Demonstrating Climate Change and the Water Cycle to Fifth Grade Students

The format of this activity was a presentation using a laptop and projector, interspersed with demonstrations and experiments that involved the students. The students were provided with separate worksheets to record their observations for each of the activities. This overview will show the chronological order in which the information was delivered and the activities carried out. I usually asked students to help explain the concepts on the slides or offer suggestions before I explained something.

**Supplies**

**Demo A**
- Thermometer (preferably digital)
- Lamp of light with 75-100 W fluorescent light bulb
- Glass bowl
- Worksheet A for each student

**Demo B**
- Glass
- Cold colored drink (Coke, Gatorade)
- Paper towel
- Worksheet B for each student

**Activity C**
- Cooler/ freezer to keep materials cold
- Ice cubes
- Freezer packs (at least 2)
- Hot packs (at least 2)
- Water at room temp
- Transparent plastic containers and lids (8 oz deli containers are perfect, I used cheap clear plastic flower pot holders from a big chain drugstore)

- Pen to label the stations
- Dishtowel for spills
**Preparations**

A. Greenhouse Demonstration
   Before starting the presentation, set up a thermometer (preferably with a digital readout that students can see) on a blank surface and position a light fixture with a fluorescent bulb about one to two feet above. It’s important to use a fluorescent bulb, because these don’t generate a lot of heat as waste, and we’re after the visible radiation only. Turn the light on and by the time you’re finished with the first four slides, the thermometer should be reading a constant temperature.

B. Water Vapor Demonstration
   Also before starting the talk, pour a cold colored drink (Gatorade, Coke) into a glass and leave it off to the side until slide 9.

C. Climate Change & Water Cycle Activity
   Some hotpacks need time to activate so experiment beforehand. I found that the kind I used worked best if I had left them exposed to air starting at the beginning of the presentation so that by the time the activity begins, they are sufficiently hot. Also, don’t keep the water you will use near the ice. The experiment works much better if it’s near room temperature.

**Presentation**

Slide 1 – Title Slide
   Good opportunity to discuss the difference between weather and climate as a matter of timescales: day-to-day variability versus long term averages. Even though weather for any one given day in the future can be hard to predict, we can be reasonably certain about a normal range of conditions at a given place during a given season.

Slide 2 – Greenhouse Effect
   How does a greenhouse keep plants warm? The glass is transparent to some wavelengths of light, like those emitted by the sun, shown in yellow, and lets their energy enter the greenhouse. This warms the surface, causing it to emit infrared radiation, which is invisible, though shown in the picture by red arrows. The glass blocks the infrared radiation, trapping it in the greenhouse and causing it to warm up.

Slide 3 – Greenhouse Effect on Earth
   The atmosphere is a layer of gases surrounding the Earth, comprised mainly of nitrogen and oxygen (drawn much thicker than actual scale). The main components of the atmosphere are transparent both to the radiation from the Sun and the radiation from Earth going back out to space. Some minor components in the atmosphere (carbon dioxide, methane, and even water and others) act like the glass walls in the greenhouse by trapping the heat radiated by the Earth, causing temperatures near the surface to rise. This natural greenhouse effect is beneficial because without it, the average temperature at the Earth’s surface would be 5°C rather than 60°F as it actually is. Without the presence of
trace amounts of greenhouse gases to trap some of the heat leaving Earth, most of the water on the planet would be frozen.

Slide 4 – Global Warming on Earth
Global warming, or more generally climate change, is being caused by human activities that add additional greenhouse gases into the atmosphere. These include combustion of fossil fuels, mainly from driving and power stations, nitrous oxide emissions due to fertilizer use, methane emissions from livestock. Ask students for suggestions.

Slide 5 – You will be demonstrating the greenhouse effect to the students using the blank surface to represent the Earth and the fluorescent light bulb to represent the sun. A glass bowl will play the role of the greenhouse. Place the bowl over the thermometer and make a reading of the temperature for the time = 0 minute point. Throughout the rest of the activities, have the students make a reading of the temperature every five to ten minutes. A stopwatch can help as a reminder of when to make a measurement. It often helped to also record the measurements on a table on the blackboard so students didn’t worry about missing anything. The temperature difference at the surface with and without the bowl is a measure of the greenhouse effect caused by the bowl trapping infrared radiation from the surface.
Note- this experiment works less well near large windows in sunny classrooms because of other greenhouse effect from the real sun and glass! Use a 75 or 100 W bulb for best results.

Slide 6 – States of Matter
Review with the students the three states or phases of matter and their properties:
Solid - retains a fixed volume and shape, not easily compressible, does not flow easily
Liquid – assumes the shape of the part of the container it occupies, not easily compressible, flows easily
Gas – assumes the shape and volume of its container, compressible, flows easily

Slide 7 – States of Water
Brainstorm with students examples of water in the three states/phases in the environment.
Ice, snow, hail, glaciers; rain, oceans, dew, lakes, rivers; steam
It’s helpful to remind students that water vapor is made up of such tiny molecules, that it’s much too small to see, so even when there’s lots of water vapor in the air, it’s invisible.

Slide 8 – State Changes of Water
Review the vocabulary, asking students for help, of the names of the processes that convert water from one state to another. Ask them what role temperature plays in these conversions.

Slide 9 – Water Vapor Experiment
Students have a worksheet to fill in for this experiment. Retrieve the glass of cold drink and confirm with students that there is liquid water on the outside of the glass. Ask students where it came from. Many students will think that it leaked through the glass
from the inside. How to prove this idea wrong? Wipe the outside of glass with a paper
towel to show that the liquid is clear, whereas the liquid inside the glass is colored. Lead
the students through the remainder of the worksheet. The most important thing from them
to take away from the exercise is the idea that water vapor exists in the air, even though
it’s invisible, and that when it comes into contact with a cold surface, it can condense
making us able to see it.

Slide 10 – The Water Cycle
Use this picture to help brainstorm with students about the parts of the water cycle and
where water is found in the environment.

Slide 11 – The Water Cycle continued
Evaporation often happens where it’s warm, and over large bodies of water.
Water vapor in the air is transported by wind and condenses to form clouds when the
temperature falls. Eventually the clouds may precipitate as rain or snow depending on the
temperature. The snow may stay as a snowpack during the winter or melt to become
liquid. The water will eventually become runoff moving through lakes, streams, and
rivers before returning to the ocean. (This picture leaves out groundwater which is quite
important in many places, but not so much in this region of California for water supplies).

Slide 12 – Precipitation Map
People need water supplies for lots of activities: drinking, washing, manufacturing,
agriculture. Most people in California live in areas of low precipitation. They rely on
reserves of water that accumulate in other parts of the state, especially the mountains,
where snow and rainfall is relatively high. (You can probably find a precipitation map
like this for most regions of the world.)

Slide 13 – Astronaut Photo
In the case of Oakland, the East Bay Municipal Utilities District provides our water. The
water supply for EBMUD comes from a watershed, the Mokelumne River basin, in the
Sierra Nevada mountains to the east of Oakland, outlined in blue on the map. A
watershed is a region of land where all water existing within its boundaries flows to a
single place. Aqueducts carry the water from the Pardee and Camanche Reservoirs across
the Central Valley to smaller reservoirs and customers in the East Bay. The mountains
are obviously a good place to collect water because the precipitation rate is fairly high
there. Also, temperatures are colder, so less water in the reservoir is lost to evaporation.
Students really like the astronaut photo and it is worth spending some time pointing out
different features to them. This photo is taken in winter and the snowcaps on the
mountains and icy bodies of water are evident. Visit the NASA website for photos of
other areas.

Slide 14 – Water Supplies
The water supplies for the residents of Oakland depend on the amount of water collected
in the Mokelumne River Basin, which depends in turn on the rate of precipitation in the
mountains. The top panel of this figure shows the snowfall in the mountains over four
years, while the bottom panel shows the flow into the reservoir for each of those years.
Notice that the streamflow is delayed in time from the snowfall because it is increased by springtime snowmelt. Also, the years where snowfall is low, the streamflow into the reservoir is also low, meaning less water for the customers. EBMUD says if there is a drought in the future, the current watershed will not have a large enough supply of water to provide its customers.

Slide 15 – Activity C
Prepare four different stations (or multiple copies of each) so that every student in the class will be able to observe every station. I usually had two copies of each station and in classes where students sat at tables of four, the stations were passed from table to table until everyone had recorded observations about each station. The ‘hot’ stations have a clear plastic container sitting on a hotpack, the ‘cold’ stations have a clear plastic container sitting on a freezer pack. One cold station should have water in the container, one should have ice, same pairs for the hot stations.

Ask the students to fill in Worksheet C, regarding their observations of the processes occurring inside the container at each station. This is where Demo B comes in particularly handy, because sometimes condensation forms outside the container, which could be confusing, but they can figure out if it’s happening inside or outside the container by seeing if they can wipe it away. Remind the students that condensation forming on the lid of the container is a sign that liquid water has evaporated to form vapor, expanded to occupy the entire volume of the container (as a gas does) and then recondensed on the lid when it came into contact with a cold surface.

Give the students the opportunity to fill in the table on Worksheet C and try to answer some of the questions on their own. Then go through the answers to the worksheet with the class. I generally found that many of the students had made the right connections on their own.

At the end, brainstorm some ideas about how to reduce emissions of greenhouse gases and conserve water with the students.