Two activities are presented that engage students in the scientific process of collecting, analyzing and interpreting snow data to:

1. Learn about the insulative properties of snow, and
2. Participate in a volunteer network to learn about snow reflective properties.

These activities are aligned with multiple Next Generation Science Standards integrating scientific practices, crosscutting concepts, and disciplinary core ideas.

### Data Collection And The Snow Sampling Kit

Students collect snow depth, snow density, albedo, snow surface temperature.

**Figure 1.** Measuring incoming and outgoing shortwave radiation using a pyranometer.

**Figure 2.** CoCoRAHS Snow Sampling Kit

More information on the CoCoRAHS Network at: [www.cocorahs-albedo.org](http://www.cocorahs-albedo.org)

**Figure 3.** Collecting snow depth and density data in the field.

### Next Generation Science Standards and Common Core State Standards in Mathematics

Student access to the national database of snow measurements offers students “opportunities to analyze large data sets and identify correlations” and “such data sets extend the range of students’ experiences and help to illustrate this important practice of analyzing and interpreting data” (NRC, 2012).

#### Next Generation Science Standards

- **Scientific Practice**
  - Analyzing and Interpreting Data
  - Crosscutting Concepts
  - Patterns & Cause and Effect
- **Disciplinary Core Ideas**
  - ESS2.C - The roles of water in Earth’s surface processes
  - ESS2.D - Weather and Climate

#### Common Core State Standards in Mathematics

- **Statistics and Probability** - Interpreting Categorical and Quantitative Data
  - (Math.HSS-ID.A.1) & (Math.HSS-ID.B.6)

### Activity I - Determining The Thermal Index Of Snow

**Introduction:** Snow is an excellent thermal insulator and is ecologically significant for plants and animals that live in snow covered regions. Using the thermal index scale formula and data generated from snow sampling activities, students can assess and interpret the insulative quality of snowpack and make predictions about temperature fluctuation at the ground/snow interface.

**Calculating The Thermal Index Of Snow:**

- Thermal index ($I_t$) is calculated at each sample site
- $I_t = t/d$, where $t$ is snow thickness (cm) and $d$ is snow density ($g/cm^3$)

#### Graphing, Analysis, and Interpretation:

Students should be able to:

- Model and describe temperature variation occurring at the ground/snow interface
- Analyze and predict whether the snowpack is providing adequate insulation for the plants and animals living below its surface.
- Describe variability in data and provide explanations for sampling error

**Figure 4.** Students record snow measurements on their data sheets.

**Figure 5.** Students data is uploaded to the class spreadsheet and shared on Google Drive.

**Figure 6.** Students create a grouped bar chart comparing individual and mean thermal index values with respect to sampling site.

### Activity II - Participating in a Citizen Science Network (CoCoRAHS) and Measuring Snow Reflectivity (Albedo)

**Introduction:** Classrooms participate in the CoCoRAHS Albedo Pilot Project of the National Community Collaborative Rain, Hail, and Snow (CoCoRAHS), collecting detailed snow data that’s used to investigate the role snow has in local and global climate patterns.

**Calculating Snow Reflectivity (Albedo):**

- Snow is one of nature’s best reflectors of the Sun’s energy and helps to regulate surface climate above the snowpack.
- Albedo is a measure of surface reflectivity and is calculated as the ratio of incoming solar radiation to outgoing (reflected) solar radiation:

  \[ \text{Albedo} = \frac{W_{\text{outgoing}}}{W_{\text{incoming}}} \]

**Graphing, Analysis, and Interpretation:**

Students should be able to:

- Calculate snow density and snow albedo
- Identify patterns in time series analysis and investigate relationships using x-y scatterplots (Fig.7)
- Analyze snow density and albedo as a time series throughout the course of the winter snow sampling season (Fig. 8)
- Describe how surface albedo affects climate in the Arctic and in regions with seasonal snow cover

**Figure 7.** Students plot an x-y scatterplot to investigate the inverse relationship between snow density and albedo.

**Figure 8.** Students plot a double y-axis time series of snow density and snow albedo to investigate relationships between the two variables.

### References

- NRC. (2012). *Supporting a systems-oriented K-12 science education that engages students in the scientific process of collecting, analyzing, and interpreting snow data to: (1) learn about the insulative properties of snow, and (2) participate in a volunteer network to learn about snow reflective properties. These activities are aligned with multiple Next Generation Science Standards integrating scientific practices, crosscutting concepts, and disciplinary core ideas.*

**Figure 9.** Students plot a double y-axis time series of snow density and snow albedo to investigate relationships between the two variables.