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In collaboration with

**Po**lar **N**ight **Ex**periment (PONEX)

Environment and Climate Change Canada

# Arctic Polar Night Experiment (PONEX)

## Teacher Guide

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# Contents

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## Module Overview

The PONEX Module seeks to engage students and work towards answering the following questions:

1) Why do scientists want to study the polar night?
2) How can clouds impact on the world's climate and weather?
3) What types of technology can be used to measure this information?

And it has 5 aims:

1) Empower students through citizen science and prevent the development of science/math anxieties
2) Connect students with scientists who bring passion to their field and can be role models and mentors, creating strong communities between post-secondary education, K-12 education, and families
3) Encourage students to pursue STEM in their futures (Science, Technology, Engineering, and Mathematics)
4) Get children outdoors and involved in environmental stewardship
5) Engage students within the Albertan / British Columbian science and social studies curriculums

Though this module was created especially schools based in and around Inuvik (i.e. the Mackenzie Delta and Beaufort Delta regions), where the PONEX project is happening, the experiments can be recreated in all schools and locations, and we encourage you to do so.

Please note that any specific resources and contacts mentioned in this guide would only be appropriate for schools

# Background Information on the PONEX mission

## Where is this research happening?

The project is happening in Inuvik, Northwest Territories, an Arctic community in northern Canada.

## What is PONEX?

PONEX stands for "Polar Night Experiment." It's a scientific campaign using a research aircraft (a specialized plane) and surface sites (specific locations on the ground) studying clouds, weather, and air quality and evaluating satellite observations in the Arctic during the winter, when the sun doesn't rise for weeks.

## Why do scientists want to study the Arctic in the polar night?

- During polar night, the Arctic sky is dark for a long time and extremely cold.
- Clouds in the Arctic have a huge impact on the world's climate and weather.
- There aren't many observations from the polar night, making this research extra valuable.

## Why are these clouds and the cold Arctic air important?

- Clouds affect how much sunlight reaches the ground and how much heat escapes back into space.
- Changes in these processes can affect weather in Canada and around the world.
- Ice clouds form in special ways during Arctic winter; we don't know much about them yet.
- The atmosphere's composition, especially the amount of aerosols that act as nuclei for ice crystals, affects the amount of clouds present.

## What types of technology are being used?

- An aircraft called Convair-580 will fly through and above the clouds, carrying instruments that can measure cloud particles, ice, aerosols (tiny solids in the air), water vapor, and more.
- Ground stations in Inuvik will collect weather measurements with special tools like radiosondes (weather balloons), lidars (laser atmospheric sensors), and disdrometers (devices to measure raindrop size).

## When will this happen?

- Scientists will be there for about 3 weeks in January 2026, flying up to 12 research flights over 24 days.

## What will scientists learn?

- How clouds and ice crystals form during polar night and how this affects the Arctic's energy balance.
- How aerosols and ice clouds interact and affect pollution and climate.
- How well satellite-based instruments observe these phenomena from space, improving satellite weather data and models.

## How does this help the community and the world?

- The project will make weather forecasts in the Arctic more accurate.
- Observations from the project will help us calibrate satellite observations over Canada
- What scientists learn here will help improve models for air quality and climate, which affect everyone.
- The results will be used in Canadian and international missions, making Arctic communities an important part of global science.

## Who is doing this work?

- Scientists from Canadian government agencies, universities, and international partners—including NASA, CSA, and ESA (European Space Agency).
- They're working with local facilities and sharing their results to help everyone better understand Arctic weather and climate.

## Can schools participate or learn more?

- Information about the flights and ground measurements may be shared with schools, especially in Inuvik.
- Scientists may offer talks or online sessions to answer student questions.
- Teachers can help students explore why Arctic science matters for northern communities and the whole planet.

# Experiments



## 1. Relative Humidity: "Wet and Dry Bulb Thermometer"

**Objective:** Measure humidity with two thermometers.

**Materials:**

- Two identical thermometers
- A small piece of cloth or gauze
- Water
- Fan or hair dryer (optional)

**Steps:**

1) Wrap the wet cloth around the bulb of one thermometer (this is the "wet bulb").
2) Leave the other thermometer dry (this is the "dry bulb").
3) Place both thermometers side by side in the same environment.
4) Wait a few minutes, or use a fan to speed up evaporation.
5) Record the temperatures.

**Explanation:**

- The wet bulb cools due to evaporation. The greater the difference between the dry and wet bulb temperatures, the lower the relative humidity.
- You can use a simple chart or online calculator to convert the temperature difference into relative humidity.

## 2. "Humidity and Hair Curl Test"

**Objective:** Demonstrate how humidity affects hair.

**Materials:**

- A strand of human or doll hair
- Spray bottle with water
- Hair dryer (optional)

**Steps:**

1) Observe and record the shape of the hair strand in dry conditions.
2) Spray water into the air around the hair (not directly on it).
3) Wait and observe any changes in curliness or frizz.
4) Optionally, use a hair dryer to simulate dry air and compare.

**Explanation:**

- Hair absorbs moisture from humid air and changes shape.
- This is a visible way to show how humidity affects materials.

## 3. "Homemade Hygrometer with Human Hair"

**Objective:** Build a simple humidity-measuring device.

**Materials:**

- A long strand of human hair (or horsehair)
- A small weight (paperclip)
- A ruler
- Tape
- Cardboard

**Steps:**

1) Tape one end of the hair to the top of the cardboard.
2) Attach the weight to the other end so the hair is stretched vertically.
3) Place a ruler next to the hair to measure its length.
4) Observe changes in length over time or in different humidity conditions.

**Explanation:**

- Hair expands and contracts with humidity.
- This is how early hygrometers worked!

## 4. Cloud Formation: "Cloud in a Jar"

**Objective:** Make a cloud in a bottle thanks to cooling from ice cubes dans aerosols.

**Materials:**

- Two glass jars with a lid
- Warm water
- Ice cubes
- Aerosol spray (e.g., hairspray)

**Steps:**

1) Pour warm water into the jars (about 1/3 full).
2) Spray a bit of aerosol into jar 1, but don't in jar 2.
3) Quickly place the lid on the jars and put ice cubes on top.
4) Watch as a cloud forms inside the jar!

**Explanation:**

- Warm water adds moisture to the air.
- The ice cools the air at the top, causing condensation.
- Aerosol particles act as condensation nuclei, helping the cloud form—just like in the atmosphere! For that reason, the cloud in jar 2 is usually harder to see.

## 5. Cloud in a Bottle (Using Air Pressure)

**Objective:** Make a cloud in a bottle thanks to cooling from depressurizing.

**Materials:**

- Clear plastic bottle with cap
- Warm water
- Matches (adult supervision required)

**Steps:**

1) Add a small amount of warm water to the bottle.
2) Light a match, blow it out, and drop it into the bottle.
3) Quickly seal the bottle and squeeze it hard several times.
4) Release the pressure and observe the cloud forming.

**Explanation:**

- The match provides particles for condensation.
- Squeezing increases pressure and temperature; releasing it causes cooling and condensation.

## 6. Optically Thin Ice Clouds with "Cotton balls"

**Objective:** Use cotton balls and your own hand to notice heat absorption.

**Materials:**

- Two cotton balls per person
- Light source (ex.: ceiling lamps)

**Steps:**

1) Take one cotton ball and spread it out really thin.
2) Raise them up to the light above. Notice that the thick cotton ball looks white or grey. Notice that the light goes through the thin cotton ball.
3) Place the thick cotton ball on the back of your hand. After a few seconds, you will feel it is absorbing and sending back heat to your hand.
4) What do you think will happen with the thin cotton ball? Maybe your hand will stay cold, because you can see through it? Maybe it will warm your hand, because the cotton absorbs and sends back heat? Try it!

**Explanation:**

- Optically thin ice clouds, like cirrus and cirrostratus, let light pass through during the day, but they also have the capacity to absorb the IR and send it back to the surface.
- Although these clouds are thin, their impact is not negligeable.

## 7. "Infrared Camera Observation"

**Objective:** Use an IR camera to visualize heat retention.

**Materials:**

- Infrared (thermal) camera or smartphone with IR attachment
- Warm surface (e.g., heated tile or hand)
- Transparent vs. opaque covers (e.g., glass vs. cloth)

**Steps:**

1) Warm a surface and observe it cooling with the IR camera.
2) Cover it with different materials and observe how heat is retained.
3) Discuss how clouds act like the opaque cover, trapping heat.

**Explanation:**

- IR cameras show how surfaces emit heat.
- Covers that trap IR mimic cloud behavior.

### 8. LiDAR: "Laser Distance Measurement" (Simplified)

**Objective:** Use a toy lidar to understand how it measures the distance.

**Materials:**

- Toy lidar sensor (available in some robotics kits like LEGO Mindstorms or Arduino)
- Objects of various heights

**Steps:**

1) Point the toy lidar sensor towards different objects.
2) Show how it maps objects by bouncing light and measuring return time.
3) Discuss how real lidar uses precise timing to measure distances using laser pulses.

**Explanation:**

- LiDAR stands for **Li**ght **D**etection **a**nd **R**anging.
- It's used in weather monitoring, topographic mapping and self-driving cars.

## Other Classroom Activities

- Draw a picture of the airplane and its instruments.
- Track the sunrise and sunset in Inuvik during January.
- Discuss how weather in the Arctic can affect the rest of Canada.
- Talk about why clouds are important and how pollution travels.