POLAR TREC

TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

# How Does Weather in Antarctica Impact Me?

## Overview

Most students, regardless of their grade level, live “in the moment,” concerned only with factors and issues that have an immediate and direct impact on their lives. This is, to a large degree, understandable given the pressures, demands, responsibilities and constraints placed on students during their high school academic years. However, as teachers, we are required to not only teach for the present based on current knowledge, but to also enlighten students on the ramifications and consequences of this current knowledge that might not currently have a direct impact on them but will in the future. One such example of a topic prevalent into today’s science curriculum is weather and climate.

Details

- Lesson
- Antarctic
- More than a week
- Download, Share, and Remix
- All Ages

Standards

**Next Generation Science Standards (NGSS)**

**Physical Science**
**HS-PS3-1, HS-PS3-4**: Energy

**Earth and Space Science**
**HS-ESS2-4, HS-ESS3-5**: Weather and Climate

Though climate change affects the atmosphere world-wide, its effects in increasing average air temperature is greatest in the polar regions. This has been scientifically confirmed, and climate change continues to expand its reach and its consequent devastating environmental effects. It is important that students clearly understand that, although the Poles might be thousands of miles away from their school and community, weather and climate observed at the Poles will play a critical role on a global scale. It thus becomes important for students to observe trends and patterns of weather at the polar regions and draw comparisons to similar weather data collected in their community. This lesson encourages observations and data collection of weather at both locations, prompting students to identify changes in patterns and trends, offer explanations as to the cause behind these changes and finally to identify factors and propose solutions to slow if not significantly impede the progression of this environmental catastrophe.

## Objectives

**The primary overview of this lesson is provide an instructional opportunity for students to:**

1) Learn about the common weather variables that comprise a weather forecast, how they are defined, the instruments used to measure these variables, and how they relate/impact weather conditions.
2) Purchase and operate a weather station at their school or some secure location that can at least record the following weather variables: temperature, barometric pressure, relative humidity, wind speed/direction. If the purchase of such equipment is not financially feasible, then the teacher might encourage the students to either gain online access to sites with current and/or archived weather data, or conduct online searches for steps that detail the construction of homemade weather instruments.
3) Students will then draw comparisons between the weather in their local community with weather recorded in Antarctica that will facilitate the primary discussion between differences and similarities in the values, ranges and patterns of weather data followed by secondary discussions involving geographic, oceanographic, topographic, and geologic considerations.

## Lesson Preparation

**Preparation of the lesson should occur in three stages:**

**Stage 1: Preparatory exploration and discussion of weather data variables and data collection.**

The teacher should be prepared to discuss weather and its relation to climate, the various weather quantities that will be included in the weather profile that students will employ in this lesson, a definition/meaning of each of the weather quantities and how they are measured, and these weather quantities correlate to seasonal observations. The weather quantities that should be addressed in this lesson activity at a minimum are: temperature, relative humidity, barometric pressure, and wind speed/direction.

**Stage 2: Assembly of a weather station or array of mounted experimental sensors to collect the following weather variables: temperature, relative humidity, barometric pressure, and wind speed/direction.**

- The teacher should have access to a weather station or devices that allow students to collect an assortment of weather variables and transfer the data to a laptop for archival and analysis. Analysis should involve at a minimum, availability of Microsoft Excel or a spreadsheet application that will allow students to graph, perform elementary mathematical/statistical calculations and a means of archiving the data for future access. (If the school does not have access to a weather station, it is possible to access weather data from a variety of online sources provided below.)
- The students should have computers and consistent Internet access to online sites with archived weather data on a global level, including Antarctica. Students should also explore how weather is assessed at various locations about Antarctica, what an Automatic Weather Station (AWS) is, the sensors that are mounted on the AWS tower and how they operate, how they are maintained and fixed should data collection issues occur, and how one can access data from all operational AWS sites.

**Stage 3: Analysis of collected weather data over a week and possibly longer intervals of time, drawing comparisons between community weather data to weather data from Antarctica obtained from online sources.**

Students should be encouraged to engage in a rigorous exploration into the weather data by:

- Plotting available weather data on graphs that are properly labeled and well-designed so that values can be readily identifiable and patterns can clearly be visualized;
- Describing the patterns consistent with mathematical behaviors (seasonal weather is typically periodic in nature over time and thus students, for example, might be familiar with sinusoidal or quadratic functions);
- Performing elementary statistical analysis of weather data, stating the average, median and mode of weather data and what, if any, significance can be drawn from these calculations; and
- For those who might exhibit a strong aptitude for math and computer science or be in an Advanced Placement science or math class, students might be challenged to employ nonlinear regression analysis to perform a curve fit to the data, seeking to describe the weather data with a mathematical function. The function could then be used to extrapolate or forecast weather for following time intervals.

## Procedure

**Step 1:** The teacher first will introduce weather and climate in the form of a PowerPoint to define and explain important vocabulary terms and outline common methods for observing and collecting data related to these quantities. The teacher should also employ visual means such as pictures or video vignettes of weather and climate on a local, regional and global stage, instruments and sensors in an Automatic Weather Station used to collect weather data at points around the world including Antarctica, the impact and consequences of climate, how scientists actively assess and conduct experiments to confirm their findings, and more importantly, potential solutions to combat the adverse effects of weather and climate.

The teacher should not only provide pictures/illustrations of an Automatic Weather Station as well as the individual sensors, but also provide them with alternative online and literature sources of information for weather.

**Step 2:** Students, working in small groups, will conduct research on weather variables, the structure and operation of sensors designed to collect weather data, the meaning of the data variable and what the approximate ranges of the variable is for the community as well as the polar regions. It is also important for the teacher to demonstrate how such data is graphed, interpreted and evaluated, based on visible patterns and trends.

**Step 3:** Mount the weather station at a suitable area that facilitates the routine observation of weather values from the students or provide students with a hand-held weather meter for trips outdoor to collect weather data. If the students will be using a hand-held weather meter, it is important that measurements be calibrated and consistent with regard to time and location.

**Step 4:** Collect the following weather variables: temperature, barometric pressure, relative humidity, wind speed and wind direction at three different times during the school day: before school, during lunch, and after school. Data will be collected for one complete month during September (beginning of the school year), December (end of the Fall semester), March (before Spring Break) and May (last week of school).

For each month and times of weather data collection outside the school, students will access the following site from the University of Wisconsin – Madison Antarctic Meteorological Research Center for corresponding weather data from two geographically separate Automatic Weather Stations:

https://amrc.ssec.wisc.edu/data/view-data.php?action=list&product=surfac...

A map of all of the current (2018) AWS in Antarctica can be accessed through the following link:

https://amrc.ssec.wisc.edu/aws/map.php?year=2018

The teacher should then compile the monthly data for the school as well as from the two Antarctic AWSs in a table that all students have access to.

**Step 5:** For the monthly graphs of the school data and the two Antarctic AWS data, the students will plot the data using a graphing calculator or an online graphing program according to the following variable arrangements:

- Graph of temperature versus time
- Graph of barometric pressure versus time
- Graph of relative humidity versus time
- Graph of wind speed versus time

The teacher will then facilitate a discussion amongst the students in which they will:

- Analyze the data and correlate with seasonal information;
- Identify patterns reflected in the data and describe them according to math functions;
- Perform statistical analysis including regression/curve-fit; and,
- Extrapolate data in an attempt to forecast a prediction of the weather condition at all locations in the future.

## Extension

As stated above in the Lesson Preparation section, the weather quantities that should be addressed are: temperature, relative humidity, barometric pressure, and wind speed/direction. Of course, there are other quantities that might also be considered such as a rain gauge and snow depth level, depending of course on the geographical location and frequency of these weather conditions.

Weather and climate are topics that are relevant to the science curriculum at all grade levels. This lesson could be extended to elementary students, where students would be asked to collect and graph select weather data variables such as temperature, humidity and wind speed over daily/weekly/monthly intervals. In addition to graphing data, students could be challenged to identify any patterns in the data and how such variations persist between different intervals. The

teacher could also engage the students in looking at the weather data from Antarctica, asking students to identify the region on a globe, and engage in a discussion as to why the geography yields weather results and patterns that differ from the weather observed in their community.

At the junior high level, the students would be asked to collect and graph the set of weather variables collected for the high school students. The students would then graph the data using a graphing calculator or online graphing program. They should then go further in their analysis by identifying patterns in the data and proposing an explanation as to the cause or rationale behind these patterns. They could also calculate average values of the weather data sets as well as identify highs and lows. As students are asked to compare and contrast weather data collected from their community and data representative of Antarctica, the teacher could drive discussion into the differences in geography between their community and Antarctica as well as the involvement of planetary revolution in the occurrence of seasons.

## Resources

Weather Data from University of Wisconsin Automatic Weather Stations:

https://amrc.ssec.wisc.edu/data/view-data.php?action=list&product=surfac...

A map of all of the current (2018) AWS in Antarctica:

https://amrc.ssec.wisc.edu/aws/map.php?year=2018

**Weather Stations**

Acurite: www.acurite.com

Handheld Kestrel meters: www.kestrelmeters.com

**Online Sources of Weather Data**

The Weather Channel: www.weather.com

NOAA: w2.weather.gov/climate

Weather Underground: www.wunderground.com

## Assessment

**Graphical Depiction of Data** – The students should be able to create proper graphs of the weather data over defined time intervals for each of the weather variables studied in this lesson and then compare results between weather in their community versus weather in Antarctica.
**Explanation of Data Evaluation** – The students should be able to identify unique trends and patterns in both sets of weather data and propose reasons/rationales behind these unique observations. Examples of questions that might be considered for discussion include:

- What are the unique patterns or trends?
- Are they increasing, decreasing, or constant?
- Do these trends occur over specific time frames, e.g., morning versus evening, data obtained during August versus data obtained in December?
- What might the significance of the time frames be noted in the data observations?

**Discussion of Global Climate** – Probably the most important aspect of any lesson, and particularly this one, is to extend the observations of weather data from all locations to explore or at least consider open-ended questions such as:

- Based on the changes of weather data throughout a year for each location, would one expect these changes in the following year or years?
- Do students note any comparative patterns or trends between the school data and the Antarctic AWS data?
- If significant changes were observed from the weather data variables in subsequent years, what could be the source or mechanism behind such changes?
- How would these changes manifest themselves in effects to the environment including the atmosphere as well as plant life, animal life, marine life, and ocean chemistry?
- Perhaps the most important issue to consider for the students is what could be done to curtail the potential adverse effects of global warming?

Although students can be assessed on these issues and questions by their oral and written responses, these questions offer a unique opportunity for students working in small groups to incorporate/integrate technology such as Flipgrid, Adobe Spark, or Infographics to name a few, to invoke creativity toward the development of a compelling visual display to support or confirm their claims and suggested approaches.

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