Topic 8: WEATHER

Workbook chapter 7

Weather is the state or condition of the atmosphere at a given location for a brief time period.

Differences in how Earth's surfaces absorb and reradiate energy from the sun cause an uneven distribution of heat. What we think of as weather is actually various factors in the atmosphere trying to distribute this heat energy more evenly.

There are several variables in the atmosphere that control weather: **temperature, air pressure, wind, moisture conditions, cloud cover, precipitation and storms**. Most weather changes occur in the lower part of the atmosphere called the **troposphere**—the layer that sits just above Earth's surface. (See ESRT p. 14)

WEATHER VARIABLES

Atmospheric temperature is a measurement of the average kinetic energy of air molecules. It is measured in Celsius or Fahrenheit degrees (ESRT p.13) using a **thermometer**.

The heating of the atmosphere is caused by:

--transfer of heat from Earth's surfaces to the air by conduction
--absorption of insolation by certain gasses and particles in the air (aerosols)
--absorption of heat radiated from Earth surfaces by CO_2, CH_4, water vapor (greenhouse gases)
--the processes of condensation (water vapor to liquid water) and deposition (water vapor to ice crystals) which release latent heat
--friction due to Coriolis effect

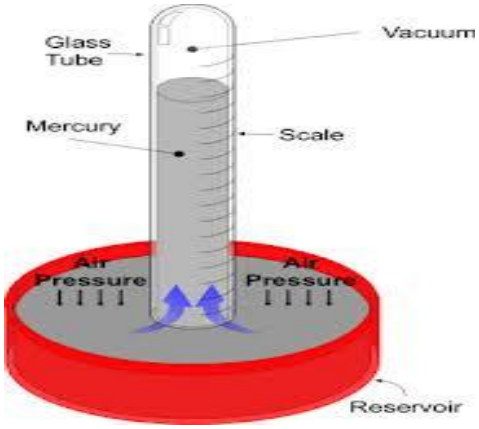
**Heat energy circulates through the atmosphere by convection.

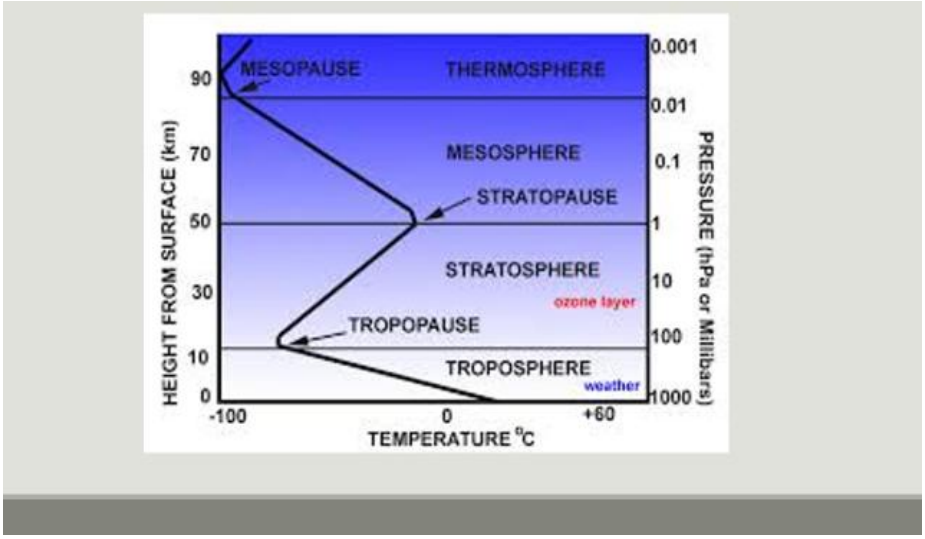
Atmospheric (air) pressure or barometric pressure is caused by the weight of the atmosphere, created by the downward pull of gravity.

The atmosphere extends many kilometers above Earth's surface. As altitude increases in the atmosphere, air pressure decreases. So, the higher you go in the atmosphere, the lower the air pressure, because most of the atmosphere is below you. Air pressure is exerted in all directions at once, so we don't feel or notice it.

Air pressure is measured in millibars or inches using a **barometer** (aneroid or mercurial). See p. 13 in the ESRT.

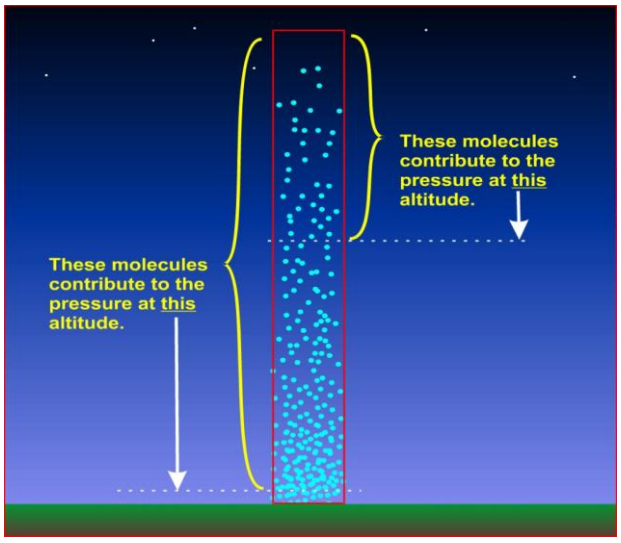
Air pressure at sea level is 29.92 inches or 1013.2 millibars.

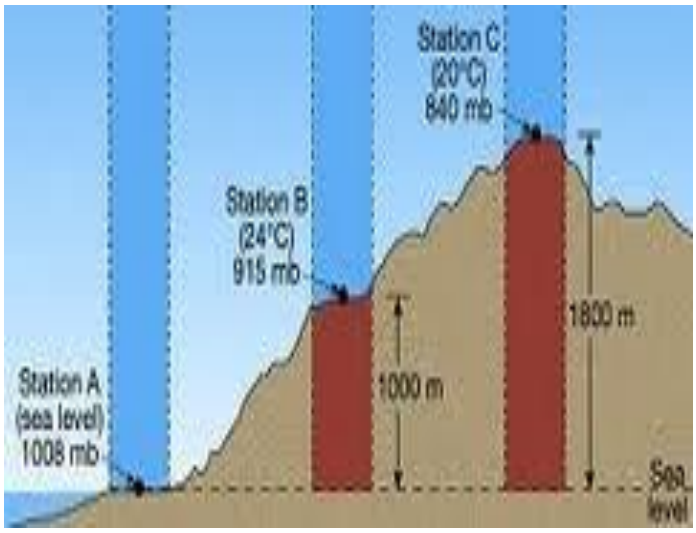




Factors that Affect Air Pressure

Altitude: air becomes less dense as altitude increases. Gravity decreases with altitude, so air molecules are freer to spread apart. There are also fewer air molecules above to exert pressure.
So, **as altitude increases, air pressure decreases.**

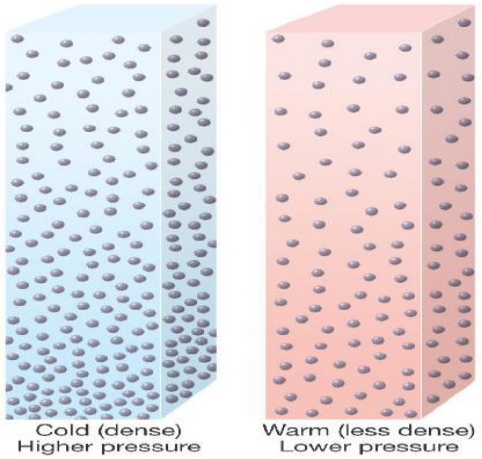




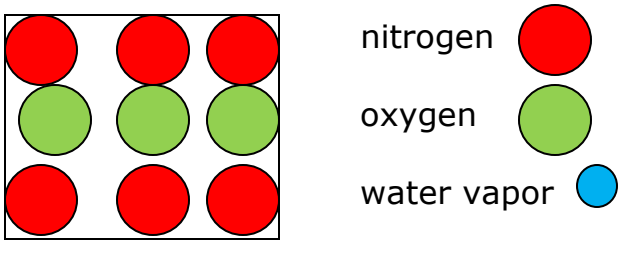
Factors that Affect Air Pressure (cont.)

Temperature: as temperature increases, air density decreases (warm air is less dense than cold air).

As air temperature increases, air pressure decreases.
As air temperature decreases, air pressure increases.



Moisture (humidity): *Adding water vapor to the air (evaporation) decreases its density.* This happens because smaller, lighter water vapor molecules push aside and replace larger, heavier oxygen and nitrogen molecules, leaving air less dense. Lower density and lower weight decreases air pressure:



Molecular masses: N_2 = 28 amu; O_2 = 32 amu; H_2O = 18 amu

As humidity increases, air pressure decreases.
As humidity decreases, air pressure increases.

Weather variables (continued)

Humidity is the amount of water vapor in the air. Water vapor enters the air by evaporation, transpiration and respiration.

The warmer the air temperature, the more water vapor air can hold, and the higher the humidity. This is because warm air has low density, so there's more space for water molecules to occupy.

Air is saturated when it holds the most water vapor it can at a given temperature.

<u>Relative humidity</u> is the amount of water vapor in the air compared to the amount it could hold at a given temperature. For example, air that contains half the amount of water vapor it can hold at a certain temperature has 50% relative humidity.

Dry air = 0% relative humidity;
saturated air = 100% relative humidity

SEE PAGE 12 IN THE ESRT!

Relative Humidity (%)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	33													
−10	100	66	33													
−8	100	71	41	13												
−6	100	73	48	20												
−4	100	77	54	32	11											
−2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	8							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	15	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	5			
20	100	91	82	74	66	58	51	44	38	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	8
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

Dew Point is the temperature at which air is saturated (100% relative humidity).

<u>As the amount of water vapor in the air remains constant, a decrease in air temperature when air is at dew point will cause water vapor to condense, and clouds will form.</u>

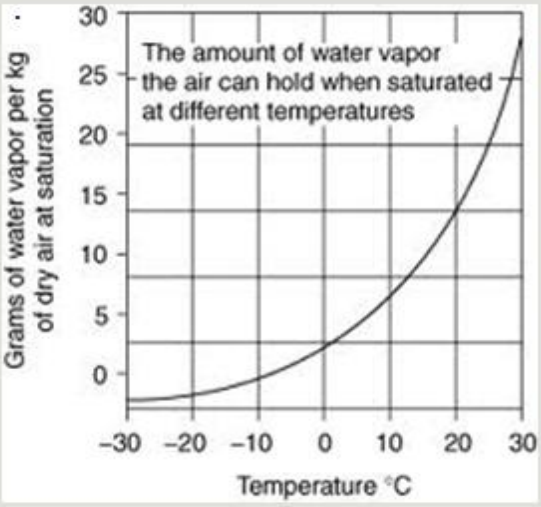
The closer dew point temperature is to air temperature, the higher the relative humidity, and the more likely precipitation will occur.

An increase in air temperature when air is at dew point will decrease relative humidity. Air will no longer be saturated (it's warmer, so it can hold more water vapor).

So: <u>decreasing air temperature will increase relative humidity, and move the dew point temperature closer to the air temperature</u>

Air Temp ↓ — Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (°C)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	−36													
−12	−12	−18	−29													
−10	−10	−14	−22													
−8	−8	−12	−18	−29												
−6	−6	−10	−14	−22												
−4	−4	−7	−12	−17	−29											
−2	−2	−5	−8	−13	−20											
0	0	−3	−6	−9	−15	−24										
2	2	−1	−3	−6	−11	−17										
4	4	1	−1	−4	−7	−11	−19									
6	6	4	1	−1	−4	−7	−13	−21								
8	8	6	3	1	−2	−5	−9	−14								
10	10	8	6	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	8	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−5	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−11	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	19	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	6	1

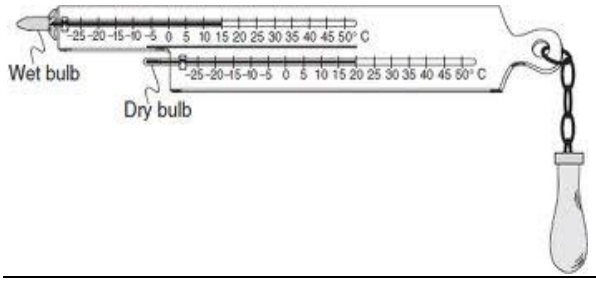


Relative humidity and dew point are measured using an instrument called a ***sling psychrometer.***

Sling psychrometers have 2 thermometers: one "dry bulb" (whose bulb is exposed to the air) and one "wet bulb" (whose bulb is covered with a moistened piece of cloth).

As the psychrometer is whirled around, water evaporates from the cloth, which lowers the temperature of the wet bulb thermometer. (Evaporation is a cooling process, drawing heat from the thermometer).

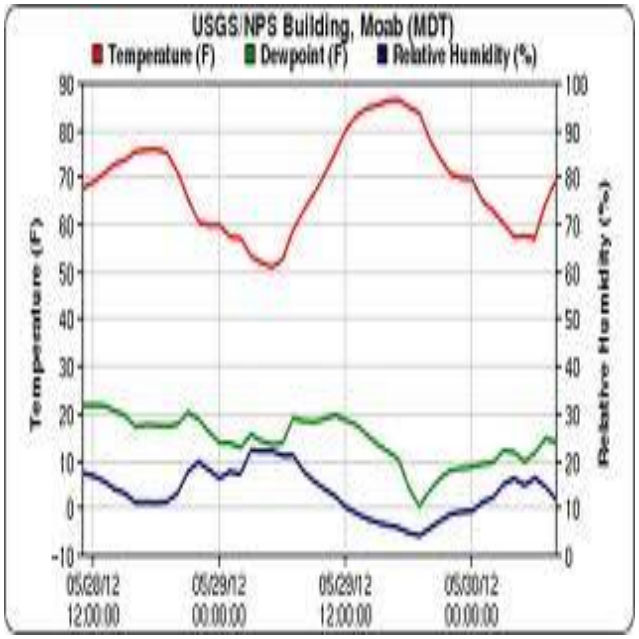
<u>The drier the air, the more water will evaporate, and the greater the drop in the wet bulb thermometer temperature.</u>



The difference in temperatures read on both the wet and dry bulb thermometers is called the **wet bulb depression**.

<u>The greater this difference, the lower the relative humidity.</u>

<u>When the wet bulb and the dry bulb have the same temperature, air is saturated (100% relative humidity) and air temperature is at dew point. (See page 12 ESRT).</u>



Time	Temp.	RH	DP
7:52 a.m.	78	82%	72
9:52 a.m.	80	76%	72
11:52 a.m.	84	67%	72
1:52 p.m.	87	65%	74

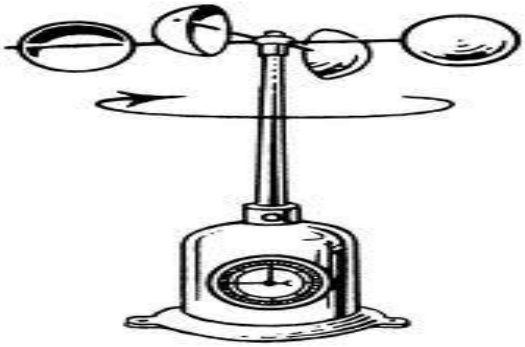
Wind is created by difference in air pressure.

Winds blow **from high pressure areas to low pressure areas**.

Wind direction is named **using the compass direction from which the wind is blowing.**

For example, if a wind starts in the southwest and blows northeast, it's called a southwest wind. A north wind blows from the north to the south.

Wind speed is measured by an **anemometer**. The number of rotations the anemometer makes is translated into knots.



How do these weather variables affect weather systems?

High pressure systems tend to have cooler, dry air.
Low pressure systems tend to have warmer, moist air.