Climate Change in my Backyard
Activity Guide for Grades 7–9

Unit 1: The Earth as a System

Unit 1 is divided into two sections that consider different Earth systems and how they interact. In 1A, students explore the Earth systems that create and affect climate including the Earth's energy balance and the greenhouse effect. They learn what the natural and human causes are of greenhouse gas emissions and explore how the sun's energy, greenhouse gases, and the Earth's surface interact to moderate global average temperature. They use a NASA data analysis tool to model different surface reflectivity and greenhouse gas scenarios. In 1B, students learn about the biosphere as a system. They explore how organisms interact with each other and their environment, how disturbances (such as climate change) can be felt throughout a food web. Finally, students learn about ecosystem services—the importance to humans of healthy, intact ecosystems.

1A. The Earth's Energy Balance and the Greenhouse Effect

Activity 1.1: Understanding the Greenhouse Effect
1. Greenhouse Effect Lab: Students complete a lab activity that models the greenhouse effect and then discuss the natural vs. human-induced changes in greenhouse gas concentrations.
2. The Earth's Energy Balance: Students create a diagram of the Earth's energy balance, answer opinion questions, and perform a skit to understand the Earth's energy balance. Students learn that all energy on Earth originates from the sun and what happens to the energy once it reaches the Earth's atmosphere. Students are introduced to the concept of greenhouse gases.

Activity 1.2: Micro-GEEBITT (Global Equilibrium Energy Balance Interactive Tinker Toy)
Students use the NASA Micro-GEEBITT climate-modeling tool to explore how changing variables in Earth systems impact global average temperature. Students model the effects of changes in surface reflectivity and greenhouse gases in different climate and emissions scenarios.

Activity 1.3: Greenhouse Gas Emissions—Natural & Human Causes
In this activity, students dig deeper into the greenhouse effect and explore natural and human-caused greenhouse gas emissions. Students brainstorm, and then research, factors that contribute to greenhouse gas emissions. They use the energy balance diagram they completed in Activity 1.2 as the basis for a new diagram that incorporates natural and human causes of greenhouse gas emissions. Students also brainstorm how they can reduce their contributions to greenhouse gas emissions.

1B. Ecosystems and Climate

Activity 1.4: Nature Walk & Ecosystem Introduction
Students take a walk through nature and make observations of their surroundings. Students then act as different elements in and ecosystem—both biotic and abiotic—and demonstrate the interconnectedness between them. The activity provides both visual and tactile demonstrations of the interconnectedness of all components of an ecosystem, and explains that they are dependent on each other for survival.

Activity 1.5: Leaf Litter Ecology lab
Students examine the ecology of a local leaf litter (the forest floor) community. Students collect and identify the living organisms on the plot, identify the trophic levels, and create a food web and a pyramid of biomass. Students then discuss how this demonstrates the carbon cycle.

Activity 1.6: Food for Thought, Climate Change, and Trophic Cascades
Students will watch a video clip and read an article about the impact of melting ice on the Arctic food web. Students diagram food webs with and without the effects of climate change, and will learn the concept of a "trophic cascade."

Activity 1.7: Ecosystem Services
Students will be introduced to the concept of ecosystem services. Ecosystem services are functions and values of intact ecosystems to humans. Students will research ecosystem services in different states/regions.

Unit 2: Identifying the key changing conditions of the Earth system

In Unit 2, students learn about the difference between weather and climate. They then look at historical temperature cycles including paleoclimate data, more recent historical temperature changes, and current changes in temperature. They then expand the climate model beyond temperature to look at changes in precipitation and cloud cover in the United States. The unit continues by having students compare regional climate changes with overall global trends to identify similarities and differences in climate by region. Students recognize that climate change does not affect all areas of the globe equally or in the same ways. The unit concludes by having students write a persuasive essay using what they know about climate and ecosystem responses to climate change.

Activity 2.1: Climate and Recent Weather Patterns
1. Weather or Not: Students review the difference between weather and climate.
2. Recent Weather Patterns: Students then research current and recent historical weather using forecasts from newspapers and the web from different locations around the country. Students also research the climate of these locations and discuss differences in individual weather reports and descriptions of climate. They pose the question: how much data and what data do we need to determine whether the climate is changing?

Activity 2.2: Historical Climate Cycles

1. Visualizing Historical Climate Cycles: This activity introduces students to the idea of historical climate cycles. Students will observe temperature data from the past 400,000 years to understand that Earth's climate has changed in the past.

2. Graphing Climate Cycles: Students graph temperature data from 10,000 years ago to the present to create a visual representation of how temperatures have increased at an accelerated pace in the recent past, as compared to the historical climate record. If desired, students can place key events in environmental and human history on the timeline to demonstrate the time frame of historical climate change, and to begin to understand the relationships between humans and climate.

3. Explaining Temperature Variation: Lastly, students compare the graph of temperature over the past 400,000 years along with a graph of carbon dioxide concentrations during that time. By analyzing these graphs together, students recognized the connection between atmospheric carbon dioxide concentration and temperature.

Activity 2.3: Climate Change Around the World

Up until now, students have focused on only on temperature when evaluating the impacts of climate change. Now, students will discuss and add other climatic factors to their analysis and investigate how changes in atmospheric carbon dioxide levels impact temperature, and can also create changes in regional precipitation and cloud cover. Students then use the MY NASA DATA website to determine whether global patterns of climate change are directly reflected in their city and in cities around the world. They discuss why different locations around the world are affected differently or to different degrees by changing climates.

Activity 2.4: Causes and Effects of Climate Changes

This activity will give students an opportunity to work alone and in groups to summarize what they have learned so far about climate change. Students use graphic organizers to identify the natural and human-induced causes of climate change and its effects on plants, animals, and humans.

Unit 3: Earth system responses to natural and human-induced changes

In Unit 3, students learn about how living things and ecosystems respond to and are affected by changing climates. Students learn about how plant life-cycle events can be used to understand climate and how they have been used in the past. They participate in Project BudBurst, a national citizen science project, and study how changing climates impact the timing of plant life-cycle events. Students explore the impacts of changing climates on plant migration by calculating seed dispersal rates for a variety of plant species and predicting whether they will be able to migrate quickly enough to keep pace with changing climates. Lastly, students analyze phenology and "green up" data to draw conclusions about changing climates, and their effect on plants.

Activity 3.1: Migration, Adaptation, and Changing Climates
Students will discuss the various ways that living things deal with changing climates including adaptation and migration. Later, students will reflect back on these ways and determine which adaptations could benefit a plant that is exposed to a changing climate.

Activity 3.2: Seasons of a Plant
Students are introduced to the concept of phenology, the timing of periodic life-cycle events. Students begin by distinguishing between biological and environmental events in an ecosystem (first snow vs. first flower). They place their events on a calendar and then brainstorm what might happen if these biological events didn't happen one year. Students then go outdoors and individually or in small groups make observations of actual phenological events.

Activity 3.3: Preparing for Project BudBurst
This activity serves as an introduction to phenology and project BudBurst, and will prepare students to start collecting data. In this activity students learn how to use the Project BudBurst website, begin to collect and record data on plant phenology, and add that data to the Project BudBurst database (data collection will be ongoing throughout the rest of the curriculum).

*NOTE: **BudBurst data collection can begin at any point in the curriculum.** Before you begin data collection, implement **Activity 3.3: Preparing for Project BudBurst,** and continue making observations as often as possible so students are able to observe each phenological event.*

1. Mystery Plant ID: Students make observations of plants unfamiliar to them, create a field guide for their plants, and practice identifying other plants by using their classmates' field guides. This activity will exercise students' observation and scientific communication skills and provide students with practice identifying plants in preparation for the other activities. This is an outdoor activity, but can also be done inside on collected or purchased flowers/plants.
2. BudBurst Data Collection: Students collect data on their chosen plant species throughout the growing season and enter it into the BudBurst website over a period of weeks or months. Students can write the data on the BudBurst data collection sheets Plant ID sheets and phenophase guides are available on the BudBurst website.

CHICAGO BOTANIC GARDEN

Activity 3.4: Plant Migration and Seed Dispersal Methods
1. <u>Seed Dispersal Predictions</u>: Students will make observations about different types of seeds, and based on those observations, make predictions about how those seeds are dispersed.
2. <u>Seed Dispersal Experiment</u>: Students will put their predictions to the test, by using a fan, water, and material to see which seeds float, stick to animal fur, or are wind-borne.
3. <u>How Far Can Seeds Travel?</u> Students will calculate how far different dispersal mechanisms are likely to move seeds over a given period of time. Students use average range and migration distance to calculate how far animal dispersed seeds might travel, experiment using a fan for wind dispersed seeds, and consider how far water-dispersed seeds travel using a global map of ocean currents. They also consider the constraints of their experiments and how those constraints (e.g. using a fan rather than wind) might affect the accuracy of their results.
4. <u>Assisted Migration</u>: Students consider the implications of plants' ability to migrate in the context of changing climates and debate whether or not humans should use assisted migration techniques to help plants migrate.

Activity 3.5: Plant Phenology Data Analysis
1. <u>Meet the Naturalists</u>: Students will learn the story behind more than 150 years of plant phenology data collected in Concord, Massachusetts. First, students will be introduced to five individuals who collected data in this location.
2. <u>Graphing Historical Data</u>: Students will graph historical plant phenology data and draw conclusions about how climate and climate change affect plant phenology.
3. <u>BudBurst and NASA "Green-up" Data</u>: Students then compare the historical data, and their BudBurst data, to NASA satellite imagery and graphs showing seasonal plant growth (Normalized Difference Vegetation Index (NDVI)). Students discuss how BudBurst can contribute to our understanding of plants' responses to climate change.

Unit 4: Predicting the consequences of changes for human civilization

In Unit 4, students learn that climate change affects people in different ways, that climate change has many types of impacts, and that these impacts are different for countries and people around the world. In a role-playing game, students take on the situations of people around the world who are being affected by changing climates in different ways. They then consider how their own personal actions contribute to climate change and investigate in more detail its specific impacts on ecological systems and human civilization. Students then choose a region of the world and investigate how this country or area has been affected. Students present their research to the class. The unit concludes with student reflections on what they have learned about climate change, how it has changed their attitudes, and whether they will make any personal changes as a result.

Activity 4.1: Faces of Climate Change
Students role-play to learn about the social, political, economic, and personal impacts of climate change on individuals in other parts of the world.

Activity 4.2: Climate Change Impacts Ecosystem Services
1. Global Impacts of Climate Change: Students begin to make connections between their actions and climate change. Students participate in a jigsaw to teach one another how climate change will affect the natural world, focusing specifically on how changing climates will affect the services that ecosystems provide to humans (economic, environmental, social etc.). In the next activity, students will research impacts of climate change in a specific area of the world.
2. Regional Impacts of Climate Change: Students will research the impacts of climate change for a particular state, region, or country around the world. Students use their research to create a presentation, poster, newsletter, or letter to a government official. Students present their research to the class.

Activity 4.3: Calculating Your Ecological (or Carbon) Footprint
Students will understand the concept of a carbon footprint. They will use online calculators to visualize how their choices affect the planet.

Activity 4.4: Personal Choices and the Planet
1. What Can I Do? This lesson focuses on positive steps students can take to reduce their ecological footprint. During the opening of the lesson, revisit the concept of energy use, then students will identify how changes in their daily habits can reduce their carbon footprint.
2. School Sustainability Audit: Students use authentic sustainability checklists to audit the energy, paper, waste, and water use at their school. They report back to school administration and propose sustainability measures that can be implemented by the school.