MAST ACADEMY OUTREACH

MIDDLE SCHOOL PROGRAM

Adventures Aboard

WOW
(Weather on Wheels)

Pre-Site Packet

MAST Academy

Maritime and Science Technology High School

Miami-Dade County Public Schools

Miami, Florida

MAST ACADEMY OUTREACH
WOW PRE-SITE PACKAGE
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M-DCPS COMPETENCY BASED CURRICULUM
WEATHER ON WHEELS (WOW) GRADE 8

GOAL
To identify, analyze and evaluate South Florida weather phenomena.

Earth/Space Science - Honors

III.1. Relate how knowledge of energy is fundamental to all the scientific disciplines.

2. Describe how climatic patterns on Earth result from an interplay of many factors.

4. Describe the effects of different cycles on the biotic and abiotic characteristics of the earth.

4. Describe the composition and layers of the atmosphere and explain how weather patterns form and occur with respect to high and low pressure ari masses, solar radiation absorption and reflection, jet streams, winds, conduction, and convection, the Coriolis effect, water in the atmosphere, and weather fronts.

Algebra I - Honors

I. 8. Use technology (e.g., calculators, computers) and manipulatives as tools to discover number patterns.

II. 5. Solve real world problems involving measurement.

9. Solve real-world and mathematical problems involving exact/estimates of measurement and effects of measurement errors on calculations.

V. 1. Collect, organize, analyze, and interpret data by constructing charts, tables, and graphs to predict and explain outcomes.

M/J U.S. History

IV 3. Give examples of the impact of technology on the development of the American society.

VI. 1. Use appropriate skills and resources to access, analyze, and synthesize information.

M/J Language Arts 3- Advanced

I. 16. Interprets functional reading material, such as newspapers, periodicals, manuals, instructions, schedules, common forms, maps, graphs, charts, tables.

III. 2. Extends the vocabulary development expectations for the seventh grade using eighth grade or higher vocabulary in reading, writing, and speaking.

4. Acquires and strengthens a personal, active vocabulary in speaking and writing in Interdisciplinary/integrated contexts.

IV. 1. Follows verbal directions.

5. Asks appropriate, challenging questions for elaboration or clarification during activities such as interviews and discussions.

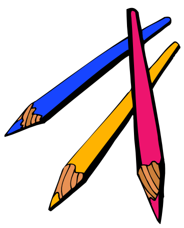
11. Demonstrates appropriated listening and/or viewing skills in a variety of settings, such as viewing film, television, drama, music and dance.

V. 2. Interprets and/or constructs questionnaires and graphics, such as charts, tables, graphs, maps, labels, and signs.

TEACHER INSTRUCTIONS
WEATHER ON WHEELS PRE-SITE ACTIVITIES

1. **Show the Weather on Wheels Pre-site DVD for instructions to prepare you and your students for this experience. Please return the video to MAST Academy, Location 7161 after viewing it.**

2. Review each pre-site activity to decide which are most appropriate for your students. Make class copies of pre-site activities and have students complete each one.



3. In addition to the handouts provided in this packet, students will need the following materials to complete the activities:

   <u>Paper Weather</u>:
   weather forecast from the Miami Herald
   colored pencils (blue, green, yellow, orange, red)

   <u>The Answer Lies in the Clouds</u>:
   photographs showing clouds
   magazines with pictures showing clouds
   scissors
   glue
   posterboard

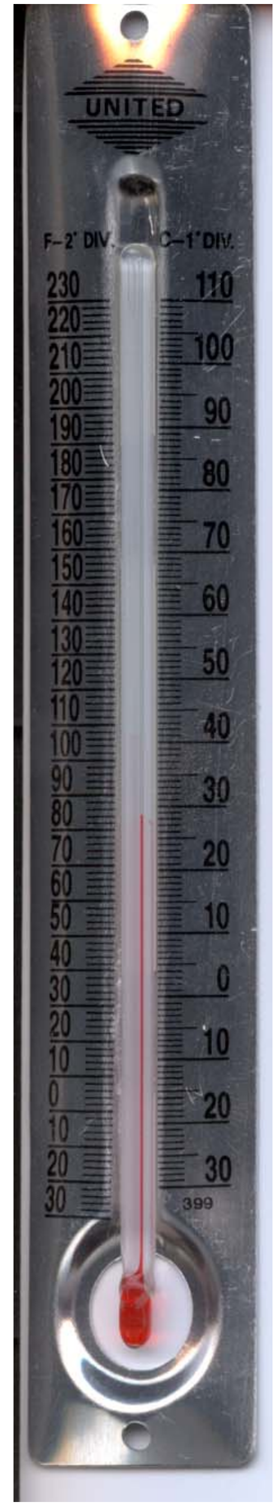
   <u>Weathering the Weather</u>:
   colored pencils (red, blue)

   <u>On the Right Track</u>:
   Scissors

   <u>Too Much, Too Little, or Just Right</u>:
   colored pencils
   calculators

4. Grade each activity you used (answer keys are provided) and total points. The grade for the pre-site activities should be incorporated into a total grade of pre, on, and post-site activities to be used to award certificates of achievement.

TEMPERATURE



Thermometer

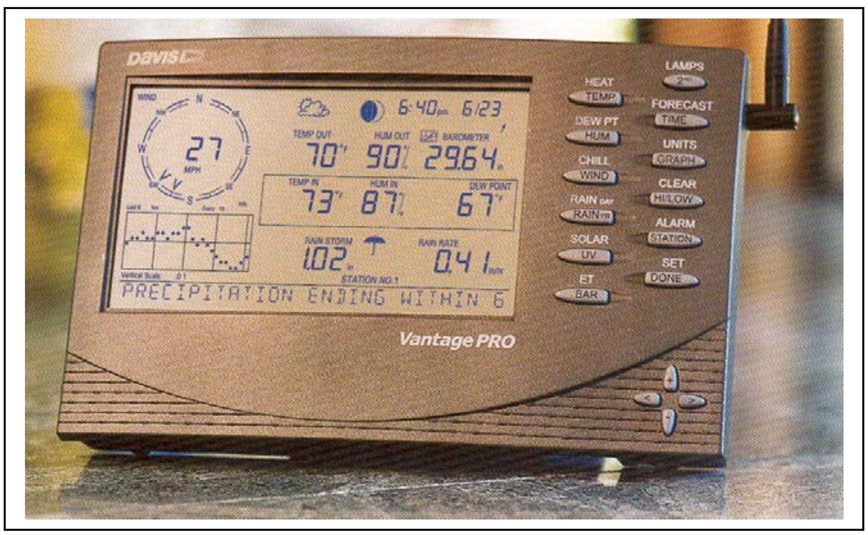
Background

Temperature is a measurement of internal energy: of how fast molecules of a substance are moving. For instance, energy from the sun causes molecules of air to move faster. As the moving molecules bump into each other more frequently, friction from the bumping produces heat, which is measured as an increase in temperature.

A **thermometer** is used to measure temperature. Thermometers for measuring air temperature contain mercury or red-colored alcohol, which expands and rises as the temperature increases, and contracts and moves down the tube as the temperature decreases.

Temperature can be measured with temperature scales. Two common scales are **Fahrenheit**, which is used most often in the United States, and **Celsius** (or **Centigrade)**, which is used in most other countries, as well as by most scientists. On **Weather on Wheels**, you will use both scales to measure temperature.

Where you place a thermometer will determine how accurate your temperature reading will be. On **Weather on Wheels**, you'll measure the temperature both in the sun and in the shade. You will also measure temperature using the **Weather Monitor**.



Weather Monitor

PRACTICE: Using the thermometer on the right:

1. What is the temperature in degrees Celsius?_______________ ^{0}C
2. What is the temperature in degrees Fahrenheit?_____________ ^{0}F

RELATIVE HUMIDITY

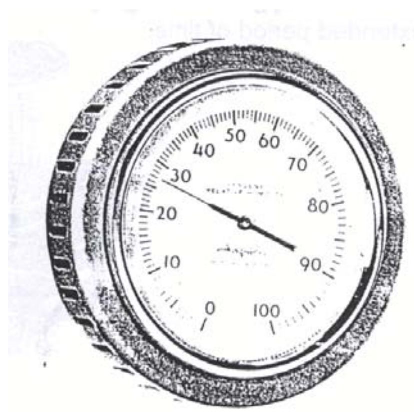
Background

Humidity refers to the amount of moisture in the air. Warmer air can hold more moisture than colder air. By comparing how much water vapor is in the air to how much water vapor the air can hold, we get a percentage called the **relative humidity**. When the relative humidity reaches 100%, we say the air is **saturated** or has reached the **dewpoint**. At this point if the temperature cools even more, or if more water evaporates and tries to escape into the air as a gas, the moisture that the air cannot hold is forced out as drops of water. These could be in the form of dew, frost, fog, or clouds, depending on where and when the change is taking place.

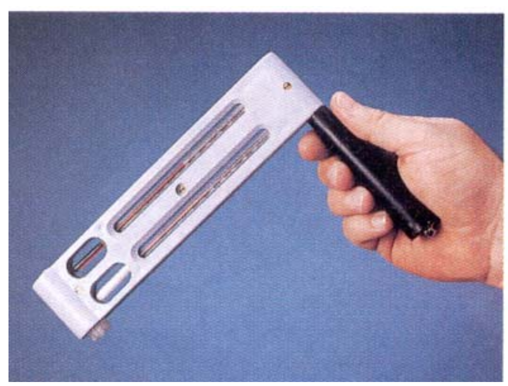
On **Weather on Wheels**, you will measure relative humidity using two instruments; a **hygrometer** and a **sling psychrometer**.

A **hygrometer** consists of a scale with a strand of fiber connected to a pointer. As the humidity decreases, the fiber tightens; increasing humidity loosens the fiber.

A **sling psychrometer** contains two thermometers: one is kept dry (the **dry bulb**), while the other is kept wet (the **wet bulb**.) Heat is required for water to change from liquid to vapor - a process called **evaporation**. Spinning the psychrometer evaporates moisture on the wet bulb thermometer, resulting in a lower reading. By comparing the readings on both thermometers, the relative humidity can be calculated. You will use a relative humidity conversion chart to calculate the relative humidity.



Hygrometer



Sling Psychrometer

On the right is a typical relative humidity conversion chart (using Celsius.) The **dry bulb** temperatures are shown in the first column (on the left), while the **difference of dry bulb minus wet bulb temperature** is shown in the first row (on top.)

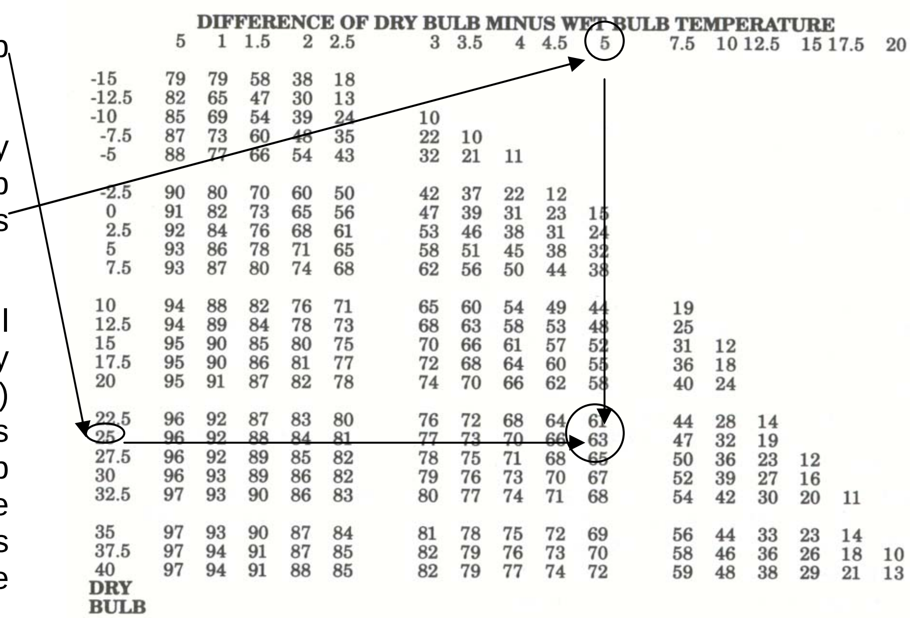
Lets say that after spinning the sling psychrometer for one minute, you obtain a wet bulb temperature of 20^o C, and a dry bulb temperature of 25^o C.

DIFFERENCE OF DRY BULB MINUS WET BULB TEMPERATURE

DRY BULB	5	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	12.5	15	17.5	20
-15	79	79	58	38	18											
-12.5	82	65	47	30	13											
-10	85	69	54	39	24	10										
-7.5	87	73	60	48	35	22	10									
-5	88	77	66	54	43	32	21	11								
-2.5	90	80	70	60	50	42	37	22	12							
0	91	82	73	65	56	47	39	31	23	15						
2.5	92	84	76	68	61	53	46	38	31	24						
5	93	86	78	71	65	58	51	45	38	32						
7.5	93	87	80	74	68	62	56	50	44	38						
10	94	88	82	76	71	65	60	54	49	44	19					
12.5	94	89	84	78	73	68	63	58	53	48	25					
15	95	90	85	80	75	70	66	61	57	52	31	12				
17.5	95	90	86	81	77	72	68	64	60	55	36	18				
20	95	91	87	82	78	74	70	66	62	58	40	24				
22.5	96	92	87	83	80	76	72	68	64	61	44	28	14			
25	96	92	88	84	81	77	73	70	66	63	47	32	19			
27.5	96	92	89	85	82	78	75	71	68	65	50	36	23	12		
30	96	93	89	86	82	79	76	73	70	67	52	39	27	16		
32.5	97	93	90	86	83	80	77	74	71	68	54	42	30	20	11	
35	97	93	90	87	84	81	78	75	72	69	56	44	33	23	14	
37.5	97	94	91	87	85	82	79	76	73	70	58	46	36	26	18	10
40	97	94	91	88	85	82	79	77	74	72	59	48	38	29	21	13

To calculate the relative humidity from the wet and dry bulb thermometer readings:

- Find 25^0 C in the dry bulb column.
- Find the difference of dry bulb minus wet bulb temperature (25^o C minus 20^0 C = 5^o C) in the top row.
- Read down this column until you reach the row of the dry bulb temperature (25^0 C.) The number where this column and the dry bulb temperature row meet is the relative humidity. In this example, the relative humidity is 63%.


DIFFERENCE OF DRY BULB MINUS WET BULB TEMPERATURE

DRY BULB	5	1	1.5	2	2.5	3	3.5	4	4.5	5	7.5	10	12.5	15	17.5	20
-15	79	79	58	38	18											
-12.5	82	65	47	30	13											
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2.5	92	84	76	68	61	53	46	38	31	24						
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7.5	93	87	80	74	68	62	56	50	44	38						
10	94	88	82	76	71	65	60	54	49	44	19					
12.5	94	89	84	78	73	68	63	58	53	48	25					
15	95	90	85	80	75	70	66	61	57	52	31	12				
17.5	95	90	86	81	77	72	68	64	60	55	36	18				
20	95	91	87	82	78	74	70	66	62	58	40	24				
22.5	96	92	87	83	80	76	72	68	64	61	44	28	14			
25	96	92	88	84	81	77	73	70	66	63	47	32	19			
27.5	96	92	89	85	82	78	75	71	68	65	50	36	23	12		
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35	97	93	90	87	84	81	78	75	72	69	56	44	33	23	14	
37.5	97	94	91	87	85	82	79	76	73	70	58	46	36	26	18	10
40	97	94	91	88	85	82	79	77	74	72	59	48	38	29	21	13

PRACTICE: Use the relative humidity conversion chart to solve the following problems.

	Dry Bulb Temperature	**Wet Bulb Temperature**	**Relative Humidity**
1.	25^0 C	22.5^0 C	____________ %
2.	30^0 C	27^0 C	____________ %
3.	27.5^0 C	23^0 C	____________ %
4.	32. 5^0 C	25^0 C	____________ %

Activity: Paper Weather

Directions:

Using the weather forecast from the Miami Herald:

1. What is the warmest city in the country today?___________________

   What is the coldest city in the country today?____________________

2. What will the high temperature be in Miami today?________________

3. Using the list of major U.S. cities and the highest temperature expected in each city that day, place the cities on the blank outline map of the United States on the opposite page, and write in their temperatures. (You may need an atlas to help you.)

4. Isotherms are lines connecting points of equal temperature on a map. Draw isotherms connecting cities on your map whose temperatures fall within 10 degrees of each other. In this way you can observe different zones, each with similar temperatures.

5. Use colored pencils to fill in each temperature zone. Choose a color scale ranging from blue to green for the cooler areas and yellow to orange for the warmer areas. Use red for hot areas.

6. Why do temperatures gradually become cooler as you go toward the poles?

   ____

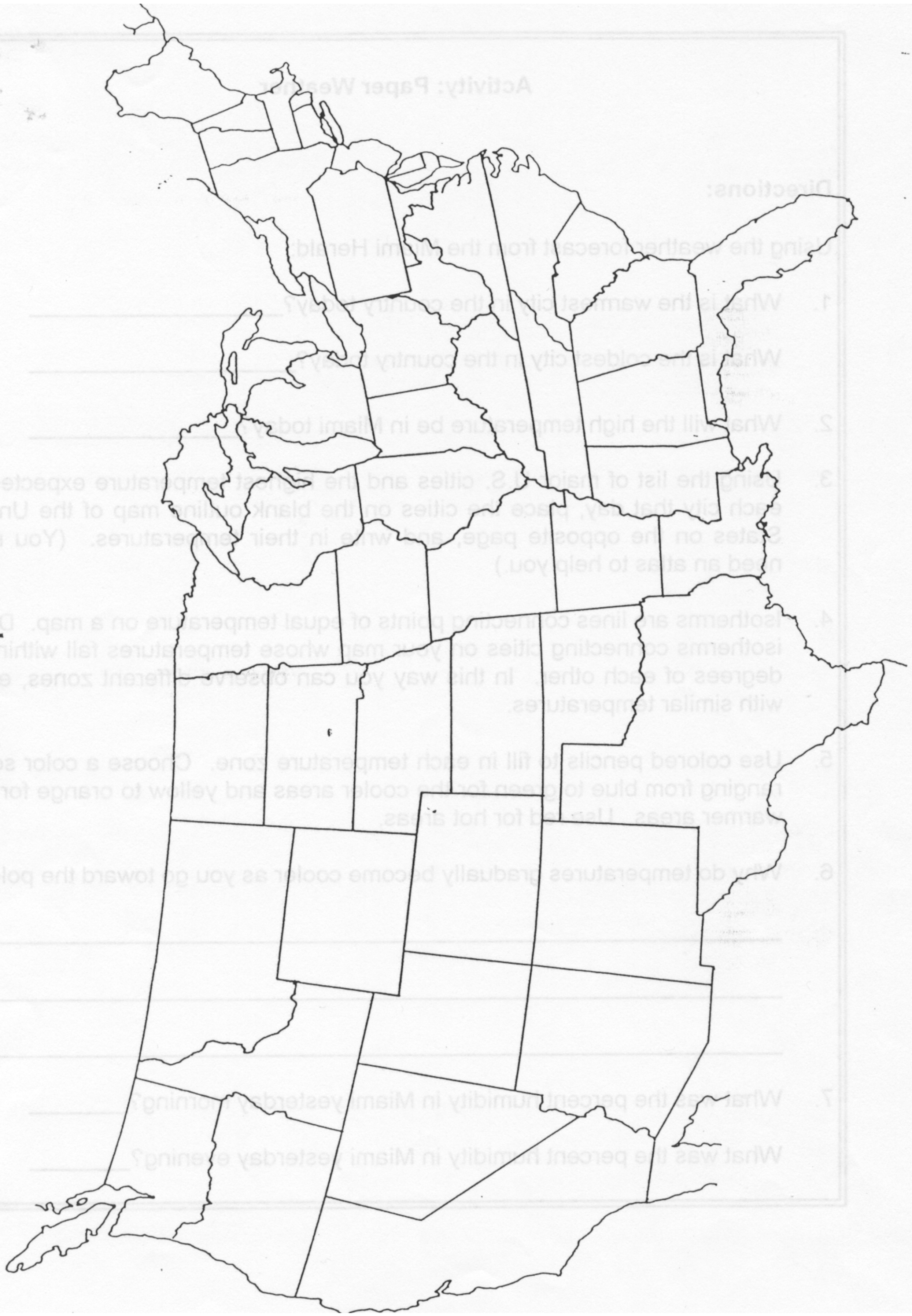
   ____

   ____

7. What was the percent humidity in Miami yesterday morning?________%

   What was the percent humidity in Miami yesterday evening?________%

Outline Map of US



CLOUDS AND PRECIPITATION

Background

When asked to draw a picture of the sky on a typical Florida day, many of us will depict a blue sky dotted with large, cotton-puff clouds. To meteorologists, however, the presence of any cloud in the sky is a sign that weather changes may be on the way. Clouds come in many shapes and sizes, and it takes an understanding of their differences to predict changes in the weather.

The structure of a cloud depends on where it develops. In general, clouds form when solar heating of the earth's surface warms air near the ground and it begins to rise. As this air rises, it expands and cools. In the process, water vapor may condense on small dust particles suspended in the air, which then combine to form clouds.

Clouds also form when the large masses of air that constantly move above us collide with each other. The denser, colder air forces less dense, warmer or moister air upwards, causing condensation of water vapor on small dust particles. In both cases - the rising of warm, moist, ground-level air and the overriding of one air mass by another - the type of clouds that results can be determined by how fast the air rises.

If the air is forced up slowly, **stratus** clouds are formed. If the air is forced up rapidly and therefore rises higher, **cumulus** clouds are formed.

One way to group clouds is by family characteristic. **Stratus clouds** are the lowest clouds. They are flat, layered, and can cover the entire sky,giving the appearance of fog. **Altostratus clouds** are middle altitude clouds. They form thin, layered veils, usually over large areas.

Cirrus clouds are high, wispy clouds made of ice crystals. Also in this family are **cirrostratus clouds**, those high, hazy clouds made of a continuous layer of ice crystals. **Cirrocumulus clouds** are high clouds made up of thin puffs of ice crystals.

Cumulus clouds are thick and fleecy. Their bases are usually flat and low, no matter how tall the clouds themselves are. **Altocumulus clouds** are small, lumpy patches or globules of clouds that form at altitudes higher than those where cumulus clouds form.

Nimbus clouds are clouds that produce **precipitation**. This precipitation is usually rain, but it can also be mist, hail, sleet or snow. Thus a **cumulonimbus cloud** is a cumulus cloud with precipitation. A **nimbostratus cloud** is a stratus cloud with precipitation.

Clouds may also be classified by **altitude,** that is, height of the cloud base above sea level. **Low altitude clouds** (below 6000 feet) are the stratus, cumulus, and nimbostratus clouds. **Middle altitude clouds** (6000-20,000 feet) are the altostratus and altocumulus clouds.

High altitude clouds (above 20,000 feet) are the cirrus, cirrostratus, and cirrocumulus clouds. Cumulonimbus clouds span all three of these altitudes; their tops may reach up six to ten miles, while their bases may be below 3000 feet.

Study the **cloud chart** on the following page. On **Weather on Wheels**, you will use a cloud chart to determine the kinds of clouds you see that day. You will also use a **rain gauge** to measure any precipitation that has fallen that day.

Rain Gauge

Activity: The Answer Lies in the Clouds

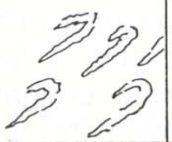
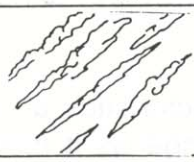
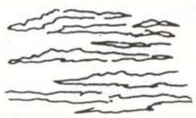
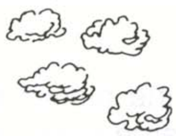
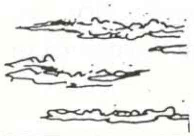
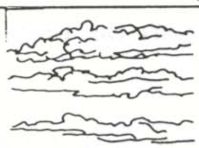
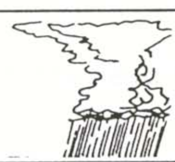
Directions:

1. Get your family's permission to bring some photographs with clouds in them to class. Also get permission to bring some magazines that have pictures with clouds in them to class for cutting up.

2. Tell the class where each of the family photos were taken, who is in them, and the types of clouds that are in the sky (use the cloud chart on the following page to help you). When you bring the photos back home, identify the clouds in the photos for your family and describe what they look like.

3. Find pictures of as many different types of clouds as possible in the magazines. Cut the pictures out, glue them on to a posterboard, and write the name of each type of cloud under its picture. Trade magazine pictures with your classmates until you get a good collection for your poster.

CLOUD CHART

Shape	Name	Altitude of Cloud Base	Description
	Cirrus	Above 20,000 feet	Thin, wispy, made of ice crystals. On bright night, moon can be seen.
	Cirrocumulus	Above 20,000 feet	Thin, white puffs of ice crystals. Form ripples in high sky.
	Cirrostratus	Above 20,000 feet	Thin sheet of white ice crystals. Makes sky look milky.
	Altocumulus	6000-20,000 feet	Small, puffy globules ranging from white to gray in color.
	Altostratus	6,000-20,000 feet	Thin, layered veil. Sun seen as bright spot.
	Stratus	Below 6,000 feet	Low, uniform, gray layers. usually form drizzle.
	Cumulus	Below 6,000 feet	Dense, white, and billowy with flat base, single or closely packed.
	Cumulonimbus	Base as low as 3,000 feet, top as high as 6-10 miles	Large, towering, dark gray, usually form thunderstorms or heavy rain.
	Nimbostratus	Very low and/or undefined because of precipitation	Densely layered, dark gray. Usually form overcast sky or dense, steady rain.

AIR MASSES AND FRONTS

Background

The characteristics of the atmosphere around us sometimes seem to change from day to day. One day the air may be extremely hot and humid. The next day it may be cool and dry. Although such a change occuring overnight may appear to occur simply because the air cools as the sun goes down, this is not a correct explanation.

An **air mass** is a large volume of air with fairly uniform characteristics at any given altitude. Although the position of an air mass may change as it moves from one place to another, the two major properties of an air mass - temperature and moisture - change little. Furthermore, because they have different properties, air masses can mix along their bounderies, but each basically retains its own identity, provided the underlying surface is similar to that where it formed.

The characteristics of different air masses are determined by the places over which they form. An air mass forming over an ocean contains large amounts of water and is thus moist. An air mass that forms over land is usually dry. An air mass forming over a polar region is cold, while an air mass that forms over the tropics is warm.

The temperature and moisture characteristics of air masses can be used to arbitrarily define four types of air masses:

Maritime tropical (mT). Air masses are warm and moist; formed over water in a tropical area.

Continental tropical (cT). Air masses are warm and dry; formed overland in a tropical region.

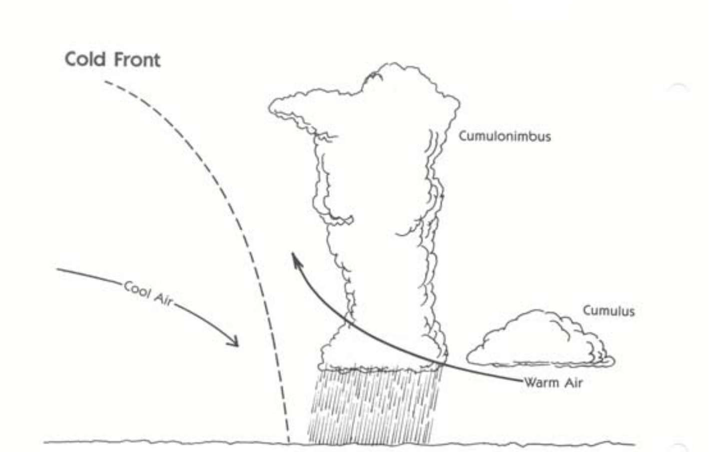
Maritime polar (mP). Air masses are cool and moist; formed over water in a polar region.

Continental polar (cP). Air masses are cool and dry; formed over land in a polar region.

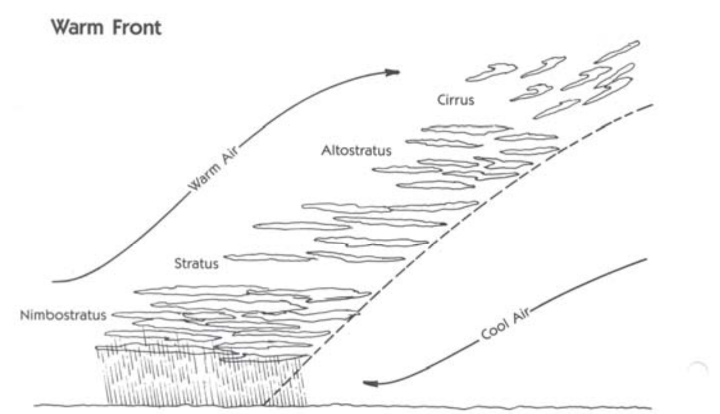
Since cold air is denser than warm air, and since dry air is denser than moist air, continental polar air masses are most dense, while maritime tropical air masses are least dense.

When different air masses meet, the place where they make contact with each other is known as a **front** or **frontal zone**. Clouds often form along the front separating air masses and, many times, some type of precipitation is produced. In the tropics, fronts are much less frequent than at higher latitudes, and then mostly during the winter.

A **cold front** is formed when the leading edge of a cool air mass moves into a warm air mass. Because cool air is much denser and therefore heavier, it pushes the lighter, warm air up. The situation causes the warm air to rise rapidly and cumulus or cumulonimbus clouds often form. Thunderstorms may occur along a cold front.

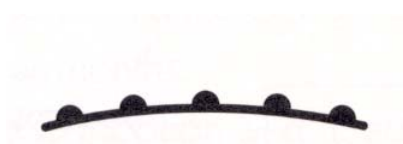


A **warm front** is the leading edge of a warm air mass. It is formed when a warm air mass overtakes and rides up over a cooler air mass. A warm front is not as steep as a cold front. This is because the advancing warm air cannot push the heavy cool air out of its way. Instead, the warm air ascends over the cool air, forming clouds that rise slowly to middle and high altitudes above the front, and also ahead of it. Behind and below come the altostratus clouds. They are followed by the still lower stratus and nimbostratus clouds. Precipitation formed by a warm front usually takes the form of a lingering drizzle or slow, steady rain. Such a weather system moves slowly and may take 12 to 24 hours to pass over an area on Earth.



A **stationary front** is a boundary that separates two different air masses that exhibit little or no movement. The temperature on one side of the front may be much colder than on the other side of the front. Fronts can dissipate if the differences in the densities of the adjacent air masses decreases and essentially vanishes.

Below are weather map symbols for cold, warm and stationary fronts.



Cold Front **Warm Front** **Stationary Front**

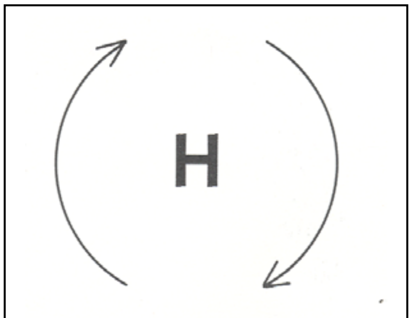
AIR PRESSURE

Background

The atmosphere, or air, around us exerts a certain amount of pressure that pushes against everyone and everything on Earth. We don't usually notice this pressure because it comes at us equally from all directions.

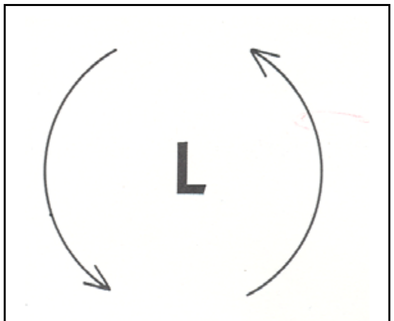
Atmospheric pressure at sea lavel is roughly 14.5 pounds for every square inch of surface. In areas above sea level, the pressure on a clear day will be less. Changes in air pressure can have an enourmous influence on weather because they make the air move around.

On a rotating planet, the air flow, or wind around a pressure system always spirals around the center of that area. In a high pressure system, the air sinds, flowing down and spiraling out from the center of the system; this flow is clockwise in the Northern hemisphere and counterclockwise in the Southern Hemisphere. This system is also known as an **anticyclone** or **high**.



High-Pressure System

In a low pressure system, the air rises and the surrounding air moves in toward the center of the system to compensate for the loss of mass and spirals inward, or counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. This system is also known as a **cyclone** or l**ow**.

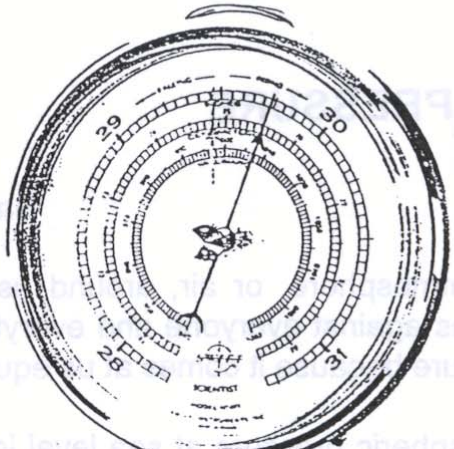


Low-Pressure System

These clockwise and counterclockwise air motions affect the type of fronts that form when air masses meet. In general, fronts are produced when pressure systems pull air masses with different properties close together.

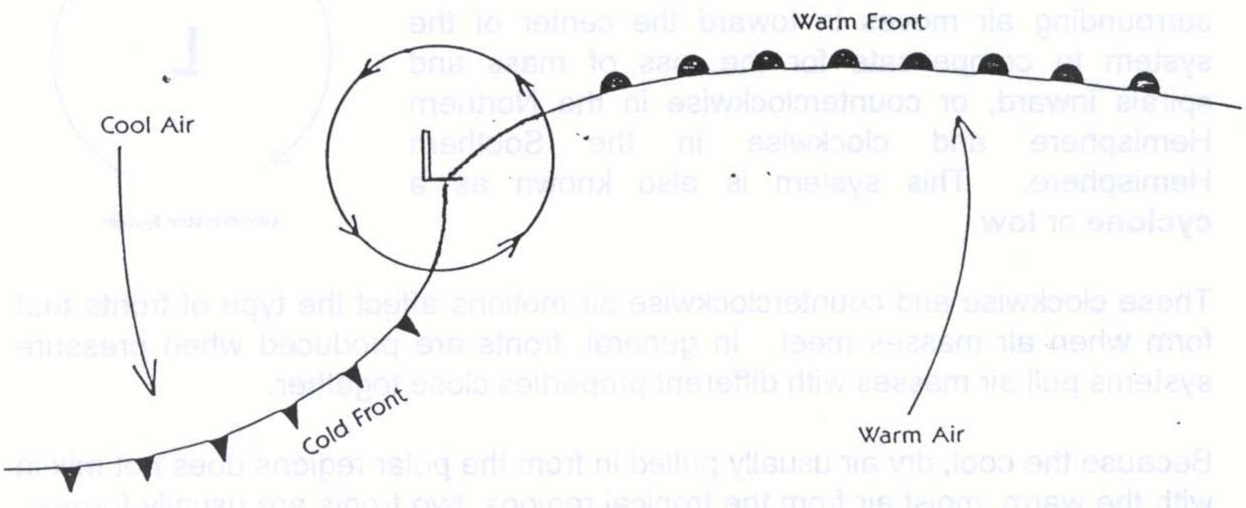
Because the coll, dry air usually pulled from the polar regiosn does not mix in with the warm, moist air from the tropical regions, two fronts are usually formed. A warm front forms along the leading edge of warmer air, and a cold front forms along the leading edge of colder air. It is along these two fronts that clouds are produced and precipitation occurs.

On **Weather on Wheels**, you will measure differences in air pressure using an **aneroid barometer**. An aneroid barometer consists of a small metal can with some of the air removed. Changes in air pressure will push in or push out the sides of the can; a lever mounted on the can, attached to a pointer, will measure these pressure changes. Air pressure will be measured in inches, centimeters, and millibars.



If you record at sea level a high pressure reading (30.00 inches or more), this usually means that the air is sinking. It is therefore exerting great force on the barometer. Generally, high pressure is associated with air that is cool and dry and skies that are clear. If you find yourself in bad weather, but notice that the barometer is rising, expect good weather to be on the way.

A low pressure reading (below 30 inches) at sea level means that air at the surface of the Earth is ascending and exerting less downward force on the barometer. With warm air rising, clouds, usually accompanied by some form of precipitation, form. When the weather is nice, but the barometer starts to fall, it means a spell of inclement weather is on the way.



Fronts Forming in a Low Pressure System

Activity: Weathering the Weather

Directions:

1. Examine the air mass and temperature map on page 18. The circles on the map show the location of some unnamed cities; the number above the circle is the Fahrenheit temperature of the city.

3. Two different kinds of air movement also appear on the map. One is a warm air mass and the other is a cool air mass. Each kind of air movement is represented by an arrow. Both are moving counterclockwise around a low pressure system, the center of which is symbolized by a large **L**. By looking at the temperatures surrounding the arrows, you should be able to tell which is the cold air mass and which is the warm air mass. Label them.

3. Find the leading edge of an air mass moving in a southeasterly direction. Look where the temperatures between nearby cities are quite different. This is probably the frontal zone where the air masses meet.
   Is it a warm front or a cold front?________________________________
   On the map, draw the appropriate front line symbol to show where the air masses meet, starting from the center of the low pressure system and working outward.

4. Find the leading edge of the warm air mass moving moving northward.
   Again, look where temperatures between nearby cities are quite different.
   Is this a warm front or a cold front?________________________________
   On the map, draw the appropriate front line symbol to show the leading edge of the warm air mass, again starting from the center of the low pressure system and working outward.

5. Color the entire cold air mass blue and the entire warm air mass red.

Remembering that most weather systems outside the tropics move from west to east, answer the following questions:

6. What is the temperature in:
   West-central Texas?______________________________________

   Northeast Mexico?_______________________________________

   Maine?____

7. According to the map:
   which is the warmest state in the United States on this day?______________
   Which is the coolest state in the United States on this day?_______________

8. Where will the air mass from the Midwest be tomorrow?__________________

   ____

9. Where do you think most of the cloudy skies and precipitation are occcuring?
   ____

10. According to the map, what is the weather like in:
Florida?____

California?____

Missouri?____

Pennsylvania?____

11. According to the map, what kind of weather is Georgia having now?
____

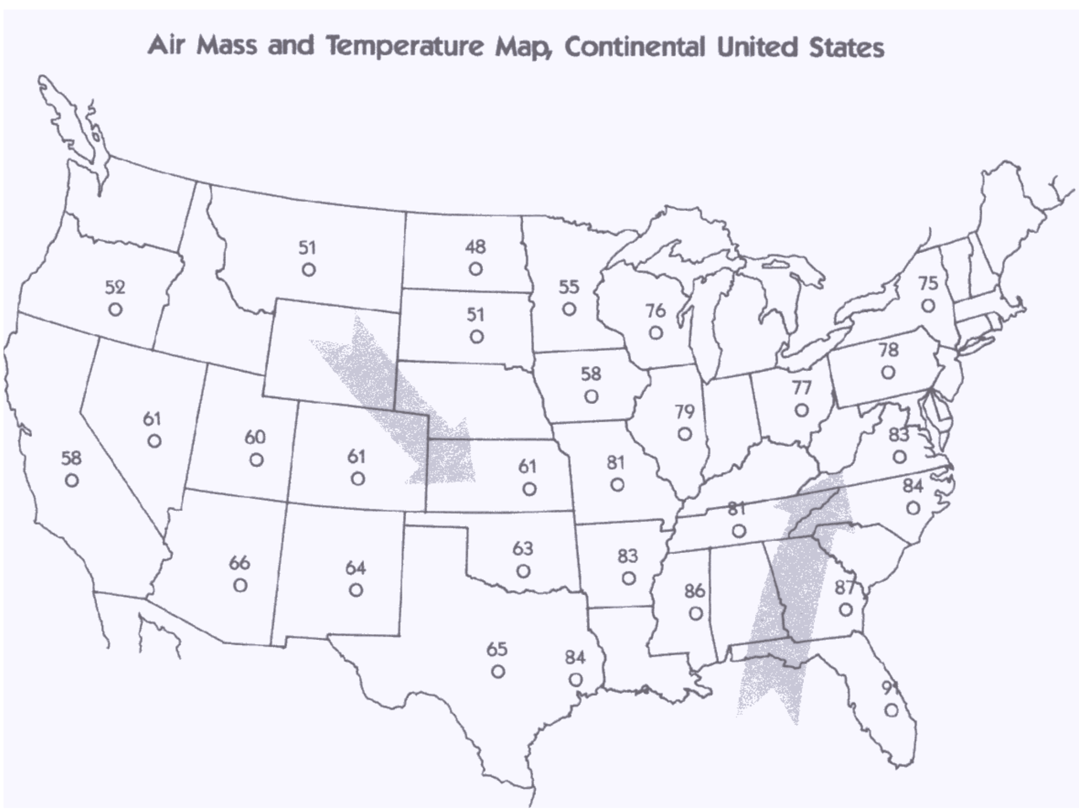
____

12. What is your forecast for Virginia? Why?______________________________

____

13. Where would a high pressure system be located?__________________

____



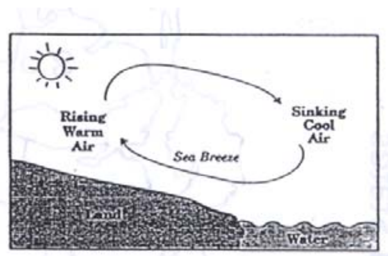
WIND AND HURRICANES

Background

Look about you for the movement of clouds in the sky, or a flag on a pole. Air is moving, sometimes lightly, occasionally strongly. **Wind** is air in motion.

What keeps the air in constant motion around the earth? On a local scale, the most important factor is the incoming solar energy from the sun that is heating the Earth. Since land heats and cools faster than water, on a sunny day, warm air rising from land heated by the sun flows toward the cooler water where the air sinks. The cooler air then moves in toward land again to replace the warm air that is rising.

This cycle continues as long as the daytime heating continues from the sun. Since air moves inland from the water, the wind is called a **sea breeze**.



At night, the opposite cycle occurs. Since the land cools quicker than water, air over the warmer water rises and flows toward cooler land where the air sinks. This reverse cycle of wind blowing out to sea is called a **land breeze**.

On a global scale, the tropical regions receive more solar radiation and heating than the poles. Similar to the land and sea breezes, the difference of heating of the earth's surface creates cycles of air movement. Air rises at the equator and sinks as it reaches higher latitudes. Air moving between the two regions is curved by the rotation of the earth to create our wind. The prevailing **Westerlies** is the wind belt at middle latitudes that generally move weather systems there from west to east.

The same difference of the earth's heating that causes the prevailing westerlies also causes a strong "river" of strong winds high above the surface of the earth. The **Jet Stream** is a narrow band of strong wind in the upper atmosphere. The center of this wind is usually found from 6 to 9 miles above the earth's surface, and flows around the earth at speeds of about 100 to 250 miles per hour. The jet stream is stronger in winter, since the temperature difference at frontal bounderies is greatest in the winter and early spring. During the winter, the jet stream is often the frontal boundary separating cold polar air at higher latitudes from the warm subtropical air of lower latitudes.

On **Weather on Wheels** you will measure wind speed using a Turbometer, a hand-held **anemometer**. You will measure the wind speed in miles per hour. You will also be able to determine the direction the wind is blowing, using a **wind vane**, located at the weather station.

weather systems. They are extreme low-pressure systems, or cyclones, where the air spirals rapidly into the center of the low. High winds and flooding from heavy rain and **storm surge** often occur, frequently bringing tremendous damage and many deaths in their wake. Hurricane Andrew, which struck South Florida on August 24 of 1992, is considered the most costly natural disaster in the history of the United States, with 35,000 homes destroyed, 300,000 people left temporarily homeless, and property losses exceeding $30 billion.

Hurricanes develop over the oceans in the tropical regions, most often in late summer and autumn, when sea surface temperatures are highest. They can range from 50 miles to 1000 miles in diameter, with maximum sustained winds from 74 miles per hour to as high as 200 miles per hour. In a hurricane, thick, water-laden cumulonimbus clouds form a circular spiral structure; the closer the clouds are to the center of the low-pressure system, the stronger the wind and rain.

Suprisingly, the very center of the low pressure system, called the "eye" of the hurricane, is a place of relative calm. It contains few, if any, clouds. Sometimes the sun or stars are visible. This pleasant condition is deceptive because high winds and tremendous rains at the edge of the hurricane eye are ravaging Earth's surface.

The eye of the hurricane is shown to the right. The shaded region indicates the eyewall, where winds are at least hurricane force.

The Atlantic hurricane season is defined as June 1st through November 30th. On the average, six hurricanes a year form in the tropical areas of the Atlantic Ocean, Gulf of Mexico, or the Caribbean, and then move westward. Some storms turn northward, a process called **recurvature**; storm surges and floods from rainfall in coastal areas sometimes result.

The National Weather Service is responsible for warning us about approaching hurricanes. Weather satellites provide the first indications of the enhanced convective cloudiness and cyclonic wind circulations that signal the beginning of a **tropical depression**. a **tropical storm** or hurricane. Hurricane conditions are also reported to the National Weather Service by airplanes, weather balloons, and ground radar stations. Although hurricanes normally move slowly, it is difficult to predict their exact path because they can change direction and accelerate very quickly, or can intensify (or weaken) rapidly.

The National Weather Service Issues a **Hurricane Watch** for a coastal area if it looks as if a hurricane may be striking within 24 to 36 hours. A **Hurricane Warning** is issued when a hurricane appears to be headed directly toward a specific area and is expected to hit the area in 24 hours or less. Action should be taken to protect yourself and your property as soon as you learn that a hurricane may be on its way to your area.
On **Weather on Wheels**, you will be expected to know how to read a **hurricane tracking chart**, which meteorologists use to plot the movement of a hurricane. The

position of a hurricane is detemined by it's **latitude** and **longitude**. Lines of latitude run east/west on a map or globe (the equator is 0^0 latitude), while lines of longitude rune north/south.

Activity: On the Right Track

A hurricane has been spotted in the Atlantic Ocean. Every twelve hours, between 7:00 a.m. and 7:00 p.m., you will receive information on the location of the eye of the hurricane and be asked to give the proper warnings to the areas that may be affected. Assume that it is a weak (Category 1) hurricane.

You must issue a hurricane warning at least 12 hours of daylight before the hurricane hits so that people have time to evacuate the area. Remember that it is dangerous to evacuate an area at night, too many accidents can occur, and people might panic.

Each time you get the location (in latitude North and longitude West) of the hurricane eye, plot its position on the hurricane tracking map. The hurricane, however, is much larger than its eye. Therefore, cut out the drawing of the hurricane on the previous page and place it in the proper position on the map (cut out the hurricane's eye so you can see the proper position). All areas covered by the entire hurricane will experience strong winds and heavy rains.

Let's begin:

7:00 a.m., August 1 - Hurricane center at 25 N and 64 W

1. Place the hurricane at that position on your map.

2. Give the new hurricane a name.____

7:00 p.m., August 1 - Hurricane center at 26 N and 67 W

3. Will you issue any warnings?_____________Why?______________________________

   ____

7:00 a.m., August 2 - Hurricane center at 27 N and 70 W

4. Where is the hurricane heading?____

5. How far has it traveled in the last 12 hours?__________________________________

6. Assume that it will be continuing at that same speed and direction. Where will it be in the next 12 hours?____

7. Will you issue any warnings?____________For what areas?____________________

____

7:00 p.m., August 2 - Hurricane center at 28 N and 73 W

8. In what direction is the storm moving now?__________________________________

9. Should you give warnings now to the people in any areas?______________________

10. Has the hurricane speed remained the same?________________________________

7:00 a.m., August 3 - Hurricane center at 28 N and 76 W

11. Should you give warnings to any areas now?_________________________________

12. What areas will be affected?____

13. Can you wait until the next location reading to give the warnings?________________

Why?____

____

7:00 p.m., August 3 - Hurricane center at 29 N and 79 W

14. In what direction do you think the hurricane will continue? _____________________

15. Should you give out any new warnings?_____________________________________

7:00 a.m., August 4 - Hurricane center at 30 N and 81 W

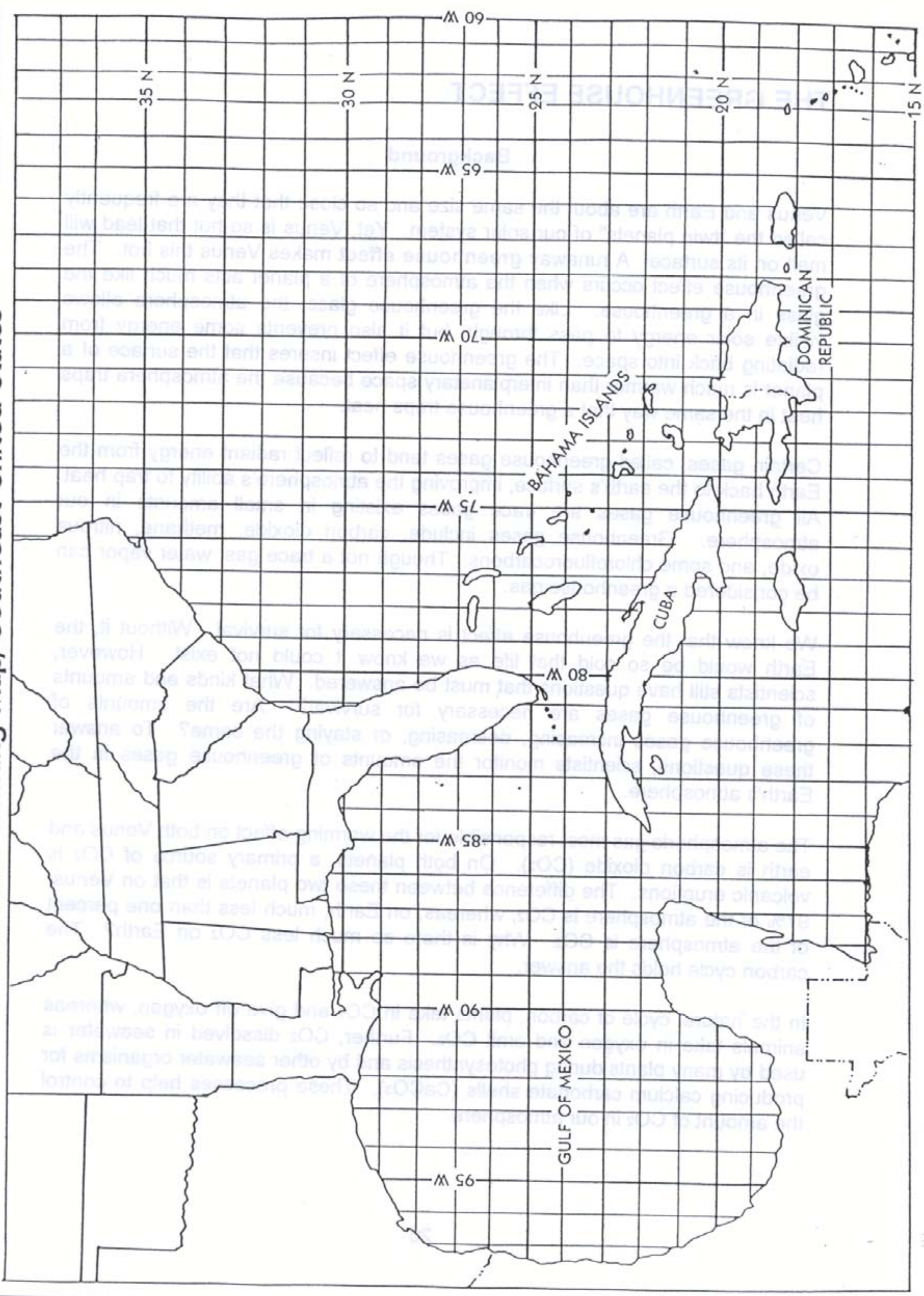
16. What direction did the hurricane take?_____________________________________

17. What was the approximate time of landfall?__________________________________

18. How much time did people in warned areas have to evacuate?__________________

Hurricane Tracking Map, Southeast United States

Scale: 1 square = 70 miles



THE GREENHOUSE EFFECT

Background

Venus and Earth are about the same size and so close that they are frequently called the "twin planets" of our solar system. Yet, Venus is so hot that lead will melt on its surface! A runaway **greenhouse effect** makes Venus this hot. The greenhouse effect occurs when the atmosphere of a planet acts much like the glass in a greenhouse. Like the greenhouse glass, the atmosphere allows visible solar energy to pass through, but it also prevents some energy from radiating back into space. The greenhouse effect insures that the surface of a planet is much warmer than interplanetary space because the atmosphere traps heat in the same way that a greenhouse traps heat.

Certain gases, called greenhouse gases tend to reflect radiant energy from the Earth back to the earth's surface, improving the atmosphere's ability to trap heat. All greenhouse gases are trace gases existing in small amounts in our atmosphere. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, and some chlorofluorocarbons. Though not a trace gas, water vapor can be considered a greenhouse gas.

We know that the greenhouse effect is necessary for survival. Without it, the Earth would be so cold that life as we know it could not exist. However, scientists still have questions that must be answered. What kinds and amounts of greenhouse gases are necessary for survival? Are the amounts of greenhouse gases increasing, decreasing, or staying the same? To answer these questions, scientists monitor the amounts of greenhouse gases in the Earth's atmosphere.

The atmospheric gas most responsible for the warming effect on both Venus and earth is carbon dioxide (CO_2). On both planets, a primary source of CO_2 is volcanic eruptions. The difference between these two planets is that on Venus, 97% of the atmosphere is CO_2, whereas, on Earth, much less than one percent of the atmosphere is CO_2. Why is there so much less CO_2 on Earth? The carbon cycle holds the answer.

In the natural cycle of carbon, plants take in CO_2 and give off oxygen, whereas animals take in oxygen and emit CO_2. Further, CO_2 dissolved in seawater is used by many plants during photosynthesis and by other seawater organisms for producing calcium carbonate shells ($CaCO_3$). These processes help to control the amount of CO_2 in our atmosphere.

Human beings complicate the natural carbon cycle because they increase the amount of CO_2 in Earth's atmosphere by burning fossil fuels (oil, gasoline, coal, etc.). Driving automobiles, heating buildings, and producing consumer goods all add to the concentration in Earth's atmosphere.

Methane (CH_4) is another greenhouse gas. It is produced in swamps, bogs, and rice paddies, as well as in the intestinal tracts of most animals, including cattle, sheep, and humans. Coal, oil, and gas exploration also contribute to the accumulation of methane in the atmosphere. However, methane concentrations are much less than CO_2 concentrations.

Nitrous oxide, (N_2O) or "laughing gas" is another greenhouse gas accumulating in the atmosphere, although not as fast as CH_4. Fertilizer decomposition, industrial processes that use nitric acid, and small amounts from automobile emissions all contribute to increasing atmospheric N_2O.

Activity: Too Much, Too Little, or Just Right

In this activity, you will plot curves for the CO_2 and CH_4 concentrations found in the atmosphere over a period of time. Concentration is measured in parts per million (ppm) for CO_2 and parts per billion for CH_4. For example, a CO_2 concentration of 350 ppm means that there are 350 parts of CO_2 in a total of one million parts of air. A CH_4 concentration of 1614 ppb means that there are 1614 parts of CH_4 in a total of one billion parts of air.

In much the same way a scientist would monitor concentrations of gases in the atmosphere, you will look for changes and trends, as well as maximum and minimum concentrations during that same time period. Data in the tables were provided by the National Oceanic and Atmospheric Administration (NOAA), Climate Monitoring and Diagnostics Laboratory.

PART A

Procedure:

1. Using Table 1, and the graph on the next page, plot the points corresponding to the monthly mean CO_2 concentration at Point Barrow, Alaska. Use a colored pencil to connect the points.

2. Using Table 2, plot the points corresponding to the monthly mean CO_2 concentration at South Pole, Antarctica. Use a different colored pencil to connect the points.

3. Print a title at the top of your graph.

4. Place a color coded legend on your graph in the space provided.

Table 1. Monthly Mean CO_2 Concentration (ppm), Point Barrow, Alaska

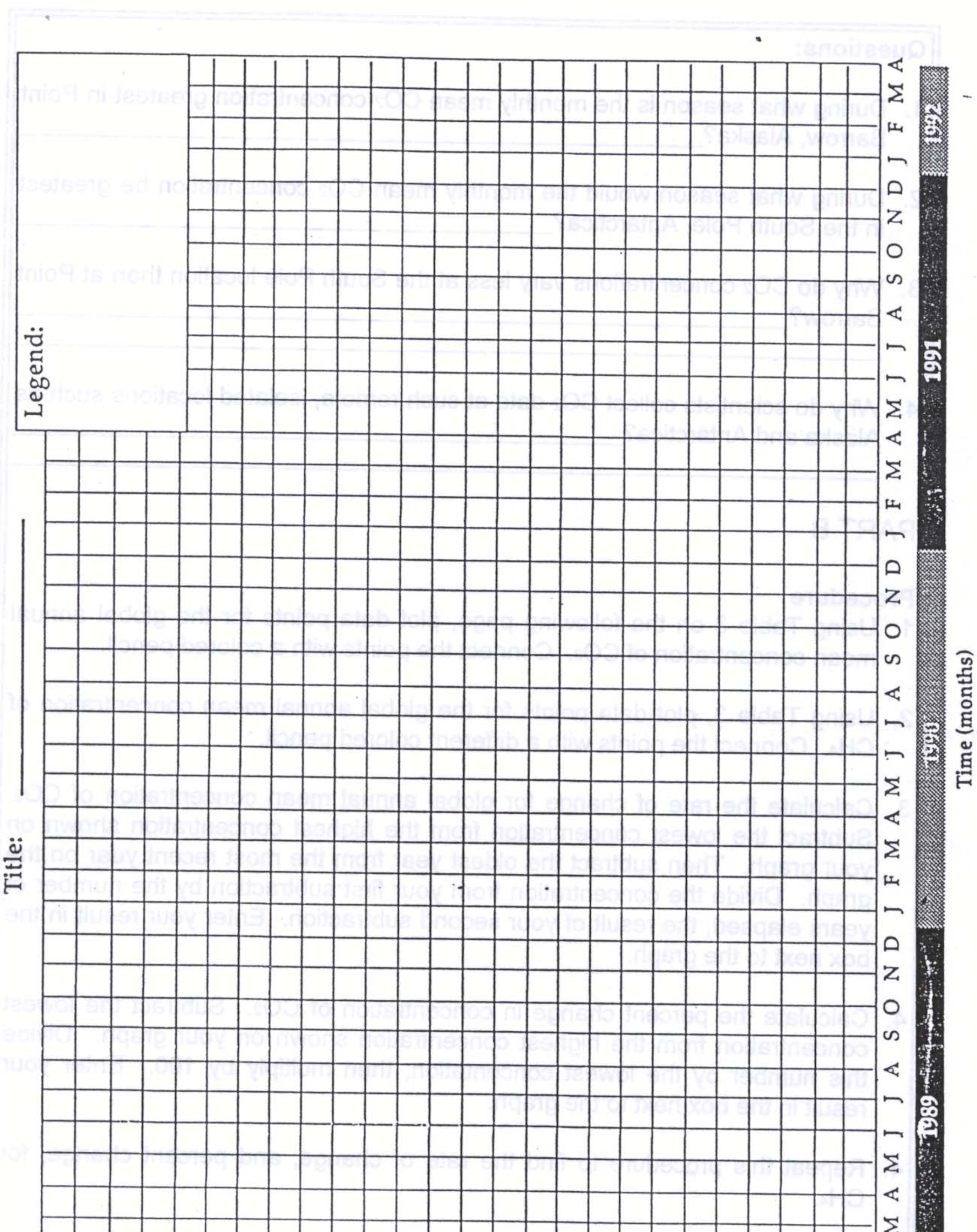
Month	1989	1990	1991	1992
Jan	360.88	359.81	360.82	361.62
Feb	358.16	359.85	362.09	362.21
Mar	359.15	361.24	361.16	362.48
Apr	359.27	361.04	361.73	362.55
May	358.74	360.48	361.52	______
Jun	357.04	356.77	359.80	______
Jul	349.34	349.49	353.69	______
Aug	344.48	345.74	347.44	______
Sep	346.18	346.37	348.28	______
Oct	351.19	353.81	356.21	______
Nov	355.81	356.63	358.34	______
Dec	358.29	359.21	360.87	______

Table 2. Monthly Mean CO_2 Concentration (ppm), South Pole, Antarctica

Month	1989	1990	1991
Jan	349.62	350.76	351.97
Feb	349.68	350.57	351.66
Mar	349.60	350.64	351.50
Apr	349.68	350.91	351.77
May	349.92	351.25	352.03
Jun	350.22	351.58	352.38
Jul	350.58	352.06	352.81
Aug	351.00	352.40	353.22
Sept	351.08	352.70	353.37
Oct	351.24	352.74	353.32
Nov	351.29	352.74	353.46
Dec	350.87	352.30	353.33

Questions:

1. During what season is the monthly mean CO_2 concentration greatest in Point Barrow, Alaska?____
2. During what season would the monthly mean CO_2 concentration be greatest in the South Pole, Antarctica?_____________________________________
3. Why do CO_2 concentrations vary less at the South Pole location than at Point Barrow?____
   ____
4. Why do scientists collect CO_2 data at such remote, isolated locations such as Alaska and Antarctica?____
   ____


Title:
Legend:
CO_2 Concentration (ppm)
370
368
364
360
356
352
348
344
340
336
332
328
324
320
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1989
1991
1992
Time (months)

PART B

Procedure

1. Using Table 3 below, plot (on the graph on the following page) data points for the global annual mean concentration of CO_2. Connect the points with a colored pencil.

2. Using Table 3, plot data points for the global annual mean concentration of CH_4. Connect the points with a different colored pencil.

3. Calculate the rate of change for global annual mean concentration of CO_2. Subtract the lowest concentration from the highest concentration shown on your graph. Then subtract the oldest year from the most recent year on the graph. Divide the concentration from your first subtraction by the number of years elapsed, the result of your second subtraction. Enter your result in the box next to the graph.

4. Calculate the percent change in concentration of CO_2. Subtract the lowest concentration from the highest concentration shown on your graph. Divide this number by the lowest concentation, then multiply by 100. Enter your result in the box next to the graph.

5. Repeat this procedure to find the rate of change, and percent change, for CH_4.

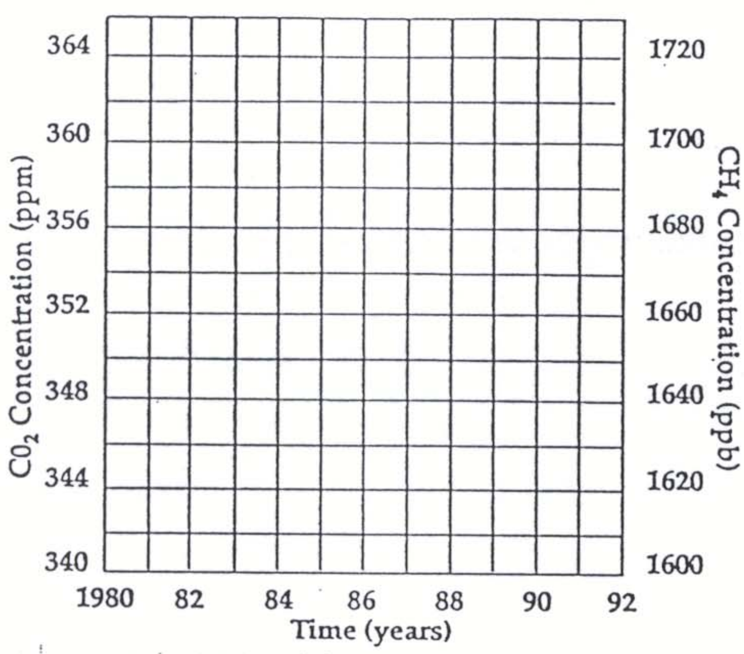
6. Print a title in the space provided above the graph.

7. Draw a color-coded legend for your graph in the space provided.

Table 3. Globally Averaged Annual Mean CO_2 Concentration (ppm)

Year	CO_2 (ppm)	CH_4 (ppb)
1981	340.23	-
1982	340.62	-
1983	341.97	1614.30
1984	343.75	1625.04
1985	345.26	1637.62
1986	346.56	1650.89
1987	348.53	1662.79
1988	351.11	1673.05
1989	352.60	1684.28
1990	353.82	1693.75
1991	355.07	1703.49

Title: ____________________



CO_2 Rate of Change:

CO_2 Percent Change:

CH_4 Rate of Change:

CH_4 Percent Change:

Legend:

Questions:

1. What happened to the CO_2 and CH_4 concentrations between 1983 and 1991?

   ____

   ____

2. Which gas showed the greatest rate of change, CO_2 or CH_4? Did this gas also show the greatest percent change? Which change is more significant?

   ____

   ____

3. Do these data alone support the idea of global warming? Explain.

   ____

   ____

   ____

ANSWER KEYS

Temperature Practice (page 5)

1. 29^0C
2. 84^0F

Relative Humidity Practice (page 7)

1. 81%
2. 79%
3. 68%
4. 54%

Paper Weather (page 8)

1. Answers will vary.
2. Answers will vary.
6. As one travels from the equator to the poles, the sun's rays shine at more of a slant, and are thus less powerful.
7. Answers will vary.

Weathering the Weather (page 17)

3. cold front
4. warm front
6. West-central Texas: 65
   Northeast Mexico: 92
   Maine: 56
7. Florida is warmest, Montana is coolest.
8. In the Southeast.
9. Along the fronts.
10. Florida: warm and sunny
    California: cool and sunny
    Missouri: thunderstorms
    Pennsylvania: becoming overcast
11. warm and humid; cooler weather on the way.
12. warm and humid as the warm front moves through.
13. Over the Rockies

On the Right Track (page 21)

2. Answers will vary.
3. No. The hurricane is more than 12 hours from landfall and is moving W - NW.
4. W - NW (toward the GA - SC border)
5. 2.8 degree latitude (193 nautical miles)
6. 28 N 73 W

7. Maybe. Northern Bahamas.
8. W - NW
9. No (watches may be issued). Maybe Northern Bahamas.
10. Yes
11. Yes
12. Northern Bahamas, Florida, Southern Georgia
13. No. It is within 12 hours of landfall.
14. W to W - NW
15. Florida West Coast
16. W - NW
17. Midnight to 3 a.m. August 3
18. 17 -20 hours (12 hours of daylight)

Too Much, Too Little, or Just Right (page 25)

Part A

1. late winter, early spring
2. spring (in Southern hemisphere)
3. South Pole is more isolated from heavily populated areas which produce CO_2 from the burning of fossil fuels.
4. High CO_2 levels even at these remote locations would indicate the seriousness of the problem.

Part B

CO_2 rate of change: 1.484 ppm/year

CH_4 rate of change: 11.149 ppb/year

1. both increased
2. CO_2 showed the greater rate of change. (compare the units! 1.484ppm/year = 1484.00 ppb/year)
   CH_4 showed the greater percent change. Since CO_2 concentrations in the atmosphere are naturally much higher than those of CH_4, the high rate of change in concentration of CO_2 compared to that of CH_4 is not as significant as it would first appear. Comparing <u>percent</u> changes more accurately reflects the changes that have actually occured.
3. One would also need temperature data to detemine if an increase in CO_2 and CH_4 levels corresponded with a increase in temperature.

The School Board of Miami-Dade County, Florida, adheres to a policy of nondiscrimination in employment and educational programs/activities and strives affirmatively to provide equal opportunity for all as required by:

Title VI of the Civil Rights Act of 1964 - prohibits discrimination on the basis of race, color, religion, or national origin.

Title VII of the Civil Rights Act of 1964, as amended - prohibits discrimination in employment on the basis of race, color, religion, gender, or national origin.

Title IX of the Education Amendments of 1972 - prohibits discrimination on the basis of gender.

Age Discrimination in Employment Act of 1967 (ADEA), as amended - prohibits discrimination on the basis of age with respect to individuals who are at least 40.

The Equal Pay Act of 1963, as amended - prohibits sex discrimination in payment of wages to women and men performing substantially equal work in the same establishment.

Section 504 of the Rehabilitation Act of 1973 - prohibits discrimination against the disabled.

Americans with Disabilities Act of 1990 (ADA) - prohibits discrimination against individuals with disabilities in employment, public service, public accommodations, and telecommunications.

The Family and Medical Leave Act of 1993 (FMLA) - requires covered employers to provide up to 12 weeks of unpaid, job-protected leave to "eligible" employees for certain family and medical reasons.

The Pregnancy Discrimination Act of 1978 - prohibits discrimination in employment on the basis of pregnancy, childbirth, or related medical conditions.

Florida Educational Equity Act (FEEA) - prohibits discrimination on the basis of race, gender, national origin, marital status, or handicap against a student or employee.

Florida Civil Rights Act of 1992 - secures for all individuals within the state freedom from discrimination because of race, color, religion, sex, national origin, age, handicap, or marital status.

School Board Rules 6Gx13- 4A-1.01, 6Gx13- 4A-1.32, and 6Gx13- 5D-1.10 - prohibit harassment and/or discrimination against a student or employee on the basis of gender, race, color, religion, ethnic or national origin, political beliefs, marital status, age, sexual orientation, social and family background, linguistic preference, pregnancy, or disability.

Veterans are provided re-employment rights in accordance with P.L. 93-508 (Federal Law) and Section 295.07 (Florida Statutes), which stipulate categorical preferences for employment.

REVISED 8/1/01