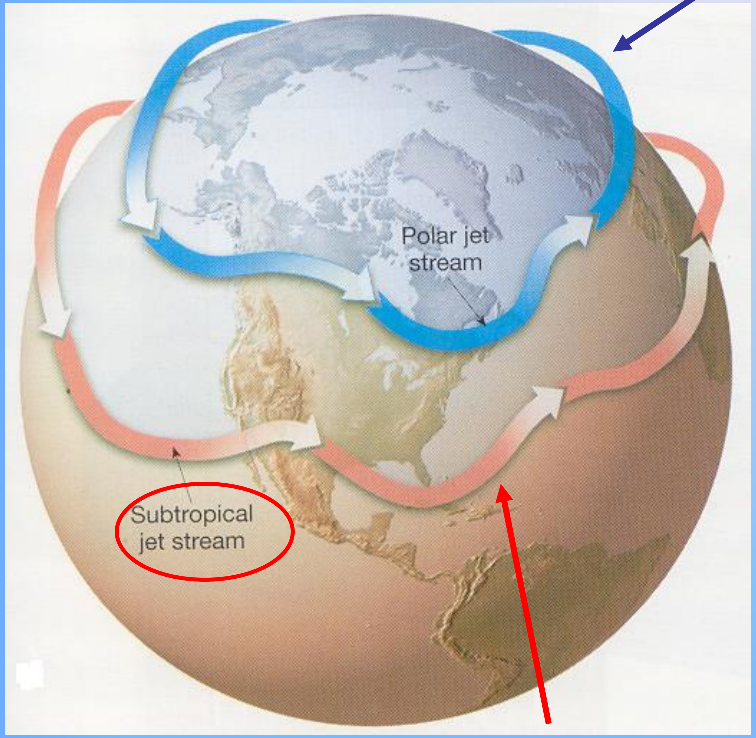
d. Jet Stream migrates with the seasons (north in summer and south in winter) and is often called the *midlatitude jet stream*.

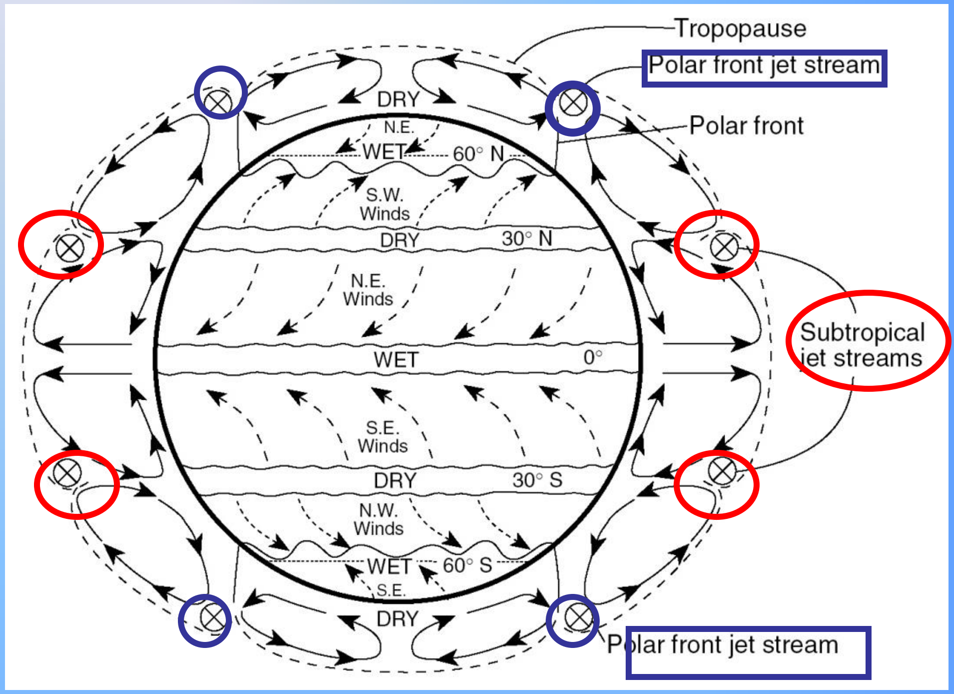
e. Integral part of the westerlies and is associated with outbreaks of severe thunderstorms and tornadoes when it shifts northward.

f. Important influence on weather by supplying energy for storms but also influences storm tracks

Polar and Subtropical Jet Streams

Polar Jet Stream

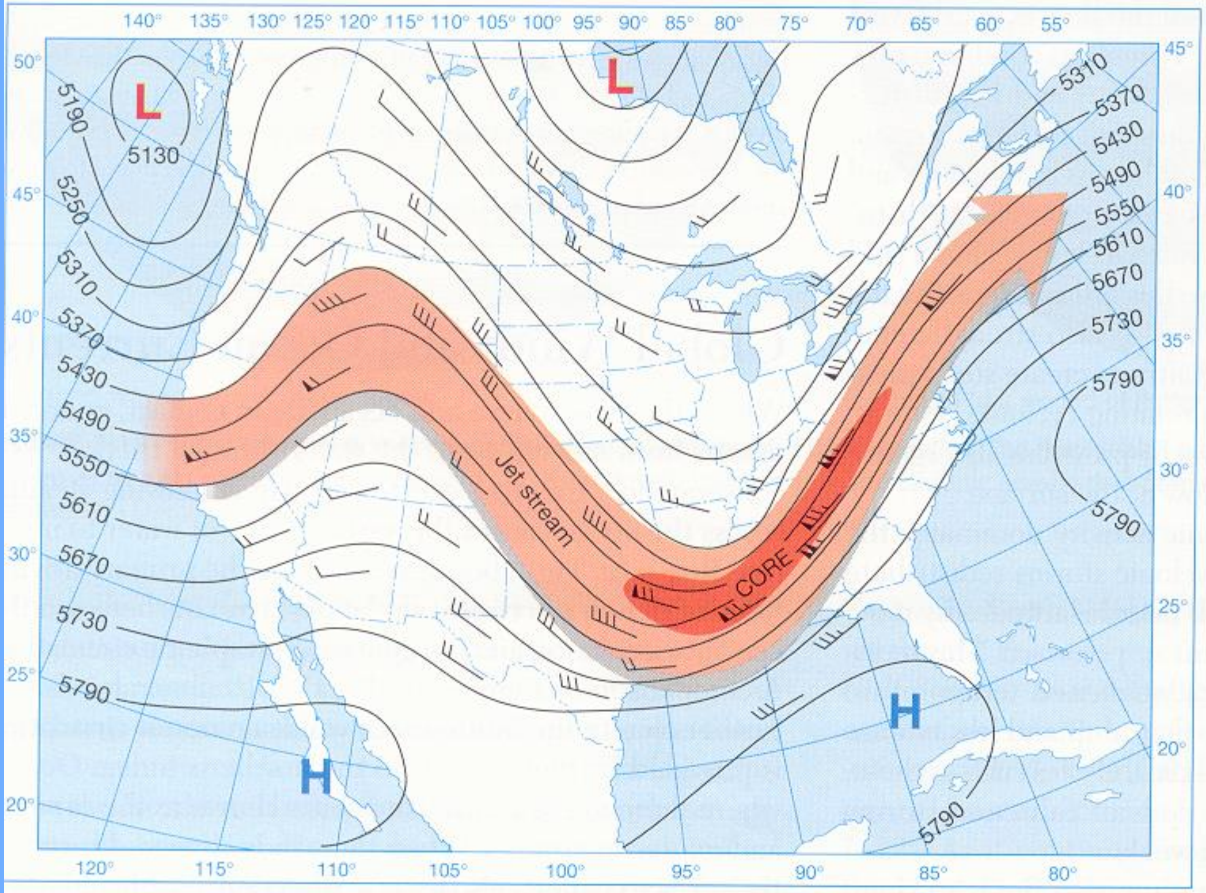




Subtropical jet stream

- The subtropical jet stream is mostly a wintertime phenomenon.
- It is slower than the polar jet stream.

The Jet Stream on a 500-mb Height Upper Air Map



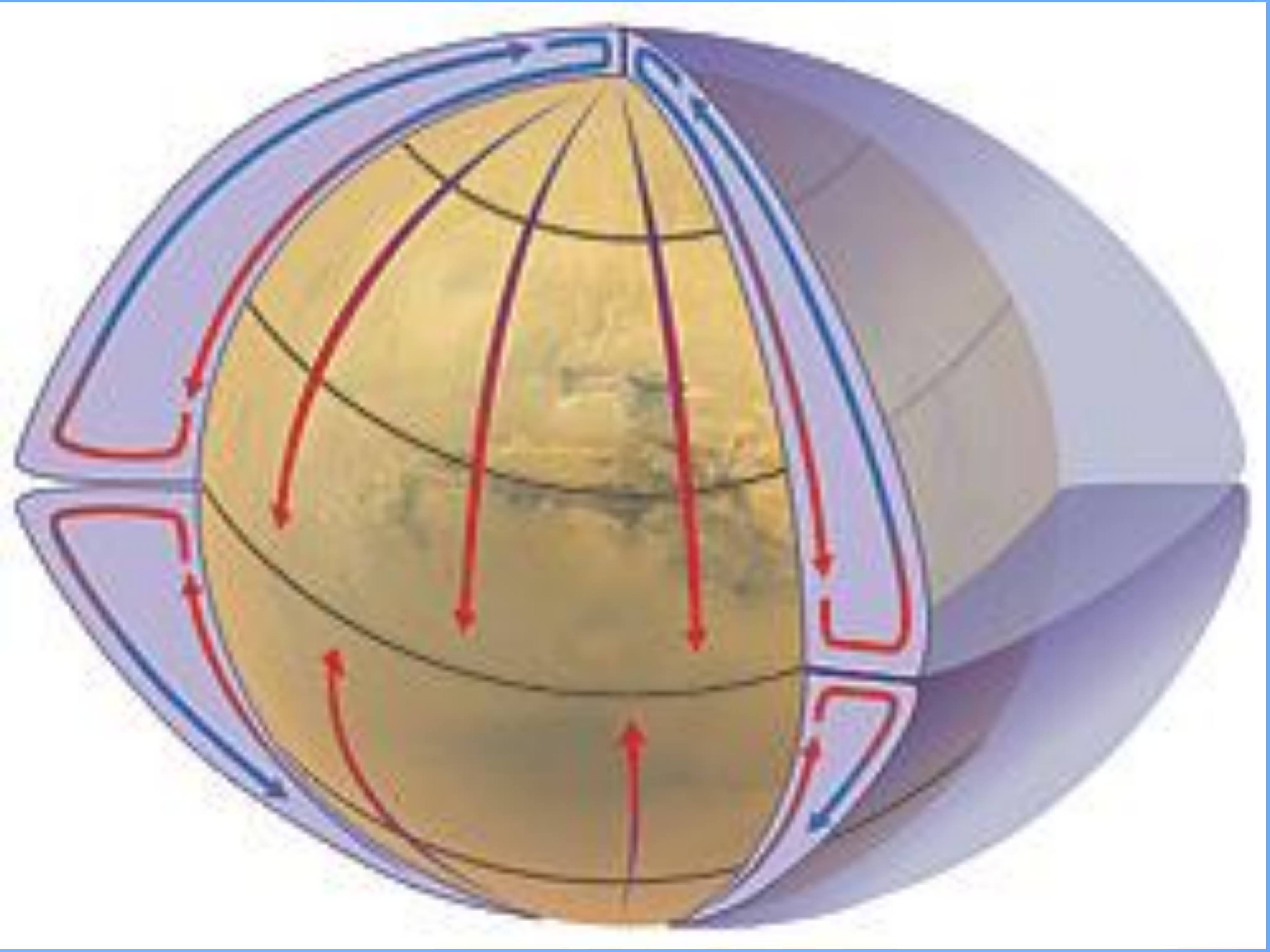
ff	Miles per hour
◎	Calm
	1–2
	3–8
	9–14
	15–20
	21–25
	26–31
	32–37
	38–43
	44–49
	50–54
	55–60
	61–66
	67–71
	72–77
	78–83
	84–89
	119–123

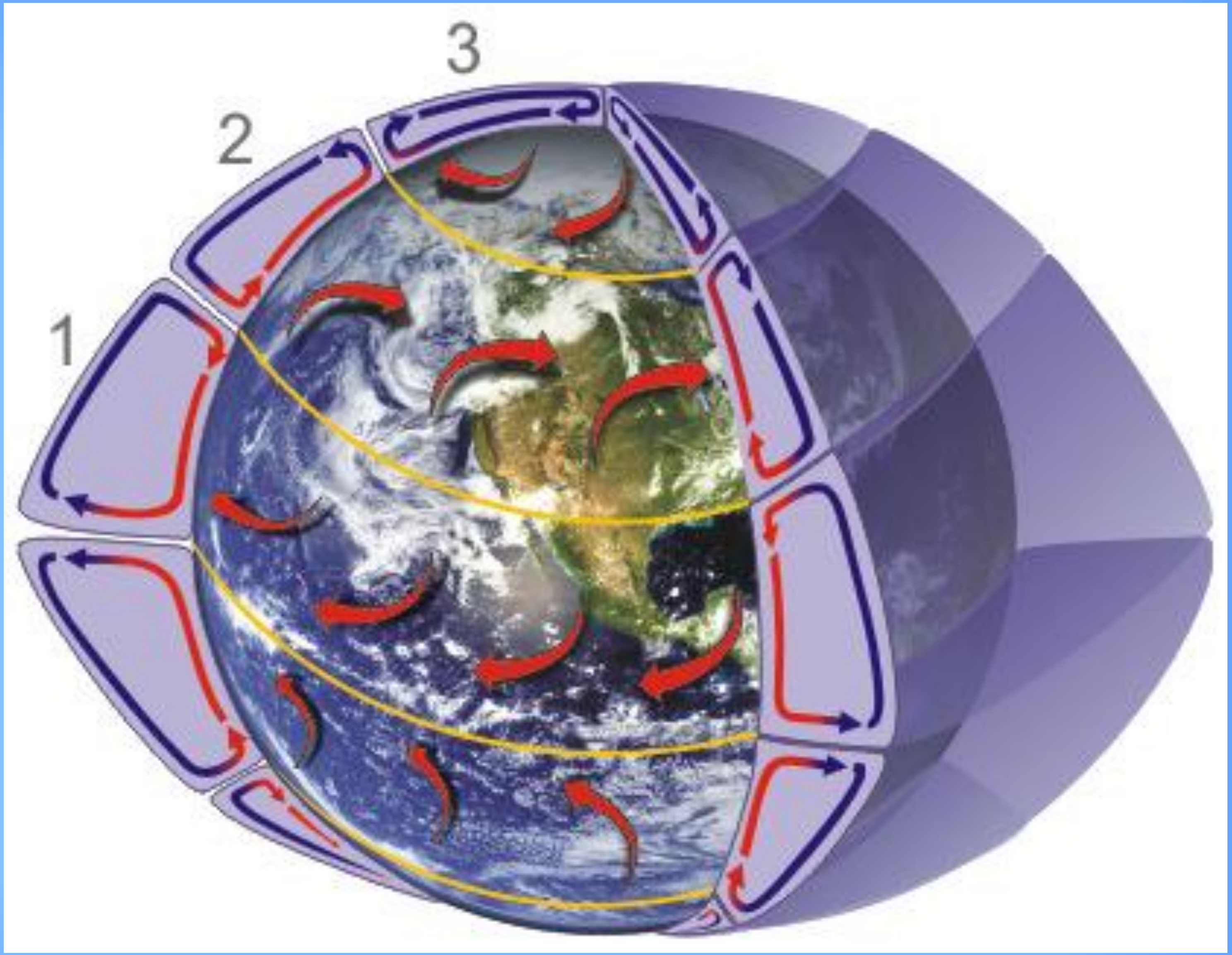
The position of the jet stream is shown in dark red.

- That’s it!

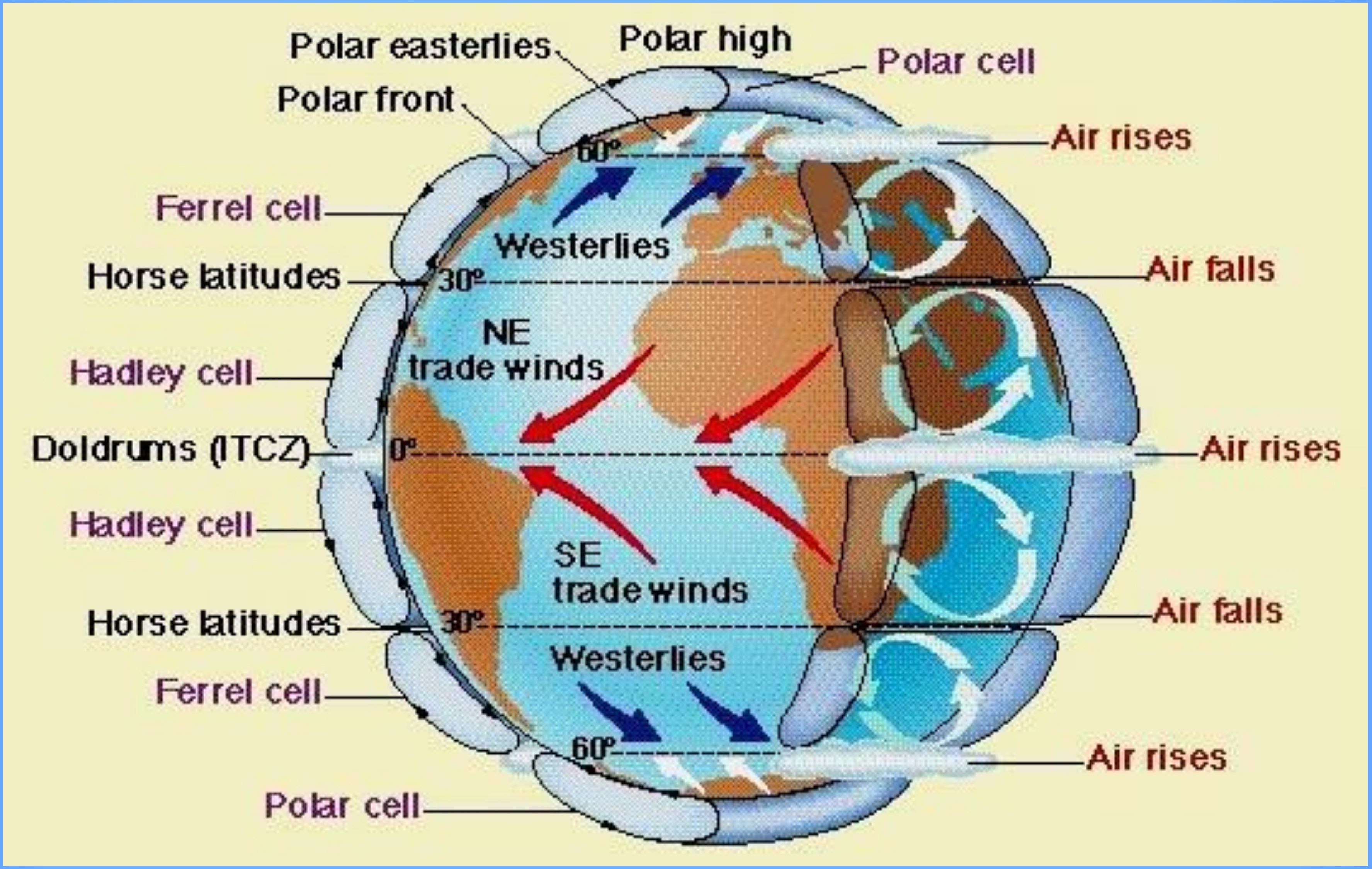
Oct. 2007 CA Wildfires

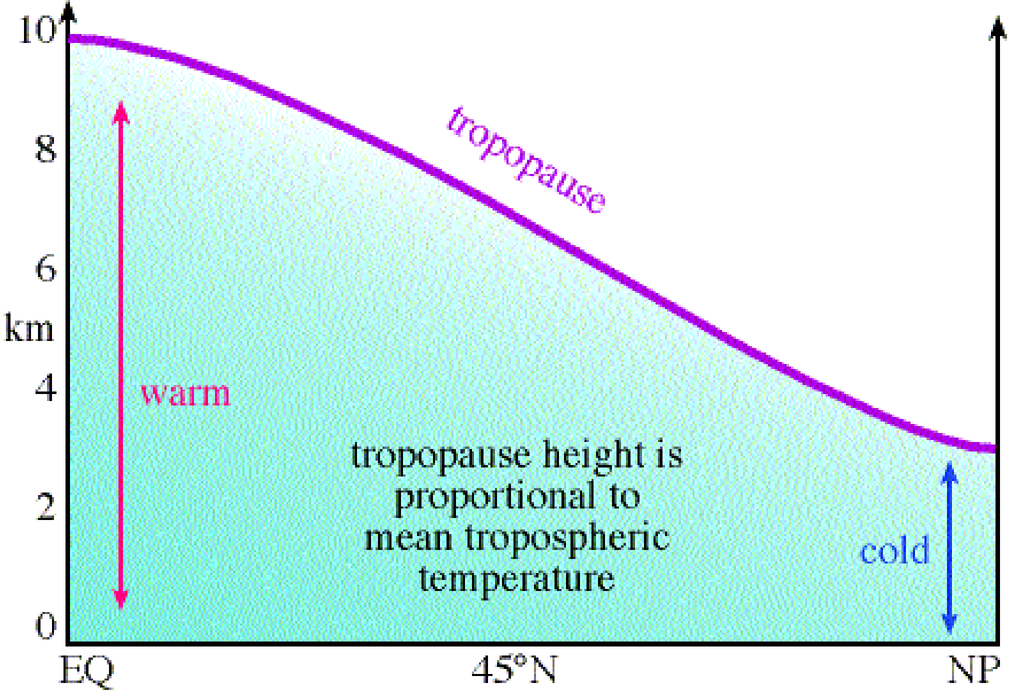
- http://www.nasa.gov/vision/earth/lookingatearth/socal_wildfires_oct07.html

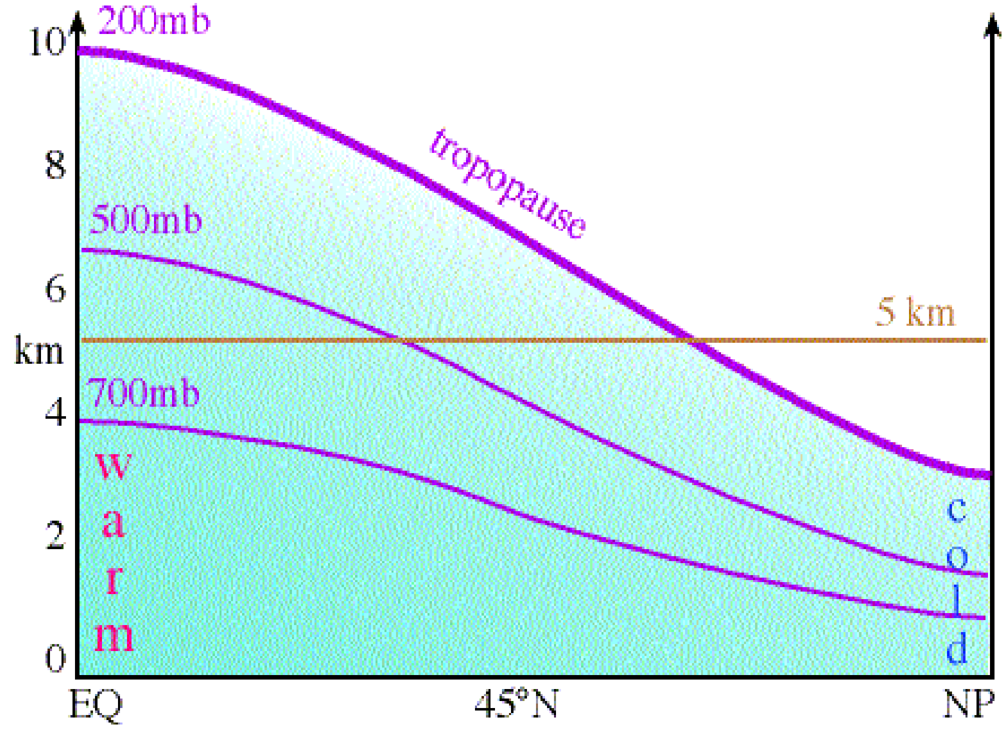



3
2
1

Planetary Wind and Moisture Belts




10
8
6
km
4
2
0
tropopause
warm
tropopause height is
proportional to
mean tropospheric
temperature
cold
EQ
45°N
NP


200mb
10
8
6
km
4
2
0
tropopause
500mb
5 km
700mb
w
a
r
m
c
o
l
d
EQ
45°N
NP