

All About Winter Weather

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**Lesson Title: All About Winter Weather**

**Lesson Overview:** In this lesson students will investigate the properties and characteristics of winter hazards that impact North Dakota including blowing snow and blizzards. Students will have the opportunity to analyze and identify the conditions that create certain types of snow as well as with weather hazards.

**Topic(s):** Regional Climate Studies

**Grade or Grade Band:** Middle School Earth Science (6-8)

**Lesson Objectives:**

- Students will be able to analyze the relationship between humidity and temperature in relationship to snow formation.
- Students will be able use evidence from data they have collected to identify winter weather hazards.

**Next Generation Science Standards:**

MS-ESS2-5 Earth's Systems- Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

MS-ESS3-2 Earth and Human Activity- Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

**North Dakota Standards:** Performance Standard MS-ESS2-5 Use data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions

**Time Needed (estimate): 4 - 50 minute periods**

**Lesson Author: Jeni Peterson**

Jeni Peterson is an Instructor of Education and the Director of the Center for Teaching and Learning at Mayville State University. Jeni collaborates with STEM Ecosystems throughout North Dakota to provide STEM learning activities and resources to K-12 partners in the Mayville region. She teaches course related to foundations of education, educational technology and elementary science methods. Jeni is a graduate of Mayville State and holds a Master's in Education from Minot State University.

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**Scientist Bio/Research:**

As a child, I tracked tropical storms in South Carolina, to severe thunderstorms in northern Illinois. In response to this interest, I sought a meteorology degree at the U. of Oklahoma. My experiences there led me to pursue a career in research. Storm chasing cemented in my mind the importance of field work and direct observations of our atmosphere. After finishing my B.S. (2004), and M.S. (2006), I left Oklahoma to seek my Ph.D. at the U. of North Dakota. Instead of focusing on severe storms and tornadoes, I conducted climate research; ironically using data collected at the Atmospheric Radiation Measurement Southern Great Plains Site in Lamont, Oklahoma. After finishing my Ph.D. in 2011, I stayed at UND to pursue my NSF Postdoc fellowship, and I am now an associate professor.

My interests today include convection, clouds, winter weather, and climate. I focus on synergistic studies that use combinations of models/observations/reanalysis to advance our knowledge of these topics. I am also interested in local meteorology (such as blizzards and blowing snow) and the societal impacts it has on the region.

When I am not working, I love to hang out with my family including my amazing wife and three daughters. I love adventures, and will ride a bike just about anywhere. I commute year-round (even with the kiddos), and do a number of endurance cycling events. I love to experience the atmosphere first-hand, and I chase storms as time allows. Finally, I am an avid photographer and love to document my various adventures.



**Summary of Research and/or Problem Being Studied**

<https://ndus.edu/2020/01/20/und-atmospheric-scientist-aaron-kennedy-seeks-answers-to-the-chilling-mysteries-of-winter-storms/>

## Preparation/Materials

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### **Background knowledge students must have to be successful:**

Students need to be able to cite evidence to support analysis of science concepts gained from experiments, simulations, video, or multimedia sources. Students should have basic background knowledge of regional weather events in North Dakota.

### **Differentiation and accommodation to support learning for all students:**

- Read all instructions and handout questions aloud to the students.
- Allow students to capture responses on an audio recorder.
- Highlight specific words on the handouts and direct the students to use these terms in their answers.

### **Essential terminology:**

Jetstream- A fast flowing, narrow, meandering current of air in the atmosphere. Occurs in proximity to changes in temperature. Cold north of the Jet, Warm south of the jet.

Meridional: highly amplified troughs and ridges (highly curved)

Zonal: When the upper level winds are parallel to the lines of latitude. Low pressure system tend to move faster (west to east) when associated with a zonal flow.

### **Resources:**

Snow Comparison Matrix Handout  
Blizzard Capital of the US Handout  
Winter Weather Pattern Matching Handout  
Three Types of Blizzards  
Properties of Snowflakes

### **Websites:**

[https://www.eoas.ubc.ca/courses/atsc113/sailing/met\\_concepts/11-met-marine-weather/11c-forecasting/](https://www.eoas.ubc.ca/courses/atsc113/sailing/met_concepts/11-met-marine-weather/11c-forecasting/)  
[https://mrcc.illinois.edu/resources/guides/howto\\_airpres\\_grnhouseeff.pdf](https://mrcc.illinois.edu/resources/guides/howto_airpres_grnhouseeff.pdf)  
<https://www.theweatherprediction.com/weatherpapers/071/index.html>  
[https://skybrary.aero/index.php/Colorado\\_Low](https://skybrary.aero/index.php/Colorado_Low)  
<https://www.weatherbug.com/news/What-Are-Alberta-Clippers>  
<http://www.eumetrain.org/satmanu/CMs/AF/print.htm>

**Materials needed:****Lesson 1:**

- Small handheld fan
- Large fish tank
- Small heavy objects to represent buildings, cars, tree etc. in the blowing snow tank
- [SnoWonder Instant Snow Mix](#)
- [EriCraft Artificial Snow](#)

**Lesson 2:**

- Alcohol thermometers
- 1 beaker ice water
- 1 beaker room temperature water

**Lesson 3:**

- Access to the internet

**Lesson 4:**

- 10 light prisms
- 10 flashlights

## Procedure/Activities

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### **Lesson 1: Blowing Snow (50 Minutes)**

#### **Engage:**

**Present slide 2** and ask students what they notice about the pictures and ask each student to turn to a partner to brainstorm what these pictures have to do with winters in North Dakota.

**Present slide 3** and point out the high walls of snow towering over the men in the picture. Ask students to think about at time when they remember having large amounts of snowfall.

**Present slide 4** Ask students “What weather stories or legends have you heard about growing up” allow students time to research and discuss the stories and theories behind any legend or story then may have heard of.

#### **Explore:**

**Prepare the two types of snow.**

**Dry Light snow:** [EriCraft Artificial Snow](#)

**Wet Heavy snow:** [SnoWonder Instant Snow Mix](#)

Distribute the Snow Comparison Matrix Handout. As a class, discuss and list the characteristics of the attributes listed on the Snow Comparison Matrix. Students will then use the matrix to provide evidence for their answers to questions 1-3 on the handout.

Step 1. Feel the two types of fake snow. How are they dissimilar? Which type do you think is more likely to blow? What type would make a better snowball?

Step 2: Use the fan and attempt to blow the snow in the buckets. Was your intuition correct? Why or why not?

Step 3: Level the snow in the tank and place objects. Making sure the lid is in place, use the fan to blow the snow around. Once it has drifted, stop.

Step 4: Use a ruler and take a measurement of snowfall.

Question: What range in snowfall was observed? What is truth?

#### **Explain:**

Watch the “Learn how to measure snowfall video”: <https://youtu.be/rsPTc3Xxe3g> Then watch the “ How Is Snowfall Officially Measured?” video: <https://www.youtube.com/watch?v=oU1Wxm9UU3Y>

#### **Extensions for learning more about this topic:**

1. Watch the following short videos for extension ideas:
  - a. [https://www.youtube.com/watch?v=GqM\\_m5pToqc](https://www.youtube.com/watch?v=GqM_m5pToqc)
  - b. <https://www.youtube.com/watch?v=mjKcuKARK1M>
  - c. <https://www.youtube.com/watch?v=NiQXNujxmUw>

## **2. Discuss**

- a. How does blowing/drifting snow impact our region?
- b. What challenges does drifting snow pose and how can we minimize these impacts?

### **Evaluation of learning:**

Class discussions and observations can be documented as evaluations of learning.

The teacher may collect the Snow Comparison Matrix Handout to evaluate learning.

## **Lesson 2: Weather Patterns (50 Minutes)**

### **Engage:**

Split the class up into groups of two or three. Display slide 9 on the board and distribute the Blizzard Capital of the US sheet. Allow students time to study the map and graph, then have them discuss the following questions from their sheets.

- 1. How many blizzards has the region seen in any given winter?**
- 2. List the 3 months with the most blizzards?**
- 3. Explain why you think our region sees so many blizzards?**

As a class, discuss how each group answered the three questions and allow students time to explain their thinking.

### **Explore:**

1. Display slide 10 and review the two maps. Draw students' attention to the land on either side of the Red River on the Topography Map. Ask: "What natural features shape the land surface in North Dakota?" It is important to point out that the land features make a wind funnel through the Red River Valley.
2. Draw students' attention to the Land Use map on slide 10. Ask "What type of ground cover do you notice in the Red River Valley?" "How does the ground cover change as we look further east or west?" Guide students to discover that the ground cover along with the topography created a funnel that directs winds straight through the valley.
3. Ask "What other features make the Red River Valley a target for Blizzards?" Guide students to discuss the lack of large buildings throughout the valley.
4. Display slide 11 and point out each of the following symbols on the map: Pressure (isobars), Low- and High-Pressure regions, winds, cold and warm fronts.
5. Display ppt slide 12 and present the information on pressure and how height can decrease the amount of pressure.
6. Split the class into small groups and distribute 2 alcohol thermometers, a beaker with ice water and a beaker with room temperature water to each group. Help students to set up the air pressure experiment: [https://mrcc.illinois.edu/resources/guides/howto\\_airpres\\_grnhouseeff.pdf](https://mrcc.illinois.edu/resources/guides/howto_airpres_grnhouseeff.pdf)

**Explain:**

1. Explain to students that high pressure in the summer brings hotter weather while high pressure in the winter brings colder weather. The inverse is true for low pressure in summer means cooler weather while low pressure in winter means warmer weather. (ppt slide 13)
2. Refer back to the air pressure demonstration while presenting ppt slides 14-17 to help explain how changes in pressure cause winds. Point out the lines on the map on ppt slide 14 and look for tight spacing of isobars. The tight spacing is an indication of faster wind speeds.
3. Demonstrate with a 3-4-foot piece of ribbon or a ribbon flag how the Jetstream movement can change. Begin by waving the ribbon in a large circle around you. Point out the troughs and ridges as the "Jetstream" moves around the "Earth" (you are the Earth). Move the ribbon at different speeds and ask students what happens as the ribbon moves slower or faster.

**Extension:**

1. Distribute the Weather Patterns Extension Activity while displaying slide 18. Point out that the larger numbers indicate higher pressure, while the lower ones indicate a lower pressure.
2. Allow the students to work with partners to identify the features on the chart. Refer back to slide 17 for assistance in identifying the features.

**Evaluation:**

Have each student complete a 3,2,1 Exit ticket:

3 things I learned today.

2 things I found interesting.

1 question I still have.

**Lesson 3: Blizzard Pattern Identification (50 Minutes)****Engage:**

Inform students that blizzard conditions can move into North Dakota from other regions. Ask students "How does a blizzard's origin affect the characteristics of the blizzard?" Allow students to discuss with a table partner how a blizzard that moved in from the north may differ from a blizzard that moved in from the south. Tell students "Today we will discuss three types of storm systems that impact North Dakota: Alberta Clippers, Colorado Lows, Arctic Fronts."

**Explore:**

1. Split the class up into groups of three. Distribute the Three Types of Blizzards handouts. Each student in the group will choose one of the types of blizzards and take that sheet from the handouts. Students should read the information from their handout and study the maps/examples provided. Allow students time to further explore and research their specific type of blizzard using information they find online.

<https://www.theweatherprediction.com/weatherpapers/071/index.html>

[https://skybrary.aero/index.php/Colorado\\_Low](https://skybrary.aero/index.php/Colorado_Low)

<https://www.weatherbug.com/news/What-Are-Alberta-Clippers>

<http://www.eumetrain.org/satmanu/CMs/AF/print.htm>

2. Distribute the Winter Weather Pattern Matching handout. Students should work together in their group of three to match each sheet with the correct blizzard type. Remind students to use the Three Types of Blizzards handout to help analyze and categorize each case.

**Extension:**

Listen to the Children's Blizzard Recording: <https://www.youtube.com/watch?v=t8CIITzNs8I>

Ask students "What type of blizzard was the Children's Blizzard?"

Winter Weather Safety: Frost Bite and Hypothermia slides 30-34. Present slides 30-34 and explain the importance of being prepared for severe weather in the winter.

- Have students create action plans, survival kits, or brochures detailing the need for winter weather safety.
- Have students create infographics or PSA explaining the differences between winter watches, warnings and advisories.

**Evaluate:**

After students have completed the Winter Weather Pattern Matching activity, ask each student to identify which case most likely has the most snowfall by writing "Most Snowfall" next to the case number. Then ask student to identify which case may have occurred with blue skies overhead by writing "Blue Skies" next to the case number.

**Lesson 4: Snowflakes and Winter Optics (50 Minutes)**

**Engage:**

Display slide 35 on the board. Inform students that the myth that "No two snowflakes are alike" is actually not true. But snowflakes do come in a variety of shapes and sizes. Ask students "What factors do you think determine the type of snowflake that forms?" Allow student time to discuss and then make a list of ideas on the board.

**Explore:**

1. Present slide 36 and explain that snowflakes can also form clumps when falling called aggregates. These are the largest snowflakes and are most common when it is warmer out.
2. Display the graph on slide 37. Ask students to identify the properties that have an effect on how a snowflake forms. Ask the students to think about how humidity affects the properties of snow.
3. Distribute the Properties of Snowflakes handout. Allow student time to review the temperature and humidity summary plot.

**Explain:**

4. Present slide 37. Explain to students that scientists have used laser and camera-based instruments to observe the types of ice crystals at the ground and in the sky (from airplanes). The shape of the snowflakes (also known as a crystal habit) was then compared to properties of the environments such as the amount of water (humidity) and the temperature.

**Extension:**

1. Present ppt slides 40-41 allowing students time to study the pictures of the Halo, Sundogs and explain how the light is refracted by hexagonal ice crystals suspended in the air.



2. Present ppt slide 42 and explain how the appearance of the pillars as light are from light reflecting off of the ice crystals suspended in the air. The following websites for further explanation on how the crystal refract the light.  
<https://www.atoptics.co.uk/halo/dogfm.htm>  
<https://www.atoptics.co.uk/halo/platpill.htm>
3. Separate students in small groups depending on the number of prisms and lights available. Each group should have at least 2 prisms and 2 flashlights
4. Allow students time to explore the optics they can create using the prisms and flashlights.
5. Questions to explore:
  - a. How does the angle of light impact the optical phenomenon?
  - b. How is color separated?

**Evaluate:**

Collect the Properties of Snowflakes Handout  
Observation and discussion with students.