Atmospheric Moisture, Lapse Rates, and Storms

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INTRODUCTION

The natural world is exceedingly interesting to study and to try to understand. No one is more keenly aware of this than fifth-grade students, especially if their teachers are knowledgeable and dynamic. Presented in coherent order, every aspect of the natural world can be explained to the student respecting their age-appropriate level of comprehension. One such aspect is the weather. Students want to know what makes the noise we call thunder, the white light called lightning; and, although aware of rain, they are not really certain of how the water got into the sky. Other facets of weather that are of interest to the students who live in the Gulf of Mexico region are hurricanes and tornadoes. This paper will concentrate on these phenomena and will present explanations designed to be understood by adolescent students. In addition, there will be a discussion about the effects that atmospheric humidity has on climatic conditions of certain regions, the success of life on Earth, and some human responses to availability of water.

Because weather and climate vary with geographical location, students will need to develop map skills. At the end of the school year, fifth graders should be able to understand why there are different climates in the world and the weather they can reasonably expect in the place where they live. Implicit in this information will be the biological factors that can logically be expected to exist in a given area of the world. This knowledge will provide innumerable possibilities for comprehension and development of social studies and reading. Furthermore, because students will be expected to locate places on the maps as well as to read and create graphs, they will be given added exposure to mathematical concepts.

OBJECTIVES

The students will use scientific methods during field and laboratory investigations. The students are expected to (B) collect information by observing and measuring, and (C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence. HISD (Obj. Sci.5.2 B; C) and TAKS (TAKS 1, 4)

Students will know that a system is a collection of cycles, structures, and processes that interact and will understand the process by which clouds form, the reasons for their shapes, their names, and their position within the atmosphere. HISD (Obj. Sci. 5.6 ABC) and TAKS (T 4).

Students will know that the natural world includes Earth materials and objects in the sky. HISD (Obj. Sci. 5.12) and TAKS (T 4).

Students will know that change can create recognizable patterns. The student is expected to identify patterns of change such as in weather, metamorphosis, and objects in the sky. HISD (Sci. 5.6a) TAKS (T 4).

Students will use geographic tools to collect, analyze and interpret data. HISD (SS. 5.6A).

Students will locate and name points on a coordinate grid using ordered pairs of whole numbers. HISD (Math. 5.9a).

RATIONALE

The principal objective for developing this unit is to satisfy students' curiosity about the abundance of rainfall in Houston as well as the frequency and severity of storms resulting in flooding. Another is that they comprehend the reasons for the many floods that occur here. A third, very important objective, and the central focus of my paper, will be to have students at my school, who are first generation American citizens, learn about the climatic conditions that their parents or grandparents experienced before their migration to this country. A rather large percentage of them left the agricultural fields in their country because of reduced availability of the principal resource for agricultural success: water. Hopefully it will help my students and their friends to understand their families' reasons for coming here.

For most immigrants from the highlands of Mexico who are accustomed to three or four months of rain in the summer followed by eight or nine months of dry weather, Houston's high humidity and excessively hot summers represent a major adjustment. They are used to wet, cool summers, dry cold winters, and relatively cool autumns and springs. Somehow they expect winters north of Mexico to be very much colder and are surprised that in Houston they are relatively rainy and mild.

UNIT BACKGROUND

Weather and Climate

What exactly is weather and how is it different from climate? Both are very much interrelated but there is a difference. **Weather** is defined as the current atmospheric condition in any given place while **climate** is the general weather conditions in that place over a long period of time. A change in one weather element can often produce changes in the other elements and may ultimately affect the region's climate (Strahler and Strahler 888).

Weather takes place in the atmospheric layer closest to the surface of the Earth, the troposphere, which is about twelve kilometers (7 miles) thick in the mid-latitudes (35 - 55° N and S). The juncture where the troposphere, the earth's hydrosphere and its lithosphere meet is called the biosphere because it is the layer in which all life is sustained. Conditions in the biosphere are balanced to provide sufficient water and heat from the Sun; both vital ingredients for land plants and animals as they require fresh water for their food and the adequate temperature in which to thrive.

The basic source of fresh water on the Earth is from the atmosphere through the condensation of water vapor. Liquid water is then recycled by means of evaporation and transpiration in the long run via the hydrologic, or water cycle. That means that there is always water in the air either being transported to the higher levels of the troposphere or on its way down in the form of precipitation.

The amount of water vapor present in the air is referred to as humidity. The quantity will vary in different parts of the world. For example, deserts will have little humidity and rain forests are usually saturated with it. Humidity varies from 0 percent in the driest of places to 4 percent in the wettest.

There are two ways in which the relative humidity in the atmosphere can change:

a. Through evaporation if the air mass moves over an exposed water surface.
b. Through a change in temperature.

The first is quite easy to understand as it refers to the amounts of water that vaporize into air masses over exposed water surfaces The larger the surface the more saturated the atmosphere near the water surface will be.

The actual amount of water vapor in a cubic unit of air is known as *absolute humidity*, which is measured in grains per ft^3 or grams per m^3. Another concept used in this essay is *specific* *humidity*, which is the ratio of water vapor in a specific volume of air, expressed in kilograms, or grams, of water vapor per kilogram of air. For any given air temperature, there is a fixed amount of water vapor that can occupy any given volume of atmospheric space. The limit is known as saturation point. In a given volume of air, the absolute humidity is compared to the maximum amount of water vapor that the air of that temperature can hold. This is called *relative humidity*, which is expressed as a percentage of saturation (100 percent humidity). Any increase in temperature will allow more water vapor to be accommodated in the space, but if no additional water vapor enters the parcel, the relative humidity will fall (Navarra 182). Even though no water vapor enters or leaves the parcel of air, the relative humidity will change if the temperature changes.

A good example of this is the change that occurs in one single day. As a day progresses, the sun heats the air enough to lower the humidity, but, as evening falls and temperatures descend, the relative humidity begins to rise until it reaches the saturation point sometime before dawn. If there is further cooling, it will reach a temperature known as *dew point* or, in low enough temperatures, *frost point.* This results in condensation of the excess vapor into liquid or solid form. This manifests itself in the form of minute droplets (or crystals) of dew, frost, or fog.

10:00 A.M.		3:00 P.M.		4:00 A.M.	
16° C	50%	32° C	20%	5° C	100%

Dew Point

Dew point is the critical temperature at which the air is fully saturated. When a parcel of air is cooled sufficiently, its relative humidity will reach 100 percent. If surface air is cooled any further, the excess water vapor may condense as dew, which is "moisture that condenses on surface objects rather than on nuclei in the air above the surface" (Navarra 187). Sometimes, when dew point is below 32 F° (0° C) the water vapor will sublimate – that is to go from gaseous state to solid without ever going through the liquid state.

Hygroscopic Nuclei (or Nuclei of Condensation)

In order for clouds, which are composed of floating liquid droplets, to form, the atmosphere must contain certain solid particles. Such particles are very small and usually invisible to the naked eye. Those that readily absorb and retain atmospheric moisture are called *hygroscopic nuclei or nuclei of condensation.* Examples of these particles are sea salts, ammonia, and similar compounds. Other solids in the air, such as sand and limestone, are *non- hygroscopic* and do not readily absorb moisture. The important thing to remember is that in order for there to be cloud formation the air needs to be dirty. That dirt has to be of a specific kind to permit water vapor to condense to a free droplet of water (Aguado and Burt 146-48).

Cloud Formation

All clouds form as a result of air cooling below its dew point. As the temperature of a bubble of air approaches its dew point on the saturation curve, some of its water vapor condenses. As the pocket or parcel of warm air ascends, it drops in temperature at a rate of 1° C every 100 meters (5.5° F per 1,000 ft) until condensation begins to occur and a cloud begins to form, exactly at dew point. The period or travel time that it takes water vapor to condense is referred to as *dry adiabatic lapse rate* (Navarra. 191). It is adiabatic because while the ascent is taking place there is no loss or gain of heat energy from the surrounding air. Dew point also decreases with altitude at a rate of 0.18° C per 100 meters (1° F per 1,000 feet); thus, condensation occurs when the temperature of the ascending warm air intercepts the cooling dew point temperature. Thereafter, every time a molecule of water vapor condenses, it releases the quantity of heat that it stored when it changed from a liquid to a vapor *(latent heat of vaporization).* That heat is called *latent heat of condensation* (Aguado and Burt170-176).

Thus, as the saturated air continues to ascend, it releases more latent heat, which slows down the rate at which the air mass cools. This cooler rate is called the *moist (or wet) adiabatic lapse rate.* Although the wet adiabatic rate averages approximately 3.5°F per 1000 feet it is less precise than the dry adiabatic rate. At low levels it is about half the dry rate (0.58°C per 100 meters) and varies to almost equal when it reaches great heights where almost no water is left to condense (Strahler and Strahler 84).

Types of Clouds

Clouds consist entirely of water droplets at temperatures down to about -12°C. Between -12° C and -30° C the cloud is a mixture of water droplets and ice crystals; below -40 °C all of the cloud particles are ice crystals (Strahler and Strahler 86).

Clouds are classified into families, arranged by height. On the basis of form there are two major classes of clouds: stratiform, or layered clouds, and cumuliform, or globular clouds. Stratiform clouds are blanket like and cover large areas. The important point about stratiform clouds is they represent air layers being forced to rise gradually over stable underlying air layers of greater density. As forced rise continues, the ascending layer of air is adiabatically cooled, and condensation is sustained over a large area. Stratiform clouds that bring rain are known as nimbostratus (Aguado and Burt 70–176). Cumuliform clouds are globular masses representing bubble like bodies of warmer air spontaneously rising because they are less dense than the surrounding air. Some cumuliform clouds are small masses no higher than they are wide; others develop tall, stalk-like shapes and penetrate high into the troposphere. When the tall, dense form is raining, it is called cumulonimbus. A useful cloud type chart for fifth graders can be found at the following website: http://eo.ucar.edu/webweather/cloud3.html.

Precipitation

Precipitation is the term used to describe the deposition of moisture from the atmosphere to the surface of the earth. There are two principal types of precipitation: spontaneous and forced or orographic. Spontaneous precipitation is the result of the automatic rising of moist air and is associated with convection, a form of atmospheric motion consisting of strong updrafts taking place within a convection cell. Air rises in the cell because it is less dense than the surrounding air. Air motion in a convection cell takes place in pulses as bubble like masses of air rise in succession (Aguado and Burt143 – 145). This happens because of differential surface texture. That is, bare areas of ground heat more rapidly than wooded areas and transmit radiant heat to the overlying air. Air over the warmer patches becomes warmed more rapidly than the adjacent air and begins to rise as a bubble or parcel. Vertical movements of this type are often called "thermals" (Strahler and Strahler 89).

Air capable of rising spontaneously during condensation is said to be unstable. Unstable air, given to spontaneous convection in the form of heavy showers and thunderstorms, is most likely to be found in warm humid areas such as the equatorial and tropical zones throughout the year, and the mid latitude regions during the summer season. In such air the updraft tends to increase in intensity as time goes on. At very high altitudes, the bulk of the water vapor has condensed and fallen as precipitation, so that the energy source is gone. When this happens, the convection cell weakens and air rise finally ceases.

Where prevailing winds encounter a low-lying cold mass of air or a mountain range, the air layer as a whole is forced to rise in order to surmount the barrier. Precipitation produced in this way is described as *orographic*, meaning "related to mountains" ("Orographic Lift"). When air moves inland toward Veracruz from the Gulf of Mexico, it eventually expands adiabatically as it ascends over the increasing height of the Sierra Negra of Mexico. The sierra's crest ranges from an elevation of 2,900 to 5,610 meters (8,990 to 17,391 feet) (Peakbagger.com). Let's assume the temperature at sea level is 20° C (68° F) and its dew-point temperature is 15° C (59° F). As the air rises up the slopes two things happen initially: The air cools at the dry adiabatic lapse rate and its dew-point temperature decreases 0.18°C per 100 meters (1°F per 1,000 feet) of ascent. Condensation in the cooling air can begin as soon as the dew-point is reached, creating dense fog.

However, after reaching the crest of the Sierra Negra, this parcel of air begins to descend on the leeward side into a valley, the elevation of which is 1,650 meters (5,115 feet) above sea level. As the air descends it is warmed at the dry adiabatic lapse rate of 1°C per 100 meters (5.5° F per 1,000 feet), recovering about 12.5 degrees centigrade (24°F). Most of the moisture having fallen on the windward side of the mountains, there is little specific humidity for the valley floor, which is in the *rain shadow,* a leeward drought condition created by increasing temperatures in the descending air parcel and the accompanying drop in relative humidity. In other words, descending air heats and dries ("Orographic Lift").

Regardless of whether precipitation is forced or spontaneous, the deposition of moisture from the atmosphere can take on the form of rain, sleet, snow or hail depending on the atmospheric temperature through which the falling water passes.

Cold and Warm Fronts

The types of air masses depend on their source regions for specific temperatures and humidity.

Air mass	Symbol	Properties	Temperature		Specific Humidity g/kg
			°F	°C	
Continental – arctic or antarctic	cA	Very cold, very dry	- 50°	- 46°	0.1
Continental polar	cP	Cold, dry	12°	-11°	1.4
Maritime polar	mP	Cold, moist	39°	4°	4.4
Contintinental tropical	cT	Warm, dry	75°	24°	11
Maritime tropical	mT	Warm moist	75°	24°	17
Maritime equatorial	mE	Warm, very moist	80°	27°	19

Properties of typical air masses according to Strahler and Strahler 102.

When cold air (cold front) invades the warm air zone, the colder air mass, being the denser, remains in contact with the ground and forces the warmer air mass to rise over it. Cold fronts are associated with strong atmospheric disturbances. As the unstable warm air is lifted, it may break out in severe thunderstorms.

On the other hand, when warm air (warm front) moves into a region of colder air, the cold mass remains closer to the ground and the warm air mass is forced to rise. Warm fronts are unstable atmospheric phenomena but lack the turbulent air motions of the cold front because they usually move at a much slower velocity. Although commonly associated with long periods of gentle, but soaking, rain, warm fronts can develop heavy showers or thunderstorms, depending upon their degree of instability ("Tropical Cyclone").

Thunderstorms represent only one type of atmospheric disturbance that involves changes in the normal pressure and wind fields every day somewhere on Earth. Each of these disturbances, including tropical cyclones, tornadoes, squalls, or sand storms, have their own special characteristics. Tropical cyclones and tornadoes are two of the most prevalent atmospheric disturbances in the Houston area. There are many weather front maps to be found in the websites. One such can be found at: http://cep.cl.k12.md.us/mckain/Meteor/MLCyclone.html.

Cyclones

There are two types of cyclones: one that occurs mostly in winter in the mid- latitudes, and another that is generated in the equatorial and tropical latitudes. Wherever it is found, however; a cyclone is an area of low pressure around which the winds flow counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. A developing mid-latitude cyclone is typically accompanied by a warm air mass pushing northward and a cold air mass pulling southward, marking the leading edges of air masses being wrapped around a center of low pressure, or the center of the cyclone (University of Illinois). The line of collision between these two opposing air masses is called the *Polar Front,* the position of which is often determined by high-altitude winds called the *Jet Stream*.

Depending on their location and strength, there are various terms by which tropical cyclones are known: hurricanes, typhoons, tropical storms, cyclonic storms, and tropical depressions. In the North Atlantic they are called hurricanes. In the Pacific they are called typhoons, and in Australia Willie-willies. Cyclones form at different latitudes and in different climatic regions. Tropical cyclones are the most powerful storms on earth. They form in late summer or early fall over warm tropical oceans, maximizing the intake of energy. High winds increase the rate of evaporation and can combine to produce violent winds, incredible waves, and tidal surges, torrential rains, and much flooding. Mid-latitude cyclones can produce a wide variety of precipitation types, such as rain, freezing rain, hail, sleet, snow pellets, and snow (“Tropical Cyclone”). The frozen forms of precipitation, except for hail, usually form in the upper layers of a cumulonimbus cloud or in winter. In polar climate areas, cyclones form year round and are the principal causes of snow.

Tropical cyclones originate over warmed equatorial waters late in the summer when water temperatures approximate 27°C (80° F), evaporation is most propitious, and pressure is low. Enormous masses of liquid evaporate and rise, condensing as the particles arrive in the cooler surrounding air of the troposphere. As the water vapor becomes liquid, huge volumes of *latent heat of condensation* are released and serve as storm fuel that drives the heavy winds and cumulus clouds that tend to loop northward. As the Earth spins toward the east, the clouds and cool winds turn toward the west. The continued turning sets in motion a circular movement that is further fed by the energy released from the condensed water molecules. As the cloud mass travels northwestward, it picks up more moisture from the warm ocean waters, perpetuating the process and increasing mass to the rotating cloud formation The upper reaches of the swirling cumulonimbus cloud spread out and in their wake send cooled moisture back into the ocean. This mechanism often cools the waters and for a while inhibits the development of another tropical storm. As for the one already formed, as it picks up moisture it also increases wind speeds and continues its northwesterly trajectory. When the mass of swirling wind and water passes over a substantial land mass, it will dissipate for lack of warm moisture to feed it (Aguado and Burt 352–361).

Those tropical storms formed in the North Atlantic Ocean hit land in the Caribbean region, the Gulf of Mexico, and sometimes the United States’ eastern seaboard. The tropical storms that carry wind speeds in excess of 116 kilometers per hour (72 miles per hour) are called hurricanes after one of the Caribbean wind gods, Huracán. Occasionally a hurricane that evolves into an extra-tropical cyclone can reach Western Europe, spreading high winds across Spain and the British Isles (“Tropical Cyclone”).

Tropical storms or cyclones also form in the Pacific Ocean. Because of the vastness of this ocean the storms form in different basins, namely the Northwestern Pacific Ocean and the Northeastern Pacific Ocean. The first, called typhoons, usually affect China, Japan, South Korea and other Southeast Asian countries as well as numerous Pacific islands, while the second affect northern Central America, western Mexico, and sometimes the continental United States.

Other basins where tropical storms develop are the Northern Indian Ocean (which has two peaks: one in April and May and then again in October and November), the Southwestern Pacific Ocean, the Southeastern Indian Ocean, and the Southwestern Indian Ocean. Tropical cyclones in the southern hemisphere typically form during the months of February and March, as we have seen in the recent tropical cyclone that struck land in southeastern Australia recently.

Beneficial effects of tropical cyclones

Although tropical storms may exact heavy losses of life and property, they do have significant beneficial effects for the planet's overall balance in the form of much needed precipitation in otherwise dry regions ("Tropical Cyclone"). The heavy precipitation that cyclones drop over land helps to replenish the underground water tables. Rivers and lakes overflow, depositing rich top soil on their floodplains. The storm surges and winds caused by the cyclones stir up the waters of coastal estuaries, which are typically important fish breeding locales (Moulton 42; Maraniss23-29).

Further benefits caused by tropical cyclones are their contribution to the maintenance of global heat balance by moving warm, moist tropical air to the mid-latitudes and Polar Regions. Were it not for that movement, the tropical regions would be unbearably hot. Finally, at sea, tropical cyclones can stir up water, leaving a cool wake behind them. As mentioned above, this can cause the region to be less favorable for a subsequent tropical cyclone.

LESSON PLANS

Many years ago when I lived in Cancún, I heard a radio alert about an oncoming hurricane. The broadcaster, while never making light of the imminent danger to lives and property, hastened to point out the benefits that they had to the land. Among those benefits he spoke of the much needed rain inland, the replenishment of the *cenotes*, the Yucatan Peninsula's underground water sources, and the oxygenating effect on the Nichupté Lagoons' waters where so many young sea creatures grow strong. At the time I had never heard of anything good coming from what seemed so bad. I was very impressed with his acceptance of nature and its forces and proposed to look at these seemingly destructive forces more objectively.

This is the attitude I wish to impart to my students.

Lesson One: Cloud Formation

(This unit will take two weeks. First three lessons will each be 60 minutes in length. The fourth lesson will begin at same time as lesson one but will take 10 days for data gathering)

Objectives: Student uses scientific methods during field and laboratory investigations. The student is expected to (B) collect information by observing and measuring: (C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence. HISD (Obj. Sci.5.2 B; C) and TAKS (TAKS 1, 4)

Materials Needed: Wide mouthed clear container, 200 ml of water at room temperature, saran wrap, a bowl, and crushed ice, pencil and journal.

Guided Activity

In order for students to understand weather, we would first start with a review of what they understand about clouds and their formations. For this purpose I would have the students write in their journals all that they remember about this subject. Then I would engage them in conversation about what they have recalled.

Explain to the students that they are going to make a model of the troposphere where all weather occurs. They are to observe their model for signs of evaporation, condensation and precipitation.

Once the instructions have been made, a person from each work table will pick up the materials with which they will work. These will be: the students will place the water into the container, cover it tightly with the saran wrap, and then place the bowl with ice in it on the top of the beaker. Students will observe what takes place in the beaker. It is a good idea for them to record their findings in their journals. After a few minutes they should be able to see some condensation on the inside of the beaker but especially under the saran wrap where the droplets will be increasing in size.

As they observe and write, you can remind them about surface tension – water molecules having the propensity to attach to each other – and thus the growing droplets. Engage the students in another discussion in which they will explain what is occurring in the beaker and to forward ideas about what will next happen. If sufficient droplets have formed under the saran wrap some may begin to fall back into the water.

Engage students in a discussion that involves what would happen if the water was warmed a bit (1 – 2 ° C). Then place one of the models on a warm plate and set the temperature to about 25°C (79°F). In a few minutes the students should be able to see and record an increased activity within the model. Repeat the operation once more increasing the temperature by 2° C.

As the students watch and notice that the container fills with vapor, the inside of the saran wrap gets quite beaded with water drops which eventually become too large to resist gravity; the students thus come to understand the water cycle on a tangible, and not an abstract level. This makes it easier to discuss with them the different types of clouds, how they form and why some can carry great amounts of water and others very little.

Since this lesson is really about observation and reasoning, an appropriate way to assess the students' work would be the accuracy and perception with which they wrote their entries. There are five factors to be constantly considered during this activity: water, evaporation, condensation, precipitation, and temperature. I would be checking each entry for mention of each one. The students would be told that the rubric with which they will be assessed will be based on accurate mention of each factor in each entry.

Entry	Complete = 5	Partial 4 – 3	Incomplete 2- 0	Total
1. Describe activity you are going to begin.				
2. Describe fully what has happened.				
3. Explain why it happened.				
4. Describe fully what occurred after energy was increased.				
5. Explain why it occurred.				
6. Connection between model and nature.				

Key: 5 = 20 points

I added a bonus question to help me detect if the student is reasoning and making the connection to the weather.

Lesson Two: Cloud Identification

Objectives: Students know that a system is a collection of cycles, structures, and processes that interact and will understand the process by which clouds form, the reasons for their shapes, their names, and their position within the atmosphere. HISD (Obj. Sci. 5.6 ABC) and TAKS (T 4)

***Materials needed*:** Ruler, graph paper, pencil**.**

Vocabulary: Cirrus, cirrostratus, cirrocumulus, altostratus, alto cumulus, stratus, cumulus, nimbostratus, stratocumulus, and cumulonimbus.

Activity:

The next step to this lesson is to learn that clouds have specific names that relate to their shape, the altitude at which they are found, and if or not they are precipitating. Their names are, from the wispiest and highest in the troposphere to the lowest and most heavily saturated. Point out the two principal types of clouds: cumulus and stratus. Show them that depending on their position in the troposphere the prefixes alto and cirrus will be appended. Then point out that the word nimbus means precipitation and will be appended as a prefix or a suffix to the words stratus or cumulus.

The following activity will help the students fix the information in their minds as well as get some practice with previously learned mathematics concepts. Each student will draw a large isosceles triangle on a simple graphing sheet of paper. Instruct the students to consider the base of the triangle as the X axis. Instruct them to write the following key: "2 cm = 1 km" on the lower right hand corner. Then, parting from the X axis, the student will proceed to create the Y axis (the left edge of the paper) ascending in increments of one centimeter highlighting the ones that represent a kilometer. The student can draw a horizontal line within the triangle at the 2 km level and then another at the 6 km one. Once this is done it will be easy for the student to begin placing the cloud names at the appropriate altitudes. The teacher might suggest that the word cirrus be placed in the apex of the triangle all those words bearing the name cumulus might be placed on one side, and the stratus on the other.

The rubric that would help to assess this exercise would be the inclusion of the key, the accuracy of the information on the y axis, and the accuracy of the placement of the clouds in the triangle.

Factors	Accurate	Inaccurate	Total
Key			
Y axis			
Cloud Placement			

* = 50 points

Lesson Three: Orographic Lift

***Objective*:** Student knows that the natural world includes Earth materials and objects in the sky. HISD (Obj. Sci. 5.12) and TAKS (T 4)

***Materials Needed*:** Classroom maps, Globe, Individual maps, markers, pencils, journals.

Vocabulary: Coreolis effect, elevation, sea level, orographic lift, rain shadow .

Activity

Since one of my principal concerns for teaching my students about weather and climate is to enlighten them and, indirectly, their parents about the climatic conditions experienced before their migration to this country, the subject of orographic lift will be very important.

This lesson will be mostly about reading maps and recognizing the interconnectedness of different and distant areas of the world. I always have at least three maps in my classroom and resort to them with a great deal of frequency. One is of the world. One is of the United States, another of Mexico, and a fourth of the state of Texas. All of them include topographic information, which helps to explain the interaction between land formations and natural phenomena.

The Texas map is particularly useful to impress the students with the ease with which a tropical storm can enter the territory and travel far inland before dissipating. The reasons are obvious as they notice that the surface consists of coastal plains and there is nothing to stop the wind. With a circular movement of my hand, I will indicate how as the storm travels inland, it loses force because it is no longer picking up warm moisture to replace that lost through precipitation.

From the map of Mexico they will realize that the terrain is fundamentally different. For, although Mexico is famous among tourists for its spectacular beaches, the majority of the country's population lives in highlands at elevations ranging between 1,600 – 2,281 meters (5,249 – 7,500 feet). These highlands are protected from the fury of cyclonic storms on both sides by mountain ranges of even greater altitude called Sierra Madre Oriental in the east and Sierra Madre Occidental in the west, both converging in the south to form the Southern Sierra ("Sierra Madre" 452).

The fury of the cyclones is experienced in the lowlands of the Yucatan peninsula, the Pacific coast and sometimes the Mexican Gulf Coast. But once the cyclonic storms reach the mountains, the moisture-laden clouds drop their moisture on the oceanic side. As the clouds lighten, they rise to the top of the mountain where they release the rest of their moisture. Should they still have some left and the winds are still pushing them, they may provide some precipitation on the leeward side of the mountain (the rain shadow) bringing welcome moisture to otherwise arid landscapes.

Even if rain does not reach the area of the rain shadow, the water that has accumulated in underground water reservoirs will replenish the rivers that flow into the valleys below, nourishing the soils and making agricultural pursuits a delight or, in its absence, a nightmare of dessication as has happened with great frequency in Mexican history.

To reinforce the above theoretical lesson, the students will be handed individual world maps (Rand McNally 21) on which they will mark rivers, hills, and mountains in the area of the Gulf of Mexico as well as the Pacific Coast. Then they will trace the routes that tropical cyclones normally follow in this part of the world. I would then have a discussion with them about the effects that these storms have on the ecosystems where they make landfall.

The rubric that would help to assess this exercise would be the inclusion of the cyclone direction, the accuracy of the information about rivers, and about mountains.

Factors	Accurate	Inaccurate	Total
Cyclone direction			
Rivers direction			

Factors	Accurate	Inaccurate	Total
Mountains			

Lesson Four: Tracking Weather

Objective: Student knows that change can create recognizable patterns. The student is expected to identify patterns of change such as in weather, metamorphosis and objects in the sky. HISD (Sci. 5.6a) TAKS (T 4).

Student uses geographic tools to collect, analyze and interpret data. HISD (SS. 5.6A)

Student locates and names points on a coordinate grid using ordered pairs of whole numbers. HISD (Math. 5.9a)

Materials needed: Computer or Newspaper, journals. Graphing paper, pencils.

Vocabulary: No new vocabulary

Activity

In my efforts to expand my students' mental horizons, I have planned a lesson in which they will be making the arrangements for a two-week trip to visit relatives in some city in a distant country. I will give them the coordinates of the city and have them locate it on the map. Then they will log onto the Internet to find out what the weather is like in that place for that day, complete with temperatures and precipitation conditions. As they begin to record their findings, I will expect them to create a comprehensive table because they will be finding out and recording their data during a span of ten days.

To follow through with their travel plans, the students can get as much information as they can using the Rand McNally resources about the city in question – its biome, cultural development, and social activities. When the students have finished their research, I expect them to know enough about what to expect when they arrive at their destination and have plans about taking adequate clothing. They will now be ready to write their reports and be able to present them to their classmates.

The rubric by which this work will be graded is more complex than the others because it is a work that brings together most of the information acquired throughout the school year.

Objective	Accuracy	Development	Assessment
Data collection			
Graphic representation			
Illustrations			
Report			
Total			

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