UNIT 12: THE HYDROLOGIC CYCLE

STUDENT NOTES PACKET

ABSTRACT

This unit covers ever transition water makes through the hydrosphere (any location water can be found as a liquid, solid, or gas) and its storage locations in addition to unique properties of water.

STUDENT NAME:

_____

NYS Regents Earth Science
Unit 12: The Hydrologic Cycle Notes Packet
After Unit 12 you should be able to:

Mr. Burgess

- *Effectively use the charts Average Chemical Composition of Earth's Crust, Hydrosphere and Troposphere, Selected Properties of Earth's Atmosphere, Properties of Water, Specific Heats of Common Materials, Planetary Wind and Moisture Belts in the Troposphere, Surface Ocean Currents of Earth, Relative Humidity, and Dewpoint*
- *Accurately describe all processes in the hydrologic (water) cycle*
- *Understand how lake-effect snow storms develop*
- *Understand how land and sea breezes develop*
- *Understand how the specific heat of materials impacts their temperature change rates*
- *Understand the factors impacting the presence of groundwater and its movement*
- *Understand how relative humidity and dewpoint are related*
- *Understand how clouds develop*
- *Understand how landscapes create a rain shadow*

Unit 12 vocabulary you should be able to use and understand:

- *Hydrosphere*
- *Atmosphere*
- *Troposphere*
- *Stratosphere*
- *Mesosphere*
- *Thermosphere*
- *Molecule*
- *Element*
- *Phase change*
- *Energy*
- *Melting*
- *Freezing*
- *Vaporization*
- *Condensation*
- *Joules*
- *Specific heat*
- *Lake effect snow*
- *Land breeze*
- *Sea breeze*
- *Climate*
- *Ocean currents*
- *Storage*
- *Transpiration*
- *Vapor*
- *Cloud*
- *Condensation nuclei*
- *Runoff*
- *Storage*
- *Infiltration*
- *Percolation*
- *Water table*
- *Zone of saturation*
- *Climate*
- *Slope*
- *Porosity*
- *Permeability*
- *Vegetation*
- *Land use*
- *Saturation*
- *Capillarity*
- *Humidity*
- *Relative Humidity*
- *Psychrometer*
- *Dry bulb*
- *Wet bulb*
- *Dew*
- *Dewpoint*
- *Altitude*
- *Low pressure*
- *Rain shadow*
- *Windward*
- *Leeward*
- *Desert*
- *Expansion*

Earth is known as the blue planet. Although we have evidence of water's existence on other planets, none cycle water so readily throughout what is known as the hydrosphere.

The term hydrosphere refers to any position on, in, or surrounding Earth where water exists in any of three phases.

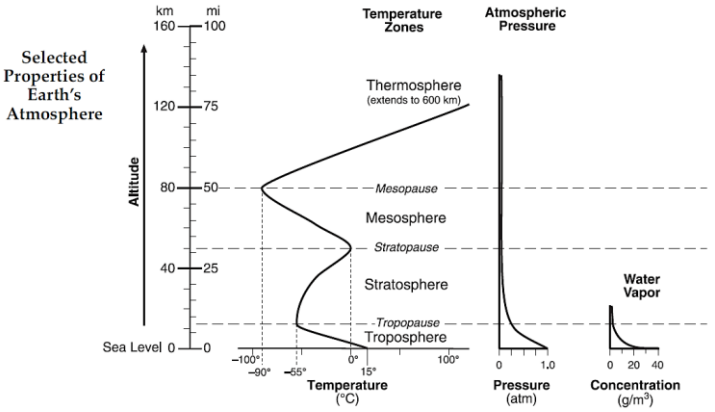
- _____
  _____
  _____
  _____
  _____
- *The majority of this chemical makeup is devoted to water's chemical formula: _____, the remaining elements are impurities in the water, such as salt (NaCl)*

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

Where is the water? Most would identify the water as being in the oceans, which is primarily where most of Earth's water is, but it is also locked in ice at the poles, in freshwater lakes and rivers, in soil and trapped in bedrock. In addition…

- *Water molecules occupy the* _____ *(and a few venture into the stratosphere), the lowest layer of the atmosphere both as droplets and as a gas.* _____
  _____
  _____



3 Phases of Water

- *Water requires an input or output of energy in order to change phases*
- _____
  _____
- _____
  _____

The chart on page 1 of the ESRT shows the energy, measured in Joules per gram of water that is necessary for certain phase changes.

- _____
- _____
- _____
- _____

Properties of Water

Heat energy gained during melting	334 J/g
Heat energy released during freezing	334 J/g
Heat energy gained during vaporization	2260 J/g
Heat energy released during condensation	2260 J/g
Density at 3.98°C	1.0 g/mL

Specific heat is a property of matter that describes how easily a material changes temperature in terms of Joules/gram per °C

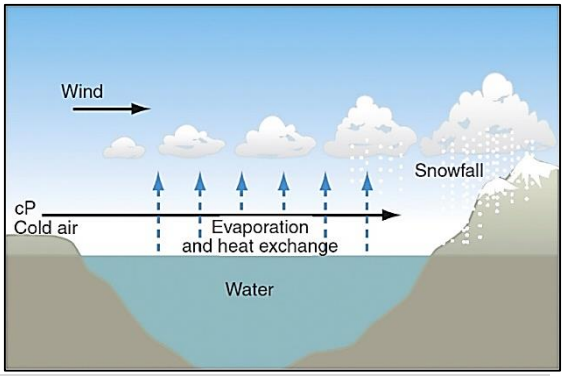
- _____
  which means that it requires a _____
  _____
- _____
  _____
  _____

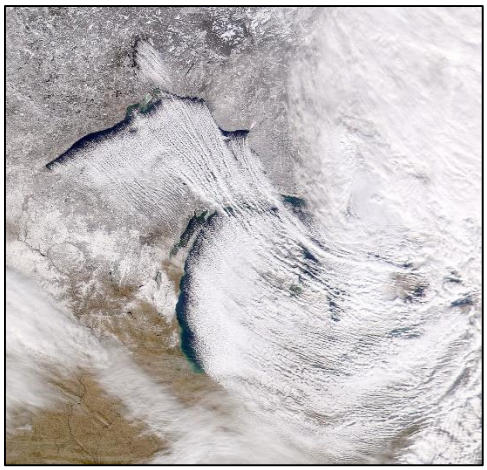
Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

The specific heat of water has significant impacts on our local weather and climate.

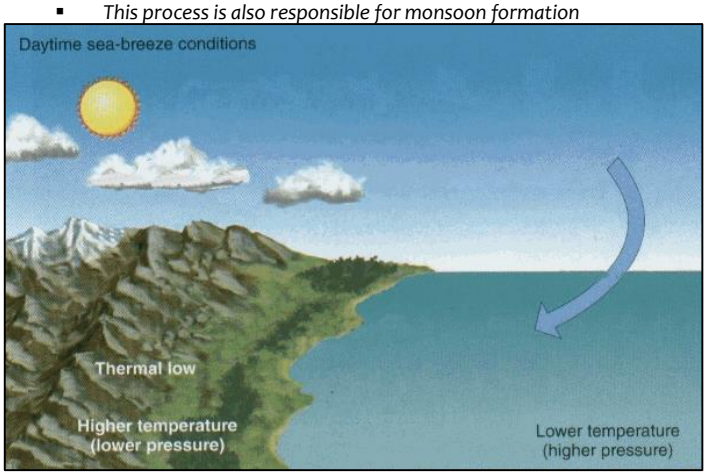
- _____
  _____
  _____
- *A cooler lake in the summer moderates temperatures*
- *Lakes and oceans prevent temperatures from getting as high or low when compared to cities away from major bodies of water at the same latitude*

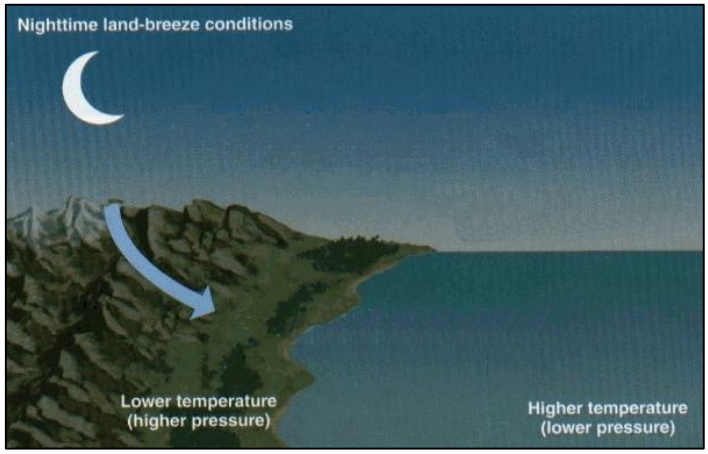




The specific heat of water impacts daily weather changes such as land and sea breezes

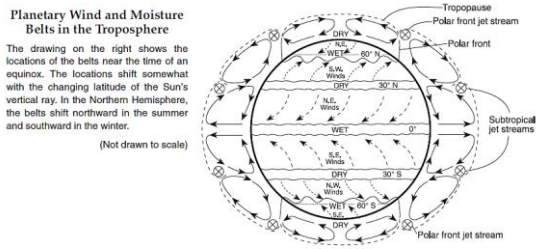
- _____
  _____
- _____
  _____
- _____
  _____
- *This process is also responsible for monsoon formation*





Global Atmospheric Circulation of Water

- *Found in the ESRT*
- _____
  _____



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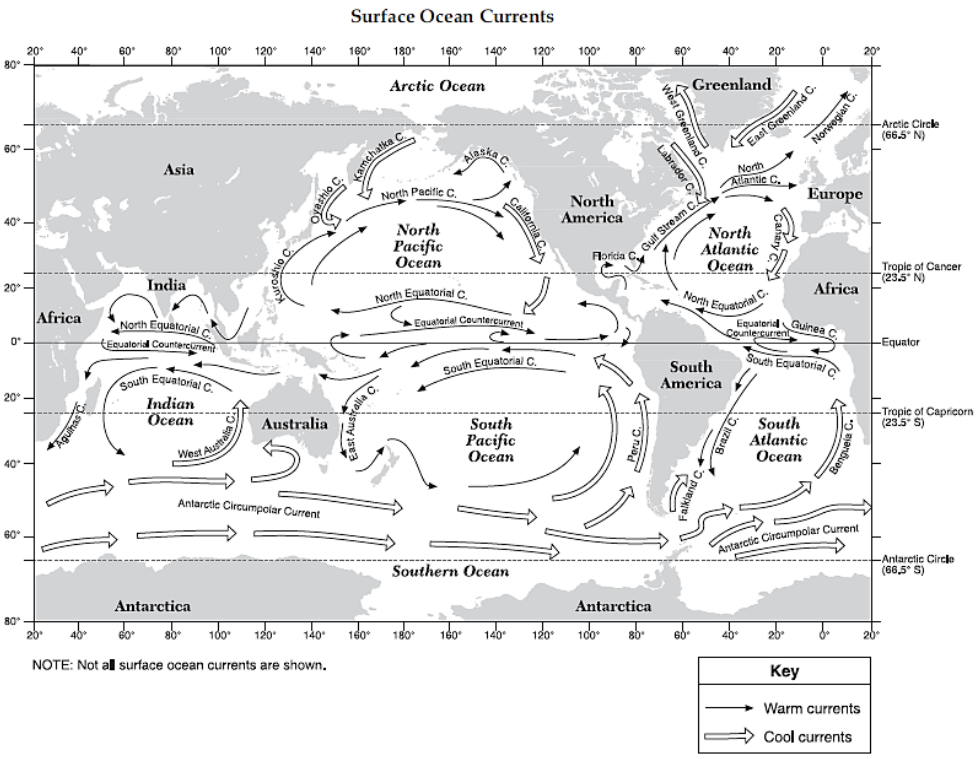
The high specific heat of water has significant influences on global climate.

- *Ocean currents are driven by surface winds on Earth*
- _____
  _____
  _____
  _____
  _____
  _____
- _____
  _____
  _____
  _____
  _____
  _____



Let's examine the cycling of water around Earth, of which there are many different components.

- _____
  _____

Evaporation takes place on the surface of lakes and rivers; however the major sources of water vapor are the world's oceans.

When water collects in lakes, rivers, and oceans, it is in _____

- *A lake is a good example of freshwater storage.*

Another source of water vapor is through the process of transpiration.

- *During transpiration,* _____ *release small amounts of water vapor into the atmosphere.*

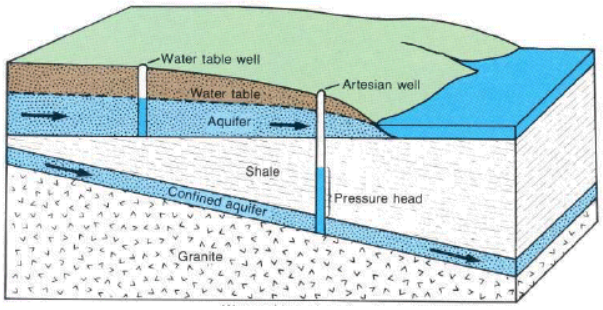
Once water vapor has entered the atmosphere, it typically congregates around bits of dust and particles known as condensation nuclei.

- *We see these formations as clouds. Clouds form as water vapor* _____ *back into a* _____

When the condensed water droplets in clouds become too heavy to remain aloft, they fall to Earth in the form of rain, snow, or hail.

- *This process is called* _____

If precipitation falls in the liquid form (rain), one of two things may happen: 1) the water runs over land in the form of _____ *into rivers, lakes and oceans, or 2) the water*_____ *the surface of the Earth to the depth of the water table.*



The Water Table

- *The water table is the* _____ *of the underground water level. Below that is the* _____ _____

What affects the amount of water underground?

- _____
- _____
- _____
- _____
- _____
- _____
- _____

Climate

- *Moist, warm climates have an increased amount of*_____

Slope

- *The* _____ *the slope, the less chance that water will infiltrate the surface*

Soil

- *Sandy soils can hold more water and drain faster because they have more pore space for water to flow*
- *Soils made mostly of clay hold water, but do not drain quickly*

Rock Type

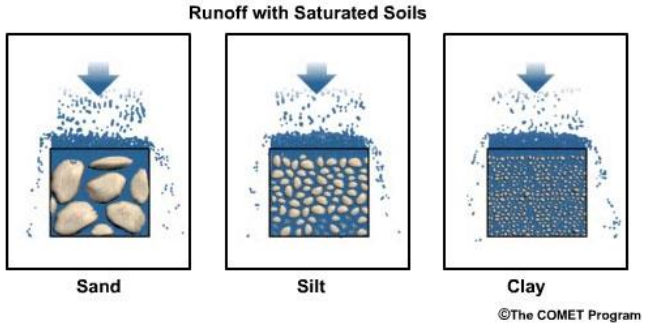
- *Some rocks that are permeable allow water to enter them*
- *Other liquids like oil can enter the rock as well*

Vegetation and Land Use

- *Soils containing more vegetation prevent runoff*
- *_____ surfaces create mass runoff (parking lots)*

Degree of Saturation

- *How moist is the soil already? (Is it almost out of room for storage?)*
- *This affects the level of the water table*



Porosity

- *Refers to the percent of a material's volume that is pore _____ space*

Porosity depends on:

- *The shape (flat particles have lower porosity)*
- *The sorting (well sorted particles have _____)*
- *Particles of the same shape but different size have _____ porosities*

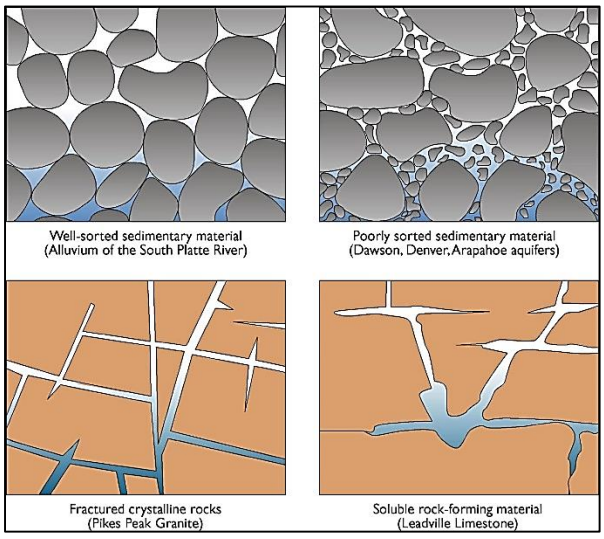
Permeability

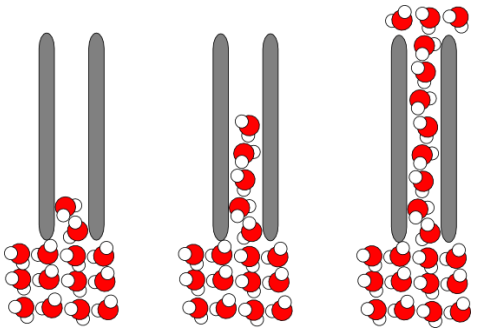
- *Refers to how easily water can _____ the pore spaces in a rock*

Depends on:

- *Generally, larger particles have a _____ permeability, smaller and unsorted sediments do not*
- *An object can have high porosity but low permeability*

Example: pumice





- *Water is attracted to soil particles and this pulls it upward and throughout the soil*
- _____
  _____
- *Example: paper towel and ink*

What is humidity?

- *Humidity describes the amount of* _____ *in the air*
- *A humid day outside is sticky and it is difficult to cool down (if the temperature is high)*

Relative Humidity (%)

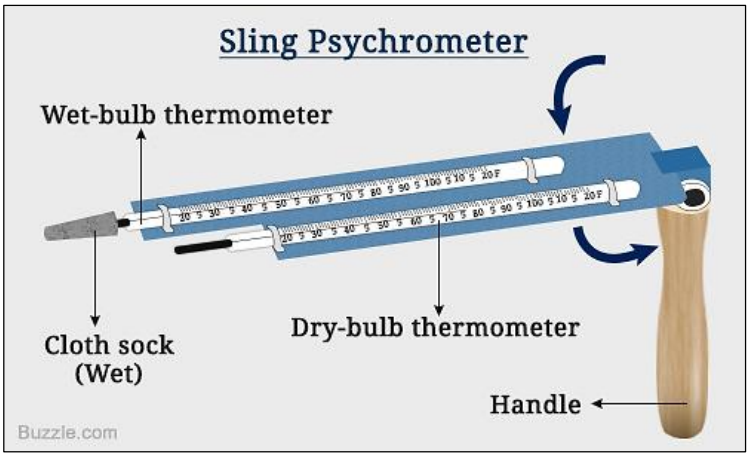
Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	23													
−10	100	66	33													
−8	100	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	6							
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	16	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	6			
20	100	91	82	74	66	58	51	44	36	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	9
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

What is relative humidity?

- *Relative humidity describes how saturated the air is with water vapor*
- *Relative humidity is shown as a* _____

How do we measure humidity?

- *With a* _____
- *Psychrometers take into account how easily water can* _____
- *This rate is dependent on how much water vapor is present in the air*



Relative Humidity

- _____
  _____
  _____
- *The more the wet bulb decreases in temperature, the drier the air is (low RH) because the air can hold more water vapor*
- *Warm air has the capacity to hold more water vapor than cool air*

Problem:

Students want to find the relative humidity of their classroom. They cover their wet bulb with a damp cloth and start spinning the psychrometer. After 3 minutes, the following readings were taken:

Dry bulb temperature: 8 °C

Wet bulb temperature: 6 °C

What is the relative humidity? _____*%*

What if the humidity is 100%?

- *It is probably _____*
- *At 100% the air can no longer hold moisture, so it may release some of what it has if the dewpoint is met*

What is a dewpoint?

- *The temperature at which water vapor begins to _____ into liquid form*
- *This is why we see dew on the grass some mornings, the dewpoint temperature was reached*

How can air reach its dewpoint temperature?

In a couple of ways:

- *The air can _____ until the air temperature is the same as the dewpoint temperature, just like during the night*
- *The air can _____ after being heated, then slowly cool to the dewpoint as it gets higher in the atmosphere*

How do we determine dewpoint?

- *Dewpoint is determined in exactly the same way as relative humidity*
- *You need the _____*
- *Apply these numbers to the Dewpoint chart*

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	−28													
−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	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−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	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	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	5	1

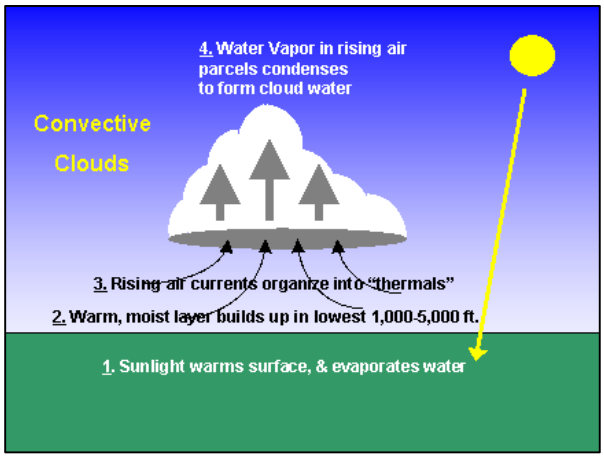
How do clouds form?

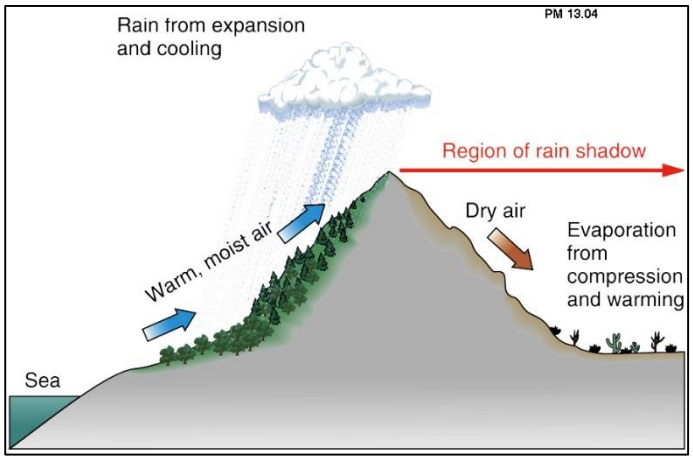
- *Clouds form when water vapor condenses on _____*
- *Condensation nuclei are small particles, usually dust*

Rising Air

- *Rising air that is moist and warm cools as _____*

  _____
- *When the dewpoint is reached, clouds begin to form*
- *Low pressure has rising air, so this is why we tend to see clouds and precipitation with low pressure systems.*





What is a rain shadow?

- *A _____ occurs when mountains force moist air upward where the water vapor condenses and precipitation occurs on the windward side*
- *The cool air containing very little moisture descends down the other side (leeward) of the mountain*
- *_____ occur in many areas as a result of a rain shadow*