Lab 5

Weather and Climate Change

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Concepts to Explore

- Atmosphere
- Weather
- The Water Cycle
- Climate

Introduction

The Earth's atmosphere is composed of 21% oxygen (O_2), 78% Nitrogen (N_2), and ~1% other gases (including water vapor, argon, carbon dioxide, hydrogen, and helium). Oxygen is essential for life and is used by most organisms for cellular respiration while carbon dioxide is used by plants and certain bacteria for photosynthesis.

Figure 1: ***Clouds are visible accumulation of water droplets that accumulate in the Earth's lowest layer of the atmosphere, the troposphere.***

Our atmosphere is composed of five layers:

1. Troposphere - nearest to the Earth's surface; layer in which weather occurs (rising and falling air); comprises one half of total atmosphere; air pressure is decreased to 10% of that at sea level.

2. Stratosphere - contains the ozone layer (important for UV ray absorption).
3. Mesosphere - layer which meteors burn up in upon entering the Earth's atmosphere.
4. Ionosphere/Thermosphere - locations of auroras (e.g., aurora borealis); layer in which the space shuttle orbits.
5. Exosphere - upper limit of the Earth's atmosphere; layer where Earth's atmosphere merges with outer space.

Weather is the state of the atmosphere at a given time and place and includes temperature, pressure, the type and amount of precipitation, wind, clouds, etc. Weather conditions can change hour to hour, day to day, and season to season. Our weather is caused by uneven heating of the Earth from the sun. The resulting temperature differentials generate wind that forces warm air to flow to regions of cooler air. This flow can occur both horizontally across the surface of the Earth (e.g., from tropical to polar regions) and vertically, causing clouds, rain, and storms to develop as warm, moist air cools and condenses as it rises. In addition to driving our weather, the sun's energy also is responsible for regulating how water moves on, above, and below the Earth's surface through the water cycle.

Figure 2: ***The water cycle - can you name the steps? Refer to Lab 2 for help!***

The water cycle describes how the amount of water on Earth remains constant over time. Water exists in three different states (in solid form as ice, as liquid water, and in a gas as water vapor) and cycles continuously through these states. The temperature and pressure determine what state water is in. The water cycle consists of the following processes:

- Evaporation of liquid water to a gas (water vapor)

- Condensation of water vapor to liquid water
- Sublimation of solid water (ice) to water vapor (think dry ice)
- Precipitation occurs when water vapor condenses to clouds/rain
- Transpiration occurs when liquid water moves through plants from roots to leaves, changes to water vapor and is released to the atmosphere through holes (stoma) in the leaves
- Surface run-off occurs when water moves from high to low ground
- Infiltration occurs when water fills porous spaces in the soil
- Percolation occurs when ground water moves in a saturated zone below Earth's surface

Figure 3: ***Clouds.***

Clouds form at many different altitudes in the troposphere when water vapor in warm air rises and cools. The water vapor condenses on microscopic dust particles in the atmosphere and transforms into either a liquid or solid and is visible as clouds. Warm air can hold more water vapor than cool air. Thus, clouds often form over the tops of mountains and over large bodies of water, since the air over these formations is typically cooler than the surrounding air.

Climate is defined as the long-term average pattern of weather in a given region. Our climate is influenced by five components: the atmosphere, the hydrosphere (mass of liquid water), the cryosphere (mass of solid water; ice), the land surface, and the biosphere (life on Earth). Climate change refers to the observed accelerated increase in the Earth's temperature over the past 100 years and its predicted continued increase. The Earth's average temperature has increased approximately 1 - 1.5 degrees F since 1900 (see figure below) and is projected to rise an additional approximately 3 - 10 degrees F over the next 100 years.

Changes in the Earth's atmosphere have contributed to global warming. Global warming is due to the accumulation of "greenhouse gases": carbon dioxide (CO_2) from burning fossil fuels (oil, gas, and coal); methane (CH_4) from agriculture, landfills, mining operations and gas pipelines; chlorofluorocarbons (CFCs) from refrigerants and aerosols; and nitrous oxide from fertilizers and other chemicals. Increased temperature results in increased evaporation, accelerated polar ice melting, increased number of extreme temperature days, heavier rains/floods, and more intense storms. These changes will have important implications across public health, infrastructure, energy, economic, and political arenas.

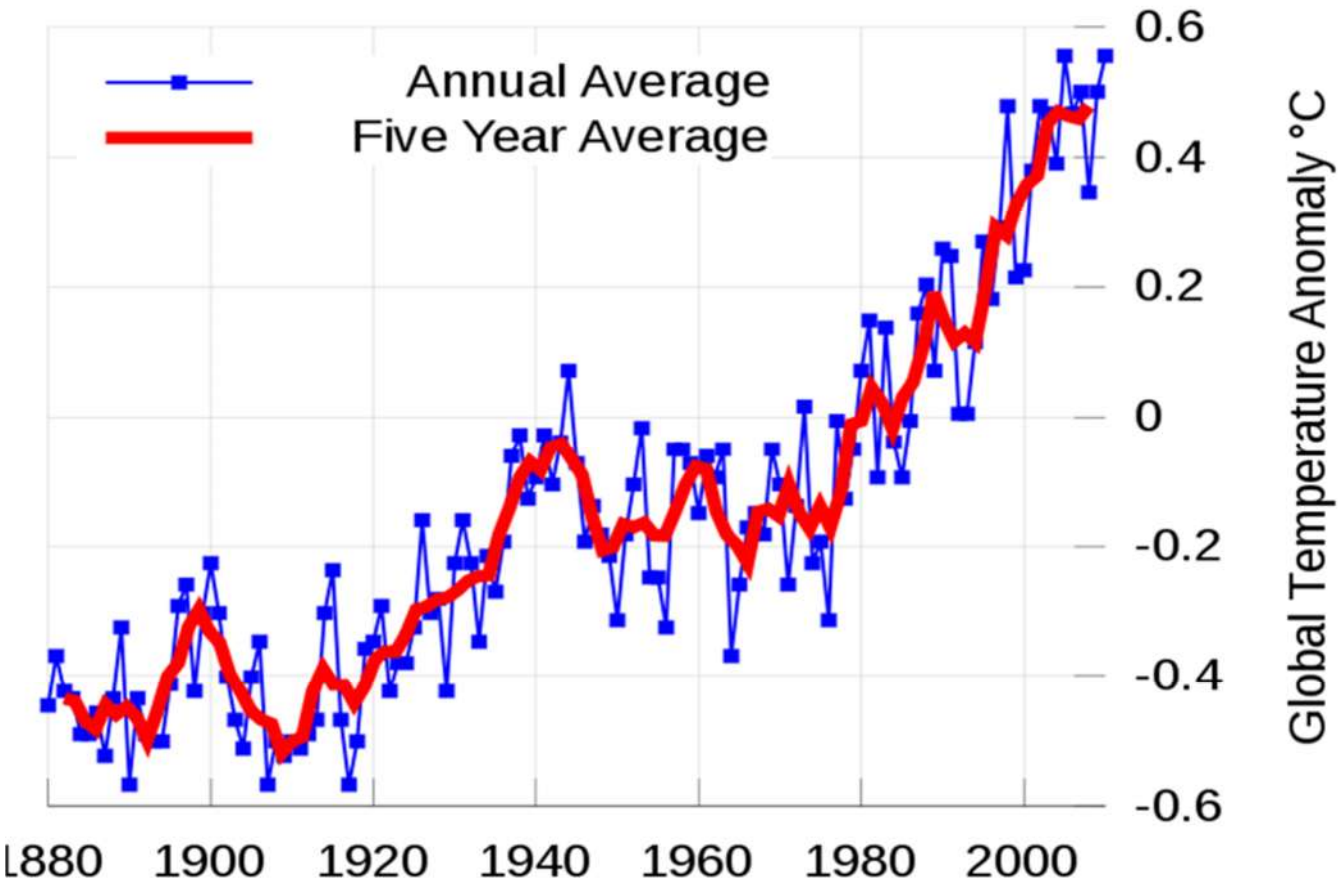

Figure 4: ***Global Temperature Anomalies. Source: www.nasa.gov***

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Demonstration 1: Modeling the Water Cycle

In this experiment you will observe how entrapped water moves from land to the atmosphere and determine how weather conditions affect this movement.

Materials

100 mL Graduated cylinder
Canning jar
Petri dish
Thermometer
*Hot water
*Water
*Ice cubes

*You must provide

Procedure

1. Using a graduated cylinder, carefully pour 20 mL of warm water (60°C) into the canning jar and secure the lid.
2. Fill the petri dish with ice and place on top of the canning jar's lid.
3. Observe the jar every 5 minutes for 30 minutes. After 30 minutes, remove the petri dish and carefully remove the lid and look at the underside.

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Experiment 1: Assessing Infiltration

In this experiment, you will observe how entrapped water moves from land to the atmosphere and determine how weather conditions affect this movement.

Materials

(2) 9 x 12 in. Bags

250 mL Beaker

400 mL Sand

*Water

*A sunny location (window sill, outside porch, etc.)

*A shady location

*You must provide

Procedure:

1. Record your hypothesis in post-lab question 1. Be sure to indicate how you expect the environment within the bag to change over the course of the experiment.
2. Measure 200 mL sand into each plastic re-sealable bag.
3. Measure 200 mL room temperature water into each bag.
4. Seal each bag, leaving a bit of air in each.
5. Place 1 bag in a sunny location and 1 bag in a shady location.
6. Observe the bags after 1 hour, then again after 12 hours. Record your observations in Table 1.