**7.E.1**

**Understand how the cycling of matter (water and gases) in and out of the atmosphere relates to Earth’s atmosphere, weather and climate and the effects of the atmosphere on humans.**

**7.E.1.1 Compare the composition, properties and structure of Earth’s atmosphere to include mixtures of gases and differences in temperature and pressure within layers.**

The earth has a variety of climates, defined by average temperature, precipitation, humidity, air pressure, and wind, over time in a particular place. The atmosphere is a mixture of gases, such as nitrogen (78%), oxygen (21%), argon (0.93%), carbon dioxide (0.04%), trace gases and water vapor. The amount of each gas in the mixture is usually very constant from the surface of the planet up to the top of the troposphere. These gases are constantly being used and renewed by the processes of respiration, photosynthesis, evaporation and condensation, the weathering of rock, and the decay of organic matter. The atmosphere has different properties at different elevations and different locations around the Earth. Air pressure, also known as atmospheric pressure, refers to the weight of the Earth’s atmosphere pressing down on everything at the surface. Air pressure varies slightly over the Earth’s surface, and variations in pressure are responsible for the weather. Low pressure is associated with storms, tornadoes, and hurricanes.

High pressure is associated with clear and dry conditions. The air pressure is less on the top of mountains (higher elevation) than in valleys. At the equator the atmosphere is warmer; at the poles it is cooler. The uneven heating of land and water causes a rising and sinking of warm and cool air masses creating convection currents and causes winds. Five layers make up the atmosphere: the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. Each of these layers has very unique properties. Weather occurs in the troposphere and is the physical condition of the atmosphere at a specific place at a specific time. Fronts, global wind systems, atmospheric pressure changes and many other factors influence the weather. Major atmospheric activities such as thunderstorms, tornadoes and hurricanes affect humans and can result in huge natural disasters. Air has weight. Air molecules are in constant motion and are affected by gravity. The force of this movement causes air pressure. Air pressure changes with elevation.

As you move up into the atmosphere, the air molecules are further apart. So, air pressure decreases as distance above the surface increases. Air pressure also decreases as the amount of water vapor in the air goes up. Since warm air is less dense than cool air, when temperatures are higher, the air pressure is usually lower. Air pressure is measured with a mercury barometer (mm of mercury) or and aneroid barometer (millibars-mb). The atmosphere has constant change but strives to maintain equilibrium.

**7.E.1.2 Explain how the cycling of water in and out of the atmosphere and atmospheric conditions relate to the weather patterns on earth.**

Water evaporates from the surface of the earth, rises and cools, condenses into rain or snow, and falls again to the surface. The water falling on land collects in rivers and lakes, soil, and porous layers of rock, and much of it flows back into the oceans. The cycling of water in and out of

the atmosphere is a significant aspect of the weather patterns on Earth. Sunlight provides the energy that evaporates water from the surface of Earth. Some of the water vapor comes from the continents, but most comes from the oceans. Winds carry the water vapor from the ocean over

the continents. Part of the water vapor condenses into clouds, then falls as rain or snow.

Some of the rain returns to the ocean from rivers and streams as runoff. Some seeps into the ground to become groundwater. Some returns to the air by evaporation from the ground or by

transpiration from plant leaves. When runoff from the continents returns to the ocean, one turn of the water cycle is completed. Other routes are possible. For example, water that evaporates from the ocean can return to the ocean as rain. The water cycle never ends. The salt water of

the ocean supplies fresh water to the continents over and over again. Weather is the state of the atmosphere at a given time and place. A complete description of the weather includes the amount and type of clouds. Rain, snow, thunderstorms, lightning, and even dust storms are part of the weather. Measurements of temperature, air pressure, wind speed and direction, and the amount of moisture in the air are also included in a description of the weather. Weather is studied and predicted by scientists called Meteorologists. The science of meteorology is the study of the entire atmosphere, including the weather. To understand and predict the weather, meteorologist must first understand how the atmosphere heats and cools, how clouds form and produce rain, and what makes the wind blow.

**7.E.1.3 Explain the relationship between the movement of air masses, high and low pressure systems, and frontal boundaries to storms (including thunderstorms, hurricanes, and tornadoes) and other weather conditions that may result.**

An air mass is a large section of the lower troposphere that has the same weather throughout. Air masses can form over continents, icecaps or the ocean. Air masses are controlled by patterns of heating and cooling over large areas of the Earth’s surface. Changes in air pressure readings indicate the passing of high and low pressure systems. Differences in air pressure cause Earth’s winds and weather changes. Storms are natural disturbances in the atmosphere that involve air pressure, clouds, precipitation, and strong winds. The major types of storms are thunderstorms, hurricanes, tornadoes, and winter storms. Each type has its own characteristics and dangers. Tornadoes are violently whirling winds sometimes visible as a funnel-shaped cloud.

They are produced by severe thunderstorms. Spiraling high winds and extremely low pressure are the unique features of tornadoes. Thunderstorms are known as electrical storms. A thunderstorm is characterized by the presence of lightning and thunder. They are produced rapidly when rising air causes cumulus clouds to build upward into a thunderhead. The cloud type associated with thunderstorms are cumulonimbus. Thunderstorms are usually accompanied by strong winds, heavy rain and sometimes snow, hail or no precipitation at all. Thunderstorms are brief, intense storms that affect a small area. Hurricanes are huge, rotating storms that form over the ocean near the equator. They produce very strong winds, heavy rains, and large, powerful waves and can cause severe flooding and damage from strong winds. Floods occur when an area is inundated with water.

Weather related flooding is most often associated with hurricanes and thunderstorms. Winter storms are associated with quickly moving cold fronts and they can produce high winds, very low temperatures plus include blizzards, ice storms, and large accumulations of snow.

**7.E.1.4 Predict weather conditions and patterns based on information obtained from:**

**•Weather data collected from direct observations and measurement (wind speed and direction, air temperature, humidity and air pressure).**

**•Weather maps, satellites and radar**

**•Cloud shapes and types and associated elevation**

The earth has a variety of climates, defined by average temperature, precipitation, humidity, air pressure, and wind, over time in a particular place. Weather forecasting is an attempt to make accurate predictions of future weather. The accuracy of weather prediction is improving as technology advances. A weather map is useful for making predictions. Weather maps usually show precipitation, wind direction, temperature, cloud cover, high or low pressure, cold and warm fronts, stationary and occluded fronts. Weather systems generally move from west to east across the USA. Long rang weather forecasting is more difficult than short-range weather predictions. Technologies such as computer, satellite images and radar enable forecasters to track movements of large-scale weather systems like air masses and fronts. Weather data collection results from using direct observations and measurements such as wind speed, wind direction, air temperature, humidity and air pressure. Wind direction can be shown by flags or blowing dust. The actual wind speed can be estimated by observing its affects. Temperature is a measure of the energy of molecules. The more energy the molecules in air have, the hotter it feels. Relative humidity compares the actual amount of water vapor in the air with the maximum amount of water vapor the air can hold at that temperature (its capacity). Differences in air pressure cause Earth’s winds and weather changes. Air pressure is simply the weight of the atmosphere per unit area. Air pressure is directed equally in all directions. Clouds have three simple names: Cirrus, Stratus, and Cumulus. These three names

represent the three main cloud types. Cirrus clouds are high level clouds and due to high altitude, the water is almost frozen to form ice crystals. If there are isolated Cirrus clouds, they do not indicate any instability in the weather and may not bring rain. However, if the clouds are dense, they often indicate that a storm might be approaching. Both Stratus clouds and Cumulus clouds are low-level. Stratus clouds are layered clouds that

usually bring a drizzle and there is widespread rain and in some cases ocean air. Cumulus clouds are neutral weather clouds. All the other clouds are combinations or variations of these types. Technology has greatly influenced the ease and accuracy of making weather predictions. Weather data at thousands of locations can be gathered instantaneously and applied to weather prediction models to produce weather maps. A cold front is the leading edge of a cooler air mass of air, replacing at ground level a warmer mass of air. The cooler, denser air wedges under the less-dense warmer air, lifting it. The upward motion causes lowered pressure along the cold front and can cause the formation of a narrow line of showers and thunderstorms when enough moisture is present. On weather maps, the surface position of the cold front is marked with the symbol of a blue line of triangles/spike pointing in the direction it is traveling. Cold fronts can move up to twice as fast as warm front and can produce sharper changes in the weather. Cold fronts are usually associated with an area of high pressure. A warm front is the leading edge of a warm air mass that displaces colder air, bringing a temperature increase and heavy rain where the front makes contact with the ground. On a weather map a warm front is represented by a solid line with semicircles pointing towards the colder air and in the direction of the movement. On a colored weather map, a warm front is drawn with a solid red line.

**7.E.1.5 Explain the influence of convection, global winds and the jet stream on weather and climatic conditions.**

Thermal energy carried by ocean currents has a strong influence on climates around the world. Areas near oceans tend to have more moderate temperatures than they would if they were farther inland but at the same latitude because water in the oceans can hold a large amount of thermal energy. Changes in weather involve air movements, formation of clouds, and precipitation. Energy is needed to make all these things happen. That energy comes from the sun. Convection is very important in moving heat through the atmosphere and the oceans. It transfers heat from one place to another. All winds result from uneven heating of the atmosphere. An island, is surrounded by cool water. During the day, the island heats faster than the water and so the air above the island becomes warmer. The molecules in the air become farther apart; so the air expands upward and outward. This expansion lowers the air pressure at the island’s surface. The cooler ocean air moves in toward the low-pressure area over the island. There is a pressure gradient between the ocean and the island. The wind moves form high to low pressure. The speed of the wind depends on the pressure gradient. The lower the pressure (the hotter the island), the steeper the pressure gradient and the stronger the wind. The pressure gradient provides the force that makes the wind blow. This force is called the pressure-gradient force. Wind speeds are very high in the upper troposphere. It is here that the spectacular jet stream is found. Jet streams are a fairly narrow zone of very strong winds in the upper troposphere. Jet streams are most common in the middle latitudes, so the winds in the jet streams are usually from the west. Winds are also influenced by the Coriolis effect, which is due to the Earth rotating on its axis. Rather than flowing directly from areas of high pressure to low pressure, as they would on a non-rotating planet, winds and currents tend to flow to the right of this direction north of the equator, and to the left of this direction south of the equator. This effect is responsible for the rotation of large cyclones. The Gulf Stream is a powerful, warm surface current in the North Atlantic Ocean. It is one of the strongest know currents. As the Gulf Stream reaches Cape Hatteras, North Caroling the cold current that flows from the north separates it from the coast. When the warm Gulf Stream waters from

the south (Florida) combine with the cold winds a dense concentration of fog forms along with an immense heat transfer causing atmospheric storms to intensify in this region.

**7.E.1.6 Conclude that the good health of humans requires: monitoring the atmosphere, maintaining air quality and stewardship.**

Air quality affects the quality of life for all organisms on Earth. Natural and human activities greatly influence the quality of the air. The environment may contain dangerous levels of substances that are harmful to human beings. Therefore, the good health of individuals requires monitoring the soil, air, and water and taking steps to make them safe. Air quality affects the quality of life for all organisms on Earth. Natural and human activities greatly influence the quality of the air. Technology has allowed us to measure the characteristics of the air and to monitor how air quality changes. This information helps us to make informed decisions to protect air quality and risks to human health and other organisms. The cumulative ecological effects of global ozone depletion, air pollution, increased particulate matter, acid rain, and global warming concern the entire global community. Studies have shown that the human impact on these factors has impacted the global system. Using less fossil fuel is the best way to improve air quality. Most forms of transportation and many industries produce carbon dioxide and add particles to the air and reduce the quality of the atmosphere. The burning of fossil fuels is the major cause of air pollution. Smog is a colloid of smoke, fog, and chemicals. Many areas have smog problems.

Smog irritates the lungs. The burning of fossil fuels releases large amounts of carbon dioxide and other gases into the air. Some of these gases mix with water vapor and then form acid rain. Acid rain is harmful to both

living and non-living things. Natural events also release pollutants such as forest fires, volcanic eruptions and plant pollen. Because air pollutants are often carried along by prevailing winds, acid rain may fall far from the source of pollution. Laws exist to help control and reduce air pollution. The Environmental Protection Agency (EPA) provides daily information about air quality. Local weather channels also issue information related to the health of the atmosphere. Air pollution does not consist entirely of man-made substances. Many pollutants are released directly from natural sources, and some pose as much of a health hazard as man-made substances.

These “natural” pollutants include radon, pollen and mold spores. Others are dust from plowed fields and volcanic eruptions. These eruptions could create situations where planes could not fly.