GLOBE Connections: Changes in Snow and Ice Extent
GLOBE protocols and learning activities that complement the Changes in Snow and Ice Extent phenomenon through hands-on investigations are detailed below. Students can conduct their own investigations and see how their data related to global patterns by using GLOBE and My NASA Data together.

Visit the GLOBE Cryosphere Protocols & Related ESDE Datasets page that outlines the datasets available in the Earth System Data Explorer. These data complement student GLOBE investigations using the following protocols.

### Changes in Snow and Ice Extent

Ice, which covers 10 percent of Earth's surface, is disappearing rapidly. While the Arctic sea ice extent is declining, air temperatures are rising. Vegetation is changing, with tundra being replaced by shrubs. Permafrost is warming and thawing over parts of the Arctic.

Students can use GLOBE protocols to study changing temperatures, permafrost and fresh water ice.

### Protocols

GLOBE protocols can be used to collect many types of data to explore the conditions related to formation and melt of sea and land ice. Students can use the protocols to collect data and share their
data with other GLOBE students around the world.

Arctic Bird Migration: Over the year, students observe when specified migratory bird species first arrive and count their numbers until few or none of them remain.

Student Outcomes:

- Students will learn to identify different species of birds, their migratory patterns and behavior, as well as using standardized methods to gather scientific data

Freshwater Ice Phenology

The purpose of the Freshwater Ice Phenology Protocol is to monitor the freeze-up and breakup processes on a selected pond/lake or large creek/river to determine the duration of the annual ice
cover. Students will select an easily accessible pond/lake or large creek/river close to their school that is known to develop an ice cover in the winter and observe and document its freeze-up and break-up.

**Frost Tube:** Students will construct a Frost Tube that is inserted into a hole in an undisturbed and uncompacted soil. During the cold months, students will measure the depth at which water in the Frost Tube freezes, indicating that the surrounding soil has frozen.

**Student Outcomes:**

- Observe when water in the Frost Tube freezes
- Collect and analyze data related to freezing of soil to understand how soil temperature and moisture coincide with changes in seasons across different biomes
- Examine relationships among air, soil and permafrost
- Communicate project results with other GLOBE schools
- Collaborate with other GLOBE schools (within your country or other countries)
- Share observations by submitting data to the GLOBE archive
- Compare the timing and depth of freezing in soils in different regions around the world
- Predict the timing and depth of freezing for upcoming seasons (advanced)

### Precipitation Protocols

**Purpose:** To determine the amount of moisture input into the local environment, monitoring how precipitation inputs change due to seasonal variations.

**Overview:** Students use a rain gauge and a snowboard to measure the daily amount of precipitation that has occurred. Students measure the depth and rain equivalent of each day’s snow and of the total snowpack. Special pH measuring techniques for precipitation are used to determine the pH of rain and melted snow.

**Student Outcomes:**

- Students will understand that precipitation is measured in depth and this depth is assumed to be equal to the amount of rainfall.

### Precipitation

Students use a rain gauge and a snowboard to measure the daily amount of precipitation that has occurred. Students measure the depth and rain equivalent of each day’s snow and of the total snowpack. Special pH measuring techniques for precipitation are used to determine the pH of rain and melted snow.

**Student Outcomes:**

- Students will understand that precipitation is measured in depth and this depth is assumed to
apply to a large area, that precipitation has a pH that can vary, and that snow is an input of water to the surface just like rain and each snowfall is equivalent to some amount of rainfall.

**Snowboard Construction:** A snowboard is a thin, flat surface that rests on top of earlier layers of snow. New snow falls on top of it and can be measured with a meter stick.

**Student Outcomes:**

- Prepare the snowboard to collect more snow

**Solid Precipitation:** Students will measure the amount of new snow that has collected on your snowboard in comparison with the total depth of snow on the ground.

**Solid Precipitation Protocol**

**Field Guide**

**Task**
- Measure the amount of new snow that has collected on your snowboard.
- Measure the total depth of snow on the ground.
- Obtain samples of new snow and snowpack for pH measurement.
- Obtain samples of new snow and snowpack to determine the water equivalent.

Prepare the snowboard to collect more snow.

**What You Need**
- A meter stick (or a longer measurement tool that can be used to measure the new snowfall)
- A snowboard
- A straight-edged container
- The overflows tube from your own group
- Two clean samples jars with covers
- A container for the snowpack
- pH equipment sample

**In the Field**
1. Insert the measuring stick vertically into the snow until it rests on the granite bedrock or is otherwise unable to be seen. Mark the depth on the stick.
2. Repeat the measurement in at least two places where the snow is least affected by drifting.
3. Report all of these numbers as the same measurement if the snowpack is so small that a depth cannot be read, record the letter "N" for need for total snowpack.
4. After a new snow has fallen on earlier snow, gently insert the measuring stick vertically into the snow until it touches the snowboard. Read and record the depth of new snow. If the new snow is shallow, record 0.0 as the depth of new snow.
5. If there is no new snow, take at least two more measurements at different spots on the snowboard. Record the total depth of snow.
In the GLOBE Learning Activity, *An Alaskan Spring Mystery: A GLOBE Data Exploration*, students analyze data about the timing of budburst for a tree species over three years in the same location. They investigate two different hypotheses for why timing differs by analyzing weather data from the same time period.

**Student Outcomes:**
- Analyze different types of data (phenology, temperature, rainfall)
- Form hypotheses based on their analysis of a dataset
- Test hypotheses with environmental data
- Come to a conclusion about the impacts of environmental factors on budburst and explain their reasoning

---

Figure 1. The global distribution of the eight biogeographic realms and the 14 major biomes. Source: GLOBE Getting to Know Your Terrestrial Biomes
Getting to Know Your Terrestrial Biomes

Help students become familiar with the Terrestrial Biome Classifications that the Seasons and Biomes project has adopted. Changes in snow and ice extent contribute to biome classification.

Student Outcomes:

- Use appropriate sources of information
- Synthesize data from different sources to create a coherent description of the main biomes
- Identify appropriate sources of information
- Organize data into tables
- Draw conclusions by synthesizing a variety of data
- Communicate results and explanations

How to Make a Climograph from Your Local Weather Data

Purpose: Students will assemble, analyze and graph the long-term air temperature and precipitation data for their general area, to understand the difference between weather and climate. These data can include snow and ice.

Student Outcomes:

- Weather is a day-to-day phenomenon and climate is a long-term average of weather
- The sun is the major source of energy for changes on the Earth’s surface
- Organisms’ functions relate to their environment
- Sunlight is the major source of energy for ecosystems
- Identify appropriate data sources
- Perform simple statistical calculations
- Organize data into tables and graphs
- Use appropriate tools and techniques
- Draw conclusions by synthesizing a variety of data
- Communicate results and explanations

Sources:

GLOBE Website