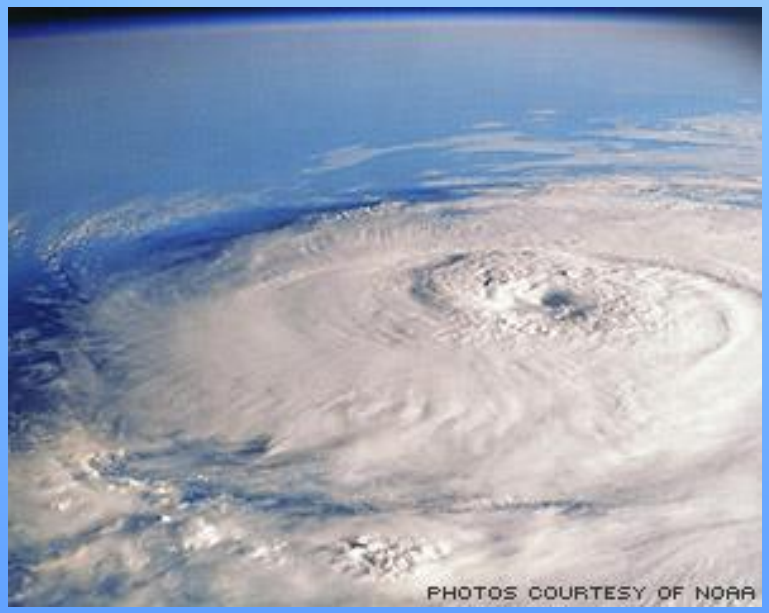
Meteorology I
Intro. to Weather



1. What is Weather?

A) Weather is the state of the atmosphere at a given time and place.

B) Weather changes on a regular basis.

C) Meteorologists forecast weather conditions over a short period of time.

Forecasts include:

- Temperature
- Barometric (air) Pressure
- Wind direction/speed
- Humidity

2. Atmosphere

A) The two main gases composing Earth's atmosphere are _Nitrogen_ and _Oxygen_.

B) This information can be found on page 1 of the ESRT under the column 'Troposphere'.

Average Chemical Composition
of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

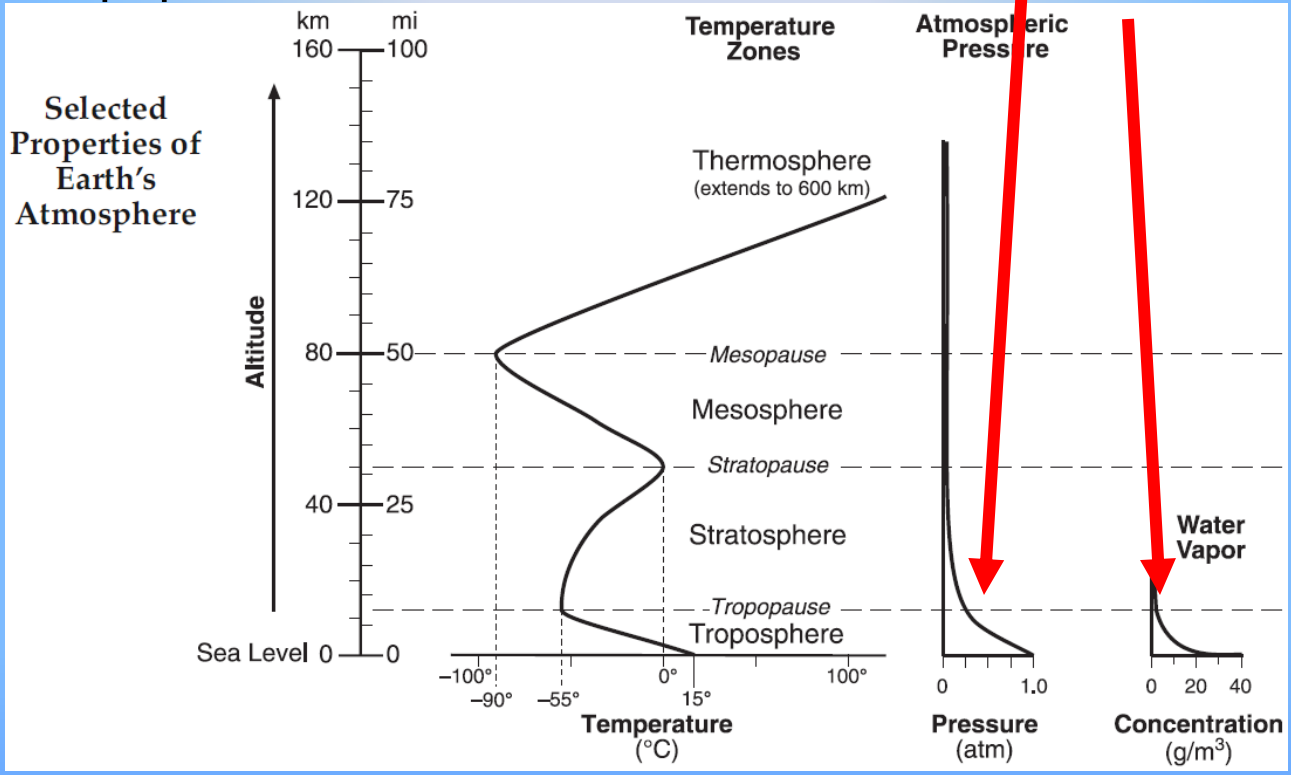
C) The atmosphere is divided into 4 layers, based on the changes in _Temperature_ as altitude increases.

D) The lowest layer of the atmosphere, where all weather occurs is the _troposphere_

E) The layers of the atmosphere can easily be seen on page 14 of the ESRT in the diagram labeled ***'Selected Properties of the Earth's Atmosphere'***

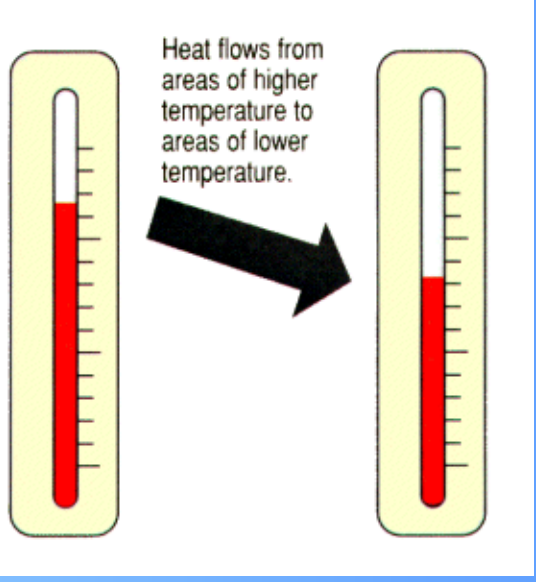
Notice the following trends…

- As altitude increases Air Pressure decreases
- As altitude increases the concentration of water vapor decreases up until the tropopause were the concentration becomes 0.



- Review Temperature Zones of the Atmosphere Worksheet

Meteorology II
Temperature



NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129					
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure

Caution Extreme Caution Dang

WIND CHILL CHART

TEMPERATURE (F)

WIND (MPH)	30	20	10	0	-10	-20	-30
5	25	13	1	-11	-22	-34	-46
10	21	9	-4	-16	-28	-41	-53
15	19	6	-7	-19	-32	-45	-58
20	17	4	-9	-22	-35	-48	-61
25	16	3	-11	-24	-37	-51	-64
30	15	1	-12	-26	-39	-53	-67

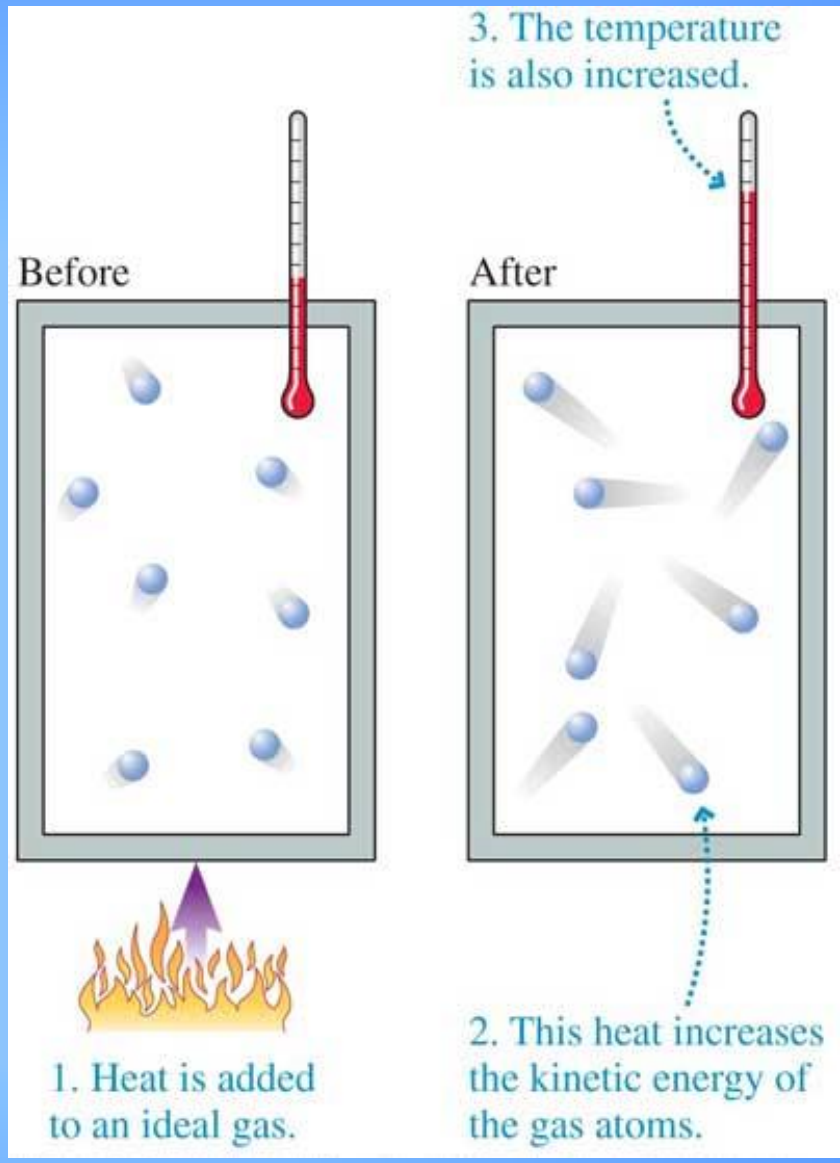
FROSTBITE TIMES: 30 min. 10 min. 5 min.

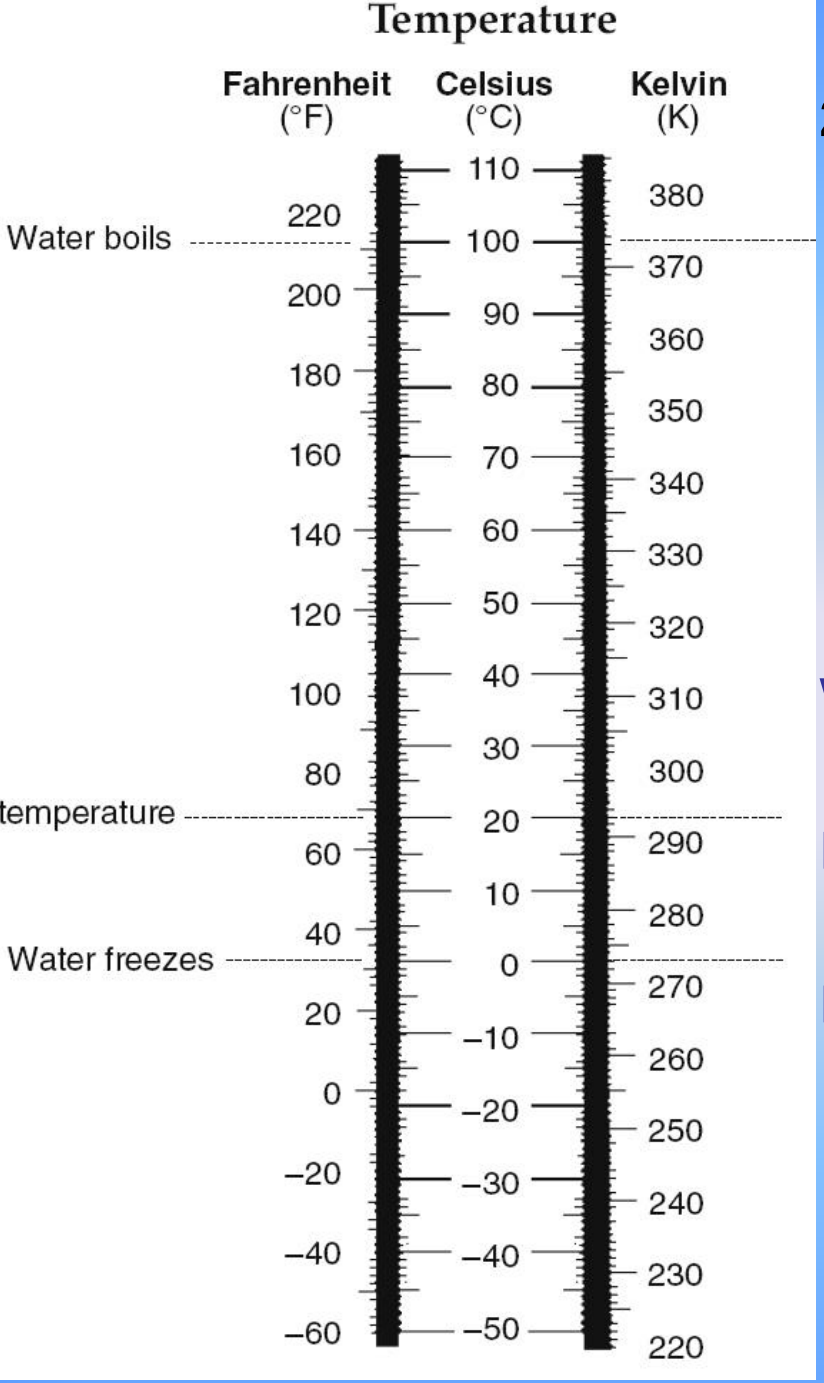
1. Temperature

A) Temperature **-** A measure of the average kinetic energy of the particles in a sample of matter, expressed in terms of units or degrees designated on a standard scale.

B) Thermometer **-** Instrument used measure temperature.

C) Celsius, Fahrenheit, and Kelvin are the scales used to measure temperature





2. Temperature Conversions:

Conversions between Celsius, Fahrenheit and Kelvin can easily be done by referring to the Earth Science Reference Tables page 13.

Practice Conversions:

Water Boils = **100** °C; **212** °F

Human Body = **38** °C; **98.6** °F

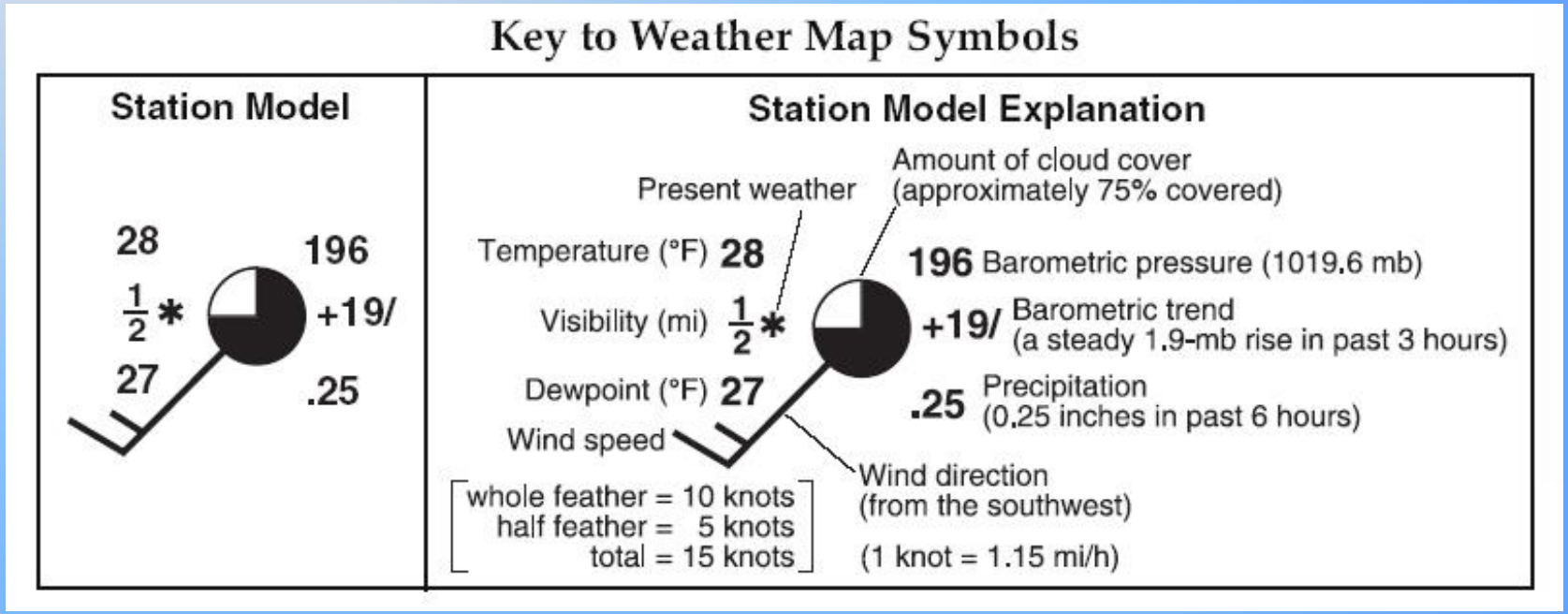
Room Temp. = **20** °C; **68** °F

Ice Melts = **0** °C; **32** °F

3. Recording Temperature

A) **Thermograph** **-** Is an instrument used to record temperature.

B) **Station Model** **-** Is a way to condense weather information at a given location at a given time on a weather map.



Recording Temperature:

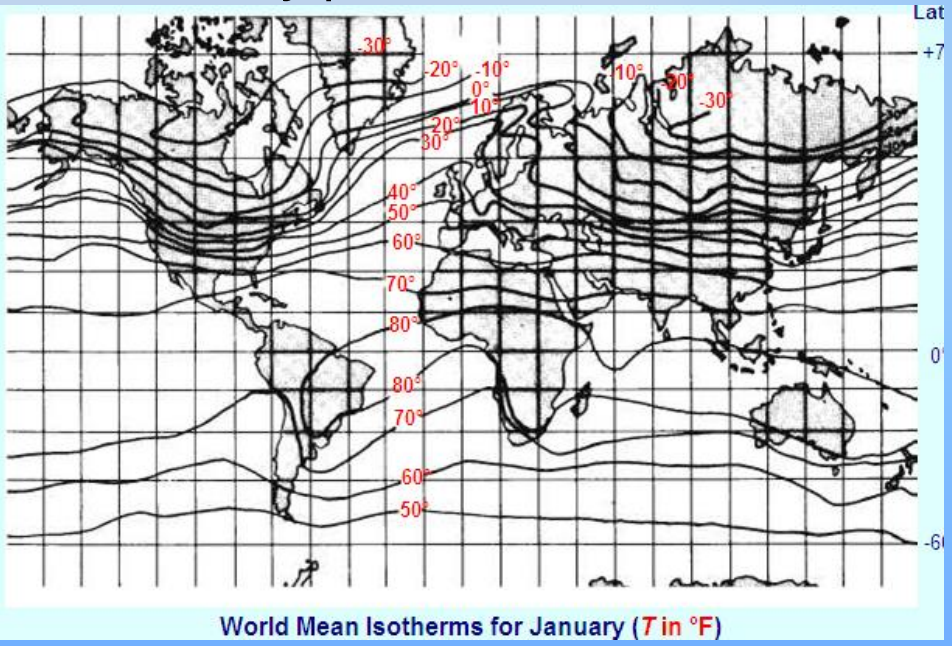
•Temperature is always recorded in the upper left hand corner of the station model. (outside the circle)

•*Temperature is always recorded in degrees Fahrenheit. Only the number is recorded the units are omitted.

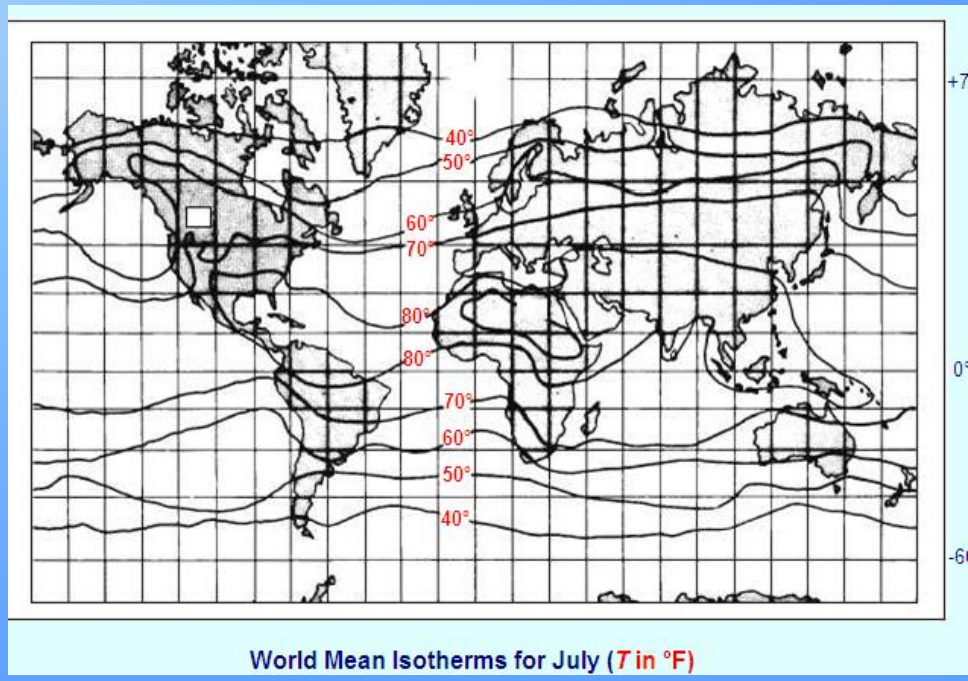
C) Isotherms **-** A Lines drawn on a weather map that connect points of equal temperature.

D) Isotherms are generally drawn at 5 or 10 degee interval.

E) Isotherms generally run East to West across the United States in fairly parallel lines.



World Mean Isotherms for January (*T* in °F)



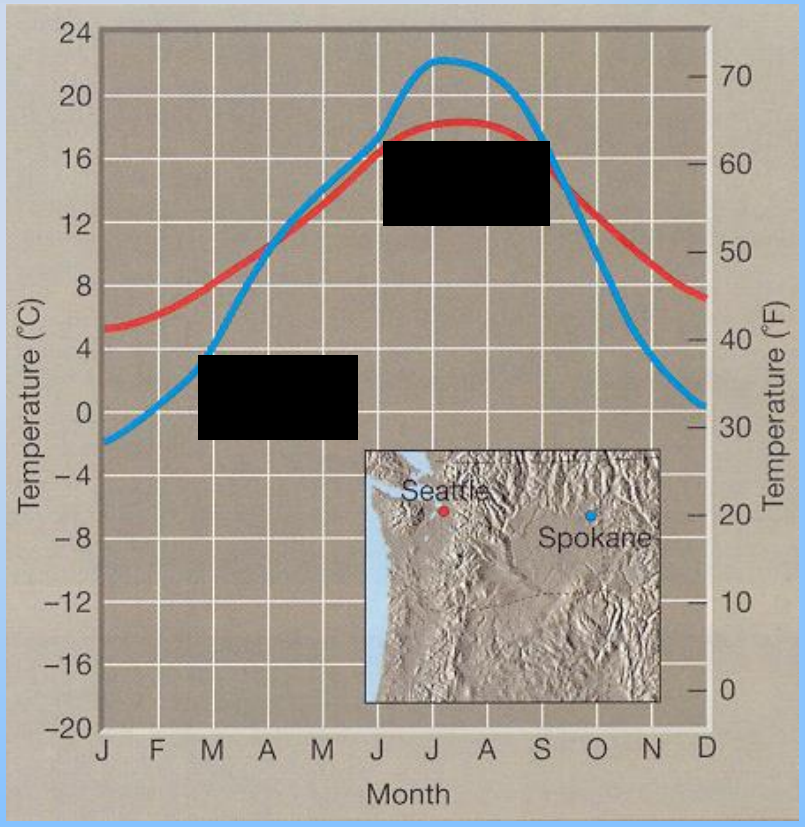
World Mean Isotherms for July (*T* in °F)

Happy day ☺

1) **QUIZ: pencil and calculator (20 mins)**
2) **Finish and turn in LAB 1-4 DUE Today**
3) **HW: VOCAB. LAB 6-5 (See Packet)**

What causes Temperature Variations??

2. Geographic Location



a. Coastal vs. Inland Locations

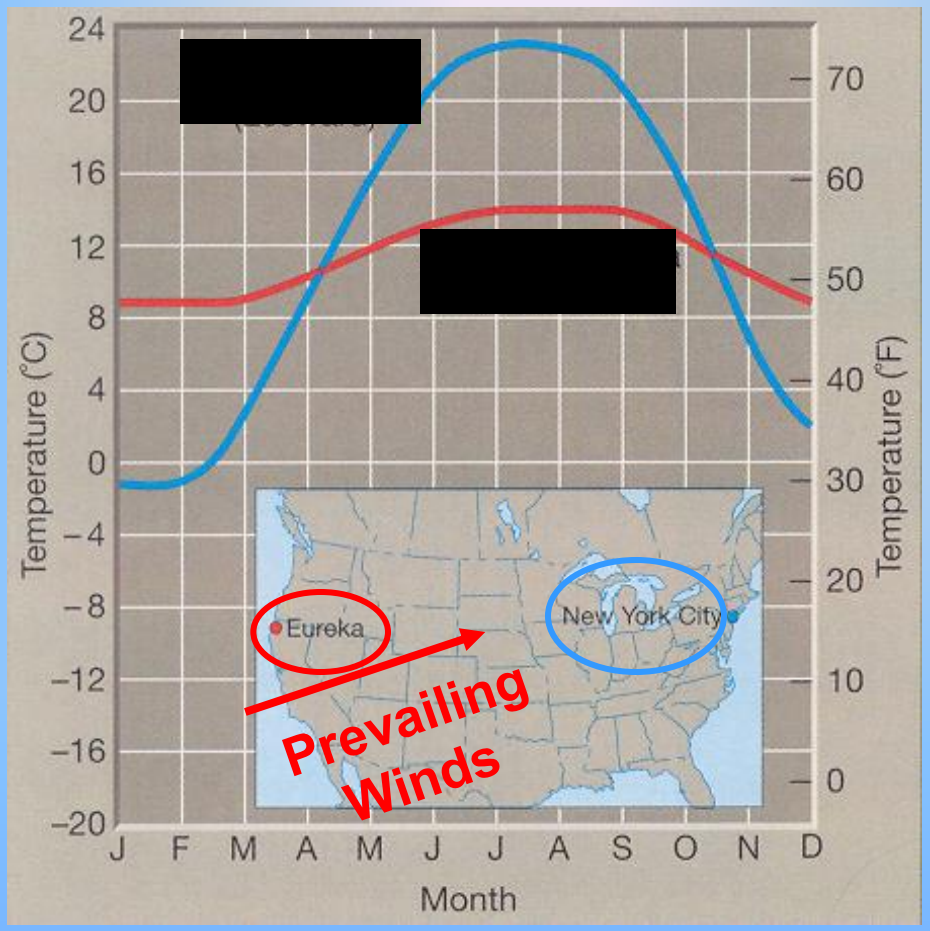
(1) Coastal regions have their yearly temperatures **moderated** by the nearby presence of a body of water.

(2) Coastal regions will have **smaller** yearly temperature ranges than inland regions

(a) **Cooler** summer temperatures

(b) **Warmer** winter temperatures

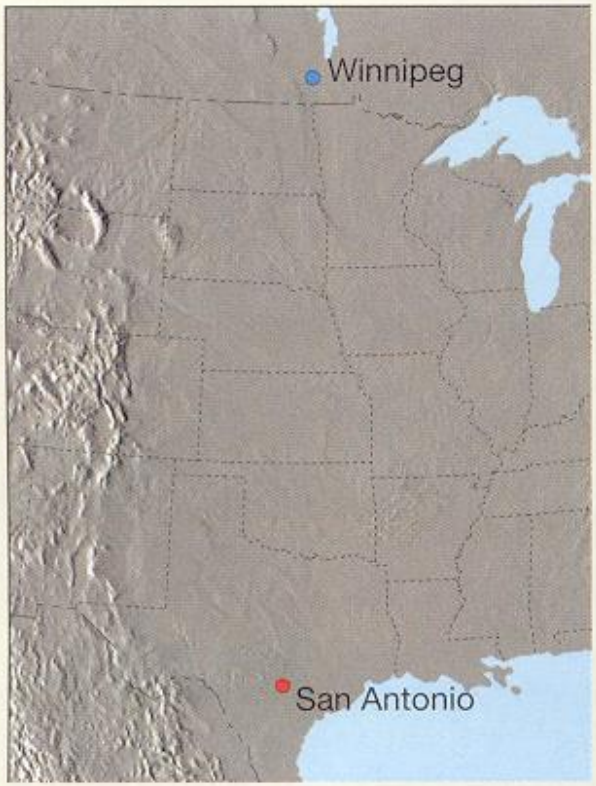
b. Windward Coast vs. Leeward Coast

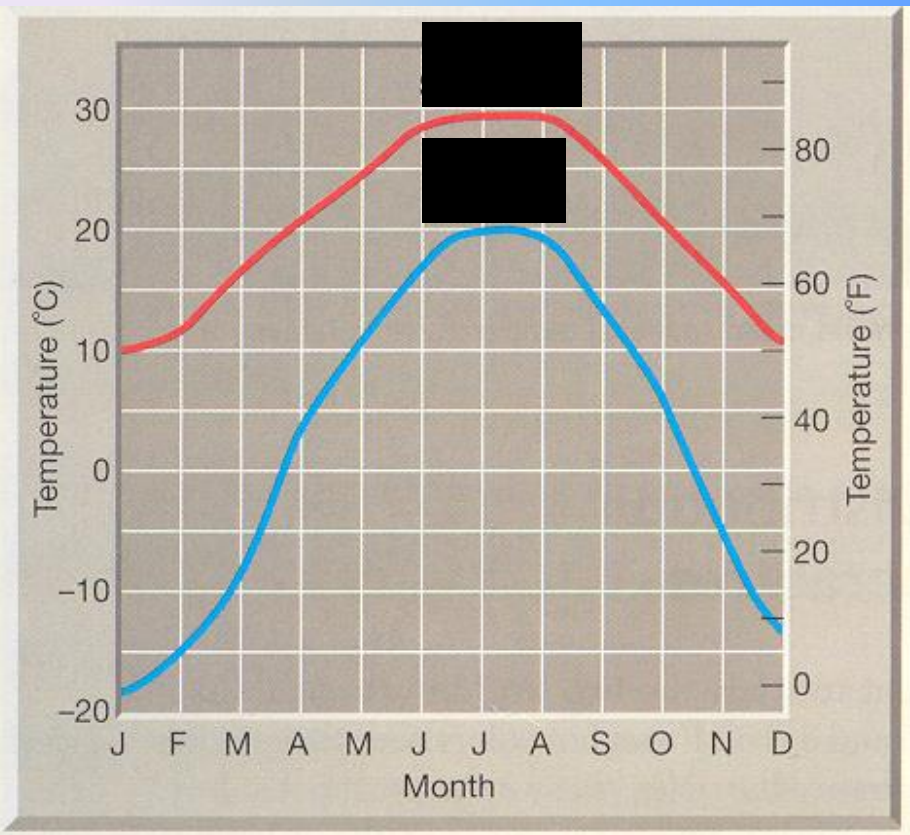


(1) Windward: Prevailing winds from the ocean will result in a **smaller** annual temperature range.

(2) Leeward: **Larger** temperature range because winds do no carry the ocean's influence on shore.

c. Latitude

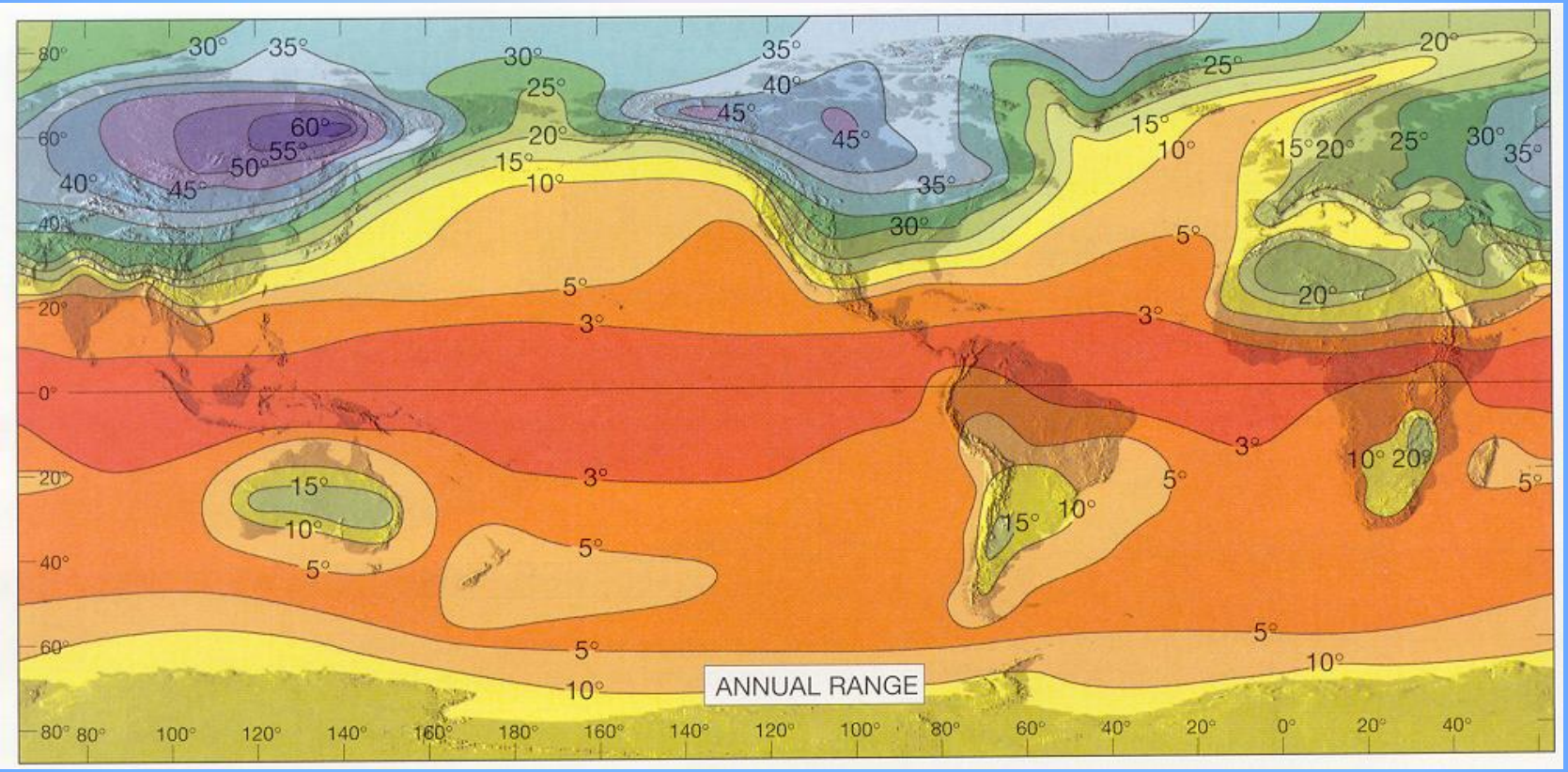




(1) On the average, as latitude increases average annual temperature **decreases**

(2) Higher latitudes also have a greater annual temperature **range**.

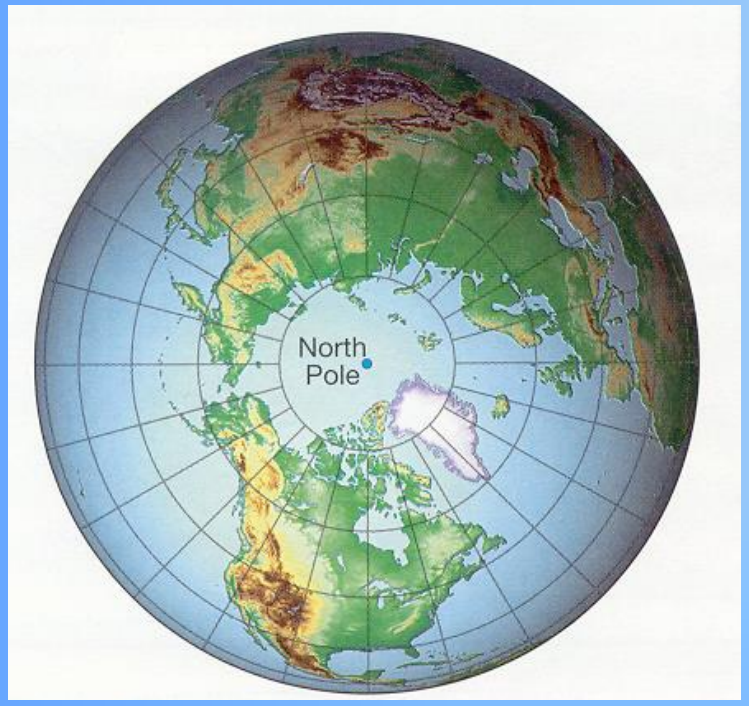
Global Annual Temperature Ranges

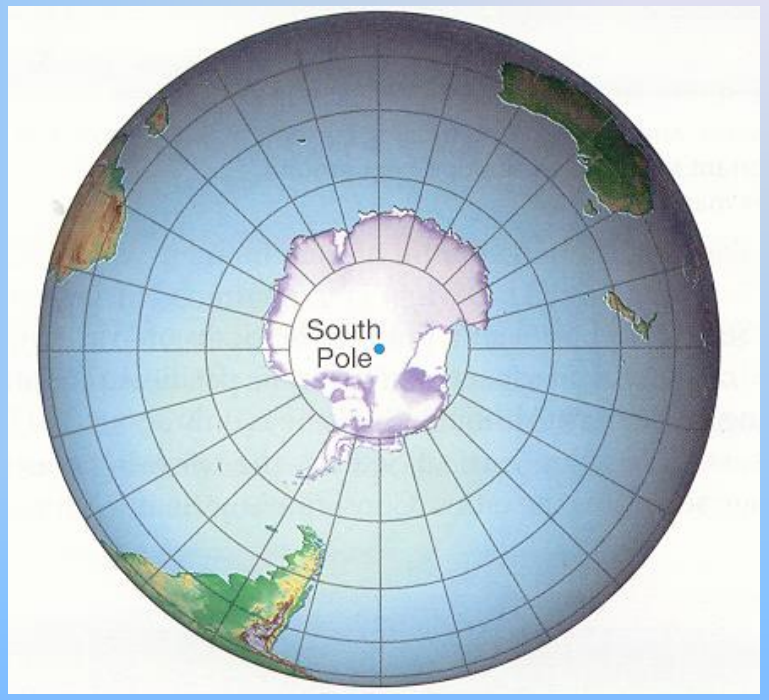


Notice the lower latitudes have smaller ranges (see notes 2c).

Compare the Southern hemisphere to the Northern hemisphere… why are they so different?

d. Northern Hemisphere vs. Southern Hemisphere



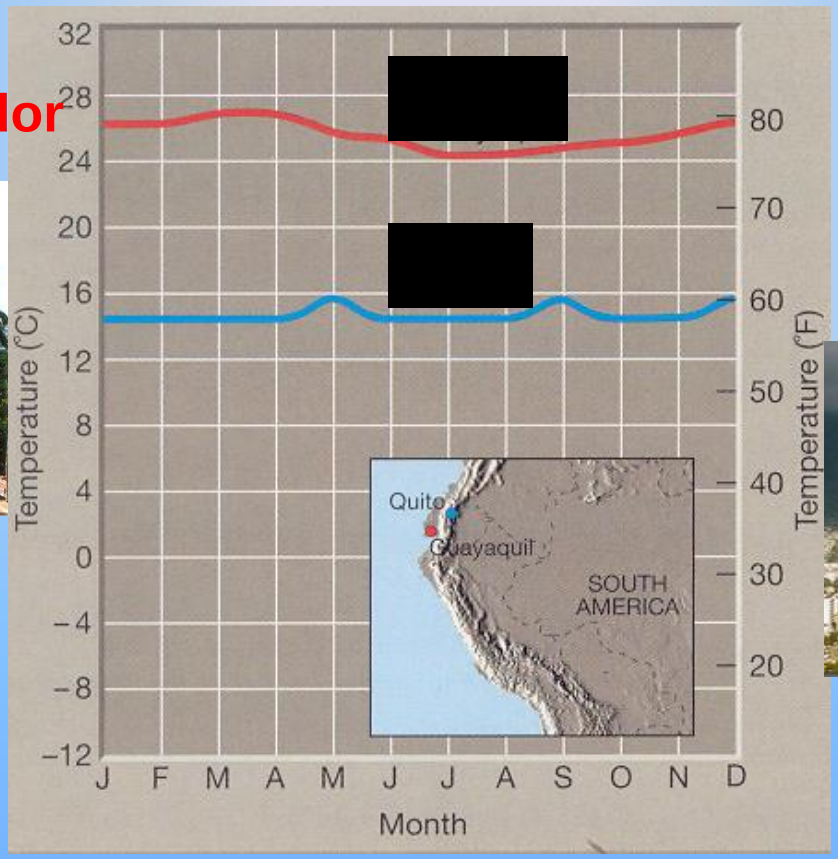


(1) The Southern Hemisphere has a **greater** percentage of water than the Northern Hemisphere (81% covered - 20 percent more than the N. Hemisphere).

(2) **Smaller** temperature variations in the Southern Hemisphere.

3. Altitude

Guayaquil, Ecuador is near sea level.

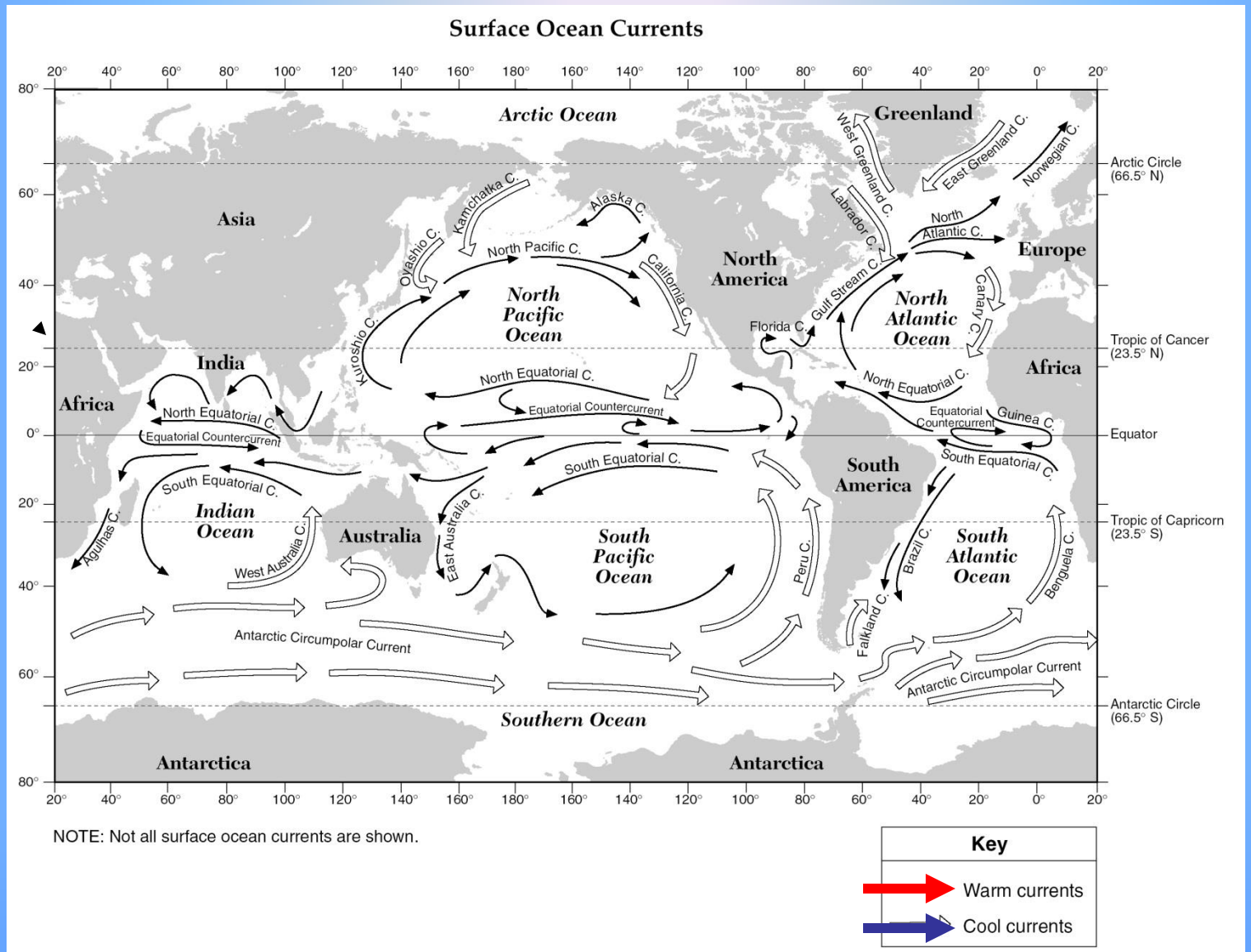


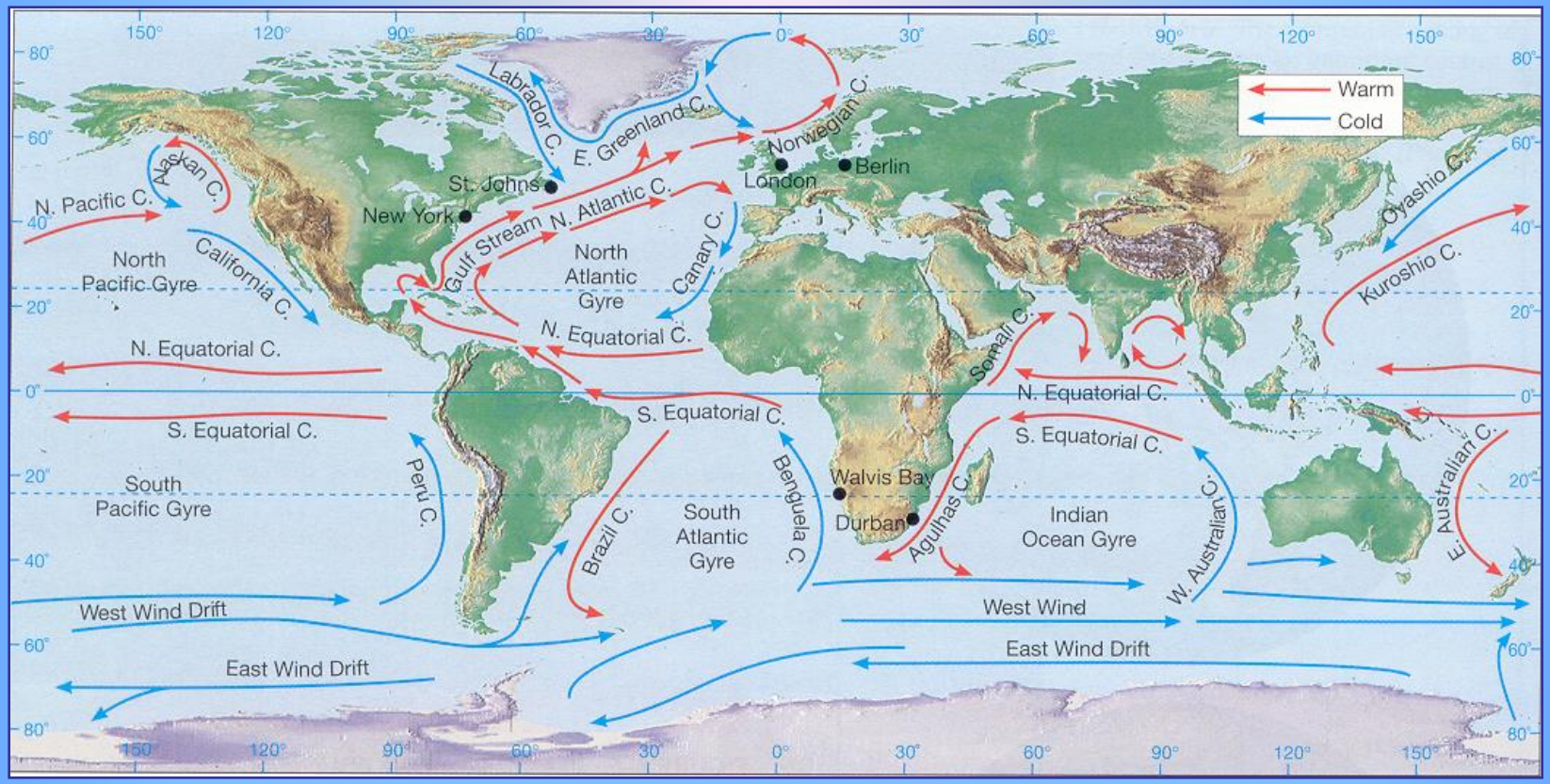
Quito, Ecuador is high in the Andes Mountain

a. As altitude increases, average annual temperature **decreases**.

b. Increased altitude results in a **larger** daily temperature range because the greater intensity of insolation due to the less dense air.

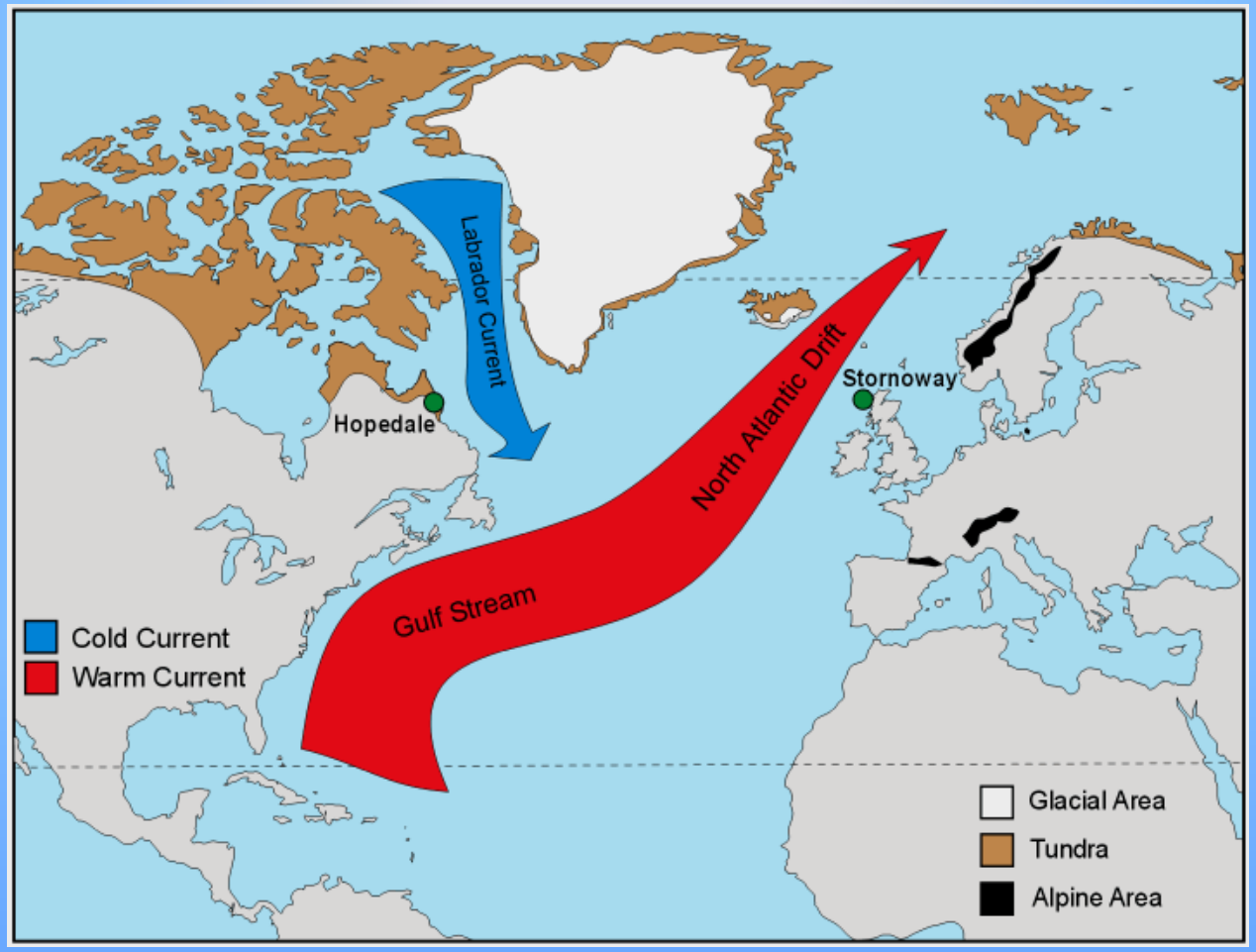
4. Ocean Currents



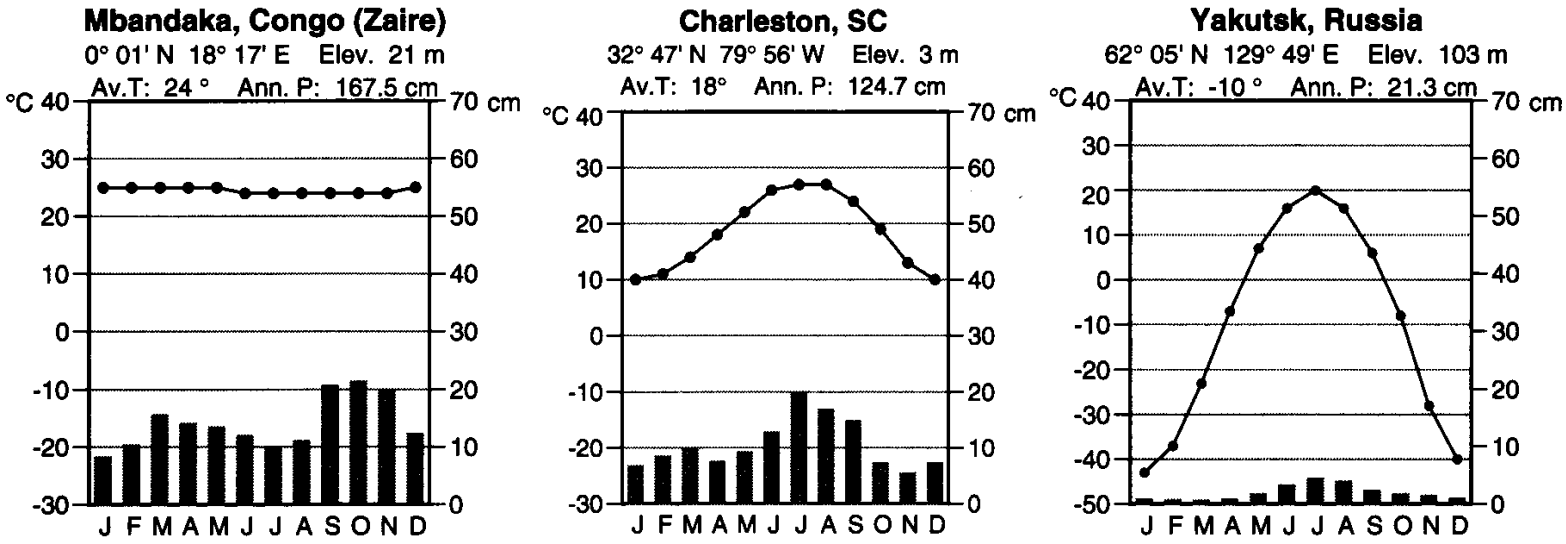


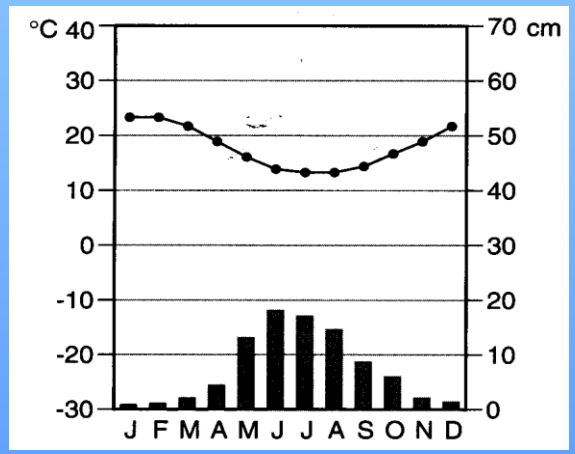
a. Currents moving towards lower latitudes are **cold**.
b. Currents moving away from the equator are **warm**.
c. Caused by frictional drag on the surface by **wind**.
d. Affect coastal areas

Ocean Currents

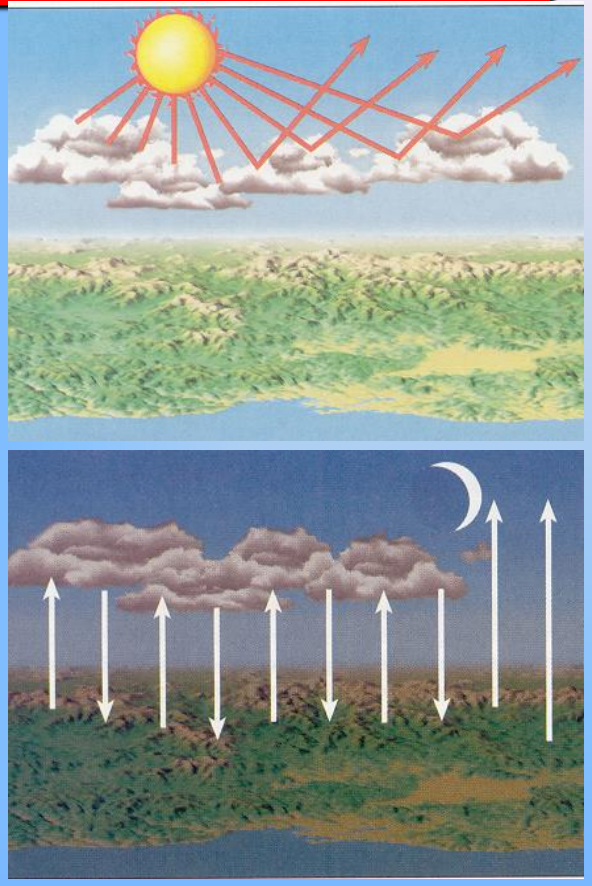


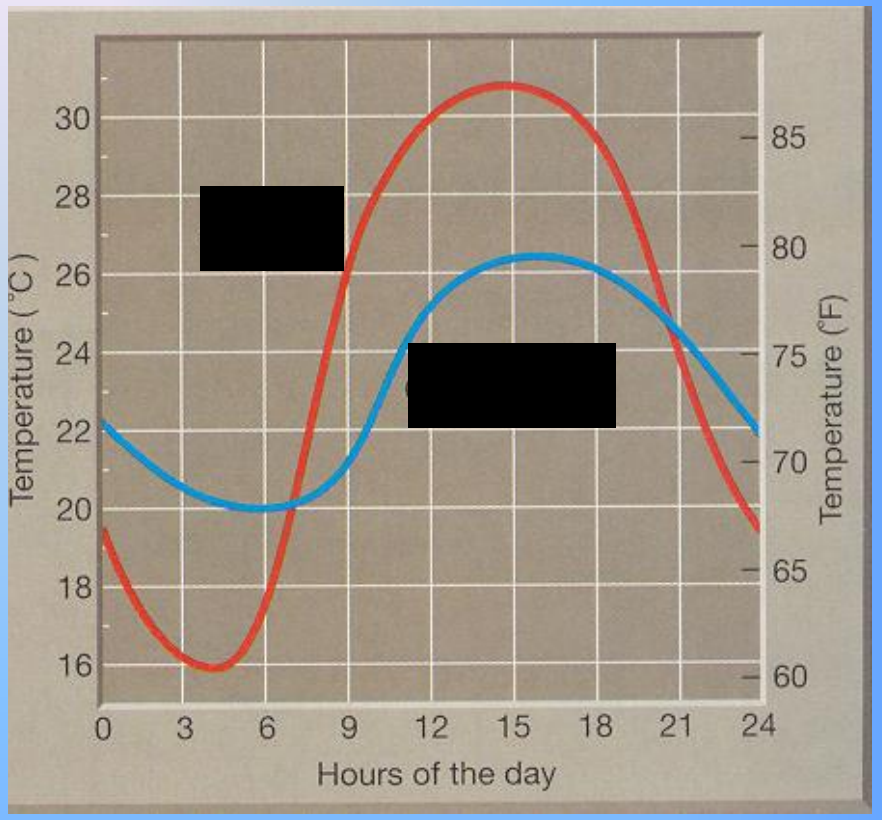
Climographs





5. Cloud Cover





a. During the day, clouds **reflect** insolation back to space.

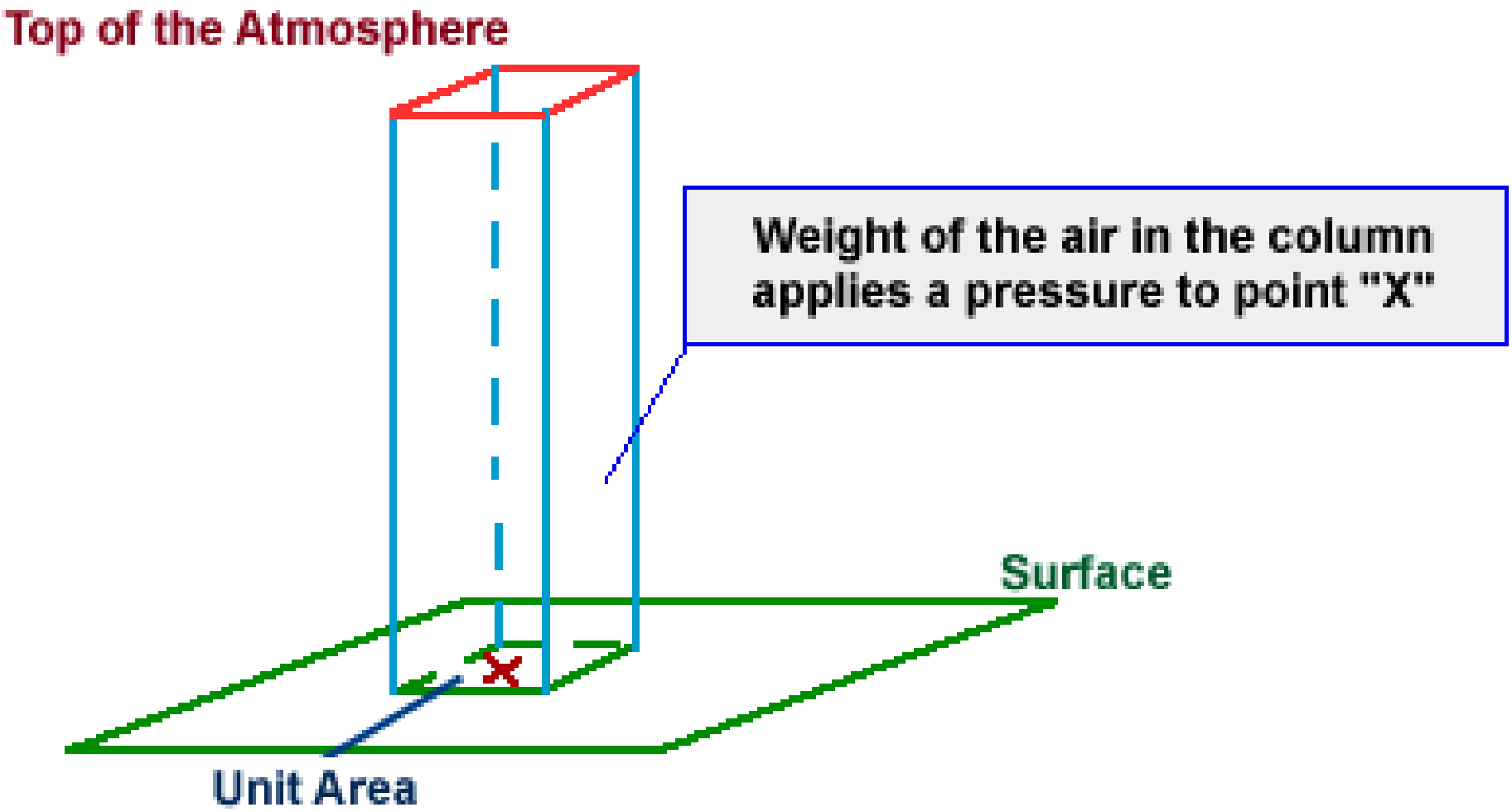
b. At night, minimum temperature will not fall as low. Clouds **absorb** terrestrial radiation and emit a portion of it toward the surface.

c. Clouds **reduce** the daily temperature range.

- Begin Atmospheric Pressure (Air Pressure)

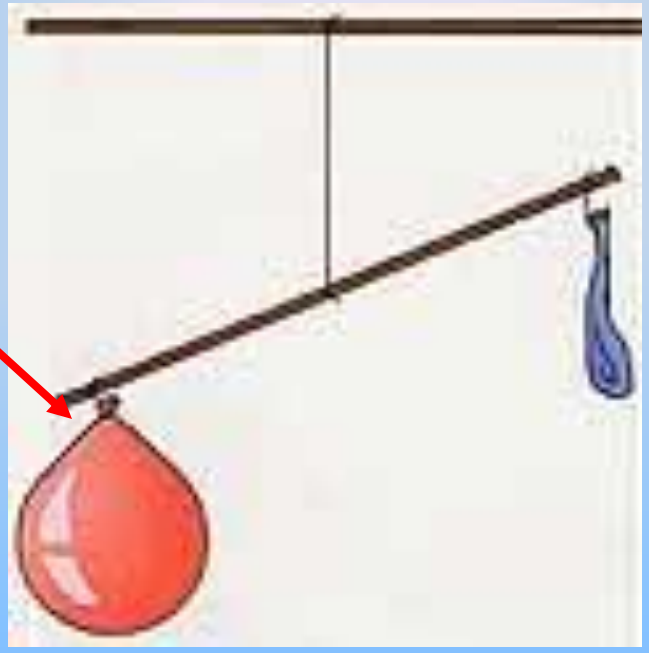
III. Air Pressure

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



A. The Cause of Air Pressure

Inflated Balloon



"Empty" Balloon

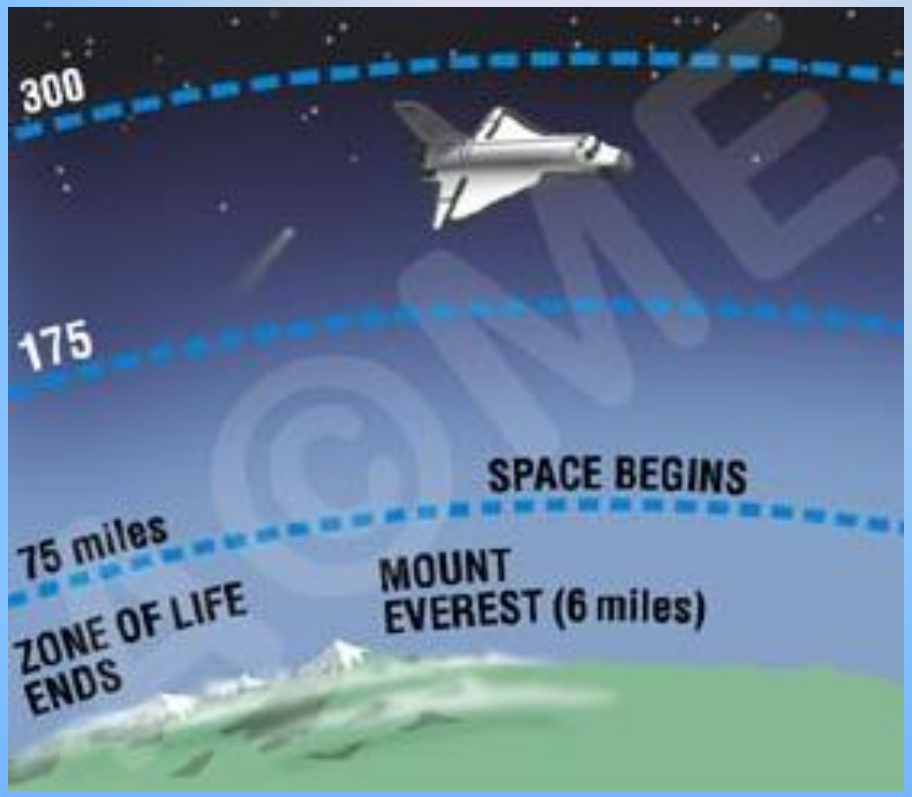
A) The **weight** of the air overhead causes pressure.

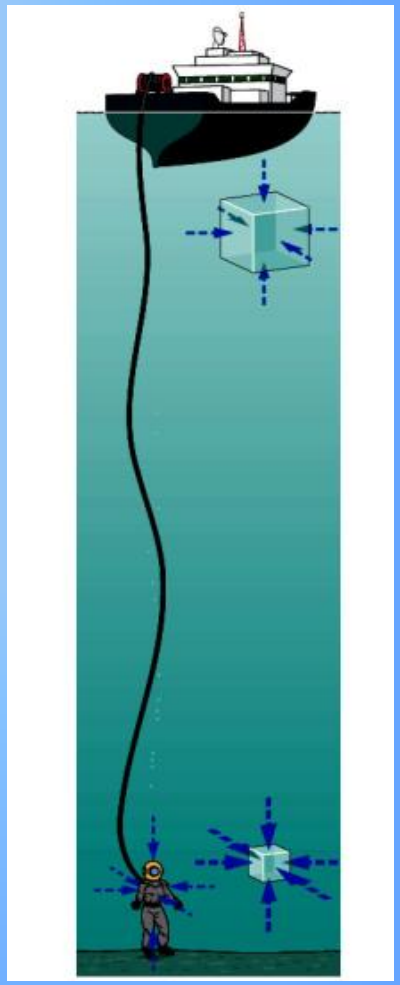
Air Pressure is the weight of the atmosphere per unit area.

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.

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

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





C) The **pressure** is equal in all directions…

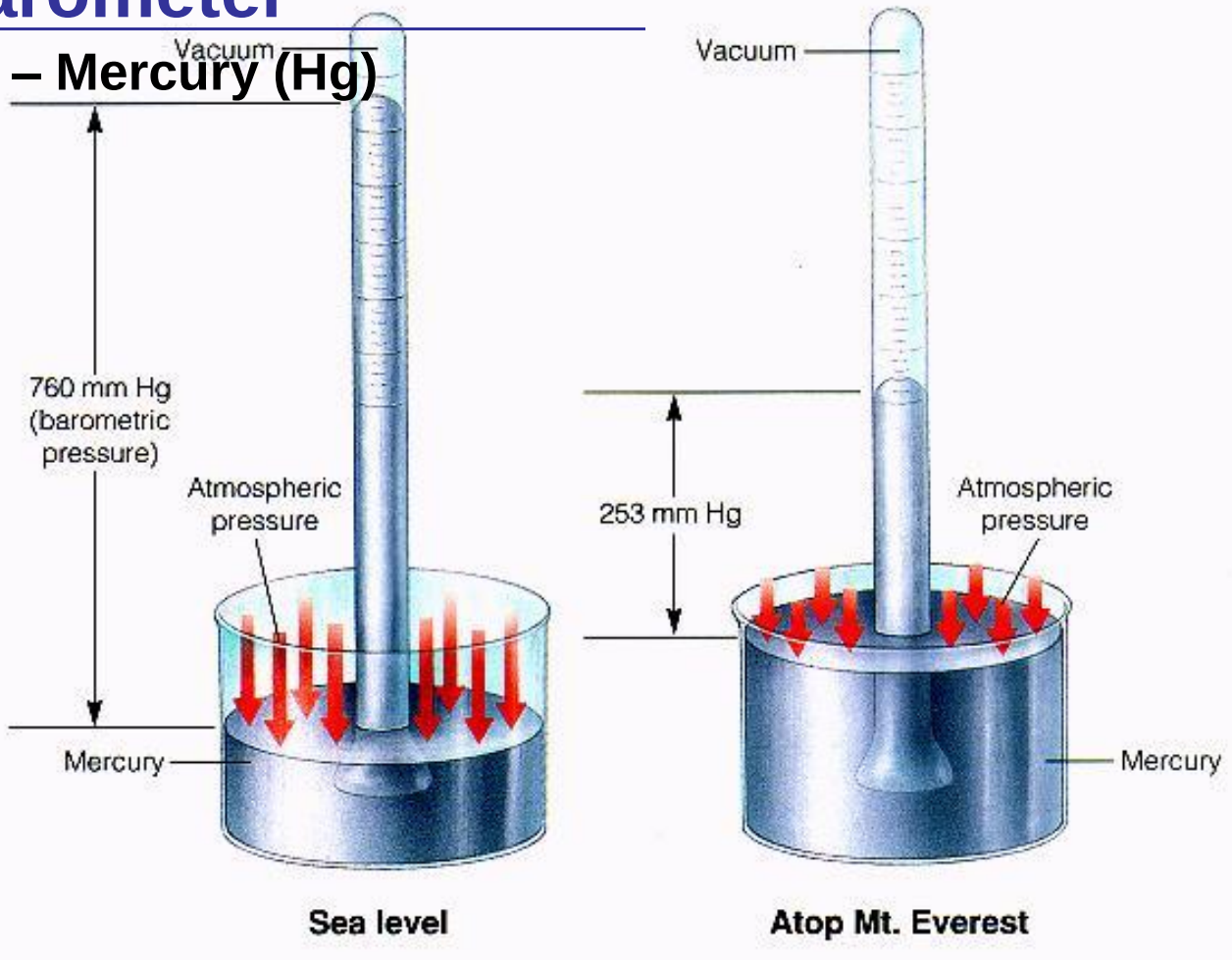
since air molecules move in all directions.

Instruments for Measuring Air Pressure

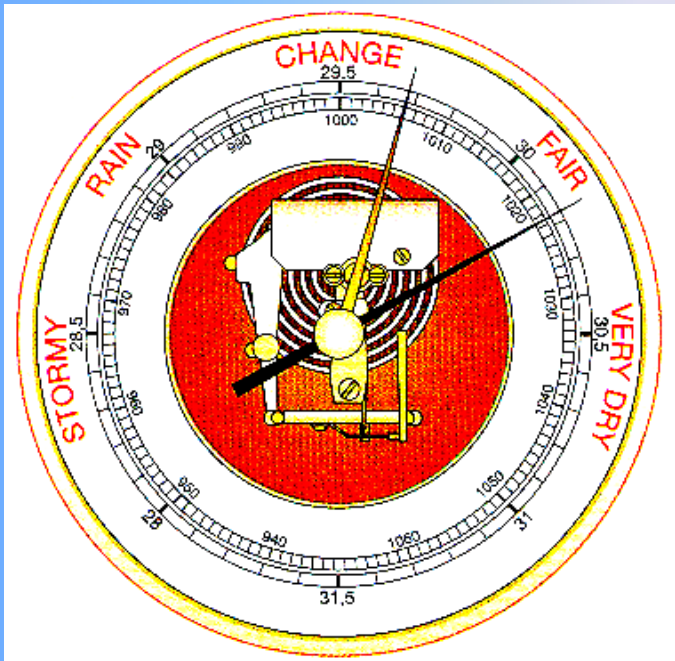
D) Barometer

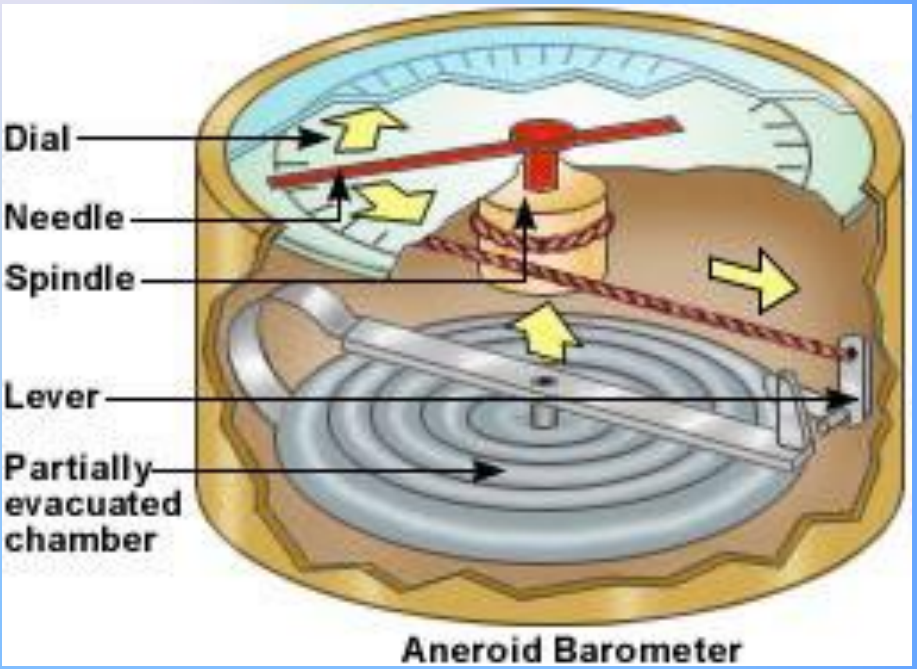
1. Liquid – Mercury (Hg)

- Inve
  stud
- A tu
  the
  then
  oper
- Mer
  colu
  leav
- High
  high
  pres
  flow
- If wa
  high



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.

2. ***Air Pressure Conversions***

A) Air pressure is measured in inches of mercury (Hg) and **Millibars (mb)**

B) One inch of mercury represents ~34 mb.

Standard pressure at sea level is

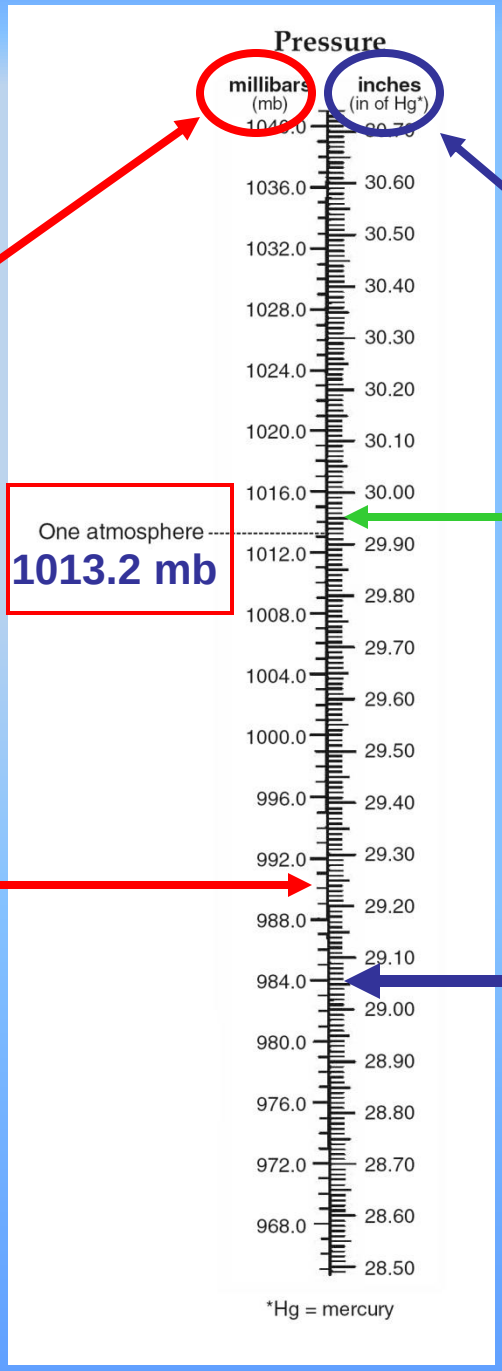
- **29.92 inches** of Hg (measured to the hundredth of an inch) or
- **1013.2 mb** (measured to the nearest tenth of a millibar)

C) Conversions between inches and millibars can easily be done by referring to your ESRT page 13.

Each increment is equal to 1.0 mb

Always express millibars to the nearest 0.1

990.0 mb

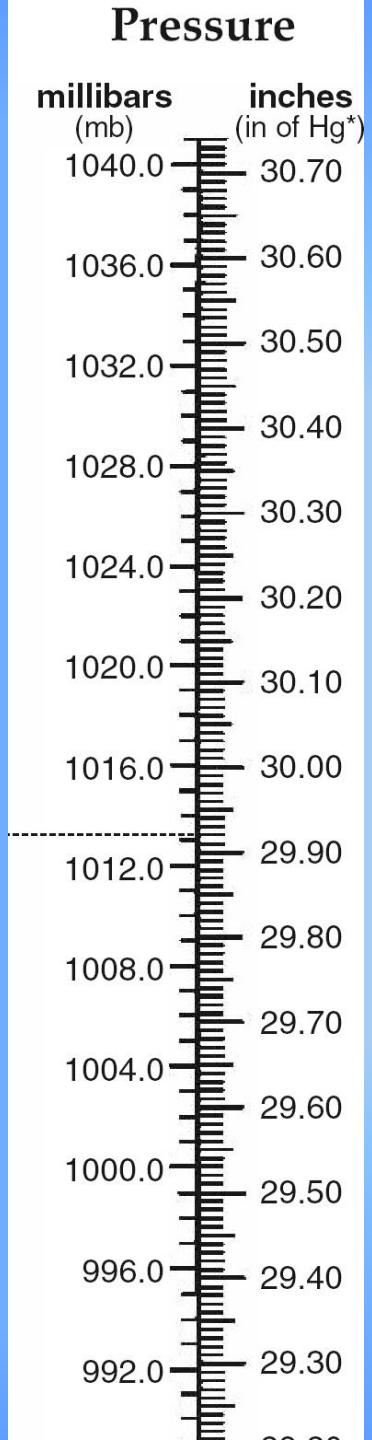


Each increment is equal to .01 inch of Hg

29.95” Hg

Always express in. of Hg to the nearest 0.01

29.05 inches of Hg



C) Conversions between inches and millibars can easily be done by referring to your

ESRT page 13..

Practice Conversions:

*One Atmospere = **29.92** in. **1013.2** mb

30.50 in.= **1033.0** mb

29.40 in. = **995.5** mb

29.76 in. = **1008.0** mb

29.88 in = 1012.0 mb

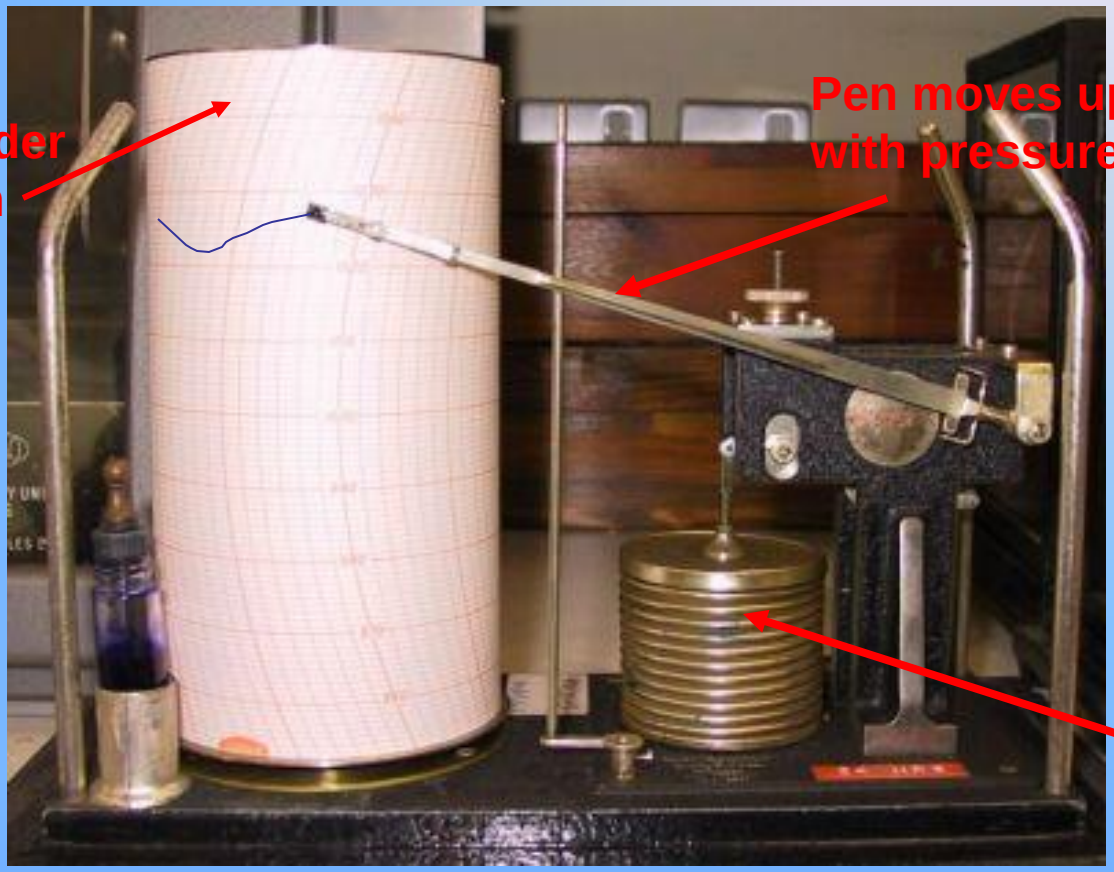
30.24 in = 1024.0 mb

30.06 in = 1018.0 mb

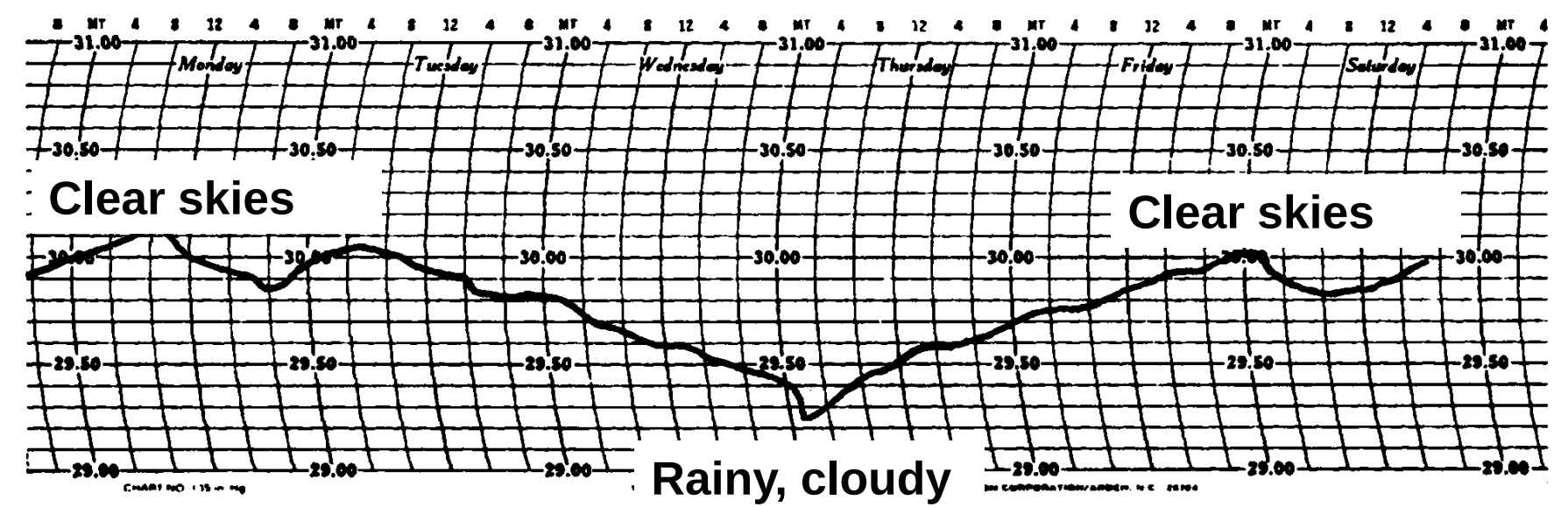
*Standard pressure at sea level

3. Recording Air Pressure:

A) **Barograph** - Instrument used to record air pressure



Barogram


Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
31.00
30.50
30.00
29.50
29.00
Clear skies
Rainy, cloudy
Clear skies

E. *Air Pressure on Weather Maps*

B) **A Station Model** - is a way to condense weather information at a given location at a given time on a weather map.

Recording Pressure on a station model:

- Pressure is always recorded in the **upper right corner**
- Pressure is recorded in an abbreviated format in ***millibars***.

Skip to **D) Placing Pressure on a Station Model:**

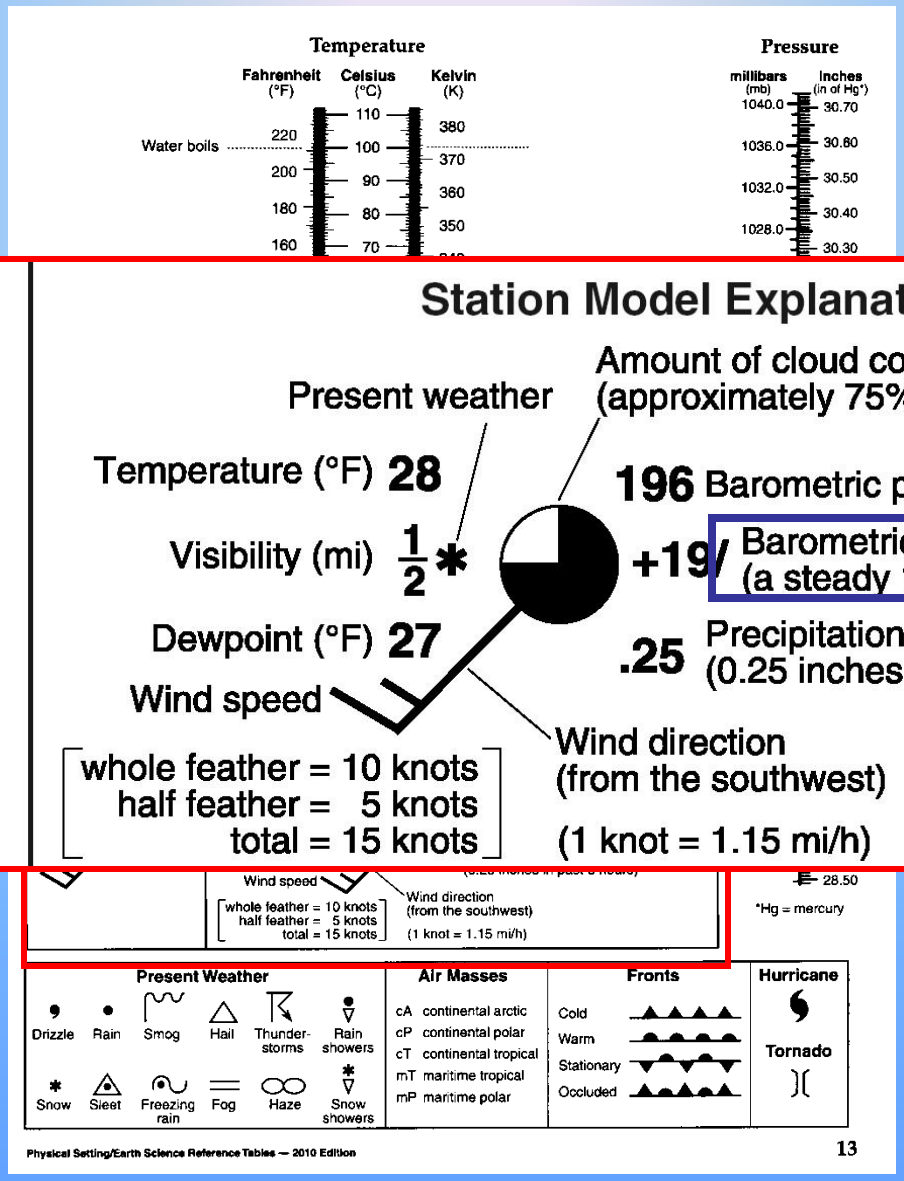
- The initial 9 or 10 and the decimal point are omitted.
- The number is not labeled with units
- The pressure is recorded at the **upper right** of the station model.

Examples:

(1) 978.6 mb

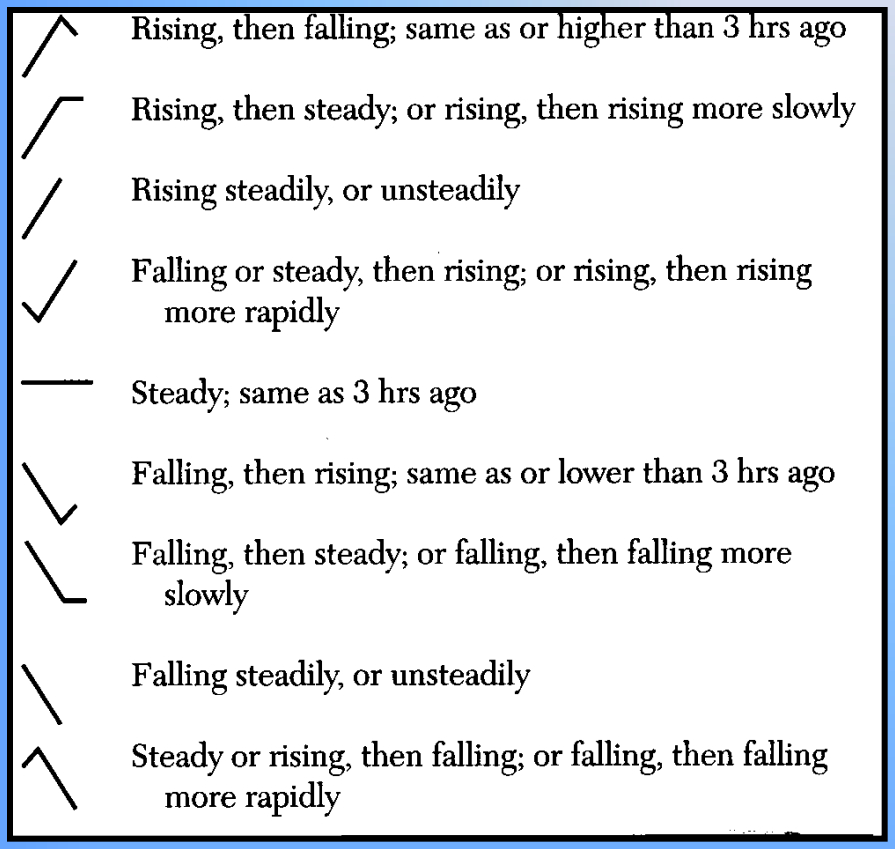
(2) 1013.9 mb

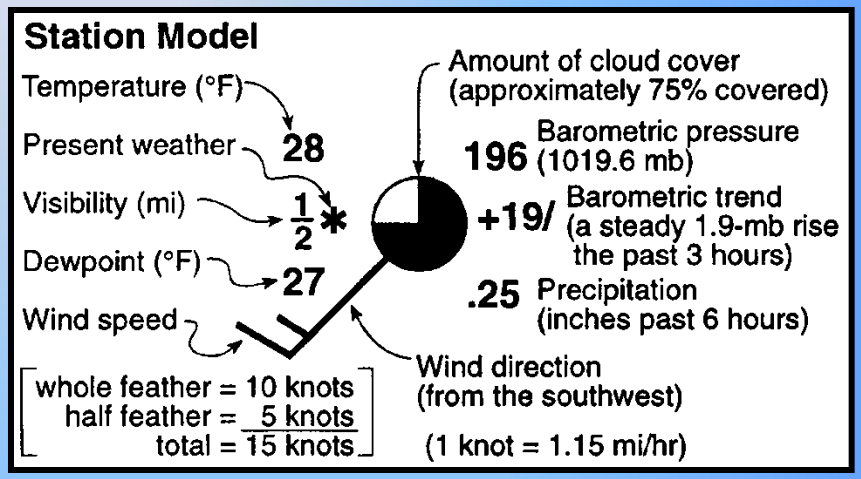
The *ESRT* Station Model



Barometric Trend

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

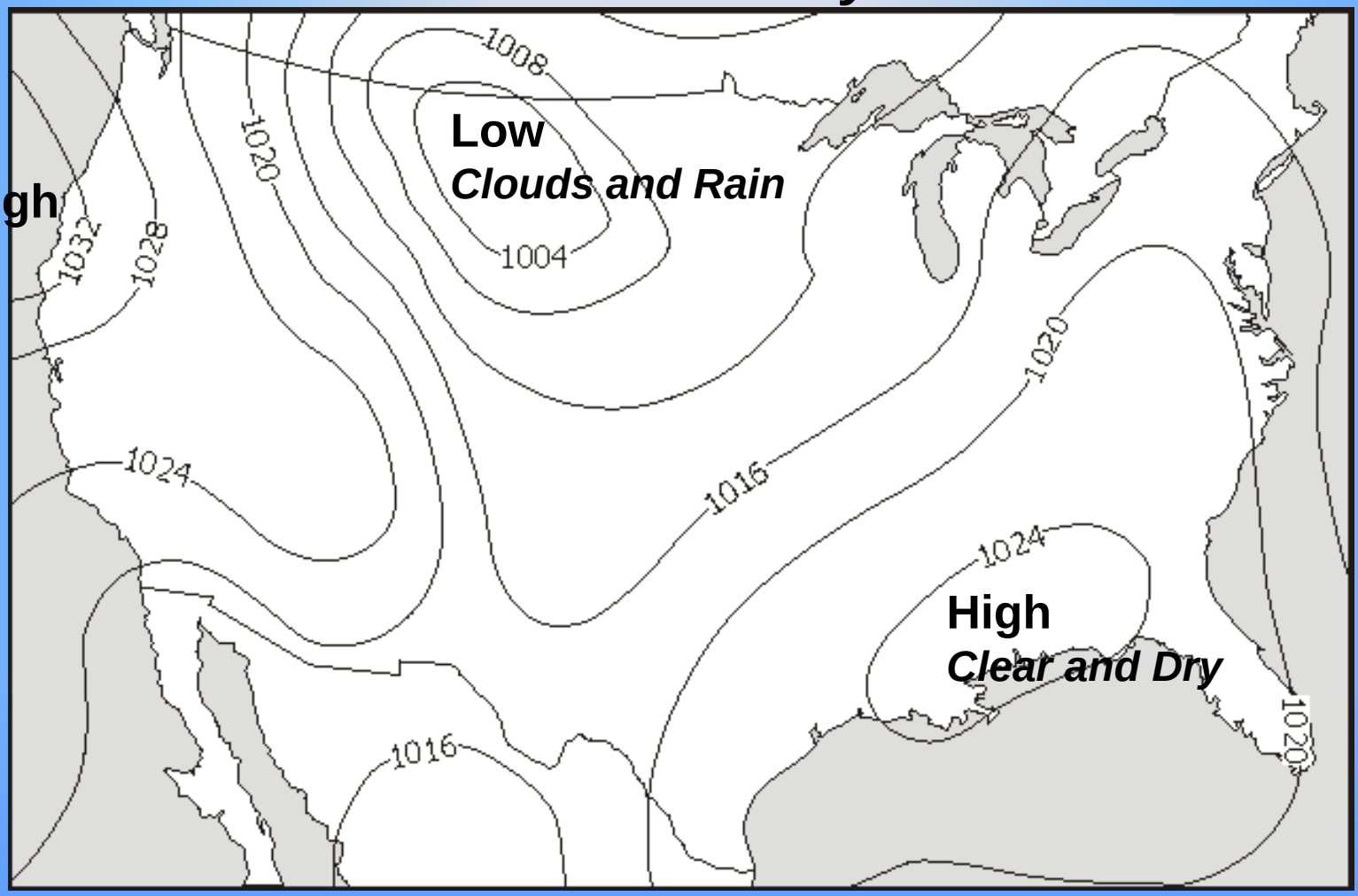




- **The current pressure is 1019.6 mb**
- **Because the pressure has been rising steadily, three hours ago the pressure was 1.9 lower.**
- **Three hours ago the air pressure was 1017.7 mb. (1019.6 mb – 1.9 mb)**

E) **Isobars** Isolines connecting points of equal air pressure.

- A 4 mb interval is always used.



Now go back to C) <u>Converting Pressure on a Station Model:</u>

"The Rule":

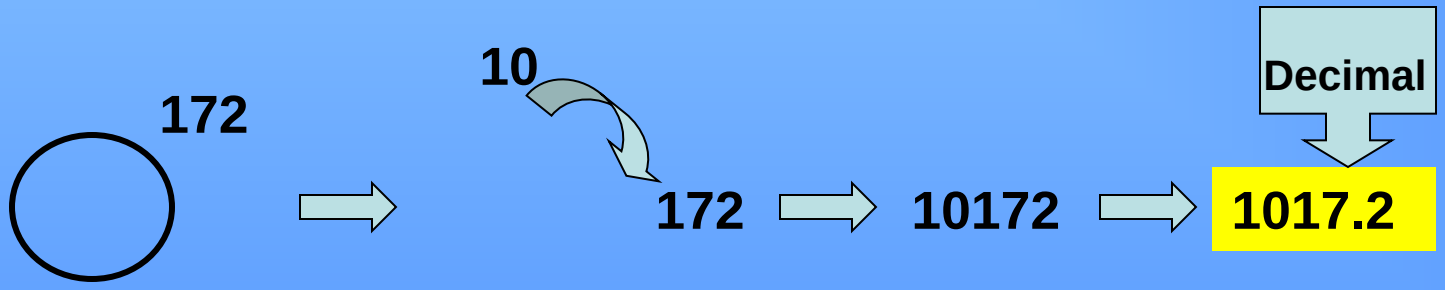
- **If the number is less than 500, place a 10 on the front and put a decimal to the left of the last digit**

  (pressure is expressed to the nearest tenth of a millibar).

- **If the number is greater than 500, place a 9 on the front and put a decimal to the left of the last digit**

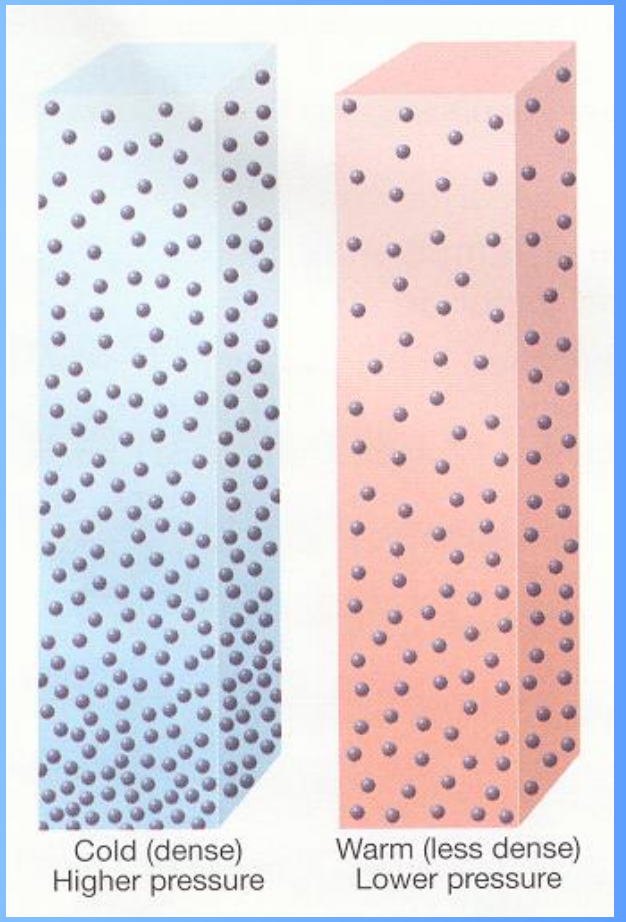
  (pressure is expressed to the nearest tenth of a millibar).

Examples:



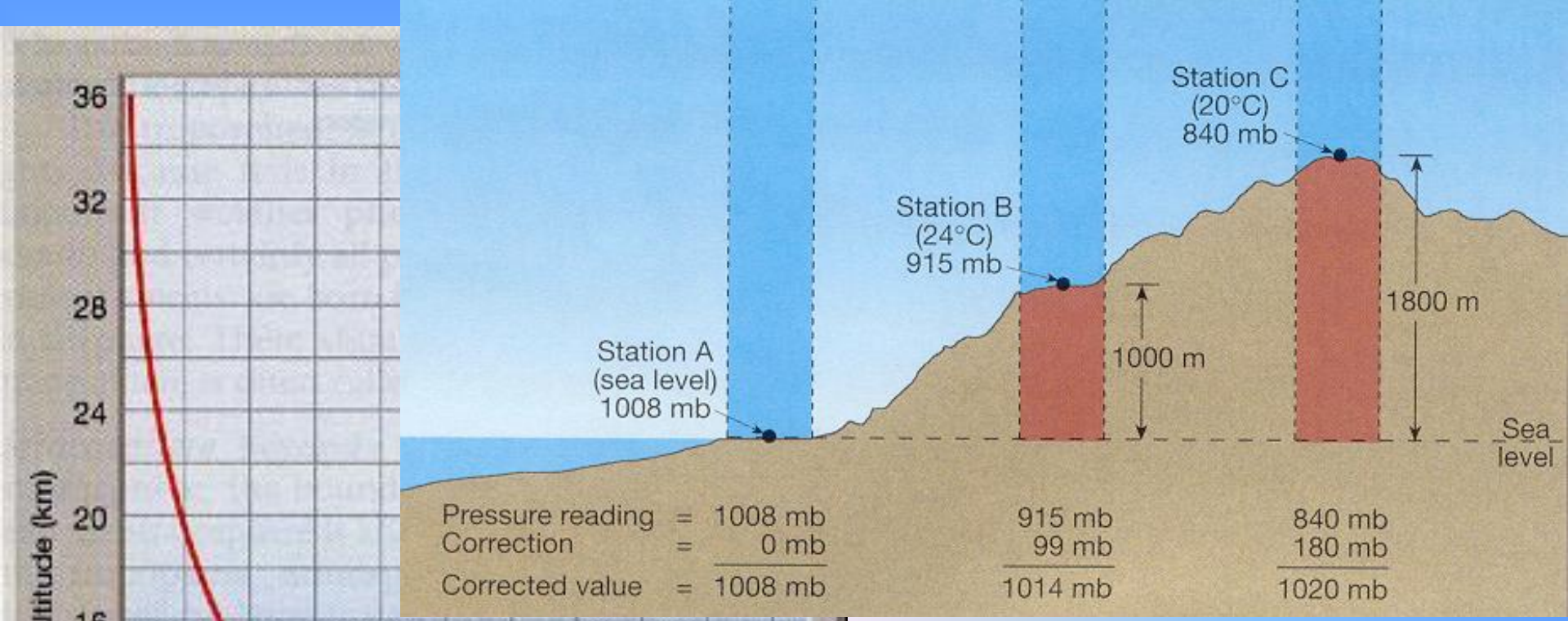
4. ***Factors Affecting Air Pressure:***

A) Pressure and Density are **directly** related.



Temperature differences cause different density.

B) Altitude – As altitude increases the air becomes thinner and air pressure decreases.



Altitude Correction

- In interpreting air pressure for the purpose of weather forecasting, meteorologists are concerned with the horizontal changes across an area.
- The effect of elevation must be factored out

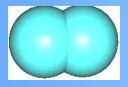
C) **Humidity** – Water Vapor in the air.

- The more humidity, the lower the air pressure, therefore a **falling pressure** is a good indicator of a **storm approaching**.

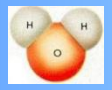
- The less humidity, the higher the air pressure, therefore a **rising pressure** signals **clear skies**.

C) Humidity

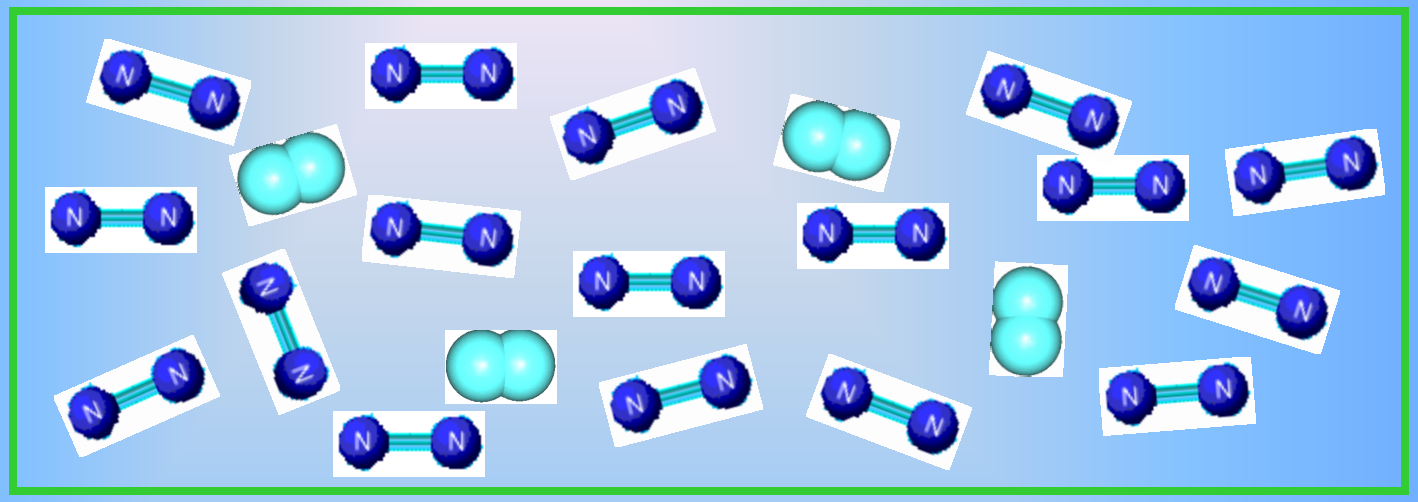
Nitrogen



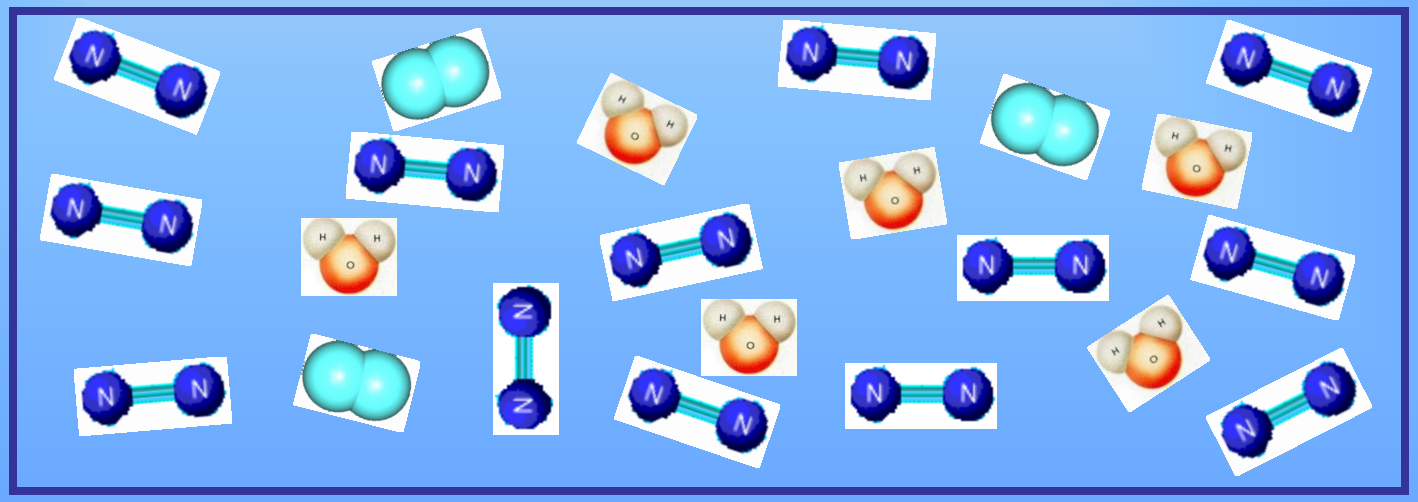
Oxygen



Water Vapor



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

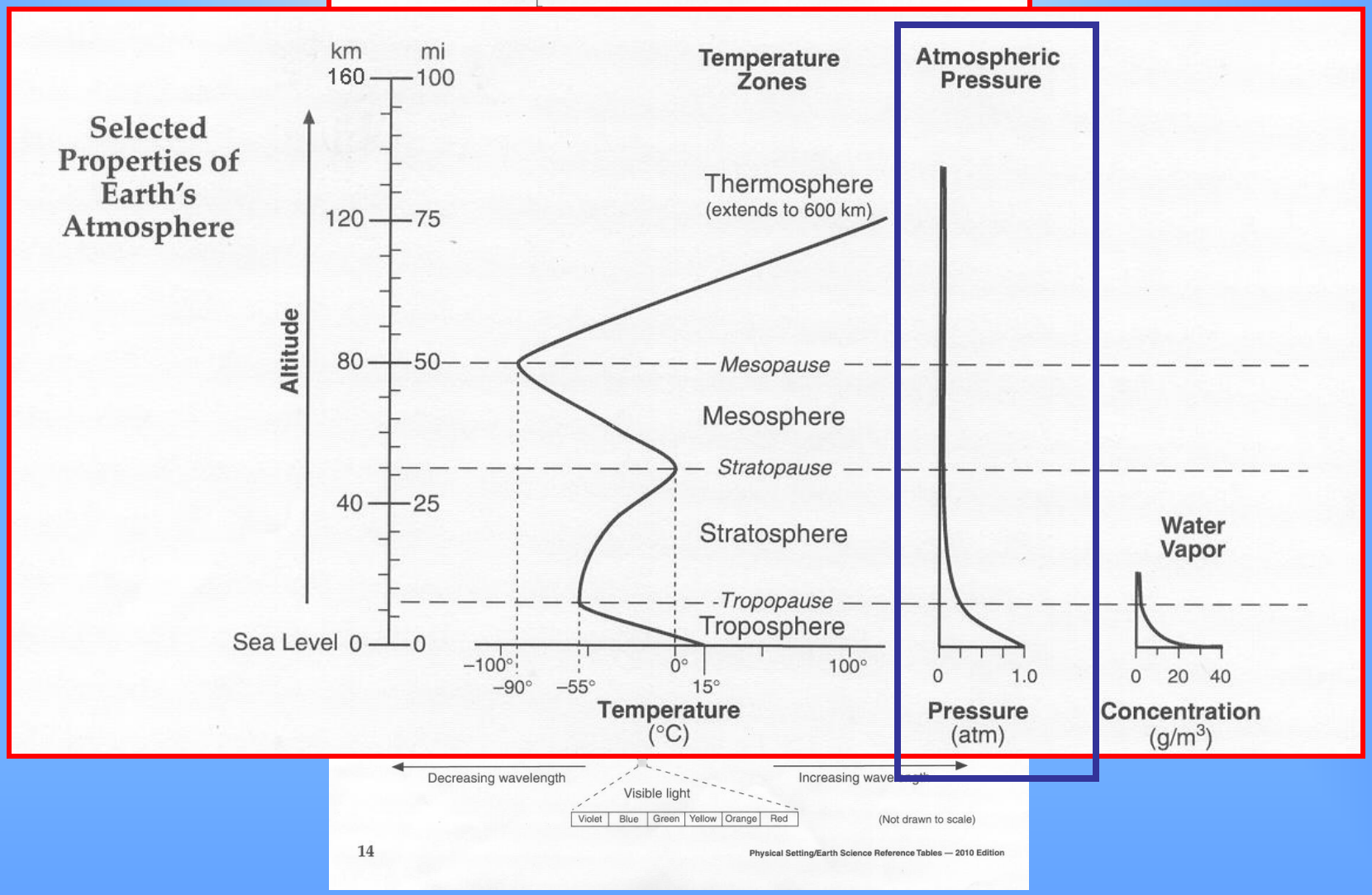


Humid air is only 97 percent oxygen and nitrogen. Lighter water vapor displaces the heavier and equal volume of nitrogen and oxygen.

Summary:
The Effect of Water Vapor on Air Pressure

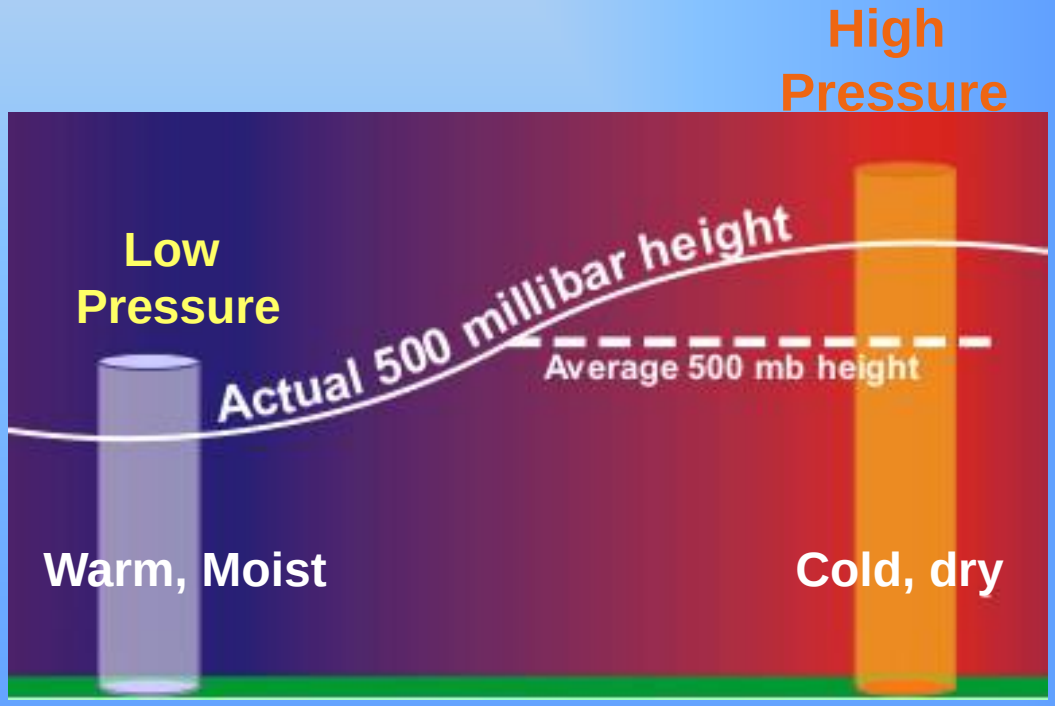
1. The more water vapor air contains, the **lighter** the air is.
2. Water vapor molecules have **less** mass than the oxygen and nitrogen molecules they displace.
3. As a result, humid air will have **lower** air pressure than drier air.

Air Pressure Change with Altitude in the *ESRT*

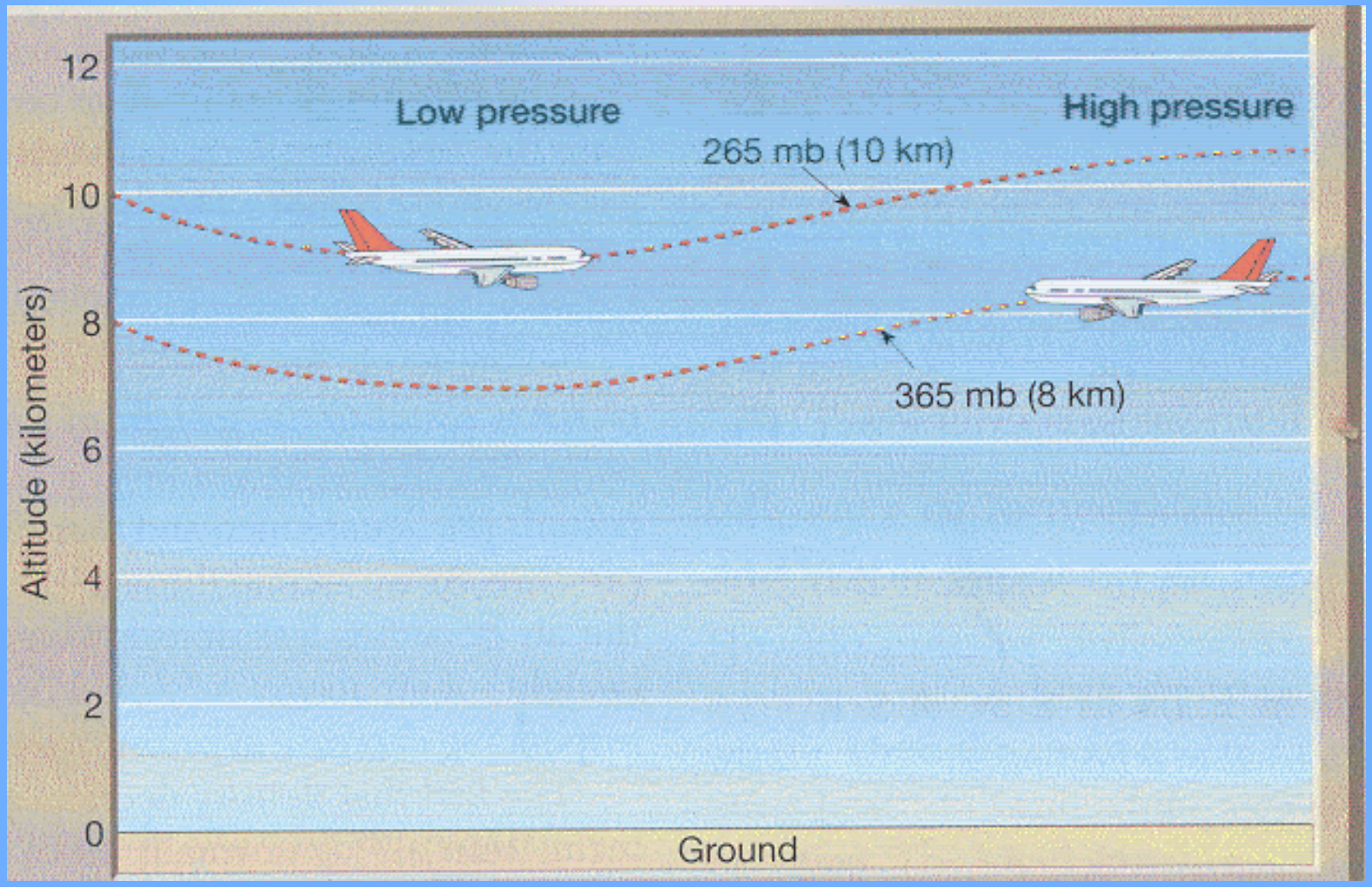


Pressure Levels Can Vary in Altitude

- 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.**